NOAA forecasts an average-sized ‘dead zone’ for the Gulf of Mexico
River discharge and nutrient loads contribute to predicted size

NOAA scientists are forecasting this summer’s Gulf of Mexico hypoxic area or “dead zone” – an area of low to no oxygen that can kill fish and other marine life – to be approximately 4,850 square miles. The 2021 forecasted area is smaller than, but close to the five-year average measured size of 5,400 square miles. This forecasted size is also substantially less than the 8,776 square mile 2017 Gulf hypoxic zone, which was the largest zone measured since mapping began in 1985. The annual prediction is based on a suite of models that incorporate the U.S. Geological Survey (USGS) river-flow and nutrient data.

The annual Gulf of Mexico dead zone is primarily caused by excess nutrient pollution from human activities in urban and agricultural areas throughout the Mississippi River watershed. When the excess nutrients reach the Gulf, they stimulate an overgrowth of algae, which eventually die and decompose, depleting oxygen as they sink to the bottom. The resulting low oxygen levels near the bottom of the Gulf cannot support most marine life. Fish, shrimp and crabs often swim out of the area, but animals that are unable to swim or move away are stressed or killed by the low oxygen. The Gulf of Mexico dead zone occurs every summer.

“Understanding the effects of hypoxia on valuable Gulf of Mexico resources has been a long term focus of NOAA’s research,” said Nicole LeBoeuf, acting director of NOAA’s National Ocean Service. “These forecasting models inform us of the potential magnitude of the Gulf of Mexico hypoxic zone that might impact the living resources and coastal economies.”

River discharge in May and the associated nutrient load to the Gulf of Mexico has been shown to be a major contributing factor to the size of the dead zone which forms each summer. In May 2021, discharge in the Mississippi and Atchafalaya rivers was about 2% below the long-term average between 1980 and 2020. The USGS estimates that this smaller-than average river discharge carried 94,700 metric tons of nitrate and 17,100 metric tons of phosphorus into the Gulf of Mexico in May alone. These nitrate loads were about 29% below the long-term average, and phosphorus loads were approximately equal to the long-term average.

The USGS operates more than 3,000 real-time stream gauges, 60 real-time nitrate sensors, and 38 long-term monitoring sites to measure nutrients in rivers throughout the Mississippi-Atchafalaya watershed. Data from these networks are used to track long-term changes in nutrient inputs to the Gulf and to help build models of nutrient sources and hotspots within the watershed.

“Recent results from USGS models show that agricultural sources (including farm fertilizer use, livestock manure and nitrogen fixing crops) together are the largest nutrient sources to the Gulf, and that much of that originates in the upper Midwest and areas along the Mississippi River. But urban areas, human waste treatment, atmospheric deposition, and natural sources also contribute large amounts,” said Don Cline, associate director for the USGS Water Resources Mission Area. “Information on where these sources contribute in the watershed can help guide management approaches to reduce nutrients in local rivers and ultimately in the Gulf.” Results from the new USGS models can be viewed online.

While the hypoxic zone forecast assumes typical coastal weather conditions, the measured dead zone size could be disrupted and its size changed by major weather events, such as hurricanes and tropical storms, which mix ocean waters, as occurred in 2018, 2019, and 2020.

A NOAA-supported monitoring survey, scheduled for later this summer, will confirm the size of the 2021 dead zone, and is a key test of the accuracy of NOAA's models.

The predicted dead zone would be larger than the long-term goal set by the Interagency Mississippi River and Gulf of Mexico Hypoxia Task Force. The Task Force strives to reduce the Gulf dead zone by identifying and implementing collaborative nutrient reduction strategies across the Mississippi River watershed and has set a goal of reducing the size of the hypoxic zone to a 5-year average measured size of 1,900 square miles. NOAA's hypoxia forecast models, together with the USGS's monitoring of nutrients in rivers, help predict how hypoxia in the Gulf of Mexico is linked to nutrients coming from throughout the Mississippi River Basin. The Task Force uses them to help inform nitrogen and phosphorus reduction targets across the watershed.

"The Hypoxia Task Force plays a critical role in managing nutrient loads in the Mississippi River Basin to reduce over time the size of the hypoxic zone," said Director of U.S. Environmental Protection Agency's (EPA) Office of Wetlands, Oceans and Watersheds, John Goodin. "Through state leadership in implementing nutrient reduction strategies, support from EPA and other federal agencies, and partnerships with basin organizations and research partners, we will continue to tackle the challenge of Gulf hypoxia. This annual forecast will continue to inform our collective efforts."

This is the fourth year NOAA is producing its own forecast, using a suite of NOAA-supported hypoxia forecast models jointly developed by the agency and its partners – teams of researchers at the University of Michigan, Louisiana State University, William & Mary's Virginia Institute of Marine Science, North Carolina State University, and Dalhousie University, and the USGS, who provided the Mississippi River loading data for the models. The NOAA forecast integrates the results of these multiple models into a separate average forecast and is released in coordination with these external groups, some of which are also developing independent forecasts.

NOAA and its partners continue to develop additional hypoxia forecast capabilities to understand impacts on living marine resources and how combining multiple modeling approaches can better predict the hypoxic zone.

Figure 1: The picture depicts the Mississippi River near Vicksburg, looking Northeast at the I-20 bridge, the confluence of the Yazoo River is in the foreground. This picture was taken by a drone flown by Jim Alvis and Mike Manning of the USGS in the summer of 2016. (USGS)

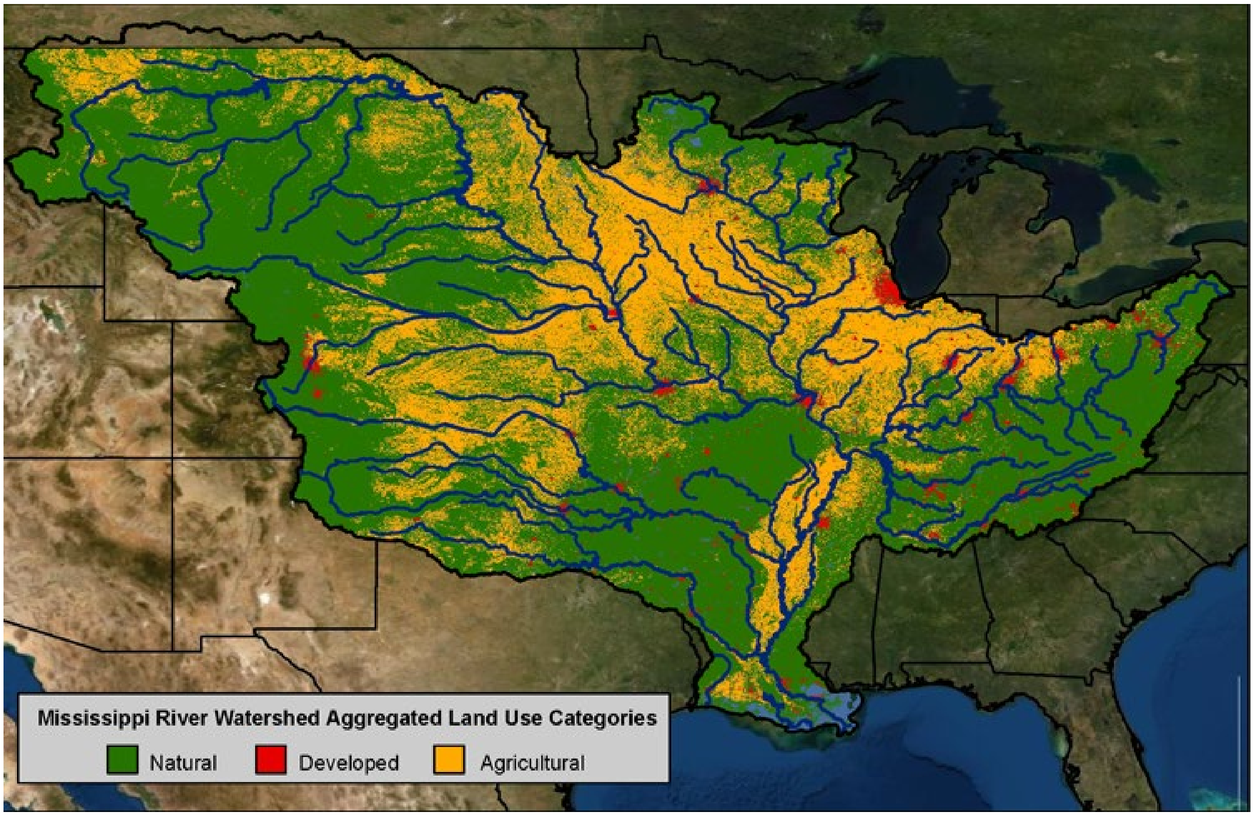

Figure 2: The Mississippi River watershed encompasses over 40% of the continental U.S and crosses 22 state boundaries. Nitrogen and phosphorus pollution in runoff and discharges from agricultural and urban areas are the major contributors to the annual summer hypoxic zone in the Gulf of Mexico.

Source - Adapted from the USGS National Land Cover Dataset to show the three major land uses across the watershed; agriculture (yellow), developed lands (red), and natural lands (green).