Written Testimony of
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Chairman Wicker, Ranking Member Cantwell, and members of the committee, thank you for the opportunity to testify here today about the science around offshore aquaculture. My name is Dr. Ben Halpern and I am the Director of the National Center for Ecological Analysis and Synthesis, the first and longest running center of its kind in the world, and a Professor of marine conservation at the Bren School of Environmental Science and Management at the University of California, Santa Barbara. I got my PhD in marine ecology and have spent the last 15 years of my career focused on global-scale research questions that address topics such as the cumulative impact of human activities on oceans and measuring the many benefits people derive from the ocean, in particular related to the food we get from fisheries and aquaculture.

My research leverages synthesis, which is a scientific tool that brings together all available data and evidence, collected as part of dozens to hundreds of studies from around the world, to extract the ‘big picture’ and identify key gaps in our knowledge. I then use other analytical tools to strategically fill those gaps. This context is important because it helps explain my scientific approach and perspective - my work doesn’t focus on if or where to site a specific aquaculture farm off the coast of California, for example, but instead focuses on broader questions about the potential and limits to growth in marine aquaculture globally or in the U.S., the comparative environmental impacts of different kinds of aquaculture, and the lessons learned about best practices for offshore aquaculture.

Aquaculture comes in many forms and flavors. There are three broad places where aquaculture is done - freshwater (on land), brackish (in estuaries), and marine. Globally, freshwater aquaculture is the majority of total production, with marine and brackish aquaculture totaling about 40% (FAO 2018). In the U.S., approximately 43% is marine (FAO 2018).

There are also three broad types of aquaculture - seaweed, shellfish, and finfish. Within each of these broad categories there are dozens to hundreds of different species that are grown globally. As of 2017, at least 18 species of marine finfish could viably be farmed in the U.S. and dozens of shellfish already are.

Marine aquaculture has huge potential to provide nutritious and environmentally-friendly food that simultaneously creates economic value and local jobs. But to produce safe, sustainable and scientifically-informed marine aquaculture requires clear policy based on the best available science.

To that end, I would like to offer three related, main points:

1. We have to get our food from somewhere, and there is huge potential in US waters for marine aquaculture.
2. All food production has impact, but not all foods are equal - well managed offshore aquaculture can have low impact.
3. Science already provides a number of key best practices and advantages of offshore aquaculture, and ecosystem-based/integrated aquaculture frameworks already exist to guide aquaculture siting.

**The U.S. has huge potential for safe and sustainable offshore aquaculture**

Americans love seafood, annually consuming nearly 50 pounds of seafood per capita, or 6.8 million metric tons total a year, above the global average. Many argue that our country was founded on the backs - or fins - of cod, and fisheries remain the fabric and diet of many communities around our country. In the last few decades, strong and effective management of fisheries has returned many of our stocks to healthy, sustainable levels. But that success creates a catch-22. There is relatively little room for further growth in sustainable harvest of wild fisheries to feed our ever-increasing appetite for seafood here or in other countries.

Indeed, currently the US imports roughly 65% of its seafood (Gephart et al. 2019) - not the 90% number that often gets mentioned, but 65% is still the majority of our seafood. Even if we didn't export any of the seafood we catch and farm in the US, we would still be more than a million metric tons short of current domestic seafood demand. Thus, there are only two options for meeting growing seafood demand in the future: import more seafood, or farm it in our own waters.

There is huge potential in US waters for marine aquaculture (Gentry et al. 2017), even when using very conservative assumptions about where and to what extent to allow aquaculture (Fig. 1). The U.S. would only need to farm 0.01% of its EEZ to produce ***all*** of the seafood people eat domestically. We don't need to do even that, though, because we have our fisheries too. This huge production potential in such a small space creates key opportunities for strategic, science-informed siting of marine aquaculture to maximize benefits and minimize conflicts and negative impacts while still meeting objectives of conservation and other marine sectors.

**All food production has impact, but not all foods are equal**

Whether we harvest fish, farm fish, grow livestock, or farm crops, we have an impact on the environment. We can't feed the nearly 330 million people in the U.S. without having an impact on the environment. But not all food production is created equal. As scientists, we measure these impacts in many different ways: the emissions of greenhouse gases that fuel climate change, the nitrogen pollution that leads to dead zones in lakes and coastal waters, the natural landscapes converted and tilled under, the spread of non-native species or pests, the use of limited freshwater resources, and so on. These costs vary enormously among different foods grown in different places using different means.

Offshore aquaculture has impacts on the environment, just like any food production. But in many cases these impacts are far less than those for other foods. Little to no freshwater is needed, feed innovations have reduced nitrogen pollution to very low levels, very small amounts of space are needed to grow food in the sea, and for shellfish and seaweed aquaculture, some can actually improve local water quality rather than add pollutants. Strategic and science-informed siting of offshore aquaculture can further reduce potential environmental impacts.

In other cases the impacts of offshore aquaculture may be similar to other foods. The potential for spread of disease, and the antibiotics used to deal with disease, is common to many food production systems. For offshore aquaculture, these risks appear easier to mitigate. In the U.S., no antibiotics have been cleared for use, and there are known best practices that significantly reduce rates of disease, so clear and established strategies exist to minimize issues of disease. Another potential impact comes from risk of escape of farmed fish into wild stocks. Integrated ecosystem-based management of aquaculture provides one mechanism for reducing these risks.

**Guiding best practices for offshore aquaculture**

There is sufficient science to inform and guide best practices for offshore aquaculture that can be used to help minimize environmental impacts. Some of these guidelines include:

- Place farms at least 300 feet (less than a football field) away from critical benthic habitat
- Farms placed in ocean currents at least 0.1mph have better growth and a lower pollution footprint
- Farms positioned at least 60 feet above the seafloor have little impact on the seafloor below
- Lower stocking densities reduce the chance of diseases - for example, the European ‘organic’ standard is 11 $kg/m^3$ for finfish
- Use anti-predator netting and anchoring to reduce wildlife conflict and entanglements
- Promptly remove attractants to minimize wildlife interactions
- Apply strict rules on antibiotics - currently none are permitted for use in US marine waters
- Require consistent and standardized monitoring and reporting of conditions and farm practices to help inform science and improve best practices
- Establish and implement distinct criteria for finfish, shellfish, and seaweed

The perception of many people in the US is that aquaculture is bad, offshore in particular (Froehlich et al. 2017). The science does not necessarily bear this out for offshore aquaculture if it is managed well, but none-the-less aquaculture policy and management efforts will continue to face this public perception. It is critical that efforts to create aquaculture policy are informed by science and adaptive to new science. Well-managed aquaculture will need to take into account community and social aspects, and the science on this is more sparse.

I would like to end by reiterating something I started with. To produce safe, sustainable and scientifically-informed marine aquaculture requires clear policy based on the best available science. As a global leader in the management of our marine resources, the U.S. has the opportunity, knowledge and capacity to do this in a way that sets a global standard.

Thank you for your time and attention. I welcome any questions you may have.

**References**

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Figure 1. From Gentry et al. 2017.

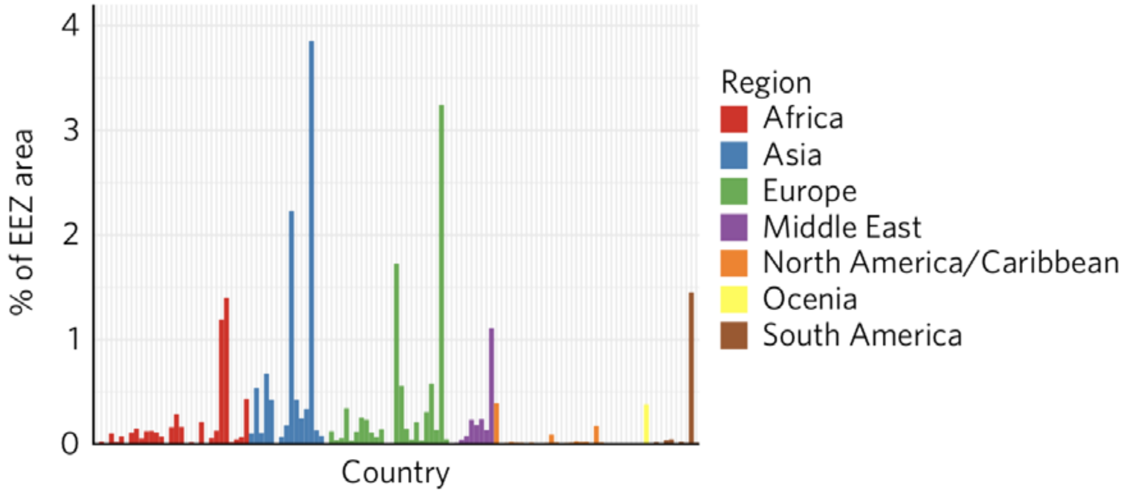


**Fig. 3 | Percent of each country's EEZ required for finfish aquaculture to supply its current seafood consumption.** Each bar represents a single country grouped by region. The vast majority of countries would need to farm much less than 1% of their EEZ to produce all of the seafood they are currently consuming. More detail is provided in Supplementary Fig. 8.