**Can fisheries management reform and sustainable aquaculture development meet projected food and nutrition requirements under climate change?**

**Scope of Work and Budget**

**The Environmental Market Solutions Lab & The Environmental Defense Fund**

**Exhibit A**

**Scope of Work**

**Project Overview**

Climate change is already reshaping our oceans and the thousands of fisheries they support. In 2018, the Environmental Market Solutions Lab (emLab) at UC Santa Barbara published a [study](https://advances.sciencemag.org/content/4/8/eaao1378) that provided novel projections of climate change impacts on global fisheries that focused on changes in productivity and changes in species’ geographic ranges. While the results of this study significantly expanded our understanding of possible climate effects on fisheries, the model developed for this work can be paired with other data streams to answer further questions about the future of global fisheries. For example, we can use our model to explore the relationship between climate-driven fisheries changes and nutrient availability, and assess the potential for various policy and management solutions to increase countries’ nutrient endowment under climate change.

However, in many tropical developing countries, even the best climate-adaptive fisheries reforms will be insufficient to maintain current catch and profits under climate change. In these countries, the development of sustainable marine aquaculture may be able to compensate for losses in capture fisheries. Although research by emLab colleagues has mapped the global biological potential for marine aquaculture presently (Gentry et al. 2017) and under climate change (Froehlich et al. 2018), this work did not account for the economic feasibility of such expansions or feed limitations in finfish aquaculture.

For the purpose of this project, we will conduct two related analyses that will (1) yield new insights on fisheries implications of climate change, and (2) help us identify optimal management strategies for ensuring global fisheries deliver food security and economic benefits to communities around the world, particularly those that are the most vulnerable to climate change. Below is a description of the two workstreams:

*Workstream #1 - Understanding the fisheries implications of climate change with respect to food and nutrition security*

* Use emLab’s [global climate model](https://advances.sciencemag.org/content/4/8/eaao1378) and available data on nutrition content of fisheries products from Dr. Chris Golden at Harvard University to analyze the effects of climate change on nutrient endowments from the sea at the country-level.
* Based on our results, consider how fisheries management could improve nutrient availability and access to fishery products, particularly in communities that are most vulnerable to climate change.
* In collaboration with EDF and other partners, explore possible policy implications of optimizing management for nutrition outcomes under climate change scenarios.

*Workstream #2 - Understanding the potential for sustainable aquaculture development to fill gaps in national food and nutrition requirements under climate change, especially in the developing tropics*

* Estimate the current and future potential for sustainable marine aquaculture under climate change accounting for economic feasibility and feed availability.
  + Estimate the biological potential for bivalve and finfish aquaculture species under climate change using the methods of Gentry et al. (2017) and Froehlich et al. (2018).
  + Refine these methods to account for economic feasibility and feed availability (for finfish aquaculture) using the methods of Free et al. (2019).
  + Calculate the food and nutrition potential using edible meat conversions and nutrition content values from Edwards et al. (2019) and Vaitla et al. (2018).
* Evaluate whether country-level gains in food and nutrition from aquaculture can compensate for county-level losses in capture fisheries potential and whether fisheries and aquaculture can meet the food and nutritious requirements projected for 2050.

**Project Deliverables & Timeline**

1. Develop an interactive report (ShinyApp) that allows users to explore (1) how climate change is likely to affect fish catch and nutrient endowment from fish products at the country-level, and (2) how fisheries management could be leveraged to increase communities’ access to fishery ­­products under different climate change scenarios and improve nutrient availability, particularly for vulnerable populations (Due March 31, 2020).
2. Develop an interactive report (ShinyApp) that allows users to explore if country-level gains in food and nutrition from aquaculture can compensate for county-level losses in capture fisheries potential and whether fisheries and aquaculture can meet food and nutrient requirements projected for 2050 (Due July 31, 2020).
3. Draft a manuscript for publication in a peer-reviewed journal (Due September 30, 2020)

**Exhibit B**

**Budget**

**Budget Summary: October 1, 2019 – September 30, 2020 (12 months)**

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| **Category** | **Budget** |
| Salaries and Benefits   * Principal Investigator (Steve Gaines, no budget requested) * Postdoctoral Researcher (Chris Free, 60% time, 12 months) * Project Researcher/Management Support (30 % time, 12 months) | $78,320 |
| Travel (Conference – 1 person, 5 days) | $2,975 |
| Supplies (Computer, publication charges) | $5,661 |
| Indirect Costs (15% of total direct costs) | $13,043 |
| Total | $100,000 |