Written Testimony of
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Thank you for the opportunity to testify here today. My name is Dr. Rebecca Selden, and I am a senior fellow for the Nereus Program Predicting Future Oceans at Rutgers University. I am an expert on the impacts of warming on ocean ecosystems and the consequences for fishing communities. My current research links information about the distribution and abundance of fish species with records of fishing at sea to understand how fishing communities adapt to shifts in species distributions.

Fisheries are the lifeblood of many coastal communities in the US and contribute billions of dollars to national GDP. The United States has some of the best-managed fisheries in the world, and its reliance on science-driven management has resulted in a dramatic improvement in the performance of our fisheries over the last ten years. According to the latest Fisheries of the United States report, the number of overfished stocks in 2017 was at an all-time low. Unfortunately, warming waters threaten that continued success.

According to the most recent IPCC report, we are virtually certain that the oceans have warmed with rising carbon dioxide levels (Rhein et al. 2013), and recent research suggests that this warming has accelerated over the last four decades (Cheng et al. 2019). We have evidence that this warming is having a profound impact on ocean ecosystems upon which we depend for food and livelihoods. My testimony will focus on the impact of this warming on fish and fisheries.

I want to make three points:

1) Marine species follow changes in ocean temperatures, often moving towards the poles and deeper as the oceans warm.
2) Fishing communities are directly impacted by the loss of important fishery species and by the potential gains of new species within fishing grounds.
3) Management can be more nimble in dealing with distribution shifts, and the sooner we act, the better we can ensure our fisheries continue to support jobs, food, and economies throughout our country despite ocean change.

The risk that changing ocean conditions pose for fisheries was demonstrated by the “warm blob” on the West Coast between 2013-2016. A mass of unusually warm water, 2-7 degrees Fahrenheit above normal, spread from Alaska to Baja California (Cavole et al. 2016). Changes in tiny organisms called zooplankton that serve as important food for fish might not have been visible to the non-scientist, but may have had the biggest impact. The most nutritious species associated with cold water disappeared (Peterson et al. 2017), leading to mass starvation of seabirds (Jones

et al. 2018), strandings of sea lions (Banuet-Martínez et al. 2017), and record low returns of coastal salmon (Cavole et al. 2016). Fishery disasters stemming from these warm ocean conditions were ultimately declared for salmon fisheries in California, Oregon, Washington, and Alaska, with total losses exceeding $70 million (NOAA 2019).

Unfortunately extreme events like the "warm blob" are only predicted to get more frequent and more intense with continued warming (Smale et al. 2019), and these impacts are added on top of long-term warming trends that are already stressing ocean ecosystems. Rapid warming in the last few decades off the Northeast coast of the US has driven species to move northward to avoid warm water. For example, populations of black sea bass used to be centered off the coast of Virginia in the 1960s, and are now off of New Jersey. On the Pacific coast, the changes have also been striking, where warming associated with the loss of sea ice in Alaska has allowed arrowtooth flounder to invade areas of the Eastern Bering Sea (Mueter and Litzow 2008). Arrowtooth flounder is a voracious predator of walleye pollock, the fish found in McDonald's Filet-o-Fish sandwich, and this important fishery—the largest by volume in the US—is at risk from increased predation by flounder (Hunsicker et al. 2013). This suggests that fisheries will be affected not only by shifts in species that we harvest, but also by shifts in the predators and prey of important commercial species.

Fishers are truly on the front lines in dealing with shifting fish stocks. To understand how fishers in the Northeast have coped with these changes, our research team of ecologists, human geographers, and economists, has brought together information on where we find key fishery species with a rich record of fishing behavior at sea. Trawlers in Rhode Island have observed black sea bass in the Gulf of Maine for the first time, and those in Massachusetts are now seeing year-round populations of summer flounder. New Jersey fishers have told us warming has "left us with no squid to catch unless we travel 100 miles, and we are not those types of wanderers" (Papaioannou and Selden 2019). This sentiment reflects similar experiences throughout fishing communities along the Eastern seaboard. Large trawlers from North Carolina steam 3 days north to catch summer flounder off the coast of New Jersey before returning home to land the fish, burning excess fuel and driving up costs (Young et al. 2019). However, our research revealed that the vast majority of fishing communities continue to fish within their traditional fishing grounds. For most fishers, it is undesirable to move away from those places at sea where they have fished for decades, despite the changes they see on the water.

Integrating shifting fish stocks into management is an issue likely to become even more important with future climate change. Black sea bass is projected to move another 300 miles north by 2100, and some species are expected to move more than 600 miles if emissions continue as they are now (Morley et al. 2018) (Figure 1, Appendix 1). Importantly, species shifting into new fishing areas may represent a valuable opportunity for emerging fisheries. However, with continued warming, the number of stocks straddling international boundaries is poised to increase (Pinsky et al. 2018), highlighting the value of using models of where we expect fish to go to begin proactive management now to minimize future conflict. Projections in effect let us drive with the headlights on, so that we're not stumbling blindly forward in our efforts to make fisheries climate-ready.

At this point, the scientific evidence is clear: it's not whether species distributions will move, it's when. Ocean acidification and deoxygenation may exacerbate these impacts. Further, the more we stress ocean ecosystems with continued warming, the more unpleasant extreme events like the warm blob are likely to become. The good news is that we can make our management more nimble to deal with shifting fish stocks. Two needs I see based on my research are (1) to utilize the best available science to detect, anticipate, and respond to changes in fish stocks (Karp et al. 2019), and (2) to coordinate management across jurisdictions where those species are likely to cross management boundaries. This committee can serve an important role in enabling that coordination and integration. I also want to emphasize that climate change makes it even more important to ensure fish stocks remain healthy and overfishing is not occurring, as overfished stocks are less resilient to climate change (Planque et al. 2010). Taking an integrated view of the impacts of climate and fisheries on marine resources will make it more likely that we continue to have healthy fish stocks and vibrant fishing communities for years to come.

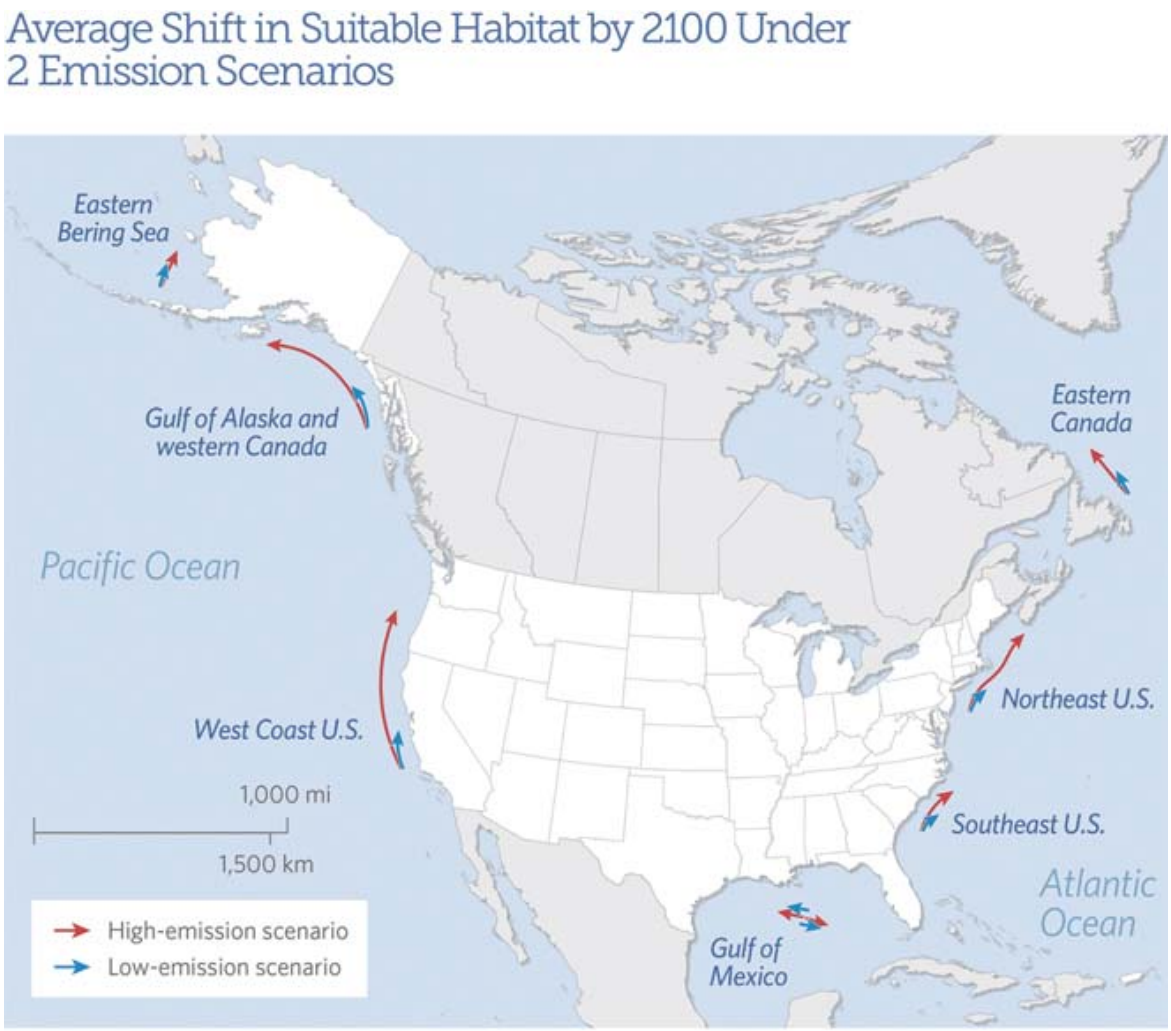

Figure 1

Source: Morley et al., 2018

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Appendix 1: Key results by region from Morley et al. (2018) under a high emissions scenario.

See OceanAdapt https://oceanadapt.rutgers.edu/ and Pew report for visualizations: https://www.pewtrusts.org/en/research-and-analysis/articles/2018/05/16/warming-waters-to-force-dramatic-shifts-in-marine-species-habitats

Gulf of Mexico

- Habitat for brown shrimp in the Gulf of Mexico is projected to decline 70%.
- Overall habitat for gray snapper is projected to increase by 71%

Southeast

- Suitable habitat for sheepshead is projected to shift more than 200 miles and overall habitat will drop by 46% along the East Coast.

Northeast

- Atlantic cod are set to lose 90% of their habitat in US waters, with the remaining habitat primarily in Canada.

Pacific Coast

- Suitable habitat for Pacific whiting within the contiguous US is projected to decline as the center of the population is forecast to move north by 730 miles.
- The center of suitable habitat for canary rockfish and jack mackerel is projected to move north by more than 1,000 miles into Alaska.
- Walleye pollock will lose 44% of its thermal habitat by the end of the century.