Applying IMTA to an Irish monoculture site for Salmon production

Foras na Mara
Marine Institute

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Background

Integrated Multi Trophic Aquaculture (IMTA) is acknowledged as a promising solution for sustainable development of aquaculture. By farming multiple lower trophic species adjacent to traditional aquaculture enterprises, such as salmon monoculture, the wastes and by-products of one species become the feed, fertiliser and energy source for the others. This practice is shown to reduce waste materials from fed species and lower the nutrient load in the water (FAO,2018).

This paper aims to give an overview of applying IMTA to an Irish monoculture site for Salmon production with the introduction of the lower trophic species *Alaria esculenta, Pecten maximus* and *Homarus gammarus*. Utilising low trophic products such as invertebrates and seaweeds (Barbier, 2019) would maximise the use of the licensed aquaculture area and reduce the environmental impact of the monoculture activity. If successful, this method could be adapted by other monoculture sites to provide more eco-efficient practices, creating more goods and services while using fewer resources and generating less waste.

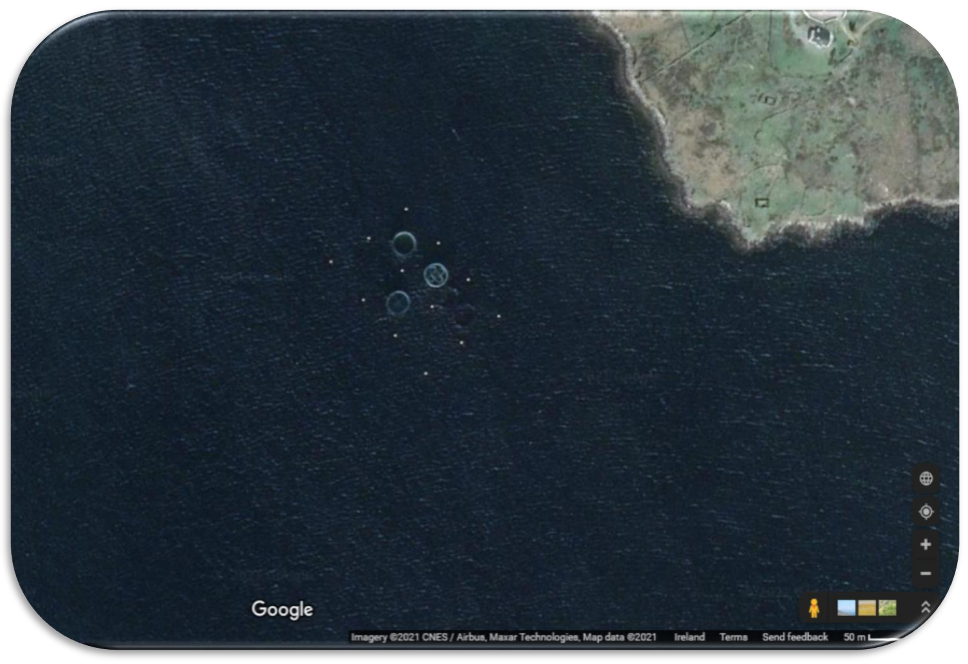

Figure 1. Satellite image of Lehanagh Pool Research Site with pens and cushion buoys visible

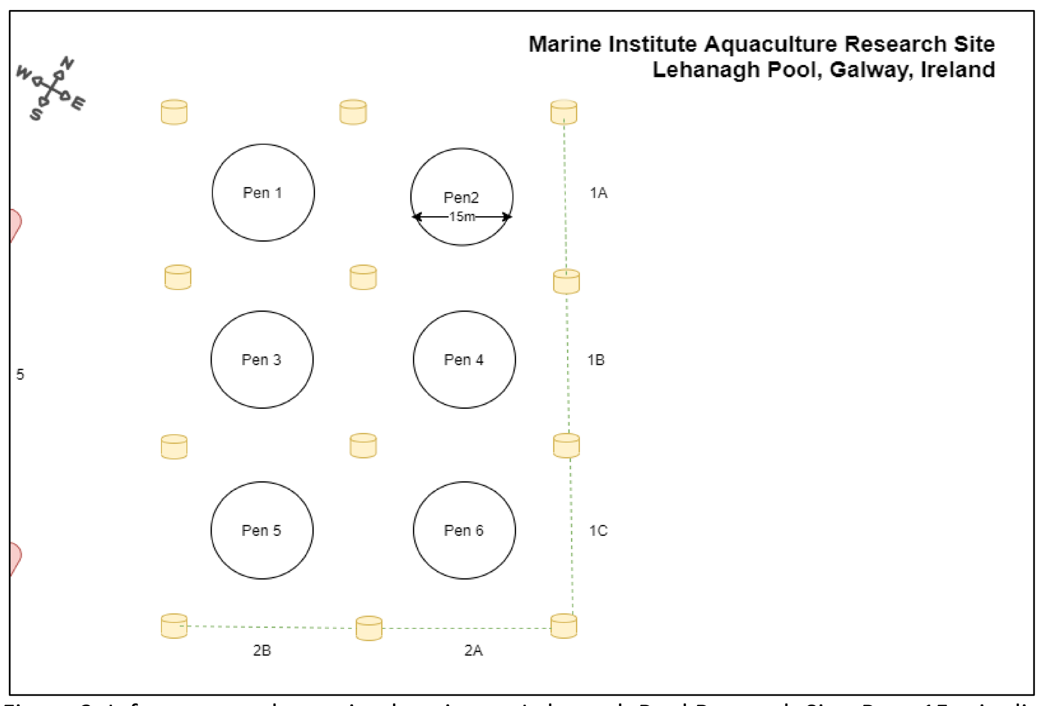

Figure 2. Infrastructure layout in plan view at Lehanagh Pool Research Site. Pens 15m in diameter. 50m spacing between yellow cushion buoys. Longlines 50m in length between cushion buoys on SE perimeter of site. Prevailing current NW-SE. Fish stocked in Pen 2, 3, 4.

Figure 3. Site image with pens and cushion buoys

Methodology

Lehanagh Pool Research site, is a coastal aquaculture installation located 0.25 km from the shore in Bertraghboy Bay, on the West Coast of Ireland. The site is a licensed 23 hectare multi species research site operated by the Marine Institute. The location is relatively sheltered with no significant fetch or swell, waves are produced by local wind conditions. Tidal range is approximately 5m, salinity is typically >32 ppt but can range from 24 to 35 ppt. Water temperatures range from 5 – 18 degrees Celsius, and current velocities are moderate with a predominantly NW-SE flow of approximately 1.5 m/s.

In this trial the decision was made to cultivate winged kelp, *Alaria esculenta*, Scallop, *Pecten maximus* and European Lobster, *Homarus gammarus* within the current grid infrastructure traditionally established to hold salmon pens. The trial site is a pilot scale (a scaled down version of traditional commercial pens). The moored grid infrastructure supports 6 pens of 15m diameter. To reflect this, grid spacing is 50m between cushion buoys.

Crop yield, biomass and condition are monitored throughout the growing cycle. This data was compared to abiotic data relating to current direction and to location on the site. Molecular analysis of the harvested seaweed was carried out to look for variation in composition based on location on the site. The costs to add the additional structures, and the cost of operating procedures to maintain the additional species are also considered.

Lobster (*Homarus gammarus*)

- 204 individuals put to sea at stage 5 development
- Grown in Sea Based Container Culture units (SBCC) (Halswell *et al.* 2016) suspended from sea pens

6 months at sea

- SBCC have a wide assemblage of organisms
- Lobster are increasing in size and found to be utilizing salmon waste (Baltadakis *et al.* 2020)

18 months at sea

- Robust development of stock
- Ready for release as stock enhancement providing an ecosystem service for local stakeholders

Kelp (*Alaria esculenta*)

- *A.esculenta* seeded to kuralon deployed to the site in October
- Kuralon was wrapped around 5 x 32mm nylon header ropes suspended between cushion buoys at -1.5m depth supported by 10" trawl floats

3 months at sea

- Kelp morphology and biomass monitored throughout the growing season.
- Each line (1a, 1b, 1c, 2a and 2b) is assessed separately as orientation on site and location from fish stocks varied (Figure 2)

6 months at sea

- Harvest took place in May ~1038kg from 200m of longlines
- Variation in total biomass found across the individual lines monitored
- Maximum yield recorded 9kg/m

Scallop (*Pecten maximus*)

- Transferred to site at average weight of 18.55g
- Low stocking densities in tradition Chinese lantern nets suspended from pen structure

6 months at sea

- Quarterly checks to assess growth rate and maintain structures

24 months at sea

- Predicted total biomass for harvest after 2 years of 38kg
- Ongoing remediation and uptake of particulate waste from the fish and environment

Results

Utilising the existing grid structure successfully yielded a crop of seaweed with maximum biomass of 9kg/m and provided a culture habitat for scallop and lobster. By utilising the existing grid structure, no additional moorings were required. There is no capital expenditure or engineering required to modify the site. This resulted in less visual impact, savings in environmental footprint and maximised the use of the existing space. The cost of this installation was €338 (excluding seed stock) which is all reusable for the future growing seasons.

Reduced environmental impact is demonstrated as waste from the salmon at the farm was remediated by the low trophic species added, through nutrient cycling in the kelp and the scallop, whilst the lobster also showed utilisation of salmon waste. When scaled up to a commercial level in Ireland there is a potential to culture over 4 tonnes of high value seaweed as an additional crop during the winter months as well as the extra added value of turning to a more circular production system. This low visual impact approach and more optimal use of the limited space for aquaculture within the coastal zone proved successful.

Discussion

The benefits of adopting an IMTA approach to aquaculture are well reported. IMTA sees a reduction in ecological impacts and creates a more circular production system with extraction and conversion of excess nutrients and energy into commercial crops. By optimally using the available areas, limited coastal space is utilized more effectively and efficiently. There is an increase in commercial biomass produced, along with a diversity of products which spread economic risk and facilitates better cash flow. In addition communities benefit from added local enterprises, and there is an increase in the societal perception of aquaculture by using more environmentally farming practices.

Although yields were not at a commercial level, a significant tonnage was achieved, providing additional value from the added products. There were further ecosystem service benefits from co-culturing novel low trophic lobster species for potential release to the wild for restocking.

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