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On

Natural Disasters in the Gulf of Mexico:
Fisheries, Wetlands, and Coastal Landscapes

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Introduction

Thank you, Mr. Chairman and Members of the Subcommittee, for the opportunity to present testimony on the U.S. Geological Survey's (USGS) science supporting recovery and restoration on the Gulf of Mexico coast following Hurricanes Katrina and Rita.

The USGS has a long history of providing science to support the resource management objectives of Federal and State partners, and we are pleased to be among those invited by the Subcommittee to testify. I am the Director of the USGS National Wetlands Research Center in Lafayette, Louisiana. Our Center, along with other USGS Science Centers in Louisiana, Mississippi, Alabama, and Florida, and Texas, is situated within or near the landfalls of Hurricanes Katrina and Rita, and we were intensely involved in storm response and now restoration science. USGS employees operated boats in the neighborhoods of New Orleans bringing hundreds of people to safety. We developed the programs to convert the street addresses of victims calling 911, trapped in their attics and on their roofs, to latitude and longitude coordinates so helicopter pilots and boat operators could locate them in the flooded city. In addition, USGS real-time flood depth information helped guide the New Orleans dewatering operations. USGS responded scientifically with immediate post-storm measurements of salinity, microbial concentrations, environmental contamination, and landscape change for barrier islands and coastal wetlands. We are now developing the science and information to support long-term recovery of the coastal landscape, including ecological restoration of the natural ecosystems on the Gulf of Mexico coast.

With recovery and restoration efforts, there is a great opportunity to apply scientific principles and knowledge to help rebuild communities while restoring the natural ecological systems and processes that are critical for coastal sustainability and ultimately, coastal resilience. Today, my testimony will focus on the immediate post-storm science that documents impacts of these storms on a vulnerable coast. I also will discuss how science can be used to build a resilient coast with functional ecosystems that protect coastal communities, and provide for continued economic and ecological benefits.

The Northern Gulf of Mexico: A Vulnerable Coast

Tropical storms and hurricanes are large-scale climatic phenomena that can cause region-wide impacts to communities as well as natural systems. Continued warming of Atlantic and Gulf of Mexico water will likely produce more intense storms in the future and continue to accelerate coastal erosion, saltwater intrusion, inland flooding, and windfall casualties impacting both human and natural resources. Fishery resources are affected by the change in wetland area, structure, and function caused by recurring storm events. Gulf Coast fisheries are at greater risk given the high recurrence probabilities of tropical storms and hurricanes and resulting impacts to coastal wetlands. The northern Gulf Coast is a hurricane-shaped ecosystem and the central coast from east Texas to Mississippi has a distinctively high hurricane frequency impacting coastal planning, protection, and restoration.

The Role of USGS

Natural hazards are key elements of the USGS mission to serve the Nation by providing reliable scientific information to

describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The focus of our science is to inform decisions that can save lives, and protect property and natural resources.

The USGS mission encompasses the scientific efforts needed to understand and ultimately manage vulnerable coastal systems and transform these into resilient, sustainable systems for the future. USGS provides the science to understand landscape function and change, including coastal wetlands and estuarine habitats that are critical to productive fisheries and other biological resources. USGS is studying habitats such as coastal wetlands and seagrass beds to develop a scientific basis for restoring and enhancing the coast and coastal habitats. These habitats can contribute directly to a diverse and sustainable coast with commercial and recreational fisheries, migratory bird wintering and staging areas, and other wildlife habitats.

The most important wetland functions for fish survival are food production, spawning and nursery habitat, refuge, and the reduction of harmful pollutants in water. Many fish and shellfish use the marsh and estuary as a nursery, usually spawning in the ocean, moving into the estuary as juveniles, and leaving as young adults. Because fish eggs and young fish have different needs than adult fish, many adult fish live in other habitats. Wetland edges and underwater grasses serve as a surface for fish to attach eggs, offer protective cover from predators, and provide a food source. The type of wetland, its geographic location, salinity level, and vegetation type determine the fish species present. Alteration of habitats, such as changes in salinity levels and hydrology, may have ecological consequences, including the reduction of biodiversity and loss of critical habitats. USGS science supports an understanding of the physical environment and biological linkages that support sound resource management for this highly dynamic system.

The coast is experiencing ongoing wetland loss, land subsidence, and habitat degradation. These coastal wetlands and barrier islands play a critical role in dampening the energy of the storm surge resulting from hurricanes while also providing critical habitat for birds, fish, and shellfish, along with recreational opportunities for residents and tourists . Development of an overarching scientific framework to guide the restoration process provides the means to integrate biological, hydrological, and geological processes in order to monitor, model, and predict restoration outcomes in an adaptive manner that will contribute to restoration of a sustainable and resilient coast.

Immediate Scientific Response

In the aftermath of the 2005 hurricane season, USGS scientists working with Federal and State partners, assessed the immediate post-storm environments along the coast, including Department of the Interior Wildlife Refuges and National Parks. Saltwater intrusion and subsequent impoundment in sensitive freshwater marshes, including fish nursery areas, were included in this assessment. Immediate impacts showed that the vegetation in many marshes died off following exposure to saltwater; however, the long-term exposure to saltwater could cause complete change in vegetation communities and contribute to the number of acres of wetland loss already documented by USGS landscape assessments.

Storm surge measurements, biological oxygen demand, and Light Detection and Ranging (LIDAR) assessments of geomorphic changes to shorelines and barrier islands have been completed. USGS Landsat satellite images are being used to assess wetland and land transformation to open water and were applied in assessing the immediate impacts of these storms.

Lake Pontchartrain water and sediment quality were assessed after these storms in response to concerns that toxic waters and sediments could threaten human health and ecological systems. Bacterial analyses showed an increase typical of flood events with a prompt return to background levels. Reduced dissolved oxygen (DO) and biochemical oxygen demand (BOD) caused localized fish kills along the northshore of Lake Pontchartrain.

USGS m onitored near-shore coastal salinity conditions on a real-time basis before and after Hurricanes Katrina and Rita, documenting saltwater intrusion into the northern boundaries of the major Louisiana estuaries. Salinity in the northern Barataria estuary went from 0.2 parts per thousand (ppt) to over 10 ppt following Hurricane Rita. Changes in the salinity of these estuaries had a direct impact on the distribution of fresh- and saltwater aquatic organisms and waterfowl. For example, surveys of the Lower Pearl River indicated that freshwater fish were no longer present. Waterfowl use of the coastal marshes shifted northward to the more freshwater zone. USGS is continuing to monitor the long-term impacts of salinity changes on habitats along the entire Louisiana coast.

The Changing Landscape and Impacts on Fish and Wildlife

Landscape Change, Wetland and Land Loss: USGS uses satellite, for example, Landsat, and high resolution

imagery together with geospatial technologies to monitor and assess landscape change. These analyses, coupled with other land-use data are integrated into models that allow projection of land loss and landscape change along the coast. Understanding the loss of wetlands is important in terms of the potential for long-term impacts on spawning and nursery habitat for estuarine aquatic species. Since 1932, Louisiana has lost over 1900 square miles of wetlands; this loss has decreased the available vegetated marsh habitat for recreational and commercially important fish and wildlife species.

There is no question that hurricanes have altered the landscape and affected people and fisheries. In Louisiana, fish harvest may have been temporarily increased by an expanding length of the land-water interface resulting from the conversion of land to open water. The break-up of vegetated marsh causes a short-term increase in the ingress routes and edge habitat vital for juvenile estuarine fish. Yet this sort of productivity may be short-lived. Geologic model simulations indicate that the length of Louisiana's coastal land-water interface has recently begun to decline. This loss of habitat does not bode well for future fisheries production.

Another concern is the amount of increased marsh loss from Katrina and Rita for southeastern Louisiana. Most of the land replaced by open water appeared in the freshwater and brackish water marshes categories, which are the most productive for fisheries. Over 22 square miles of freshwater marsh (3 percent of all fresh marsh in southeastern Louisiana) were lost, along with 50 square miles of brackish water marsh (11 percent of all brackish water marsh in southeastern Louisiana). Total land loss for these two marsh types of 72 square miles represents over 60 percent of the 118 square miles of total land loss estimated in southeastern Louisiana. It should be noted that the majority (79 square miles) of land lost was on the east side of the Mississippi River, and exceeded by 33 percent the total wetland loss of 60 square miles that was projected to take place over the next 50 years, under current loss rate scenarios.

These landscape changes created new water bodies and expanded water bodies formed on the eastern side of the Mississippi River basin. Many of the new water areas consist of shallow ponds where the marsh surface has been sheared or ripped to the root mat or to the underlying firm substrate of clay by storm surge. Remnant marsh balls (large mats) and other debris litter some sheared areas, while other areas appear as large shallow ponds or lakes with large areas of exposed mud flats that vary depending on water level. Groups of small interconnected ponds have been expanded in some areas by the shearing of the intervening marsh. Areas of floating freshwater marsh and some scrub/shrub vegetation were completely removed in the northern area adjacent to the Louisiana-Mississippi border, while a series of shears was cut across the southern portion of the basin. The absence of these vegetative root mats makes these areas more susceptible to future erosion. The freshwater marsh in the Breton Sound southern area basin was completely rearranged, displaying multiple Northwest-Southeast trend in the shears. Large deposits of debris and layers of marsh (called wrack) blocked canals and other hydrologic pathways. USGS will continue to monitor how this may impact future hydrodynamic and flooding conditions. Over 90 percent of the new open water area appearing after the hurricanes in the area south of New Orleans occurred within the fresh- and brackish water marsh communities. USGS scientists and partners are continuing to monitor and project future transformation of coastal landscapes.

Fish, Wildlife, and Invasive Species: Conversion of emergent marsh to open water will impact many wildlife species. The Louisiana coastal marsh is recognized as an important and productive fisheries nursery habitat, and conversion to open water reduces fish nursery habitat. Moreover, juvenile fish and coastal invertebrates are important food sources for migratory birds, such as wading birds and waterfowl, and the conversion of marsh to open water can only reduce food abundance for these species.

Storm impacts to wildlife habitats range from wind damage to vegetation to salinity increases that kill important food resources. In southwestern Louisiana, the storm surge from Hurricane Rita caused significant increases in water salinity in many wetlands, killing freshwater fish and invertebrates. Saltwater influx in southwest Louisiana has eliminated crawfish from the production ponds that serve as important habitat for migratory waterfowl and wading birds. Similar effects resulted from saltwater intrusion to freshwater wetlands where submerged aquatic vegetation serves as the food for migratory waterfowl and other wildlife. Distribution of wintering waterfowl was altered this past winter, with fewer birds using the coastal marshes, and more using the agricultural wetlands. USGS will continue to monitor food availability and other parameters that may impact waterfowl and other migratory bird distribution and survival.

Hurricanes are known to cause declines in migratory land birds during passage through the Gulf Coast region. Winds from Hurricanes Katrina and Rita caused significant damage to trees, and associated fruits and insects, coincident with fall migration of birds through the region. Diminished food resources, including fruits, seeds, and insects have been implicated as a factor causing declines of over-wintering migrants in the Caribbean and may have the same impact on birds migrating across the Gulf using coastal Louisiana habitats. USGS sampled fruit and insect availability following Hurricane Rita and found these important foods for birds during migration to be greatly reduced. Damage from storm surge and salinity increases decimated insect populations that support bird migration. Moreover, landscape changes that promote expansion of the invasive Chinese tallow tree are being monitored by USGS to determine long-term impacts on bird habitat quality. Using radar technology, USGS has demonstrated changes in habitat use patterns by birds migrating

through coastal Louisiana. These changes were likely due to significant changes in vegetation structure and food resources. This landscape-scale shift in patterns of migration habitat use may have population-level impacts in certain species, especially those with population sizes already at marginal levels.

Hurricane Modeling - Integrating Storm Physics and Biological Impacts:

Understanding hurricane frequency and landfall patterns is an important process in calculating insurance liabilities and rates for coastal communities as well as forecasting future environmental risk under changing climate. The extreme wind and waves of tropical storms and hurricanes are fueled by the heat exchange in warm tropical waters. With increased seawater temperature in the Gulf of Mexico, the probability of higher sustained wind intensity of these storms is expected to increase.

The USGS has developed specialized tools and expertise for investigating tropical storm impacts on the coast and inland. One such model, the HURASIM or Hurricane Simulation Model, was developed and subsequently applied following the hurricanes of 2005. The model was used to predict the wind-driven dispersal of a new invasive moth species, the cactus moth. Model results demonstrate the likelihood of the expansion of the cactus moth range from the southeastern United States to the arid southwest by recurring tropical storms along the Gulf Coast. The model identifies specific areas where land managers should survey for early detection of the moth so that eradication and control measures can be taken before large-scale damage to refuges and natural arid habitats occurs.

Coastal ecosystems along the Gulf of Mexico, such as freshwater cypress forests and saltwater mangrove forests, are impacted by recurring hurricanes. USGS developed a model to simulate hurricane impacts on coastal mangroves, a habitat that serves as nursery grounds for fisheries as well as habitat for many colonial and migratory birds and other wildlife. Mangrove forests occupy the intertidal zone of tropical coastlines worldwide and provide a habitat that not only supports fish and wildlife but protects the coast from storm impacts. This model allows resource managers to integrate hurricane and storm dynamics into coastal habitat conservation and restoration.

To support this modeling enterprise, USGS has developed numerous tools using internet resources and print materials to assess short- and long-term impacts from hurricanes. For Hurricanes Katrina and Rita, a centralized clearinghouse using internet-based resources was developed for the immediate distribution of satellite and aerial photography, geospatial data, and maps for scientists, first responders, and the public. USGS is working with partners to develop data and information management systems for ecosystem management and restoration for the Gulf Coast.

Scientific knowledge that informs an adaptive management and restoration effort can help lead to intelligent coastal planning and minimize risks to the human-built and natural environments on the coast.

Science can help guide recovery, restoration, and management actions to create a coast that is productive, resilient, and sustainable for the future.

Thank you, Mr. Chairman, this completes my statement. I will be pleased to respond to questions.