Response to Senator Coburn's Waste Report

The National Science Foundation (NSF) has been the backbone of America's science and engineering research enterprise for over 70 years. In fact, NSF is the only federal agency that supports all fields of fundamental science and engineering research and education. NSF supports cutting-edge research projects — many of which serve as bellwethers for solutions to the myriad complex issues facing society. NSF programs also traditionally integrate research and education, fast tracking innovation excellence via hands-on learning to train our next generation of researchers and innovators.

Each year, NSF competitively awards thousands of grants that collectively advance our nation's scientific capabilities and engage the talents of hundreds of thousands of researchers, postdoctoral fellows, technicians, teachers and students in every field of science and engineering.

NSF is the primary source of federal funding for non-medical basic research, providing approximately 12,000 new awards annually. Through its merit review process, NSF ensures that proposals submitted are reviewed in a fair, competitive and in-depth manner. Competition for funding is intense, with only about one out of five proposals ultimately being approved.

Each proposal submitted to NSF is reviewed by science and engineering experts well-versed in their particular discipline or field of expertise. All proposals submitted to NSF are reviewed according to two merit review criteria: *Intellectual Merit* and *Broader Impacts*. NSF's merit review process is widely considered to be the "gold standard" of scientific review. Perhaps the best evidence of NSF's success is the repeated replication of its merit review model for discovery, education and innovation around the globe.

The results of this process — funding the best and brightest ideas through competitive merit review — have been profound. NSF-supported research has underpinned multitudinous discoveries leading to new inventions — the Internet, web browsers, Doppler radar, Magnetic Resonance Imaging, DNA fingerprinting, and bar codes — to name a few. These diverse examples underscore NSF's significant contributions to our nation's prosperity, health and wellbeing. NSF-funded discoveries have expanded our understanding of the world in which we live, led to life-saving medical advances, enhanced our national security, improved our everyday lives and yielded insights into the creation of the universe.

NSF's task of identifying and funding work at the frontiers of science and engineering requires keeping close track of research around the United States and the world; maintaining constant contact with the research community to advance the horizons of inquiry; and choosing the most promising people to conduct the research.

The following grant cited in the report illustrates an example of promising NSF-funded research awarded support through the merit review process.

RUI: Elevated environmental CO2 impairs acclimation to hypoxia in crustaceans
NSF Award 1147008
Sen. Coburn's Waste Report: "to study how a shrimp running on a treadmill responds to alterations in oxygen and carbon dioxide levels"
College of Charleston

Crustaceans, such as shrimp and crab, are not only important in the ecology of estuarine systems, but are the basis for multi-million dollar local economies along the U.S. East Coast and Gulf of Mexico. Shrimp and crab landings have been in decline since the mid-1990s, and aquaculture production has been threatened by infection with bacterial, viral and fungal pathogens. Understanding marine ecologies is paramount to protecting the livelihoods of fishermen who depend upon the ocean's bounty. Many crustaceans, such as shrimp and crabs, live in coastal waters like the Gulf of Mexico, where they are important sources of income to entire communities and important sources of nutrition for all.

In many places, including the Gulf, shrimp and other shellfish are subject to significant environmental stresses, potentially threatening both the marine ecosystem and key elements of the fishing industry. Oxygen depletion, also known as hypoxia, is a primary concern for these crustaceans. Researchers at the College of Charleston aimed to find out how they cope with increased environmental stress. This research seeks to understand if bacterial infection affects the ability of crustaceans to take up oxygen from their environment, and how this in turn affects their metabolism and growth, and whether a decline in metabolism due to bacterial infection switches on genes associated with response to low dissolved oxygen levels in water (hypoxia), known to be a primary cause of mass mortality of marine life. Understanding the interaction between environmental stressors and pathogens will be relevant to managing an important U.S. industry.

This research was featured on the NBC Today Show in November 2008, where the two researchers explained how the research on these simple animals could help us learn about the impact of disease on important physiological functions. In their natural ocean environments, shrimp live in moving water, which requires them to move constantly in order to survive. So these scientists wanted to know how hypoxia, in combination with a decline in the shrimp's immune defense against bacteria, interferes with their ability to move. Of course, it is much easier to study shrimp in tanks, so researchers developed a "treadmill" to imitate flowing water and get shrimp to move the way they move in the ocean. This process is similar to doctors putting humans on a treadmill to test heart health.

Shrimp are the most heavily-cultured species for human consumption, with an annual global market of close to $9 billion in 2009. Unfortunately, the U.S. has been slow in growing its shrimp aquaculture industry. As a result, the U.S. imports over 90 percent of the shrimp consumed in this country, which is valued at $400 million. China has already invested heavily in research related to disease and disease resistance in crustaceans, but the U.S. invests comparatively very little in this area. This research will not only help improve our understanding of shrimp health and immune response in natural and farmed environments, but also aid in growing the nation's aquaculture industry, decreasing the seafood trade deficit, and creating new jobs. This research is also extremely important in predicting the present and future effects of increased pollution and other environmental changes on marine life, and in protecting the fishing industry from natural and man-made disasters.