Memorandum Received By: The State of Hawai'i Office of Planning and Sustainable Development
To: The State Greenhouse Gas Sequestration Task Force
From: The Center for Food Safety

We understand the Greenhouse Gas Sequestration Taskforce is seeking information regarding interactions of offshore aquaculture and climate change as part of the federal proposal for the Pacific Islands Aquaculture Management Program. While it may be true that some forms of bivalve and seaweed aquaculture may help sequester carbon, offshore finfish aquaculture, as the National Oceanic and Atmospheric Administration currently proposes,[1] is vastly different, and should not be part of any ocean management program. Commercial cultivation of finfish in marine and coastal ecosystems carries with it numerous inherent impacts, which climate change will exacerbate. No amount of mitigation can sufficiently protect the ocean, coastal communities, and consumers once these facilities are approved.

Industrial ocean fish farming—also known as offshore or marine finfish aquaculture—involves the mass cultivation of finfish in the ocean, in net pens, pods, and cages, which can have devastating environmental and socio-economic impacts. Industrial offshore aquaculture near Hawaii, as described in the Programmatic EIS for the Pacific Islands Aquaculture Management Program, is associated with many environmental and public health concerns, including: the escape of farmed fish into the wild; outcompeting wild fish for habitat; food and mates or intermixing with wild fish and altering their genetics and behaviors; the spread of diseases and parasites from farmed fish to wild fish and other marine life; and pollution from excess feed, wastes and any antibiotics or other chemicals used flowing through the open pens into natural waters. Industrial aquaculture also significantly affects public health, as antibiotics, pesticides and other chemicals that are heavily used to prevent disease and parasites in industrial aquaculture can accumulate in fish tissues.

Climate change continues to increase the intensity of storms in the Pacific Islands region, and significant concerns remain regarding offshore aquaculture facilities' abilities to secure equipment under the force of a major, or series or major, storms. Beginning in 1980, climate change has contributed to an increase in risk of hurricanes and other tropical cyclones in Hawaii.[2] Global climate models consistently project a significant increase in sea surface temperatures in the vast Central Pacific, which would drive an increase in destructive tropical storms with high-intensity winds, extreme rainfall, and high storm surge that could affect Hawaii, Guam, and other islands in the region. A recent study projected that tropical storm frequency for the area would double by 2100 under a global temperature increase of 2 degrees Celsius.[3] The increasing frequency of extreme precipitation events is also compounding coastal flooding risk when storm surge and heavy rainfall occur together. As climate change continues unabated, the intensity of tropical storms is projected to continue to increase, making hurricanes and other storms more and more destructive.

Offshore aquaculture facilities remain vulnerable to these extreme weather events, which frequently result in fish escapes. In January 2020, 73,600 salmon escaped from a net pen during a storm

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[1] National Oceanic and Atmospheric Administration, *Pacific Islands Aquaculture Management Program Draft Programmatic Environmental Impact Statement* (May 7, 2021), https://www.regulations.gov/document/NOAA-NMFS-2021-0044-0003 (PEIS).
[2] Hiroyuki Murakami, et al., *Detected climatic change in global distribution of tropical cyclon*es, PNAS (May 4, 2020), https://www.pnas.org/content/117/20/10706; *see also* PEIS at 48, 72, 121.
[3] Hiroyuki Murakami, et al., *Projected increase in tropical cyclones near Hawaii*, 3 Nature Climate Change 749-54 (2013), https://www.nature.com/articles/nclimate1890.

in Mowi, Scotland, marking the third major escape in the area since October 2019.[4] From facilities in Norway, a series of storms resulted in approximately four million escaped fish in a single year.[5] Even without extreme weather, in August 2017, an industrial net pen operation maintained by Cooke Aquaculture Pacific, LLC allowed for approximately 160,000 farmed Atlantic salmon to escape into Puget Sound and the Pacific.[6]

In fact, in countries where the majority of marine finfish farms operate, escapes due to weather are not isolated or rare occurrences. In a given year, a single company or facility will likely experience multiple escapes. AquaChile, for example, reported the escape of 787,929 fish in 2013 due to bad weather damaging cages.[7] Five years later, in 2018, 680,000 fish escaped from Marine Harvest Chile due to bad weather.[8] Bakkafrost Faroe Islands, too, reported weather as the cause of 109,515 fish escaping in 2017, Scottish Sea Farm in Scotland, of 258,000 fish escaping in 2000, and Huon Aquaculture in Tasmania of 120,000 fish escaping in 2018.[9] Recognizing the regularity of fish escapes from ocean-based net pens, the U.S. Council on Environmental Quality has stated that it "must be *assumed* that escapes will occur" from net pens, even in the absence of severe weather.[10]

With respect to 233 documented fish escapes globally from 1995-2014, severe weather and storms caused 24 percent of the escapes.[11] And of all escapes, those caused by severe weather averaged 36 times as many fish lost compared to other common causes, such as net holes, predator attacks, human error, and undefined equipment failure.[12]

These fish escapes impact local stocks in a variety of ways including predation, competition for food, habitat, and spawning areas, and interbreeding with wild populations of the same fish.[13] For example, Atlantic salmon that have escaped from aquaculture operations in Washington State and British Columbia compete with wild Pacific stocks, and increasing numbers of Atlantic salmon have been observed returning to rivers on the West Coast.[14] In the Atlantic region, the U.S. Fish and Wildlife Service has determined that "Atlantic salmon that escape from farms and hatcheries pose a threat to native Atlantic salmon populations."[15] They also predict that "escapement and resultant interactions with

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[4] *Escape calls high energy salmon sites into question*, The Fish Site (Jan. 20, 2020), https://thefishsite.com/articles/mowi-reports-mass-salmon-escape-from-colonsay.
[5] PEIS at 171.
[6] E. Tammy Kim, *Washington State's Great Salmon Spill and the Environmental Perils of Fish Farming*, The New Yorker (Sept. 13, 2017), https://www.newyorker.com/tech/elements/washington-states-great-salmon-spill-and-the-environmentalperils-of-fish-farming.
[7] Lola Novarro, *Here are the largest recorded farmed Atlantic salmon escapes in history*, IntraFish (Feb. 1, 2019), https://www.intrafish.com/aquaculture/here-are-the-largest-recorded-farmed-atlantic-salmon-escapes-in-history/2-1-388082.
[8] *Id*.
[9] *Id*.
[10] Council for Environment Quality & Office of Science and Technology Policy, Case Study No. 1: Growth-Enhanced Salmon, at 23 (2001), https://clintonwhitehouse5.archives.gov/media/pdf/salmon.pdf; *CEQ and OSTP Assessment: Case Studies of Environmental Regulations for Biotechnology*, https://hygeia-analytics.com/wp-content/uploads/2016/12/RP_RegGETech_CEQ.pdf.
[11] Center for Food Safety, *Like Water and Oil*, at 6 (Oct. 2014), http://www.centerforfoodsafety.org/files/like-water-and-oil-aquaculture_54029.pdf.
[12] *Id*.
[13] PEIS at 158.
[14] Goldburg, et al., *Marine Aquaculture in the United States: Environmental Impacts and Policy Options*, Pew Oceans Commission (2001), https://fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/marine_aquaculture_pew_2001.pdf.
[15] Endangered and Threatened Species; Proposed Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (Salmo salar) in the Gulf of Maine, 64 Fed. Reg. 62627, 62635 (Nov. 17, 1999).

native stocks are expected to increase given the continued operation of farms and growth of the industry under current practices."[16]

Furthermore, reliance on the sterility of farmed fish to prevent interbreeding is never 100% guaranteed; therefore, the "long-term consequences of continued farmed [fish] escapes and subsequent interbreeding . . . include a loss of genetic diversity."[17] Studies have also shown that when farmed and wild fish interbreed their offspring have diminished survival skills, reduced fitness, and potentially altered life history characteristics such as altered timing of development events.[18] Researchers in Ireland, for example, have found that the interactions of farm escapees and wild salmon reduced the overall fitness of wild species and could lead to the extinction of wild populations.[19]

Even when broodstock are collected from the wild, as proposed, escape poses a threat to wild stocks.[20] The longer a broodstock line is developed (i.e., bred to improve growth, quality, and disease resistance, etc.) the greater the chance that their genes may begin to drift from their wild counterparts.[21] While maintaining the wild genetic structure of cultured fish in the Pacific Islands region has been suggested to safeguard against escapes, the possibility of genetic separation would likely remain as the industry matures.[22]

Finally, escaped farmed fish will likely spread a multitude of parasites and diseases to wild stocks, which could prove fatal when transmitted.[23] While natural levels of pathogens are generally not a concern for wild stocks, cultured species live at higher densities in confined cages, where diseases and parasites could rapidly transfer throughout the population, causing mass mortality. A 23-year study in Finland found that not only do the high stocking densities of homogenous fish enhance transmission opportunities of common pathogens, but fish farms also promote the evolution of more virulent strains.[24] The now defunct Kona Blue Water Farms in Hawaii encountered problems with skin flukes, a parasitic flat worm that attaches to fish to eat their skin and suck their blood.[25] In the case of salmon, the U.S. Fish and Wildlife Service has observed that while fish diseases have always affected wild Atlantic

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[16] *Id*.

[17] Fisheries and Oceans Canada, *Newfoundland and Labrador Region, Stock Assessment of Newfoundland and Labrador Atlantic Salmon* (2016), *available at* http://waves-vagues.dfo-mpo.gc.ca/Library/40619655.pdf ("Genetic analysis of juvenile Atlantic Salmon from southern Newfoundland revealed that hybridization between wild and farmed salmon was extensive throughout Fortune Bay and Bay d'Espoir (17 of 18 locations), with one-third of all juvenile salmon sampled being of hybrid ancestry."); *see also* Mark Quinn, CBC News, *DFO study confirms 'widespread' mating of farmed, wild salmon in N.L.* (Sept. 21, 2016), https://www.cbc.ca/news/canada/newfoundland-labrador/farmed-salmon-mating-with-wild-in-nl-dfo-study-1.3770864.

[18] This occurs because farmed fish selected for aquaculture are bred to thrive in controlled, rather than wild, environments. Congressional Research Service, Open Ocean Aquaculture, at 7 (Aug. 9, 2010), https://crsreports.congress.gov/product/pdf/RL/RL32694/19.

[19] *Id*.

[20] PEIS at 171.

[21] *Id*.

[22] *Id*.

[23] Jillian Fry, et al., *Ecosystem and Public Health Risks from Nearshore and Offshore Finfish Aquaculture*, at 6-7 (2017), https://clf.jhsph.edu/sites/default/files/2019-09/ecosystem-and-public-health-risks-from-nearshore-and-offshore-finfish-aquaculture.pdf.

[24] Pulkkinen, K. et al., *Intensive fish farming and the evolution of pathogen virulence: the case of culumnaris disease in Finland*, Proceedings of the Royal Society Biological Sciences (Oct. 2009), https://royalsocietypublishing.org/doi/10.1098/rspb.2009.1659.

[25] Kona Blue Water Farms, LLC, *Supplemental Environmental Assessment for a Modification to Net Pen Designs within the existing Production Capacity and Farm Lease Area for Kona Blue's Offshore Open Ocean Fish Farm off Unualoha Point, Kona, Hawaii*, at 39 (Jan. 2, 2009), http://oeqc2.doh.hawaii.gov/EA_EIS_Library/2009-03-08-HA-DEA-Kona-Blue-Water-Aquafarm.PDF; Fish Vet Group, *Parasite Focus: Gyrodactylus*. The Fish Site (Dec. 4, 2006), http://www.thefishsite.com/articles/104/parasite-focus-gyrodactylus.

salmon, “the threats of major loss due to disease are generally associated with salmon aquaculture.”[26] Sea lice is one of the most notorious pathogens associated with aquaculture facilities.[27] Salmon farms have exposed wild pink salmon to lice infestations in British Columbia’s Broughton Archipelago, resulting in a “sharp decline” in wild population.[28]

Escaped fish in the open ocean carry these diseases and pathogens well beyond the facility from which they were reared, infecting other species with whom they come into contact. Infectious Salmon Anemia, for example, is a viral infection that originates in fish farms and typically only develops in marine environments. Farmed fish escapees in Canada have been documented to carry the disease to nearby rivers, transmitting it to wild salmon populations living in freshwater where the disease would otherwise have not been found.[29] Similarly, the Scottish government has reported the prevalence of Infectious Pancreatic Necrosis, a highly contagious viral infection attributed to young Salmonid species held under intensively farmed conditions.[30] In yet another example, the furunculosis disease[31] spread quickly to roughly 70 percent of Norwegian farms after the industry received infected juveniles from Scotland.[32] Escapees from infected Norwegian farms were found in nearby rivers, and they are the suspected cause of a furunculosis epidemic among wild populations.[33]

Climate change only exacerbates this possibility of disease spread. Fish are vulnerable to changes in their aquatic habitat, especially, in the case of net pens, where they cannot move away.[34] Not only does climate change increase the risk of escapes, but it can impact the production environment including pathogen prevalence and/or virulence and host susceptibility (immunosuppression) and transmission.[35]

In sum, industrial ocean fish farming presents a multitude of risks, many of which will be exacerbated by climate change. The inevitable escape of farmed fish from facilities in the Pacific Islands region will contribute to loss of biodiversity and disease spread from farmed fish to wild populations. CFS does not recommend industrial ocean fish farming as part of a sustainable ocean management program.

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[26] 64 Fed. Reg. at 62633 (Nov 17, 1999)
[27] PEIS at 172.
[28] Krosek, M. & R. Hilborn, *Sea lice (Lepeophtheirus salmonis) infestations and the productivity of pink salmon (Oncorhynchus gorbuscha) in the Broughton Archipelago, British Columbia, Canada*, Canadian Journal of Fisheries and Aquatic Sciences, at 6 (Sept. 20, 2001), https://cdnsciencepub.com/doi/abs/10.1139/f10-137.
[29] Naylor, R. et al., *Fugitive Salmon: Assessing the Risks of Escaped Fish from Net-Pen Aquaculture*, at 427-437, BioScience, 55 (May 2005), https://academic.oup.com/bioscience/article/55/5/427/226100.
[30] Scottish Government, *Diseases of Wild and Farmed Fish* (Dec. 17, 2019), https://www.gov.scot/publications/diseases-of-wild-and-farmed-finfish/pages/infectious-pancreatic-necrosis-ipn/.
[31] Furunculosis is characterized by small hemorrhages at the base of fins in acute infections which can grow to multiple hemorrhages in the muscle and liver, necrosis of the kidney, and intestinal inflammation in chronic infections. The Scottish Government, Furunculosis in Salmon, https://www.gov.scot/publications/diseases-of-wild-and-farmed-finfish/pages/furunculosis-in-salmon/.
[32] Naylor (2005).
[33] *Id*.
[34] Food and Agriculture Organization of the United Nations, *Impacts of Climate Change on Fisheries and Aquaculture*, at 526 (2018), http://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1152846/.
[35] *Id*.