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AIT Research

Developing Sustainable Freshwater Aquaculture using Irish Peatlands during COVID-19 Crisis

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Introduction

Figure 1: Aerial view of the **AquaMona trial fish farm** located in the middle of Mount Lucas Wind Farm, Co. Offlay.

Aquaculture is one of the **fastest growing food** producing industries in the world[1]. Aquaculture will contribute to **meeting global need for sustainable food production**. The Irish aquaculture sector was worth €208.4M in 2017[2]. However, several factors have hampered the growth of the industry, including disease and environmental impacts[1,3]. **Bord Iascaigh Mhara (BIM),** undertook a feasibility study to assess the potential use of **peatlands (bogs**), for sustainable aquaculture diversification[4]. In April 2019 BIM, in conjunction with **Bord na Mona**, begun the **AquaMona project** and opened a trial fish farm at the Mount Lucas Wind Farm[4,5] (*Figure 1*). AquaMona is a **new concept** in **integrated multitrophic aquaculture (IMTA),** which uses cutaway bogs to farm rainbow trout (*Oncorhynchus mykiss*) and Eurasian perch (*Perca fluviatilis*) with associated organic status that is powered by wind energy and utilises algae and duckweed to treat rearing water[5]. There is total reliance upon **natural processes** for **water quality** and waste management negating the ability to use antibiotics or other chemical biocides that would address **risks to process security and ecosystem.**

Algal communities have been exploiting during this a previous studies to address latter threat. This includes wastewater process efficacy through assimilation of nutrients, along with providing health benefits to fish both in terms of nutrition and bioactives[6]. However, there is a **lack of knowledge** on the specific contributory **role of algae** in the **aquaculture process for this purpose**. Equally missing is the **relationship** between algae, **microbial communities and the role of harmful cyanobacteria in this process.**

The Aim of this research is to develop a comprehensive understanding of the relationship between algal and microbial communities in freshwater aquaculture so as to specifically inform and guide the development of this novel innovative peatland cut-away IMTA process. This would provide unique new knowledge for aquaculture industry as to critical role of algal and microbial communities in maintaining optimal IMTA conditions.

Methodology

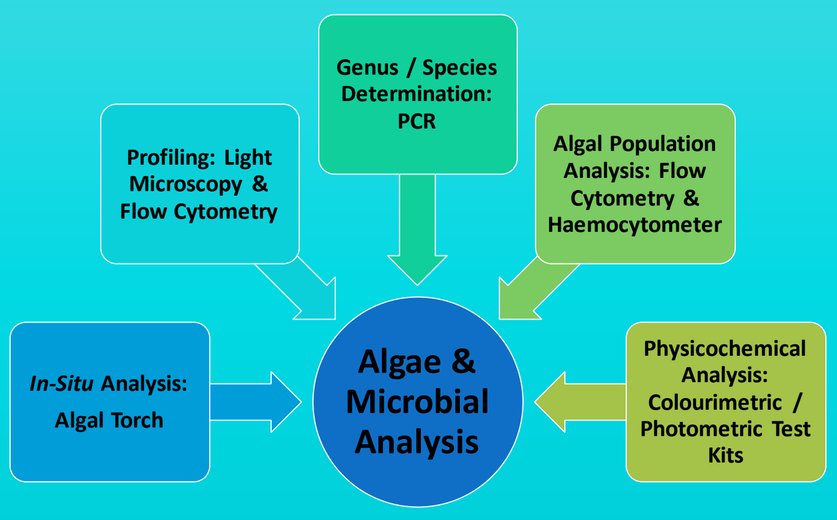

Figure 2: Breakdown of methods applied to assist in analysing the relationship between the algal and microbial communities of Mount Lucas Fish Farm.

Results to Date

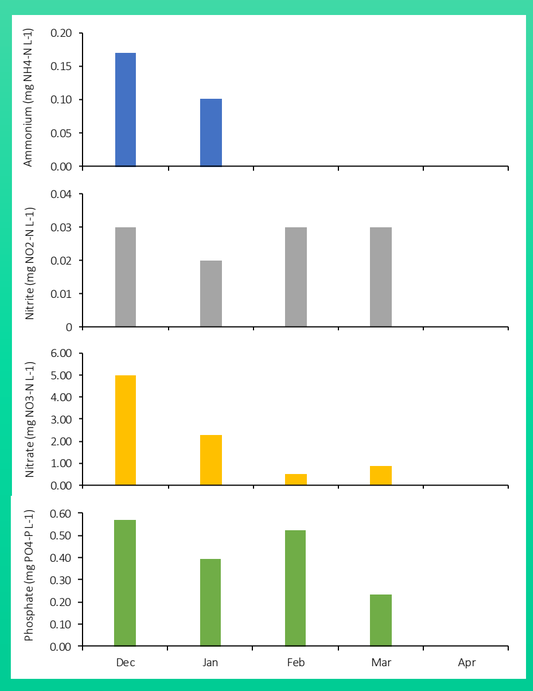

Figure 3: Physicochemical analysis of culture ponds from December 2019 to April 2020. n = 8

Physicochemical Analysis
Analysis included ammonium, nitrite, nitrate and phosphate analysis (Figure 3). Decreases were observed in ammonium and nitrate from February onwards.

Algae & Microbial Analysis
Analysis included algal counts, bacterial counts, cyanobacteria levels and chlorophyll concentrations (Figure 4). Increases in cyanobacteria coincided with decreases in algae from February. Fish mortalities have also been included.

Due to the COVID-19 pandemic, results for April have not yet been fully established.

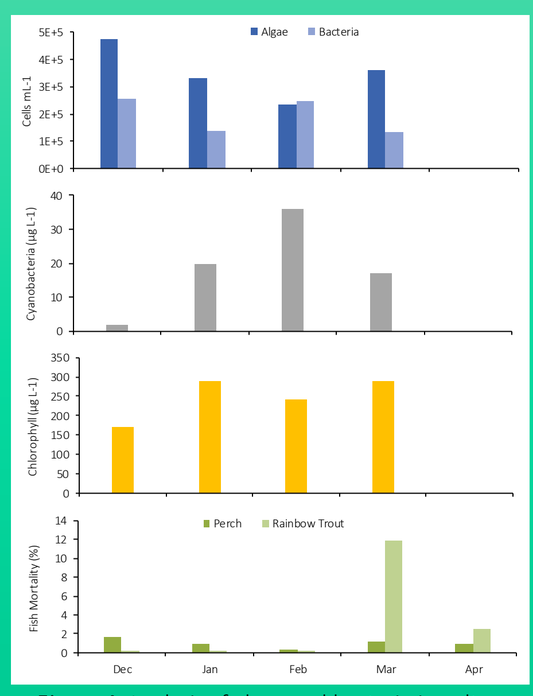

Figure 4: Analysis of algae and bacteria in culture ponds from December 2019 to April 2020. n = 8

Discussion

Unpredictable changes in our weather has had major repercussions on the fish farm.
- February 2020 displayed the highest level of rainfall for a single month in Ireland since records began.
- Traditional average = 70.3 mm of rainfall. February 2020 - 197.5 mm of rain fell.
- Algal and nitrate levels diluted. Algae's preferred nutrient source is nitrate.
- The nitrogen phosphorous ratio (N:P) was reduced = Cyanobacteria growth favoured.
- Cyanobacteria's preferred nutrient source is ammonium ∴ Nitrification process could not occur preventing nitrate from forming further limiting algae growth and recovery.

Cyanobacteria growth
- Cyanobacteria is always present at low levels within the farm. Approximate 90:10 Algae:Cyanobacteria.
- Higher ratios of algae keeps cyanobacterial levels in check preventing toxic conditions.
- Reduced algal levels and nitrate concentration increased favourable conditions for cyanobacteria.
- Subsequent burst in cyanobacterial growth = catastrophic implications for the fish.
- High mortality rates within the rainbow trout population of the farm were observed. Up to
- >18% mortality was recorded at times during the month of March.

Mitigation measures suggested and applied
- Introduction of straw to help absorb the cyanobacteria.
- Use of small amounts of activated charcoal to neutralise and eliminate the Cyanobacteria toxins.
- Cyanobacteria levels have began to decrease and algae / chlorophyll levels are on the rise.

More research needs to be conducted to establish the efficacy of the measures, and to also determine which cyanobacteria species are causing issues so as to ensure that the most appropriate mitigation processes are being applied.

Challenges & Solutions

- COVID-19 has had dramatic effects on the way research is now conducted.
- Limited data sharing ability in real-time.
- Although limited lab work was conducted, it was very effective where analysis has been conducted during the lockdown period supplemented with *in-situ* monitoring of Trout and Perch on commercial farm at Mount Lucas (Bord na Mona).
- Samples are also preserved for future analysis post COVID-19 restrictions.
- Clear effectives solutions have been furnished to BIM to help over come cyanobacteria problem in real time to alleviate fish mortality

Future Work

- Analysis of backlogged samples.
- Continued assessment of beneficial uses of algae. Mainly water quality and immunology.
- Molecular analysis in harmful cyanobacterial species present and their toxic compounds.
- Development of tools for monitoring and decision making

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