EFFICIENCY AND ENVIRONMENTAL PERFORMANCE OF IMTA IN MARINE AND FRESHWATER SYSTEMS


Cooperation in Fisheries, Aquaculture and Seafood Processing
Introduction

Σ inputs → Fish farm → Σ waste
Introduction

Ecosystem

∑ Inputs

Fish farm

∑ wastes

Other products

Ecosystem services

Σ wastes
Ecological principles for aquaculture

In pond systems

Aubin et al., 2017
Integrated Multitrophic Aquaculture

IMTA systems are designed in order to:

1. Decrease the dependence on external inputs
2. Optimize the use of nutrients and energy in the production loop, in order to increase the system efficiency
3. Decrease the waste effluent and bio-deposit impacts by limiting the loss of nutrients (in water, sediments and air)
4. Diversify farm-products and generate a more robust source of income (less dependent on mono-product markets)
5. Generate and use different types and levels of ecosystem functions and services
Facing the complexity

- In IMTA relationship between species are multiple:
  - Trophic
  - Chemical
  - Behavioral
- The whole is greater than the sum of the parts
  - Optimizing the system is different from optimizing each part
- IMTA are still empirically built
- Social perception of IMTA are not well known
There is a need for

- More descriptions / observations of IMTA
  - To collect references in different contexts
- Modelling developments
  - To understand the system operation
  - To help design
- Global approaches
  - To assess the multiple performances
  - To identify the factors of implementation success
IMTA Effect
Efficiency and environmental conservation
ERANET COFASP 2015
IMTA Effect project

- Extension of IMTA to freshwater systems
- Understanding of the interactions of species of different trophic levels in IMTA,
- Provision of reliable practical references for system implementation
- A focus on the primary production, as it can be considered as:
  - the major trophic level in the capture of dissolved nutrient
  - the major functional component in the conversion of the CO$_2$ into O$_2$;
  - a source of food for the reared species, in a perspective of closed system approach (total recycling);
  - a source of income,
Organization

- Experimental approach aiming:
  - The assessment of the efficiency of different IMTA systems;
  - Nutrient and energy flows analyses (role of the different species in the food web, and the evaluation of the recycling efficiency) (WP1 & WP2).
- Modelling: to adapt and create specific tools for system running prediction connected with environmental analysis (WP3).
- Economic and social evaluation: to understand the perception of the IMTA by stakeholders through the ecological services framework (WP4).
Modelling approaches

LCA/EMERGY
Environmental assessment

DEB
Predict dynamic mass balance: predict growth (L,w), oxygen consumption, excretion and water quality (concentration of the elements)

ECOPATH
Robust (based on empirical data but not generic)
STATIC
represents the fluxes between species. Predict the consequences of changes in communities (trophic and other interactions)

Stable isotopes:
determine diet composition, identifies the trophic links

Mechanistic/Generic/high potential/but high investment
DYNAMIC

Information on interactions and level of feeding for instance (F-level).

Improve mass balance (e.g. growth exhibited at one food level)

Boundaries of parameters (productivity)
(e.g Fishbase gives averages).

Group 1
System complexity

Group 2
Ifremer case study

France

Producing seabass in RAS, phytoplankton for oysters, and worms on sediments
UDJG-Romfish Case Study

Romania

Cyprinid polyculture (common carp, silver carp, bighead carp, grass carp)

Fish stocking structure:
- **Cyprinus carpio** 74%
- *Ctenopharyngodon idella* 14%
- *Hypophthalmichthys molitrix* 6%
- *Hypophthalmichthys nobilis* 6%

Traditional system fish stocking structure:
- **Cyprinus carpio** 93%
- *Ctenopharyngodon idella* 4%
- *Hypophthalmichthys molitrix* 1.5%
- *Hypophthalmichthys nobilis* 1.5%
Conclusion

- There is a large number of systems which can be considered as IMTA.
- There is no one-size-fit-all solution; depending on the contexts (economic, environmental, social), the mix of species will be different.
- The challenge is to propose operational principles and calculation tools to guide the IMTA conception.
- The proof of concept has to be experienced more and more.
- In a scientific point of view, the interspecific interactions and the complexity are challenges to face.
- Therefore the exchange of experience is a necessity.
Thank you for your attention

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