

The logo features a stylized, abstract shape resembling a fish or a wave, composed of various shades of blue and green, positioned to the right of the text.

European Aquaculture

Technology and Innovation Platform

The Future of European Aquaculture

Our Vision: A Strategic Agenda for
Research & Innovation

2012

The Future of European Aquaculture

This document expresses the Vision of our European Technology Platform and explores how the challenges facing its achievement can be addressed by using technology and innovation. Its preparation has been facilitated by the European Aquaculture Technology and Innovation Platform, EATIP and much of the work described has been achieved within the European FP7 Support Action 'Aquinnova'.

A Snapshot (2010 data)



AQUINNOVA is a support action that received financial support from the Commission of the European Communities under the Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 245238. This publication reflects the views only of the author and the European Commission cannot be held responsible for any use which may be made of the information contained therein.

Message from the EATiP Chairman



In common with many who work in European aquaculture, I have a deep passion for innovation. I have worked on the creation of new businesses and know that aquaculture is a comprehensive and complicated challenge if one is to be successful, but I love tough challenges.

We have developed EATiP to provide answers to questions, to identify solutions to problems and develop a framework to guide the European aquaculture sector towards growth and sustainable development.

This document summarises EATiP's Vision and Strategic Research and Innovation Agenda which have integrated the expertise of more than 400 European stakeholders to identify the ambitions and challenges for European aquaculture. They have recognised where aquaculture can make significant contributions to Europe and the associate needs for successful innovation and development. Their efforts have been considerable, professional and constructive and the Board of Directors and I thank them for this.

Finally, I wish to recognise the support of the European Commission for its financing of the 'Aquainnova' project, which has enabled the development of different initiatives and consultation actions described here.

It is therefore both a privilege and a pleasure to present this document, believing firmly that the realisation of our dream for the future of European aquaculture, our Vision, will be achieved by 2030.

Gustavo Larrazábal

Chairman of EATiP

A handwritten signature in black ink, appearing to read 'G. Larrazábal', written over a horizontal line.

Table of Contents

| | |
|--|-----------|
| Putting European Aquaculture into context | 3 |
| What is Aquaculture? | 3 |
| The Role and Contributions of European Aquaculture | 3 |
| Challenges to Progress | 4 |
| International Dimension | 5 |
| EATiP and its Vision for European Aquaculture | 6 |
| What are European Technology Platforms? | 6 |
| The Vision for European Aquaculture | 7 |
| Factors for Success | 8 |
| Unlocking the Potential - Growth Forecasts | 10 |
| Scenarios for European Aquaculture | 10 |
| Coldwater - Vision 2030 | 11 |
| Freshwater - Vision 2030 | 12 |
| Shellfish - Vision 2030 | 13 |
| Mediterranean - Vision 2030 | 14 |
| Strategic Goals & Plans for Action | 15 |
| Consultation with Stakeholders | 15 |
| From Planning to Delivery | 16 |
| The Strategic Research and Innovation Agenda | 18 |
| Product Quality, Consumer Safety and Health | 18 |
| Technology and Systems | 20 |
| Managing the Biological Lifecycle | 22 |
| Sustainable Feed Production | 24 |
| Integration with the Environment | 26 |
| Knowledge Management | 28 |
| Aquatic Animal Health and Welfare | 30 |
| Socio-economics, Management & Governance | 31 |
| The Plan of Action | 34 |
| Mobilising Actors and Resources | 34 |
| Initial Priority Actions | 34 |
| A Live Document | 34 |
| The Way Forward | 35 |
| <hr/> | |
| The European Aquaculture Technology and Innovation Platform | 37 |
| The EATiP Operating Council | 38 |
| List of Members | 39 |

Putting European Aquaculture into Context

What is Aquaculture?

Aquaculture is the cultivation of fish, shellfish (including oysters, mussels, clams and crustaceans) and seaweeds. It has been practiced for thousands of years by such civilisations as the Chinese and the ancient Romans. Progress in technology and management over the last 60 years have made aquaculture a major contributor to food supply at the global level.

In 2011, according to the FAO, aquaculture produced 63.6 million tons representing 49% of all aquatic food destined for human consumption worldwide – meaning that it matches food supplies from fisheries.



The role and contributions of European Aquaculture

Aquaculture takes place in all EU and EEA Member States and creates annually some 2.6 million tons of produce from both freshwater and the sea, valued at €7 billion. The European aquaculture sector is today a large and modern industry, directly employing an estimated 100,000 people in production and an additional 90,000 in the service, processing and other linked activities, including research.

European aquaculture has a clear value chain that links suppliers to the production sector, through processing and to the final consumer and provides a clear economic advantage for Europe, providing jobs, adding value and lowering import dependence. 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.

To fulfil this function, European aquaculture:

- **Adapts to Evolving Consumer and Market Demands** through the provision of new added-value and convenience products in support of consumer lifestyle changes and preferences.

- **Constantly Applies Technological Advances** created by institutional, academic and industrial research efforts. Aquaculture has been revolutionised through developments in diet, veterinary treatments, stock selection and farming technologies – not only in Europe but also elsewhere in the world. In addition, technology has also facilitated the rearing of a wider range of fish species, using high performance feeds, in innovative farming facilities. Such advances have led to improved productivity and a seven-fold increase in worldwide production over the last 40 years.
- **Maintains Extraordinary Diversity** in its range of species grown, its scale and types of operation and the various climatic and environmental conditions across Europe under which it operates.
- **Employs Highly Skilled Personnel** at each level of the value chain, from producers to equipment and feed suppliers, veterinary and health services, researchers, processors and marketers.

Based on this excellence in science, technology and industry, aquaculture is now seen as an integral component of Europe's Bioeconomy¹ – a concept that is recognised as being in need of development in response to the Grand Societal Challenges of Europe.

"If aquaculture did not exist we would have to invent it."

Commissioner Maria Damanaki
Directorate-General for
Maritime Affairs and Fisheries

¹ See <http://tinyurl.com/bioeconomy>

Challenges to Progress

However, the European aquaculture industry also faces a number of challenges to its progress:

- **Competition in the marketplace:** While European capture fisheries are restructuring in response to the need for improved stock management, market competition is rising from imports of all types of seafood,² both from fisheries and aquaculture. In 1994, 60% of European seafood needs were provided by European fisheries and aquaculture, whereas today 65% of seafood consumed in Europe is imported.
- **Access to and competition for space:** This is an overriding challenge to be resolved, both in coastal and in inland areas. While technological solutions can provide some answers, resolving conflicting interests and issues that affect both land and water use requires improved cooperation and consensus amongst stakeholders and policy-makers.
- **Maintaining health and welfare:** For all livestock this is a constant concern, particularly in the light of the potential effects of climate change, and where new management strategies are needed to support growth.
- **Improving resource use:** Raising levels of competitiveness covers a wide range of topics, including farm systems technology, husbandry, feeds and nutrition. Constant efforts have to be made to improve efficiency in all aspects of aquaculture management.

- **Aquaculture governance within the Common Fisheries Policy:** Aquaculture deploys processes more similar to agriculture than to capture fisheries yet is administered under the Common Fisheries Policy (CFP), which has rarely taken such structural differences into account. The current proposals for Common Fisheries Policy reform³ have now recognised that aquaculture is a strong pillar of the CFP, which should lead to more effective governance measures.

Should these and other technical challenges not be addressed and overcome, the European aquaculture industry will fall behind its rivals in terms of competitiveness in the marketplace.

This would not only result in lost revenue and employment in direct and indirect jobs but would also affect the EU's food security position given that 65% of EU seafood needs are imported. In addition, it would also worsen the EU balance on protein supply, which is currently 72% of needs.

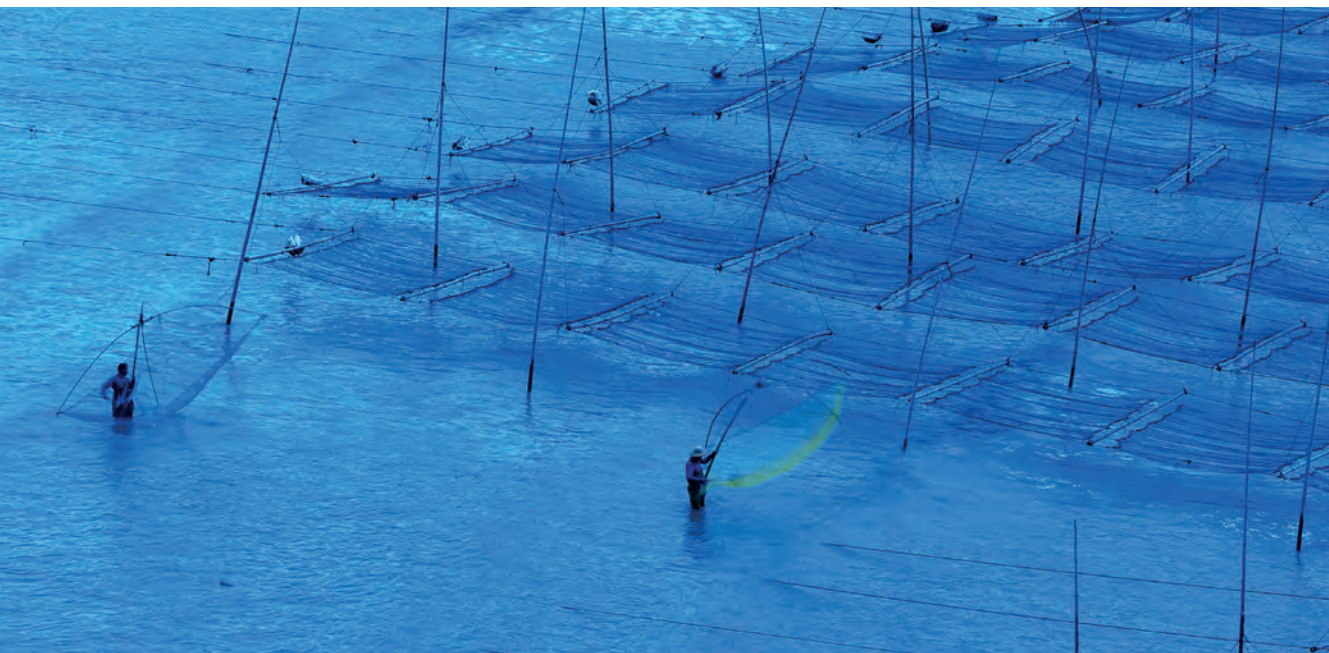
“Fisheries and aquaculture make crucial contributions to the world’s wellbeing and prosperity. In the last five decades, world fish food supply has outpaced global population growth, and today fish constitutes an important source of nutritious food and animal protein for much of the world’s population. In addition, the sector provides livelihoods and income, both directly and indirectly, for a significant share of the world’s population.”

Arni M. Mathiesen

Assistant Director-General
FAO Fisheries and Aquaculture Department

² The term ‘seafood’ includes all edible products from marine and freshwater sources

³ See <http://ec.europa.eu/fisheries/reform/>



International Dimension

European aquaculture does not operate in isolation but is part of a global economy and market for seafood products. Major European businesses have global operations while smaller entities have realised the benefits and opportunities that their expertise offers through international activities. It is expected that this trend will continue.

Supply and service companies in the value-chain are also world leaders in many areas (e.g. feeds, animal health, equipment and technology), providing significant contributions to improvement and growth of global aquaculture.

Europe has many world-leading aquaculture researchers and facilities, in universities, research institutions and the private sector. New knowledge will be a driving force for future growth and should create new areas of development and revenue. Similar opportunities exist for the training sector, both in Europe and internationally. Universities and training organisations have excelled in providing scientists, policy-makers, managers and workers. As new technologies and innovation move forward, the export of best training practice and vocational training could become a growth activity.

There are many areas where European aquaculture plays a global role and many opportunities will develop in the future, particularly given the current and forecast rates of global aquaculture development. To assist this approach, EATiP has established an International Desk to facilitate international cooperation efforts.

Europe has one of the strictest governance systems for aquaculture in the world, with sustainability at the core while guaranteeing food safety, environmental management and worker safety. Europe sets the benchmark for sustainable production and it is anticipated that global aquaculture governance must improve to meet the expectations of consumers and society at large.

European producers are keen to see common governance rules at the global level, to establish a level playing field and maintain their competitiveness within the global market.

EATiP and its Vision for European Aquaculture

EATiP is the European Technology Platform for Aquaculture that began in 2007 when stakeholders in the European aquaculture industry met to identify gaps and needs in knowledge, technology, skills and policy within their sector.

Innovation was recognised as a key dimension and focus of EATiP,

a position confirmed by the 'Europe 2020'⁴ strategy which identified the need for economic growth that was:

- **SMART** – based on an economy founded on knowledge and innovation
- **SUSTAINABLE** – promoting a more resource-efficient, 'greener' and more competitive economy
- **INCLUSIVE** – fostering a high employment economy while delivering social and territorial cohesion

In spite of the challenges posed by the diversity of an industry rearing such a wide range of animals and plants in so many different environments, more than 50 organisations across Europe agreed to create the European Aquaculture Technology and Innovation Platform.

What are European Technology Platforms?

In 2003, the European Council called for the creation of European Technology Platforms⁵ to bring together technological know-how, industry, regulators and financial institutions to develop a strategic agenda for leading technologies.

European Technology Platforms (ETPs), officially recognised by the European Commission, are industry-led stakeholder forums, charged with defining research priorities, that provide a framework to define these and develop action plans on a number of technological areas where achieving EU growth, competitiveness and sustainability requires major research and technological advances in the medium to long term.

To achieve their goals, ETPs:

- **DEFINE** a Vision containing targeted goals for what their sector will be contributing and how it will be working in the future.
- **ALLOW** industry to open dialogue between relevant stakeholders so as to define research and development priorities for their sector in an open and transparent way.
- **ACHIEVE** their goals by identifying technological challenges to Europe's future competitiveness in their industrial sector. These are used to develop a strategic research agenda that addresses these challenges. From this agenda, a practical action plan is developed to ensure that any new research leads to real innovation in industry, assisted by effective technology transfer mechanisms, the dissemination of information and skill development.
- **ENSURE** that research carried out on their sector has a high degree of industrial relevance throughout the entire economic value chain. They are also active in mobilising public authorities at national and regional levels to assist development in the most effective way possible.

"European Technology Platforms are set to play a key role in supporting European industrial competitiveness and, ultimately, in improving significantly the daily lives of the European citizen in many areas."

Commissioner Potočník
DG Research

⁴ See <http://ec.europa.eu/europe2020/>

⁵ See <http://tinyurl.com/627l6t>

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, so as 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 for European Aquaculture

Our Vision and the Goals of the EATiP Strategic and Innovation Agenda are summarised in this document. Moreover, they are based upon the contributions of over 400 experts from industry and other stakeholders, who have identified where aquaculture can contribute to European development priorities and where knowledge gaps need to be overcome to allow successful innovation and development.

They are not only in line with the priorities of Europe 2020, but also respond to the Key Challenges identified in the European Council's review of the Sustainable Development Strategy⁶ and the Lund Declaration.⁷

EATiP has 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

These priorities are addressed within eight different Thematic Areas, each of which is identifiable within the European aquaculture value chain, and for which EATiP has created expert groups:

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**

Each Thematic Area developed its own targets, goals and research requirements, as well as an action plan to ensure that their targets are met. These are summarised in this document but can be viewed in full on www.eatip.eu

This work has led to the definition and aspirations of the Vision for European Aquaculture in 2030 and the Strategic Research and Innovation Agenda that are described in the following sections.

⁶ See <http://tinyurl.com/manr7a>

⁷ See <http://tinyurl.com/ycp2b3t>

Factors for Success

To work on the Thematic Areas has led to agreement on a range of important factors that need to be addressed so as to achieve the Vision for European Aquaculture in 2030:

Dynamic Research and Innovation

- Resolving applied and fundamental research challenges, relating to sectorial and societal needs and combined with improved access by scientists to 'state of the art' facilities
- Applying multi-disciplinary approaches
- Ensuring the effective management and transfer of both knowledge and technology.
- Developing curricula and competence-building relative to the needs of the aquaculture value chain
- Building specialised and efficient networks to ensure successful technology transfer and innovation implementation

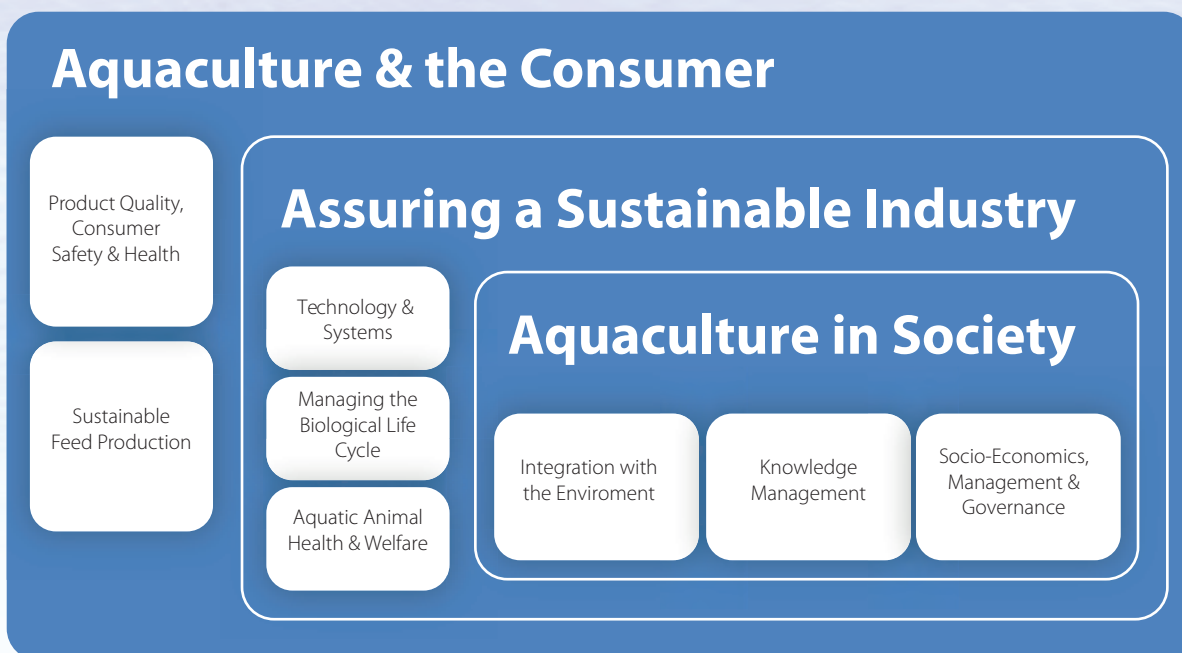
Responsible Aquaculture Value-Chain

- Supplying the consumer not only with the products required, but also with the associated information assuring them that the product has been produced sustainably.
- Producing high quality, safe and nutritious food, ethically and efficiently
- Incorporating innovative technology and management systems, producing more from less and with minimal waste
- Providing a wide range of career opportunities within a safe, stable working environment

Accountable to Society

- Participating in multi-disciplinary and multi-stakeholder governance, assuring the requirements of transparency and responsibility
- Communicating with society on all aspects of the aquaculture value chain
- Assuring the recognised stewardship of natural resources for a sustainable activity

EATiP's Core Priorities





These factors highlight the need for the best coordination across the Thematic Areas and the integration of this approach at National and European levels, underlining the following requirements.

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

Achieving these levels of coordination requires extensive public/private cooperation, stimulating the creation of an innovation-friendly environment for all players involved.

Unlocking the Potential

EATiP has adopted seven baseline principles to guide its work and suggests that, in order to flourish, the European aquaculture industry should:

- Provide the European consumer with desirable products of the highest quality at an affordable price
- Assure that aquaculture's impact on the environment is minimal
- Respect the conditions for optimal livestock health and welfare
- Develop and integrate new technologies within the entire value chain
- Improve economic performance at each level of the value chain
- Guarantee the training and skill development of those working in the sector and attract talented professionals
- Provide clear contributions and benefits to society

These seven principles have been incorporated into the work of EATiP's Thematic Areas, each of which has identified Goals and Action Plans to unlock the future potential of European aquaculture and promote sustainable growth.

Before we examine the proposals of the Thematic Areas, let us examine European aquaculture in detail, following the four main sectors in which it is active (i.e. Mediterranean, Coldwater, Shellfish and Freshwater) to assess the potential of each for future growth.

Scenarios for European Aquaculture

Each sector was the subject of a consultative workshop, where expert stakeholders worked on characterisation, challenges and opportunities. This approach included in-depth reviews of production and marketing patterns, legislative influences, advantages, strengths and challenges. Each workshop considered growth potential and analysed limiting factors so that a realistic vision and associated projections could be developed. The EATiP Thematic Areas took the conclusions and recommendations so as to develop the outline 2030 scenarios that follow.⁸

The 2030 scenarios demonstrate the differences in views on potential growth in the different sectors, whether this be for technology, markets, legislation, knowledge and/or other factors that might influence development. Overall, several common views can be summarised as follows:

- The main species produced in each sector will continue to dominate production, while diversification will contribute to competitiveness in different ways
- Integrated multitrophic aquaculture (IMTA), diversification in species and activity are all seen as opportunities
- Significant improvements in feed composition and conversion, combined with new management and operational technologies, will contribute to higher productivity
- Improved husbandry will target such characteristics as robustness, disease resistance and overall product quality, resulting in higher levels of performance and consumer acceptance
- The achievement and recognition of environmental sustainability, where new tools for governance are recommended, will be shared throughout European aquaculture

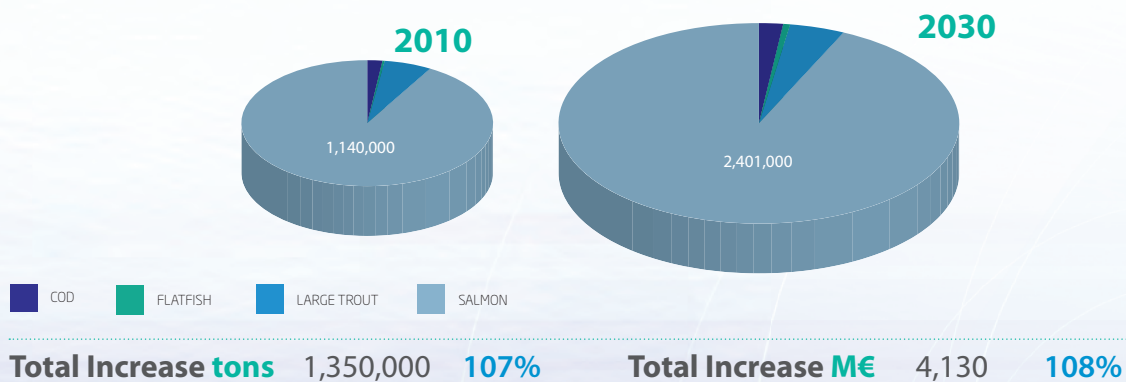
The combined effect of these scenarios would result in European aquaculture achieving average annual growth of 3.1% - providing 4.5 million tons of sustainable food products, worth €14 billion, and more than 150,000 direct jobs by the year 2030.

⁸ the glossary (p. 41) provides explanations for acronyms

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



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 on-growing
- Improve IMTA operation for integration with bioenergy production

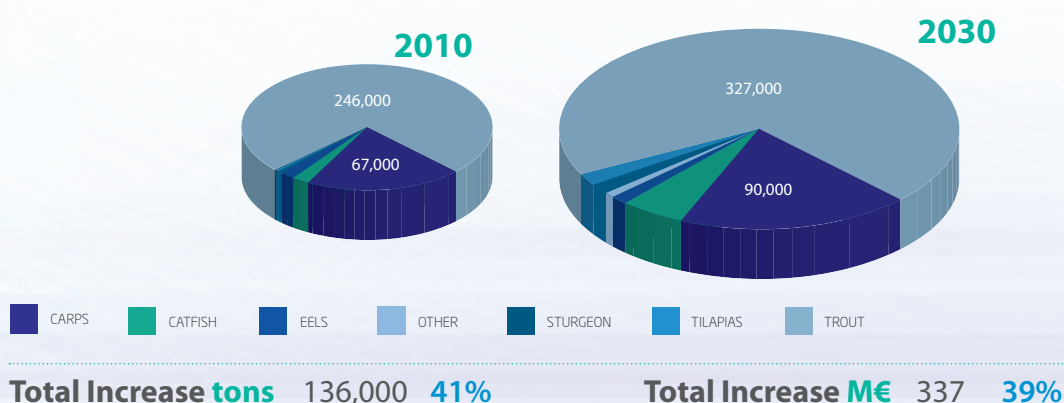
Effects

- 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)



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

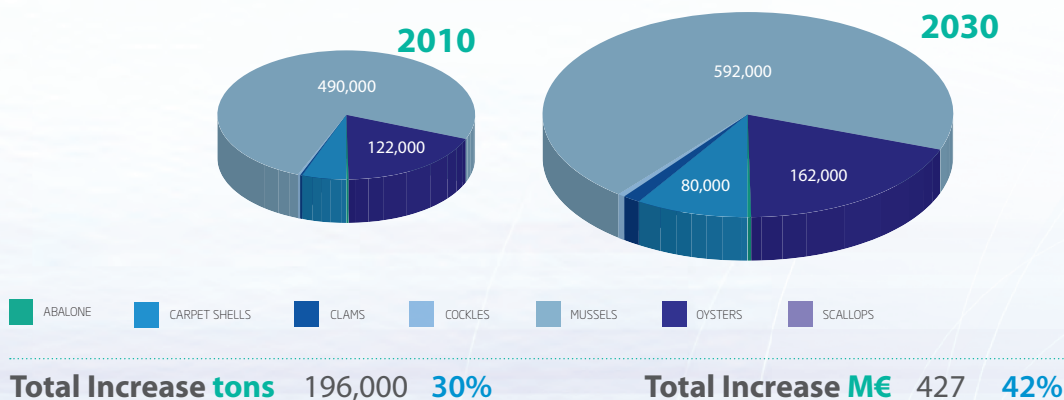
Effects

- 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



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

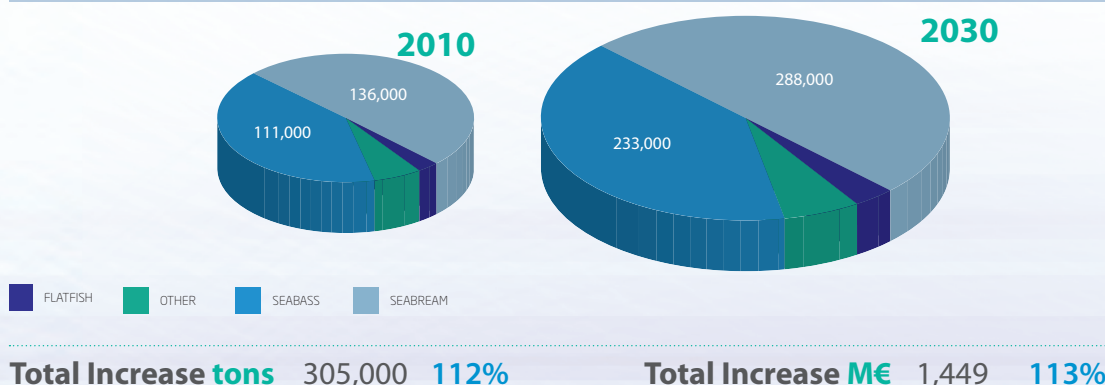
Effects

- 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%



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

Strategic Goals & Plans for Action

EATiP has drawn up a Strategic Research and Innovation Agenda (SRIA) to identify opportunities and challenges for growth and development in European aquaculture and the research or associate actions required to respond to them. Key Targets have been identified for each Thematic Area, alongside the main goals to achieve these. For each of these goals to be met successfully, supporting objectives or sub-goals have been provided.

Within the FP7 project 'Aquainnova', a comprehensive review of the achievements and state-of-the-art position for EC-funded aquaculture research and innovation was made. More than 120 Technical Leaflets were prepared and reviewed for their relevance to the work of the Thematic Areas, providing valuable benchmarks for reference. Their core challenges and outcomes were identified and classified in relation to:

- the research results achieved,
- whether they could be the subject of technology transfer,
- whether they were beneficial to SMEs,
- whether they could provide support to policy development or application.

The sample below provides an example of this approach and all of these Leaflets can be found in the Library section of www.eatip.eu

Consultation with stakeholders

The SRIA has been the subject of a focused consultation process - the widest ever achieved for European aquaculture. Four dedicated workshops were organised within the 'Aquainnova' FP7 project, supported by web-based public consultation, bringing together the Thematic Areas with more than 200 stakeholders from the different sectors described.

This approach allowed EATiP to assure best governance in terms of identifying priorities for the different components of European aquaculture and to debate the best means of resolving the issues identified. The content and results of the individual workshops are published in the Consultation section at www.eatip.eu

The Thematic Areas have reviewed and incorporated the results of this consultation, assuring that the views and opinions of the stakeholders of European aquaculture have been taken into account.



From Planning to Delivery

Early in 2012, the EATiP Board and Operating Council identified major risks that would affect achievement of the Vision. Based on this exercise, EATiP has developed a Risk Management Plan to assist responses to the risks associated with the sector's development and includes details on the risk tolerance levels and necessary actions or reactions (acceptance, avoidance or transfer of risks faced by the sector/sub-sectors). This approach to Risk Management is part of EATiP's strategic planning effort and incorporates the following activities:

- Continuously identifying risks
 - Assessing their impact, likelihood and threat level
- Prioritising risks
 - Implementing strategies for response

Where Risks are categorised as being:

- Strategic
- Operational
- Hazardous

Key characteristics of risks:

- Risks can be identified as adverse consequences of events or changed conditions.
- Their occurrence is uncertain and may have different extents of likelihood.

EATiP's Risk Management Policy Statement:

To provide a clear and strong basis for informed decision-making at all levels of the platform.

For the sector to be able to apply the factors identified for success, a Risk Management exercise was made for each of the four identified aquaculture sectors – Mediterranean / Coldwater / Shellfish / Freshwater – so as to identify the potential challenges, perceived or real, that could affect the sustainable growth desired.

The main elements and the forecast effects identified are listed below.

STRATEGIC RISKS

- **Competition:** From aquaculture production in other regions/countries - oversupply to markets, lower profitability, lack of raw materials, 'boom and bust' conditions
- **European and National Policies:** Inadequate regulations (raw materials, drugs, additives, feed ingredients), new environment/planning policies limiting production growth and/or investments
- **Public Perception and Consumer Concerns:** Negative perceptions of aquaculture products with particular regard to quality, safety, environmental impact and sustainability
- **Financial/Economic Risk:** Global and European macro-economics – inadequate financing capacities, lack of investors in production/services, lack of investment in RTDi

OPERATIONAL RISKS

- **Sectoral competence and skills:** Lack of skilled personnel and training opportunities
- **Knowledge Management:** Ineffective knowledge transfer pathways from research to industry/policymakers
- **Lack of funding/research required to implement SRIA and Plans for Action:** Insufficient investments in programmes and personnel to achieve SRIA



HAZARD RISKS

- **Climate Change:** Increases in number and strength of storms could lead to damage, flooding, cage breakage and increased escapees; increases in sea temperature/climatic variability causes increase in disease prevalence; scarcity of fresh water- business collapse; species maturity/reproduction affected - decreases in fry production, robustness and growth;
- **Disease:** Lack of control measures for existing diseases, appearance of new diseases - stock losses, restrictions on the movement of live aquatic animals and/or fresh products, market collapse

- **Food safety - Public health:** Potential negative effects on consumers (e.g. shellfish toxins/viruses, fish feed ingredients) – lack of consumer confidence could lead to loss of market- collapse of profitability

This risk-management exercise, together with the work of each Thematic Area expert group, has been combined to create the Strategic Research and Innovation Agenda (SRIA) for European aquaculture, together with its Plan of Action.

“The strongest growth is expected in the consumption of farmed fish and chicken, by convenience these also seem to be the animal protein sources with the smallest carbon footprint”

Jacques Diouf

Director General, Food and Agriculture Organization of the United Nations

The Strategic Research and Innovation Agenda

Targets, Goals and sub-goals by Thematic Area



Product Quality, Consumer Safety and Health

Key Target:

"To build a sustainable, cost-effective competitive advantage through the production of high quality, healthy, nutritious and safe seafood, accompanied by scientific data documenting these facts and communicating these effectively to the relevant interests groups and consumers."

Background:

Public awareness of a healthy diet and a more sophisticated understanding of nutritional science will continue to increase. So too will the understanding of the role that aquaculture products have to play in a balanced diet, and the broader European health agenda. As aquaculture products become more firmly established in the consciousness of the population, so issues relating to product quality and consumer safety will continue to be a priority, providing assurance in the safety and value of greater consumer consumption. The further development of functional aquaculture food, promoting health benefits, is an underlying consideration. Four key goals have been identified.

► **GOAL 1: Maximise the health benefits of aquaculture products**

- Identify relevant bioactive compounds present in aquaculture products
- Better understand the mechanisms and synergies underlying the health benefits of bioactive components from aquaculture products in the promotion of human health
- Investigate the specific effects of aquaculture products in sub-groups of the population with specific dietary needs
- Explore the differences in terms of health benefit between species and production methods including feed composition

► **GOAL 2: Ensure the continuing safety of aquaculture products**

- 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
- Make available to producers of aquaculture products user-friendly methods to monitor and control the safety of the production, targeting known and emerging hazards
- Ensure the manufacture of authentic aquaculture products, regarding the species, quality, processing, use of additives, production method and geographic origin
- Better understand the mechanisms and synergies underlying the health risks of undesirable compounds potentially present in aquaculture products for risk management purposes

► **GOAL 3: Deliver high quality European aquaculture products - fully meeting consumer expectations including appearance, taste, texture, nutrition and provenance claims**

- Define and standardise quality parameters of aquaculture products
- Develop and validate practical tools and fast methods for processors to measure aquaculture product quality, including physical/chemical parameters such as texture, colour, fat content and to mimic organoleptic parameters such as juiciness
- Develop and/or implement new technologies and materials in the seafood processing industry which enhance quality, including that of products to be sold alive
- Define and describe the parameters that can be manipulated to create differentiated products targeted at particular markets and consumer groups
- Develop and establish the foundations for the successful commercial implementation of a robust product certification and a consumer-friendly labelling system for European aquaculture products, based on provenance and quality.

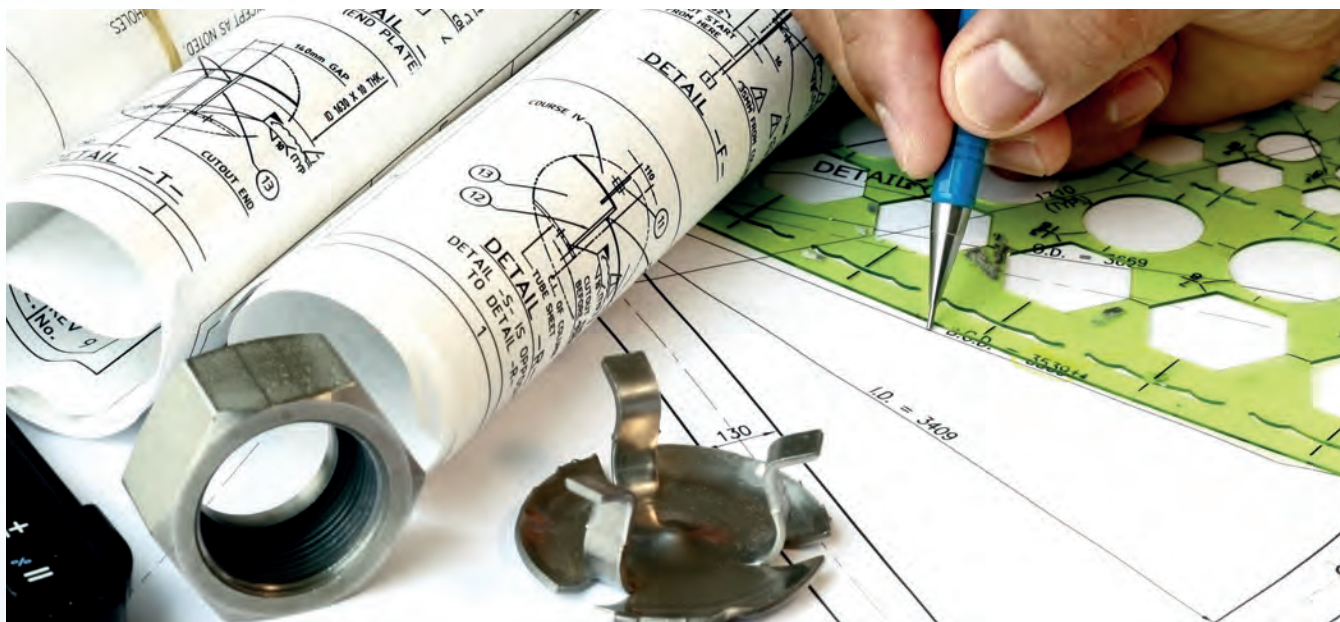
► **GOAL 4: Understand the dynamics of European seafood markets**

- Issue clear recommendations and guidelines for informed policy making on recommended consumption levels
- Identify and close commercially harmful gaps in consumers' perception about aquaculture products and the current scientific knowledge
- Understand the dynamics of European seafood trade

“...aquaculture provides huge opportunities and raises considerable challenges, particularly in relation to environmental sustainability of production as well as to the quality and safety of the products.”⁹

EU Aquaculture Strategy 2009

⁹ <http://tinyurl.com/EUaqsrategy-2009>



Technology and Systems (T&S)

Key Target:

"To advance aquaculture industry technologies and systems so that Europe can become an environmentally and economically sustainable net supplier of seafood, characterised by a safe and attractive working environment."

Background:

As aquaculture moves from being a new farming activity to an evolving modern food industry, it is crucial that technology and systems are used to maximum advantage to fully exploit the potential of the European aquaculture industry. Contributions to automation, monitoring and analysis are key to increasing operational efficiency. Maximising advances in processing technology, with specific regard to product storage and shelf life, will complement the considerations on product quality. Four key goals have been identified in this field.

► GOAL 1: Ensure an environmentally sustainable industry by the application of new knowledge and technology innovations

- Development of technology preventing escapes of fish and eggs from production systems.
- Development of renewable energy sources for aquaculture production facilities.
- To effectively manage nutrients cycling in production systems in order to increase its retention in aquaculture products (polyculture, IMTA, integrated aquaculture).
- Reduce waste release from aquaculture production.
- Develop and upgrade existing technologies for more efficient use of fresh water resources
- Develop T&S for the mass production of aquatic organisms (e.g. plankton, seaweed) for industrial use

► **GOAL 2: Meet the demand for aquaculture products in Europe by the development of efficient technologies to support continued growth**

- Develop technology and systems for best aquaculture site selection
- Develop farming equipment and operational procedures for off-shore sites
- Maximise efficiency of Recirculation Aquaculture Systems (RAS) and reduce accumulation of persistent compounds
- Develop marine and freshwater integrated aquaculture systems (e.g. polyculture, IMTA) for production of present and new species and environmental services
- Develop production systems for new aquaculture products (e.g. new species, premium class and/or certified products) for changing markets
- Reduce the incidence of diseases by developing T&S
- Develop T&S for improved utilisation of existing sites
- Develop technology to support production of new fish feeds (formulated, live feeds etc.)

► **GOAL 3: Ensure the profitability of the aquaculture industry by developing improved management systems and technology**

- To improve technology for transfer, handling and slaughtering of aquaculture products with respect to welfare and ethics
- Develop automation for all stages of production (hatcheries, on growing, processing) for present and future production systems
- Improve or develop novel systems to control biofouling of aquaculture equipment
- Develop technologies for improved quality of seed for all present and future production systems
- Develop technologies for complete utilisation of farmed products

► **GOAL 4: Ensure technology for ethical and healthy production of high quality aquatic products**

- Integrate technology management and biology to improve welfare and prevent disease outbreaks
- Improve technology for transfer, handling and slaughtering of aquaculture livestock with respect to welfare and ethics
- Develop standardised detection and quantification methods for pathogens affecting humans
- Develop technology and procedures for monitoring welfare status of aquatic animals during all production stages
- Develop technology to prevent contamination of shellfish from external sources of human pathogens

“Don’t worry about what anybody else is going to do...
The best way to predict the future is to invent it.”

Alan Kay



Managing the Biological Lifecycle

Key Target:

“European aquaculture in 2030 will produce larger volumes and contribute to a decrease of imports through a significant improvement of its competitiveness. It will also focus on being a commercial stakeholder in aquaculture worldwide. For the biological inputs, this competitiveness will be obtained from: product specificity, targeted production environments, a high level of professionalism & skills and clear political & societal support.”

Background:

Attaining competitiveness and efficiency within the European aquaculture value chain will be essential if the sector is to remain at the forefront of an increasingly competitive global aquaculture industry, where the EU is arguably already at a disadvantage. Further advances in aquatic species husbandry and the optimisation of biotechnology will assist in the delivery of four core goals.

► GOAL 1: Establish predictability and improve output and cost control at every production stage of the lifecycle

- Develop indicators and tools to estimate/measure predictability and establishing the current variation level in farms
- Improve animal performance at all stages, including egg and larval quality and its effects on performance during grow-out
- Improve sanitary control by better understanding the microbial environment (biotic & abiotic)
- Ameliorate technological performance (protocols standardisation / amended technology)
- Support and promote a competent, highly skilled workforce throughout the value chain

► **GOAL 2: Genetic improvement of productive, health and animal welfare traits**

- 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
- Develop efficient tools (genetic, molecular, genomics) or adapt existing tools from other sectors, to introduce disease resistance in breeding programmes and obtain robust animals, resistant to disease, stress, changing environment
- 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
- Identification of the fields for transnational ‘-omic’ research with clear potential benefit for industry (e.g. metabolomic indices of juvenile quality and develop strategies to utilise these in breeding programmes)
- Increase industry and policymakers’ awareness and competence about potential gains and implementation of selective breeding programmes

► **GOAL 3: Improve broodstock management methods and control of sex and reproduction in captivity**

- Identify reproduction-related problems and knowledge gaps for each major aquaculture species in Europe (finfish and molluscs)
- Evaluate the impact of sexual maturation on growth, welfare and potential risk of disease susceptibility
- Understand the role of genetic, physiological, nutritional, behavioural and environmental factors on the spawning of gametes of high quality and the timing of spawning to (i) facilitate year-round supply (for mass spawning) or (ii) to reproduce selected broodstock (for implementation of breeding programmes)
- Control puberty by understanding the role of genetic and physiological factors, including the effects of environment, husbandry practices and nutrition

- Cryopreserve for biosecurity, predictability, distribution and bio-banking including reference libraries of natural populations
- Understand the basis of sex determination and sex differentiation (genetic, environmental and physiological) to enable sex-ratio control measures
- Develop new sterilisation methods as an alternative to triploidy, and, when not possible, methods to allow production of triploids on an industrial scale for species usually propagated from mass spawning (such as cod, sea bass and sea bream). Acquire knowledge on impact/behaviour of sterile animals in the wild.
- Develop tools for (i) the identification of wild signature for shellfish production or restocking purposes, and (ii) to constitute and conserve genetic variability similar to wild populations
- Improve the knowledge of the technical personnel of aquaculture operations on the available methods to control and enhance reproduction in cultured species

► **GOAL 4: Manage the lifecycle of carefully selected “new” species that have high economic importance**

- Produce desktop study of new candidates for aquaculture, based on objective criteria, for example:
 - indicators issued from market studies
 - biological specificity (e.g. reproduction in a different season than currently cultured fishes, better growth in some specific environmental conditions, lower trophic level, dependence on exclusively plant feeds etc.)
 - open new markets
 - open new aquaculture sectors for production (e.g. offshore for tuna)
 - allow polyculture and/or integrated (multi-trophic) aquaculture or RAS
- Develop innovative (e.g. generic) tools to domesticate more easily new species benefiting from the expertise acquired from already mastered species
- Optimise the management of natural stocks (e.g. Best Gardening Practice) in particular to develop/restore production of European species



Sustainable Feed Production

Key Target:

"Sustainable fish feeds, [whose manufacture will be] based on solid scientific knowledge and reliable raw materials, will contribute to making aquaculture one of the most efficient producers of high value food for humans, and one that respects environment and fish welfare."

Background:

Fish feeds continue, at the present time, to provide one of the most contentious issues in discussions surrounding aquaculture. It is essential, if the sector is to develop further and for society to fully embrace the solutions that aquaculture can offer, that science-based objective methodologies are applied to the sustainable feed debate. Nonetheless, the basic efficiency of nutrient conversion and assimilation gives the opportunity for aquaculture to be the most efficient provider of high quality, nutritious food.

Five key goals have been identified for this area.

► **GOAL 1: 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.**

- Improve knowledge on nutritional requirements of fish commonly farmed in Europe and for promising new species
- Characterise the nutritional value of alternative raw materials, particularly for new promising or underutilised sustainable marine or terrestrial sources, to increase flexibility in formulating highly nutritious feeds, of low environmental impact and appropriate for different aquaculture systems
- Clarify the potential of commonly used and novel micro-ingredients to optimise efficiency of diet utilisation by fish

- Evaluate the effects of using alternative feed ingredients to the content of key bioactive compounds of aquaculture products and understand how to optimise their nutritional value in order to tailor aquaculture products for maximising the consumer health benefits
- Adapt feeding procedures to ensure optimal feed utilisation and minimise environmental impact
- Provide necessary information to support/change regulatory measures

► **GOAL 2: Advanced novel feed technologies to produce cost effective feed with improved quality**

- Develop novel technology and improved processing routes for cost effective and sustainable fish feed production
- Novel and improved larval feed technology for better survival, larval growth performance and quality
- Improved understanding of the interactions between ingredient properties and processing conditions affecting physical feed quality and utilisation of nutrients

► **GOAL 3: Understand and minimise undesirable effects of alternative diets on fish health and welfare**

- Response of alimentary systems in farmed fish to alternative feeds and development of methods and markers for assessing dietary effects
- Roles of nutrition, diet and feed additives on gastrointestinal and systemic immune system and disease susceptibility

- Evaluation of the relation of dietary changes to the aetiology of production diseases
- Evaluation of diet involvement in stress, behavioural and feeding responses of fish and methods for remediating possible adverse effects and optimising performance

► **GOAL 4: Adapt and utilize advanced methods to understand and model nutritional responses**

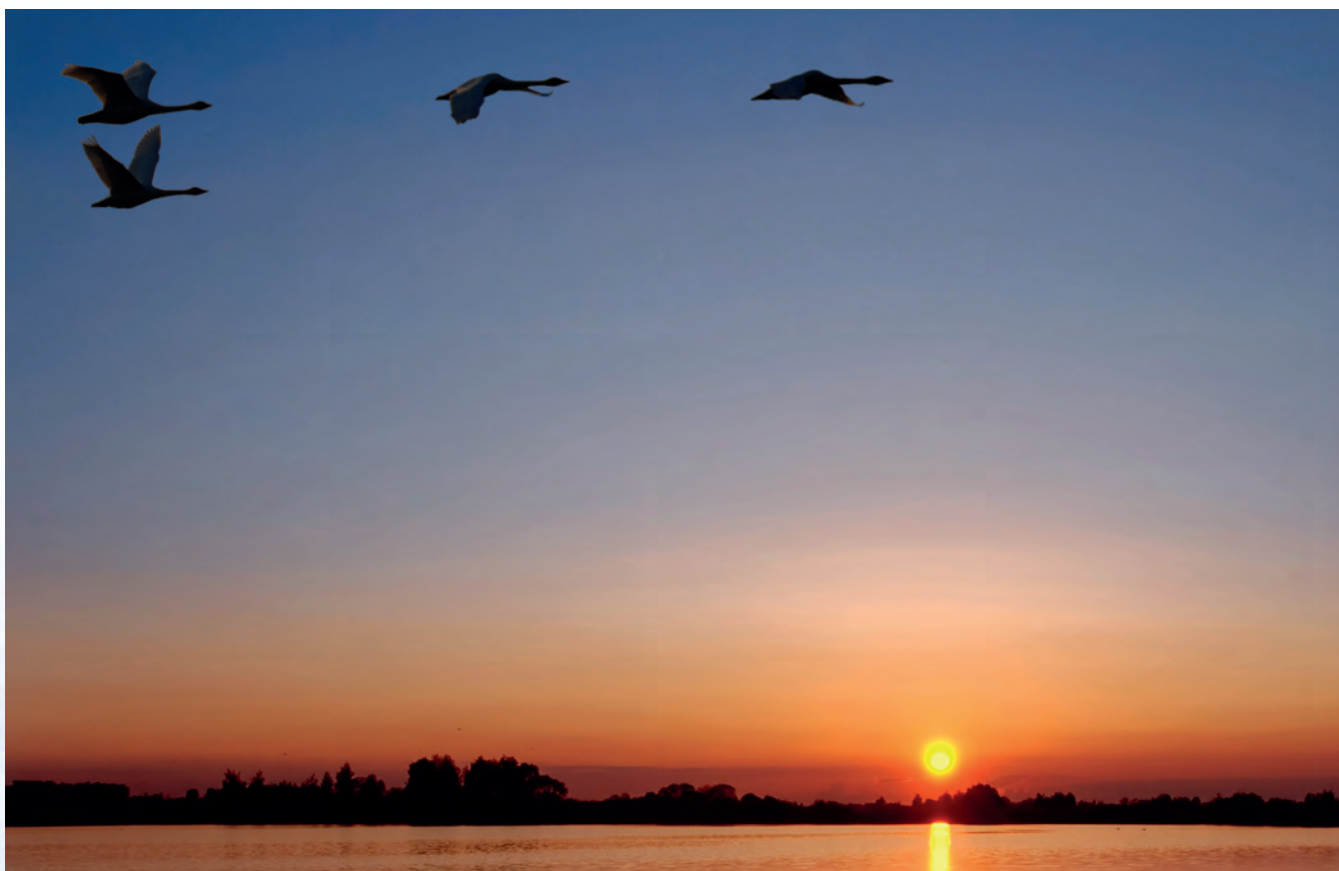
- In vivo and in vitro models to examine physiological responses to nutrients
- Integrative tools and 'omic' tools
- Mathematical modelling of nutritional responses and possible contaminant accumulation in fish

► **GOAL 5: Resolve strategic research problems in fish nutrition**

- Develop feeds to i) maximise protein accretion and minimise lipid deposition, ii) achieve optimal product composition that will promote human health
- Develop selection tools for improving nutrient utilisation and protein/lipid deposition contributing to biological efficiency of aquaculture species via selective breeding and via choice of broodstock material (species or strains)
- Formulate targeted feed and feeding practices that condition farmed species to novel feeds, increase adaptability, reduce stress, and increase biological efficiency

“Creativity can solve almost any problem. The creative act, the defeat of habit by originality, overcomes everything.”

George Lois



Integration with the Environment

Key Target:

"Aquaculture in 2030 will produce nutritious food with less environmental footprints than any other food production for humans."

Background:

Managing the interactions between aquaculture and the environment is a complex issue that requires a holistic approach; this is because European environmental legislation envisages an ecosystem-based management of aquaculture but aquaculture is very sensitive to other human activities that may negatively affect the state of freshwater and coastal waters. In accepting the needs of society to exploit natural resources, the ultimate challenge for aquaculture is to keep the consequences of environmental pressures at an acceptable level while maintaining the full integrity of ecosystem structure and function.

► GOAL 1: 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)

- Establish a science-based concept for the management of biogenic waste emission to open waters with relevant indicators for assessing chemical and ecosystem state as a contribution for the implementation of the Water Framework Directive (WFD)
- 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 shellfish and macro-algae farmed in aquaculture locations
- Establish integrated management tools for waste emission which consider assimilation capabilities, hydrodynamic energy and presence of sensitive habitats as a tool for siting, spatial planning and ecosystem-based management of aquaculture

► **GOAL 2: Establish technology to minimise emission of biogenic matter from aquaculture and to minimise the potential environmental influence of the actual emissions by means of environmental management and integrated multi-trophic aquaculture (Technology to minimise biogenic influence)**

- Improve feeding technology, feeding management and feed composition in order to minimise biogenic emission from aquaculture installations per unit fish produced
- Learn how optimal siting and the best available technology for environmental management can minimise the potential environmental influence of emissions per unit fish produced
- Explore the potential environmental benefits of an expansion of marine aquaculture of fish, shellfish and macro-algae to exposed Atlantic and European marginal seas
- Explore the potentials of utilising wastes from existing and new European fish farms in exposed waters for combining fed and extractive aquaculture (IMTA), with a focus on co-farming of fish, macro-algae and vulnerable non-fed invertebrates

► **GOAL 3: Understand the fate and cumulative effects of synthetic agents used in aquaculture and minimising their impact on the environment (Fate of synthetic agents in ecosystem)**

- Understand better the mechanisms and risks for harmful ecosystem interactions of pharmaceuticals and chemical antifouling agents
- Study the cumulative effects and fate of pharmaceuticals, chemical antifouling agents, and new feed ingredients that are introduced and their ecosystem interaction in the near site and far-field environments
- Improve access to field data with the possibility of building a transparent surveillance and reporting network on fish infections and volumes and classes of pharmaceuticals used by fish farms to regulatory agencies in order to minimise their use and their impact on the environment

► **GOAL 4: Establish more fundamental knowledge to understand the interactions between farmed and wild stocks, including wildlife (Interactions of farmed and wild stocks)**

- Improve knowledge of the potential positive and negative aquaculture interactions with fisheries and ecosystems, including wild life, predators and exotic species
- Enhance knowledge and understanding of the genetic interactions between wild and farmed stocks,
- Understand better disease and parasite interactions between farmed and wild organisms

► **GOAL 5: Develop or adapt tools and measures in support of appropriate environmental governance for aquaculture (Tools for environmental governance)**

- Develop new planning tools and adapt existing tools used for site selection, based on ecosystem assimilative capacity and spatial planning for further aquaculture development
- Develop new management tools and adapt existing tools and measures used for environmental monitoring, production optimisation and minimising aquaculture influence
- Harmonise environmental regulations and legislation, implementing common regulations between European countries
- Develop techniques and procedures for quantification of environmental and ecological services provided by aquaculture farms and encourage voluntary farmer-based contributions to environmental management



Knowledge Management

Key Target:

"In 2030, the European aquaculture industry will be widely regarded as an environmental, economic and socially sustainable activity. This respect will be grounded in evidence based scientific knowledge, industrial strength and consumer confidence. Knowledge and innovation will be integral to the competitive advantages of the European aquaculture industry."

Background:

European scientists will continue to be major contributors to the international scientific community, providing relevant input to all stages of the aquaculture value chain. The aquaculture sector will be attractive to a wide range of highly educated people, with positive growth and employment opportunities. The industry will be characterised by its ability to fast-track progress from knowledge development and intellectual protection through to innovation, industrial application and product development. European aquaculture will adopt cutting edge knowledge management practices to support state-of-the art technological development. This will be the key factor that allows the aquaculture industry to meet the imminent market demand for fish & shellfish production, due to limited natural resources coupled with a growing world population. This Target and its supporting objectives will be met by achieving the following goals and sub-goals.

► GOAL 1: Manage knowledge efficiently and effectively within the European Aquaculture sector

- Create knowledge that is focused on outcomes and impacts on industry and ensure that research effort is not duplicated
- Manage and transfer knowledge including the dedicated transfer to identified users and translation of research results for stakeholder uptake
- Encourage the protection of legal rights, management of intellectual property and adherence to ethical standards in a manner that ensures open innovation and the development of a sustainable sector
- Promote sustainable aquaculture practices through the transfer and application of knowledge and technology, including the challenges of food production, environmental protection, product safety and economic viability

► GOAL 2: Ensure the availability and efficient use of aquaculture research infrastructures across all boundaries to benefit the industry

- Ensure international and inter-regional cooperation to develop research infrastructures that can meet emerging needs
- Increase the awareness of existing research infrastructures (functionalities, scale, services and access) for all stakeholders

► **GOAL 3: Collect and collate evidence for informed communications on the benefits of the European aquaculture sector for Society and the Environment**

- Develop an evidence-based knowledge resource to inform communications on the environmental and societal attributes provided by the different sectors of European aquaculture
- Understand better the perceptions of aquaculture across Europe and identify stakeholder groups as advocates so that public communication campaigns are targeted and responsive



► **GOAL 4: Foster and build the human capital of the European aquaculture sector**

- Promotion of formal and informal lifelong-learning opportunities at all levels as a central strategy to ensure knowledge transfer for a sustainable, innovative and competent workforce
- Explore new models and partnerships for learning and its accreditation to encourage career development and innovation in the sector
- Attract and retain talented, enthusiastic and able individuals to work in the aquaculture sector and to foster entrepreneurship
- Seek to maximise appropriate career pathways and job satisfaction.
- Promote and enable peer-to-peer networking and collaboration as key components of an innovative European aquaculture sector
- Create and sustain effective links between industry and research communities.

"The key to competitiveness for just about any economy in the world right now is knowledge."

Máire Geoghegan-Quinn

European Commissioner for
Research, Innovation and Science



Aquatic Animal Health and Welfare

Key Target:

"By 2030, further improvement in aquatic animal health and welfare in European aquaculture will produce high quality, robust animals - resulting in increased productivity that builds on environmental and welfare standards."

Background:

The extremely high standards of fish health and welfare observed in European aquaculture are a credit to the different production sectors and indicative of the investment made in fish health and welfare research and sectoral education. This competitive advantage can be maintained in fish health and welfare knowledge, improving productivity and the output from the entire production cycle, by addressing four key goals.

► GOAL 1: Improve fish health and welfare by increasing the understanding of host pathogen interactions and to have access to effective vaccines and immunomodulators

- Improve the understanding of host pathogen interactions
- Development of new vaccines & improvement of existing vaccines and diagnostic tests, including their application to all stages of finfish life cycles.
- Research is required on mode of action and use of immunomodulators

► GOAL 2: Apply epidemiological principles to minimise the threat of existing, emerging and exotic diseases

- Improve understanding of transmission mechanisms of pathogens at all levels from farm, through country, to Europe wide

- Understand the industry structure (network) and its vulnerabilities to endemic and epidemic diseases
- Development of framework (model) for evaluating the relative importance of health and welfare threats, including bio-economic modelling, risk assessment and biosecurity.
- Improve strategic data availability through standardisation
- Turn understanding into strategies through industry, government and academic participation in research and consultation

► **GOAL 3: Use and develop best practice to optimise efficacy of treatments and prevention methods**

- Minimise treatment when possible by using best practice
- Investigate alternative remedies and methods such as probiotics and biological control
- Improve and streamline the medicine and vaccine licensing system
- Improve application of management measures with emphasis on alternative control measures
- Develop methods for effective delivery of treatments in novel systems e.g. large off-shore cages, well boats etc.

► **GOAL 4: Measure welfare/stress and understand its consequences if compromised in order to incorporate welfare as core component of production management**

- Develop and improve existing welfare/stress indices
- Understand and quantify short and long term consequences of compromised welfare, such as reduced growth, reduced feed efficiency, health, treatment effects, product quality
- Incorporate welfare/low stress management as a major factor in production and legislation decisions and in on-going risk, cost and gap analysis





Socio-economics, Management & Governance

Key Target:

"Create the economic, social, management, political and governance framework conditions that enable innovative development of sustainable aquaculture and future food and nutrition security, viable companies and livelihoods within Europe's coastlines and freshwater aquatic resources."

Background:

European aquaculture operates within a commercial globally-influenced market. As world economic trends move from state intervention, subsidies and centralised planning towards deregulated free trade, it is vital that aquaculture is not disadvantaged through legislation, regulation or arbitrary intervention and interference. As such, the EATiP will aim to resolve the following key goals and sub-goals for the European aquaculture sector:

► GOAL 1: Promote effective governance - establishing a 'level playing field' for aquaculture within and outside Europe

- Standardise decision-making processes on aquaculture activities by employing good governance principles (e.g. cohesiveness, openness, participation, effectiveness and accountability)
- Ensure that policies consider potential impacts of management measures on aquaculture from vertical (local, national, regional and international) and horizontal (between sectors e.g. aquaculture and fisheries) perspectives
- Simplify legislation and reduce time from application to award of operating licence
- Ensure food produced with ingredients and processes outside Europe complies with EC standards
- Link social and economic dimensions of aquaculture with environmental considerations in a fair, legitimate and transparent manner

- Develop a European database to better inform the aquaculture industry of drivers that underpin local, national, regional and international markets
- Provide a transparent and user-friendly decision support system for effective aquaculture governance that weighs potential benefits and costs of different management measures to all interested parties

► **GOAL 2: Establish an enabling environment for innovation and growth to allow aquaculture to realise its full potential**

- Identify standard methods to measure trade-offs between risk and return on aquaculture projects in regulatory evaluations
- Identify incentives to promote investment in aquaculture and ensure longevity of sustainable production
- Establish policies that recognise property rights of aquaculture enterprises and offer methods on how to balance economic, social and environmental impacts of aquaculture on a specific area
- Facilitate open and inclusive dialogue in decision-making about growth of all aquaculture related activities
- Ensure communication on research and development between industry, scientists and policy makers is facilitated through joint development of effective communication strategies

► **GOAL 3: Understand better the social and economic dimensions of aquaculture at different scales**

- Endorse and develop aquaculture as an attractive and viable livelihood for achieving income generation and food security for all interested communities, including coastal and inland rural areas
- Understand and promote social and economic benefits associated with aquaculture through evidence-based scientific information, communicated using different media formats appropriate for different target audiences
- Improve knowledge on and understand better what parameters explain social and economic impacts of aquaculture, including spatio-temporal trends
- Increase understanding of methods and tools to apply social and economic data to decision-making
- Provide a transparent decision support system for linking relationships between social and economic factors with environmental considerations to inform what type of governance structure is needed and best supports sustainable development of the sector

“Aquaculture is an important economic activity in certain coastal and continental areas of the EU.”

EU Aquaculture Strategy 2009

The Plan of Action

Mobilising Actors and Resources

Each of the EATiP expert groups has identified key targets for their respective thematic area. In total, this has created an interrelated set of 39 key goals and 145 sub-goals. To achieve these ambitions, the next stage is to mobilise the relevant actors and resources towards the actions that will achieve these goals and realise the Vision.

Such mobilisation requires a coordinated effort, maximising the expertise and competence of a wide range of stakeholders across the entire aquaculture value chain - from suppliers through production and processing to retail, as well as the research community, training providers and support services. In parallel, financing will need to be accessed, both for investments (private and public - at European, regional and national levels) as well as funding for RTDi activities. New networking needs, communication channels and management challenges have been identified that accompany the material requirements, including access to sites and technology, required by the Vision.

Initial Priority Actions

The EATiP Operating Council, after working with core groups of thematic experts, has generated its first list of potential actions, which also encompasses the ideas and proposals of more than 200 multi-stakeholder



contributors and focuses on how the overall Vision and targets set for 2030 will be achieved effectively.

Actions are not limited to research and innovation but include any activity needed to achieve the goals and sub-goals identified, including; policy requirements, knowledge transfer, networking, training and sectorial management.

The Plan of Action has been defined so as to capture key information on the specific actions identified to date, including;

- Description
- Type - RTDi, Knowledge Transfer, Policy, Other
- Expected Results

- Timeline (Short, Medium, Long)
- Estimated funding requirement

The list of actions is neither exclusive nor prescriptive but more a starting point for discussion on what needs to be done. In some cases, several options have been proposed to achieve a specific sub-goal where experts have suggested different activities as a response (e.g. a genomics approach to research vs. a field study).

By listing the suggested approaches alongside estimated costs and timelines, it is possible to assess each idea from two perspectives; a) probability of success and b) cost/benefit. This approach will contribute to improved recommendations on future investments in responding to the actions identified.

A Live Document

As EATiP's SRIA moves towards implementation, the Plan of Action will be a live document on the EATiP website - allowing any stakeholder to:

- provide ideas and suggest alternative or missing actions
- provide their opinions on which actions should be prioritised

Furthermore, initiatives or projects that are already underway (national, European, global) will be included – effectively mapping the efforts made to achieve the SRIA, allowing EATiP to ensure the monitoring of progress towards the Vision and eliminating effort duplication.

By visibly linking the progress and results of the Plan of Action to achievement of the SRIA, a new strategic framework for optimising financial support, from public and private sources, to the sustainable development of European Aquaculture will be provided.

The Way Forward

Aquaculture offers Europe great opportunities as a commercial activity, providing valued employment and revenue. It also offers Europe the chance to further enhance its reputation as a provider of high quality, sustainably-raised fish and shellfish products for European consumers or export markets. Given the current challenges in fisheries stock management and the rising level of seafood imports, European Aquaculture shows high potential for growth and is essential for Europe's strategies for food supply, security and safety.

As elaborated in the Goals of the Thematic Areas, the following targets have been identified:

- Improve competitiveness through product development following customer needs, targeted production environments and a high level of professionalism and skill evolution
- Use knowledge and innovation to build cost-effective competitive advantages
- Create the economic, social, management, political and governance framework conditions that will enable the innovative growth and development of a sustainable aquaculture sector
- Produce and provide high quality, healthy, nutritious and safe fish and shellfish products that meet consumer demand
- Adopt cutting-edge knowledge management practices to support state-of-the-art technological development
- 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 systems that are environmentally and economically sustainable
- Improve health and welfare so as to rear high quality, robust aquatic animals
- Provide a safe, attractive, challenging and rewarding work environment

These approaches will confirm Europe as a global leader in the commercial, research and service sectors that make the aquaculture value-chain. This will also create new opportunities in the international dimension for global aquaculture development, where the technology and services created will reinforce Europe's international position.

To achieve these targets, there is a clear need to adopt a more holistic but targeted approach to the sector's development, given the breadth, depth and range of aquaculture in both the EU and the EEA. The proposed reform of the Common Fisheries Policy, in combination with the revised Strategy for Sustainable Development of European Aquaculture,¹⁰ contributes to this. Support from the RTDi actions foreseen in Horizon 2020¹¹ and the recognised position of aquaculture within the European Bioeconomy are also important considerations.

¹⁰ See <http://tinyurl.com/aqstrategy>

¹¹ See <http://ec.europa.eu/research/horizon2020/>

While the work of the Thematic Areas has identified a number of common concerns that technology and innovation can address in support of the aquaculture industry, they also confirm that to reach the EATiP vision, the following considerations are paramount:

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

These factors highlight the need for the best coordination across the Thematic Areas identified and the integration of this approach at National and European levels, reinforcing the following requirements:

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

Achieving these coordination needs will require extensive public/private cooperation in order to create an innovation-friendly environment for all players involved.

EATiP's initial risk management plan has highlighted issues that could affect growth and development

This provides initial awareness and responses to broad and specific risks that could directly affect operations or that are of strategic or hazardous origin. Monitoring and surveying this plan will give a clear and strong basis for informed decision-making at all levels over time.

The Plan of Action for implementing EATiP's SRIA requires the mobilisation of a wide range of actors and resources.

A comprehensive list of actions, based on the associated details of the identified thematic goals, gives a solid base for not only identifying but also following the topics relative to RTDi, policy, knowledge transfer and other issues that affect their successful achievement.

EATiP applies best governance principles to the achievement of its goals and actions

This document introduces EATiP's Vision for European Aquaculture in 2030, identifying opportunities and responses to the challenges that will allow sustainable growth and development. Both the SRIA and Action Plan are live initiatives, which will receive further consultation and inputs for their achievement.

The European Aquaculture Technology and Innovation Platform

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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.

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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 edited by Courtney Hough, John Joyce, David Murphy & David Bassett.

Design by Design Tactics
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“The real challenge, therefore, is to turn innovation from a buzzword into a systemic and widely distributed capability. It has to be woven into the everyday fabric of the company just like any other organizational capability, such as quality, or supply chain management, or customer service.”

Rowan Gibson

The EATiP Operating Council

Chairs and Facilitators of the Thematic Areas

| Chairperson | Facilitator(s) |
|---|---|
| Product Quality & Human Safety and Health | |
| Arne Sørvig -replacing Nigel Edwards [Seachill](UK) | Iciar Martinez [CSiC](Spain) - replacing Edel Elvevoll [NCF5](Norway) Maria Leonor Nunes [IPIMAR](Portugal) |
| Technology and systems | |
| Ulrik Ulriksen [OCEA AS](Norway) - replacing Jone Gjerde [AKVA Group](Norway) | Laszlo Varadi [HAKI] (Hungary) |
| Managing the biological lifecycle | |
| Patrick Lavens [Inve] (Belgium) | Beatrice 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) - replacing Cato Lyngøy [Marine Harvest] (Norway) | Randolph Richards [Institute of Aquaculture] (UK) |
| Socio-economics, Management & Governance | |
| Rosa Chapela [CETMAR] (Spain) | Frank Asche [University of Stavanger] (Norway) Selina Stead [University of Newcastle] UK |

List of Members

Commercial companies

Akvagroup ASA, Norway
 Aquark, Greece
 Aquabiotech Group, Malta
 AquaTT, Ireland
 BioMar A/S, Denmark
 Ferme Marine de Douhet, France
 Grupo Tinamenor SL, Spain
 Inve Technologies SA, Belgium
 Kefalonia Fisheries SA, Greece
 Marine Farms ASA, Norway
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 Selonda Group, Greece
 Skretting AS (Nutreco Group), Norway

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 Azti Tecnalia, Spain
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 DTU Food, Denmark
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 HCMR - Hellenic Centre for Marine Research, Greece
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 Institute of Aquaculture (IOA), University of Stirling, UK
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Representative Organisations

CIPA - Comité Interprofessionnel des Produits de l'Aquaculture, France
 COPA-COGECA - European Agricultural Union - General Confederation of Agricultural Cooperatives, Belgium
 FEFAC - European Feed Manufacturers' Federation, Belgium
 EMPA - European Mollusc Producers Association, France
 FEAP - Federation of European Aquaculture Producers, France/Belgium

International Organisations

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

Civil Society Organisations

EAS - European Aquaculture Society, Belgium
 EBCE - European Bureau for Conservation and Development, Belgium

Observers

European Commission
 European Investment Bank



Glossary

EEA – European Economic Area

EU – European Union

FAO – Food and Agriculture Organization of the United Nations

FCR – Feed Conversion Ratio

FP7 – Seventh Framework Programme of the European Union for the funding of research and technological development

HORIZON 2020 - the new framework programme for Research and Development for the period 2014-2020

IMTA – Integrated Multi-Trophic Aquaculture

M€ - Millions of Euros

-OMICS - informally refers to a field of study in biology ending in -omics, such as genomics, proteomics or metabolomics

PUFA – Poly-Unsaturated Fatty Acids

RAS – Recirculating Aquaculture System

RTDi- Research, Technical Development & Innovation

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

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