



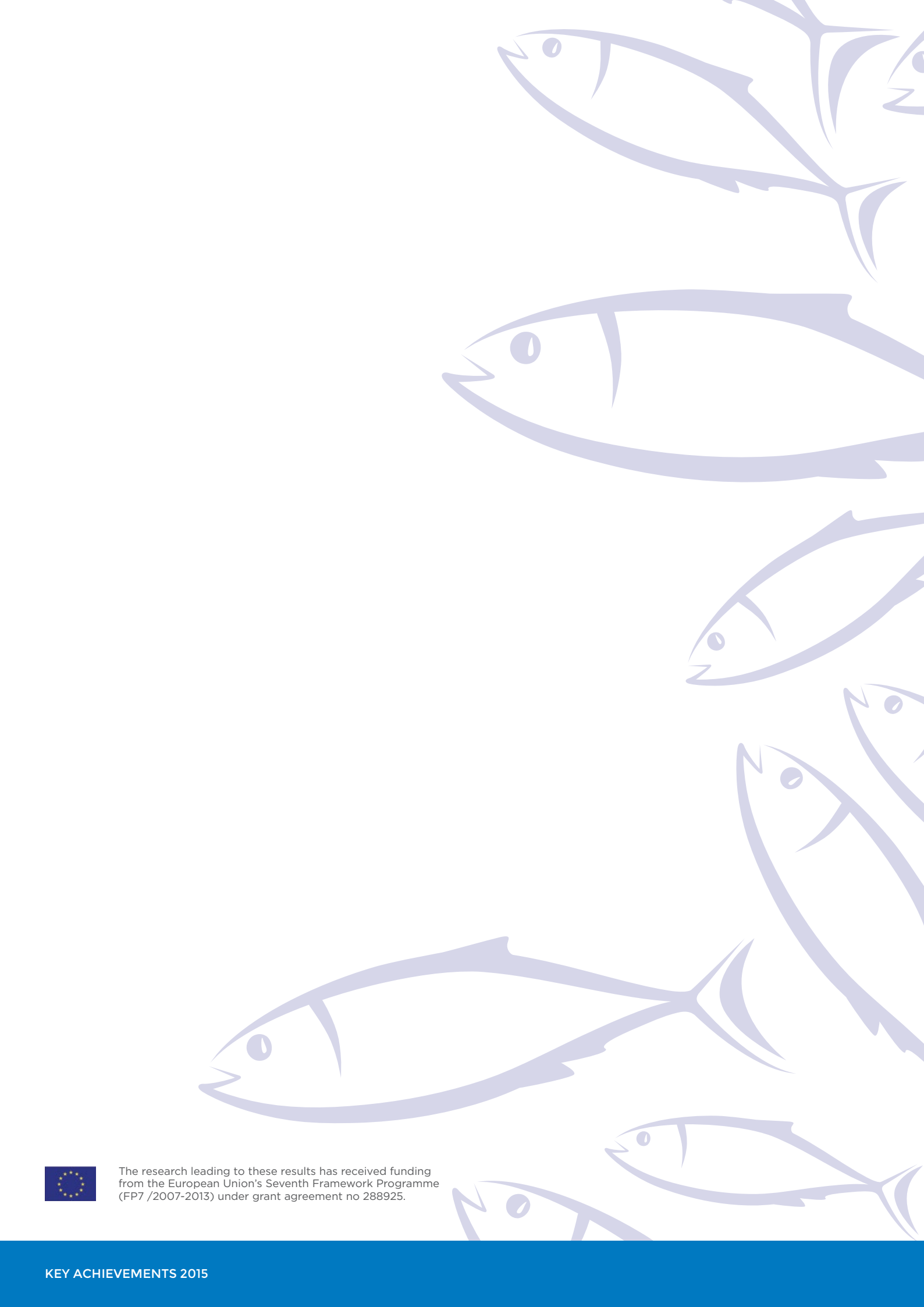
ARRAINA

Advanced Research Initiatives for
Nutrition & Aquaculture



KEY ACHIEVEMENTS

2015



The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7 /2007-2013) under grant agreement no 288925.



INTRODUCTION



This booklet showcases examples of **ARRAINA**'s key achievements and provides detailed summaries of each, as well as introducing the project, its core functions, and its progress to date. The aim of this booklet is to communicate to the general public how **ARRAINA**'s work is benefitting society as a whole including the research community and industry, as well as helping to achieve significant value creation in Europe.

ABOUT ARRAINA

Traditionally fish feeds for European aquaculture include ingredients such as fish meal and fish oil derived from capture fisheries. However, there is increasing pressure on these raw materials due to growing demands from a variety of users including the fisheries sector, the expanding aquaculture sector and the human health market (e.g. fish oil food supplements).

Hence the sustainability and competitiveness of aquaculture may depend on the replacement of fish meal and fish oil with alternative ingredients

such as plant-based feeds.

ARRAINA has been responding to this need by measuring the long-term effects these changes in diet will have on the full life cycle of fish for which presently little is known. **ARRAINA** has also generated knowledge on the food safety issues relating to fillets resulting from replacement of traditional ingredients with novel plant based ones, in particular relating to impacts on human health. **ARRAINA** has also developed tools to help determine any environmental impacts occurring from the change of diet.

By developing applied tools and solutions of technological interest to the European fish feed industry, in collaboration with SMEs, **ARRAINA** will further strengthen the links between the scientific community and the EU feed industry and will contribute to increasing the productivity and performance of the aquaculture sector leading to competitive advantage of the whole sector at a global level.



ABOUT THE AQUACULTURE SECTOR IN EUROPE

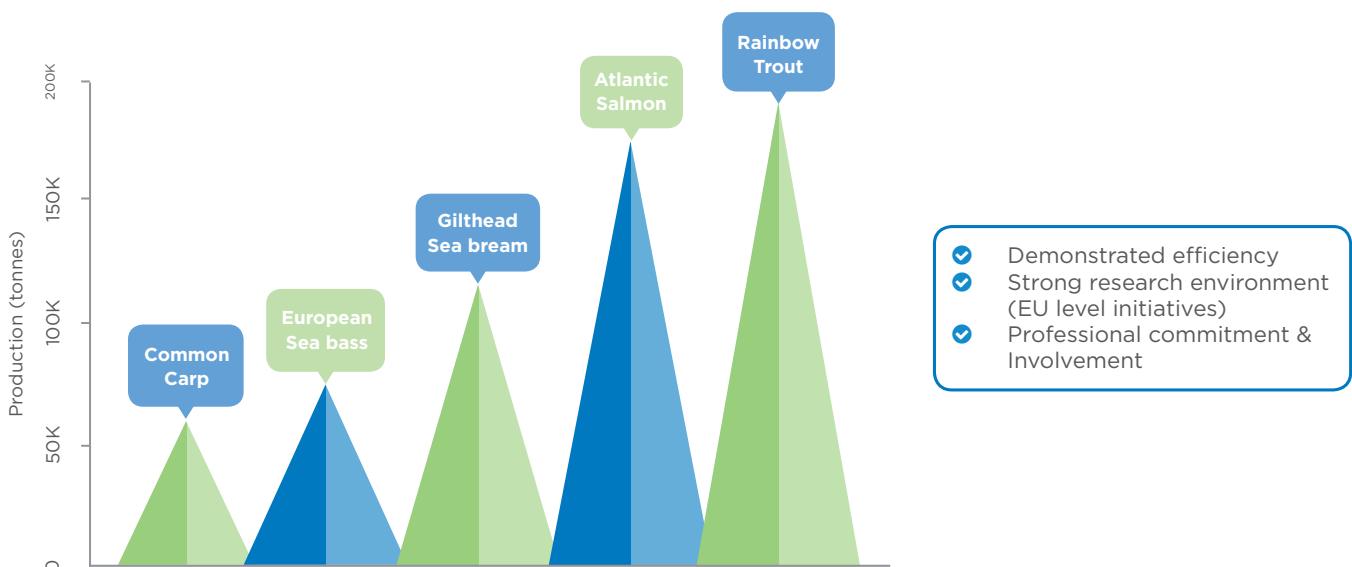
One of the key challenges facing society currently is food security. Aquaculture production needs to increase in order to meet the predicted demand of 165 million tonnes of “seafood” by 2030. To achieve this the aquaculture industry must incorporate the following:

- ✓ Efficient use of resources
- ✓ Consideration of aquaculture as part of animal production sectors
- ✓ The Ecosystem Approach

European aquaculture offers good quality products, respecting strict environmental sustainability, animal health and consumer protection standards. European aquaculture is an important economic activity in many coastal and continental areas and provides jobs in rural areas. Its full potential has not, however, been developed to date, although European and national policy is looking to address

this and provide the framework for sustainable growth across this diverse sector. Sustainable fish feeds, manufactured based on solid scientific knowledge and reliable raw materials, can contribute to ensuring that aquaculture is a very efficient, environmentally sustainable, and fish welfare friendly industry that produces highly nutritious quality food for humans.

TOP FIVE FARMED FISH SPECIES IN EU 28



Graphical representation of finfish species farmed in the EU. (This chart represents the EU 28 production, excluding Norway, which contributes strongly to European aquaculture with about 1.2 million metric tonnes of Atlantic salmon.)

Today’s fish feeds are produced from a large variety of feed ingredients. These have different nutritional and physical properties. During feed production, the physical and functional characteristics of ingredients can cause considerable variation in the quality of finished feeds.

The production of high-quality feeds starts with the selection of high quality ingredients, and therefore it is important to understand what “quality” implies

in aquaculture feed manufacturing. A quality ingredient can be one that contributes to the nutritional value of the feed (such as its profile in terms of amino acids, fatty acids, vitamins and minerals, its digestibility and palatability which impacts feed efficiency), or one that improves the physical integrity of the feed (such as pellet hardness, durability, binding, starch gelatinisation, density, oil absorption capacity and ultimately the pellet water stability).

★ WHY ARRAINA RESULTS ARE IMPORTANT

This booklet describes in general the key results generated by the **ARRAINA** project. It also highlights how these results respond to the overarching challenges affecting the aquaculture sector in Europe particularly. In general, these results are important as they deal with many of the key challenges facing the aquaculture sector today.

Under scenarios of alternative feeds in all five species, specific knowledge gaps are being tackled by the **ARRAINA** project. The following diagram provides a quick overview of the specific areas being researched for each element in the lifecycle of a fish.



For general information on the project, the project factsheet can be downloaded from the **ARRAINA** website, www.arraina.eu as a PDF.

For more information please contact the **ARRAINA** Project Coordinator, Sadasivam Kaushik, kaushik@st-pee.inra.fr or the Project Manager, Heloise Simonson, Heloise.Simonson@paris.inra.fr.

CREDITS

This technical booklet was prepared under the EU Seventh Framework Programme by the **ARRAINA** project No. 288925: Advanced Research Initiatives for Nutrition & Aquaculture. The views expressed in this work are the sole responsibility of the **ARRAINA** team involved and do not necessary reflect the views of the European Commission. The technical content was prepared by all partners. AquaTT is responsible for the production and design of the booklet.

+ KEY OUTPUT 1

SEARCHABLE DATABASE ON NUTRITIONALLY REGULATED BIOMARKERS FOR THE FIVE MAIN SPECIES PRODUCED IN EUROPE (ATLANTIC SALMON, RAINBOW TROUT, CARP, EUROPEAN SEA BASS, AND GILTHEAD SEA BREAM)



AT A GLANCE

FULL TITLE: An online database listing key biomarkers for five fish species (Atlantic salmon, rainbow trout, carp, European sea bass, gilthead sea bream) providing information of nutrient requirements and changes related to specific biological/metabolic processes.

WHERE TO FIND IT: www.nutrigroup-iats.org/arraina-biomarkers

WHO TO CONTACT FOR MORE INFORMATION: Jaime Pérez-Sánchez (jaime.perez.sanchez@csic.es)

STATUS: Ready for uptake. Will be updated by the end of 2016.

KNOWLEDGE DESCRIPTION

Online tool to identify easy and highly informative nutritionally-regulated biomarkers for the five main fish species produced in Europe (Atlantic salmon, rainbow trout, carp, European sea bass, and gilthead sea bream). The tool is designed for single or combined searches of biomarkers which provide information on nutrient requirements or changes related to specific biological/metabolic processes. The tool also includes information for the assessment of fish safety and quality at harvest.

KEY INFORMATION

Biomarkers covering a wide range of biological

processes and nutrient requirements combining conventional histological and biochemical biomarkers with data on gene expression, proteomics and metabolomics are provided.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed producers
APPLICATION: Improvement of fish feed formulation
- ➔ **END-USER 2:** Fish farmers
APPLICATION: Improvement of production efficacy

POTENTIAL



IMPACT

Fish feed producers will develop new feeds with formulations that are more appropriate to each fish species and farming conditions. Fish farmers will use feeds which are more suitable for their facilities leading to a better performance and more sustainable aquaculture.

+ KEY OUTPUT 2

TOOLS TO PREDICT FLESH FATTY ACID PROFILES



AT A GLANCE

FULL TITLE: An online database for predictive modelling of flesh fatty acid on the basis of different nutritional backgrounds for some marine fish species farmed in the EU (aquafat tool).

WHERE TO FIND IT: www.nutrigroup-iats.org/aquafat/index.php/site/view/presentacion/en

WHO TO CONTACT FOR MORE INFORMATION: Jaume Pérez-Sánchez (jaime.perez.sanchez@csic.es)

STATUS: Ready for uptake.

KNOWLEDGE DESCRIPTION

An interactive and highly informative online tool to predict the fatty acid composition of the fillet of farmed fish fed with different diets. Fish are the most important source of omega-3 highly unsaturated fatty acids in the human diet and the 'aquafat' tool was developed to ensure the compatibility of new aquafeeds with healthy fish for human consumers. The tool was initially developed for marine fish with a high value for European aquaculture (gilthead sea bream, European sea bass, turbot, sole). Future database updates will include model data from other fish species of interest in aquaculture (e.g. Atlantic salmon, trout, and carp).

KEY INFORMATION

The proposed mathematical model is able to predict the proportion of saturated, monounsaturated and

polyunsaturated fatty acids in a fish fillet when key data on diet composition and fish fat content are provided. This tool allows the generation of data on the nutritional value of farmed fish for human consumption.

END-USER & APPLICATION

- ➔ **END-USER 1:** Fish farmers
APPLICATION: Guarantee the quality of farmed fish
- ➔ **END-USER 2:** Consumers
APPLICATION: Ensure nutritional value of farmed fish
- ➔ **END-USER 3:** Retailers
APPLICATION: Objectively inform consumers

POTENTIAL

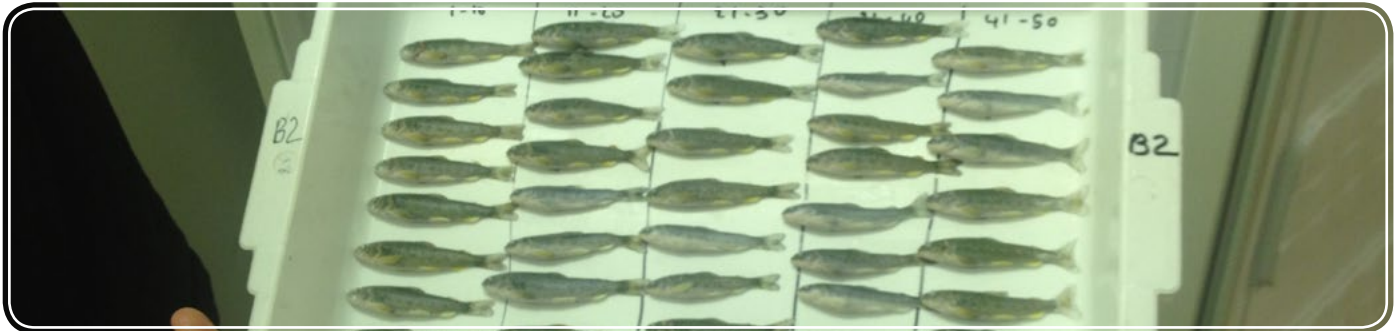


IMPACT

This tool can be used to inform all stakeholders that farmed fish are of high nutritional value. It will help to ensure and show that the fatty acid profiles of farmed seafood are conserved. It will also support the possibility to produce more tailored and healthy seafood products according to the guidelines of essential fatty acid requirements in humans.

+ KEY OUTPUT 3

DEVELOPING NOVEL DELIVERY VECTORS FOR NUTRIENTS TO BE TRANSFERRED TO LARVAE



AT A GLANCE

FULL TITLE: Understanding the most efficient method to ensure improved incorporation of important nutrients such as amino acids by fish species.

WHERE TO FIND IT: **ARRAINA** deliverables 2.3 (Effect of the different microparticle prototypes on the digestive function of early larval fish) and 2.4 (Report on efficacy of novel delivery vectors of nutrients for eggs, embryos and early larvae), scientific publications, posters and oral presentations in symposiums

WHO TO CONTACT FOR MORE INFORMATION: ULPGC (marisol.izquierdo@ulpgc.es), SPAROS, CSIC, USI, NARIC, BIOMAR

STATUS: To be completed in 2016.

KNOWLEDGE DESCRIPTION

Currently, the opportunities to exert a nutritional stimulus during fish development stage are restricted to maternal transfer and the onset of external feeding. In mammals some “developmental windows” were identified when the organism presents high genetic flexibility on processes such as cell production, and organ and tissue formation. Modulation of physical factors like temperature has demonstrated the existence of such “developmental windows” in fish. When controlled during specific time frames of development, such as larval stage, temperature has both short-term and long-term effects on growth and muscle. Hence new tools have to emerge to modulate the nutritional reserves of a fish egg.

KEY INFORMATION

“Sonophoresis (low-frequency ultrasound treatments) can be used to enhance the incorporation of amino acids and glucose in gilthead sea bream and rainbow trout eggs.” Delivery vectors such as this can be used to efficiently feed essential nutrients such as vitamins and minerals to early larvae.

END-USER & APPLICATION

- ➔ **END-USER 1:** Hatcheries
APPLICATION: To determine the best tool to use to improve how fish species can incorporate nutrients from feed ingredients
- ➔ **END-USER 2:** Feed producers
APPLICATION: To modify egg composition

POTENTIAL



IMPACT

The results can improve nutritional quality or application of treatments of fish eggs leading to the production of high quality juveniles.

+ KEY OUTPUT 4

DEVELOPMENT OF WEANING DIETS WITH APPROPRIATE PHYSICAL AND NUTRITIONAL CHARACTERISTICS

AT A GLANCE

FULL TITLE: Optimised diet for improved survival, bone and body development of marine fish larvae.

WHERE TO FIND IT: **ARRAINA** deliverable 2.5 (Scientific publications on digestibility of different feed microparticles for marine fish larvae) Scientific publications, posters and oral presentations in symposiums - ISFNF 2014, EAS 2014, EAFP 2015, EAS 2015

WHO TO CONTACT FOR MORE INFORMATION: ULPGC, USI, SPAROS, NIFES, BIOMAR

STATUS: Under development. Completed by mid-2016.

KNOWLEDGE DESCRIPTION

For rearing marine fish larvae, there is a need to develop microdiets with precise physical and nutritional characteristics. The improvement of microdiets for fish larvae has been a major challenge in recent years. Besides their tremendous growth rates, fish larvae have an immature digestive system at early developmental stages and a progressive metamorphic process that suggests special nutritional requirements. While fish meal is well recognised as the reference protein source for juvenile and adult fish, its proteins may be too complex for easy digestion in fish larvae. Moreover, there is a need to identify replacements for fish meal such as plant protein-rich ingredients, but these may be deficient in some micronutrients present in marine ingredients or contain anti-nutritional factors. Therefore this study aimed to examine the effect of three protein sources: fish meal, squid meal and a mixture of vegetable protein concentrates, on gilthead sea bream larvae performance and digestive function.

KEY INFORMATION

Studies undertaken aimed to improve the physical characteristics of microdiets for larvae which facilitate water stability, rate of passage of foodstuffs through the digestive tract and

absorption of nutrients. Studies also dealt with the analyses of the potential of different forms of micronutrients (vitamins and trace elements) on growth and development of marine fish larvae.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed producers
APPLICATION: Appropriate diets for rearing larvae in fish hatcheries
- ➔ **END-USER 2:** Commercial and research hatcheries
APPLICATION: Understanding different choices of microdiets for optimum production of marine fish larvae



POTENTIAL



IMPACT

Development of water stable and nutritionally adequate larval diets. Fine tuning nutrient delivery to fast-growing marine fish larvae.

+ KEY OUTPUT 5

SYNTHESIS ON MINERAL REQUIREMENTS OF FISH

AT A GLANCE

FULL TITLE: Quantifying dietary phosphorus of fish – a meta-analytic approach, and mineral requirements of fish: A systematic review.

WHERE TO FIND IT: Review papers: Aquaculture Nutrition (Phosphorus), Reviews in Aquaculture (minerals)

WHO TO CONTACT FOR MORE INFORMATION: INRA (kaushik@st-pee.inra.fr)

STATUS: Published

KNOWLEDGE DESCRIPTION

Meta-analysis of literature data on mineral and trace element requirements of fish was performed with the major objectives of identifying appropriate response criteria and the factors affecting the minimal dietary inclusion levels for marine fish species. Fish meal based diets are considered to be rich in, or good sources of, minerals and trace elements. Resorting to plant protein based feeds can alter the availability of such minerals and trace elements to farmed fish. Our knowledge on the levels of mineral and trace elements to be supplied in the feeds of farmed fish is limited. As a first step towards ensuring adequate supply, to secure fish growth and health, a systematic and thorough review of all available data on minerals required by fish and on B-vitamin requirements was compiled and two reviews have been made available.

KEY INFORMATION

Optimal levels of phosphorus, as well as other minerals known to be abundant in fish meal, need to be established when fish are fed plant based instead of fish meal based diets. This meta-analysis of literature data on mineral and trace element requirements of fish demonstrates that a large amount of information can be generated from the published data using a systematic approach and the use of appropriate analytical tools. Information such as (i) impact of response criteria on minimal dietary inclusion levels, (ii) comparison of the meta-

analytic estimates with that of model-predicted estimates and National Research Council (NRC) values available in literature, (iii) compilation of a large array of data on mineral and trace element concentrations of whole fish and different tissues, (iv) analysis of published data for factors that might affect the minimal dietary inclusion-level estimates, and (v) prospective discussion on ideas to propel research in mineral and trace element nutrition of fish has been provided in this review.

END-USER & APPLICATION

→ **END-USER 1:** Feed producers

APPLICATION: Fish feed, and fish farms.

Environmental impact assessment, improved skeletal and body growth of fish



POTENTIAL



IMPACT

For making feeds with appropriate balance of minerals and trace elements which can ensure good body and skeletal growth, and for preventing micronutrient deficiencies in fish. Understanding the knowledge gaps that exist in terms of available data and its validation could inform future funding needs.

+ KEY OUTPUT 6

OPTIMISED MINERAL SUPPLY FOR FISH REARED IN RECIRCULATION AQUACULTURE SYSTEMS (RAS)



AT A GLANCE

FULL TITLE: Recirculation Aquaculture Systems (RAS) are becoming increasingly important as water efficient production systems. Under such conditions, the need for a dietary supply of minerals such as magnesium (Mg), copper (Cu), zinc (Zn), calcium (Ca), iron (Fe), phosphorus (P), manganese (Mn), and selenium (Se) can be different. Studies dealt with evaluating the effects of RAS on mineral balance in fish.

WHERE TO FIND IT: Scientific publication

WHO TO CONTACT FOR MORE INFORMATION: INRA (kaushik@st-pee.inra.fr)

STATUS: Ongoing

KNOWLEDGE DESCRIPTION

Mineral requirements of fish may vary dependent on contents in the surrounding water. RAS systems, where the water is recirculated to various extent, may support parts of the mineral required for growth and fish health. This is due to fish taking up minerals both from the water and from its diet.

KEY INFORMATION

An experimental RAS system was established and tested on carp and rainbow trout to identify the requirement for Cu, Fe, Zn, Mn, P, Ca, Mg, Na and Se. Results indicated growth improvements when water exchange was high.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed producers, farmers, hatcheries
APPLICATION: Knowledge of how to adapt premixes for fish reared in RAS
- ➔ **END-USER 2:** Feed manufacturers/ Aquaculture Engineers
APPLICATION: Adaptation of feeds depending upon rearing systems

POTENTIAL



IMPACT

Reduced environmental impacts due to specific design of premixes for diets used for rearing fish in recirculated aquaculture systems; this will allow more efficient and sustainable land based aquaculture.

+ KEY OUTPUT 7

NEED FOR A DIETARY SUPPLY OF PHOSPHOLIPIDS (PL) FOR REARING JUVENILE SALMON AND SEA BREAM



AT A GLANCE

FULL TITLE: The supply of optimum levels of marine phospholipids is necessary in order to improve growth and performance in Atlantic salmon and sea bream.

WHERE TO FIND IT: Scientific publication, EAS 2014

WHO TO CONTACT FOR MORE INFORMATION: University of Stirling (salmon), ULPGC (sea bream)

STATUS: Ongoing

KNOWLEDGE DESCRIPTION

Traditionally the first feeding diets of marine fish have soybean lecithin added to secure normal gut development. For diets lacking in marine ingredients (which naturally hold some marine PL), knowledge was needed to establish the efficacy of soybean lecithin compared to marine PL; whether it is necessary to add PL, and at which level could the PL (marine or soybean type) hinder deformities in early life stages. Results exist both for salmon and sea bream.

KEY INFORMATION

Marine PL was found to be more efficient than soybean lecithin in protection against intestinal steatosis and vertebral deformity. Experiments performed with marine phospholipids resulted

in substantially lower occurrence of deformities in Atlantic salmon and sea bream. The system to identify mineral requirement dependent on water mineral content was established, and several fish trials were performed. Development of diets for first feeding salmon and sea bream should include this information when using plant based diets.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed producers
APPLICATION: Knowledge of how to adapt premixed diets for juvenile fish
- ➔ **END-USER 2:** Feed manufacturers
APPLICATION: Formulation of feeds with adequate levels of phospholipids for rearing juvenile Atlantic salmon or marine fish.

POTENTIAL



IMPACT

Production of healthy fingerlings and smolts of Atlantic salmon and juveniles of sea bream.

+ KEY OUTPUT 8

REVISED FEED FORMULATIONS TO ENSURE THAT LOW FISH MEAL LOW FISH OIL DIETS SUPPLY OPTIMUM LEVELS OF MICRONUTRIENTS

AT A GLANCE

FULL TITLE: Understanding the key nutritional requirements including B-vitamins, micronutrients and critical minerals of different species to support good body and skeletal growth of fish fed diets with reduced levels of fish meal and fish oil.

WHERE TO FIND IT: Scientific review publications, presentations at events e.g. AE2014/2015

WHO TO CONTACT FOR MORE INFORMATION: NIFES (Gro Ingunn Hemre, ghe@nifes.no), University of Stirling (Doug Tocher), CSIC (Jaume Perez Sanchez), ULPGC (Marisol Izquierdo), INRA (Sadasivam Kaushik)

STATUS: Ongoing



KNOWLEDGE DESCRIPTION

We need to refine our knowledge on the nutritional requirements of fish farmed in Europe, especially when developing diets relying less on ingredients from traditional fisheries and based more on plant based ingredients. Optimal levels of over 20 key micronutrients were defined for feeds with high levels of plant ingredients. The long-term effects of such feeds on growth performance, physiological wellbeing and health and production economics are assessed.

KEY INFORMATION

- ✓ **Trout** – Able to grow on a totally plant-based diet without marine ingredients from first feeding until juvenile stage without

compromising growth when reared at 7°C.

- ✓ **Salmon** – Improved growth and performance in salmon fed low fish meal and fish oil feeds by increasing dietary micronutrient levels.
- ✓ **Sea bream** – Diets containing less than 7.5% marine ingredients supported rapid growth and health, provided that diets are adequately balanced in essential nutrients.
- ✓ **Sea bass** – At the juvenile stage, the dietary levels of fish meal and fish oil can be reduced to 5% and 6%, respectively, without any adverse effects on growth and performance.
- ✓ **Carp** – Plant-based diets can maintain equal growth and health of carp fingerlings as feeds with fish meal.

END-USER & APPLICATION

- ➔ **END-USER 1:** Fish feed industry/premix producers/scientists

APPLICATION: To be able to determine the nutritionally adequate diet for a given species that will allow body growth without any adverse effects on health. Data provide latitude of action for feed formulators and producers to have more flexibility in developing sustainable feeds.

POTENTIAL



IMPACT

Secure growth and fish health when using plant based diets for farmed fish.

+ KEY OUTPUT 9

ANALYSE AND REDUCE SUSPENDED MATTER RELEASE INTO THE ENVIRONMENT DUE TO FAECAL WASTE PRODUCTION OF FARMED FISH



AT A GLANCE

FULL TITLE: The effects of different raw materials used on digestibility, faeces characteristics and faecal waste production were analysed; the potential of enzyme additions on fecal matter release was analysed.

WHERE TO FIND IT: EU Deliverables, PPT presentations. E. Fountoulaki, D. Nikolopoulou, A. Vasilaki, M.N. Alexi, Jorge Dias, EAS 2014 www.easonline.org (abstract of EAS events).

WHO TO CONTACT FOR MORE INFORMATION: Eleni Fountoulaki (efoudo@hcmr.gr); Johan Schrama

STATUS: Completed 2014

KNOWLEDGE DESCRIPTION

The amount and quality of faecal waste are important factors for managing water quality in aquaculture operations. The impact of dietary supplementation of enzymes on the quantity and quality of the faecal waste of common carp was assessed, especially to see if different plant ingredients react differently to such dietary additives.

KEY INFORMATION

ARRAINA demonstrated that enzyme supplementation in common carp can reduce faecal waste production. This effect of enzymes

is dependent on diet composition. The reduction was 17% for a diet containing 30% sunflower meal. Enzyme supplementation had little impact on the stability and characteristics of the faecal pellets.

END-USER & APPLICATION

- ➔ **END-USER 1:** Fish farmers
APPLICATION: Lowered waste production, impact on water quality
- ➔ **END-USER 2:** Feed producers
APPLICATION: Formulation of feeds with reduced faecal waste

POTENTIAL



IMPACT

Selection of raw materials on the basis of their environmental impact.

+ KEY OUTPUT 10

A WEB-BASED TOOL TO ASSESS THE ENVIRONMENTAL IMPACTS OF FEEDS USED FOR FISH FARMING - wastEst

AT A GLANCE

FULL TITLE: wastEst: a computational tool to estimate the environmental load of different fish diets, from basic growth performance measurements, based on the use of predictive models of fish body composition.

WHERE TO FIND IT: www.sparos.pt/index.php/en/produtos/wastest

WHO TO CONTACT FOR MORE INFORMATION: SPAROS (Tomé Silva, tomesilva@sparos.pt)

STATUS: Online and functional (calibrated for sea bream, sea bass and carp) by the end of 2016.

KNOWLEDGE DESCRIPTION

The online web application that allows the user to estimate the environmental impact (in terms of normalised measures of waste production) simply based on growth performance measurements (initial body weight, final body weight, food conversion ratio) and basic information on feed composition, providing confidence intervals that reflect the amount of information provided.

KEY INFORMATION

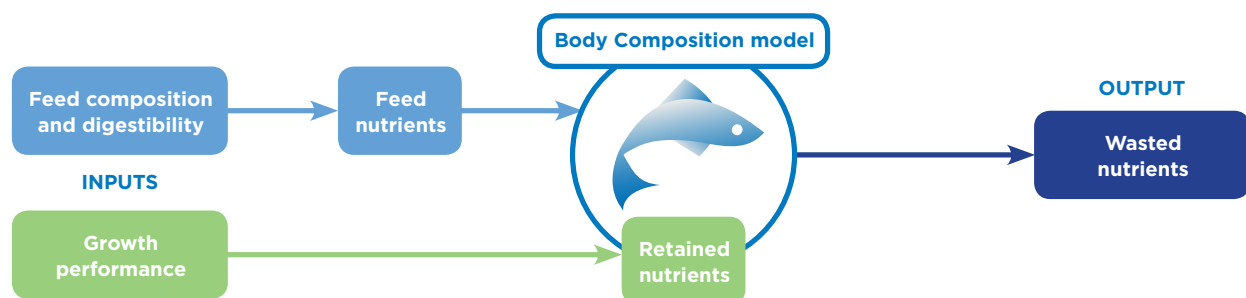
The main innovative aspect of this tool lies in leveraging the wide range of information available on fish body composition to enable end users to have a reasonable estimation of mass budgets (and, hence, waste production). The formulation of this tool within a bootstrap framework is a further

asset, allowing the tool to provide confidence intervals for the estimated parameters that reflect the variability and uncertainty of the given parameters.

END-USER & APPLICATION

- ➔ **END-USER 1:** Fish farmers
APPLICATION: Low-cost assessment of waste load
- ➔ **END-USER 2:** Feed producers
APPLICATION: R&D; providing waste load estimates to customers
- ➔ **END-USER 3:** Researchers
APPLICATION: Trial design; data analysis

wastEst Concept to Assess Impacts of Feeds



POTENTIAL



IMPACT

Successful exploitation of this tool by end users will enable them to better assess and compare scenarios in terms of environmental impact, using information that is readily available for fish farming in both an industrial and research capacity. One immediate impact of the tool is to increase awareness and concern about estimation of waste loads and environmental impact. At the farm level, the increased pressure for regulatory frameworks addressing environmental impacts leads to a necessity for practical tools that enable fish farmers to use the information they have on growth performance to ensure and document compliance within safe boundaries.

+ KEY OUTPUT 11

ASSESSING THE IMPACT OF ALTERNATIVE INGREDIENTS ON THE PHYSICAL CHARACTERISTICS OF EXTRUDED FISH FEEDS



AT A GLANCE

FULL TITLE: Characterise the effect of variable levels of plant ingredients on the physical characteristics of extruded pellets.

WHERE TO FIND IT: First **ARRAINA** technical booklet www.arraina.eu/images/ARRAINA/Media_Center/ARRAINA_1st_Technical_Booklet_web.pdf

WHO TO CONTACT FOR MORE INFORMATION: SPAROS (Jorge Dias, jorgedias@sparos.pt)

STATUS: Completed early 2015. Ready for uptake.

KNOWLEDGE DESCRIPTION

Besides its nutritional adequacy, the efficacy of a given aquaculture feed also relies heavily on a series of technological criteria, such as optimal pellet durability, water stability and its suitability to the species' feeding behaviour. Empirical knowledge demonstrates that when using plant-protein ingredients, even slight changes on formulations can have profound effects on the physical properties of extruded feeds.

KEY INFORMATION

Knowledge generated in the framework of the **ARRAINA** project confirms that within the "commonly used" incorporation levels and with a careful adjustment of extrusion conditions, the use of plant ingredients results in fish pellets with high

physical quality, without detrimental effects on the environmental loads associated to feed losses.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed producers
APPLICATION: Higher quality and lower economical losses
- ➔ **END-USER 2:** Fish farmers
APPLICATION: Guarantee of high quality feeds
- ➔ **END-USER 3:** Researchers
APPLICATION: Relevant information for formulation of test feeds
- ➔ **END-USER 4:** General public
APPLICATION: Reduction on environmental load of aquaculture

POTENTIAL



IMPACT

Extrusion technology is an efficient feed manufacturing process and plays an essential role in ensuring competitiveness of the European aquaculture industry. Advantages of extruded aquaculture feeds include enhanced feed efficiency, a better control of pellet density and water stability, which are all aspects that contribute towards a reduction of feed wastes and a minimisation of the environmental impact of farming systems. Understanding that introducing plant based ingredients can be done without affecting the end product is very important for a more sustainable aquaculture industry.

+ KEY OUTPUT 12

DETERMINING THE POTENTIAL PRESENCE AND PREVALENCE OF CONTAMINANTS IN FISH FILLETS FOR HUMAN CONSUMPTION

AT A GLANCE

FULL TITLE: To identify new emerging targeted e.g. *mycotoxins, non-organochlorine pesticides and relevant metabolites and polyaromatic hydrocarbons (PAHs)* and non-targeted contaminants which are related to novel alternative ingredients in fish feeds; and to assess their feed-to-flesh carry-over in fish which were reared on alternative feeds during a full production cycle.

WHERE TO FIND IT: EU Deliverables Reports, Scientific publications (peer-reviewed papers and conference abstracts), PPT presentations. Torstensen et al., ISFNF 2014, EAS 2014, EAS 2015

WHO TO CONTACT FOR MORE INFORMATION: CSIC, NIFES

STATUS: Completed by end 2016

KNOWLEDGE DESCRIPTION

In some cases, there are contaminants including pesticides and mycotoxins (toxic substances produced by fungi) which are associated with non-marine based ingredients used in aquaculture feeds. **ARRAINA** recognised the necessity to develop “universal” screening methods for fast and sensitive analysis, to be applied for a wide range of organic contaminants, independently from their chemical properties.

In order to assure food quality and safety for fish products reared for human consumption, tests were carried out to determine the presence of these contaminants at various stages, both in the ingredients as well as the final feed diet, and most importantly the final fish flesh. Past studies have dealt with eight EU regulated mycotoxins plus ten mycotoxins of potential relevance for food safety. Studies also dealt with EU regulated pesticides and PAHs.

KEY INFORMATION

In **ARRAINA**, mycotoxins were, in all cases, found below the maximum permitted levels in products

for animal feeding (European Commission Recommendation 2006/576/EC). None of the dietary mycotoxins were detected in the fillets of sea bream or Atlantic salmon fed for respectively eight and seven months on these diets. Light PAHs were mainly found in ingredients, feed and edible fillets. Pesticides were found in ingredients and feed but not in edible fillets.

END-USER & APPLICATION

- ➔ **END-USER 1:** Feed manufacturers
APPLICATION: To ensure food safety along the value chain
- ➔ **END-USER 2:** Public authorities
APPLICATION: To be able to provide evidence and knowledge on the safety of farmed seafood when reared with plant based diets
- ➔ **END-USER 3:** Consumers
APPLICATION: To consume quality and nutritiously sound seafood products without risk from contaminants

POTENTIAL



IMPACT

Ensuring food safety along the food chain. These results can help to ensure application of regulations on pesticides and mycotoxins by feed producers. Informing and reassuring consumers on the absence of pesticides and mycotoxins in the fillets.

+ KEY OUTPUT 13

APPLICATION AND VALIDATION OF THE CONCEPT OF “NUTRITIONAL PROGRAMMING” EARLY IN LIFE OR THROUGH BROODSTOCK NUTRITION TO MODIFY THE METABOLIC POTENTIAL OF FISH SPECIES - CAN WE PREPARE THE FISH FOR ACCEPTING LOW FISH MEAL/LOW FISH OIL FEEDS?

AT A GLANCE

FULL TITLE: Proof of the possibility of early fish metabolic/nutritional programming to increase fish farming performance with alternative diets such as plant-based diets.

WHERE TO FIND IT: Publications, communications in international events such as AE 2014

WHO TO CONTACT FOR MORE INFORMATION: INRA (S. Panserat), ULPGC (M. Izquierdo)

STATUS: Ongoing - due to be complete by 2016

KNOWLEDGE DESCRIPTION

Nutritional programming is gaining momentum as a strategy to alter specific metabolic pathways or functions in farmed animals. Numerous studies in mammals have demonstrated that a nutritional intervention (or stimulus) during a critical period of development can result in a persistent effect lasting into adulthood. The possibility of manipulating the first nutritional experience of fish during their first feed can be a valuable approach to understanding why some fish show a low ability to use dietary carbohydrates as an energy source. In particular, **ARRAINA** looked at the effect of glucose supplementation and carbohydrate supplementation in affecting the gene expression of juvenile fish. **ARRAINA** worked at identifying the levels of supplementation which would result in a change of metabolic function in juvenile fish to become more likely to be able use dietary carbohydrate.

KEY INFORMATION

Sea bream have positively responded to being initially fed with dietary carbohydrate as the main energy source as opposed to the traditional

marine ingredients source. Results are still being generated as to the effect of this nutritional programming on the progenies of rainbow trout. Results are also still ongoing on the effect of using glucose supplementation in first feed as a primary source of energy in place of marine based ingredients.

END-USER & APPLICATION

➔ **END-USER 1:** Hatcheries

APPLICATION: Increase in fish growth performance through the use of novel fish capable of greater robustness and resilience when confronted with feeds with low levels of marine ingredients. This approach will reduce the time and cost required to produce more efficient progenies.

➔ **END-USER 2:** Broodstock producers

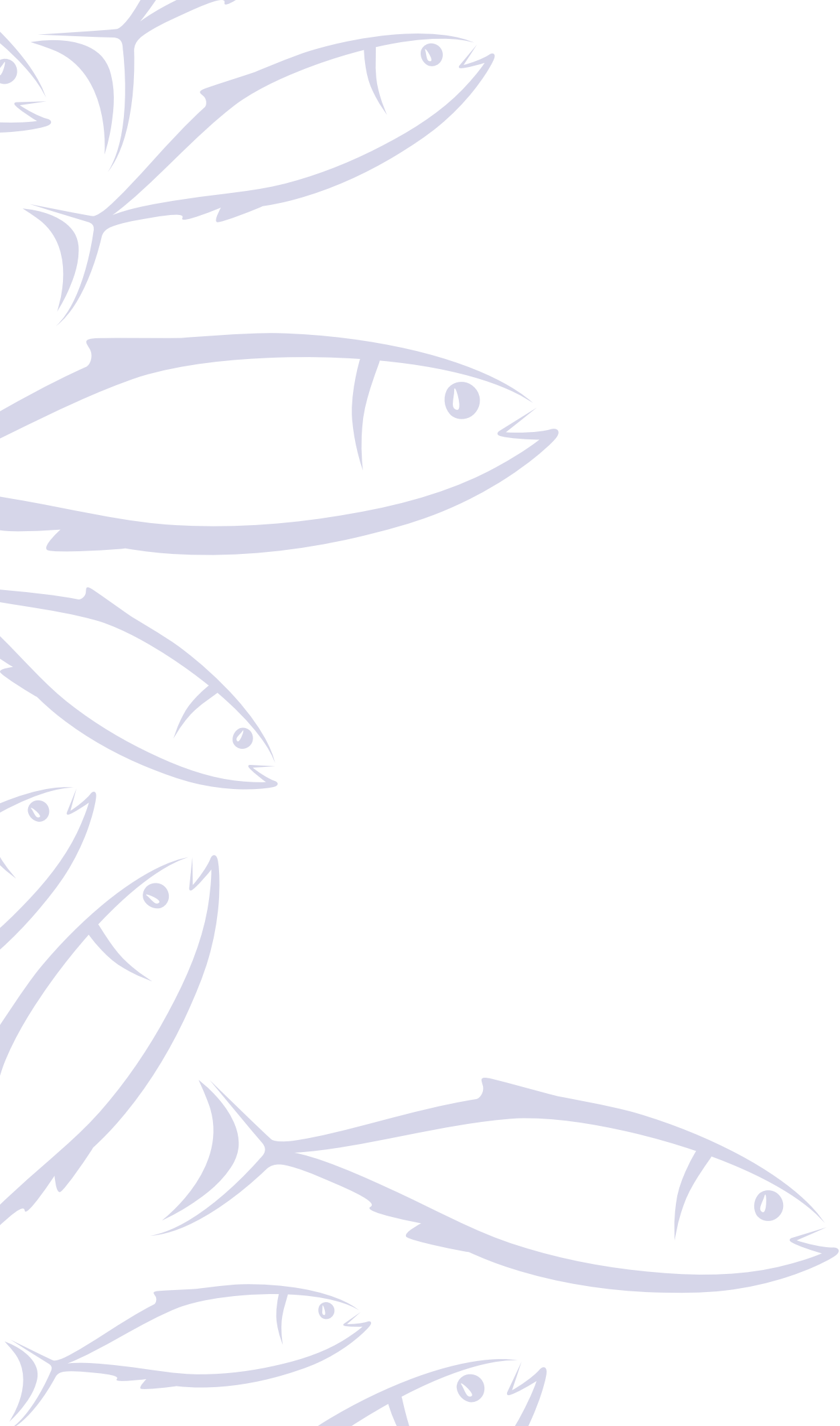
APPLICATION: Preparing broodstock fish with given physiological potential to accept specific feeds or sets of nutrients. For instance, juvenile fish capable of using and/or benefiting from feeds with high levels of plant-based ingredients .

POTENTIAL



IMPACT

Reduced barriers to initiating a change in diets from marine based ingredients to those that are plant based.





Designed and developed by AquaTT



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