AE 2020 – The Blue and The Green

aquaculture europe

VOL. 45 (1) MARCH 2020

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September 2020

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An Integrated Holistic Assessment of Mediterranean Aquaculture

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Training and Capacity Building Collaborations between Europe and SE Asia:

EURASTiP Case Studies

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THE MEMBERS' MAGAZINE OF THE EUROPEAN AQUACULTURE SOCIETY

1st Semester 2020
Afgiftekantoor: 8400 Oostende Mail

Defining Integrated Multi-Trophic Aquaculture: a consensus

Photo courtesy of project partner ISC. Juvenile sea spaghetti (*Himanthalia elongata*) 'buttons' transplanted from the lab and growing at sea in Galway, Ireland

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Integrated Multi-Trophic Aquaculture (IMTA) systems are a circular economy paradigm that contribute towards making aquaculture more sustainable and competitive. However, despite being encouraged by European Union (EU) policies such as the Blue Growth Strategy, the Atlantic Action Plan and RIS3, there are socio-economic, administrative and regulatory bottlenecks hampering the uptake of IMTA on an industrial scale. To overcome these, eight organisations from Spain, Portugal, France, Ireland, and the United Kingdom have partnered up to implement the INTEGRATE project (Integrate Aquaculture: an eco-innovative solution to foster sustainability in the Atlantic Area). Funded by the ERDF through the Interreg Atlantic Area Programme, the project started in 2017 and will finalise in May 2020.

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION
integrate
Integrate Aquaculture: an eco-innovative solution to foster sustainability in the Atlantic Area

INTEGRATE supports cooperation between different sectors, including academia, industry and administration, thus strengthening collaborative networks in the field of European Atlantic IMTA.

The need for a definition

During the first half of the INTEGRATE Project each of the Atlantic Area (AA) partner countries held a series of expert roundtables, with the goal of identifying IMTA best-practice as it currently stands within the AA. The main aim was to find commonalities in approach between countries, as well as identify areas in which they diverged, mainly due to differences in IMTA systems used, or species cultured. From these roundtables a common problem emerged: although the conceptual definition of IMTA was clear, even intuitive, a more utilitarian definition making some of the details explicit was necessary, for instance for regulatory purposes.

It was envisaged by IMTA stakeholders and producers that by addressing this need, IMTA could be better regulated and commercialised, perhaps by facilitating the development of an IMTA technical standard. This standard might later form the basis of an IMTA specific eco-label, further promoting the IMTA sustainable aquaculture 'brand', thus enabling the social and economic potential of IMTA in a series of steps.

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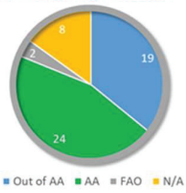
CAN WE PROPOSE ONE COMMON DEFINITION OF IMTA?

PROFILE OF THE PARTICIPANTS

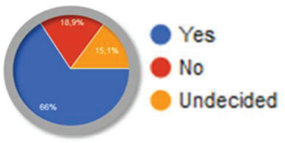
53 contributions from more than 17 countries (out and within Atlantic Area).

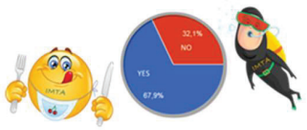
- Researchers
- Producers
- Industries
- R&D
- Policy markers



WHAT PERCEPTION OF THE CONCEPT ?

Does IMTA need to be defined?





Key point of IMTA is « Multi-trophic »

Key point of IMTA is « Aquaculture »

KEY ASPECTS OF IMTA

Interactions between co-cultured species

Most important interaction(s)

- Efficient transfer of matter and/or energy
- Disease mitigation
- The lowest occupation of space

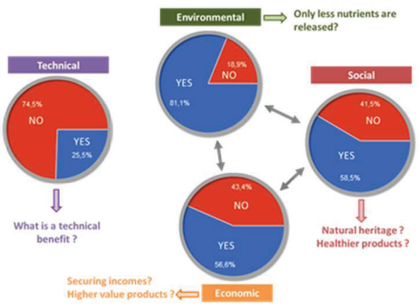
Any negative effects?

- Competition between species for space, oxygen, feed
- High nutrient flow can stimulate undesired organisms.
- Biosecurity : Antibiotics/chemical ; disease/pathogens
- Life cycles that do not overlap.
- Hindrance of water currents in open sea-based sites.
- Challenges with mooring of the installations : Heavy structures to be installed and secured

Regulatory framework

- No official text clearly dedicated to IMTA regulation
- IMTA is only proposed/suggested in some regulations in force.
- The question of co-cultivation is considered for health and environmental security

Technical, environmental, social & economic issues



Direct *versus* indirect revenue / benefit must be clarified

Geographic scale

Define how the compartments should be connected for IMTA

Different farmers can work together depending on their own skills and manage their own production.
Cooperation of different experts to combine and value their own skills better than Multi-skills single producers.

GENERAL CONCLUSIONS/QUESTIONS

1/ A definition is needed but it will be difficult to cover all the applications
2/ Should IMTA definition consider land-based and at-sea systems separately ?
3/ How to estimate the "success" of IMTA?
4/ To fit for Sustainable Development scheme:
- Define what are environmental, economic and social benefits
- Define their interactions

5/ Which position of IMTA relative to conventional/traditional aquaculture sectors ?

Figure 1. Summary of the questionnaire results

International experts from within and outside of the AA brought forward their opinions by means of a questionnaire that we launched in December 2018. The questions were derived from analysis of the thematic roundtables within each country and were devised in order to outline how much consensus existed within the IMTA community about what IMTA is. A summary of the analysis of the questionnaire results is presented in Figure 1 (*page 23)*.

By analysing the questionnaire, we were able to identify areas about which there was consensus versus areas in which there was a polarised split, and others with a more diverse range of opinions. These areas of discordance became the focus of the questions that we used to facilitate discussion sessions during a focused 'IMTA definition event' hosted at the Interreg Atlantic Area Managing Authority in Porto, 9th May 2019). During the event we brought together about 40 international IMTA experts from within and outside the AA. Our main aim during this event was to work towards finding consensus, or a way around a lack of consensus, with regards to what should be included in a definition of IMTA (and how).

Although within the IMTA community there are diverse opinions about the appropriateness of 'defining' IMTA, within the INTEGRATE Project community of IMTA stakeholders there was a clear consensus that it is an essential step in furthering the development of the industry. The starting point of the event was therefore that the need for a definition exists, and what the event aimed to achieve further to this was twofold:

- To operationalise the conceptual definition of IMTA;
- To decide and agree on what is and what is not IMTA.

It is important to stress that this is not a fundamental definition, but one that will be useful in policy terms, to facilitate funding and to enable national governments to be better able to direct licensing and appeals, among others. Additionally, a longer-term view sees the definition as the basis of development of an IMTA eco-label.

Photo courtesy of project partner CEVA. Assays of various harvesting techniques of Nori (*Porphyra purpurea*) cultivated from natural recruitment on oyster pockets as part of IMTA in the bay of Mont-Saint-Michel, France

Starting from the premise that a definition is needed, also based on previous work, through our INTEGRATE Project activities, i.e roundtables, questionnaire and definition event, we have been able to confirm this. An infographic of the INTEGRATE Project's process of obtaining a definition of IMTA can be found in Figure 2 (*page 26)*.

Table 1: The main contentions and their resolution

CONTENTION	RESOLUTION
A global definition of IMTA – is it possible or should we define different criteria according to each system?	Yes, it is possible and **necessary to have a global IMTA definition** including all its various iterations, i.e. freshwater/marine; land-based/open-water; recirculating/flow-through, amongst others. It is essential that the definition be broad and all-encompassing so that it can be understood across the board, and this simple definition will be accompanied by a technical standard which can be detailed and layered. In this way, all stakeholder groups will be represented at an appropriate level of detail for their needs, and this will help to guarantee wider adoption of IMTA practices in the European Atlantic Area.
Are terrestrial organisms compatible with IMTA systems?	Although integrated systems can also include terrestrial organisms, all agreed that the **primary product and core activity** must be **aquatic**.
Are phrases such as 'trophic levels' or 'functional groups' useful and easily understood by public and policy makers? Should we use something as complex, or use an all-encompassing, easier term?	Neither trophic levels nor species are adequate terms. **Functional group** was agreed to be the most appropriate descriptor of the 'unit' in an IMTA system as it is the 'function' of each organism that dictates its compatibility alongside other organisms to create balanced IMTA.
Should social and economic benefits be explicitly included alongside environmental benefits in the definition?	Although social and economic benefits are inevitable and coupled to environmental benefits, they should not be part of the definition; they are associated indirect effects. In fact, careful thought should be given before including such factors in any definition/standard as they can result in difficulty managing the expectations of those gaining certification by implying benefits that may, or may not, materialise.

Photo courtesy of project partner CTAQUA. Floating cages of seaweeds (*Gracilaria and Ulva* spp.) as part of IMTA in Bay of Cádiz, Spain

Photo courtesy of project partner CTAQUA. Suspended bags of oysters (*Magallana gigas*) as part of IMTA in the Bay of Cádiz, Spain

Photo courtesy of project partner CEVA. Artificial seeding of dulse (*Palmaria palmate*) on a piece of oyster pocket. Fertile sporophytes were used to produce spores in hatchery. The idea was to recycle old oyster pockets as artificial substrates for Dulse cultivation in Pleubian, France

Photo courtesy of project partner IPMA. Suspended bags of oysters (*Magallana gigas*) as part of IMTA in Olhão, Portugal

Is one definition even possible? And what should it contain?

Although it was clear that a definition is needed, we knew from the start that it would not be a simple task. There remained many points of contention, which we aimed to resolve at our IMTA definition event in May 2019.

Divided into different land-based and sea-based groups, the participants discussed the following points of contention and worked towards resolutions (Table 1).

Interpretation of the "Multi-Trophic" part of the concept:

While participants showed different interpretations of the term multi-trophic, and had preferred related vocabulary, a preference for the term 'functional groups' was shown in relation to an IMTA definition. As it is important not to constrain the definition too tightly and limit its use, prescriptive formulae such as '*IMTA must include an excretive only organism*', or '*IMTA must include both organic and inorganic extractive groups*' are not appropriate within a definition. But there must be a minimum number of two distinct functional groups, i.e. at least one **excretive species** and one **extractive**. This would move away from a '*fed aquaculture*' definition, to one where the '*income of nutrients*' is a defining factor – perhaps a change in perception of the system.

Similarly, quantification of the degree of trophic connectivity should not be specified in any definition. There should be broad scope for inclusion of all IMTA systems, whether these are strongly or weakly energetically connected, as long as the connection can be demonstrated. What matters are not absolute values, but that IMTA farms do not compromise functionality of the ecosystems in which they are situated.

A part of the discussion focused on management of the energy flow between organisms. There was a broad consensus that the **energy exchange** between them must be **intentionally managed**. This means it is possible to use wild organisms that proliferate naturally in IMTA systems if their proliferation is intentional and managed. For example, tilapia grown in green water that feed on naturally proliferating phytoplankton. What is imperative is the harvest/removal (not necessarily sale), of the secondary species that allows manipulation of nutrient cycles – the critical factor is the removal of biomass, and therefore control of, for instance, N and P, within the system.

Expected benefits of IMTA:

Food production needs aquaculture, and aquaculture needs to be sustainable and efficient. Therefore, the focus of the work should be towards increased sustainability and efficiency, *which the final definition should facilitate*. Neither a definition *per se*, nor IMTA-certification are end goals but aim at stimulation of good practice in industry via an economic incentive.

It is clear that social and economic benefits cannot be disassociated from environmental benefits – and that these benefits will have a bearing on various relations in areas where aquaculture is important - i.e. in areas with the tourist industry or where the image of aquaculture is a problem. These social and economic factors can be used as opportunities for communication and promotion of IMTA. However, the core-principle of IMTA is *multi-trophic*, as this is what singles it out from other types of aquaculture. IMTA is by definition an environmental concept as nutrient uptake is the core principle, therefore nothing else is necessary in order to define it.

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The INTEGRATE approach to defining IMTA

ROUNDTABLES 20

- 5 economic roundtables
- 5 technical roundtables
- 5 social and regulatory roundtables
- 5 environmental roundtables

Each COUNTRY hosted 4 roundtables:

- France
- Ireland
- Portugal
- Spain
- United Kingdom

PARTICIPANTS 350

At the 20 workshops more than 350 participants were involved, representing academia, industry and state institutions

QUESTIONNAIRE 52

OBJECTIVE

Developed to understand areas of consensus, and lack thereof, with regards to understanding 'what is IMTA'.

 # NUMBER OF CONTRIBUTORS

52

TARGET AUDIENCE

Experts with direct knowledge or experience of IMTA, both academics and producers.

- International representation (FAO)
- Worldwide: Australia, Brazil, Canada, Chile, Israel, Mexico, South Africa, USA.
- Europe outside AA: Denmark, Italy, Netherlands, Norway
- Atlantic Area: France, Ireland, Portugal, Spain, UK

DEFINITION EVENT 40

Porto (Portugal) Event: MAY 9, 2019

To discuss the points identified from the questionnaire where there was lack of consensus about what constituted IMTA.

11 countries

AA: France, Ireland, Portugal, Spain, UK

Europe: Norway; Italy; Hungary; Belgium

Worldwide: Israel, China

40 experts

- Academia (22)
- Industry (7)
- State/regulatory bodies (7)
- NGOs (3)

2 WORKING GROUPS:

- A land-based systems
- B sea-based systems

4 THEMED DISCUSSION SESSIONS:

- Fundamental terms of IMTA
- Environmental, social and economic benefits of IMTA
- Integration; scale, connectivity and ownership
- IMTA regulatory framework

DEFINITION OF IMTA:

Enhanced production of aquatic organisms (with or without terrestrial organisms) of two or more functional groups, that are trophically connected by demonstrated nutrient flows and whose biomass is fully or partially removed by harvesting to facilitate ecological balance.

What does the 'I' in IMTA mean?

If integration is key, what are the geographical or space issues?

Several participants mentioned the practical difficulties of establishing 'true' IMTA, i.e. direct nutrient transfer between functional groups, as this can be very difficult to achieve operationally. It was stressed that the system has to be practical to implement. This is especially true for offshore systems.

What is clear is that integration relates to the water connectivity rather than scale over which this connectivity occurs. The connectivity between functional groups must be initially proven, and after that a modelling approach could be used to anticipate and balance nutrient transfer. This lessens the burden of proof that would otherwise fall on the producers and is currently difficult and costly to carry out (e.g. isotopic tracing).

Importantly, a point was raised that it is not restrictive enough to talk only about connectivity. It is also possible that the impact of the emission at source is not dealt with even if there is an extractive culture downstream. In such a case, the system would be physically connected but near-field impacts would be missed. Prior to the event, Thierry Chopin, IMTA expert and Scientific Director of the Canadian Integrated Multi-Trophic Aquaculture Network, sent a presentation, in which he states: "*The integrated in IMTA should be understood as cultivation in proximity, not considering absolute distances but connectivity in terms of ecosystemic functionalities*". This "connectivity in terms of ecosystemic functionalities" perhaps is enough to capture the necessity of both physical connectivity between compartments and address emissions related impacts wherever they occur.

What is the consensus?

There should be **one global definition with sub-definitions** to accommodate the diversity of systems that constitute IMTA. The global definition should be **simple, aimed at legislators and policy makers and accompanied by a technical standard**, which can be exacting and layered. It could be possible to define different levels of IMTA accreditation depending on the system used.

The definition should contain reference to the following components:

- Principally aquatic
- Demonstrated flow of nutrients
- Between 2 (or more), managed, functional groups
- The secondary (tertiary etc.) species must be harvested

The definition should NOT specify:

- The degree of trophic connectivity between compartments
- Social or economic performance markers

Taking all of the above information into account, we were able to agree on the following definition:

IMTA = Enhanced production of aquatic organisms (with or without terrestrial organisms) of two or more functional groups, that are trophically connected by demonstrated nutrient flows and whose biomass is fully or partially removed by harvesting to facilitate ecological balance.

Next steps

It was concluded that we are not yet at the right stage to discuss the regulatory framework. It is not certain what should be monitored yet, and IMTA will have to comply with existing aquaculture legislation in any case. Furthermore, new regulations will add complexity to an already heavily regulated enterprise. There was concern that IMTA could make it more difficult for new developments to occur if it became a compulsory regulation by government, for example, i.e. might the cost in development increase?

However, if and when the time comes, there are tools to adapt the existing regulation and incorporate IMTA into existing frameworks. For example, above the national regulations sits the Marine Spatial Planning-Ecosystem Based Management (MSP-EBM) approach and it would be possible to introduce IMTA at this level. The re-evaluation cycles for the EU legislation, for example the Water Framework Directive (WFD), are reviewed every 6 years; therefore, it may be possible to incorporate IMTA by coordinating the timing. It was felt that whichever regulatory framework is adapted to include IMTA, it should specifically acknowledge IMTA in order to support its development. Underneath the broader regulatory framework within which IMTA eventually sits, new and specific legislation would be appropriate as, for example, fish and invertebrate industries currently conform to different regulatory standards.

An IMTA specific eco-label is desirable in due course and should be industry driven, although it is important to clarify why a specific eco-label is more appropriate than incorporation of an IMTA section into already existing labels. One reason refers to the fact mentioned above that different aquaculture sectors conform to different standards. It could be possible in the future to have an IMTA 'system' certification, while currently, each species would have to apply individually for certification. The Aquaculture Stewardship Council (ASC) have previously discussed the possibility of an IMTA system certification but concluded that the data were not yet sufficient to inform it. Pilot and pre-commercial scale data should expand the knowledge of what an IMTA system is. This process also aims to clarify many of the issues about what is or is not IMTA, and whether the end result is an eco-label, the process itself is important in terms of further developing the industry.

The INTEGRATE Project partners are currently working on a Technical Standard, which will accompany the definition and in which aspects as the scope, glossary, connectivity items, sub-definitions, among others, will be treated in more detail.

Acknowledgements

We would like to thank all participants of the expert roundtables, respondents of the questionnaire and participants of the IMTA definition event in May 2019.

INTEGRATE is funded by the ERDF through the INTERREG Atlantic Area 2014-2020 Programme (project grant number EAPA_232/2016).

For more information about the INTEGRATE Project please visit our website at www.integrate-imta.eu