

Welfare of farmed fish

Towards a sustainable development of European aquaculture



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Towards a sustainable development of
European aquaculture

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Welfare of farmed fish; towards a sustainable development of European aquaculture

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The European project FASTFISH has developed a fish behaviour monitoring system for aquaculture to ensure that fish production continues to be legitimised by society and remains competitive in production performance. Adoption of the monitoring system in society is a political process of choices and strategies, requiring experience and capacity from all stakeholders. The main challenge of FASTFISH is to combine learning processes as well as accountability for retailers and non-governmental organisations by establishing a platform facilitating stakeholder arrangements.

In het Europese project FASTFISH is een monitorsysteem ontworpen voor aquacultuur zodat de productie van vis gelegitimeerd blijft voor maatschappij en concurrerend in productie. Inbedding in de maatschappij is een politiek proces van keuzes en strategieën. Dit vergt ervaringen en het bouwen van capaciteit door alle betrokkenen. De grootste uitdaging van FASTFISH is om het supermarkten en dierenbeschermingsorganisaties mogelijk te maken de productiecondities te verifiëren en een platform te zijn voor nieuwe stakeholderarrangementen.

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Preface

This publication describes the strategic issues involved in implementing a fish welfare monitoring system in the European aquaculture industry. Aquaculture is one of the world's fastest growing food production technologies aimed at responding to global demand for seafood. With the growth of the industry, issues related to welfare and environmental impact have become very important in terms of legitimisation and the sustainable growth of aquaculture. Overall welfare assessment is a systematic attempt to assess the welfare status of fish in relation to housing and management based on observations and to initiate a dialogue between stakeholders aimed at improving production processes and developing welfare concepts.

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The FASTFISH project team and its partners contributed to this report. Special thanks are due to Tore Kristiansen as encouraging project manager, Lars Stiens for developing the web based survey and Nikos Papandroulakis for the input from Greece.



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Summary

The European project FASTFISH has developed a monitoring system as a strategic process to obtain insight into fish welfare aimed at directing aquaculture towards sustainable development. The system requires new sensor techniques for observing fish behaviour and rearing conditions as well as software for registration, FAST-TOOL, due to the size of modern farms. The information is stored in a database to develop 'products' like benchmark indicators or a fish concept for a market segment that values high welfare.

Implementation and development of FAST-TOOL involves finding a way to incorporate different stakeholder views whilst improving welfare by monitoring. The adoption process is a social process about politics, choices and directions. Indicators represent information about production conditions but are part of the dialogue between different stakeholders, each of whom holds a different view on fish welfare. This requires a platform where stakeholders can meet and develop arrangements based on scientific research and set new directions. Furthermore, the role of the platform can be extended to cover the adoption of new insights, monitor progress and achievements about learning and verification and market welfare friendly fish. A body will supervise the platform to address controversial use of information that undermines the building of trust and therefore the use of FAST-TOOL.

The development and implementation of fish welfare assessment is also about developing the technical aspects of the monitoring system and generate capacity and experience among all stakeholders. Self-assessment of fish behaviour by farm managers makes huge demands on their ability to perform monitoring and data entry and work with the system on a daily basis. The involvement of farm managers can be enhanced through a participatory approach combined with education and personal development opportunities. At the same time, fish farm customers such as retailers and food service companies as well as special interest groups must be able to verify production circumstances. The main challenge for the system is to combine learning and accountability processes.

Samenvatting

In het Europese project FASTFISH is een monitor ontworpen om het inzicht in het welzijn van vissen te vergroten en te verbeteren om een transitie te krijgen naar een duurzame ontwikkeling van de aquacultuursector. Nieuwe technologie en software (FAST-TOOL) zijn in dit project ontwikkeld die het mogelijk maken om het gedrag van vissen en houderijcondities in aquacultuur te observeren gegeven de huidige omvang van een viskweker. De informatie wordt opgeslagen in een database om 'producten' te ontwikkelen zoals indicatoren voor benchmarking en marketingconcepten voor consumentensegmenten die een hoger welzijn waarderen. De techniek is specifiek ontwikkeld gericht op de viskwekerij op zee, maar de benadering voor implementatie zal ook voor kwekerij op land relevant zijn.

Implementatie van FAST-TOOL met als doel het verbeteren van het welzijn, betekent dat de verschillende standpunten van alle stakeholders moeten worden meegenomen. Inbedding in de maatschappij is een politiek proces van keuzes en strategieën. De informatie uit de observaties moet worden vertaald naar indicatoren, maar deze zullen onderwerp zijn van onderhandeling tussen de verschillende betrokkenen die ieder een eigen visie hebben op welzijn. Er is een platform nodig die het vormen van institutionele arrangementen van stakeholders faciliteert waarbij de wetenschappelijke kennis naar het gedrag van vis in relatie tot de houderij condities wordt gebruikt. Daarnaast kan het platform nieuwe richtingen uitzetten voor onderzoek en nieuwe inzichten uitdragen, evenals de voortgang toetsen van het gebruik van informatie om te leren en te verifiëren. Hiervoor is toezicht nodig op het gebruik van de informatie.

Ontwikkeling en implementatie van viswelzijn betekent ook het opdoen van ervaringen en het bouwen van capaciteit door alle betrokkenen. Het monitoren door de managers van viskwekerij vraagt veel van de vaardigheden en gewoonten om dit dagelijks te doen. De betrokkenheid van viskwekers kan worden vergroot door een expertadvies te geven over de observatie die de viskweker leren hoe om te gaan met veranderende welzijnscondities. Tegelijkertijd is het de uitdaging om het klanten en dierenbeschermingsorganisaties mogelijk te maken de productiecondities te verifiëren.

1 Introduction

1.1 Background

Aquaculture is currently the world's fastest growing food production technology. Production has increased from around 3.5 million tonnes in 1970 to around 145 million tonnes in 2007 (FAO, 2008). Growth of the global population and economic growth have been important drivers for the increased demand for seafood in recent decades (Delgado et al., 2003). Issues related to welfare and environmental impact have become very important with the growth of the industry in terms of legitimisation of aquaculture. Overall welfare assessment is a systematic attempt to assess the welfare status of animals in relation to housing and management based on observations of the animals, their environment and scientific knowledge (Bracke et al., 1999). Overall welfare assessment can contribute to strategic decision making i.e. create a documentation base for company investments, farm design and production plans and protocols. It will also help identify problem areas in aquaculture as well as provide an information base for food authorities and customers and a database for epidemiological research.

Currently there are no systems designed to monitor fish welfare. FAST-TOOL facilitates this process through instruments and software that enable fish behaviour to be observed by involving the farm operator and manager. The system is designed to generate online daily expert reports about fish welfare for decision support management. FAST-TOOL was developed as part of the European FASTFISH project. The system has been tested on fish farms in both Norway and Greece. Implementation is a strategic process aimed at contributing to the sustainable development of aquaculture. The information allows different products to be developed for different markets and the social embedding of the FAST-TOOL assessment system by institutionalisation. The aim of this report is to address the what, why and how of the FAST-TOOL system for its successful implementation.

1.2 Problem statement

Fish welfare has never been the primary focus in the European fish farming industry in the past. Various welfare problems related to the intensification of production have arisen, e.g. acute and chronic stress, disease, deformations, nutritional deficiencies in the early juvenile stage, environmental stressors and poor husbandry. Decision support systems are important due to the increased size of an average farm and because disease threatens economic performance. Furthermore, welfare is increasingly becoming the subject of public debate among consumers and animal rights organisations. Regulatory authorities are also developing new directives for fish farming incorporating welfare considerations as a key issue. Pressure on the welfare and environment challenges all stakeholders to develop and validate sustainable production methods.

Implementation requires a technical structure to observe fish behaviour and a social process to validate farm practice. Interaction with stakeholders is necessary in today's complex society in order to express the validity of this approach to improve welfare.

The objective is to study how FAST-TOOL can be implemented in the fish farming business and society. Implementation of FAST-TOOL is a strategic approach aimed at establishing sustainable aquaculture development. The following research questions were formulated:

- Who are or will be involved in the welfare approach, which stakeholders and what are their aims?
- The monitoring instrument is a self-assessment system by fish farmers. The question is therefore what are their attitudes and intentions regarding the use of FAST-TOOL?
- The purpose of the system is to create sustainable development. What is the context in which stakeholders accept the system and how can it contribute to sustainable aquaculture development?



1.3 Approach

The specific approach followed in the FASTFISH project and the design of the monitoring system of fish behaviour is described in the next chapter. In order to obtain insight into the stakeholders, their role and involvement in such a system are reported in Chapter 3. As FAST-TOOL has been designed as a self-assessment system, the attitudes and intentions of farm managers regarding this system are presented based on a survey in Norway and Greece. Chapter 4 describes the main drivers of use by fish farm managers. Based on the findings in Chapters 2, 3 and 4, an implementation plan is proposed in Chapter 5. Drawing on governance literature, implications for additional services related to the tool (it might generate products that benefit several stakeholders), organisational conditions regarding the marketing of the tool (to establish confidence in the tool) and possible governmental measures are studied.

2 FAST-TOOL

2.1 Introduction

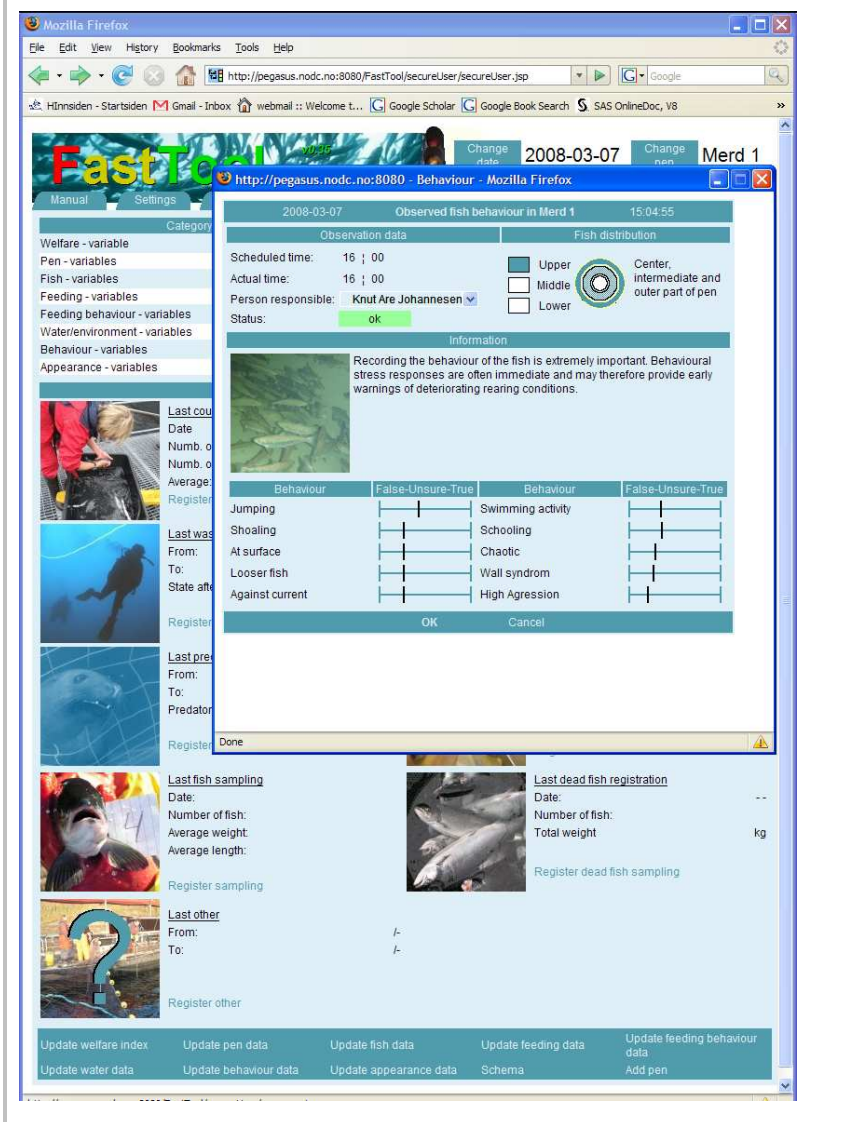
FAST-TOOL was developed as part of the FASTFISH project as an inclusive support system by involving the managers who operate and/or supervise fish farms and providing them with expert advice. In this respect, it aims to be an inclusive monitoring system aimed at stimulating improvements in production methods at individual farm level on a daily basis. This approach contrasts with the more common top-down practice in international supply chains aimed at verifying whether a producer complies with a given set of rules or standards with respect to welfare. This chapter describes the FAST-TOOL approach, what it consists of, how fish behaviour and rearing conditions are observed and how an expert database is created for decision support.

2.2 Observing fish behaviour

FAST-TOOL is the software program which translates fish welfare observations into an expert database providing advice and a decision support system to support the fish farm operator in farm management. Observations of fish behaviour are based on the judgement of the farm operator and on sensors of various measurement instruments. These instruments are necessary because the size of rearing units has increased twelvefold since 1990 (current units may be 15 to 20 metres deep) and the water can be turbid, making observation difficult.

The approach developed in FASTFISH is scientifically validated, which implies that, based on the behaviour of the fish and rearing conditions, the most realistic possible estimates are made of welfare on a scale from good to bad. Experimental studies relating to stress factors and their impact on behaviour as well as immunology formed the basis for establishing the preliminary indicators by the FASTFISH team.

Figure 1 FAST-TOOL input screen for rating fish behaviour at the indicators by the fish farm operator



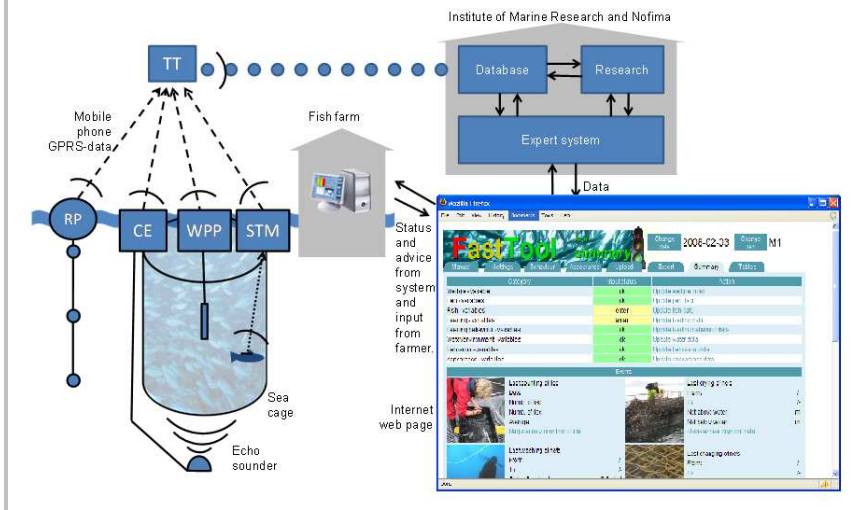
The observations of fish behaviour and rearing conditions provide the input for the indicators that can quantify stress at group level, such as feeding moti-

vation and individual or group swimming behaviour and a novel indicator based on the relationship between stress level and fish mucus production. To correctly interpret these indicators and identify the stressors, vital information on present and previous rearing conditions must be available. This will be generated by the database and expert system which will also give early warning when rearing conditions or stress-level indicators reach harmful levels.

This information must be delivered by the farmers on a daily basis. The data is then sent to the research institute. The expert system in FAST-TOOL will assess the information in the database and record the welfare level (and other relevant data) during a production cycle. Based on the incoming data, the system will send a report/advice about deviation from the normal or optimal conditions. This can usually be generated automatically because of the underlying models that are currently available or under development. The advice should be designed to provide information to farmers that can be used as an early-warning and that supports decision making. This is illustrated in Figure 2.

The proposed system for overall monitoring and assessment of fish behaviour is based on underwater cameras and four measurement systems: the welfare meter profiling probe (WPP), the reference probe (RP), the SmartTag Digital system (STM) and the Cage Eye echo sounder (CE). WPP creates detailed series of measurements of dissolved oxygen (DO), temperature, salinity, fluorescence and turbidity inside the cage by winching a measurement probe from top to bottom of the cage every hour. The reference probe measures DO and current outside the cage at three designated depths. The SmartTag Digital system gives the depth position, respiration frequency and respiration volume for selected fish and the Cage Eye echo sounder provides the vertical distribution of the fish population as a whole in the rearing unit. The data from the measurement systems appears directly in FAST-TOOL. In addition, the farm operator uses his own observations and those of an underwater camera to rate the indicators. FAST-TOOL data transmission communicates via a GPRS mobile telephone system.

Figure 2 Design of FAST-TOOL monitoring system



After each daily update of the data set, the expert models will run again on the data. All the information is presented visually in a graphic user interface with colour coding indicating whether the values are a cause for concern or not, as well as providing summaries of the measurements over time enabling the fish farmers to identify and monitor any changes in the environment over a longer period.

2.3 Costs

Welfare measurement implies the need for investments by fish farms in equipment for observing fish behaviour and registering welfare. Cost information about fish farming is shown as well as the costs of using FAST-TOOL that are currently available.

An overview of the average cost structure of the fish farmers in 2006 is shown in Table 1. Feed is the main input in the salmon farming industry and it also represents the biggest share of the operating costs in the industry (Roll 2007, 10). The costs of the use of technology are not specified in the statistics, but it can be assumed that technology costs are included in the 'other operating expenses per kilo'.

Table 1	Costs per kilo produced salmon and rainbow trout (2006, in NOK; 100 NOK = 11.2 EUR)	
Smolt		1.56
Feeding		8.49
Insurance		0.16
Wages and salaries		1.54
Estimated depreciation		0.77
Other operating expenses 2.14		
NET Financial expenses		0.25
Production		14.92
Slaughter		2.19
Total costs per kilo		17.11
Source: Directorate of Fisheries 2008a.		

Cost of FAST-TOOL distinguishes between a fixed fee and operating costs. Fixed costs are a subscription fee that is around 50,000 NOK for the primary probe and 10,000 for a secondary probe (e.g. for an additional pen). Additional operating costs are maintenance and data communication. Server maintenance, storage and data processing costs amount to 1,000 NOK per probe, per year.

Data communication costs are based on 12 daily data sets, each around 100kb in size and a data rate of 12.50 NOK per MB. Annual data traffic costs amount to 7,665 NOK per probe, including a margin of 40% for the service provider (Johannessen, 2008). Costs of assessment, data entry and studying the expert advice have to be accounted for, although exact estimates on how the operation manager performs these tasks and his education and experience are provided. Craftsmanship may play an important role in limiting additional costs and receiving higher returns (Ingenbleek et al., 2007).

2.4 Benefits

FAST-TOOL is a tool with which fish farms can monitor fish behaviour more extensively and thus further optimise the production process. This system aims to communicate and generate awareness about fish welfare in relation to farm performance. In this sense, it is a strategic approach aimed at redirecting the

competitive European aquaculture industry. The following benefits are considered.

FAST-TOOL provides an early warning system because it is a participatory system that monitors fish behaviour and rearing conditions on a daily basis. For high growth rates, it is important to ensure that fish welfare is maintained at a high level. There is ample evidence from animal science showing that various welfare improvement strategies will increase production as well as improve efficiency, product revenues and working conditions. Early detection of deteriorating conditions should result in more contented fish and happier operators.

FAST-TOOL helps reduce disease where it poses a great risk for the farm and promotes action at the level of the farm/rearing unit. More experience with disease and how to deal with it will reduce its impact on growth performance and mortality rates. For example, the total losses in the salmon farming industry in 2006 were 7.8 per cent of the production, 85% of which was due to different kinds of diseases (Fisheries. no 2005).

FAST-TOOL allows a comparison of farm results and production and management systems to improve technical as well as economic results in a group of local farms or at company level.

An additional benefit to users considered by the product development team is the ability to generate 'fish CVs' that document the welfare conditions of the fish over time and that can be used by fish farmers to provide the product history requirements demanded by large retailers. This information is the input for setting standards about sustainable aquaculture.

An additional feature of FAST-TOOL is that it provides descriptive statistics of relevant indicators for the geographical region in which the fish farmer operates. This enables a comparison of the welfare conditions in a specific location with a region and country, thereby providing decision support for long-term issues, such as the location of fish farms.

FAST-TOOL informs consumers and creates transparency about production circumstances in aquaculture to enable them to make an informed choice between different fish production methods.

2.5 Conclusion

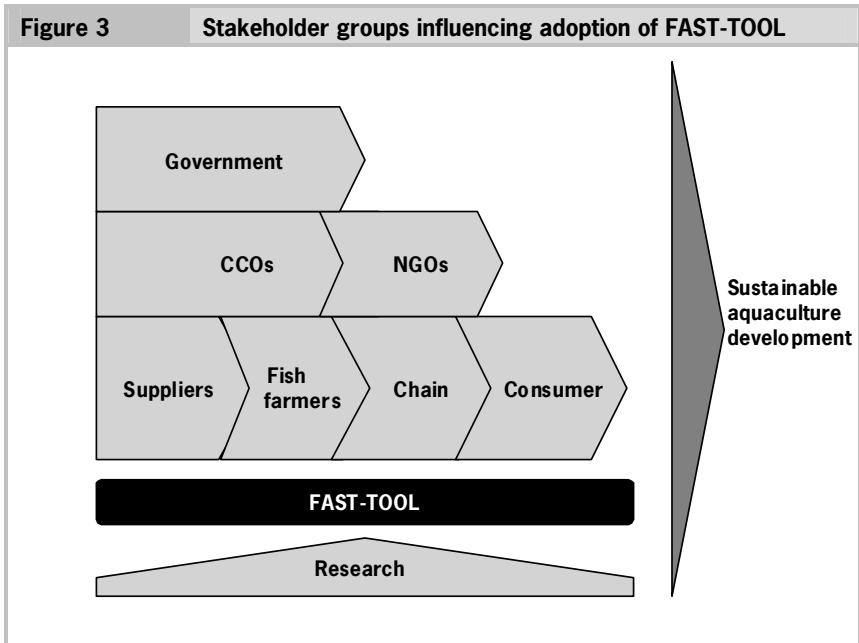
FASTFISH developed a monitoring system to provide decision support for fish farm managers. The approach is designed as a participatory monitoring system requiring self-assessment as well as instrumentation for the scientifically based

monitoring of fish behaviour and rearing conditions, generating expert advice. The costs consist of instrumentation as well as investments in improving fish welfare. There is ample evidence for the latter, but improved disease management will probably reduce investment risks due to better growth and lower mortality rates. FAST-TOOL allows for benchmarking as an input for setting standards and enabling consumers to make informed choices about production circumstances.

3 FAST-TOOLS' stakeholders

3.1 Introduction to stakeholders and transition themes

The strategic approach of FAST-TOOL involves many stakeholders beyond the farm and supply chain. Who are these stakeholders and what role do they play? In our current complex society, stakeholders and special interest groups can influence the adoption of the assessment system. An increasing number of organisations in society are concerned about aquaculture and the welfare of fish. At some point, all these stakeholders will play a role in the implementation of FAST-TOOL. An overview of the institutional context is shown in Figure 3. Stakeholders can be grouped in farmers, suppliers, retailers/food services and other chain partners, NGOs, government, research, code-of-conduct organisations (CCOs) that formulate criteria for fish welfare and sustainability.



FAST-TOOL requires the involvement and acceptance of this idea by chain parties, special interest groups, consumer organisations and government. Adoption of a technological innovation requires adjustments in culture (value and norms) and structure (routines, organisations, issuing etc.). In that case, implementation of a fish monitoring tool is a strategic process towards the development of sustainable aquaculture. Transfer of technology used to be a common approach for establishing implementation. However, the increasing complexity of agricultural issues such as animal welfare and environmental conservation require a broader base of stakeholders than fish farmers if the new system is to contribute to the development of sustainable aquaculture. Implementation should acknowledge the role of stakeholders that have a financial and/or social impact on the system. Furthermore, it acknowledges the value of stakeholders sharing ideas and information among themselves rather than relying on direction or advice from government agencies or other professionals. It therefore encourages 'ownership' of both problems and solutions and cooperation in further development (sources: Black, 2000; Martin and Sherington, 1997; Donkers and Immink, 2008).

A transition process towards adoption affects several themes because technological knowledge is not unambiguously translated towards the market but involves several themes. FAST-TOOL is a technical instrument that allows fish welfare to be monitored in a scientifically reliable and valid way. Whether stakeholders and society share this idea, i.e. validate the technical system, depends on a much broader context of economic, socio-cultural, ecological and institutional themes of transitions (Rotmans et al., 2000). The different themes reflect the Triple-P concept of sustainability: people, planet, profit (Serageldin, 1996; Serageldin and Steer, 1994). The implementation of FAST-TOOL will affect stakeholders and the themes presented in Table 1, the relationships between FAST-TOOL stakeholders and the themes of transition.

Table 1.	The relationships between FAST-TOOL stakeholders and the themes of transition					
	Techno-logy	Economic	Ecologi-cal	Social	Cultural	Institu-tional
Fish farmers		•			•	•
Suppliers	•	•				
Processors		•			•	•
Retailers & Food services	•	•				•
NGOs			•	•	•	•
Government	•		•	•		
Research	•	•	•	•		
CCOs		•		•		•

3.2 Research

Research institutes and universities are at the basis of the FASTFISH approach. Research looks at fish welfare, the observation and registration system and the social context. The research institutes will use FAST-TOOL to retrieve new data about fish welfare and develop new scientific models and results to improve the quality of expert advice for fish farms and information for indicators of fish welfare.

Research must consider how to use the knowledge developed in FASTFISH to ensure that the costs and effort associated with the research are recouped. In line with the European Welfare Quality project, a proposal was made to establish a body that manages the information: EWAC the European Centre for Animal Welfare.

The European Welfare Quality project has proposed the foundation of an animal welfare institute at European level to manage the results generated by this extensive project as well as the implementation and further development (Blokhuys et al., 2007). Cooperation with this initiative offers opportunities because the initiative essentially has the same aims as the FASTFISH consortium. Another idea is to establish a specialised aquaculture body, for example together with the other European projects in the same SSP as BENEFISH.

European Centre for Animal Welfare

The proposed European Centre for Animal Welfare (ECAW) plays a central role in assuring the welfare of all vertebrate animals kept for economic purposes. Three closely integrated functions of ECAW are:

- to set, update, upgrade and manage a European animal welfare standard and to define welfare assessment tools - to check that standards are met
 - using the available scientific knowledge and relevant input from stakeholders;
- to initiate, coordinate, integrate and utilise scientific research for sustained progress of the animal welfare standards;
- to encourage dialogue between stakeholders (policy makers, scientists, citizens, producers etc.) by providing transparent, ready-to-use information on the standards, their scientific basis and implementation in order to maximise the benefits in the EU and ensure the promotion of proactive animal welfare policies worldwide.

From: ECAW: The European Centre for Animal Welfare (Blokhuis et al., 2008)

3.3 Fish farms/processors

Fish farming is highly integrated with the processors; only a small percentage of the farms are independent. The processors market the fish directly to retailers, food services, other processors and traders. In Norway, for example, the nine biggest processing companies together own more than 50% of the fish farms (Directorate of Fisheries, 2008) e.g. Marine Harvest, Lerøy Seafood. In Greece, 5-6 companies own more than 50% of the fish farms, e.g. Nireus, Selonda. In order to operate the fish farms, these companies have operation managers and managers who monitor the performance of several farms. The decision to use FAST-TOOL will be taken at management level, whereas the operation manager will be the person who uses FAST-TOOL.

Processors sell whole, sliced or processed fish to retailers, food services and other customers. Each processor has its own method of adding value to the product, by optimised logistics, tracing and tracking, brand equity, etc. Processors are frequently the owners of fish farms, giving them direct influence over the production circumstances. The FAST-TOOL assessment system allows them to make strategic decisions based on benchmarking on welfare.

The economic theme will be most relevant for the decision to use FAST-TOOL. Investments in welfare equipment and improvements should not negatively affect their performance or market access. Craftsmanship is important to outperform but also to learn and share ideas and experiences besides a clear economic interest. They must remain competitive, also at global level.

For fish farmers, the FAST-TOOL assessment system could generate expert advice through a participatory 'bottom-up' approach as expansion is organised nowadays, by education and human development. For the mainstream market for salmon production, the focus on costs is crucial whereas for the local and regional markets, additional investments in welfare will also benefit the production. Therefore, insight into farm performance and improved economic results are major objectives for the owners of fish farms. Furthermore, experience of management systems as well as equipment may be shared with other local fish farms.

However, processors that have already invested in welfare might regard implementation of a new monitoring system as a threat to their investment, for example if the value of their investment is reduced because other investments are given priority by customers or NGOs following new insight obtained from FAST-TOOL. Processes will therefore need time to yield return on investment or a possible gradual adoption or accountability based on the system, besides time to learn to work with the system.

3.4 Retailers/food services

Supply chain partners, particularly in retail, consider welfare practice in their sourcing decisions or market arrangements. For ease of sourcing and reducing risks, retailers need reliable systems to verify fish production conditions. In practice, an independent welfare audit assessment is often required by retailers and other customers as a prerequisite to supply in order to find farms best equipped to comply with standards that are often externally defined. Results monitoring is used to establish who can participate and who cannot (Vellema and Van den Bosch, 2004). This is becoming an increasingly common practice both inside and outside the EU (Ingenbleek et al., 2008; Gavinelli, 2007). In this way, retailers and food service expand their decision making backward in the channel to include products, food safety, animal welfare and sustainability. Their influence has increased and their sourcing criteria are formulated in special standards like Globalgap. If a processor wants to supply an organisation that

has adopted the Globalgap sourcing criteria, it must comply with these standards. When retailers and food services adopt the FAST-TOOL assessment system, or elements from it, this can therefore become an essential element of customers' requirements and part of 'the licence to deliver' for retailers, or a contribution to corporate social responsibility.

Quality expressed in price is dominant in retailing. Differentiation in consumer quality perception based on welfare quality restricts market opportunities because a relatively small group of consumers actively looks for a welfare product. This will require an additional step in increasing consumer awareness of welfare in the production practice when making choices, e.g. by advertising and labelling products with higher welfare standards.

A special segment in retailers and food service gives local markets such as specialty restaurants, local supermarkets or franchise supermarket stores wanting to distinguish themselves from the mainstream the opportunity of offering a welfare segment. These parties also use labels but sales are often based on the intrinsic quality of the product. When higher welfare implies a better product, in particular taste, they would not specifically communicate the production practice but the quality.

3.5 Suppliers

The supply industry consists of feed suppliers, fish suppliers, equipment suppliers and a range of other suppliers (insurance, medicine etc.). Some of them have a relevant relationship to improve fish welfare and the monitor system.

Feed is by far the largest component of the costs of salmon production, accounting for over 50%. Furthermore, the fish feed industry is dominated by a small number of large players (Brunborg, 2005). The feed industry influences fish welfare because the quality of the feed is an integral part of the wellbeing of the fish. Furthermore, if the feed is based on fish meal then it also affects the fish cultures elsewhere in the oceans. Feeding management systems aimed at optimising production efficiency and oxygen monitoring systems to warn about critically low levels are commonly used on farms. Periodical indicators are often used, such as mortality rates, growth performance and condition factors and health indexes issued by veterinary services. However, these data are often just registered in logbooks but seldom systematically analysed in terms of stress assessment. However, this background enables them to put the scores on the

FAST-TOOL indicators in a context that contributes to the use and acceptance of welfare advice by the computer.

The equipment suppliers offer housing systems that will affect the level of fish welfare. Practical system developers face the challenge of designing systems that take into account fish welfare and facilitate welfare monitoring.

3.6 Non-governmental organisations

Non-governmental organisations (NGOs) tend to be the defenders of animal rights and nature conservation. These include the International Fund for Animal Welfare, Royal Society for the Prevention of Cruelty to Animals (RSPCA) and Eurogroup for Animals and represent certain groups of consumers and citizens. Other stakeholders are also influenced by them, such as supply chain parties and governments. Special interest groups are important to companies because they can help to legitimise (Handelman and Arnold 1999; Suchman 1995) the farm's activities in the network of stakeholders surrounding the farm. At the same time, the culture of special interest groups of naming and shaming is risky for companies. The interaction between NGOs and supply chain parties therefore works in two ways.

Transparency of production systems to consumers is important to all of them; all information should be openly available and accessible including assessments to allow consumers to make objective choices (Peeling, 2007). They are also important to stakeholders because they assign great value to an assessment system from a 'belief system' approach to achieve higher welfare levels.

There are several animal interest groups and interest groups focusing on the environment that are relevant to open sea aquaculture. Interest groups have different approaches and activities either through policy making or by marketing. Some NGOs are critical of market mechanisms aimed at improving welfare and demand a strong supervisory role from the government. Others are more pragmatic in wanting to improve welfare for a large group by contributing to policy making. Although some oppose technical solutions or any solutions other than organic, their overall goals are to improve welfare and the environment.

3.7 Consumers

In the purchasing process of consumers, fish welfare is a 'credence attribute' (Andersen, 1994). Based on the product itself, it is difficult for consumers to determine whether the fish is farmed in sustainable and welfare friendly production conditions. The products are therefore presented by labels or images that reflect a certain production standard aimed at influencing perception and articulating the attribute in the buying decision-making process (Immink and Tacken, 2007). Consumer decision-making processes develop rapidly depending on the retailer type. Consequently, information about welfare is 'associated' with the quality of the product, whereas the ethical side of production was the aim of the communication. As long as consumers trust presentation and information, they will continue to buy or consider the product. However, when the information and, in particular, the perception is addressed by NGOs or critical consumer programmes in the media, trust in the product could quickly disappear. The FAST-TOOL assessment system allows a fundamental chain of information about welfare developments related to aquaculture products to be built by tracing and tracking the information to consumers, giving them the choice between different production conditions.

3.8 Government

The government's role is to issue regulations where necessary around aquaculture and facilitate sustainable development. The main role of the government in this transition process is being the supplier of FAST-TOOL as the research has been funded by both European and national governments. The government can also use FAST-TOOL as an instrument to reflect the relevance of current regulations, establish more rules and monitor fish farms on statutory compliance. FAST-TOOL can be used by governments to set a minimum standard. Governments will base their actions on the latest scientific insights but also take into account society at European and national level.

FAST-TOOL can support policy instruments that facilitate the transition process both with respect to production and demand. Examples are investment reductions for producers and vouchers for arrangements between NGOs and research institutes (Immink et al., 2006). Furthermore, the government can extend insight and improve fish welfare through research on costs of welfare concepts and supporting public-private partnerships, for example.

3.9 Code of conduct organisations

When welfare norms transcend the national minimum level, they enter the realm of 'code of conduct organisations' (CCOs). These organisations are therefore potential users of FAST-TOOL as an important intermediary in making welfare knowledge compatible for market parties as well as other stakeholders, because these organisations set criteria on different aspects of sustainability and at different levels. Such a code of conduct organisation (as Ingenbleek and Meulenbergh, 2006, p. 453 call it) is defined as 'a non-governmental organisation that develops one or more formal statements of rules of conduct regarding environmental and/or social domains of sustainability that producers voluntarily agree to implement.' In these organisations, different groups of stakeholders (e.g. farmers, processors, animal interest groups, retailers and food service) jointly discuss and negotiate the welfare criteria. They build on the stakeholder's reputation and they can build on the knowledge and other stakeholder resources to fulfil their social ambitions. Code of conduct organisations (CCOs) contribute to fish welfare by setting new standards of production (higher than the legal minimum) and by implementing new welfare standards through production, processing and distribution.

These types of organisations operate in domains where rules or legislation on the focal ethical issues are absent, fall short (according to those who establish the CCO), or are difficult to control by public policy. CCOs provide a platform where firms and their community stakeholders can discuss their joint responsibility and the desirable level and feasibility of standards. The process of formulating criteria may vary, depending on the type of CCO (Ingenbleek and Immink, 2008). Depending on the mission that the CCO aims to fulfil, a distinction can be made between business-to-business and business-to-consumer production standards. Business-to-business standards are usually established to facilitate the verification of the supply chain in their sourcing practice and guarantee a certain level of welfare and/or sustainability, for example Globalgap and Freedom Food. Business-to-consumer standards are established with the aim of serving a particular market segment, for example Organic.

CCOs play an important role in the economic theme of developing the marketing of the welfare product. CCOs with stringent requirements show the market that welfare friendly production is feasible and encourages retailers to develop requirements which, although less strict, will improve the level of welfare for many animals. The CCO with stringent requirements raises the market to a higher level and allows for more differentiation between their level and the

baseline when their standard is really chosen to differentiate from mainstream production.

CCOs have their own assessment methodology and they will question whether they should incorporate implementation of FAST-TOOL assessment. Existing CCOs will question the applicability of FAST-TOOL and the feasibility in their current practices. Also, the development of FAST-TOOL may well lead to the establishment of new CCOs around the monitoring instrument.

In addition, many CCOs have an exclusive character, organic being one of the few examples that are more inclusive, but still the underlying knowledge of welfare constitutes a large gap. Most also use outside expert assessment applying pre-set indicators, standardised procedures and tools to secure accountability and transparency (Vellema and Van den Bosch, 2004). This may contradict the aim of engaging a wide range of stakeholders in the structural change of an entire sector and developing a scientifically validated understanding of the relationship between welfare and production conditions as an approach to sustainable development.

3.10 Conclusion

The FASTFISH approach must be regarded as a transition path involving different stakeholders with a particular stake in the system. These stakes are relevant in a number of themes; besides the technical domain in which the current development of FAST-TOOL has mainly taken place, the economic, ecological, social, cultural and institutional domains are also relevant. This implies that directing aquaculture towards welfare improvement practice is not univocal. Furthermore, monitoring systems used by stakeholders often have an exclusive character of top-down pre-set production standards that contrast with the setup of FAST-TOOL, i.e. a bottom-up inclusive approach.

4 Fish farm managers' use of FAST-TOOL

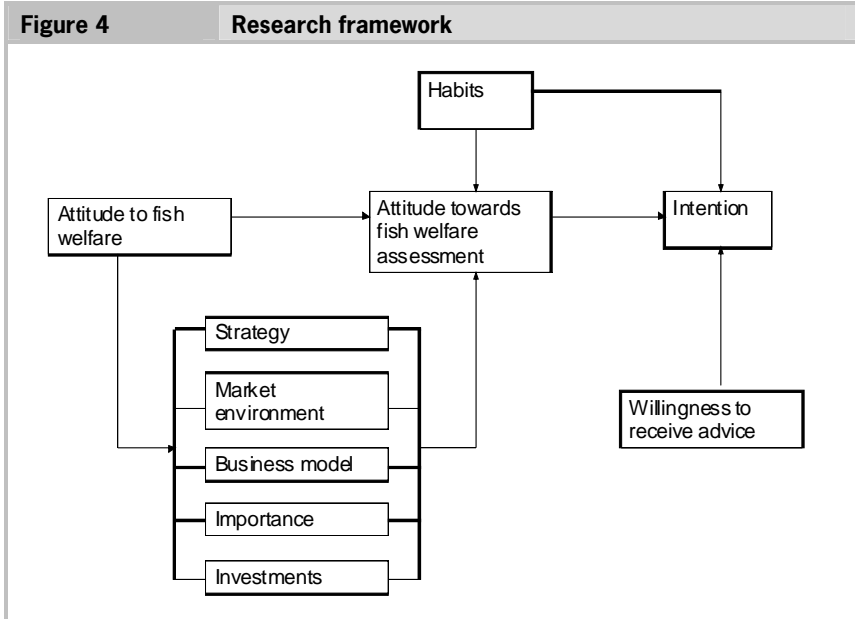
4.1 Introduction

FAST-TOOL has been designed as a participatory system requiring self-assessment of fish behaviour by fish farm managers. What are the drivers for farm managers to comply and update the fish welfare status on a daily basis? What are their attitudes towards fish welfare and towards fish welfare assessment? A survey was performed to investigate the attitude towards welfare and welfare assessment and find out how the several drivers affect the intention to use FAST-TOOL.

4.2 Research framework

Behaviour is the result of a dynamic process stemming from several factors. Understanding these factors on the basis of theories like the social psychology theory makes it possible to explore implementation strategies for FAST-TOOL. Attitudes form one of the apparently obvious indicators of the manager, because each manager approaches fish welfare assessment with his own set of pre-existing values and assumptions. Attitude towards an object is one of the main predictors of behaviour (Eagly and Chaiken, 1993). An attitude can be defined as a learned predisposition to respond consistently to a situation or object favourably or unfavourably, '...what people think about, feel about and how they would like to behave...' (Triandis, 1971:14). A distinction is made between attitude target and attitude object. Target is the entity (e.g. thing, person) towards which behaviour is directed (e.g. register stress levels), denoted as attitude towards behaviour and, in this case, attitude towards fish welfare attention. Attitudes towards behaviour are evaluations of a target incorporating action, context and time. Although in some theories attitude towards a target does not appear in the model (Fishbein and Ajzen, 1975), composite models have been developed where attitude target directly impacts on attitude towards behaviour. This is a more spontaneous relationship that contrasts with a deliberative route that accounts for the context of the object (Eagly and Chaiken, 1993). Attitude towards the target does not directly influence behaviour because behavioural choices require that an individual use some cognitive process, however rudi-

mentary, to translate his evaluation of an entity into a choice of overt behaviour, forming a positive attitude toward some behaviour (Eagly and Chaiken, 1993). However, attitudes do not always imply behaviour, because of an individual assessment of constraints of time or ability, resources or knowledge (Ajzen's 1987).



Attitude towards behaviour is influenced by socio-psychological processes besides the attitude towards the target, as depicted in Figure 4 (Eagly and Chaiken, 1993). These are rewards and punishments expected to follow from engaging in the behaviour, equal to the behavioural beliefs of Fishbein and Ajzen's (1975), such as the fish welfare policy, reputation of the fish farm and strategy. Furthermore, rudimentary normative processes occur that pertain to approval and disapproval that significant others (i.e. competitors, NGOs) are expected to express in relation to behaviour (Ajzen, 1985). Habit is another contextual factor taken into account that refers to automatic or regular actions by the farm manager (Triandis, 1980). However, habit constitutes a different relationship because it directly influences both attitude towards behaviour as well as the intention itself, whereas the former processes influence intention by a me-

diation process of attitude towards behaviour. Measures included that interact in the attitude towards behaviour and intention relationship are elaborated further.

- Strategy of the fish farm manager is important to remain competitive in the business. Strategy is included in the framework with respect to the quality of the fish produced compared with competitors. It therefore influences the attitude towards fish welfare assessment. Porter (1980) identified two competencies that are most important when they aim at a broad market scope: product differentiation and product cost (efficiency). These result in two generic strategies that are often applied: differentiation strategy focusing on quality outperformance or cost leadership. A company should develop a strategic advantage over its competitors and also anticipate public groups that are interested in or affect the organisation's ability to meet its goals (Kotler and Armstrong, 2006).
- Fish welfare in the business model is defined as daily attention to fish welfare. Fish farms that have adopted attention to welfare can create 'goodwill' for the customers as well as for animal interest organisations. Their current practice of monitoring fish welfare is expected to affect their attitude towards fish welfare assessment. An important challenge for companies is to incorporate such a policy in the business model and in their daily practices.
- The importance to customers of attention to fish welfare seems to be an important feature in market access and whether customers decide to return to this particular fish farm. The relevance attached by the fish farm customer to attention to fish welfare is expected to affect the attitude towards fish welfare assessment. Attention to welfare can improve the fish farm's reputation in building customer loyalty based on distinctive ethical values. Therefore, attention to fish welfare is included in the framework in terms of whether this is importance and relevant to their customers.
- The market environment refers to all the forces outside marketing that affect the ability to build and maintain successful relationships with target customers. Fish farm companies do not operate in isolation but are part of an environment facing pressure from public interest groups. Therefore, market environment is included to influence attitude towards assessment from the perspective of the perceived pressure of NGOs.
- Specific investments in fish welfare are included because investments already made in the fish farm function indicate whether attention to fish welfare has priority. The level of investments in fish welfare is considered as well as whether these investments are lost when they stop producing fish.

- Habits are types of routine behaviour that occur relatively automatically without self-instruction (Triandis, 1980). In this perspective, habits contrast with other contextual psychological processes involving behaviour that requires some reasoning. Habits can impinge directly on intention, with no mediation from other processes and can also indirectly affect behaviour by influencing attitudes (Eagly and Chaiken, 1993). Habit is therefore included because it affects both attitude towards assessment and intention in terms of taking risks with the farm and the level of experimentation and change in farm practice.
- Willingness to receive advice is expected to influence intention. Although a manager might have a positive attitude towards fish welfare assessment, this does not necessarily imply intention. For this particular research, the willingness to receive such advice and to pay for expert advice is included.

The framework specifies how attitudes influence intentional use of FAST-TOOL. It also shows that external factors affect the relationship between attitude and intention.

4.3 Research method

Data collection

A survey was performed in Greece and Norway consisting of a description of FAST-TOOL accompanied by a questionnaire. The questionnaire was based on literature and discussions with researchers. It was tested with an operational manager from a fish farm as well as a manager of several fish farms in Norway in March 2008. Following the test, the questionnaire was adapted and the distribution was considered. For the Norwegian situation, an online version was developed and distributed by e-mail. For the Greek situation, the electronic version was considered too advanced and the questionnaire was distributed by traditional mail. The survey was held between June and September 2008.

Sample

There are around 1,000 fish farms in the two countries. In total, 37 completed questionnaires were received representing many more fish farms. For the Norwegian situation, the respondents accounted for around 125 fish farms, representing around 17% of all the fish farms; for Greece the respondents represented over 50% of the production.

Measures

The analyses started by exploring frequencies and descriptions of the data from the questionnaire and the measures from the research framework. Table 2 shows the mean, standard deviation and number of responses and Cronbach's alpha. Besides the measures from the research framework, an additional measure was included as a subject in the questionnaire, i.e. the impact of expert advice, to reflect the intentional behaviour measure. Impact concerned the expected benefits, the improvement of fish welfare management and economic benefits of fish production from the expert advice from FAST-TOOL.

Table 2	Measurement description			
Measures	n	mean	s.d.	alpha
Attitude towards fish welfare	37	5.46	1.25	.85
Attitude towards fish welfare assessment	37	5.44	1.61	.97
Fish welfare in business model	32	4.69	.76	.81
Importance to customers	32	5.17	1.49	.94
Pressure from NGOs	26	4.14	1.77	.95
Investments in welfare	33	5.25	1.20	.82
Habits	28	3.08	1.36	.79
Willingness to receive advice	28	4.91	1.09	.85
Intention towards welfare assessment	28	4.92	1.20	.90
Impact of advice	28	4.89	1.22	.96

4.4 Results

Descriptive statistics

In the sample, 90% claimed that attention to fish welfare was part of their daily processes. All measures were pre-specified to score on a 1-7 Likert scale. Major elements of monitoring are the numbers of dead fish (mean 6.93, s.d. 0.25), water temperature and escaped fish. Other elements often monitored are the numbers of escaped fish, oxygen level, water quality and salinity level. The least elements monitored are turbidity level and algae content (mean 3.59, s.d. 1.89).

Welfare is regarded as a multifactor element. Several dimensions contribute to the definition of welfare from the perspective of the respondents. It appears that welfare is a multifactor concept where happiness and absence of stress is

indicated as the most important factor (45% of the total variance explained). A second factor is the health of the fish and pressure of disease (23% of the total variance explained).

With respect to management software and the frequency of use, 65% responded that they always use farm management software and 39% constantly monitored this on a daily basis. For the use of FAST-TOOL, the level of automation and experience in farm management is relevant. Automation practices related to fish farm management such as feed were indicated in the survey. Respondents either agreed that online welfare assessment could easily be incorporated in their farm operations or they strongly disagreed. No correlation was found between incorporation possibilities of FAST-TOOL and the level of experience of working with computer management software.

Group differences

In explaining intention, every fish farm manager has an individual approach towards fish welfare attention with their own set of pre-existing values and assumptions. Managers who support welfare and/or those who support welfare assessment have different motivations. Attitudes are used to explain the differences. The theory uses attitudes because these motivate intention and therefore behaviour and exert selective effects at various stages. Furthermore, discrepant attitudes often characterise different subgroups and this makes it possible to distinguish between the managers (Eagly and Chaiken, 1993). In this study, group differences are firstly considered for the attitude towards fish welfare attention, secondly between the two countries and thirdly between operation managers and managers of several farms. The latter revealed no significant results and are not included in the report. The cut-off for managers with a positive attitude towards fish welfare was chosen as 4.99 because the sample is then divided into 50% of the respondents for each of the two groups.

Differences between managers with a positive or negative attitude towards fish welfare are shown in Table 3, with means and t-test for equality of means; measures are all on the Likert scale (1=low-7=high). Clear differences appear between managers who support fish welfare (positive attitude) and managers who oppose fish welfare (negative attitude). Those who support fish welfare experience significantly more pressure from NGOs to work on fish welfare. This may also come from their customers, because they indicate significantly more that fish welfare is also meaningful and relevant for their customers. These managers regard fish welfare and assessment as much more important; they indicate that their business performance will be higher through FAST-TOOL as-

assessment, i.e. they perceive that high fish welfare will reduce the probability of disease and speed up growth. Furthermore, higher specific investments in fish welfare were made on fish farms run by managers who support attention to fish welfare. Intentional use of FAST-TOOL requires the participation of fish managers and they want to receive something in return. This is confirmed by the significant difference in willingness to receive advice. The group supporting fish welfare values expert advice more and is more prepared to improve fish welfare and make sacrifices to obtain insight into fish welfare at the farm and encourage fish welfare management practice. There is therefore a clear distinction between managers who support attention to fish welfare and those who oppose it. This might be because managers who have a positive attitude towards fish welfare may be more aware of the social impact of aquaculture and rearing conditions and the impact of welfare on their business performance.

Table 3		Differences between positive (support) and negative (opposition) attitude towards fish welfare attention among managers of fish farms at a significant level of 0.05			
Measure		Mean	S.d.	t-value	Sig. (2-tailed)
Pressure from NGOs	Support	4.89	1.64	-2.418	.02
	Opposition	3.30	1.64		
Importance to customers	Support	5.92	1.30	-3.504	.00
	Opposition	4.28	1.27		
Investments in welfare	Support	5.67	1.12	-2.501	.02
	Opposition	4.69	1.07		
Willingness to receive advice	Support	5.54	.86	-4.245	.00
	Opposition	4.16	.84		
Impact of advice	Support	5.60	.83	-4.402	.00
	Opposition	4.02	1.05		

Differences between countries were found as respondents from Norway perceived significantly higher specific investments in fish welfare ($t= 2.737$, $p<0.05$) and also indicated higher attention levels for fish welfare in their business model than Greece respondents ($t=2.929$, $p<0.05$). This might be explained by the general culture difference and the place of animal welfare in the social debate, which is confirmed by the substantially greater pressure from NGOs perceived by Norwegian respondents ($t= 2.248$, $p<0.10$).

Estimation results

Regression analysis was performed to understand which driver most influences the intention to use FAST-TOOL in the future. Two models were estimated and are shown in Table 4. The decision to include measures is based on the backward regression method, because the responses do not allow the inclusion of all measures with a rule of thumb of 5 responses for each measurement.

The first model considers intention as dependent, the respondent's estimated chance that he will apply welfare assessment within the next two years, i.e. daily monitor fish welfare, update this in the computer and receive online welfare advice. This model achieved good levels of predictive accuracy (adjusted R-square = 0.19). The model is statistically well below the 0.10 level. The model shows that habits have a significant influence on how managers estimate the chance of performing welfare assessment within the next two years. Managers who often experiment and adapt farm practice estimate this chance to be much higher. The influence of NGOs on how managers perceive performance of welfare assessment is even stronger, although significantly at the .10 level. The importance that customers attach to fish welfare attention has very little effect on this perception.

The second model considers the impact of welfare advice on improving fish growth and the economic farm results as dependent. This model achieved good levels of predictive accuracy (adjusted R-square = 0.28). The model is statistically well below the 0.05 level. The model shows that managers who often experiment and adapt farm practice estimate the effect of advice to be much higher than more conventional managers. The influence of NGOs on how managers perceive the impact is even stronger, whereas the relevance of customers has no influence.

The two models confirm the role of habits and NGOs besides the role of other stakeholders than chain parties in the FAST-TOOL approach to sustainable aquaculture development.

Table 4. Influence on fish farm managers' perception of 1) intention to apply welfare assessment and 2) impact of advice. Standardised Beta coefficients and significance between brackets

	Intention	Impact
Attitude towards behaviour	-0.32 (0.88)	0.16 (0.44)
Importance to customers		
Pressure from NGOs	0.07 (0.80)	0.11 (0.66)
Habits	0.42 (0.10)	0.40 (0.10)
	0.36 (0.08)	0.35 (0.07)
R-square	0.34	0.41
Adj R-square	0.19	0.28
F(sign)	2.30 (0.09)	3.11 (0.04)
N	22	22

Note: Lowest tolerance value found is 0.54 in both models measuring the fraction of the total variance in the explaining variable not predicted by another explaining variables is high (Hair, et al., 1999). Much higher than the critical minimum value of 0.10; Hair, et al., 1999) and this indicates that multicollinearity should not be a problem.

4.5 Conclusion

The FAST-TOOL approach requires the participation of fish farms that provide information about fish behaviour in the rearing unit. The intentional use of farm managers appears to be driven by the pressure of non-governmental organisations; this is particularly the case for the Norwegian managers. However habits are also important. Managers who are used to adapting new technology are the first to be targeted and use FAST-TOOL. They are the pioneers who will have to convince the remaining farms that are currently less aware of the role of fish welfare in the performance of the farm.

5 Implementation of FAST-TOOL

5.1 Introduction

The challenge for conceptualising FAST-TOOL is to find a way to incorporate different stakeholder views whilst continuing to improve welfare by monitoring. Now it is clear what benefits and costs are associated with use of the FAST-TOOL, who are the important stakeholders for this system and how the farm managers view the system, the next question is how to successfully implement FAST-TOOL.

The implementation of FAST-TOOL distinguishes between the 'products' that can be developed from the FASTFISH approach and the institutionalisation required for the long-term operation of the assessment system. Society has a wide range of stakeholders who are either involved in aquaculture or who have some stake in aquaculture development. The availability of information about the production conditions of the fish is valuable for all these stakeholders. Current and future use of FAST-TOOL is characterised by the open system to all relevant stakeholders to develop participation and accountability. A body is required to facilitate the development of the products that stem from the assessment system.

An initial implementation plan was designed based on the literature, discussion with researchers and discussion with fish farm managers in Norway. A questionnaire was subsequently developed to test this plan and interviews were conducted with representatives from all stakeholder groups to discuss the plan.

5.2 Products from FAST-TOOL

The products that can stem from FAST-TOOL were divided into four categories shown in Table 5: the Welfare Network Levels. The 'whereto' depends on the intentions; the main challenge will be the incorporation of multiple stakeholders.

Table 5		The Welfare Network Levels			
	Level 1	Level 2	Level 3	Level 4	
<i>Objectives</i> <i>FAST-TOOL</i>	Objective assessment of welfare	Education and human development	Certification and benchmarking	Marketing information and creating awareness for consumers	
<i>Data</i>	Raw data 0-1000	Parameters 0-100	Criteria 0-10	Classes 0-1 (,2,3)	
<i>Stakeholders</i>	Fish farmers Research	Fish farmers Extension Suppliers Government	Fish farmers NGO CCO Retailer Other chain	Fish farmers NGO Retail CCO	
<i>Approach</i>	Assessment	Judgement in study group Extension	Defining values and criteria Creating incentive for competition	Overall welfare parameter Promotion	
<i>Key points</i>	Efficiency of assessment	Impact of advice	Conflict resolution	Product market combination	
<i>Results</i>	Information	Improved technical results	Improvement and/or retention of reputation	Marketing with added value	

The different levels are adopted from the structure applied in the Welfare Quality project (Botreau et al., 2007). The structure shows the activities of the system: measuring welfare objectively (level 1), developing aquaculture (level 2), formulating criteria (level 3) and consumer marketing (level 4). The question of where to in levels 1-4 stems directly from the question: who uses the information and who learns, who sets the rules. Chapter 3 showed that the question of where to will be answered quite differently by different stakeholders.

Level 1

At this basic level, information on fish production from assessment is obtained for input for the other levels. Issues aimed at gaining farmers' commitment con-

cern the assessment and applicability of the advice, particularly if fish farms are to invest in further development contributing to sustainable aquaculture.

Acceptance will increase when there is a logical method in fish-based monitoring and definition of welfare, the practical implementation of on-farm monitoring and the socio-economic impact of the assessment scores (Keeling et al., 2007). For fish farmers producing for the mainstream markets, welfare is primarily about fish health and zootechnical performance. A small number of fish farmers produce for standards where the agricultural objective is more broadly defined in terms of animal care, nature and the environment, e.g. organic, which changes the definition of good farming and welfare as well (e.g. Bock et al., 2007; Donkers and Immink, 2008). Also in the mainstream market, farms have to remain competitive with the investments in welfare equipment and improvement. The higher standards of production should not damage their position in global trade, i.e. their production should not be undermined by products produced under different, usually lower, production conditions that compete on price (interview Van Eijk, Product board fish).

Most farmers assess the welfare of their fish on the fish itself, such as swimming and group behaviour, depth of swimming, playfulness, etc. This is very similar to many criteria included in the FAST-TOOL. This farmer's assessment should be reflected in the monitoring approach.

Operation managers are not used to registering this type of information or may lack the incentive to do so systematically on a daily basis. Nor may farmers be well enough equipped or have the necessary computer skills to operate FAST-TOOL. Operation managers on farms are paid to run the farm and incentives to increase performance in order to improve welfare are rare.

Welfare measures should be sufficiently flexible to set criteria at different levels and set off welfare criteria against other criteria if they contradict each other or contradict immediate practice on the farm, to allow the development of different products at the next levels (Ingenbleek and Immink, 2008).

Aquaculture closely interacts with the environment and production practices will therefore also influence the environment; for example feed and antibiotics directly affect the sea ecology system. Most stakeholders take a broader view than solely welfare, and also take into account the environment or labour. Extension of the measures in the FASTTOOL system or integration with existing systems is incorporated into future development.

The increased assessment by government, retailers, NGOs or CCOs has raised the efficiency of these assessments by different organisations in terms of costs and by farmers in terms of costs but in particular the required time and

control over the assessment. FAWC (farm Animal Welfare Council) recommends that scheme owners work towards refining their standards and inspection procedures to achieve an increasing inclusion of welfare outcomes, so as to provide both a better reflection of the welfare of the animals within a production system and the level of stockmanship on the farm (Butterworth and Kjaernes, 2007). In this respect, measures must be recorded similarly irrespective of who does what and when (repeatability of the measures).

The FAST-TOOL assessment system is just the start of an approach to promote welfare monitoring in practice. As the system and insights develop, FAST-TOOL will require updates and need to incorporate new measures and/or replace technology.

Level 2

At level 2, the observations of the assessment are translated into information useful for management decisions and benchmarking. The relevance of the monitoring results in terms of management information will be significant for farm owners' interest in accepting a monitoring system (Keeling et al., 2007). Farms where assessment practice is implemented have more information that allows them to adopt measures in the short term (e.g. an early warning system) and measures in the long term (investments) and can therefore reduce risks and increase efficiency, thus gaining a competitive advantage over non-participating farms.

The online-monitor will be used on the farm and farmers will also be the major users of this information initially. On-farm experimentation and learning have always been important for improving productivity and generating knowledge. A larger number of farmers and a greater diversity of human capital facilitate knowledge transaction and promote innovations resulting in regional competitive advantage for the producers in this region (Porter, 1990; Roll, 2008).

Top-down transfer of technology has not proved to be a sustainable approach. This is also reflected in the problem of getting farm managers to respond to the questionnaire in this study. They probably share the need but do not yet see the benefits, but it is an indication that the subject is not currently regarded as relevant, or that the registration required by government already demands too much labour, as one farmer indicated.

Farm managers have to trust this system. This can be achieved when FAST-TOOL works in a lee environment for the first years. This will allow farmers to work without obligations but become aware of the system and its potential in the near future. Farmers can contribute to welfare investment when it is indi-

cated what issues will be important within the next 5 years. When there is a relationship with CCOs or other sellers, they could indicate what is obligatory to a greater or lesser extent, thereby creating awareness of the timeline of investments. The farm manager will always make a return on investment judgement about the benefits of investing in information for FAST-TOOL for farm performance as well as the products in levels 3 and 4.

When the system works in a free environment, or one where fish farmers use the monitoring system without obligations, farmers can build experience and capacity. Nonetheless, after several years the initial situation could change and the ability to work without obligations might disappear. This should be communicated when the monitoring system is introduced. During the first few years, fish farmers may work without obligations to become accustomed to the new approach. The information will be made available to the public and act as input for the 'products' to be developed by stakeholders.

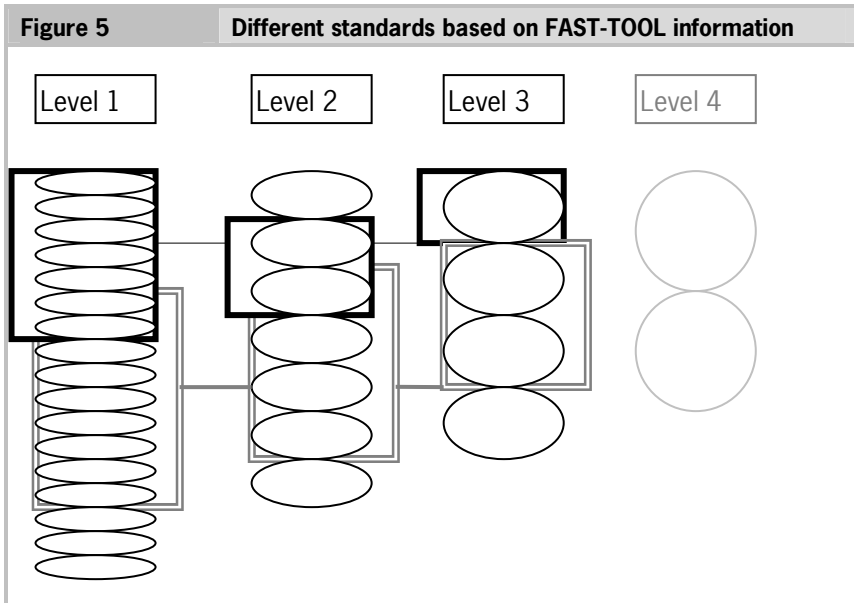
Benchmarking should therefore be performed by empowering managers and local farm groups to engage them in the on-going process of experimentation, learning and development, equal to the best practice of extension (e.g. Coutts, 1994). In Welfare Quality and others (Baltussen et al., 2008) benchmarking is described as a valuable strategy. A future challenge is to increase the scale in benchmarking. One of the features besides all the parameters is the comparison of housing and management systems. Government can interact at this level by subsidising more welfare friendly production systems like tax reductions on investments.

Level 3

At level 3, other stakeholders will become involved and work with the information in levels 1 and 2. The importance attributed to different aspects of animal welfare varies among stakeholders as this is a multidimensional concept and there is no unique measure of welfare (Veissier, 2007). Translating animal behaviour into norms is an additional step. This requires the judgement of experts: (1) what is the level of welfare when defined as high, or required (2) when two parameters provide a contradictory score on welfare or when technology is not yet capable of measuring certain behaviour.

Different aspects of welfare must be clearly stated to reflect what is meaningful to animals but also agreed by stakeholders, to ensure that wider ethical and sociological issues (such as the contextual nature of both human-animal relationships and scientific forms of knowing) have been addressed before products can be developed at this level and successfully put into practice. A welfare

monitor is not a standard. This requires an additional step where different supply chains and different stakeholders interact to formulate criteria. Different levels are also necessary because market players tackle different ranges of sustainability and level in their requirements serving different market segments, main stream, idealist and case-solvers. This requires collaboration and information sharing between all parties. Information sharing is a means of comparing and confronting each other's ability to detect the discrepancies between ideal and actual chain performance (Smit, 2006).



Within the process of developing sustainable aquaculture, not only is a standardisation process performed but also a marketing task, in the sense that different products are developed to meet the wishes of specific stakeholders, just as there are different marketing channels. Besides retail chains, there are food service chains and other business-to-business chains that will distribute the fish and require different information (Coughlan, 2006). Therefore, different groups of stakeholders can set standards based on the same input information from FAST-TOOL. This is depicted in Figure 5 which shows how different groups of stakeholders can apply the information from FAST-TOOL, each using their own parameters and weighing these into criteria that represent their shared values.

The different chains of blocks represent stakeholder groups with shared values. In each arrangement, an ethical commission has to decide how different parameters weigh up and when a particular score is sufficiently welfare friendly. In most cases, this will be a decision process that balances 'ideal criteria' for the fish, on the one hand and the practical feasibility on the other. NGOs play an important role in formulating the ideal criteria. Retailers and other chain partners primarily set limiting conditions such as costs of welfare investments, marketing and logistics.

A value judgement by experts is necessary, such as an ethical committee or steering committee depending on the aim. Formulation of criteria and sub-criteria about on-farm measures is required before welfare information can act as input in standards and be passed on to consumers. In an ideal world, the relative importance attributed to each welfare aspect should reflect the priorities of animals. However, the priorities are difficult to ascertain; the aggregation of welfare measures into an overall assessment of welfare has to rely on expert opinion on what counts for animals and what society finds acceptable/unacceptable (Veissier, 2007). This opens the option of negotiating indicators and may result in processes like data validation with fish farm managers or a dialogue on the critical limits of specific indicators and the input of both experienced and scientific knowledge.

Competition and benchmarking are important stimuli for innovation in these companies (Porter, 1990) and is also vital for sustainable development (Friedman, 2008). Competition can increase speed to market (Porter, 1985). The reputation of the fish farm is important for the economics of future business and therefore processors increasingly regard animal welfare as a fundamental aspect of their reputation. Sustainable benchmark systems provide an incentive to contribute to sustainable development (Interview Nagel, Greenpeace). The balanced scorecard (www.globalscorecard.net) is one example of an approach that makes it possible to identify the discrepancies between (more) ideal and actual performance and decide which actions to take with respect to these two main functions. Greenpeace e-waste monitor shows how it initiates dynamics in mainstream production with respect to sustainability investments. The subsequent monitoring results show that the second place can become first with a few adjustments and consequently receive substantial exposure, whereas no one wants to receive the least score on sustainability development.

<http://www.greenpeace.org/international/campaigns/toxics/electronics/how-the-companies-line-up>

The FAST-TOOL system can also contribute by marketing the reputation of an organisation. Whether consumers should receive the information is questionable, but if consumers want that information it must be available (Interview Oosterhuis, Ahold). The brand itself expresses this particular quality or values of the organisation. Ahold and McDonalds, among others, show that chain parties who do not own the farms will also take responsibility when their reputation is at stake.

Monitoring at this level requires independent verification besides self-assessment in FAST-TOOL. The institutional challenge is how information from the monitor can be an instrument for customers and other stakeholders to verify the production circumstances. Communication about FAST-TOOL and transparency about its development paves the way for negotiation and institutional arrangements aimed at combining a participatory and verification approach serving the primary stakes of both the farms and their customers.

Level 4

In marketing, the challenge is to develop an economically healthy welfare concept in which welfare could be a distinguishing attribute and for which consumers are willing to pay. The translation of the additional costs to consumer prices is complex and requires communication about the production processes.

The contribution at this level focuses on developing communication and fish product concepts for a particular market segment. Communication creates consumer awareness of production and the supply offers a choice of products with higher welfare standards. At this stage, all information about the production process is reduced to one indicator. An additional step is created to make the information accessible to the consumer and start communication. Examples might be a traffic light system or stars expressing the level of welfare (interview, De Jong, Animal Protection Group).

This implies that the issues addressed at the earlier levels also apply here and in particular negotiation about the overall indicator. And when a distinction is made by a traffic light or stars, the different levels have to be defined. This is a process between special interest groups and supply chain parties where the development of a product assortment is a trade-off between ideal welfare criteria and achieving minimum baseline sales.

The potential economic advantage resulting from a high score will allay farmers' fears and increase the appeal of the monitoring tool as a marketing device (Keeling et al., 2007). The market segments will have the size of niche markets or local markets; quality products (usually those that are considered to

have superior taste) are widely assumed to result from production processes that exhibit higher levels of welfare (Kjaernes et al., 2007).

This level requires strong effort on matching demand with supply (Interview De Jong, Animal Protection Group), in particular marketing competencies to define product-market combinations and offer the fish to the right target group in the right place with the right promotion (e.g. labelling). Welfare as part of the marketing strategy has really taken off, particularly in countries like Great Britain and the Netherlands. Supply chains are marketing their products with higher welfare through retailers and specialised food stores. The root cause of the problems plaguing many idealistic supply chains is a mismatch between the type of supplied products and the type of supply chain (Fisher, 1997). Therefore, the supply chain first has to consider the nature of the demand for the products in the chain. Many aspects are important, for example product life cycle, demand, product variety and services.

The technology of FAST-TOOL makes it possible to communicate directly with the targeted customers. Real life images of the underwater cameras could provide the transparency required by a group of consumers. An example of this is the concept of Peter's Farm veal that enables its customers to take a real-life look at the farming conditions by webcam as they log onto a website with a special code provided on the product packaging for tracing and tracking (<http://www.petersfarm.com/default.asp?p=http://www.petersfarm.com/nl/46.asp>). Peter's Farm veal has been successfully introduced in several supermarkets throughout Europe, particularly in upmarket retailers because of the innovative communication of the welfare of the products sold by the retailers. At this level, tracing and tracking could therefore be a distinctive marketing instrument to deliver value through additional features.

Introducing a welfare label is another marketing approach, such as the Fair Trade certification label. A fish welfare label could be developed that includes additional welfare standards that have to be assessed by the FAST-TOOL. Research within the Welfare Quality® programme has counted over 100 welfare schemes in different product categories developed by this type of organisation in six Western European countries (Roex and Miele, 2005). The huge increase in consumer labels with specific quality elements has not prevented Welfare Quality from constructing a prototype label. Peeling (Eurogroup for Animals) would like to certify more than one level of welfare, to allow the consumer to differentiate between two products on the grounds of welfare. Others question labels; Efaró (European Fisheries & Aquaculture Research Organisations) has substantial doubts about the MSC label.

5.3 Institutionalisation of FAST-TOOL

The main challenge is how to make FAST-TOOL part of the different perspectives of an evolving and learning monitoring system to initiate sustainable development of aquaculture. This is challenging because in the current practice international supply chains operate with exclusive systems and negotiation about indicators is more emotionally driven rather than based on scientifically validated information regarding the welfare of fish (Interview Vink, Nutreco). An example is when NGOs address density in the pens or the processing distance to the slaughter location, or issue advice to consumers to purchase or a specific kind of fish or not (interview Van Eijk, Product board fish). Such activities have a great impact on the fish assortment at retailers or the reputation of aquaculture, but the message is not always without controversy despite the fact that the aquaculture sector supports such initiatives. Another example is the way that retailers request NGOs to support a welfare feature in order to receive legitimisation for selling this product (interview Oosterhuis, Ahold). The FAST-TOOL assessment system makes it possible to fill the gap of ample research on fish welfare in aquaculture and maximise the objectivity of judgements. With respect to the information and its use, the key question is whose absence will jeopardise the process of developing or even implementing a monitoring system (Guijt, 1999). Therefore, a platform must be established that provides direction in using the information stemming from the FAST-TOOL system.

A supervisory body has an important task in safeguarding trust and cooperation in the FAST-TOOL assessment system by monitoring the activities from the platform (Ingenbleek et al., 2008). Improper use of the information can undermine that trust and therefore the use of FAST-TOOL. An example of improper use might be when a processor claims to sell welfare friendly fish because the fish from these locations have higher scores on a particular item, despite scores on other items being below average, i.e. when the processor provides selective information for commercial reasons. Such an action might even produce a counter reaction from an NGO. Fish farm habits play an important role in the intention to use FAST-TOOL. Keeping track on how farmers trust the system, for example how they anticipate the transparency of their production and safeguarding the proper use of this information, is necessary to stimulate use. The examples show that trust in the FAST-TOOL assessment system must be established and maintained. A scientific objective assessment system does not necessarily imply a validated system by other stakeholders. The body accumulates the knowledge and experience of farms and the market and supports innovation

and adaptation. The body can consist of representatives of the major stakeholders.

Because developing and revising criteria very much depends on the context, managing conflicting interests between stakeholders is important because of the impact; the parties represent a large market or may damage the reputation of a company and the stake of FAST-TOOL if they use it as input. For example, demands of special interest groups may be higher than the levels that retailers are willing to implement, given the pressures they experience in their own environment. Or the interests of the fish farms may conflict with those of the retailers, because the standards desired by the supermarkets ultimately differ from the standards that fish farms have already adopted. There may also be conflicting interests among countries, because institutional environments differ widely across Europe (Ingenbleek and Immink, 2008). Understanding the decision-making process is relevant to produce strategies to prevent conflicts.

An ethical commission is necessary to resolve disputes about what is 'right' or 'wrong' for the fish for two reasons. The parameters carry information that approximates complex processes. Despite the research of FASTFISH among others into the welfare of fish in aquaculture, researchers might not reach a definite conclusion about how a particular practice and/or behaviour influences the happiness of the fish, even though their studies are based on scientific research. The translation of information to action leaves room for subjectivity that requires interpretation (Guijt, 1998). Furthermore, there is a wide gap in the state of the art in welfare research; many aspects of welfare are not understood and insights and hypotheses might change. Therefore, pronouncement might sometimes be necessary that reflects the vision of all stakeholders and to prioritise additional research.

5.4 Conclusion

Implementation of FAST-TOOL requires institutionalisation in order to offer a platform on which to develop several 'products' from the various levels of opportunities. The first level consists of obtaining the data from the various fish farms. This allows discussion between the different stakeholders about the approach followed by FASTFISH as well as the products that can be developed from this data, such as benchmarking products for the industry and welfare marketing concepts.

Implementation of FAST-TOOL must involve education in order to promote the participatory approach and include the opportunity for verification to allow for accountability. When fish farm companies are not directly involved in setting standards by making them formal stakeholders in the standardisation process, a cultural gap may be created between those formulating the standards and those implementing them. In the context of today's society, combining human development and interpretation is no easy task and requires a platform that facilitates the building of institutional arrangements and relationship management.

A platform must be established that directs the use of information stemming from the FAST-TOOL system. The scientifically validated monitoring information can feed the stakeholder discussion about what is good fish welfare and also give directions for further research aimed at understanding fish welfare. The platform allows the current limited understanding of welfare to be addressed whilst underlining the need of stakeholders to improve welfare. The platform can therefore also be important for setting the agenda for defining the hypotheses about the impact of the environment on welfare conditions as well as negotiating the indicators and the various acceptability levels for welfare conditions that have not been yet scientifically validated or that are subject to varying interpretations by researchers.

6 Conclusions and advice

Implementation of FAST-TOOL is a strategic process in which monitoring fish behaviour and fish welfare is also about politics, choices and directions, i.e. a social process. When welfare is important to all stakeholders, the aim should be to incorporate multiple perspectives. This implies the formulation of common goals between stakeholders that establish an institutional arrangement that uses the information from monitoring to develop certain products, facilitated by a platform.

Monitoring welfare is embedded in negotiations and collaborative decision making by stakeholder groups, each using specific information from FAST-TOOL. The platform roles can be extended to deal with the adoption of new insights, monitor the progress and achievements related to learning and verification and find ways in which farms with low welfare can be given temporary access and opportunities to market their fish. The platform needs to be supervised by a body to retain trust in the system, facilitate stakeholder processes and resolve conflicts between stakeholders. Furthermore, the body's role can be extended to deal with the adoption of new insights, monitor the progress and achievements related to learning and the verification and marketing of welfare friendly fish.

Adoption of the tool can be achieved if farmers are legally obliged to apply the tool in their farm systems. A faster and probably more successful approach is to enable market forces to stimulate adoption through governance. Sustainable aquaculture development by means of a monitoring system will be the result of the dynamics and the interaction between entrepreneurs, supply chain organisations, social organisations and consumers. The stakeholders involved share the opinion that market parties need to be the initiators for improving welfare. In collaboration at European level with the EWAC initiative, a national daughter body can aim to fulfil the specific local needs, for example the extent to which government is represented in the body and is involved in the decision making.

The scientific validated information forms the basis for negotiations between stakeholders about the indicators. Understanding of fish welfare is currently developing and new technology will increase knowledge about the relationship between stressors and fish behaviour. The information should be extended with

environmental data because most stakeholders are not only concerned with the impact on welfare but also on the environment.

Scientifically validated information does not automatically imply validation of the information by other stakeholders. Interpretation of the indicators will become an important process when developing products from FAST-TOOL in groups of stakeholders holding different views on welfare and sustainability development. Market parties will depart from the standpoint for criteria formulation of consumer segments aimed at higher welfare as part of a broader reconfiguration of quality. This is in response to both consumer concerns and the commitment of retailers and food services to quality and welfare and sustainability, including these in their sourcing standards. On the other hand, special interest groups will base their approach on what is best for the fish in the trade-off between the cost of welfare investments and the extent to which these raise the level of welfare. Scenario analysis is a facilitating instrument that outlines the different paths of development and could provide insight into the process underlying the trajectory.

The development and implementation of fish welfare assessment is also about the sophistication of the technical aspects of the monitoring system. Managers of fish farms need to develop the habit of working with the system. Self-assessment places huge demands on the managers' ability to perform monitoring and data entry on a daily basis. The involvement of farm managers can be enhanced by a participatory approach, by providing education and personal development opportunities and by creating awareness of fish welfare in society and its relationship with farm performance.

Creating capacity and experience among all stakeholders with respect to monitoring welfare has priority at the first stage of development. This will firstly be aimed at the pioneers who will start communication about welfare with the aquaculture sector. Initially implementation is best performed in a lee environment, given the potentially conflicting material at hand and the threat of losing the required trust in the approach required for the intention to operate transparently. Gradual implementation is therefore preferred, also because of the effort put into the development of FAST-TOOL so far.

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