Statement of

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Good morning, Madam Chair and members of the committee. Thank you for affording me this opportunity to speak with you today. My name is Tom Frazer. I am a Professor and Director of the School of Natural Resources and Environment in the Institute of Food and Agricultural Sciences at the University of Florida.

I understand, based on the background information provided by staff, that the committee has received substantial testimony focused on the causes of climate change, as well as its consequences, both realized and potential. You have heard from internationally renowned scholars and experts that climate change is real and that humans are responsible for it. I agree. You have heard also that marked reductions in global greenhouse gas emissions are essential and urgently needed to stabilize the earth's climate and avoid significant detrimental effects. Again, I agree. In fact, I would argue that the substantial, long-lasting opportunity costs associated with delaying reductions in greenhouse emissions outweigh any short-term benefits. The climate-related challenges that we face today are certainly not going away in the near future, and they will only be exacerbated by further increases in greenhouse gas emissions [1,2]. For example, if current conditions were stabilized, we will still see a 1.1°F (0.6°C) increase in global temperatures over the next century [2], and a scenario with continuing increases in emissions and no mitigation yields a 5.0° – 10.2°F (2.8° – 5.7°C) increase during the same time frame [2]. Given these projections, reducing greenhouse gas emissions and staying on that course for the foreseeable future should be major investments.

With that said, we also should be compelled, as a society, to invest aggressively in the science needed to inform effective adaptation and mitigation. Reducing emissions is key. It is essentially the equivalent of feeding, clothing and housing your children today. Investing in science, on the other hand, is equivalent to saving for their college education. In fact, consistent, long-term investment in science makes the most sense because many valuable insights can only be gained by observations and experiments conducted over time. In other words, good science can take a while to come to fruition.

The science I am talking about is needed to incrementally adapt existing management to the new norm so that we are able to conserve and safeguard natural resources that sustain livelihoods and economies of communities in the United States and around the globe. In addition, science drives technological innovation and advancement or transformational change, and given the challenges that we will experience due to past actions and potential challenges that depend on current and future actions, I suggest to the committee that the call for transformational change has never been as strong as it is today.

My background is in the arenas of marine ecology and fisheries science, and I draw on my academic training and other professional experiences to provide here some examples of how and where investments in science would yield substantial value.

Wild caught fisheries yield approximately 90 million metric tons of fish and shellfish per year, with the bulk of this production being consumed by people, including those who have little access to other sources of protein [3]. However, this bountiful natural resource is already threatened, with about one-third of stocks classified as overfished [3], and changing climate introduces new challenges.

Among those challenges are changes in the ranges of exploited species, both expansions and contractions, and changes associated with alterations to habitats. As sea surface temperatures increase, some warm-water species can expand their ranges northward, but some cold-water species will be forced to contract their ranges. As global climate changes, we will also see changes in habitats. These changes range from shifts in major ocean currents that will alter patterns in movement and recruitment to potential loss of inshore, structural habitats, such as seagrass meadows, that provide food and shelter for a large number of exploited fishery species. As a less drastic, but still significant example, a “flashier” environment caused by more frequent, and larger storm events can alter the salinity regime in estuaries, which could make them less hospitable for juveniles of many fished species. Furthermore, warmer temperatures have added stress to the world’s coral reefs, which were already challenged by coastal development and associated human activities (I’ll talk about this in more detail in just a minute).

In response to such challenges, managers will have to adapt their strategies, with the key thrust being a commitment to ecosystem-based fishery management as proposed by NOAA Fisheries [4]. For example, managers will need to be able to differentiate between range expansions driven by increased stock abundances that result from effective management actions and range shifts driven by changes in water temperatures and ocean currents. Fisheries managers will also need to factor habitat and other environmental variables into stock assessments and stock projections because altered habitats appear to be an inevitable consequence of climate change. Overall, managers will need to move from harvest quotas established primarily on the basis of historical landings to quotas that account for a changing or non-stationary environment. This flexibility is not explicitly articulated in the current version of the Magnuson-Stevens Fisheries Conservation and Management Act. In addition, fisheries managers will need to consider ways to help, and potentially even fund, adaptation by the recreational and commercial fishing industries, such as moving access points and wholesale and retail outlets. Without such incremental adaptations, we, in the U.S., stand to lose a substantial portion of the 1.7 million jobs, $212 billion in sales and $100 billion in gross domestic product generated by these industries [5].

Science comes into play because it is the best base for designing and implementing the necessary adaptations to existing management of our nation’s fisheries. One way that science can help is by providing timely and accurate information on the status and trends of stocks and habitats. Our existing monitoring of recreational and commercial catches and our tracking of critical habitats are insufficient, and we will only fall further behind given the pace of change we will experience in the coming decades. In addition, our understanding of the interactions between fished species and their habitats and our ability to employ models to provide early warnings of detrimental consequences are inadequate. A second way that science can help is to transform the tools and techniques needed to mitigate undesirable changes in fished stocks or the habitats that support them. Given the time constraints imposed as part of this hearing, I will focus on one example of mitigating loss of habitat, rehabilitating coral reefs.

Coral reefs occupy a relatively small proportion of the ocean realm, but harbor more than 25% of marine biodiversity. Coral reefs also support important recreational, commercial and subsistence fisheries around the globe. In fact, coral reefs yield approximately 25% of the total fish catch in developing nations and contribute substantially to the economies of more than 100 countries that promote reef-related tourism [6]. They are, however, one of the most imperiled habitats on the planet due to nutrient pollution, physical damage, overfishing and other local stresses. Recent reports suggest that greater than 60% of the world's reefs are threatened due to these stresses and climate change only heightens this percentage [6,7].

Managers must continue to address local stresses, and, as already indicated, we need to reduce emissions of greenhouse gases to address global stresses. Regardless of our efforts, nearly all coral reefs will be threatened by conditions generated from existing levels of climate change by the year 2050 [6]. In fact, managers should prepare to mitigate both existing damage and the damage that will occur from the inevitable changes in global climate that already have been initiated.

Rehabilitating or restoring damaged and degraded reefs will require transformational innovations and advancements based on sound science. Key questions to be addressed include the following:

- How do we create a supply chain for coral reef rehabilitation that does not consist solely of transplanting survivors?
- Can we identify and culture genotypes that exhibit increased resistance and resilience to local or global stressors?
- Can we identify genes that encode increased resistance and resilience in the symbiotic algae that sustain reef-building corals and what are the risks and rewards associated with manipulating those genes?
- How might we increase survivorship of transplanted corals?
- What characteristics do rehabilitated reefs need to possess to ensure they provide most if not all of the ecosystem services derived from natural coral reefs?

Answering these questions and transferring the new knowledge into effective and efficient innovations and advancements will take time and a consistent stream of resources. In fact, it is an investment that we should begin now.

In conclusion, I reiterate my agreement with much of what you have heard from others. Climate change poses significant threats, and now is the time to begin addressing the human activities that drive it. My goal today was to introduce a potentially new topic: the need for consistent investment in science that will support incremental adaptation to the effects of climate change and build the basis for transformational change in mitigating existing and future effects. My hope is that this initial contribution might persuade you to include discussions of the risks and rewards associated with long-term investments in science in your future deliberations regarding the essential and urgently needed efforts to reduce greenhouse gas emissions. I will close by saying that I am happy to participate in those discussions.

REFERENCES

1. IPCC, 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
2. USGCRP, 2017. *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp.
3. FAO, 2018. *The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals*. Rome. Licence: CC BY-NC-SA 3.0 IGO, http://www.fao.org/state-of-fisheries-aquaculture
4. Public Law 109-497: Magnuson-Stevens Fishery Conservation and Management Act as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act, 2007. https://www.fisheries.noaa.gov/national/laws-and-policies/policy-directive-system
5. National Marine Fisheries Service, 2018. *Fisheries Economics of the United States, 2016.* U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-187, 243 pp.
6. Burke L, Reytar K, Spalding M, Perry A., 2011. *Reefs at risk revisited*. World Resources Institute, Washington, DC. 115 pp.

7. Pandolfi JM, Bradbury RH, Sala E, Hughes TP, Bjorndal KA, et al., 2003. *Global trajectories of the long-term decline of coral reef ecosystems*. Science 301: 955–958.