Development of practical fish welfare criteria for aquaculture

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Summary

To date, there are no guidelines available worldwide which can provide guidance for improving the welfare of numerous species in aquaculture and at the same time be audited within the framework of a certification system (exception: the RSPCA guidelines for Atlantic salmon and Rainbow trout). The fair-fish international association was entrusted by Friend of the Sea (FOS), one of the leading international certification schemes for sustainable fisheries and aquaculture, with the task of developing fish welfare criteria for the FOS standard that make a difference to the fish, can be implemented in practice and are auditable. The work is in the hands of the Fish Ethology and Welfare Group, a research and advice centre founded by fair-fish.

The criteria are based on the one hand on the scientific findings on ethology and its interpretation for the welfare of a gradually growing number of species (43 at the time of the first version of this report) presented in our free access online database Fish-EthoBase.net, and on the other hand on the real life examination in FOS-certified fish farms during two visits. The first visit served as a gap analysis, providing the farmer with a report and recommendations for improvements. In the second visit, half a year later, we determined which of the suggestions could be implemented and which could not, and for what reasons.

A total of 51 fish farms belonging to 33 companies were visited in 12 countries (8 EU member states, Turkey, 2 Latin America states). The survey covered the husbandry of 24 fish species, including hatchery and/or slaughter, depending on the company.

The problems of high severity identified during the first visit mainly concerned humane slaughter (73% of the companies), stress (48%) and environmental enrichment (36%). The main problems of medium severity were lacks in fish welfare training (82%) and in monitoring fish welfare indicators (15%), whereas the following issues were identified in each 12% of the companies: population density, crowding, procedure traceability of fish handling, and water quality control. A total of 41 distinct problems were identified across the 33 companies and answered with a total of 145 recommendations for improving fish welfare. Only in two companies (6%) no problems were observed.

At the second visit after about six months, 14% of all proposed measures had already been implemented while 29% were in the planning stage. There are hurdles with regard to human anaesthesia: 47% of the companies to whom we addressed corresponding recommendations had implemented measures or planned it. The main concerns were about the possible loss of meat quality (haemorrhage under electrical anaesthesia) and higher operating costs. In particular, farms with net cages (Sea bream, Sea bass) and small farms with raceways (Trouts) are sceptical. The integration of environmental enrichment will also need time: at the second visit, in 27% of the companies with recommendations on this issue, solutions were under study. The plant managers fear above all higher management costs and negative hygienic effects. Finally, 43% of our recommendations to get fish welfare training were followed or under consideration. As expected, easiest to apply is stress reduction; in 67% of the companies with stress reduction recommendations, improvements were implemented or under study.

The definition of fish welfare criteria, which are to become a binding component of the FOS standard, faces the problem that many of the issues identified cannot yet be solved by copying existing examples on a similarly equipped farm of the same fish species. It is therefore planned to make criteria mandatory after a realistic transition period. This corresponds to the current situation of the long neglected fish welfare in aquaculture which has grown extremely rapidly in terms of quantity since the 1950s and continues to grow, while the number of species exceeds terrestrial livestock farming by eighteen times. The aim to improve the welfare of as many farms as possible will only be achieved step by step through smart developments in practice.

1 Scientific basis

The basis of our consulting activities is the fish ethological database (FishEthoBase.net, 2019), which was established in 2013 and is continuously updated. Here we briefly update what we were able to present at this meeting in 2017. The FishEthoBase is based on the documented behaviour of a species in its natural habitat and relates this to the behaviour in aquaculture and in experiments (laboratory) to work out the deficit under normal captive conditions. The findings are presented separately according to the four main life phases (larvae, juveniles, adults and spawn), which essentially correspond to the four production phases in aquaculture (*Fig. 1*).

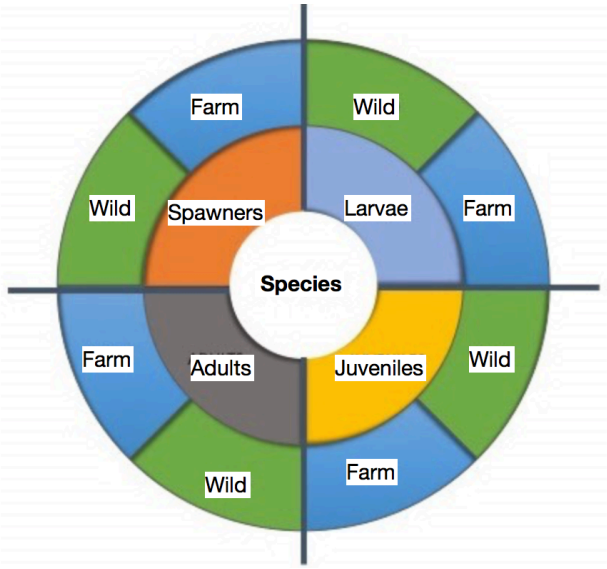

Fig. 1: Logic and organisation of the FishEthoBase profiles: Wild and captive knowledge, separated according to the four main life stages (larvae, juveniles, adults and spawn), which essentially correspond to the four production stages in aquaculture.

For the development of fish welfare criteria for the standard of Friend of the Sea (FOS), against which farms with a total of more than 30 species are certified, we limited ourselves to the short ethological profiles of the FishEthoBase, as these include 43 species (*Tab. 2)* at the time of the first version of this report (46 in January 2020).

The short profiles concentrate on those 10 criteria (*Tab. 1*) that we consider indispensable for the description of the ethology of a species, with the aim of being able to describe as many of the more than 500 farmed aquatic species (362 fish species, 104 mollusc species and 62 shellfish species) as possible in the foreseeable future. (Further ethological criteria are taken into account in the full profiles, which are more complex to compile, of which 9 have been published at the time of the first version of this report, whereas 9 in January 2020).

Two further questions are then asked in each short profile criterion (*Tab. 1*):
- Is there potential for improvement?
- How certain are these findings?

Thus, the short profiles allow to generate a FishEthoScore for each species (*Fig. 2 and Tab. 2*) which provides first rough assessment of the species' situation under farming conditions.

	FishEthoBase Short profiles: 10 core criteria
1	**Home range:** A) Are minimal farming conditions likely to provide the home range of the species? B) Is there potential for improvement? C) How certain are these findings?
2	**Depth range:** A) Are minimal farming conditions likely to provide the depth range of the species? B) … C) …
3	**Migration:** A) Are minimal farming conditions compatible with the migrating or habitat-changing behaviour of the species? B) … C) …
4	**Reproduction:** A) Is the species likely to reproduce in captivity without manipulation? B) … C) …
5	**Aggregation:** A) Is the aggregation imposed by minimal farming conditions likely to be compatible with the natural behaviour of the species? B) … C) …
6	**Aggression:** A) Is the species likely to be non-aggressive and non-territorial? B) … C) …
7	**Substrate, shelter:** A) Are minimal farming conditions likely to match the natural substrate and shelter needs of the species? B) … C) …
8	**Stress:** A) Are minimal farming conditions (handling, confinement etc.) likely not to stress the individuals of the species? B) … C) …
9	**Malformation:** A) Are malformations of this species likely to be rare under farming conditions? B) … C) …
10	**Slaughter:** A) Is a humane slaughter protocol likely to be applied under minimal farming conditions? B) … C) …

Tab. 1: The 10 criteria of the FishEthoBase short profiles

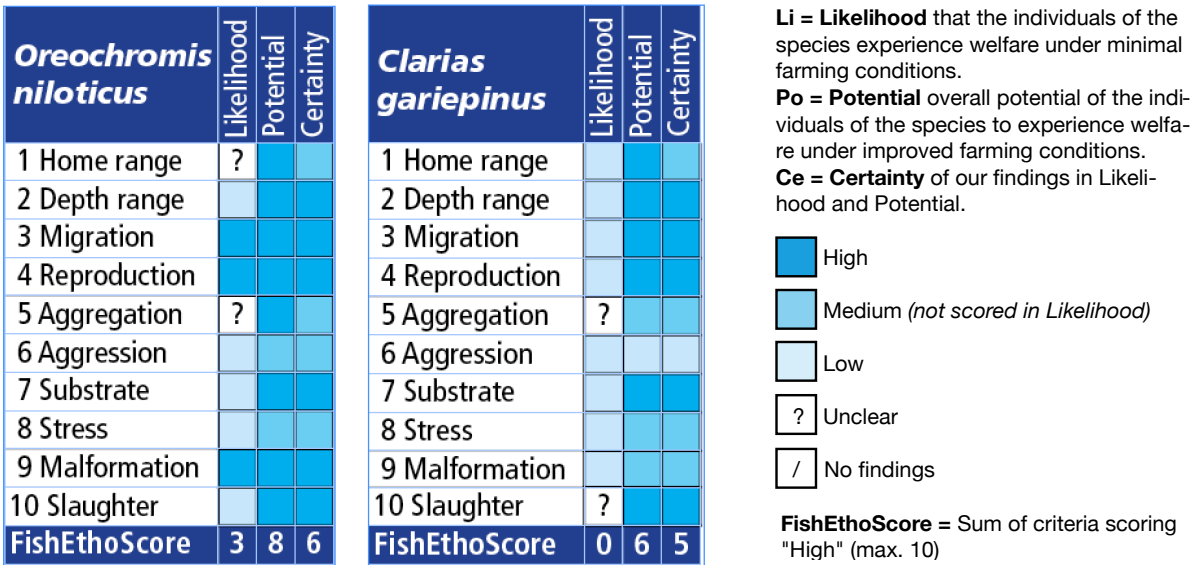

Fig. 2: Example of the summaries of two short profiles

Species	Li	Po	Ce	Do	Animals (in mllions)
Nile tilapia *Oreochromis niloticus*	3	8	6	5	4,900-15,700
African catfish *Clarias gariepinus*	0	6	5	4	160-500
Yellowtail amberjack Seriola lalandi	4	4	4	2	(20-66)*
Common carp *Cyprinus carpio*	1	4	2	5	1,700-8,700
Grayling *Thymallus thymallus*	2	3	0	3	<1
Greater amberjack *Seriola dumerili*	1	3	2	2	(20-66)*
European seabass *Dicentrachus labrax*	0	3	5	5	320-400
Atlantic cod *Gadus morhua*	1	2	4	4	<1
European perch *Perca fluvialtilis*	0	2	4	4	<1-1
Atlantic salmon *Salmo salar*	1	2	3	5	282 - 659
Southern bluefin tuna *Thunnus maccoyii*	1	2	3	3	8-26
Cherry salmon *Oncorhynchus masou*	0	2	3	4	?
Pacific whiteleg shrimp *Litopenaeus vannamei*	0	2	3	4	?
Russian sturgeon *Acipenser gueldenstadtii*	0	2	2	4	<1-1
Siberian sturgeon *Acipenser baerii*	0	2	0	5	<1-1
Grass carp *Ctenophayryngodon idella*	0	2	0	5	2,329 - 11,646
Arctic char *Salvellinus alpinius alpinus*	1	1	2	5	4-14
Red porgy *Pagrus pagrus*	1	1	2	4	1-3
Cobia *Rachycentron canadum*	1	1	1	4	5-7
Rainbow trout *Oncorhynchus mykiss*	0	1	4	5	152 - 3,627
Gilthead seabream *Sparus aurata*	0	1	3	5	417 - 556
Meagre *Argyrosomus regius*	0	1	3	4	14-46
Common octopus *Octopus vulgaris*	0	1	3	3	?
White sturgeon *Acipenser transmontanus*	0	1	2	4	?
Giant tiger prawn *Penaeus monodon*	0	1	2	4	?
Turbot *Scophthalmus maximus*	0	1	1	3	33-93
Pikeperch *Sander lucioperca*	0	1	1	4	1-4
Atlantic sturgeon *Acipenser naccarii*	0	1	0	4	?
Sterlet sturgeon *Acipenser ruthenus*	0	1	0	4	<1
Burbot *Lota lota*	0	1	0	3	<1
Atlantic halibut *Hippoglossus hippoglossus*	0	0	5	3	<1
Wreckfish *Polyprion americanus*	0	0	3	2	?
Barramundi *Lates calcarifer*	0	0	2	4	38-255
Brook trout *Salvelinus fontinalis*	0	0	1	5	1-5
Common dentex *Dentex dentex*	0	0	1	4	<1
Striped mullet *Mugil cephalus*	0	0	1	4	10-30
Pangasius *Pangasianodon hypopththalmus*	0	0	0	3	280 - 839
Hybrid sturgeon *BAEyNAC, NACxBAE*	0	0	0	5	?
Stellate sturgeon *Acipenser stellatus*	0	0	0	4	<1
Senegolese sole *Solea senegalensis*	0	0	0	3	1-4
Dover sole *Solea solea*	0	0	0	3	<1
Sharpsnout seabream *Diplodus puntazzo*	0	0	0	2	<1-1
Malabar grouper *Epinephelus malabaricus*	0	0	0	2	<1

omnivorous mostly carnivorous carnivorous

Tab. 2: FishEthoScores, domestication level and number of farmed animals. First 43 short profiles

1.1 Analysis of existing scientific knowledge

The FishEthoBase is the first and to our knowledge the only comprehensive database on the ethology and welfare of numerous aquatic species kept in aquaculture today. Even though it contained only 43 farmed species, it already allows an overview and comparison of very different species in terms of their general welfare and possibilities for improvement. It also reveals gaps in research, but also discrepancies between scientific knowledge and practice. One of the goals of the FishEthoBase is to reduce these discrepancies through communication between the two actors.

With an analysis of the FishEthoScores of the first 41 species (the analysis was carried out before the profiles for *Pagrus pagrus* and *Octopus vulgaris* were established) we tried to answer the following questions:

- Do fish in aquaculture experience fish welfare?
- Are there species with potential for more fish welfare?
- Are there species whose current fish welfare is far from their best possible fish welfare in aquaculture?
- Does the available knowledge influence the current or potential fish welfare in aquaculture?
- Are fish species that currently experience more fish welfare than others also those that have the highest potential for fish welfare under optimal farming conditions?

The fish welfare of the 41 species under the current minimum aquaculture conditions corresponds to an average likelihood score of 0.44 ± 0.02 (arithmetic mean ± standard deviation); with a theoretical maximum of 10, the highest values being achieved by Seriola lalandi (4) and Oreochromis niloticus (3).

The optimal conditions documented in the literature so far result in an average potential score of 1.37 ± 0.04 for the 41 species, with a maximum of 10. The highest values are achieved by Oreochromis niloticus (8) and Clarias gariepinus (6).

The certainty of the previous findings also reaches a low value with an average Certainty-Score of 1.93 ± 0.04 at a theoretical maximum of 10. The most reliable findings are Oreochromis niloticus (6), Clarias gariepinus (5) and Dicentrarchus labrax (5)

In addition, we examined the improvement capacity (potential minus likelihood, as an estimate of the distance of a species from its best possible fish welfare in aquaculture). Overall, there is little room for improvement for the 41 species studied: The average improvement capacity is 0.93 points (minimum value 0: potential already exhausted in likelihood, maximum value 10: full potential with lowest likelihood). The species with the highest value is Clarias gariepinus with a fish welfare distance between minimum and optimal conditions of 6 points, followed by Oreochromis niloticus (5).

In contrast to these low results, the average domestication level of the 41 species studied is quite high with 3.90 ± 0.02, with numerous fully domesticated species (value 5), i.e. species for which selective breeding programmes have been established focusing on different traits such as growth, yield, meat quality, etc.

We examined the Spearman correlations between the FishEthoScores for Likelihood, Potential and Certainty and the Domestication Level and Improvement Capacity. All tests were conducted on two sides, with ↵ = 0.05. We found significant correlations between Likelihood and Potential, the latter variable correlates significantly with Certainty and Improvement Capacity. No other significant correlations were found.

Correlation matrix	Likelihood	Potential	Certainty	Domestication	Improvement Capacity
Likelihood	1.00				
Potential	0.60	1.00			
Certainty	0.21	0.56	1.00		
Domestication	0.02	0.11	0.14	1.00	
Improvement Capacity	0.08	0.80	0.49	0.18	1.00

Tab. 3: Correlation matrix for selected variables, across the first 41 FishEthoBase short profiles. Values are Spearman. Significant values are highlighted in yellow.

1.2 Discussion of the results so far

Conventional aquaculture conditions (Likelihood) are generally not very conducive to animal welfare, and possibilities for improvement (Potential) are very modest for most of the species, despite a relatively high level of certainty of knowledge, especially here. This is all the more significant as the species studied are usually not niche products, but rather species that have been farmed frequently and sometimes for decades.

It is striking that the level of domestication is not related to fish welfare, neither in conventional nor in improved animal husbandry. The level of domestication merely indicates the extent to which it has been possible to control the reproduction of a species. The highest level (5) has been achieved not only in species that have been farmed for a long time, but also in species with a very short aquaculture history.

Finally, it is interesting to compare omnivorous and carnivorous species. The vast majority of the 43 species studied are predators, which is due to the fact that the western market mainly demands predatory fish, which has influenced our previous species selection, since our previous stakeholders are mainly active in Europe. The few omnivorous or partial species are more likely to be found in the first half of the descending list according to the potential score.

While terrestrial livestock farming has concentrated entirely on omnivorous species (around 30) in the course of its development, the aquaculture industry, which has only been expanding rapidly since the 1950s, allow themselves the luxury to work with over 500 species. It is no wonder that the extremely rapid growth in animal numbers and species diversity means that there are major gaps in knowledge about ethology and animal welfare in many species. Industry and trade argue that species diversity is essential for a wide range of products—an argument that sounds downright absurd from the perspective of terrestrial animal husbandry. The aquaculture industry would be well advised to concentrate on a manageable number of species, and to focus on those which a) offer the best potential for fish welfare and b) are not predators and therefore do not need to be fed from forage fisheries (viable alternative feeding of predators have mostly still not passed the laboratory stage despite years of research). If the market is looking for a wide range of species in their supply, it is much easier to find it in the oceans—one more reason to finally manage wild stocks carefully.

2 Practice application: Fish welfare guidelines for an international certification scheme

In May 2017, fair-fish international, owner of the FishEthoBase [1], together with Friend of the Sea (FOS), one of the leading labels for sustainable fishing and aquaculture, agreed on a cooperation with the following goal:

- to develop a set of core fish welfare criteria for all fish species kept on FOS-certified farms, with the aim of integrating corresponding guidelines into the FOS certification standard,
- developed on the basis of two visits to FOS-certified companies. The first visit served a gap analysis between the scientific knowledge gained and the observations before species and ended in a report to the farmer with recommendations on how he could improve the welfare of his fish. Half a year later, a second visit was carried out to determine which improvements had already been successfully implemented or were in the planning stage and which had not, and for what reasons not.

The decisive factor in our approach was not to develop guidelines at the table, but in direct interaction with practice. In this way we wanted to ensure that future fish welfare guidelines

- feasible,
- controllable, and
- relevant for which fish.

This plan convinced the Silicon Valley-based foundation Open Philanthropy Project (OP) [2], which aims to promote animal welfare in aquaculture. In this context, OP awarded project contributions to various certification programs (including ASC or GAA/BAP) and NGOs (including the Albert Schweitzer Foundation) before the end of 2017, thus launching a unique competitive boost for fish welfare standards. Twenty years after the first efforts of fair-fish in Switzerland and Vissenbescherming in Holland, the long neglected and smiled at topic finally received broad support.

Work started in early 2018 with the first site visits and continued until late summer 2020 with the handover of the criteria and indicators for the last of 24 species. In early 2019, the work was officially

taken over by our newly founded spin-off Fish Ethology and Welfare Group (FishEthoGroup) [3], based at the CCMAR Marine Research Institute of the University of the Algarve in Faro, under an agreement between CCMAR and fair-fish international.

2.1 Results of the first visits to FOS aquaculture farms

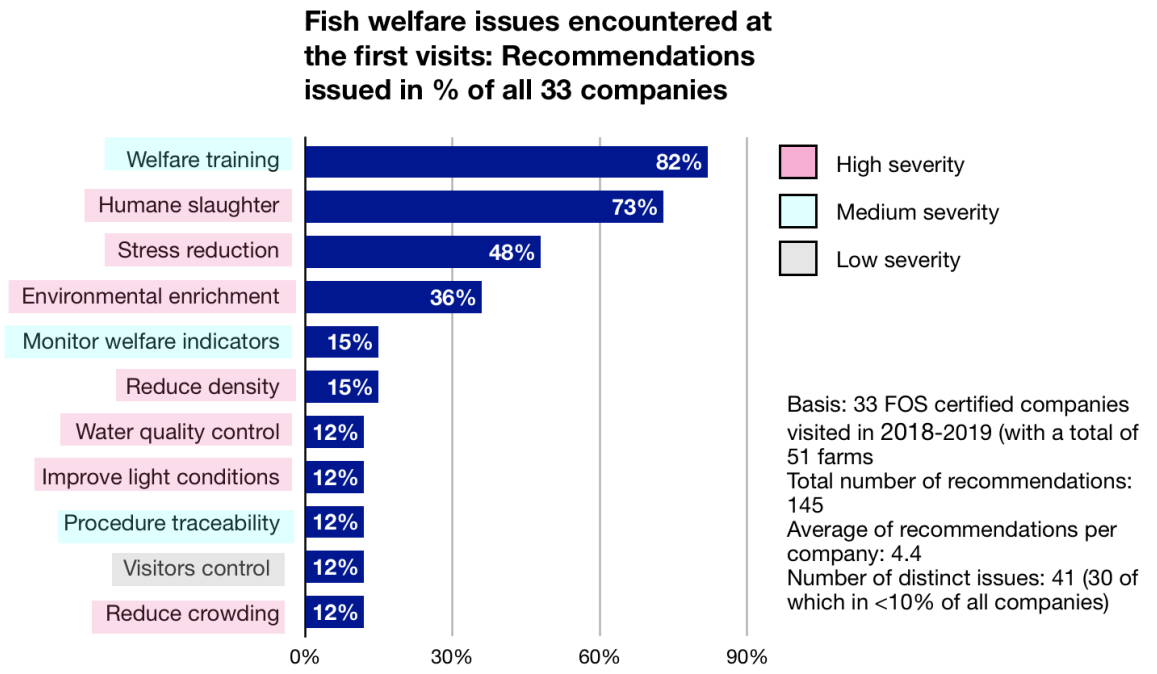

Fig. 3: Recommendations to FOS fish farmers, by frequency

Between January 2018 and March 2019 we visited 51 fish farms belonging to 33 companies in 12 countries (28 companies in 8 EU member states, 3 companies in Turkey, 1 company in Panama, 1 company in Chile). The reports contained an average 4.5 recommendations per farm.

In criteria with high severity, the most frequent recommendation was for stunning before slaughter (in 73% of all companies), followed by stress reduction during handling and harvesting (48%), environmental enrichment (36%), reduction of density (15%) or of crowding (12%), improving light conditions (12%), and water quality control(12%). A further 18 recommendations, each with less than 10% of the companies, require in particular the dimensions of the housing system to the needs of the species, and daily removal and killing of moribund fish.

For criteria of medium severity, the lack of training of personnel in fish welfare issues (in 82% of all companies) came first by far, followed by a lack of observation and noting of fish welfare indicators (15%) and a lack of traceability of stressful measures like handling of fish, etc. (12%). The remaining 3 recommendations in this category concerned only 3% of all companies and also mainly concerned fish monitoring issues.

For criteria of low severity, we gave 9 recommendations to the companies, mainly concerning hygiene and control (registration of visits (12%), footbath and wheelbath at the entrance (9%), as well as measures to improve data collection.

2.2 First consequences: Humane slaughter and fish welfare training

We were astonished by the high percentage of three quarters of the companies visited, which harvest the fish without anaesthetising them afterwards. On the one hand, these are mainly breeding Sea bream (Sparus aurata) and Sea bass (Dicentrarchus labrax) in the Mediterranean, for which we propose solutions with electric anaesthesia, which have now been implemented or are under serious

examination (see section 2.3). On the other hand, many smaller trout farms in Northern Italy are sceptical about electric stunning because they fear a loss of quality (haemorrhaging) and higher operating costs. However, these companies are aware that slaughtering trout without anaesthesia could lead to market losses in the future. Colleagues from a Northern Italian research institute have therefore developed an alternative to stunning by thermal shock, which is being tested experimentally by our FishEthoGroup in comparison to stunning with electricity, with MS222 and without stunning.

The lack of training of personnel in fish welfare issues observed in more than four-fifths of the companies has also led us to develop a Fish Welfare Course. The three-day course for practitioners, auditors and other interested parties from the industry has been held for the first time in November 2019 by experts at the headquarters of FishEthoGroup at the Marine Research Institute CCMAR of the Universidade do Algarve in Portugal, with about 50 participants [4]. A second course will be held online in spring 2021.

2.3 Improvements noted during the second visits

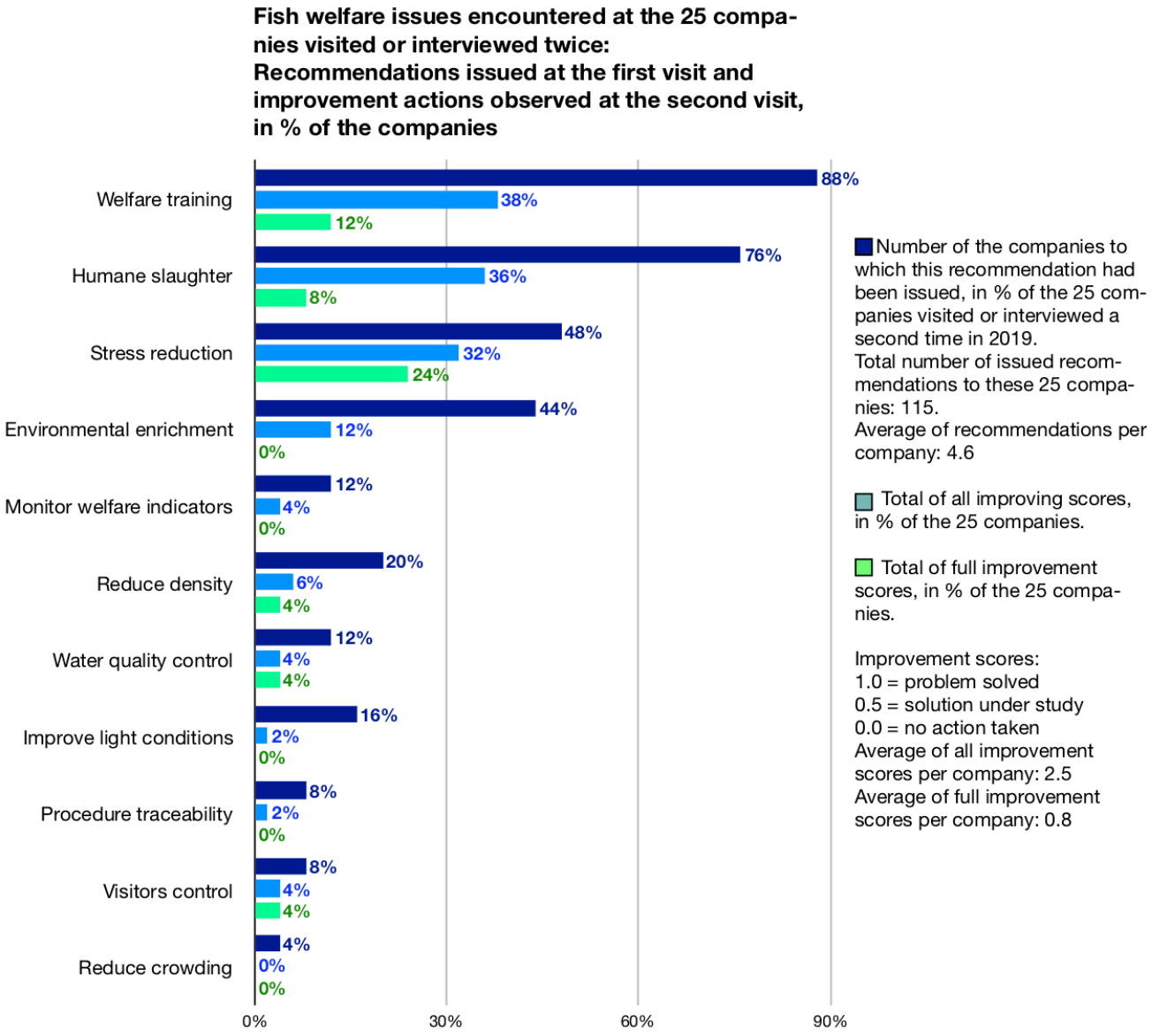

Fig. 4: Implementation of our recommendations after half a year

We were able to visit 25 of the 33 companies a second time or to interview them by questionnaire or telephone (mainly companies that had not yet addressed any of the recommendations). For 8 companies, a second visit or interview was not possible for the following reasons:

- No recommendations issued after first visit, therefore no second visit needed (2);

- Second visit impossible, because the company had been severely damaged by storms (1);
- the management changed after the first visit was not interested (1);
- No reply or refusal of the demand for a second visit for unknown reasons (4).

The results of the second visits represent the vast majority of cases.

During the visit or interview, we checked which of the recommended improvements had been implemented or were at least under serious consideration, and which were not, and for what reasons. To get an overview of the situation, we scored the reactions of the companies as follows:

- Improvement implemented: Score = 1.0
- Improvement under serious consideration: Score = 0.5
- Measure neither implemented nor considered: Score = 0.0

At the second visit after about six months, the 25 companies had already implemented 17% of all the recommendations we had made to them, and 37% companies were in the planning stage. While these companies had received an average of 4.6 recommendations per company, they reached an average improvement score of 2.5 per company. This means that these companies have implemented more than half of the improvements in six months or are currently seriously considering solutions. If we relate this to the usual transition periods for newly introduced label criteria of one, two or even more years, the adjustment performance of these companies so far signals that an integration of fish welfare criteria criteria into the FOS certification standard is not unrealistic. This presupposes, of course, that the measures only under planning so far will be implemented later as well, let alone measures not yet taken into account for the time being.

However, the fact that the FOS-certified companies still face a challenging task becomes clear when we consider all 33 companies that were once visited: Of the total 145 recommendations made (an average of 4.4 per company), only 20 (14%) were fully implemented during the second visits.

As expected, the easiest measures to implement are those to reduce stress. At the second visit, 67% of the companies to whom we recommended to tackle this issue were found to reduce or plan to reduce stress by handling procedures, to limit the time the fish spend out of water to a maximum of 15 seconds, to reduce the number of sorting processes during the fish's life cycle or to harvest the fish using pumps instead of nets. 50% percent of these companies have already a solution at work.

47% of the companies to whom we recommended pre-slaughter stunning were found at the second visit seriously planning to implement a stunning procedure; 11% of these companies meanwhile already implemented electric stunning.

43% of the companies to whom we recommended to get fish welfare training reported at the second visit currently examining participation, in many cases by participation in our Fish Welfare Course; 14% of these companies have already found a solution (one company has solved the problem by having three of its employees complete a specialist training course, whereas the quality manager has also completed a fish veterinary course).

As expected, more difficult to tackle are those recommendations that intervene more strongly in the operational process, such as the installation of structures (substrate, hiding places), the avoidance of crowding or the introduction of monitoring measures regarding behaviour, water quality and handling processes; see *Fig. 4* for details.

3. Development of fish welfare criteria for the FOS-Standard

From the outset, Friend of the Sea had decided to integrate the future fish welfare criteria as a binding component of its own standard and—in contrast to what the Aquaculture Stewardship Council (ASC) [5] appears to be doing—not to pursue an add-on strategy that would allow individual farms to choose whether to subject themselves to animal welfare requirements in addition to environmental ones. Friend of the Sea found it difficult to communicate on the market one FOS label with and one without fish welfare add-ons. Thus, the definition of fish welfare criteria applicable to all FOS farms faces the fact that for some of the problems observed there are no practical examples yet that a comparable farm could simply adopt. We therefore recommended that Friend of the Sea (FOS) should not make such criteria mandatory until a farm with the same species and similar system has implemented a recognised solution. This would be in line with the current situation of the long neglected fish welfare in aquaculture, which has grown and still grows extremely rapidly in terms of volume since the 1950s and by farming a number of species eighteen times greater than in terrestrial farming.

The aim is to improve the welfare of fish on as many FOS certified farms as possible or to lose as few farms as possible when integrating welfare into the FOS standard. However, the FOS certification scheme does not allow for the flexibility we proposed. Similar to ASC, for example, any change or addition to the standard requires a predetermined decision-making process in which the representatives of the various interest groups must agree, which is only possible on the basis of conclusively formulated proposals. Nevertheless, in order to improve fish welfare step by step according to wise developments in practice, FOS will classify the criteria into one of the following three categories according to their current feasibility:

- ESSENTIAL: In the event of non-conformity identified by the auditor, the farm will be given three months to rectify the problem. If the nonconformity persists during a follow-up inspection, the company loses the certificate.
- IMPORTANT: In the case of a non-conformity identified by the auditor, the company will be given three weeks to present a corrective plan which must be carried out at the next inspection about one year later, otherwise the company loses its certificate.
- RECOMMENDED: In the case of a nonconformity identified by the auditor, the farm is free to follow a recommendation for improvement. The auditor's reports on the behaviour of the farms are an indicator of whether a criterion in this category should be declared mandatory in the future.

European seabass – Ongrowing			
13.WELFARE REQUIREMENTS			
13.01 Captive environment			
No	**Requirement**	**Level**	**Indicators ***
13.01.1	Production units should providing horizontal and vertical withdrawal space, optimising fish welfare conditions regarding spatial constraints.	Essential	There must always be horizontal and vertical empty space.
13.01.2	Production units must not have sharp protrusions which may be injurious to the fish.	Essential	Absence of dangerous protrusions.
13.01.3	Production units and equipment must be checked for holes, faults and fouling. All equipment must be maintained regularly and records must be ready for inspection.	Essential	Good overall condition of nets and infraestructures. Records of periodicity and methods.
13.01.4	Farm design should be such that inspection of all stock is possible.	Essential	Water visibility, ROVs, divers, cameras...
13.01.5	Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. NorthAtlantic latitudes photoperiod max. range: 16L:8D-8L:16D.	Essential	Facility allocated within the natural photoperiod and geographical range of the species.
13.01.6		Important	Depth net-pen.
13.01.7	Additional lighting either fixed or portable must be available, but only should be switched to allow examination of the animals and equipment.	Important	Stock inspection all times.
13.01.8	Structural enrichment should be provided. If deemed impossible or harmful, other type of enrichment should be implemented (occupational, dietary, social, sensorial).	Recommended	Presence of enrichment – but observing 13.1.3
13.01.9	The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-1kHz frequency range in any point of the tank at all times.	Important	Absence of noise, recorded with a hydrophone and analysed with appropriate software.

* Management-based indicators, see: Operational Welfare Indicators (OWI table)

Tab. 4: Example (extraxt) of a fish welfare criteria and criteria sheet for Friend of the Sea

This is the path on which currently recommended criteria can be given a more binding character in a next revision of the standard.

For each of the 24 fish species (see table 5) integrated into the project, the FishEthoGroup developed a set of over 80 criteria and indicators, each subdivided into up to 5 production or life stages: eggs, larvae, juveniles, adults, parent animals. (See table 1 for an example).

At deadline of this repprt (end of August 2020) the experts of Friend of the Sea are in the process of integrating the recommendations of the FishEthoGroup into a proposal for the extension of the standard and preparing stakeholder consultation.

Atlantic salmon *Salmo salar*
Brown trout *Salmo trutta*
Lake Garda carpione *Salmo carpio*
Rainbow trout *Oncorhynchus mykiss*
Brook trout *Salvelinus fontinalis*
Arctic char *Salvelinus alpinus*
Gilthead seabeam *Sparus aurata*
European Sebass *Dicentrarchus labrax*
Meagre *Argyrosomus regius*
Common dentex *Dentex dentex*
Sharpsnout seabream *Diplodus puntazzo*
Flathead grey mullet *Mugil cephalus*
Thinlipp mullet *Liza ramada*
Greater amberjack *Seriola dumerilii*
Yellow amberjack *Seriola lalandi*
Cobia *Rachycentron canadum*
Sibierian sturgeon *Acipenser baerii*
Russian sturgeon Acipenser gueldenstaedtii
Starry sturgeon *Acipenser stellatus*
Adriatisc sturgeon *Acipenser naccarii*
White sturgeon *Acipenser transmontanus*
Sterlet *Acipenser ruthenus*
Beluga *Huso huso*
Turbot *Psetta maxima*

Tab. 5: The 24 species observed during the project

4. Future research and consulting activities

At a meeting of the fish welfare projects supported by Open Philanthropy in April 2019 in Brussels, it became clear that fair-fish international resp. its FishEthoGroup had made the most progress in the development of guidelines. At the beginning of 2020, Open Philanthropy complied with our application for continued funding. This allows the FishEthoGroup to support the implementation of the fish

welfare criteria on the currently about one hundred FOS-certified aquaculture farms with research, consulting and training. At the same time, the FishEthoGroup has started to make its services available to other players in the aquaculture sector in order to promote fish welfare.

Literature and links

[1] http://www.fishethobase.net/db

[2] https://www.openphilanthropy.org

[3] http://www.fishethogroup.net

[4] https://www.ccmar.ualg.pt/advanced-tech-training/fish-welfare-course

[5] https://www.asc-aqua.org/news/latest-news/asc-responds-to-fish-welfare-report/