TOOLBOX
AQUACULTURE

Marine Institute
Foras na Mara

Determining the change in biogeochemistry in Lehanagh due to IMTA and the benefit of IMTA over salmon monoculture

SUGGESTED USERS	PLANNING PROCESS	TYPE OF AQUACULTURE
Aquaculture producers Regulators Spatial planners	Permit Location EIA Consultation Decision	Integrated Multi-Trophic Aquaculture (IMTA)

SUMMARY

Determining the change in biogeochemistry in Lehanagh due to IMTA and the benefit of IMTA over salmon monoculture.

DESCRIPTION

Use of two model configurations to establish the change in water quality parameters in response to IMTA and the impact if producers reverted to salmon monoculture. The three models are: 1) A standard NPZD model, and 2) ROMS-NPZD-IMTA stocked with salmon, lumpfish, lobster and seaweed. Hence, the study captures the changes in water quality due to deployment of IMTA. The ROMS-NPZD-IMTA model should be used to optimise the distribution of IMTA species to maximise productivity and minimise the environmental impact.

THE ISSUE BEING ADDRESSED

In the coastal environment, nitrogen is the limiting-nutrient for primary productivity. Deployment of monoculture aquaculture to the coastal environment leads to the addition of nitrogenous wastes to the water column and the benthos. Additional nitrogen has the potential to drive blooms if other conditions such as light are sufficient. Integrated multitrophic aquaculture (IMTA) has the potential to offset nitrogenous inputs to coastal waters via bioremediator species such as lobster and seaweed. While lobster operate as filter feeders, seaweed species remove inorganic nitrogen from the water column as it is excreted from fish and mineralised from the benthos. As both bioremediators can be harvested, IMTA mitigates the environmental impact whilst generating marketable products.

The ROMS-NPZD-IMTA model was used to explore the impact of an IMTA configuration on inorganic nitrogen, phytoplankton and chlorophyll a.

THE APPROACH

The ROMS-NPZD-IMTA model describes the growth of salmon, lumpfish, lobster and seaweed in response to finfish species receiving a sustenance diet of pellet aquaculture feed. The model resolves the mineralisation of wasted aquaculture feed and finfish faeces, as well as the ingestion of waste aquaculture feed by lobster. The model requires information on the species specific daily feed rate, food conversion ratio, mortality rate, feed wastage, faecal excretion, fraction of feed that is respired into the water column, and the N and C content of aquaculture pellets. The NPZD module requires initial grids throughout the model domain for nitrate, ammonia, chlorophyll a and phytoplankton. The IMTA module requires an initial grid specifying the location (lat, lon) and depths at which different species are located.

THE RESULTS

The model was used to explore the outcome of the following scenario for a seven week simulation:

- Initial salmon stocking: 7000 salmon @ 105g weight each, distributed throughout the 14m depth of the net-pen
- Initial lumpfish stocking: 500 lumpfish @25g weight each, within the upper 2m of the net-pen
- Initial lobster stocking: 200 lobster @ 0.75g weight each, distributed between 6 and 10m deep in the net-pen
- Initial Ulva weight of 5g distributed between 3-6m deep in the net-pen
- Fish were fed at a constant rate throughout the day, with wastage of feed ascribed as 3% to reflect a lean operation.

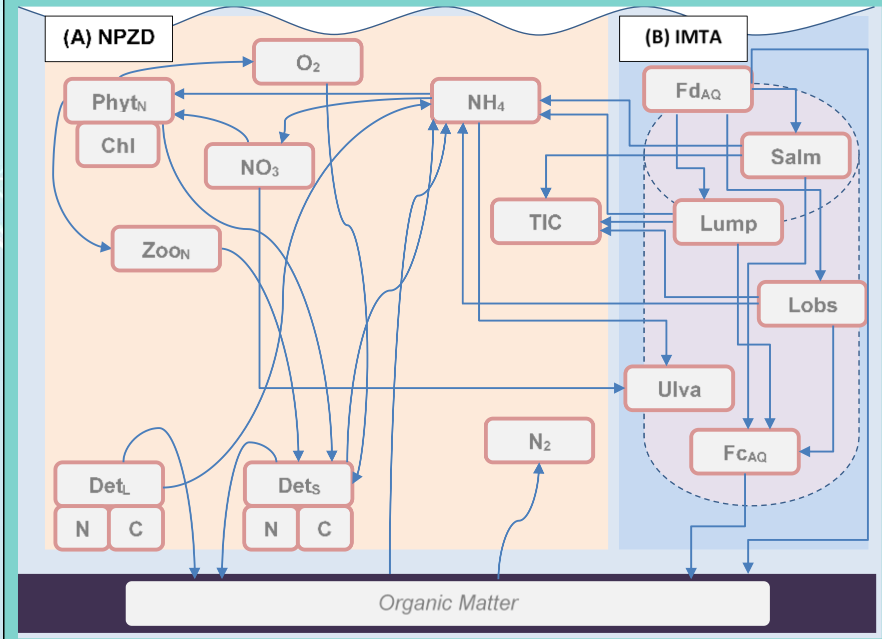
A baseline NPZD scenario was run to establish a baseline for comparison. As a result of IMTA deployment:

- There was a decrease in NH_4 of 10-15%
- There was an increase in NO_3 by 40-60%
- There was an increase in chlorophyll a and phytoplankton by 20-30%

The model may be used to explore an ensemble of IMTA configurations to determine the stocking rate of lobster and seaweed which would most closely resemble the natural concentrations in the water column.

THE BROADER APPLICABILITY

The model can be used to establish the potential yield of seaweed where finfish monoculture currently exists. Where an aquaculture industry is seeking to expand operations, bioremediators may add economic value to the expansion and assist with licence compliance.



SWOT ANALYSIS

STRENGTHS	The model will provide an insight into what aspect would be greatest impacted by the IMTA deployment.
WEAKNESSES	Benthic mineralisation of faeces and wasted feed is simplified.
OPPORTUNITIES	The model can be used to determine the optimum deployment which mitigates the impact on the water column.
THREATS	The model requires input parameters which reflect the intake, metabolism and excretions of the species as they were deployed; generic parameters from literature may not capture site-specific interactions.

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LINK	Core engine: https://www.myroms.org/ ROMS-NPZD-IMTA model will be published in a scientific journal at future date. Interested users will be able to develop codes compatible with their numerical modelling system based on the methodology described in the scientific paper. We will aim to make the code available to users after peer reviewed publication.