FEDERATION OF VETERINARIANS OF EUROPE

Veterinary aspects of aquatic animal health and welfare, aquaculture and ornamental fish trade

Report of FVE working group on Aquatic Animal Health and Aquaculture

Date adoption: 21 November 2014

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MAIN CONCLUSIONS & RECOMMENDATIONS

EUROPEAN AQUACULTURE

Aquatic food products represent one of the world`s most nutritious and healthy food sources and is a major contributor to food supply at global level. In Europe, there has been an increasing demand for aquatic products. In 2010, the import of aquaculture products into the EU was estimated to account for 65% of aquatic food consumption. The aquaculture production in Europe is renowned for its high quality, sustainability and consumer protection standards.

Therefore **FVE recommends strongly investing in the growing potential of Europe's aquaculture.**

INVOLVEMENT OF THE VETERINARY PROFESSION IN AQUACULTURE

The involvement of veterinarians in the aquaculture sector is vital; being essential in the investigation and treatment of diseases, epidemiological analysis, nutrition, feeding and welfare of aquatic animals. Veterinarians can advise and work with producers to promote the health and welfare of their aquatic animals. Veterinarians are a vital link in ensuring human health through controlling food safety and food security, similarly as with other food producing species.

Therefore FVE recommends to

- **Expand the role of veterinarians in fish and shellfish health, welfare and food safety** in order to let the aquaculture grow, to make it more profitable and more sustainable. Veterinarians should lead the public policies related to the aquaculture sector (Competent Authority).
- **Promote veterinary research** in order to gaining better understanding of fish diseases, aquatic animal medicinal products and vaccines.
- **Strengthen the collaboration between the industry, government and the veterinary profession** such as by better utilization of data capture technologies, increasing veterinary involvement in the trade of ornamental fish and in restocking exercises.
- **Increase the collaboration between veterinarians working in aquaculture to exchange best veterinary practices and knowlege in aquaculture**, but also by strengthening the network for notifiying and analysing emerging diseases and threats.

HEALTH, WELFARE AND SUSTAINABILITY IN EUROPEAN AQUACULTURE

The balance of evidence at present, indicates that some fish have the capacity of experience pain. The question of fish consciousness, and whether they are aware of pain- and therefore can be said to suffer- is more controversial. Even so, the important thing is to treat them as if they could.

Welfare assessment should be based upon a thorough understanding of the biology of the species, and the related needs and requirements of a farmed species. The welfare indicators used, should be species-specific, validated, reliable, feasible and auditable.

Prevention is better than cure! The presence of veterinarians in the fast expanding aquaculture industry is crucial to make sure farmed individuals are treated with care; correctly and species-adjusted in the right environment.

One of the great global challenges in the future will be to produce large amounts of food in environmentally sustainable ways. Aquaculture needs to be a part of the solution and not part of the problem!

Therefore FVE recommends:

- A **mandatory incorporation of veterinary-health and welfare-plans as part of the management on every aquaculture farm.**
- **Intensified research regarding welfare indicators**

AVAILABILITY AND USE OF MEDICINES IN AQUACULTURE

Fish need medicines too! The availability of veterinary medicinal products including vaccines for administering to farmed aquatic animals is extremely limited, constraining prevention and treatment of disease and leading to welfare problems.
Bacteria resistant to antibiotics can transfer between animals, animal products and humans. As with other animals, **antibiotics should be used responsibly** and with caution and always used according to the veterinary prescription and based on examination and diagnosis of the disease.

Therefore FVE recommends:

- The aquaculture industry, animal health industry, regulatory authorities and veterinary profession should **join forces to improve availability for aquatic animals.**
- As with other animals, **antimicrobials should be used responsibly** and with caution and always used according to the veterinary prescription and based on examination and diagnosis of the disease.

VETERINARY EDUCATION IN AQUATIC MEDICINE

A survey in 2013 done by FVE and EAEVE in regard to teaching of aquatic medicines in undergraduate veterinary education revealed that Aquatic Animal Medicine (AAM) is taught in almost all European veterinary faculties. However, the level of teaching is inconsistent between the faculties. Aquaculture medicine teaching is also provided by some non-veterinary faculties such as Stirling University and in

Norway. In April 2014, a European College of Aquatic Animal Health was provisionally accepted by the European Board of Veterinary Specialization (EBVS).

Therefore FVE recommends:

- **Aquatic animal medicine teaching should be obligatory** for all veterinary students.
- A selected number of (accredited) European veterinary higher education institutes should offer **"Post-graduate Aquatic medicine" courses.** Exchange of students and teachers should be promoted.
- European and national legislation on animal health and welfare mostly covers aquatic animals in the scope of the legislation, however often the legislative details do not fit aquatic animals eg. EC transport Regulation 1/2005. Care should be taken to **adopt legislation suitable for aquatic animals**.
- **Examinations, diagnosis and treatment of aquatic animals should be performed only by veterinarians** licensed by the statutory body of the native country.
- Aquatic veterinarians should maintain and develop their knowledge and skills throughout their career by following **continuous professional development (CPD)**.
- The **Competent Authority should provide** the personnel (and namely the veterinarians) working in the public sector in the domain of aquatic animal health/ hygiene with the **relevant extra-courses** (AH, AW, epidemiology, environment protection, laws, etc.)

TRADE AND MOVEMENT OF ORNAMENTAL FISH

The keeping of ornamental fish is a hobby that has become more popular in industrialized countries. The trade in freshwater ornamental fish can negatively affect wild populations and may also lead to disease risks.

Therefore FVE recommends:

- Care must be taken not to introduce exotic disease or antibiotic-resistant bacteria together with the introduction of **ornamental exotic fish species or via contaminated water.**

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SCOPE and MANDATE

This report was prepared by the FVE Working group on Aquaculture on the request of the FVE Board and the FVE members; 46 national veterinary organizations across 38 European countries and 4 Sections, each of which represents key groups within our profession: Practitioners (UEVP), Hygienists (UEVH), Veterinary State Officers (EASVO) and Veterinarians in Education, Research and Industry (EVERI).

The mandate given to the working group was:

- to collect information regarding the health and welfare of the aquaculture sector
- to make recommendations to the FVE Board on possible methods to involve the veterinary profession in the sector
- to support the Board producing science-based input to national and EU decision makers about aquaculture
- to provide guidelines on training of veterinarians in this strategically important sector

Figures under country name:
RED = number of veterinarians in the country
ORANGE= population

European map with veterinarians and inhabitants in FVE member countries

HEALTH AND WELFARE IN EUROPEAN AQUACULTURE

INTRODUCTION

According to the European Commission (2013), aquaculture should be understood as the rearing or cultivation of aquatic organisms using techniques designed to increase the production of the organisms in question, beyond the natural capacity of the environment. The organisms remain the property of a natural or legal person throughout the rearing or cultivation stage, up to and including harvesting.

Aquaculture has been practiced for thousands of years. An early form consisted of trapping wild aquatic animals in lagoons, ponds or small lakes. Lagoons and coastal ponds were first fitted out to retain fish swept in by the tide. In Europe, the Romans kept oysters and fattened fish in specially designed tanks.

It is estimated that now more than 600 aquatic species are cultured worldwide for production in a variety of farming systems using freshwater, brackish water and marine water/sea water. World aquaculture production can at present be categorized into inland aquaculture and mariculture. Inland aquaculture generally use freshwater, but some production operations use saline water in inland areas.

Atlantic salmon farm in Norway

Mariculture includes production operations in the sea and intertidal zones as well as those operated with land-based (onshore) production facilities and structures.

Aquatic food products represent one of the world`s most nutritious and healthy food sources and is a major contributor to food supply at global level. According to the European Food Information Council, the global aquaculture industry has been growing at a rate of 7 % each year since 2000 and is at present one of the fastest growing food producing sectors in the world. The substantial growth in production over the recent years has largely occurred in Asia and South America.

With a production of 90.43 million tons in 2012, the world aquaculture industry now provides almost half of all fish for human food (FAO data). The total global production includes 66.63 million tons of food fish (finfish, shellfish, amphibians, freshwater turtles and other aquatic animals for human consumption), 23.78 million tons of aquatic algae (mostly marine macroalgae /seaweeds) and 22.4 thousand tons of non-food products (pearls and shells, etc.). Two-thirds of the food fish production were finfish species grown from inland aquaculture (38.6 million tons) and mariculture (5.6 million tons) and the rest crustaceans (2.5 million tons), molluscs (0.287 million tons) and other species (0.5 million tons).

Table 7
Farmed food fish production by top 15 producers and main groups of farmed species in 2012

Producer	Finfish: Inland aquaculture	Finfish: Mariculture	Crustaceans	Molluscs	Other species	National total	Share in world total
	(Tonnes)			(Tonnes)			(Percentage)
China	23 341 134	1 028 399	3 592 588	12 343 169	803 016	41 108 306	61.7
India	3 812 420	84 164	299 926	12 905	...	4 209 415	6.3
Viet Nam	2 091 200	51 000	513 100	400 000	30 200	3 085 500	4.6
Indonesia	2 097 407	582 077	387 698	...	477	3 067 660	4.6
Bangladesh	1 525 672	63 220	137 174	...	...	1 726 066	2.6
Norway	85	1 319 033	...	2 001	...	1 321 119	2.0
Thailand	380 986	19 994	623 660	205 192	4 045	1 233 877	1.9
Chile	59 527	758 587	...	253 307	...	1 071 421	1.6
Egypt	1 016 629	...	1 109	...	...	1 017 738	1.5
Myanmar	822 589	1 868	58 981	...	1 731	885 169	1.3
Philippines	310 042	361 722	72 822	46 308	...	790 894	1.2
Brazil	611 343	...	74 415	20 699	1 005	707 461	1.1
Japan	33 957	250 472	1 596	345 914	1 108	633 047	1.0
Republic of Korea	14 099	76 307	2 838	373 488	17 672	484 404	0.7
United States of America	185 598	21 169	44 928	168 329	...	420 024	0.6
Top 15 subtotal	**36 302 688**	**4 618 012**	**5 810 835**	**14 171 312**	**859 254**	**61 762 101**	**92.7**
Rest of world	2 296 562	933 893	635 983	999 426	5 288	4 871 152	7.3
World	**38 599 250**	**5 551 905**	**6 446 818**	**15 170 738**	**864 542**	**66 633 253**	**100**

Note: The symbol "..." means the production data are not available or the production volume is regarded as negligibly low.

FAO, 2014, state of World Fisheries and Aquaculture

The aquaculture production in Europe is renowned for its high quality, sustainability and consumer protection standards. European aquaculture include more than 35 different species and takes a variety of forms: extensive or intensive, in natural settings or tanks, in fresh water or sea water, in flow-through or recirculation systems, traditional or modern, classic or organic, sheltered or exposed etc. The total production in Europe reached in 2012 almost 2.9 million tons, providing about 100.000 direct jobs in coastal and rural areas. European aquaculture industries produce fresh-water fish, salt-water-fish, shellfish and small amounts of seaweed.

Aquaculture activities depending on sea water include different systems of finfish and shellfish farming. In 2012, European aquaculture produced 2.9 million tons of fish and shellfish. Marine cold-water species represented the largest sector, followed by freshwater species and marine Mediterranean species. In European freshwater, trout and carp dominate the finfish production. Fish farming in fresh water is of significant importance for restocking public waters with minor species, but also necessary for the preservation of biodiversity, such as brown trout, arctic char, sturgeons, pikes, and others. In sea water, sea bass, sea bream and turbot dominate the finfish production in the Mediterranean. Atlantic salmon, trout and cod dominate the production of finfish in cold seawater.

Shellfish farming is still an extensive type of aquaculture. It is based primarily on specimens born in the wild and on nutriments provided by the environment, without any type of input (filter-feeding animals). Production of shellfish species farmed in Europe in quantity includes oysters, mussels, clams and crustaceans. In Europe, oyster and mussel farming account for 90% of all shellfish farming. Two different oyster-species are cultured: Flat oyster (*Oestra edulis*) and Pacific cupped oyster (*Crassostrea gigas)*. The yearly European oyster production has reached 126.000 tons and France accounts for 90% of the production in the EU. Mussel- farming also focus on two species, depending on the geographical area of production: Blue mussel (*Mytilus edulis*) in northern areas and Mediterranean mussel (*Mytilus galloprovincialis*) in southern areas. Other species of shellfish cultured in Europe are clams, scallops, abalones and carpetshells.

Caviar is also increasingly produced though aquaculture. While traditionally these were the eggs of wild catches, now several species of sturgeon are reared to produce caviar. Alternatively caviar can also be collected from other fish produced by aquaculture such as salmon, steelhead trout, trout, lumpfish and whitefish. Caviar from aquaculture reduces the environmental and ecological problems related to production of sturgeon from wild-catches (over-fishing, smuggling, etc) , while some issues are still under discussions such as welfare concerns related to the harvest of roe.

There is a huge potential for growth in the European aquaculture industry. The demand for safe and affordable aquatic products in Europe is increasing. Even if the production on global level has been rapidly growing over the last years, the production in Europe has remained stagnant in the same period and even is declining in some European countries. The total global food fish production was in 2012 estimated to be 66.6 million tons. For Europe, same year, the aquaculture production (finfish and shellfish) was estimated to be about 2.9 million tons. By 2030, the total global need is forecasted to be more than 160 million tons per year.

Trade flows by continent 2010-2012
FAO, 2014, State of World Fisheries and Aquaculture

In Europe, there has been an increasing dependence on foreign imports. In 2010 the import of aquaculture products to Europe were estimated to account for 65% of aquatic food consumption. Currently, the European Union is, by far, the largest single market for imported fish and fishery products. (FAO data)

The EU aquaculture industry also plays a vital role in sustaining the farming and subsequent stocking of salmonids and other freshwater species. Specifically, the restocking of trout and other species used in commercial angling in both enclosed (still) water and open fisheries plays a vital part in supporting sustainable European fisheries.
Farmed fish are also widely used and relied upon, by many Member States Agencies in the restoration and conservation of autochthonous fish populations. Farming for restocking is one of the oldest aquaculture activities and has begun in Europe in the early 1900's.

What does an intensive and fast growing aquaculture industry with its wide variety of species, mean to health and welfare of farmed individuals?

HEALTH AND WELFARE - THE SAME ISSUE?

The question is not «Can they reason» nor «Can they talk» but «Can they suffer» (James Bentham, philosopher 1789).

Health and welfare is not quite the same issue, but there is a certain overlap. Health is more about how the individuals are – welfare more about how they cope. It has been argued, health is the state of complete physical well-being and not merely the absence of disease. Good health alone is not enough to conclude on the welfare level. An animal is experiencing good welfare only when it is "fit and happy" - meaning both in a good physical and mental state. The welfare level is a temporary characteristic of the individual animal. When welfare-needs of individuals in a population are met, then welfare of the population can be considered good.
Often, fish producers and even some veterinarians see animal welfare solely related to the biological functioning of an animal, meaning that an animal which is biologically well functioning with good health, low stress level and adequate growth and reproduction, also has a good quality of life. However, this is a too restricted view of welfare.

It has been strongly debated for many years whether or not fish can experience pain, fear and suffering. The balance of evidence at present indicates that some fish have the capacity to experience pain. From studies of sensory systems, brain structure and functionality there is evidence for the neural components of pain reception in some species of fish (Sneddon et al 2003). The question of fish consciousness, and whether they are aware of pain and therefore can be said to suffer is more controversial. Whether non-human animals feel pain can only be inferred (conclude from evidence and reasoning rather than from explicit facts) and this is also the case for aquatic animals. Scientific findings however show that in certain fish, pain will capture the attention of fish and that fish can learn by methods that are known to require consciousness in humans (Vindas et al, 2012) However, even if the question whether fish are able to experience pain, fear and suffering or not, is still under debate, the important thing is to treat them as if they could.

Animal welfare has been a subject of discussion since humans first kept pets and production animals. Animal welfare is about the well-being of animals as individuals and about ensuring they have a good quality of life and are not treated in ways that can cause suffering. The concept of welfare is the same for all animals, i.e. mammals, birds and fish, used for human consumption and given protection under the Treaty of Amsterdam.

There are different definitions of animal welfare.
The OIE Resolution, Art.7.1.1. of the Terrestrial Code, reads:
-Animal welfare means how an animal is coping with the conditions in which it lives.

-An animal is in good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behavior and not suffering from unpleasant states as pain, fear and distress.
-Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing.
-Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry and human treatment.

Can welfare be measured?
There is not a single welfare indicator or measurement we can use to measure or predict the exact level of welfare that will cover all possible rearing systems, farmed species and potential situations. Judging the level of welfare, the best strategy is a multidisciplinary approach with a range of factors. To understand, compare and develop actions to improve fish welfare, measures and welfare-indicators are needed.

NOT "ONLY A FISH"!

In practical fish farming, good fish welfare requires rearing conditions where fish can maintain homeostasis and normal development and are protected against physical damages and chronic stress. Most aquatic animals, including fish, go through extensive physiological and morphological changes in the development from egg to mature individuals. A high number of factors throughout the farming period may thus affect fish welfare, including for example the physical and chemical environment, feeding, social interaction, occurrence of fish pathogens, parasites and predators, and the procedures during handling, transport and slaughtering.

Farming of aquatic animals is in many ways comparable to other livestock production. However, farmed aquatic animals are held in large groups in an aquatic medium and therefore it is difficult to observe the individual in its farm environment. In contrast to other major forms of livestock production, there is a paucity of scientific information on the welfare of animals raised under intensive aquacultural conditions.

MORTALITY -WHY DO THEY DIE?

As well as in the wild, farmed aquatic animals die from many different causes. In a farming situation, there will additionally be management-related factors which can have negative influence on the individuals. Sometimes there will be incidents and mortalities with unsolved cause. An investigation conducted in Norway recently, followed 3 groups including 308 million farmed fish distributed on 288 sites with Atlantic salmon and 30 sites with Rainbow trout. The groups were followed from transfer to sea until time of slaughter. The first preliminary results after investigating the 3 groups, show a variation in total loss at the time of slaughter, from 17% to 19,4%.

Why do so many fish die?

The final conclusions are not ready yet. However, infections, quality of the fish at time they are transferred to sea, environmental causes and injury caused by mechanical influences will most likely be suggested as some of the main causes for the mortalities (Bleie, 2014, personal communication). More investigation and data capture will provide base line mortalities for all sectors of aquaculture production.

Extreme weather circumstances can influence the behavior and welfare of aquatic animals

SOMETHING CAN BE DONE: "PREVENTION BETTER THAN CURE!"

Prevention of health and welfare problems before they happen is always the best cure!

The veterinary profession – as knowledgeable and accountable professionals - has an important responsibility in promoting and assuring health and welfare of all animals. Like all other animals, aquatic animals also need a specialised veterinary care. The presence of veterinarians in the fast expanding aquaculture industry is crucial to make sure farmed individuals are treated with care; correctly and species-adjusted in the right environment.

Animal welfare has an overall impact, not only focused on welfare aspects, but also considering factors with possible incidence on animal diseases and food safety. Stress can lead to immunosuppression and all farmed species are susceptible to stress factors i.e. water quality and – flow rates, stocking density, handling, transport, predators, removal from water, environmental conditions and parasites.

The huge prevalence of salmon louse (*Lepeophtheirus salmonis*) is regarded as one of the major health and welfare problems in farming of Atlantic salmon. The lice adhere to the surface of the fish. Feeding off skin and mucus, lice can cause perforation and great damage to the tissue with danger of manifestation of bacterial infections. It is an increasing problem with salmon louse being resistant to one or more anti-lice-chemicals.

Cleaner fish (photo NVI Bergen)

The use of cleaner fish eating salmon lice off the skin of the farmed fish, has become more common during the last years. With cleaner fish and farmed fish together in the same cages, the cleaner fish can keep the prevalence of lice down. Cleaner fish are farmed or caught from wild populations.

As any other animal, cleaner fish should be kept species-specific and in the best way. So far, there is still lack of knowledge regarding both health- and welfare issues in these animals.

Measureable animal welfare indicators will support decision-making on the acceptable conditions for farmed animals and can be used to underpin monitoring and control programs, implemented at farm level, to guarantee standards of animal health and welfare, including help to control disease and food safety. The evaluation of the overall interaction between animal welfare, animal disease and food safety may support the development of control and monitoring plans at farm level through specific indicators. Veterinarians are, with their knowledge and competence, a vital link between these issues- ensuring human health through controlling food safety and food security.

Food safety hazards associated with aquaculture products vary greatly according to methods of production, farm management and location. Good aquaculture practices (GAP) can reduce spore prevalence in aquatic animals and some of the pre-harvest risk reduction measures implemented are removing bottom sludge, proper cleaning and disinfection of ponds, good hygienic condition of feed used in feeding, and the daily removal of weak, damaged or dead individuals.

Significant research has in particular involved identifying specific, measureable responses to poor welfare that can be used as practical and reliable operational welfare indicators (“OWI”) to assess the welfare of farmed aquatic animal populations. OWI’s will become more and more important in the future as aquaculture expands to meet the demands of a growing population. Welfare assessment should be based upon a thorough understanding of the biology of the species, and the related needs and requirements of a farmed species. The welfare indicators used, should hence be species-specific, validated, reliable, feasible and auditable. Examples of Operational-Welfare-Indicators are mortality, fin damage, deviation from expected feed consumption and levels of carbon dioxide and oxygen.

One of the best ways to prevent low welfare, disease and use of medicines in aquaculture, is continuously maintenance of good health and welfare among the stock. Use of medicines should never replace good hygiene, stockmanship or other management-related factors. Veterinarian knowledge and competence regarding these issues are key factors for success and every farm should have a written veterinary health plan including regular mandatory vet-visits.

The maintenance of good health and welfare and the food safety aspect in the aquaculture industry, should include continuous following up on plans covering control strategies, biosecurity, competent stockmanship and handling/transport/slaughter/killing, water quality and -flow, stocking density, feeding regimes, use of vaccines and focus on producing more robust aquatic animals thorough effective selection programs.

Written Veterinary Health and Welfare Plan

The value of a written health and welfare plan is increasingly recognized in aquatic animal farming. It is recommended that a written Veterinary Health and Welfare Plan is established and agreed between producer, stockpeople and a veterinarian familiar with the farm who can ensure that the plan addresses issues specific to the farm. The plan should cover, as a minimum, biosecurity, management, monitoring and control of disease and physical injury, strategies for dealing with major common diseases, contingency plans to deal with disasters, recording and classification of the causes of mortality, and training of personnel. In the plan, targets for specific conditions or management practices can be agreed and regularly reviewed in order to allow for continual improvement. Training areas for personnel at the sites should cover recognition of signs of poor welfare and disease, investigation of health and welfare problems, administration and recording of the use of animal medicines, vaccination, sea lice and other parasites, monitoring health, and management of procedures including handling, crowding, grading, culling and humane slaughter.

Every aquaculture-farm should have the opportunity to incorporate a veterinary-health-plan as a part of the management. While this is already a legal requirement in certain countries and for certain aquaculture production units (e.g. organic), FVE believes this should be extended to all aquaculture farms. A veterinary-health-plan can be adjusted to each farm and activity on the sites but should include regular mandatory vet-visits. Having the veterinarian regularly follow up the written plan including inspecting and monitoring the state of the individuals, mortality rates, management and important parameters and giving competent advice on-site, it is easier to adjust management and optimize the living conditions for the farmed individuals. Optimized living conditions might reduce risk of disease and prevent use of medicines. The following issues should be treated as possible high-risk-factors concerning optimized living conditions and should be assessed by the veterinarian at every mandatory visit or additional visits.

Water quality

Good and stable water quality is essential for health and welfare of farmed aquatic animals. Water is source of oxygen for respiration. Crucial factors that determines water quality and carrying capacity, includes the flow rate of incoming water, water exchange rate, temperature and ph. Water dilutes wastes and with sufficient water flow, even removes feces and uneaten feed. There is little doubt that poor or unstable water quality and lowered water circulation will lead to disturbance in aquatic animals due to acute or chronic stress. This will lead to increased aggression level and reduced ability to control homeostasis, resulting in reduced growth and resistance to disease.

Lack of fresh water in pond.

Stocking density-does it matter how many animals we put in a cage?

The optimal stocking density is species-specific and dependent on life stage. Generally very high and very low densities should be avoided. Farmed terrestrial animals, even birds, live in a 2- dimensional space. The stocking density can quite easily be estimated as number of animals (or birds) per square meter or weight (biomass) per square meter. Aquatic animals can occupy 3-dimensional spaces and any estimate of density, whether number of animals or biomass, has to be related to the volume, not area, and is therefore measured in cubic meters. Even this is not simple, since the animals may not be evenly distributed, especially in large areas or volumes. For example for bottom dwelling species (e.g. halibut) the area available for them to lie on is actually important, it is not sufficient to focus solely on cubic meters.

It has been argued that the stocking density must allow aquatic animals to show most normal behavior. If the stocking density is too high, there will be more physical contact with damage to skin and eyes, water quality is reduced and the struggle for feed increases. On the other hand, with low densities, in some species there is increased aggression and resultant stress

Feeding

Whether aquaculture moves towards more intensive models of carnivorous farming in finfish or more extensive environmentally balanced models such as the herbivorous model prominent in parts of Asia, the expertise and knowledge acquired by the veterinary profession in animal and human health issues relating to farming and domesticating wild animals, is a foundation for aquatic animal health and welfare. The challenge of insufficient fish oil and fish meal to feed the expansion of carnivorous fish farming may require additional government intervention to promote the farming of herbivorous fish and mollusks. Some companies are also researching adding insects to the feed. Insects are rich in proteins, and its amino acid make-up is similar to that of fish meal. Insects and insect larvae are important components of the diet of wild fish. Insect meal could make an important contribution to the sustainable development of the aquaculture industry.

Aquatic animals should be offered feed that is sufficient and optimal in nutrient content, quality and administrated adjusted to species. The feeding method used, must minimize competition and hence aggression, and ensure that all individuals have access to feed.

The diet is highly variable. Fish will lose appetite below a threshold which depends on the species. Some fish hibernate and consume very little for several months until the temperature of the water rises. For fish farmers, it is important to watch constantly the feeding requirements of the fish and adapt the feed accordingly. If too much feed is given, it will pollute the environment.

Systems failing to distribute feed to all the individuals tend to lead to increased aggression. Uneven feed acquisition can lead to growth variation and to size hierarchies and thereby reinforce dominance hierarchies. A key factor in avoiding competition is the amount of feed provided and there is still considerable debate to feeding strategies.

Handling and transport

Crowding, handling and grading are stressful and can cause injuries. Accordingly, these actions should be kept to a minimum. Fish should only be removed from water when absolutely necessary and for as short a period as possible (e.g. for Salmon this should ideally be less than 15 seconds, otherwise anesthesia is advised). Fish should not be kept crowded before slaughter for more than two hours.

In aquatic animal farming, the animals are often moved. Loading and transport can cause extensive stress. Poor conditions during transport, such as overcrowding and inadequate water quality, may result in irreparable damage and increased mortality. Transporting aquatic animals is also a significant risk for spreading disease. Because of this and the welfare issues involved, transportation must be kept to an absolute minimum. While transport of aquatic animals is included into the scope of the European Transport Regulation (EC/1/2005), the provisions in the Regulation does not cover the needs of aquatic animals. (EFSA 2004)

Stunning and killing

A semi-quantitative risk assessment (EFSA, 2009) was used to rank the risk of poor welfare associated with the different commercially applied stunning and killing methods for: Atlantic salmon, sea bass, sea bream, trout and eel. With specific reference to Atlantic salmon, pre-slaughter stages which have a direct impact on the welfare immediately before and during killing were included. Five stunning and killing methods were assessed with the conclusion that percussive methods and electrical stunning were assessed to reliably cause unconsciousness in the vast majority of salmon. Exsanguination should be carried out immediately after stunning, and in every case before recovery from stunning occurs.

Effective selection programs

Selective breeding is widely used in aquaculture to produce more robust fish that grow more rapidly as well as to attain improved feed conversion rates, greater resistance to disease and delayed sexual maturation. Genetic engineering must be done in an ethical manner, avoiding suffering and situations unacceptable from a welfare point of view.

Competent stockmanship

Competent stockmanship on the farms can prevent injuries and ensure early detection and reporting of disease. The staff on the farms should have the right competence to observe and judge changes in behavior, including swimming behavior, moribund fish, changes in appetite- and changes in water quality. Veterinarians with their competence and knowledge have a significantly important role in contributing to make this possible. Veterinarians insofar as their own competence should be involved in the preparation of manuals on Good Farm Hygiene and Management Practices.

Biosecurity

Biosecurity can be defined as the implementation of measures that reduce the risk of introduction and spread of disease agents. Biosecurity should be used in order to avoid entry of infectious diseases into the farm or in order to prevent spread of pathogens within and from the farm. In terrestrial animals important elements of biosecurity are avoiding animal mixing, cleaning and disinfection. This is difficult in the aquatic environment, and the effective regulated use of biocides and disinfectants has an important role.

Vaccination

Vaccination reduces the risks of disease outbreak in the population and for spread of disease within the farm, to other farms and to wild fish. The incidence of several of the diseases that until recently were a major problem in aquaculture, has been substantially reduced through the development of effective vaccination and improved management. Some diseases however, continue to present serious problems. Even if vaccination has played a key role in reducing the incidence of certain diseases, it can also have adverse side-effects such as peritonitis in the case of i/p injection vaccination causing adhesions between organs in the abdominal cavity. The vaccination procedure per se can also be stressful to the fish as it involves handling and injection, if the fish are not anaesthetised. Goals for future development are the development of oral vaccines, vaccines with effective adjuvants with minimal side-effects and the adoption of high-quality standards to use when vaccinating.

SUSTAINABILITY- A MUST IN THE LONG RUN

71% of our planet is covered with water, and our oceans, lakes and rivers represent one of the least understood ecosystems. In contrast to agricultural farming practices, which are usually conducted on private land, aquatic farming activities are not seldom conducted in public water bodies (rivers, lakes, coastal area) and so must be conducted responsibly. One of the great global challenges in the future will be to produce large amounts of food in environmentally sustainable ways. Aquaculture needs to be a part of the solution and not part of the problem!

Aquaculture has one big advantage over the rearing of terrestrial animals: you have to feed them a lot less. Fish are more feed-efficient due to being poikilothermic and not having to deal with so much gravity. It takes roughly a kg of feed to produce a kg of farmed fish; it takes almost two kg of feed to produce a kg of chicken, about three for a kg of pork, and about seven for a kg of beef. As a source of animal protein that can meet the needs of nine billion people with the least demand on Earth's resources, aquaculture—particularly for omnivores like tilapia, carp, and catfish—is worth investing in.

In 2013, the European Commission, together with Member States governments and the European Parliament, agreed on the new Common Fisheries Policy to boost the European fisheries and aquaculture sectors and make them more environmentally, economically and socially sustainable.

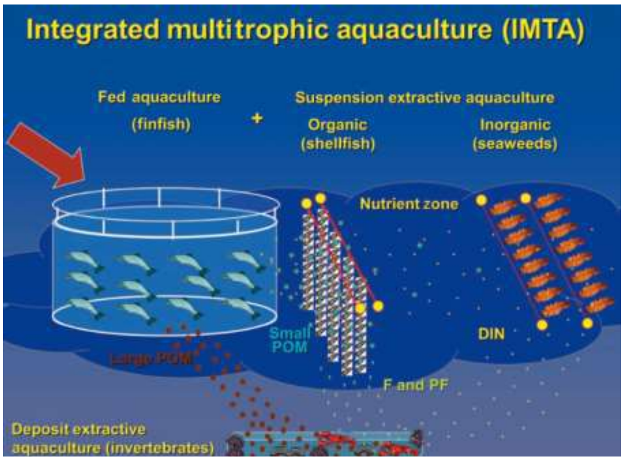
European Commission Campaign Sustainable Fish

When taking fish from our seas, we need to make sure enough are left in the water, to maintain our ecosystems health and to be able to keep on fishing in the future. Sustainable aquaculture provides opportunities to reduce the dependence on wild stocks, to meet increased consumer demand and maintain or create new jobs and businesses.

There are different definitions of sustainability. The FAO definition of sustainable agricultural development is as follows: “The management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable".

Consumers become increasingly more interested in the ethical quality of products. Information about ethical production can have a positive effect on how consumers perceive or accept farmed fish. There is a great possibility that investments in better equipment in the aquaculture industry could lead to better feed utilization, increased growth and lower mortality rates. Documentation of good health and welfare in the farmed individuals can be crucial for consumers who are willing to pay more for a more ethical product.

According to the FAO (2013) there are some main challenges regarding the development of the future aquaculture: Aquaculture feed sector needs to reduce its independence upon the use of potentially food grade marine fishery resources such as small pelagics, fishmeal and fish oil. Aquaculture activities must not adversely affect the livelihood of the poor and should produce affordable foods.



Source : Diana et al. 2013 – BioScience 63(4)

Trends in modern aquaculture to reach sustainability is increased development and use of integrated multitrophic systems (IMTA) and recirculating aquaculture systems (RAS) so as to maximize nutrient utilization, water use and minimize environmental impact. IMTA include organisms from different trophic levels of an ecosystem (e.g. fish, shellfish, algae) so that the byproducts of one become the inputs of another.

RAS are landbased systems in which water is re-used after mechanical, chemical and biological treatment. Compared to other systems, these represent advantages like water saving, control of water quality, high biosecurity levels and easier control of waste production. The disadvantages of this system are high operational costs including high energy consumptions.

On the other hand extensive traditional aquaculture in wetlands and coastal lagoons, represents a social, cultural and economic heritage, which is profoundly linked to biodiversity ecosystem preservation but also fish health and welfare good status.

AQUACULTURE; GOOD FOR RURAL AREAS?

Over 56% of the populations in the EU Member States are living in rural areas. Average income per head is lower in rural regions than in towns and cities, the skill base is narrower and the service sector less developed. Many of the rural areas are facing significant challenges. Looking at the aquaculture development trends in Europe, aquaculture has a positive role in rural development, both in coastal and inland situations. Although the main element of aquaculture will remain food production, the importance of various services to be provided in recreation, rural tourism, nature conservation and water management will increase in the future, and this will provide employment and business opportunities for the rural populations. According to the FAO, the contribution of marine aquaculture has led to employment and reduced rural migration. It has been noted in a number of countries, especially in rural areas with few alternative economic activities, that aquaculture related activities have been able to provide stable, long-term jobs.

VETERINARY INVOLVEMENT IN AQUACULTURE

PARTICIPANTS IN THE AQUACULTURE SECTOR

1. Aquaculture production businesses (APB) account for the majority of economic activity in the sector. Other participants include those in the ornamental fish trade and those involved in angling activities for leisure and tourism.

2. In some countries, fishermen have moved into aquaculture such as on bluefin tuna, seeing aquaculture as a more productive and predictable alternative to the traditional fishing industry.

3. APB's interact and do business with government ,private (for profit) veterinarians, and a range of stockholders, including scientists, biologists, environmentalists, planners, vaccination teams, transporters, well boat operators, nutritionists, geneticists, paraprofessionals, academic researchers, drug companies and aquatic animal health

inspectors. The objectives of these different service providers vary; from government regulation and promotion to adding value in the search for profits through increased efficiencies and increased demand for the product.

4. The choice for Government is how much resource to allocate to aquaculture or whether to leave the development of the sector to the vagaries of the market state. The drive to secure coastal rural employment as a means of ensuring the sustainability of local communities is of political importance.

COMPETENT AUTHORITY

The Competent authority for aquaculture and aquatic products should preferably be within the public Veterinary Services. If not, close coordination should be set between the Competent Authority and the public Veterinary Services. Whatever the organisation is, the Competent Authority should be staffed with relevant veterinary competencies.

The Competent Authority is notably in charge of managing passive and active surveillance of international and national notifiable diseases; of building and carrying out official policy in animal health, veterinary medicines and veterinary public health and other relevant duties.

VETERINARIANS ARE CRITICAL FOR SUCCESSFUL AQUACULTURE

5. Presently veterinarians service the aquaculture sector in several ways:

a. **As private veterinarian/practitioner** – a increasing number of specialist veterinarians make their living through the provision of services and products to commercial ABP's. The veterinarians provide diagnostic services as well as investigating disease outbreaks or mortality. Private veterinarians also provide specialist clinical services to ornamental fish owners.

b. **Veterinarians in industry** - may be employed directly by larger aquaculture companies, pharmaceutical companies (in vaccine and/or medicine development, manufacturing or licensing) or by feed companies to assist in fish feed formulation, manufacture and post-selling assistance. Some are also employed in breeding companies as geneticists in selecting disease resistant strains.

c. **Veterinarians in audit and retail:** some veterinarians provide audit expertise and carry out supplier audit programs on behalf of multinational and national retailers.

d. **Veterinarians in Non-Governmental Organisations (NGO's)**: Some are employed in farmers associations, consultancy groups to carry out bio-security schemes, to inform and train farmers and other aquaculture operators on aquatic animal health, welfare and food safety related issues. These activities can be performed in collaboration with 'official veterinarians'.

e. **Official Veterinarians -** Veterinarians employed in government departments, national reference laboratory and other government agencies ensure that national and European legislation are complied with. In some EC countries veterinary inspectors carry out the regime of inspections and approvals under Directive 2006/88/EC. Official veterinarians also work in designated border inspection posts to ensure compliance with the requirements of Chapter IV of Regulation (EC) 1251/2008. Veterinarians are part of the Food and Veterinary Office audit teams carrying out internal audits on member countries and third country audits.

f. Veterinarians in research - they are employed in academia or private research; the focus may be aquaculture disease, nutrition, epidemiology, rearing units and behaviour but also public health aspects. Aquatic animals are increasingly used as a research model for human diseases.

Future Opportunities

In occur to expand the aquaculture industry, to make it more profitable and more sustainable, the role of veterinarians in fish and shellfish health, welfare and food safety should be promoted at Community Level. More veterinary involvement will be needed into the operation of the farms, not only related to clinical activities, diagnostic and therapeutic interventions but with a 360 degrees counseling activity. This will include support for effective management of the farm following the developed Veterinary Health and Welfare Plan, operative implementation of legislation and into the application of quality and environmental certification schemes.

1. Post-mortem inspection of fish at slaughter, carcass processing and filleting is an opportunity to **capture data regarding disease, parasite infestation, fin damage and welfare**. Date capture of a representative number of fish at time of slaughter can be used to assist production efficiencies, genetic breeding programs, welfare objectives and husbandry techniques. It is suggested that there is a statutory component to this inspection.
2. **Para-professionals should be regulated** under the existing National Veterinary Licensing Framework to ensure they are sufficiently educated, meet minimum standards and are accountable to protect the welfare of the animals they take care of.
3. In the field of prescription and supply of Veterinary Medicines, responsible use of antimicrobial drugs should be encouraged and increasing awareness raised of the effects of antimicrobial resistance.
4. **Ornamental fish breeders and retailers should be licensed** to build compliance and commitment in responsible pet trade and ownership. A networked model to encourage owners to avail of specialist veterinary advice for exotic ornamental aquatic pets and for veterinarians to submit samples to National Reference Laboratory to assist in scanning surveillance for aquatic diseases. Licensing to be under control of Local Government Veterinary Service.
5. **Movements of half-grown shellfish for relaying should be inspected and sampled pre- and post-movement** to ensure that the optimal conditions exist for a successful relay, to prevent disease introduction and for disease surveillance. In light of the increasing disease outbreaks in the Pacific oyster industry in France and other countries, this calls for greater veterinary investigation into *Oyster Herpes Virus* and *Vibrio Aesturianus*.
6. **Knowledge transfer networks** involving practical instructions on aquaculture husbandry/ nutrition/ bio-security involving veterinarians with expertise and post-graduate experience focusing on marine animal welfare and added value from reducing mortalities and health programs tailored towards specific requirements of a local coastal management plan.
7. **Restocking** plans for inland waters and seas: fundamental veterinary issues (health, welfare, and epidemiology) are related with this important activity aimed to the preservation of fish biodiversity.

Methods of promotion of veterinary involvement in aquaculture:

- Ensure good communication and collaboration between the industry, the government and veterinary faculties;

- Career days at universities to show career path of aquatic vets to introduce veterinary students to aquaculture. Create information leaflets using career profiles of existing veterinarians working in aquaculture;
- Identify funding of post-graduate fellowships and research in aquatic animals;
- Exploit the opportunities provided by Horizon 2020 to create projects that can focus and/or help to resolve the critical issues facing veterinary intervention in aquaculture including farmed aquatic animal welfare, sustainable feeding practices, availability and targeted use of veterinary medicinal products.
- Ensure veterinary involvement in the "restocking plans" (rivers, lake or seas)

Conclusion

The involvement of veterinarians in the aquaculture sector is desirable, logical and necessary. The veterinary profession, through its network of university teaching, academic research, industry involvement and legislative and regulatory inputs is a key factor in the investigation of diseases, epidemiological analysis, nutrition and feeding and welfare of aquatic animals. Veterinarians are a vital link in ensuring human health through controlling food safety and food security.

Veterinarians should lead the public policies related to the aquaculture sector (Competent Authority).

The professional regulation of the veterinarians ensures that the veterinarian is licensed by the legal authority to carry out his tasks, something that shall be done in an independent, ethical and personally responsible capacity. The veterinarian is accountable to the licensing authority. This position should be recognized in the legislation, especially where the competent authority delegates tasks to the veterinarian or to other professionals.

Veterinarians should be involved in the recovery plans of rivers, control of wild, environmental protection the preservation of an important zoological heritage with high levels of biodiversity.

MEDICINES

1. Fish need medicines too! While biosecurity has generally improved, disease and parasites are still major problems and are the greatest health and welfare problems.

2. The different classes of aquatic veterinary medicinal products (A-VMP) existing are antimicrobials (antibacterial, antifungal and antiparasitics), anaesthetics, hormones, immune-stimulants and vaccines. Due to the authorization and licensing methods in Europe, many A-VMPs are limited to a certain country.

Vaccination of fish (©Asgeir Østvik)

3. The availability of veterinary medicinal products for treating farmed aquatic animals is extremely limited, constraining prevention and treatment of disease. While some products may exist for the major species (salmon and trout) almost none exist for minor species such as eel, tuna and shellfish. For example, the UK has 6 products licensed for treating parasites in Salmon, but only one trout. Other major disease threats such as fungal infections are limited to a single licensed product in only some EU countries. Some countries such as Belgium have no medicines at all licensed for aquatic animals while they have substantial amount of fish and shellfish farms. (FEAP, FVE overview 2014)

4. Further restrictions on the use of veterinary medicines are imposed through authorisation from environmental authorities for the use and discharge of pharmaceutical ingredients. In some cases such restrictions impose conditions which run counter to good prescribing practice, for example by making it impossible to treat simultaneously, or within a reasonable time period, all animals in one biological unit.

5. If no authorized A-VMP exists to treat a condition, a veterinarian may in particular to avoid causing unacceptable suffering, treat the animal in accordance with the principle of the 'Cascade'. The Cascade is a European legislative provision that allows a veterinarian to prescribe unauthorised medicines that would not otherwise be permitted, namely either a VMP licensed for another species or condition, or a human medicines or VMP authorized abroad or a product made extemporaneously. When no specific withdrawal period is defined, a withdrawal period of 500 degree days for meat of fish has to be respected. Veterinarians routinely have to resort to the 'Cascade' to cure aquatic animals, given the extremely limited availability of A-VMPs especially for minor species (all fish species except Salmon and Trout), minor conditions or minor markets (countries with only a limited aquaculture). While the 'Cascade' is defined in European Legislation (Directive/2001/82/EC), member states can implement it differently. In practice, some countries have implemented the 'cascade' much stricter than others; leading to additional hurdles such as when importing products.

6. Lack of A-VMPs exist for all minor species but in particular there is:

    a. a need for more vaccines to prevent diseases
    b. a need for A-VMPs to treat fungal and parasitic conditions of farmed aquatic animals (*Argulus sp*., *ichthyophthiriosis* « white spot », *Saprolegnia sp*., proliferative kidney disease, monogeneans infections, Uronema sp., etc...) ;
    c. a need for further authorisaiton for anaesthetics for different uses, such as sedation and anesthesia for manipulation during transport, during i/p immunization, during stripping and milking of breeding.

    There are also problems with drug resistance for several conditions which further reduce the availability of efficient a-VMPs in aquaculture (sea-lice, furunculosis or yersiniosis).

7. The lack of authorized veterinary medicines or the difficulty to get them, leads to the sector searching for other solutions and other products. The result is that there is significant use of products with biocide activity. Some of those substances are very beneficial but very inconsistently regulated in different EU Member States and without proper knowledge risk-benefit. These substances would benefit from simpler legislation facilitating a more consistent approach.

8. The animal health industry needs a return on investment. Aquaculture is seen as a limited market with stringent regulatory procedures. This is especially true for minor indication or minor species, the animal health industry is reluctant due to the high costs of research and development to bring a licensed product to market. Therefore, non-traditional ways of development of A-VMPs will have to be found e.g. via orphan funds or similar initiatives as the US MUMS Coalition and AADAP (Aquatic Animal Drug Approval Partnership).

9. Medicines are mostly administered at the level of the group level, rather than to the individual, typically via the feed (mixing on feed mill level or at farm level). Oral medication, including medicated feed, should only be administered on the basis of a veterinary prescription and with respect to the withdrawal period. A veterinary prescription can only be made after the animals have been examined by a veterinarian and after a clinical diagnosis including diagnostic testing has been made. Mixing medicated feed on farm level for the treatment of animals in the aquaculture industry, is in principle less recommendable than mixing at the feed mill level. The application of both correct substances and dosage is of significant importance. Mixing on farm level is often connected to a greater risk of non-homogeneous and suboptimal distribution of pharmaceutical substances in the feed. This represents a potential of too high dosage in some individuals and too low in others and might lead to negative side-effects regarding health- and welfare issues. The bottleneck with mixing on feed mill level is that this service is not easily available in all countries. There often is a need for smaller quantities of medicated feed; the feed mills don’t produce/deliver medicated feed unless the order exceeds a certain amount of kilograms. As long as there is an absence of guaranteed supply of medicated feed by feed producers, continuing the practice of farm premix licenses will be the only alternative.

10. Another method to treat fish is via water “bathing”. This approach can be used for vaccination, although individual injection is common in salmon and trout.

11. In-feed therapeutic medication may create a number of issues, such as: sick animals may not ingest sufficient medication and normal animals are medicated, despite not needing treatment for clinical signs. This may increase size variability in the population, which may contribute to other welfare issues, such as competition. Also, at low temperatures, feeding ratios are very low which may lead to an inadequate concentration of active substance. However, the population medication approach does have the benefit of reducing the level of infectious organisms in the environment, and thus reducing the risk of a wider disease

outbreak.

12. Furthermore, the effective therapeutic use of medicines and other substances may be prevented or restricted because of environmental/pollution concerns, potentially creating short term welfare issues and longer term efficacy issues. Formalin is one treatment that may be in this category, but is currently still available under the Cascade.

13. The working group believes it is essential but also possible to improve availability of A-VMPs. They recommends the following steps:

    a. The aquaculture industry, animal health industry, regulatory authorities and veterinary profession should join forces and develop together an action plan with concrete steps and a joint mission to improve availability especially to address the most urgent gaps.
    b. A-VMPs available in European member states should be usable for veterinarians all over the EU; in other words, a true single market of VMPs is needed.
    c. A truly functional import procedure of A-VMPs from EFTA and certain third countries (e.g. US and Canada) should exist.
    d. MRLs from A-VMPs should be extended, as much as possible, to other fish species and MRLs from other food producing animals extrapolated to fish. Regulatory procedures should be as light as is possible without compromising safety.
    e. Promote research on withdrawal period and specially into the 500 degrees days, which can lead to extremely long withdrawal periods in cold weather and reduces the availability of some treatments for aquatic animals when required too closely to their harvest.
    f. Risk based reduced requirements for environmental risk assessment should be promoted assuring a balanced Return of Investment
    g. Aquaculture industry, animal health industry, research institutes, regulatory authorities and veterinary profession should join forces to prioritise the disease conditions which require medicines and vaccines and to promote the research the data requirements, the development and bringing onto the market of urgently needed products.
    h. Opportunities should be found to research and fund the above mentioned steps

14. Antimicrobial resistance and (shell)fish.

a. Since bacterial pathogens of (shell)fish only grow at the temperature of their surrounding aquatic environment, very few of the bacterial pathogens of farmed (shell)fish in a temperate climate are capable of infecting humans, so the risk of human disease being caused by antibiotic resistant fish pathogens is very low.
b. Responsible use guidelines for antibiotics in aquaculture exist in some countries, such as the RUMA guidelines in the UK called 'Responsible use of antimicrobials in fish production (2004, revision 2007)'
c. A leaflet on the responsible use of antibiotics is currently being developed by FVE, FEAP and Copa-Cogeca (include link to leaflet when ready).

15. Use of medicinal products in aquaculture and the environment. There are many differences between aquatic and terrestrial management systems, such as the methods used for administration of medicines and environment in which the medicines are released. Unique problems are related to the application of drugs in aquatic environments.

EDUCATION

1. The veterinary profession is unique in two ways: it is one of the only 7 professions which degrees are automatically recognized across the EU, and it has a well-established trans-European accreditation system of the quality of the teaching at the undergraduate level (run by EAEVE and FVE), at middle-tier level by VetCee (run by EAEVE, EBVS and FVE) and on specialist level (by EBVS).

2. The accreditation of veterinary education in Europe focuses on the acquisition of adequate competences, particularly in relation to knowledge and skills. The minimum requirements are, in large measure, based on the subjects listed at the European Directive 2013/55/EC on the recognition of professional qualifications. The training of veterinary surgeons shall comprise a total of at least five years of full-time theoretical and practical study, covering at least the study programme referred to in point 5.4.1 of Annex V. The European Commission can change this study programme with a view to adapting it to scientific and technical progress. The study programme mentions all the basic subjects a veterinary study program should include such as animal biology, epidemiology, pathology, virology, reproduction, etc; it does not specifically mention species.

3. A survey in 2013 done by FVE and EAEVE in regard to teaching of aquatic medicines in undergraduate veterinary education revealed that Aquatic Animal Medicine (AAM) is taught in almost all European veterinary faculties. It is part of the curriculum at 57 establishments out of the 62 which answered the survey. As part of other courses, AAM is covered within Infectious and Parasitic Diseases, Anatomy, Pathology, Food Hygiene and Animal Production. AAM teaching is obligatory at 83.6% of the establishments in an average 26.5 hours, while is elective at 16.4% in 101.5 mean hours. Post-graduate courses or specific CPD programmes on AAM are organised by a third of the establishments only, and are predominantly offered in the framework of Master's or PhD programme in Aquaculture, Marine Biology and Marine Resources.

4. With the rise of aquaculture from 1950 onwards, aquatic medicine increased significance in veterinary training. In the ’80-ies some non-veterinary faculties such the University of Stirling, natural science department also started specific courses and research in aquaculture. A number of European veterinary faculties, especially in countries with a significant amount of aquaculture, started to specialize in aquatic medicine, such as the veterinary faculty of Oslo, Norway and Las Palmas, Spain.

5. In April 2014, the European College of Aquatic Animal Health (ECCAH) was provisionally accepted by the European Board of Veterinary Specialisation (EBVS). This College will in the future, provide a source of aquaculture teachers and researchers.

6. The World Aquatic Veterinary Medical Association (WAVMA) has developed a Certified Aquatic Veterinarian (CertAqV) Credentialing Program to recognize Day-1 competency. The Program requires knowledge, skills and experience that can be obtained in veterinary or non-veterinary academic courses, or through CEPD, clinical experience or self-study, in 9 core areas specifically focused on aquatic veterinary subject matter, such as life support and environmental systems, taxonomy, anatomy and physiology, husbandry and industries, pathobiology and epidemiology, disease diagnostics & treatment, public health, zoonotics & seafood safety, legislation, regulations & policies, client Relations and animal Welfare and well-being.
To remain certified veterinarians are required to have at least 10 hours of CEPD each year. Additional information on the CertAqV Program is available at www.wavma.org/CertAqV-Pgm.

7. The working group recommends the following minimum requirements of a veterinary education in relation to aquaculture teaching:

✓ **During undergraduate veterinary training all students should attend minimum an obligatory <u>30 hours course</u> on diseases of aquatic animals. Some faculties should also offer a <u>‘Post-graduate Aquatic medicines”</u>, which includes 6-8 elective courses**

connected to husbandry (nutrition, genetics, aquaculture, food hygiene, etc.) during a two year period.

Veterinary students must get a basic knowledge in aquaculture as part of the basic undergraduate curriculum. If they want more knowledge in aquatic medicines, they should be able to take a post-graduate course, consisting of 6-8 courses to achieve a degree in aquatic animal diseases.
These post-graduate courses can also be made available to undergraduate students as electives.

The accreditation of a European veterinary faculty by the EAEVE/FVE accreditation system should be connected to obligatory teaching of basic aquaculture subjects, such as pathology and food hygiene.

- ✓ **Examinations, diagnosis and treatment of aquatic animals should be performed only by <u>veterinarians licensed by the statutory body</u> of the native country.**

A veterinarian is a professional with a comprehensive scientific education, licensed by the legal authority, to carry out, in an independent, ethical and personally responsible capacity, all aspects of veterinary medicine, in the interest of the health and welfare of animals, the interest of the client and of the society. The veterinarian is supervised by and accountable to the licensing body or authority. Liability insurance is obligatory. Improper professional behaviour and misconduct can lead to a penalty or even withdrawal of the license.

Paraprofessionals are also active in aquatic field. However, their education criteria are unclear and not harmonised, some lack basic knowledge in diagnosing, treating aquatic animals, they do not have any licence connected to diseases and they cannot be called to be accountable, neither have they necessary a liability insurance if something goes wrong.

Therefore, FVE is strongly of the opinion that all examinations, diagnosis, treatment and animal health certifications of aquatic animals should be done ONLY by licensed veterinarians. Paraprofessionals should only be able to do specific tasks and always work under the supervision of a licensed veterinarian.

- ✓ **Aquatic Veterinarians should maintain and develop their knowledge and skills throughout their career by following continuous professional development (CPD) minimum once a year**

To get new and further knowledge in treatments, diagnostic methods, disease updates etc. it is vital to organise and take part in an annual conference or CPD course dealing with aquatic medicine. CPD can be acquired both by attending conferences, workshops, seminar or webinars, but also through reading of veterinary (aquatic) journals or publications or through participating in online aquatic medicine fora.

- ✓ **The Competent Authority should provide the personnel (and namely the veterinarians) working in the public sector in the domain of aquatic animal health/**

hygiene with the relevant extra-courses (AH, AW, epidemiology, environment protection, laws, etc.).

Fish consumption is growing in European countries in order to „be healthy eat fish”. There are special rules for handling, trading, transporting and processing fish as food, which are not similar to other kinds of meat. Nowadays laws are continuously changing all the time, so it is vital for a food hygiene specialist to be up to date in the latest law.

Annex II: Curriculum Budapest

TRADE AND MOVEMENT OF ORNAMENTAL FISH

"Care must be taken not to introduce exotic disease together
with the introduction of often exotic species"

1. The keeping of ornamental fish is a hobby that has become more popular in industrialized countries. The estimated number of aquaria containing ornamental fish in the EU is 8,272,000 and in all of Europe there are an estimated 9,221,000 aquaria. The largest numbers of aquaria are in France, Germany and Italy.

2. The trade in ornamental aquarium species comprises two sectors, marine and freshwater. They are mostly purchased by hobbyists and the majority (at least 90%) of the trade in ornamental species comprises freshwater species. The main source of imported ornamental fish into the EU is Asia, Africa and America. Asia is the most important region exporting fresh water and marine aquatics to the European Union. Popular freshwater species include barbs, danios and related carp-like fishes (Cyprinodontiformes), and cichlids. The Cyprinidae Family is an important family of freshwater. *Carassius auratus* (Gold fish) is the most widely cultivated ornamental fish in the world.

3. Most marine ornamental fish are harvested from the wild, and only 1-10% of species in trade are estimated to be captive bred. By contrast, approximately 90% of freshwater ornamental fish are captive bred with farms in countries such as Singapore, Malaysia, Japan, Israel and the US.

4. The trade in freshwater ornamental fish can negatively affect wild populations and may also lead to disease risks. Ornamental fishery resources face a range of challenges: the need for their conservation and sustainable use; the need to ensure that benefits are equitably

shared; problems caused by habitat loss and degradation, harmful, fishing practices (over-fishing and destructive fishing, such as the use of cyanide).

Zoonotic Risks

Bacterial Diseases Agent:

5. There have been a number of reports of human pathogens isolated from aquarium fish and their water and human bacterial infections associated with aquarium keeping.
    a. *Aeromonas hydrophila*, *Aeromonas caviae*, *Aeromonas sobria*, and *Aeromonas schubertii* have all been implicated in human disease and are found in association with aquatic finfish. Human infections with *Aeromonas spp* often develop in immunocompromised persons for whom the bacteremia can prove life threatening. In healthy individuals, the most common signs of an *Aeromonas spp* infection include localized wound swelling and gastroenteritis.
    b. *Vibrio vulnificus* infection is the most common fish-derived Vibrio infection, and the major route of exposure has been reported to be through puncture wounds and ingestion.
    c. *Mycobacterium spp* affect people who handle or work with fish, and the resultant infections have been called fish handlers' disease or fish tank granuloma. In affected humans, lesions typically develop on the extremities and are either ulcerative or raised granulomatous nodules.

Infection with Mycobacterium spp

    d. *Streptococcus iniae* is another bacterium of concern because of the serious clinical signs that develop in infected humans.
    e. *Erysipelothrix rhusiopathiae* are typically obtained during contact or handling of animal tissues; an existing wound or injury sustained during animal handling is the point of entry.
    f. *Edwardsiella*, *Escherichia*, *Salmonella* and *Klebsiella spp*. also have zoonotic potential.

Viral diseases

6. A total of 22 viruses that have ability to cross the species barrier from ornamental fish to food producing fish were identified by literature search (see Callisto report II).

7. For ornamental fish the regulation addresses Koi herpes virus (KHV) disease, and furthermore five countries within the EU have a national program on Spring viraemia of carp (SVC) , which is not EU listed. Of course there are other diseases of relevance for the ornamental aquaculture industry, but not meeting the set criteria. One country and some farms or compartments within countries have decided on a program with respect to KHV. Often the farms with a free status do not have any susceptible species, but want to have the status in case they want to start producing carp. Countries have usually refrained from a programme, as the cost of the programme is much higher than the value of the carp production industry (aquaculture and koi import). Especially when the animals concerned are mostly kept as pets, the economic value is considered low.

Antimicrobial Resistance (AMR)

8. *Aeromonas sp*., *Pseudomonas sp*., *Staphylococcus sp*., *Acinetobacter sp*.,*Flexibacter sp*.,*Alcaligenes sp*., *Shewanella putrefaciens* and many *Mycobacteria sp*. are seen in diseased imported ornamental fish. These bacterial isolates also possess zoonotic potential. Antibiotic resistance was identified in many bacteria cultured from imported ornamental fish (Dobiasova et al. 2014). This is also important for human health.

Movement and Trade of Ornamental Fish

9. An animal health certificate should be at each movement (Council Decision 1251/2008) and all ornamental fish imported/exported must be healthy and free from any clinical signs of disease. For ornamental aquatic animals health regulations are established in the Council Directive 2006/88/EC. This legislation provides rules for import and intra-community trade with respect to aquatic animal diseases aimed at control and prevention measures and requirements for placement on the market.

10. Ornamental fish trade is important to trans-boundary transfer of diseases via this trade. The most widely traded ornamental fish are goldfish (*Carassius auratus*) and koi carp (*Cyprinus carpio koi*).These species are susceptible to spring viraemia of carp (SVC) and koi herpes

virus disease and as a vector of some pathogens (EHN,EUS,IHN,VHS) which diseases are in the World Organisation for Animal Health (OIE) notifiable list. The OIE and EU lists of susceptible species do not list any species kept in hobby aquaria. Given the disease risk, the group feels ornamental fish should be considered.

OIE notifiable list of fish diseases are:	**Council Directive 2006/88/EC:**
• Epizootic haematopoietic necrosis • Infection with Aphanomyces invadans (epizootic ulcerative syndrome). • Infection with Gyrodactylus salaris • Infection with HPR-deleted or HPR0 infectious salmon anaemia virus • Infection with salmonid alphavirus • Infectious haematopoietic necrosis • Koi herpesvirus disease • Red sea bream iridoviral disease • Spring viraemia of carp • Viral haemorrhagic septicaemia	Fish Exotic Diseases • Epizootic haematopoietic necrosis Non Exotic Diseases • Viral haemorrhagic septicaemia • Infectious haematopoietic necrosis • Koi herpesvirus disease • Infectious salmon anemia

Acknowledgments

FVE invited all individuals and organisations, who wished so, to peer review this report in the period of 1 August to 15 September 2014. FVE is very grateful for the many constructive input it received from all experts from organisations such as the FVE member organisations, FEAP, UK Fish Veterinary Society, Stirling University, RSPCA, European Institutions, WAVMA and all fish veterinarians who contributed to this report.

Main references:

We only list the main references here. Many more were used to prepare this report.

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Annex I: FVE working group on aquaculture members:

- ✓ Kari NORHEIM, Chair (Norway)
- ✓ James CASEY (Ireland)
- ✓ Andrea FABRIS (Italy)
- ✓ Baska FERENC (Hungary)
- ✓ Armand LAUTRAITE (France)
- ✓ Buket OZKAN, Turkey
- ✓ Alain SCHONBRODT, Belgium
- ✓ Nancy DE BRIYNE, Deputy Executive Director, FVE (Secretariat)

Annex II CURRICULUM - AQUACULTURE

TOPIC:	**Aquaculture**
Faculty:	**Veterinary**
Semester:	**10.**
Lectures	**18 (3 x 6 hours = 2 x 6 on the Campus, 6 hours in an intensive fish farm**
Credit:	**2**
demands:	**Fish hygiene**

	Pathology Department
Teachter(s) (e-mail):	**Ferenc Baska (Baska.Ferenc@aotk.szie.hu)**
Aim of the course:	**In 18 lectures to prepeare the „collegues" for the practical work with farmed fishes in thier native countries. (Norway – salmon, Israel – barramundi, tilapia etc.)**

Lectures

Hours	
1 - 6	Warm water recirculation systems Disinfection in Aquaculture Water quality parameters
7- 12	Use of veterinary medicines Hygiene of the propagation Disease control at EC Level Fish Health laboratories in Europe and Israel
13-18	Submission of samples to a laboratory Specific diseases of salmonid fishes Specific diseases of sturgeon, eel, percid and catfishes.

References

Obligatory:	**Lectures in ppt form provided**
Suggested:	Roberts (2000): Fish pathology Kabata (1990) Tropical fish diseases Stosskopf (1990) Fish Medicine

Exam:

Written

CURRICULUM OF SUBJECT

Subject:	**Fish diseases**
Specialization:	**Veterinary medicine**
Term of the subject:	**8th**
Number of lectures/semester practicals/semester	**30 -**
Credit:	**2**
Prerequisites:	**Zoology, Pathophysiology**

Name of Department:	**Department of Pathology**
Responsible teacher (email):	**BASKA, Ferenc (Baska.Ferenc@aotk.szie.hu)**
Teacher(s) take part in teaching:	**Baska, Ferenc**
Aim of subject:	The aim of the training course on fish pathology is to introduce the students into the modern knowledges both in the infective fish diseases and environmentally and farming technologically influenced health condition of fishes. After a brief introduction into the anatomy and physiology of farmed fishes (mostly carp fishes and salmonids) detailed informations on infective (viral, bacterial, fungal, parasitological) and non-infective diseases and intoxications are going to provided.

Weekly schedule of lectures	
Week	
1.	The structure of the fish. The integument. Taxonomic features.
2.	The motion. The digestive system. Digestion.
3.	Gills and respiration. Blood and vascular system.
4.	Urinary system, excretion. Gonads and reproduction. Endocrin system. Nervous system. Sensory organs.
5.	Water environment and it's characteristics. The food-chain. Fish pond and fish farm. Technical characteristics and function of the fishing establishment.
6.	Fish culture technology and it's effect on fish. Spawning, rearing, harvesting, wintering, transporting.
7.	On the spot examination of fish and pond. Requirements towards specimens for laboratory examination.

8.	Diseases caused by viruses. KHV, SVC, VHS, IPN…
9.	Bacterial diseases. Erythrodermatitis, vibriosis…
10.	Diseases caused by algae and moulds. Gill necrosis, saprolegniasis, toxicosis caused by algae.
11.	Importance of parasitic infection. Diseases caused by protozoan parasites. White spot disease.
12.	Diseases caused by sporozoan parasites. Coccidiosis, Swimbaldder-inflammation.
13.	Diseases caused by metazoan parasites. Gill worms, helmints, blood-sucker parasites.
14.	Diseases caused by environmental factors. Loss of oxygen, feeding disorders. Treatment and medication in the fish farming praxis.
15.	Toxicosis of fish. Heavy metal, insecticide and other toxicosis. Regulations in the EC, veterinary controll.

Recommended literature	
Obligatory:	Baska, F (2013): Lecture ppt files Roberts, R.J. (2000) Fish Pathology
Recommended:	Kabata (1990) Tropical fish diseases Stosskopf (1990) Fish Medicine

Type and method of exam:

Written semifinal exam

Note(s):

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