December 11, 2019

STATE OF MAINE
BOARD OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

NORDIC AQUAFARMS, INC		
Belfast and Northport	)	**APPLICATION FOR AIR EMISSION, SITE**
Waldo County, Maine	)	**LOCATION OF DEVELOPMENT,**
	)	**NATURAL RESOURCES PROTECTION**
A-1146-71-A-N	)	**ACT, and MAINE POLLUTANT**
L-28319-26-A-N	)	**DISCHARGE ELIMINATION**
L-28319-TG-B-N	)	**SYSTEM/WASTE DISCHARGE LICENSES**
L-28319-4E-C-N	)	
L-28319-L6-D-N	)	
L-28319-TW-E-N		
W-009200-6F-A-N	)	

PRE-FILED DIRECT TESTIMONY OF DR. CARRIE BYRON

Introduction and Qualifications

I am a Research Assistant Professor at the School of Marine Sciences, University of New England, an External Graduate Faculty in Aquaculture and Aquatic Resources at the University of Maine, and an Editor for aquaculture manuscripts submitted to the International Council for the Exploration of the Sea Journal of Marine Sciences. I was trained in the marine sciences as a National Science Foundation Fellow at the University of New England; and I was a National Science Foundation Coastal Institute Fellow at the University of Rhode Island. I received a Bachelor of Science in Zoology and Conservation Biology from the University of Wisconsin-Madison, and a Master of Science in Environmental Studies from the University of Massachusetts-Boston. I received a Ph.D. in Environmental Science from the University of Rhode Island (URI) in 2010 and was awarded the Science, Technology, Engineering, and Mathematics, or STEM award, as the most outstanding university-wide STEM graduate degree of that year at URI.

As a faculty member at UNE, my teaching and research includes the areas of Marine Ecology, Marine Biology, Sustainable Aquaculture, and Coastal Resource Management. My research focuses on sustainable aquaculture, and its multi-disciplinary ecological and technological interactions. I also focus on productivity of aquaculture in Maine, ecological impacts, and food security impacts of sustainable aquaculture. I have received multiple grants for my research, and participated in the recently completed, five-year, $20 million National Science Foundation aquaculture grant to the University of Maine conducted in partnership with the University of New England, an award that funded my studies on carrying capacity of coastal marine aquaculture.

Testimony

The testimony I share with you today summarizes my professional scientific opinions which are based on the best available science to date on aquaculture and environmental issues arising from the proposals before you from Nordic Aquafarms.

1. Recirculating Aquaculture Systems (RAS) for Salmon Aquaculture

Scientifically speaking in terms of environmental impacts, there are no better alternatives to salmon aquaculture production than land-based recirculating aquaculture systems. Ocean-based net pen technologies have advanced significantly over the past 20 years but ocean conditions are changing rapidly with accelerated warming, stronger and more frequent ocean storms, accelerated toxic algal blooms, and advancing marine diseases due to coastal pollution. In addition, to replace these proposed recirculating aquaculture systems with other systems such as net pens at the scale of production proposed by Nordic (33,000 MT), a significant amount of crowded nearshore ocean space would be required causing additional user conflicts with Maine's existing fisheries and recreational industries. Offshore aquaculture outside of the influence of Maine's coastal zones could be a possible alternative. However, there is no existing permitting regime for offshore salmon aquaculture in federal waters. Some land-based aquaculture practices for the salmonids, which include similar species as Atlantic salmon, trout and Arctic char, are more impactful on the environment in comparison. For example, U.S. production of rainbow trout is about 50 million pounds per year, with Idaho accounting for about 75% of that total. However, Idaho trout is grown in flow-through concrete troughs with no recirculation. Wastewaters are discharged directly to the Snake River in Idaho. The amount of water used and nitrogen discharged per pound of fish produced in this system are significantly higher than water use and discharge estimates provided by Nordic for their proposed recirculating aquaculture system. Thus, salmonid culture in this manner is not a viable alternative for Maine.

Recirculating aquaculture systems meet the highest environmental and social standards in the world today. No other alternative salmonid production system can make this claim. Four major seafood certification bodies, all of which employ some of the world's most respected aquaculture scientists to make their rigorous evaluations, agree. GLOBAL G.A.P. (Good Agricultural Practice), created by several European supermarket chains, is the world's most widely implemented farm certification scheme, and it has certified recirculating aquaculture systems as a best practice. Many customers for aquaculture products now demand evidence of GLOBAL G.A.P. certification as a prerequisite for doing business. The Aquaculture Stewardship Council, founded by the World Wide Fund for Nature and the Dutch Sustainable Trade Initiative, is the only aquaculture certification recognized by the International Social and Environmental Accreditation and Labelling Alliance (ISEAL) Code of Good Practice for Setting Social and Environmental Standards. The Aquaculture Stewardship Council has certified recirculating aquaculture systems as having the highest environmental sustainability and social responsibility. The Monterey Bay Aquarium's "Seafood Watch Program" has recommended as a "Best Choice", "salmon farmed worldwide in indoor recirculating tanks". The Global Aquaculture Alliance has certified recirculating aquaculture systems as "Best Aquaculture Practices".

2. **Water use**

There is no 100% recirculating aquaculture system. All recirculating aquaculture systems must exchange a small percentage of the rearing waters for optimal system's performance and for optimal fish health. The amount of water exchanged is usually 2-5% of the volume of the system and is dependent upon capital investments made in the most modern wastewater treatment technologies, and the permitting structures of the jurisdictions in which the systems are located

Nordic plans to discharge 7.7 million gallons per day, and that may seem like a lot of water. However, in comparison to other permits for land based salmon aquaculture systems, considering production efficiencies of water use - the amount of water use per pound of salmonid production on land – it is best in class. We have received data from another state and from publically available permits in Maine. The table below demonstrates that Nordic is best in class in terms of water use efficiency in salmon production. Nordic is clearly pushing the innovation technology envelope in recirculating aquaculture systems not only here in Maine but also on the world stage.

Recirculating Aquaculture System (RAS) Facilities	**Gallons of water used per pound of fish produced**
Permitted, existing RAS site in Maine	6408
Proposed permit of new RAS in Maine	154
RAS permitted in another US state	382
Proposed permit of Nordic Aquafarms	39

From an oceanographic perspective, it is estimated that Penobscot Bay exchanges 2.6 trillion gallons a day. The water use planned by Nordic of 7.7 million gallons per day when compared to the Bay's daily exchange is the equivalent of 1 drop in a 5-gallon bucket. At these proposed levels of discharge, there will be no impacts on bay-wide temperatures or salinities with this small amount of water inputs compared with daily tidal and other exchanges.

3. **Discharges**

Aquaculture effluents are not concentrated wastes in the same sense as conventional wastes from sewage plants. Aquaculture effluents have much lower concentrations of total solids and nutrients due to the high degree of filtration and treatment that occurs. However, given the volumes of waters discharged they still present environmental concerns. Older technologies for producing salmonids such as flow through troughs and net pens discharge all of their wastes directly to aquatic environments.

However, the aquaculture science community, after more than 40 years of research and development in recirculating aquaculture systems, have made significant breakthroughs in

feeds and waste treatment systems that ameliorate any large-scale environmental impacts. At very significant capital and operating costs, Nordic plans to implement the latest advances in feed and waste treatment technologies.

Food conversions are expected to be 1.1 pounds of dry feed to wet fish weight, which is now an industry-wide standard in salmonid aquaculture as feed manufacturing has advanced considerably over the last decade. Technological advances in monitoring systems ensure all feeds put into the systems are eaten by fish with the small amounts of uneaten feeds removed by the waste treatment systems so that waste feeds are not discharged in effluents. Dusts and fine particulates in fish feeds have decreased to almost nothing. Nordic's feed formulations are expected to change throughout the salmonid growing cycle in order to maintain fish (and consumer) health. Nordic is at the forefront of sourcing the most sustainable feeds available in the world today and plans to monitor closely its fish in to fish out ratios, explore alternatives to fish oils from fisheries such as algae oils, and economically viable alternatives to fish meals such as the newly available insect-based commercial proteins now formulated for salmonid feeds.

Nordic will have one of the world's most sophisticated aquaculture waste treatment systems that not only removes larger, settleable solids but also will employ state-of-the-art microfiltration screening of such a small size (0.02-0.04 micrometers) that bacteria will be removed. Nordic will have nitrification units similar to all other recirculating aquaculture systems in the world today. These transform toxic ammonia-nitrogen from fish wastes through bacterial action to the non-toxic nitrate-nitrogen. All other commercial recirculating aquaculture systems in the world today stop here and discharge the nitrate nitrogen to receiving waters. This is of environmental concern. However, Nordic will employ a further, very expensive and innovative water treatment after this, called denitrification technology. Denitification removes the nitrate-nitrogen to nitrogen gas, a harmless discharge to the atmosphere. Nordic will remove about 85% of the total nitrogen, which would exceed any wastewater treatment system of its size in the State of Maine. Overall, 99% of the solids, 99% of the biological oxygen demand, 99% of the chemical oxygen demand, and 99% of the phosphorus will be removed by this very advanced system.

According to a 2011 study that examined nutrient sources and transport mechanisms in Penobscot Bay, approximately 12% of the nitrogen in the Bay came from agricultural runoff, 18% from developments, and 4% from point source discharges, with the remaining 66% from atmospheric deposition (due to winds from the Midwest). Nordic's discharge is anticipated to add less than 1% to the point source discharge figure.

4. **Escapees**

Escapement from land-based salmonid farms is of no environmental concern in comparison to escapes that have been reported from water-based net pens.

We are in partnership with a major Norwegian university and are aware there has been concerns raised about fish escapes from recirculating aquaculture systems facilities in Norway. These escaped fish were from land-based recirculating aquaculture systems of

small nursery-sized fish growing facilities, of which there are many in Norway. Fish escapes were from transfers made from land-based facilities near the shore to fish well boats that were transferring small fish for stocking into ocean-based net pens. These were not escapees of large, adult fish from recirculating aquaculture system growout facilities.

There are stringent regulations in Norway that require **three (3) barriers** to be placed between the fish growout facility and the environment. Nordic plans to have **twelve (12) barriers** between the fish growout facility and the environment. Indeed there will be complex, highly advanced wastewater treatment facility that I have already described between the fish growout tanks and the environment, making escapement next to impossible, with the one possible exception of deliberate, illegal movement. Nordic proposes to deliver fish not from boats but rather from hatcheries and nurseries on land using the best available land-based transfer technologies.

Dated: December 11, 2019

By: _____
Carrie Byron, Ph.D.

Notary for Cumberland County, Maine
Commission Expires 04/12/23
Janna A. Merritt