



European Aquaculture
Technology and Innovation Platform

**A Review of the
Strategic Research and
Innovation Agenda**

Our Vision for the future of
European Aquaculture

2017

A snapshot of European Aquaculture



>40 different species raised in European aquaculture



3 million tons of fish and molluscs– European Continent



1.3 million tons – European Union



330,000 tons freshwater fish



680,000 tons molluscs



2 million tons marine fish



5 billion juvenile fish from hatcheries



€9 billion ex-farm value



200,000 jobs in direct and indirect employment



3.2 million tons of formulated feeds



Active and increasing professional/research partnerships



Disparate zoning and spatial aquaculture planning



Strong but sometimes restrictive legislation



Difficult licensing and access to space

Message from the EATiP Chairman

Alongside many others who share a passion for European aquaculture and its sustainable development, I participated in the creation of EATiP in 2007. We started from scratch with little but a lot of enthusiasm and the desire to create a framework to promote research and innovation that would help the growth of a healthy European aquaculture value chain.



Through the European 'Aquainnova' project, EATiP developed its Vision, a Strategic Research and Innovation Agenda and an Action Plan to achieve our ambitions. Our optimism was immediately countered by the global financial crisis which affected our sector in many different ways, with many areas of European aquaculture being seriously impacted. More than ever, we needed answers to our challenges.

10 years on from our initial concept, EATiP has become an official European Technology Platform that is active in promoting innovation challenges and solutions, collaborating with a broad spectrum of interests to raise aquaculture to the highest rank in food and biomass production.

5 years on from the completion of our Strategic Research and Innovation Agenda, the Board of EATiP and I wished to review the concrete progress made on achieving our initial objectives. As you will see in this review, while significant advances have been made, new objectives and challenges have been identified and developed.

Achieving the goals identified in this review and aligning these with the objectives of EATiP and the strategic direction for developing European aquaculture, incorporating new skills and approaches, will give the strongest support for the progress and growth that is needed. We must continue to promote the research and innovation that is required to achieve the ambitions that we have for European aquaculture in 2030.

Gustavo Larrazábal

Chairman of EATiP

A handwritten signature in black ink, appearing to read 'Gustavo Larrazábal', written over a light blue circular watermark.

Acknowledgements

This review has been achieved by the voluntary efforts of many who are active in European aquaculture, mainly in the research and professional arenas, and who contributed to the SRIA survey. Within EATiP, the Board, the Chairs and the Vice-Chairs of the Thematic Areas and representatives of Member Organisations have all given valuable consultative inputs to this review. Specific thanks are given to the EFARO organisation, the FABRE Technology Platform and the COFASP ERANET for inputs and discussions relative to their own Strategic Research and Innovation Agendas.

Prioritisation of the research needs is difficult task but several challenges and requirements have been highlighted. These include, as examples, better zoning planning and real-time environmental monitoring, technologies and management to improve welfare and new approaches to aquatic animal health. There is an underlying appreciation that best management practices need to be applied in all aspects of farm governance.

Improving communication by and within the aquaculture sector is a clear priority. Resolving issues concerning the public perception of aquaculture to raise social license is accompanied by better cooperation between the profession and the researchers. EATiP and National or Regional Platforms are actively addressing these aspects in their activities.

Finally, we must acknowledge all who have contributed to debates within different meetings, conferences and workshops on how best to advance European aquaculture, demonstrating European commitment to excellence and successful innovation.

Courtney Hough, General Secretary – Editor

Synnøve Helland, Member of the Board of Directors – SRIA Survey Coordinator

Table of Contents

Background	3
Introduction	3
The EATiP Vision	4
VISION Statement	5
Progress and achievements	6
EATiP SRIA survey	7
Prioritisation of EATiP Thematic Areas	7
Product quality, consumer safety and health	7
Technology and Systems	7
Managing the Biological Lifecycle	8
Sustainable Feed Production	8
Integration with the Environment	8
Knowledge Management	9
Aquatic Animal Welfare	9
Socio-economics, Management & Governance	10
New topics identified within the survey	10
Conclusions on EATiP Survey	11
Coldwater Marine - Growth Forecasts	12
Freshwater - Growth Forecasts	13
Shellfish - Growth Forecasts	14
Mediterranean - Growth Forecasts	15
Integration of European Aquaculture Research Agendas	16
Conclusions	18
Environmental issues	19
Aquatic animal health	20
Improving productivity and competitiveness	21
Sustainable feed supply	22
Additional topics of common interest	22
Moving Forward	23
<hr/>	
The European Aquaculture Technology and Innovation Platform	25
The EATiP Operating Council	26
List of Members	27

Background

The Strategic Research & Innovation Agenda (SRIA) of our European Aquaculture Technology and Innovation Platform (EATiP), prepared in 2012, explored how the challenges facing the achievement of its Vision for European aquaculture could be addressed by using technology and innovation.

In 2016, the Board of Directors of EATiP decided to engage a review of the achievements of research and innovation actions, either as completed work or ongoing projects, that contribute to the EATiP Vision. A comprehensive questionnaire – based on progress and a review of the topics identified in the original SRIA – was provided to European aquaculture stakeholders. This action looked to identify:

- What has been achieved in recent European and national aquaculture RTD activities?
- What are the current and future priorities for aquaculture research?
- What is missing from the original SRIA?

Identifying gaps and new topics of importance for European aquaculture is of high interest to all and has been addressed in the survey and EATiP meetings.

Introduction

Our original efforts were wide in scope but encompassed technical, environmental and social approaches for the promotion of research and innovation for the sustainable development of our professional aquaculture activities.

Since we started EATiP in 2008, there have been many changes in policies and associated legislation that affect the use of natural resources and a growing awareness that no-one can work in isolation. All food production systems are under the microscope and all must provide the answers that the consumer asks of them. Transparency and accountability are prime conditions for all who work in aquaculture. The application of spatial planning, Marine Protected Areas and Natura 2000 zones are critical issues that affect the viability of aquaculture development in Europe. Improving both access to space and licensing conditions remain high on the 'wish list' for the profession's growth and development. In addition, the sensitivity of aquaculture to the effects of climate change is under close examination.

With the growing understanding of the role of the Bioeconomy within Europe and the need to apply circularity in the use of natural resources, recognizing that 'waste' can represent a high-value material to be used, aquaculture has a range of opportunities for its sustainable development – both in Europe and around the world.

EATiP has cooperated openly with many other European Technology Platforms and organisations devoted to supporting the development of aquaculture, at the European and international levels.

In this review, account has been taken of different approaches and opinions to present a common view for how to achieve the successful and sustainable development of European aquaculture and its value-chain.



EATiP Vision

The EATiP Vision was developed through the actions of its 8 Thematic Areas, overseen by the EATiP Board of Directors, which were facilitated by the FP7 'Aquainnova' project that allowed the participation of and consultation with more than 500 stakeholders in European aquaculture.

1. **Product Quality, Consumer Safety and Health**
2. **Technology and Systems**
3. **Managing the Biological Life Cycle**
4. **Sustainable Feed Production**
5. **Integration with the Environment**
6. **Knowledge Management**
7. **Aquatic Animal Health and Welfare**
8. **Socio-economics, Management & Governance**

The basis of the EATiP Vision is 'the core function of aquaculture is to provide safe food of the highest quality and nutritional value, across a wide range of products adapted to consumer preferences and lifestyles'.

Nonetheless, EATiP understands that new and different approaches to aquaculture include the cultivation of macro- and micro algae, techniques such as aquaponics and integrated multi-trophic aquaculture, and that these also offer wide-ranging and exciting opportunities for aquaculture's future in Europe and elsewhere.

Fulfilling aquaculture's potential is achieved by adapting to evolving consumer and market demands, constantly applying technological advances, maintaining diversity in the range of species cultivated and employing highly skilled personnel.

The main challenges for the sector's progress were identified as being:

1. Competition in the marketplace
2. Access to and competition for space
3. Improving resource use
4. Governance of the sector

Responding to these and other technical challenges are necessary to maintain market and economic competitiveness of the sector.

The importance of the development and contribution of aquaculture throughout the world is recognized by EATiP and it has examined how to achieve mutual benefits between European and global interests, to assure attainment of sustainable aquaculture growth world-wide.

In achieving this review of the SRIA, there is overall agreement that the 2012 Vision for European aquaculture remains valid.



The Vision

In 2030, European aquaculture will be sustainable and globally competitive – a dynamic activity in coastal and inland economies, not only supplying significant amounts of high quality and nutritious food to the consumer but also diversifying to provide a range of new products and integrated services.

Aquaculture production will grow and diversify in Europe, following consumer and market demands, adapting to climatic and geographic circumstances, in harmony with nature and society.

This will be achieved by enhancing husbandry, welfare, technology and knowledge management while improving the understanding of the factors influencing development, be these technical, commercial or social, to assure the sustainability of European aquaculture and its global role in technological leadership.

The vision of the European aquaculture industry is, by the year 2030, to provide annually 4.5 million tons of sustainable food products, worth € 14 billion, and supporting more than 150,000 direct jobs.

The Vision was accompanied by 3 core priorities:

ESTABLISH a stronger relationship between the aquaculture industry and the consumer

ASSURE a sustainable aquaculture sector

CONSOLIDATE the role and importance of aquaculture in society

which were used as the guidelines for the thematic approach of EATiP to the challenges identified and where the key factors identified for success were:

- Dynamic Research and Innovation
- A Responsible Aquaculture Value-Chain
- Being accountable to Society

In turn, responding to establishing and consolidating these factors, the following requirements were underlined:

1. Research and innovation efforts on aquaculture must be increased, focused and supported
2. The capacity for progress must be strengthened within the aquaculture value chain – including the legislative framework, RTDi and education, financing and market conditions
3. Networks must be built and consolidated, within and between the research and industrial sectors, and including civil society and governmental representation

The EATiP Vision also outlined growth scenarios for the different sub-sectors of European aquaculture, accompanied by the identification and assessment of risks that could affect achievement of these. These were separated into:

- Strategic risk
 - o Competition circumstances
 - o European and national policies
 - o Public perception and consumer concerns
 - o Financial/Economic risks
 - o Operational risks
 - o Sectoral competence and skills
 - o Knowledge management
 - o Lack of funding or the research required to implement the SRIA and associated action plans
- Hazard risks
 - o Effects of climate change
 - o Disease and infections
 - o Food safety and Public health

The combination of identifying and analysing the challenges, priorities, needs and risks that face the European aquaculture sector provided the base for each EATiP Thematic Area to prepare their key Goals and related Sub-Goals (see EATiP Vision for details). These were completed in 2012.

Progress and achievements

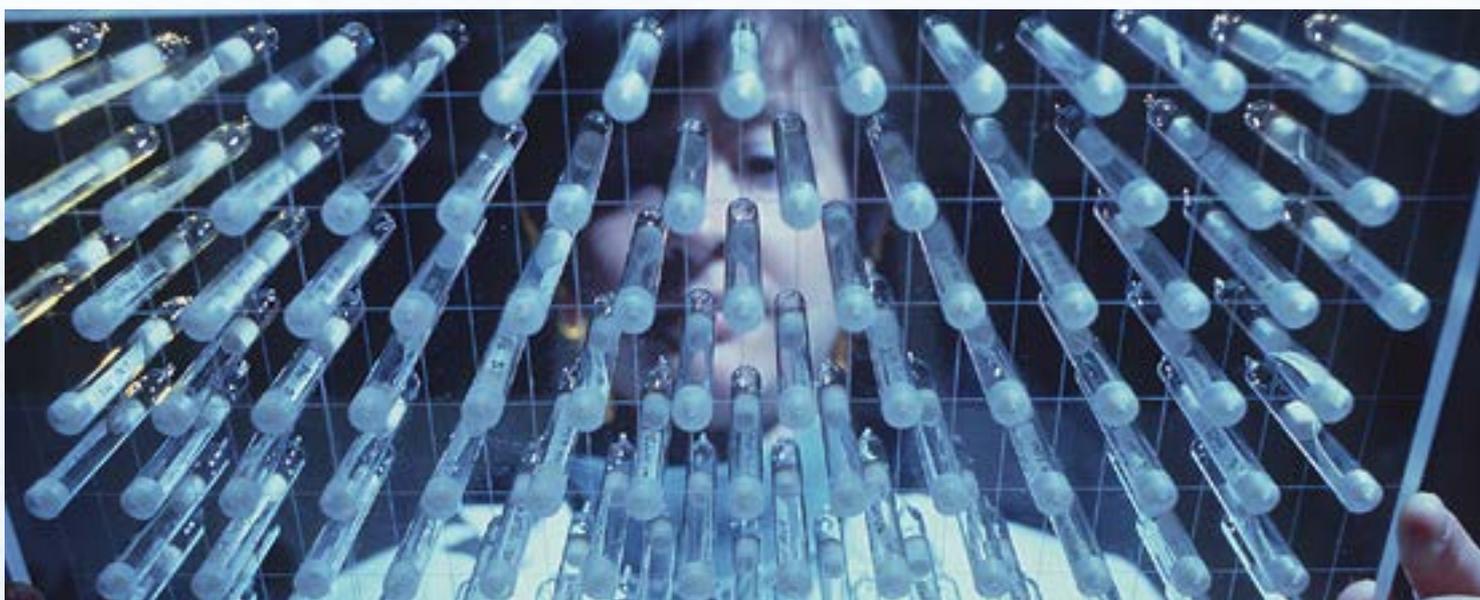
The EATiP Vision made clear the need to marry RTDi objectives with policy and the first major achievement was the EC Communication on “Strategic Guidelines for the sustainable development of EU aquaculture”¹ where responses were made to several of the policy objectives outlined in the SRIA. Furthermore, the revised Common Fisheries Policy (CFP) of 2014 recognised the position of aquaculture and provisions for development were included in the CFP and its accompanying instruments, namely the European Maritime and Fisheries Fund (EMFF) and the Common Organisation of the Markets for Fisheries and Aquaculture Products (COM).

As a recognised European Technology Platform (ETP), EATiP has maintained close contact with the ETPs active in the Bioeconomy, particularly with Food for Life, FABRE TP, Global Animal Health, Organics, Textiles and Plants TPs. These contacts, combined with participation in events involving DG Research and Innovation, have increased the awareness within EATiP of related issues and priorities that affect or are influenced by aquaculture. EATiP has participated in the Bioeconomy Stakeholders Panel of the European Commission since its creation.

Furthermore, other organisations involved in aquaculture have also developed their own strategic research agendas or documents outlining priorities for research and development. These include:

- The European Fisheries and Aquaculture Research Organisation [EFARO], an association of the Directors of the main European Research Institutes involved in fisheries, aquaculture and its interaction with the marine environment
- The Eranet ‘COFASP’- Cooperation in fisheries, aquaculture and seafood processing
- The FABRE TP – Farm animal breeding Technology Platform
- The TP Organics – ETP for Organic Food and Farming

Monitoring achievements and progress in research and innovation is a challenge, since research is achieved at the European and National levels, as well as within the private and professional sectors. For EATiP to be aware of developments, it has relied on communication with its membership and dialogue with the services of the European Commission.



¹ COM/2013/0229 final

EATiP SRIA SURVEY

In recognizing this situation, the EATiP Board requested a survey on progress on achieving the SRIA. Accompanied by a prioritisation of thematic area approaches and specific topics, this was achieved during 2016 by using an online survey that was designed to obtain a view on work that has been done on the Goals and Sub-Goals of each Thematic Area, identified in the SRIA. Participants prioritised these. Since research funding is limited, such prioritisation thus enables focus.

Importantly, the survey also asked the respondents in what project subjects they had participated – relative to the Goals and Sub-Goals in the EATiP SRIA, enabling identification of topics had been addressed (supported by European, National or 'Other' [e.g. private] funding).

It should be noted that the survey was completed on an anonymous basis although identification of the respondent's location, activity and gender was requested.

Finally, the survey also asked for identification of new or updated 'Hot topics' that should be given attention.

The full details of the survey are available on the EATiP website and the conclusions are as follows.

► Prioritisation of EATiP Thematic Areas

The survey gave priority to the following Thematic Areas (in order), being 'Very important' or higher:

1. Product quality, consumer safety and health
2. Aquatic animal health & welfare
3. Sustainable feed production
4. Integration with the environment

Within the responses received, it was also seen that the highest level of participants' participation in projects were in the areas of:

1. Product quality, consumer safety and health
2. Technology & Systems
3. Managing the Biological Lifecycle

These differences reflect the importance of industry interests achieving research and development work on Aquatic Animal Health and Sustainable Feeds.

► Product quality, consumer safety and health

In respect of project participation, the highest involvement was in the Goals **"Ensuring the continuing safety of aquaculture products"** and **"Maximise the health benefits of aquaculture products"**; nationally -funded participation exceeded European.

Highest prioritisation was given to:

- Identify and close commercially harmful gaps in consumers' perception about aquaculture products and the current scientific knowledge
- Identify, manage and eliminate existing and potential physical, chemical and biological new hazards and emerging risks; including virus, bacteria, toxins,

persistent organic pollutants (POPs) and other toxic substances

- Define and standardise quality parameters of aquaculture products
- Explore the differences in terms of health benefit between species and production methods including feed composition

► Technology and Systems

The highest levels of participation were in the Goals **"Ensure an environmentally sustainable industry by the application of new knowledge and technology innovations"** and **"Meet the demand for aquaculture products in Europe by the development of efficient technologies to support continued growth"**. Again, nationally-funded participation was higher than European.

Highest prioritisation was given to:

- Integrate technology management and biology to improve welfare and prevent disease outbreaks
- Reduce the incidence of diseases by developing technology and systems
- Develop technologies for improved quality of seed for all present and future production systems

While many other topics were scored highly (Important to Very important), it is interesting to note that these prioritised Sub-Goals focused on

- Technology/systems to improve health and reduce disease/infections
- Raising the quality of seed stock

► Managing the Biological Lifecycle

Project participation levels were highest for the Goals “Genetic improvement of productive, health and animal welfare traits” and “Establish predictability and improve output and cost control at every production stage of the lifecycle”.

A higher level of equilibrium was seen in funding in this area, European and national funding being more equal.

Highest priorities were given to:

- Selective breeding to target important traits e.g. adaptation to alternative feed sources, disease resistance, feed efficiency, fillet yield, flesh quality, nutritional profile and human health factors
- Improve animal performance at all stages, including egg and larval quality and its effects on performance during grow-out
- Develop efficient tools (genetic, molecular, genomics) or adapt existing tools from other sectors, to introduce disease resistance in breeding programs and obtain « robust » animals, resistant to disease, stress and changing environmental conditions
- Identify and quantify genetic correlations between productive, disease resistance and welfare traits that will enforce synergies between traits and avoid unwanted effects of selective breeding for productivity traits

The focus is clearly on improving the performance of the species cultivated, accompanied by breeding or use of other tools to have disease resistance. Genetics and selective breeding are very important contributions within this area.

► Sustainable Feed Production

In this case, project participation was higher in European funded projects than national ones, although this may also reflect that many feed companies achieve a lot of in-house research themselves. While respondent participation levels were lower, the Goals “Base formulation of future fish feeds on solid knowledge of fish nutritional and feeding requirements, and expand the number of well characterised and sustainable raw materials which can be used” and “Resolve strategic research problems in fish nutrition” were highly marked.

Highest prioritisation was given to:

- Improve knowledge on nutritional requirements of fish commonly farmed in Europe and for promising new species
- Provide a sufficient characterization of nutritional value of alternative raw materials, considering their sustainability, to increase flexibility in formulating highly nutritious feeds and appropriate for different aquaculture systems
- Formulate targeted feed and feeding practices that condition farmed species to novel feeds, increase adaptability, reduce stress, and increase biological efficiency

These responses indicate that better nutritional knowledge and the best formulation of feeds adapted to such requirements, using alternative raw materials, remains the high priority.

► Integration with the Environment

The responses for this area indicated higher levels of national funding in the first 2 goals but more equal for the others. Nonetheless, lower response counts were recorded on this topic than other areas. The goals registering the highest interest were “Tools for environmental governance”, “Establish fundamental scientific knowledge on the assimilation capacity of biogenic wastes from aquaculture to determine acceptable emission rates for benthic and pelagic ecosystems (Biogenic waste assimilation in ecosystems)” and “Technology to minimise biogenic influence”.

Highest prioritisation was given to:

- Harmonise environmental regulations and legislation, implementing common regulations between European countries
- Establish integrated management tools for waste emission considering assimilation capabilities, hydrodynamic energy and presence of sensitive habitats as a tool for siting, spatial planning and ecosystem-based management of aquaculture
- Determine assimilative capabilities and the environmentally-acceptable critical loading rates of biogenic wastes per volume and per area of sea floor, including the contribution or ecological services of farmed shellfish and macro-algae
- Improve feeding technology, feeding management and feed composition to minimise biogenic emission from aquaculture installations per unit fish produced

While the first topic is less research, the development of (on-site/on-farm) management and monitoring tools for biogenic wastes and impacts appears as a top priority.



► Knowledge Management

This area showed higher levels of European funding for use of research infrastructures (probably due to the European 'AquaExcel' project) while other goals were more equally funded. The goals receiving the most attention were "Ensure the availability and efficient use of aquaculture research infrastructures across all boundaries to benefit the industry" and "Manage knowledge efficiently and effectively within the European aquaculture sector".

The highest priority rankings were given to:

- Manage and transfer knowledge including the dedicated transfer to identified users and translation of research results for stakeholder uptake
- Create and sustain effective links between industry and research communities
- Promote sustainable aquaculture practices through the transfer and application of knowledge and technology, including food production, environmental protection, production, environmental protection, product safety and economic viability

There is a clear priority for improving links between the professionals and the research communities and using these to transfer knowledge. This is accompanied by the promotion and support for communicating and applying knowledge for best practices to assure sustainable aquaculture activities.

► Aquatic Animal Health and Welfare

The survey indicated the highest activity to be in the goal "Improve fish health and welfare by increasing the understanding of host pathogen interactions and have access to effective vaccines and immunomodulators", where the development of vaccines and improving knowledge of host-pathogen interactions have been the subject of National, European and 'Other' funded projects.

In terms of priority rankings, the top topics were:

- Development of new vaccines & improvement of existing vaccines and diagnostic tests, including their application to all stages of finfish life cycles
- Minimise treatment when possible by using best practice
- Improve the understanding of host-pathogen interactions
- Improve understanding of transmission mechanisms of pathogens at all levels from farm, through country, to Europe wide

Aside from the evident need for vaccines, improved understanding of how pathogens are transmitted and defining host-pathogen interactions appear as high priorities. As for other areas of research, best practice in disease/farm management is underlined.

► Socio-Economics, Management and Governance

The survey responses indicate that few participants have been engaged in projects covering this area. Nonetheless, the highest participation was in the goals relating to “Promote effective governance – establishing a ‘level playing field’ for aquaculture within and outside Europe” and “Understand better the social and economic dimensions of aquaculture at different scales”. Funding appears to be higher for Europe as opposed to National and ‘other’ contributors.

Priority ranking was highest for the following sub-goals:

- Simplify legislation and reduce time from application to award of operating licence
- Identify incentives to promote investment in aquaculture and ensure longevity of sustainable production
- Link social and economic dimensions of aquaculture with environmental considerations in a fair, legitimate and transparent manner

The first and top priority was included within the targets of the European Commission ‘Strategic Guidelines’ while the EMFF also focuses on supporting investments for sustainable aquaculture. On the other hand, the EC is engaged in ‘Fitness Checks’ on environmental legislation and the European Commission has also published “Guidance on Aquaculture and NATURA 2000” and a future brief on ‘Sustainable Aquaculture’ [Science for Environment Policy].

► New topics identified within the survey

A wide range of ‘new’ topics were put forward in responses to the survey, although these were given without extensive justification and many were duplicates of existing sub-Goal targets. These are summarised in the Survey Annex (see the EATIP website), but, evidently, without prioritisation. While some of these topics are very broad in nature or indicate a general approach/opinion, most have already been highlighted in the original EATIP Vision document. Nonetheless, the largest contribution was for technologies for monitoring or improving farm operation, specifically in offshore or extreme marine conditions.

In the biology section, attention to better control in hatcheries and associate interactions and effects were noted. New molecular tools for breeding programmes were also highlighted.

Survey respondents provided several observations on social aspects (Transparency, social license...) but without guidance.

“Human innovative interventions in agriculture have the potential to deliver new tools and innovative solutions to tackle some of the important challenges our society is facing today. For example, the agri-food sector is increasingly affected by a changing climate that is causing environmental degradation. At the same time, however, it has to deliver on food security and respond to increasing consumer demands while maintaining the livelihoods of European farmers.”

European Commission Commissioner Vytenis Andriukaitis
Health Food and Safety

Conclusions on EATiP Survey

The survey results indicate that research actions have been initiated or achieved on all the Goals and Sub-Goals identified within the original EATiP SRIA. The priorities identified in the previous section can be accompanied by additional recommendations:

Measures to improve performance, raise disease resistance and improve overall productivity were high on the agenda.

1. Higher accent on technologies for operating aquaculture in marine and extreme environments are needed, alongside better equipment for operations and management.
2. Better control within hatchery operation and breeding programmes using new molecular tools are also of high priority
3. Feeds that have the best nutritional requirements, while using alternative raw materials, remains a priority while assurance is required on the use of sustainable ingredients but without reducing the dietary and health attributes of the final product.
4. Aquatic animal health remains a top priority for the profession since the treatment of diseases and infections remains problematic (lack of availability of veterinary medicines) and where much hope is attributed to new vaccines and better host-pathogen understanding.

The issue of improving the links between the professionals and the research communities was strongly supported – indeed, this is one of the core ambitions of EATiP – where assuring the effective transfer or research into the different components of the aquaculture value chain is a key requirement.

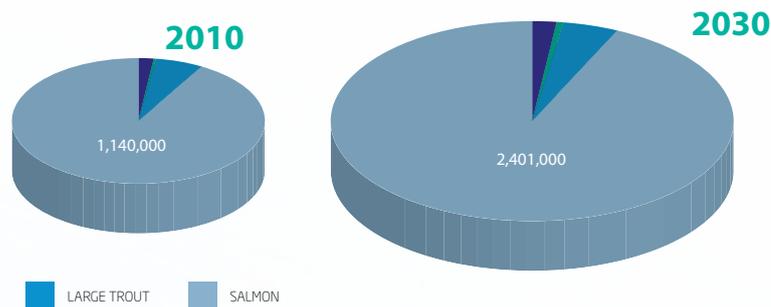
Finally, running throughout the survey results, a common theme emerged of applying best practices in different themes (aquatic animal health, knowledge management, farm operations). These would contribute to improving the social license and public acceptability of aquaculture.



Coldwater Marine - Growth Forecasts

Vision 2030

- Production Growth of >100% = 4%/year
- Salmon will remain the main species but all others will increase
- FCR decreases to 1.2, 20% improvement
- Employee productivity increases by 50%
- Trend towards Integrated Multifunctional farms
- Higher levels of offshore aquaculture
- Maximise recognition of the product's health benefits



Total Increase tons 1,350,000 107%

Total Increase M€ 4,130 108%

Challenges

- Develop robust, perhaps sterile, juvenile fish for exposed sites
- Maintain PUFA quality while feed components (plants) change
- Minimise impact of escapes
- Production costs will influence species choice
- New partnerships needed to promote/realise IMTA objectives
- Mastering the management of offshore production

Action Plan

- Develop and use more plant materials for feeds
- Robust animals reared and customised for growing environment and markets
- Better communication and promotion
- Develop solutions for escapes
- Identify limitations for open sea ongrowing
- Improve IMTA operation for integration with bioenergy production

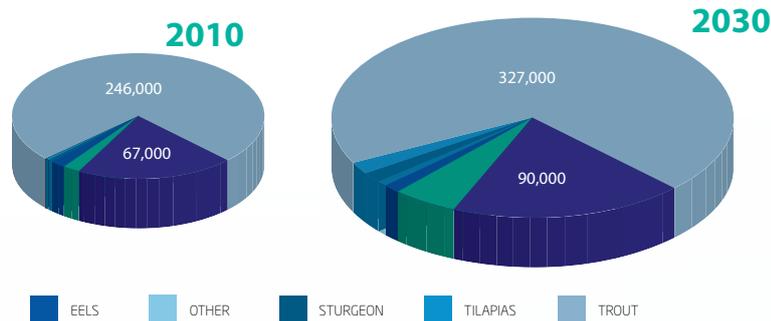
Effects

- Production will double to provide 2.6 million tons
- Salmon will remain the major product
- €13.5 billion ex-farm but €20 billion increase in total value
- 6,000 more jobs
- 2,700 hectares of space for new farms
- Hatcheries to supply over 2.5 billion juvenile fish
- Overall feed requirement up to over 3 million tons
- Diversification will consolidate position of aquaculture

Freshwater - Growth Forecasts

Vision 2030

- Production growth >40% = 1.5%/year
- Trout and carp remain core products
- Will diversify & establish new activities
- Recognition and expansion of ecosystem services
- Product diversity for mass and target niche markets
- Productivity increases of 50%/employee
- FCR decreases to 0.9 for trout (15% improvement)



Total Increase tons 136,000 41%

Total Increase M€ 337 39%

Challenges

- Identify advantages of freshwater aquaculture
- Complex legislation hindering development
- Define clear targets for lesser-known species
- Integrate RAS better and improved use of outputs
- Raise productivity of traditional farms
- Better recognition of contributions to society

Action Plan

- Encourage diversification and integration
- Increase competitiveness and maintain highest product quality
- Promote innovation for sustainability
- Improve responses to predators
- Improve market understanding
- Define environmental services
- Focus on local economies
- Establish a genetic bank of native populations

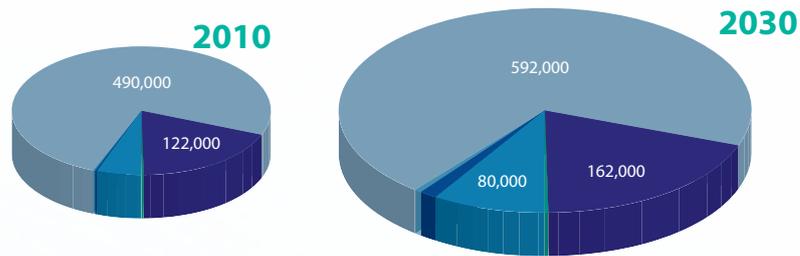
Effects

- Production will grow to 480,000 tons of fish
- Moderate growth for established species
€1.4 billion, increasing €0.5 billion ex-farm value
- 7,000 more jobs, highest rise to occur in processing
- 30,000 hectares of space needed for expansion, mainly for extensive production
- Hatcheries to supply over 1.3 billion juvenile fish
- Overall feed requirement up by 80,000 tons
- Active diversification within the sector

Shellfish - Growth Forecasts

Vision 2030

- Production growth 30% = 1.3%/year, initially for mussels and minor species
- Shellfish demand will increase
- Natural, safe and sustainable sector
- Activity diversification on-farm
- Integrated multifunctional farms
- Higher levels of offshore production



Total Increase tons 196,000 30%

Total Increase M€ 427 42%

Challenges

- Assuring production in deeper waters
- Developing disease-resistant stock
- Access to clean waters
- Increasing competitiveness
- Improving knowledge on pathogens – detection & quantification

Action Plan

- Improved environmental governance, enhanced by new technologies and knowledge
- Access to new space and better use of existing sites
- Genetic improvement for disease resistance and higher productivity
- Assure consistent quality control for continued product safety
- Increased hatchery supplies of spat
- Diversify species profile at commercial levels
- Planning tools for environmental governance and development

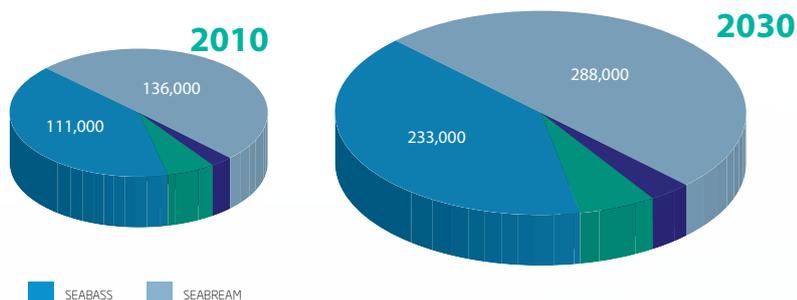
Effects

- Production will grow to around 850,000 tons of shellfish: Growth will be mainly for mussels in short-term
- €1.4 billion, increasing by €0.5 billion ex-farm value
- Higher workforce level, looking to bring skilled young people into the business
- 30,000 hectares of space needed for expansion, mainly for extensive production
- Higher hatchery production of spat for on-growing

Mediterranean - Growth Forecasts

Vision 2030

- Production growth >100% = minimum 4%/year
- Higher expansion rates for meagre and sole
- FCR decreases to 1.2 (35% improvement)
- Aquaculture will diversify – functional additives, bio-energy (algae)
- Main species: seabass, seabream, sole, meagre, turbot
- Productivity/employee increases by 20%
- Juvenile survival increases by 20%



Total Increase tons 305,000 112%

Total Increase M€ 1,449 113%

Challenges

- Understand consumer perceptions
- Effective marine & coastal spatial planning
- Obtain robust fish, selected broodstock
- Disease control & prevention
- Overcome climatic challenges, severe weather
- Ensure innovation and best knowledge management

Action Plan

- Access to new production sites, licences
- Understand consumer choice
- Diversify species profile
- Communicate quality aspects of Mediterranean products
- Simplification of legislation
- Incorporate technological developments
- Assure environmental sustainability
- Encourage diversification and integration
- Integrated spatial planning for aquaculture development

Effects

- Production >600,000 tons of fish
- €2.7 billion ex-farm but €5 billion increase in total value
- 10,000 more jobs
- Total sea farm space of 2,100 hectares
- Hatcheries to supply nearly 3 billion juveniles
- Feed demand increases by 200,000 tons

Integration of European Aquaculture Research Agendas

As indicated, EFARO, FABRETP and ORGANICSTP have recently developed positions and research agendas, accompanied by the efforts of the COFASP ERANET, which covered fisheries, aquaculture and seafood processing. Although these documents vary in approach and scope, there are several common positions that can be highlighted since each has addressed specific issues that can assist the development of the European aquaculture sector.

The following summaries cover briefly the key topics and issues identified within these documents.

EFARO

Medium and Long-Term topics - taken from the Aquaculture Future vision document, looking to 2030-2050 (medium and long-term scenarios). This covers social, environmental, economic issues (sustainability factors) accompanied by technical/scientific and regulators considerations.

EFARO (2030)	Aquaculture	Highlighted topics	
Zoning/Planning	Knowledge management	Environmental monitoring/ indicators	Sustainable feed ingredients identified
Application of high welfare standards	Best practice for elimination of invasive or alien species	Engineering & bio-technical solutions reduce escapees	Technologies for exposed off-shore farms
Reduction of crop cycle time	Reduction of energy needs/ kg product	Energy used is renewable	High quality products respecting safety and ethical production standards

The longer-term topics/positions include the following

EFARO (2050)	Aquaculture	Highlighted topics	
Perception issues resolved	Novel feed ingredients available – algae/seaweed/ insects	IMTA systems in place	Vaccination to minimise pathologies
Robust juveniles	New disease treatments	Stakeholder collaboration for boosting innovation	Research base addresses environmental and economic improvements

COFASP

Covering medium-Term & long Term Topics ¹

COFASP	Aquaculture	Highlighted topics	
Social Acceptance	Communication	Environmental monitoring/ indicators	Sustainable feed ingredients identified
New grow-out technologies	Real-time Monitoring of environmental and biological indicators	Engineering & bio-technical solutions reduce escapees	Technologies for exposed off-shore farms
Organic aquaculture	Technology development	Energy used is renewable	High quality products respecting safety and ethical production standards

FABRE TP

Short-Medium Term Topics – Taken from the FABRE TP Research Priority topics for the 2018-2020 H2020 Work Programme.

FABRE TP	Aquaculture	Highlighted topics	
Genomics for improved selective breeding & grow-out	New tools for phenotyping for fish & shellfish	Tools for improving fertility & reproduction	Increase disease resistance through breeding
Understand genetic determinism, role and impact of microbiome	Explore the use of genome editing to accelerate genetic improvement of relevant traits		Develop communication tools on modern aqua- breeding

ORGANICS TP

Short-Medium Term Topics – Taken from the ORGANICS TP Research Priority topics for the 2018-2020 H2020 Work Programme. The topics reference issues identified on defining green approaches for organic aquaculture. The topics are all related to breeding and cover the main aquaculture species reared in European aquaculture.

ORGANICS TP	Aquaculture	Highlighted topics	
Integrated aquaculture systems breeding & grow-out	Assurance of high system performance	Polyculture and multi-trophic systems	Alternative feed ingredients Water quality & feeding quality
Fish welfare & stock- ing density determinism, role and impact of microbiome	Breeding programmes adapted to organic aquaculture needs		High quality products respecting safety and ethical production standards

¹ These are broad titles that are expanded and explained in the COFASP SRA – only the aquaculture components have been included.



Conclusions

The positions presented by EFARO correspond more closely to the original approach of EATiP in establishing a vision for European aquaculture that encompasses not only technical considerations but also regulatory and social requirements. While the FABRE positions focus primarily on breeding and ORGANICS on integrated systems adapted to organic principles, COFASP also accounts for market demand and seafood processing within the scope of its document.

There are many common issues within each document, supported by the original EATiP Vision and the survey.

During the 2017 EATiP Annual Meeting, EATiP Members present were asked to discuss the issues and achieve a prioritisation exercise of research needs to meet the EATiP Vision; this included the EFARO, COFASP and FABRE TP objectives. These results have been carried over into the following section, which gives a review of the top priority research topics and actions that result from this EATiP SRIA review.

Topics are presented in order of the ranking levels (1 = First, 2 = second etc.)

“ Eighty percent of current aquaculture production is derived from animals low in the food chain such as herbivorous, omnivorous fish and molluscs. ”

FAO - Food and Agriculture Organization of the United Nations

Environmental issues



The EATiP SRIA specified that ‘aquaculture in 2030 will produce nutritious food with less environmental footprints than any other food production for humans’, a statement that is notably supported by the food conversion efficiency and extractive aquaculture, including mollusc and seaweed production.

Tools for environmental monitoring in real time

There is a clear need for real-time information on the environments related to aquaculture, for measuring both the potential impacts of aquaculture on the environment but also the reverse. New sensors and satellite technologies are already contributing but novel approaches to on-farm monitoring will aid planning and investment strategies for sustainable practices. Such monitoring will also provide valuable background information for new or expanded sites, based on referenced information, data and science.

Aquatic animal health

Responding to disease and infections, including parasites, remain a top priority for all livestock production. For aquaculture, both fish and shellfish can be seriously affected. Chemical and antibiotic treatments are used less and less so new approaches are required.

Research needs are highlighted as being the following:

Selective breeding for robustness (specially disease resistance)

Highlighted by all of the referenced Visions and SRIAs, selective breeding to raise the levels of robustness – including resistance to disease, infections and stress – is a clear requirement. The design and implementation of appropriate schemes at hatchery/farm level must be supported by new technologies and support systems.

Technologies to reduce diseases in the hatcheries/farms

Technologies and management systems that reduce disease incidence and effects on-site are also highlighted, accompanied by the appreciation of raising welfare standards. Such research and innovative developments evidently need to be adopted within best practice schemes.

Vaccines and treatments to minimise pathologies (diseases, infections...)

The application of best practice - accompanied by the development of new vaccines, remedies and treatments - is essential for professional aquaculture to improve productivity and maintain competitiveness. Obtaining solutions to the most prevalent infections is a top priority for all sectors of aquaculture. The potential effects of climate change and new infections need close evaluation.



Improving productivity and competitiveness

All aquaculture producers require to be competitive within the European market place, given the level of imports (>65%) and comparative pricing. Experience of 'boom and 'bust' in different sub-sectors has led to sectoral consolidation in certain areas but most farms, in number, remain as SMEs or smaller. Improving productivity and stock management remain as top priorities for competitiveness.

The topics identified to achieve such improvements are:

Technologies for improving farm operation, including in extreme marine conditions

The availability of coastal space for marine farming – both fish and shellfish – is a critical factor if European aquaculture is to grow and develop. The potential of offshore farming has long been recognised but this has been tempered by recognition of risks and significant changes in farm operation. Similarly, coastal and freshwater farming conditions can be improved by new technologies and management systems, where automation and real-time monitoring are key factors that could assist this aspect.

Best practices for optimal farm management

The implementation of new or improved operating systems requires not only investment in and adoption of these, changes in operational management and skill requirements are evident. The identification and updating of the best practices applied to shellfish and fish farming for optimal management should be promoted.

Selective breeding for improved grow-out performance

As for improving robustness, selective breeding is identified as having the clear potential for improving farm grow-out performance. This can be at the level of the hatchery (for stronger and fitter juveniles) and the farm for higher growth speeds and improved feed conversion.

Technologies & management practices to improve welfare

Alongside the previous point, an important component of the public appreciation of fish farming is the assurance of best welfare practices in livestock rearing. Research on and application of technologies and management practices that assure the highest welfare standards can contribute to raising public confidence in aquaculture activities.

“ We have to ensure that it is possible to produce sufficient, good, healthy and sustainable food for all mankind – let us make certain that Europe also contributes to help address this challenge. ”

European Commission Commissioner Vella

Sustainable feed supply

The limitations on specific resource supplies for compound feeds, combined with rising awareness of the footprints of different ingredients, has led to a focus on alternative materials for fish feed manufacture. Much research has been done on this topic, which remains a core issue on the sustainability of the sector. Highlighted by all SRIAS, the core topic is:

Alternative and sustainable raw materials for fish feeds

Such research has to be accompanied by assuring that formulation is based on solid knowledge of the fish nutritional requirements, alongside the environmental impacts and footprints of alternative raw materials. Highlighted research needs on the use of micro-algae, seaweeds and insects are evident.

Additional topics of common interest

Improved communication to resolve public perception issues

Improving the public perception of professional aquaculture is a common issue for all aquaculture stakeholders, where the targets and means of communication may change – dependent on numerous factors, including location, the species and the market. Resolving several of the issues already cited will contribute to a higher level of communication on the benefits and services provided by aquaculture.

Assuring the impact of research

All European RTD work is evaluated for impact, specifically on the target actions and objectives of each project. Nonetheless, dissemination actions and/or technology transfer can only be effective once the RTD is finished, which is often at the end of the project. The aquaculture profession remains concerned that this position needs to be improved, particularly since project consortia are dissolved at the end of projects.

Attention should be given as how to best communicate results and assuring that opportunities for technology transfer are not lost due to this situation.

Zoning and Planning

The issue of access to space for aquaculture development in Europe, accompanied by appropriate licensing conditions, has been identified as a key strategic subject to resolve. Knowledge of carrying capacity and assuring the minimum effects on the ecosystem are paramount,

where best available technologies and management must be applied. The development and application of planned zoning for aquaculture production will enable social and economic benefits for coastal and rural communities.

Increased attention to influences affecting sectoral sustainability (e.g. energy, resource use...)

The examination of influences and indicators of sectoral sustainability has been made by many different interests, including the European 'Consensus' project, but improved knowledge and data availability influence the appreciation of factors affecting the understanding of 'sustainability'. With increased international trade of aquaculture products, consumers have a higher interest in sustainably-produced food. Further work needs to be done on establishing an international basis for sustainable aquaculture, covering resource use and environmental footprint assessment.

Ocean warming and climate change

These are issues that while appearing distant from some basic topics are currently addressed by the European H2020 projects "CLIMEFISH" and "CERES". More specific national projects are also being achieved.

Standardised quality parameters

Establishing a 'level playing field' covers a wide range of topics where a standardisation of the parameters that influence or are defined as 'quality' would assist consumer acceptance of European aquaculture. The Aquaculture Advisory Council is addressing this issue.

Regulatory approach

On the regulatory side, a harmonised approach – within and outside Europe – towards governance, legislation and controls is needed to establish the level playing field, reducing the ‘boom and bust’ scenarios and maintaining the competitiveness of European aquaculture and its sub-sectors. Effective planning for farm locations is a key requirement.

This topic should be followed by the Aquaculture Advisory Council and the European administration.

Strategic direction

Aquaculture is identified by many as providing unique opportunities to provide high quality, healthy food. It is also the source of new materials and products of high value, obtained from macro- and micro-algae as examples. To feed the world in 2050, the Food and Agriculture Organisation of the United Nations identified that the required increase in food production can be achieved if the necessary investment is undertaken and policies conducive to food (from agriculture, fisheries and aquaculture) production are put in place. The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) have to be framed within global action on sustainable development until

2030 and at least nine of SDGs are of direct relevance to Food and Nutrition Security.

Improving knowledge management, technology transfer and innovation uptake are recognised as being key issues for resolution within the research and industrial arenas. Supporting this approach within existing networks while adapting to new structures and the use of new communication tools needs promotion.

Within Europe, recognition and development of the Bioeconomy, the encouragement for Blue Growth and the clear recognition of the role and potential of aquaculture within the Common Fisheries Policy provide strategic support for aquaculture development.

At a broader level, the development of European aquaculture must be in line with other strategic actions concerning food security, waste reduction, the circular economy and sustainability. Highlighted in the FOOD2030 background document, aquaculture should also play a key role in food and nutrition security (FNS) at a global level.



Long term FNS requires an approach to production that is underpinned by sustainability, covers the complete food value chain, connects all resources and their use, while linking terrestrial and marine conditions. Food2030 recognises the complexities of food production systems and the diversity of related responsibilities. These include:

1. The sustainable use of resources, including land and water
2. Improving primary production practices and raising knowledge on production-specific inputs
3. Handling and processing of food, including packaging and distribution, and related waste streams, including non-food materials

Such an approach requires integration of different aspects, several of which have been highlighted as research needs within the SRIAs of EATiP, EFARO, FABRE TP and COFASP.

Moving Forward

Targets and actions

On a geographic level, European aquaculture has grown significantly while, in many countries of the European Union, stagnation has occurred for a variety of reasons. Within a highly competitive EU market for seafood, where ~65% is imported, this position reinforces the need for improved efficiency, competitiveness and social licence.

The following targets remain crucial for sustainable and responsible development of the European aquaculture sector:

- Produce and provide high quality, healthy, nutritious and safe fish and shellfish products that meet consumer demand
- Create the economic, social, management, political and governance framework conditions that will enable the innovative growth and development of a sustainable aquaculture sector
- Use knowledge and innovation to build cost-effective competitive advantages
- Improve competitiveness through product development, following customer needs, targeted production environments and an elevated level of professionalism and skill evolution
- Adopt cutting-edge knowledge management practices to support state-of-the-art technological developments
- Achieve targeted production levels with less environmental footprints than any other type of food production for humans
- Use sustainable fish feeds that will make aquaculture one of the most efficient producers of safe, high-protein and nutritious food products
- Advance aquaculture industry technology and cultivation systems that are environmentally and economically sustainable
- Adapt health and welfare conditions to rear high quality, robust aquatic animals
- Provide a safe, attractive, challenging and rewarding work environment

Achieving these targets requires:

- A Responsible Aquaculture Value-Chain that assures the stewardship for providing high quality, safe and nutritious food to the consumer
- Dynamic European Research and Innovation that, while achieving the research needed, provides the base necessary for knowledge management and competence-building for aquaculture in the future
- Sectoral accountability to Society through participation in transparent governance and assuring communication on its activities and responsibilities

Effective coordination was identified in the EATiP Vision document as being essential to meet these targets, integrating actions at National and European levels. This recommendation has been followed by many examples of cooperative actions reported to EATiP since the publication of its Vision. Nonetheless, such dynamic efforts must continue and expand to enable the identification of new opportunities and responses to the challenges facing aquaculture production in the 21st century.

The European Aquaculture Technology and Innovation Platform

Board of Directors

Chairman – Gustavo Larrazábal (Aquanaria - Spain)
Karl Almas - SINTEF (Norway)
Karine Berger - EMPA (France)
Jean-Sebastien Bruant - Ferme Marine de Douhet (France)
Santiago Cabaleiro - APROMAR (Spain)
Claire Caralp - Aquimer (France)
Ole Christensen - Biomar AS (Denmark)
Marco Gilmozzi - FEAP President (Italy)
Synnove Helland - Nofima AS (Norway)
Iciar Martinez - Universidad del Pais Vasco (Spain)
Mihalis Panagis - Selonda SA (Greece)
Noralf Ronningen - Aqualine (Norway)
Francois Simard - International Union for the Conservation of Nature (Mediterranean Office - Spain)
John Stephanis - Epidavros Fisheries SA (Greece)

The Chairman and Board of Directors of EATiP wish to thank the Chairs, Facilitators and Members of its Thematic Areas, the participants in the consultative workshops and the personnel of EATiP Member Organisations whose contributions have formed the Vision, the Strategic Research and Innovation Agenda and the Plan of Action.

The EATiP will continue to use the Thematic Areas in a dynamic way to allow for scenario planning, project formulation and funding circumstances, applying forecasting and futures techniques to address the uncertainties that face the EU aquaculture industry in the mid to longer term.

Secretariat

General Secretary – Courtney Hough
Executive Secretary – Catherine Pons

Rue de Paris 9
B-4020 Liege
Belgium
Tel: +32 43 38 29 95
Fax: +32 43 37 98 46
www.eatip.eu

The EATiP is a non-profit association, registered in Belgium (N° 808.986.136)

The EATiP Board, Thematic Area Chairs and Facilitators have worked collectively in the development of the Vision Documents, Strategic Research Agendas and Action Plans.

This document was prepared and edited by Courtney Hough, Maurine Toussaint and Synnove Helland

Based on an original design by Design Tactics
www.designtactics.net

Photo credits to FEAP, Maurine Toussaint, University of Ghent, Stephan Hofer, Fotolia, and CanStock Photo Inc.

“ The seafood farmed in the EU is fresh, it’s tasty, it’s healthy.
It meets the most stringent environmental
and consumer protection standards ”

European Commission Commissioner Vella
MARE and ENVI

The EATiP Operating Council

Chairs and Facilitators of the Thematic Areas

Chairperson	Facilitator(s)
Product Quality & Human Safety and Health	
Arne Sørvig (Norway)	Iciar Martinez [CSIC](Spain) Maria Leonor Nunes [IPIMAR](Portugal)
Technology and systems	
Ulrik Ulriksen [OCEA AS](Norway)	Laszlo Varadi [HAKI] (Hungary)
Managing the biological lifecycle	
Patrick Lavens [INVE Technologies] (Belgium)	Béatrice Chatain [IFREMER] (France)
Sustainable feed production	
Ole Christensen [Biomar] (Denmark)	Maria Alexis [HCMR] (Greece)
Integration with the environment	
Fernando Torrent [CULMAREX] (Spain)	Yngvar Olsen [NTNU] (Norway)
Knowledge management	
Karl Almas [SINTEF Aquaculture] (Norway)	David Murphy [AquaTT] (Ireland)
Aquatic animal health and welfare	
Hamish Rodger [Vet-Aqua International] (Ireland)	Randolph Richards [Institute of Aquaculture] (UK)
Socio-economics, Management & Governance	
Rosa Chapela [CETMAR] (Spain)	Frank Asche [University of Stavanger] (Norway)

List of Members

Commercial companies

AKVA group ASA, Norway
 Akvaforsk Genetics Center, Norway
 Aquabiotech Group, Malta
 Aqualine AS, Norway
 AquaTT, Ireland
 BioMar A/S, Denmark
 DHI, Denmark
 Ferme Marine de Douhet, France
 Aquanaria, Spain
 Kefalonia Fisheries SA, Greece
 Inve Technologies SA, Belgium
 Marine Harvest AS, Norway
 Nesne Elektronik, Turkey
 Nutreco Nederland BV, The Netherlands
 Plate-Forme d'Innovation Nouvelles Vagues, France
 Selonda, Greece
 Sorgeloos4Aquaculture, Belgium
 Sparos Lda, Portugal

Research Community

AZTI - Tecnalia, Spain
 CEVA - Centre d'Etude et de Valorisation des Algues, France
 CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Portugal
 DTU Food, Denmark
 ECOAQUA - Instituto Universitario de Acuicultura Sostenible y Ecosistemas Marinos, Spain
 HCMR - Hellenic Centre for Marine Research, Greece
 IEO - Spanish Institute of Oceanography, Spain
 IFREMER - Institut français de recherche pour l'exploitation de la mer, France
 IMR - Institute of Marine Research, Norway
 INRA - Institut scientifique de la recherche agronomique, France
 IRTA - Investigación y Tecnología Agroalimentarias, Spain

LUKE - Natural Resources Institute, Finland
 Marine Institute, Ireland
 NIFES - National Institute of Nutrition & Seafood Research, Norway
 Nofima AS, Norway
 NTNU - Norwegian University of Science and Technology, Norway
 NVI - Norwegian Veterinary Institute, Norway
 SINTEF Fisheries & Aquaculture, Norway
 Universidad del Pais Vasco/Euskal Herriko Unibertsitatea, UPV/EHU, Spain
 University of Ghent, Belgium
 University of Nordland, Norway
 University of Stirling, IOA - Institute of Aquaculture, UK
 University of Tromsø, Norway
 University of Udine, Italy
 University Szent István, Hungary

Representative Organisations

APROMAR - Asociación Empresarial de Acuicultura de España, Spain
 CIPA - Comité Interprofessionnel des Produits de l'Aquaculture, France
 COPA-COGECA, Belgium
 EMPA - European Mollusc Producers Association, France
 FEAP - Federation of European Aquaculture Producers, France/Belgium
 FEFAC - European Feed Manufacturers' Federation, Belgium
 Fundacion OESA, Spain
 STICHTING VISSENBESCHERMING - Foundation for the Protection of Fish, The Netherlands
 XRAQ - Reference Center for R&D Catalunya, Spain

International Organisations

EUROFISH, Denmark
 IUCN - International Union for the Conservation of Nature, Switzerland

LIST OF MEMBERS

Civil Society Organisations

EAS - European Aquaculture Society, Belgium

EBCD - European Bureau for Conservation and Development, Belgium

Observers

European Commission

European Investment Bank

Mirror Platforms

Aquacircle, Denmark

POLE AQUIMER, France

KNAQ - Kompetenz Netzwerk Aquakultur, Germany

NCE Aquatech Cluster, Norway

NCE Seafood Innovation Cluster, Norway

PTEPA - Plataforma Tecnológica Española de la Pesca y la Acuicultura

SAIC - Scottish Aquaculture Innovation Centre

I N N O V A T I O N

T E C H N O L O G Y

C O L L E C T I V E I N T E R E S T

C O L L A B O R A T I O N

C O L L E C T I V E K N O W L E D G E

S A F E A N D H E A L T H Y

S E A F O O D

F U T U R E O F A Q U A C U L T U R E



www.eatip.eu

