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EUROPEAN INLAND FISHERIES ADVISORY COMMISSION

Report of the

EIFAC AD HOC WORKING PARTY ON HANDLING OF FISHES IN FISHERIES AND AQUACULTURE

Utrecht, Netherlands, 24–26 March 2004

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREPARATION OF THIS DOCUMENT

The handling of fishes is increasingly subject to legislation and regulation. In 2002, the twenty-second session of the European Inland Fisheries Advisory Commission of FAO (EIFAC) realized the need to identify current legislation and regulations in the EIFAC member countries. Also, it was felt there was a need to exchange information on the practice of handling fishes in fisheries and aquaculture, e.g. catching and handling, husbandry conditions, transport and slaughter of fishes. The session established an EIFAC Ad Hoc Working Party on Handling of Fishes in Fisheries and Aquaculture as a forum to exchange information about the handling of fishes for those working in fisheries and aquaculture. The terms of reference of the ad hoc Working Party are presented in the Preface to this document.

This EIFAC Occasional Paper contains two parts. The first part provides the report of the EIFAC Workshop on Handling of Fishes in Fisheries and Aquaculture, which was held in Utrecht, Netherlands, from 24 to 26 March 2004. The second part provides an overview of the handling of fishes in commercial inland fisheries, recreational fisheries, aquaculture and fisheries research, compiled by Mr A.J.P. Raat (Dutch Organization for the Improvement of Inland Fisheries (OVB) and Mr P. van de Nieuwegiessen (Wageningen University Research).

In March 2003, Mr A.J.P. Raat, the convener of the ad hoc Working Party, sent an inquiry on the current practice of handling of fishes in EIFAC member countries to EIFAC National Correspondents. The inquiry was designed to compile data on handling of fishes from EIFAC member countries. The results of the inquiry are included in this report. The convener is grateful to the following persons for their reaction to the questionnaire: U.A. Grosch (Berlin, Germany), H. Wedekind (Groß Glienicke, Germany), M. Pietrock (Groß Glienicke, Germany), E. Dupont (Marloie, Belgium), J.W. van de Vis (IJmuiden, Netherlands), E. Lambooij (Lelystad, Netherlands), P. Hickley (Kidderminster, United Kingdom), N. Tredwin (Weymouth, United Kingdom), R. Poole and colleagues (Newport, Ireland).

The revision of the draft version of the overview was carried out by Mr A.J.P. Raat. The document was circulated for review to the participants of the Utrecht workshop. The contributions to the present document by the participants of the Utrecht workshop are acknowledged with great appreciation. Finally, Mr P. Hickley (Vice-chairperson of EIFAC), Mr I. Cowx (Chairperson of EIFAC Sub-Commission IV), Mr R. Roesch (Langenargen, Germany) and Mr B.P. North (Stirling, Scotland) reviewed the document. The convener acknowledges the input of Mr H. van de Vis (IJmuiden, Netherlands). The comments and suggestions of the above mentioned persons are gratefully acknowledged by the convener of the Working Party.

The report of the Utrecht Workshop of the EIFAC ad hoc Working Party was presented in June 2004 to the Twenty-third Session of EIFAC in Wierzba, Poland. It was decided to publish the report of the workshop and the overview of the handling of fishes as an EIFAC Occasional Paper. The overview of the handling of fishes in fisheries and aquaculture is based on a technical document of the Dutch Organisation for the Improvement of Inland Fisheries (the Organisatie ter Verbetering van de Binnenvisserij OVB), Nieuwegein, Netherlands. OVB offered the facilities for the activities of the Working Party.

FAO/European Inland Fisheries Advisory Commission.
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EIFAC Occasional Paper. No. 40. Rome, FAO. 2008. 88p.

ABSTRACT

This document presents the results of the EIFAC Ad Hoc Working Party on Handling of Fishes in Fisheries and Aquaculture, including the report of its workshop held from 24 to 26 March 2004 in Utrecht, Netherlands. The welfare of fishes has become a subject of attention in recent years. A concise definition of welfare is inherently difficult and instead, definitions are feelings-based, function-based and nature-based. However, none of these three concepts offers a comprehensive view on the major ethical concerns over the quality of life of animals. Concerns have been raised about the potential for infringed fish welfare in fisheries, aquaculture and fisheries research. Most of these concerns have been related to farm escapees, post-release mortality, and some capture methods which have been shown to induce stress responses. Fish welfare problems in recreational fisheries deal with the physiological effects of angling and subsequent hooking mortality. Several factors may influence fish welfare during angling: physiological factors, environmental factors and fishing method factors. Husbandry practices in aquaculture have the potential to impact on the welfare of cultured fish including: handling, inappropriate stocking density, confinement, transportation, water quality deterioration, social interaction, light regime, slaughter. Many issues also apply to the use of fish in scientific investigations. Here, fish are commonly held in captivity for experimentation and fish are caught or sampled in surveys and monitoring programmes. Fish are being tagged using invasive methods. Concerns have been raised about the effects of electric fishing techniques, commonly used to sample fish from fresh waters. Indicators often used to assess the welfare status of an animal are stress physiology, animal behaviour and health status. There are similarities and differences between fishes and mammals with regard to the subjective experience of pain and suffering.

Independent of the question on pain and suffering of fishes, members of the ad hoc Working Party agreed that handling of fishes must be carried out in a responsible way. Fishes show reactions to injurious stimuli. These stimuli result in physiological stress responses. Depending on the duration and intensity of the exposure to the stressor, the stress response varies from acute to chronic. Handling causing injuries and damage to the fishes should be avoided in fisheries, aquaculture and fisheries research. Careful handling of the fishes implies prevention of damage or unnecessary injuries, prevention of unnecessary stress and prevention of unnecessary prolongation of the period before the target fish is killed. Those responsible for handling of fishes in fisheries, aquaculture and fisheries research should have basic knowledge of the effects of handling on fishes and have justifiable objectives (“reasonable purpose”), within the context of the situation. Furthermore the rules and regulations with regard to these activities must be taken into account. To ensure the welfare of fish in commercial fisheries, recreational fisheries and aquaculture, sufficient legislation and regulation is necessary. All EIFAC member countries discussed in this report have legislation and regulations concerning animal welfare. However, some of the legislation and regulations do not provide specific attention to fish welfare.

Key words: Handling, Fish Welfare, Inland Capture Fisheries, Aquaculture, EIFAC, European Inland Fisheries Advisory Commission, Europe

CONTENTS

PREFACE

Attention about animal welfare has increased in recent years, and the welfare of fishes has also become a subject of attention (Kestin, 1993; FAWC, 1996; Lymbery, 2002; Erickson, 2003; FSBI, 2002). Furthermore, the handling of fishes and fish stocks is increasingly subject to legislation and regulation. The European Inland Fisheries Advisory Commission (EIFAC) felt there was a need to exchange information on the practice of handling fishes in fisheries and aquaculture and to identify current legislation and regulations in EIFAC member countries. The twenty-second session[1] of EIFAC in Windermere, United Kingdom, in 2002, decided to establish an ad hoc Working Party on Handling of Fishes in Fisheries and Aquaculture, with the following terms of reference:

- compilation of the basic scientific knowledge on the effects of handling of fishes in fisheries and aquaculture (fishery methods, harvest, holding and rearing, use of anaesthetics, slaughter);
- compilation of the current practice of handling of fishes in fisheries and aquaculture, including training programmes, and collation of existing codes of practice and guidance in EIFAC member countries and relevant information from other countries;
- listing of the current and proposed legislation and regulation on handling in fisheries and aquaculture and in experimental settings in EIFAC member countries (including EU regulations);
- identification of the relevant Web sites and other sources for information on welfare of fishes and handling of fishes and other relevant topics;
- distribution of information about the discussion on fish welfare in EIFAC member countries.

Part one of this report presents the result of the EIFAC Ad Hoc Working Party, in particular the Workshop held in Utrecht in March 2004. Part two gives an overview of current knowledge available in scientific literature, grey literature and on the World Wide Web, on several issues relating to fish welfare, and provides comprehensive reference lists and relevant Web sites dealing with aspects of fish welfare.

Nieuwegein, February 2006

Lex Raat
Convener, EIFAC Ad Hoc Working Party on Handling of Fishes in Fisheries and Aquaculture

[1] FAO 2002. Report of the twenty-second session of the European Inland Fisheries Advisory Commission. Windermere, United Kingdom, 12–19 June 2002. FAO Fisheries Report. No. 681. Rome, FAO. 42p. ftp://ftp.fao.org/docrep/fao/005/y3930e/y3930e00.pdf

PART ONE

REPORT OF THE EIFAC WORKSHOP ON HANDLING OF FISHES IN FISHERIES AND AQUACULTURE, 24–26 MARCH 2004

INTRODUCTION

1. The handling of fishes is increasingly subject to legislation and regulation. In 2002 the twenty-second session of European Inland Fisheries Advisory Commission of FAO (EIFAC) in Windermere, United Kingdom, realized the need to identify current legislation and regulations in the EIFAC member countries. Also, a need was felt to exchange information on the actual practise of handling fishes in fisheries and aquaculture, e.g. catching and handling, husbandry conditions, transport and slaughter of fishes. The Session decided to establish an EIFAC Ad Hoc Working Party on Handling of Fishes in Fisheries and Aquaculture. The ad hoc Working Party is a forum to exchange information about the handling of fishes for people working in fisheries and aquaculture. The ad hoc Working Party was convened by Mr A.J.P. Raat, Organization for the Improvement of Inland Fisheries (OVB), Netherlands.

2. In March 2004 the convener of the ad hoc Working Party, Mr A.J.P. Raat, organized an international EIFAC Workshop on Handling of Fishes in Fisheries and Aquaculture in Utrecht (Netherlands). The workshop was attended by 16 persons from six European countries. The list of participants can be found in the Annex to the workshop report.

AIMS OF THE EIFAC WORKSHOP

3. The meeting had the following aims:

- Compilation of the current practice of handling of fishes in fisheries and aquaculture, including training programmes, and collation of existing codes of practice and guidance in EIFAC member countries and relevant information from other countries;
- Compilation of the current and proposed legislation and regulation on handling in fisheries and aquaculture and in experimental settings in EIFAC member countries (including EU regulations);
- Distribution of information about the discussion on welfare of fishes in EIFAC member countries.

OUTPUT OF THE EIFAC WORKSHOP

4. The EIFAC Workshop covered a wide range of interests in the handling of fishes with emphasis on freshwater fishes. The Workshop explored how new knowledge, guidelines and codes of practice, regulations and legislation might influence inland fisheries, fisheries management, inland fisheries research and aquaculture. The participants gave short presentations about their professional experience of handling fishes and the current state of regulation and legislation in their countries. Trends and developments were also identified. The general outcome is an improved understanding and awareness of the effects of handling of fishes in inland fisheries, fisheries research and aquaculture. Furthermore positive suggestions for better management and a direction set for future work were supplied by the participants.

5. This report gives a summary of the EIFAC Workshop Handling of Fishes. The conclusions and recommendations of the participants of the Workshop were presented to the twenty-third session of EIFAC in Wierzba, Poland, June 2004, for future actions.

6. Furthermore the participants of the Workshop amended and updated the draft document *Handling of fishes* that was prepared for discussion by the convener of the Working Party. The revised document *Handling of fishes in commercial inland fisheries, recreational fisheries, aquaculture and fisheries research. An overview*, consolidates the available information on handling of fishes and supplies basic information for a future position statement of EIFAC. The document was presented to the twenty-third session of EIFAC in 2004 for information and publication.

GENERAL CONSIDERATIONS

7. The participants of the Workshop recommend that in fisheries, fisheries research and aquaculture one should be aware that fishes are sophisticated animals, which makes a fish subject to careful handling.

Box 1: Valuation of fishes

- (Human) use values (fishes object). These values embed an anthropocentric, moral position and perpetuate a relationship of domination between people and nature:
  - fishes as objects for fisheries;
  - fishes as objects in laboratory and field experiments.
- (Human) use values (market value). These assigned values are market prices or their equivalent (observable terms of exchange between goods and services):
  - fishes in commercial (recreational) fisheries;
  - fishes in aquaculture;
  - fishes for consumption;
  - trade in ornamental fishes.
- (Fish) inherent values (fishes subject). These values reside in the object – the fish – itself.
  - fishes are unique individual creatures;
  - fishes cannot be made by humans;
  - fishes can live, reproduce and grow;
  - fishes in the aquatic resource.

8. The participants to the Workshop noted that animal welfare, including the welfare of fishes, is subject to debate in our society. The attitude of the public towards fishes has been changed in the EIFAC member countries during the past fifty years. The valuation of the fishes has been broadened. In our present society fishes represent both human use values as well as inherent values. The human use values are complex and difficult to formulate in generally acceptable and operational terms. The inherent values are by definition intangible. This has brought the use and handling of fishes not only in the realm of fish biologists, fisheries workers and aquaculturists, but also in the public debate. This is reflected in the Animal Welfare legislation in various EIFAC member countries. Handling of fishes is a human action which needs a responsible approach by those who are in charge of the handling and use of the fishes.

9. The present public debate in many EIFAC member countries deals with the acceptability of (recreational) fisheries or special forms of these fisheries, such as catch-and-release fishing (forbidden in some parts of Germany), use of fishing methods (e.g. electric fishing), holding of fishes (e.g. in cages, keepnets) or live fish bait fishing (forbidden in The Netherlands).

10. In aquaculture and commercial fisheries the perceptions of consumers and the public regarding the conditions in which the fishes are raised and captured, play a role in the acceptance of the products. Here the experience with human welfare and the perceptions of the welfare of mammals and birds is often extrapolated to fishes. However, this does not exclude a critical analysis of the handling procedures in practice and, when needed, an improvement of the applied methods and technology, by those responsible for the handling of the animals.

11. The participants of the Workshop observed that although there is a critical public attitude to the handling of fishes, the behaviour of the consumer until now seems to be mainly directed by the price and the perceived safety and quality of the products.

12. The participants of the Workshop noted that there is an important role for the fisheries and aquaculture sectors to respond to the awareness of the public concern about the use and handling of the fishes.

13. In many countries the use of animals, including fishes, for experimental purposes, seems to be more strictly regulated than their use in other human activities. The participants of the Workshop

observed that this is an additional reason for the fisheries and aquaculture sectors to take their responsibility for improving the way that fishes are used, kept, sampled, captured, handled and killed.

14. The participants of the Workshop noted that aquaculture and fisheries organizations are aware of the need to improve the conditions from the perspective of the welfare of the fishes. There are many codes of conduct and guidelines that take the welfare of the fishes into consideration. However, further efforts are needed to improve the translation of these codes of conduct and guidelines to the way in which fish are handled in practice. Training and education programmes can improve the awareness among individual persons. The certification of actions (to "clarify the welfare criteria") by the sector itself is also a good marketing instrument, which endorses the acceptability of fisheries and aquaculture products.

15. The participants of the Workshop noted that part of the public perception of fish welfare issues in fisheries and aquaculture is based on anthropocentric assumptions. Communication with stakeholders such as consumers, trade, non-governmental organization (NGOs), fishermen, angling organizations, aquaculturists and government, can lead to a better understanding of the way these issues are taken up by the fisheries and aquaculture sectors.

WELFARE AND FISHES

16. The participants of the Workshop noted the difficulty of finding a comprehensive, generally acceptable definition of fish welfare. However, in the EIFAC member countries, scientific considerations and ethical standards mandate a respect for all life forms. Thus the framework based on the "five freedoms" (defined in the United Kingdom Farm Animal Welfare Council), that recognises five domains in which welfare may be compromised, is relevant for the identification of fish welfare criteria in fisheries, fisheries research and aquaculture.

Box 2: Five "freedoms" defined in the United Kingdom Farm Animal Welfare Council.

Domain 1. Water and food deprivation, malnutrition. Fishes should have ready access to (fresh) water and an appropriate diet in sufficient quantities and with a composition that maintains full health and vigour.
Domain 2. Environmental challenge. Fishes should have a suitable environment, including shelter and a comfortable resting area, whether in their natural environment or in holding conditions.
Domain 3. Disease, injury and functional impairment. Disease should be prevented or rapidly diagnosed and treated.
Domain 4. Behavioural/interactive restriction. Fishes should have sufficient space, proper facilities and where appropriate, the company of the fishes own kind.
Domain 5. Mental and physical suffering. Conditions that produce potentially unacceptable levels of anxiety, fear, distress, boredom, sickness, pain, thirst, hunger and so on should be minimised.

17. The participants of the Workshop emphasize that there is a lack of scientifically sound criteria to assess fish welfare. In addition, they noted that not all criteria are applicable in field circumstances and that many of the criteria are restricted for use under controlled conditions e.g. laboratory experiments or intensive aquaculture. Moreover, criteria with respect to welfare of fish are:

- species specific (e.g. eel and catfish);
- individual/ genetically specific (e.g. catfish);
- gender specific (e.g. catfish and carp);
- depending on size and age;
- depending on the environment.

Box 3: Criteria for fish welfare.

Behavioural:
- swimming activity;
- escape;
- elevated gill ventilation;
- stereotype behaviour (aquaculture only);
- coping styles (agonistic behaviour: aquaculture only).

Physiological:
- stress physiology: blood: neuroendocrine responses, muscle outer appearance;
- brain activity for assessment of stunning/killing methods;
- heart rate;
- *post mortem* biochemistry of muscle tissue.

Morphological:
- injuries;
- fin damage;
- body condition indices.

Performance-based indicators:
- mortality;
- feed conversion efficiency (aquaculture only);
- flesh quality;
- growth rate;
- reproductive success (fisheries only; long-term exposure to a stressor);
- resistance against diseases, disease state (aquaculture only);
- pathological changes (aquaculture only).

Environmental:
- water quality;
- water availability;
- endemic diseases/ parasites.

PAIN AND SUFFERING OF FISHES

18. The participants of the Workshop discussed the similarities and differences of fishes and mammals with regard to the subjective experience of pain and suffering. The argument was put forward that the cortical regions, that are essential for human pain experience, are not present in the brains of the fishes, and therefore the "human" experience of pain is a neurological impossibility. However, following this reasoning it can be argued that birds are blind, because they do not possess a visual cortex (FSBI, 2002). In the case of the birds this task (processing of visual stimuli) is performed by the mid brain optic tectum. It is therefore not impossible that parts of the brain other than the cerebral cortex have evolved the capacity for generating negative emotional states/suffering in non-mammalian vertebrates, including fishes.

19. Recent studies, which have caused controversy in the scientific community, were presented to the participants at the Workshop suggesting that fishes are capable of perceiving pain. The results of these studies by a scientific group from the Roslin Institute in Edinburgh, albeit refuted by others, are based on similarities between fishes and higher vertebrates in their basic structure of neurones and their neuronal biochemistry. There are also similarities in stress responses and in behavioural and decision-making responses to tissue damaging, or potentially tissue damaging, incidents. Recent anatomical and electrophysiological studies have further demonstrated that fishes are capable of nociception: the simple detection of a noxious, potentially painful stimulus and the reflex response to this. The pain-related behaviour which was observed however, is not a simple reflex. Thus, the presence of a neocortex as a brain structure, seems not necessarily required for the perception of pain by fishes.

20. The discussion on pain and suffering of fishes during the Workshop did not result in a shared opinion among the participants. However, independent of the question on pain and suffering of fishes, the participants agreed that handling of fishes has to be done in a responsible way.

RESPONSIBLE HANDLING OF FISHES

21. The participants of the Workshop noted that fishes show reactions to injurious stimuli. These stimuli result in behaviour leading to physiological stress responses. Depending on the duration and intensity of the exposure to the stressor, the stress response varies from acute to chronic.

22. The participants of the Workshop agreed that handling causing injuries and damage to the fishes should be avoided in fisheries, aquaculture and fisheries research. This means that careful handling of the fishes implies prevention of damage or unnecessary injuries, prevention of unnecessary stress and prevention of unnecessary prolongation of the period before the killing takes place.

23. The participants of the Workshop noted that those responsible for handling of fishes in fisheries, aquaculture and fisheries research should have basic knowledge of the effects of handling on fishes and have justifiable objectives ("reasonable purpose"), within the context of the situation, and furthermore take into account the rules and regulations with regard to these activities.

HANDLING OF FISHES: FISHERIES RESEARCH

24. The participants of the Workshop noted that in many EIFAC member countries there is legislation dealing with animal experimentation, including those with fishes. Most countries do not have specific regulations or legislation for fishes in experimental settings.

25. Special fields of interest relating to fish welfare that were identified during the Workshop were:

- Tagging and marking. It was noted, that recently a relevant report of concerted action within the EU framework FAIR Tagging methods for stock assessment and research in fisheries was published (Davenport *et al.,* 2002).
- Stunning and consciousness of fish.
  - It was noted that most anaesthetics and related chemicals used for stunning the fishes do result in enhanced brain activity and increase in heart rate.
  - It was further noted that in most EIFAC member countries anaesthetics for fisheries use are not certified (in several countries only MS 222 is certified).
  - It was concluded that there is a need for better understanding and certification of anaesthetics for use in fish handling and fish research (e.g. clove oil, Benzocaine, 2-Phenoxyethanol).
- Implantation techniques:
  - It was noted that the practice of implantation is subject to wide variation within the EIFAC member countries with regard to legislation, experience, procedures and protocols.
  - It was concluded that international co-operation in training for the use of invasive methods and techniques in EIFAC member countries is advisable. EIFAC should play a co-ordinating and stimulating role for initiatives for concerted action.
- Parasite infections.
- Sampling of fishes:
  - It was noted that there is a need for more information on the aspects of fish welfare affected by fisheries methods (e.g. electric fishing, gill netting).
  - It was noted that standardization of fishing methods should take into account the available information on fish welfare.
  - It was advised that in monitoring and sampling programmes more attention should be paid to alternative methods, which leave the fishes in their natural environment (e.g. acoustic surveys).

HANDLING OF FISHES IN PRACTICE: FISHES IN AQUACULTURE

26. The participants of the Workshop identified several topics relevant from the perspective of fish welfare:

- Rearing conditions:
  - water quality;
  - stocking density/ Loading rate;
  - light regime;
  - feeding regime;
  - design of a tank.
- Transportation.
- Fasting, sorting and crowding, transport.
- Harvest: the process of catching and handling of farmed fish. It was noted that more research effort must be invested in the technical aspects of fish capture in aquaculture situations.
- Slaughter: the process of stunning and killing. It was noted that more research effort must be invested in the technical aspects of fish killing, taking into account industrial constraints.
- Stunning/killing and flesh quality. It was noted that an efficient and rapid stunning/killing of the fishes usually leads to a better quality of the flesh. Prolonged storage of the fishes prior to stunning or killing, may have a negative effect on the flesh quality.
- Problems with parasites, predators and birds.
- Disease treatment and prevention of diseases.
- Technical aspects: optimise conditions.

27. The participants of the Workshop noted that the Council of Europe standing committee of the European Convention for the Protection of Animals kept for Farming Purposes is presently working on farmed fish, including a *Draft recommendation concerning farmed fish* (which was adopted in December 2005 and published by the Council of Europe[2]). It was recommended by the participants that EIFAC should have a liaison with the Council of Europe regarding their activities in the field of aquaculture.

28. It was further noted that in the European Union, retailers, animal welfare associations and governments are increasingly demanding humane methods to convert live farmed fishes into food. The European Food Safety Authority (EFSA) is currently reviewing current stunning and killing methods for all animals (including fishes). Various European research institutes are taking part in the expert working group. It was recommended by the participants of the Workshop that EIFAC should have a liaison with these activities.

HANDLING OF FISHES IN PRACTICE: ORNAMENTAL FISHES

29. The participants of the Workshop noted that about 80 percent of ornamental fishes are captured from natural waters and are not cultured. The following topics are relevant from the perspective of fish welfare:

- capture;
- transportation;
- holding conditions.

30. Although mortality due to the trade in ornamental fishes can be substantial on global, European, national and local scale, actions by EIFAC have no priority when considered from the terms of reference of this advisory body.

HANDLING OF FISHES IN PRACTICE: FISHERIES MANAGEMENT

31. Welfare of fishes deals not only with individual fishes but also with wild fish populations. The participants of the Workshop identified several topics relevant from the perspective of fish welfare:

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[2] Recommendation Concerning Farmed Fish, adopted by the Standing Committee on 5 December 2005. Standing Committee of the European Convention for the Protection of Animals kept for Farming Purposes (T-AP). http://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety,_use_of_animals/Farming/Rec%20fish%20E.asp

- catch and release fisheries;
- put and take fisheries;
- stocking practices;
- use of live bait fish;
- keepnets;
- harvest: the process of catching, handling, slaughter for wild fish;
- protection from predators;
- disease and parasites;
- eradicating fish stocks (e.g. rotenone);
- biomanipulation fisheries;
- effect of hydro power plants;
- effects of damming on (migratory) species;
- enforcement of regulations.

32. The participants of the Workshop recommended that EIFAC should take action to extend knowledge and guidance about the fish welfare aspect of fisheries management.

RELEVANT INFORMATION

33. The participants of the Workshop noted that relevant information on handling of fishes is summarized in the following documents:

- *Handling of fishes*, discussion paper prepared by A.J.P. Raat and P. van de Nieuwegiessen for the EIFAC ad hoc Working Party on Handling of Fishes in Fisheries and Aquaculture.
- *Guidelines for the use of fishes in research* of the American Fisheries Society (Nickum *et al*., 2004).
- *Fish welfare*. *Briefing paper 2* of the Fisheries Society of the British Isles (FSBI, 2002).
- *Information resources on fish welfare 1970-2003* of the Animal Welfare Information centre of the US department of Agriculture (Erickson, 2003).

34. All persons professionally engaged with handling of fishes should be aware of the existence of these papers and should apply the information and guidelines in their handling of the fishes.

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ANNEX

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PART TWO

HANDLING OF FISHES IN COMMERCIAL INLAND FISHERIES, RECREATIONAL FISHERIES, AQUACULTURE AND FISHERIES RESEARCH. AN OVERVIEW

CHAPTER 1 FISH WELFARE

1.1 Defining animal welfare

In recent years, animal welfare has been the subject of intense debate and public concern. However, to discuss animal welfare objectively, a definition of animal welfare is required. Producing such a definition has not been easy, particularly because the concept of animal welfare is complex and the phrase has been used in different contexts. Most definitions can be divided into three broad categories (Duncan and Fraser, 1997; Fraser *et al.*, 1997).

- *Feelings-based definitions*: These definitions are normally based on subjective mental states. The requirement for good welfare is that a certain animal should feel mentally well, it should be free of pain and fear and it should have access to positive experiences, such as social contacts. Naturally, such definitions are only valid if the animal of concern is able to experience these subjective mental states. Furthermore, the use of these definitions depends on understanding of these subjective mental states.
- *Function-based definitions*: These definitions are based on the physical state of an animal. Here, for an animal to experience good welfare it should be healthy and its biological systems should be functioning appropriately. However, these definitions are based on the assumption that animals in good physical health are also in a good mental state.
- *Nature-based definitions*: These definitions are based on the biological functioning of an animal. Good welfare requires that an animal is allowed to perform its natural behaviour and live a natural life. These definitions assume that animals are suffering if they cannot express their full behavioural repertoire. However, a part of their natural behaviour is based on escaping from adverse situations, such as escaping from a predator, and it may be hard to argue that an animal is suffering if this behaviour cannot be expressed. Furthermore, the concept provides little guidance on many important animal welfare issues, such as the use of analgesia, euthanasia and medication.

Unfortunately, none of the concepts of animal welfare offer a comprehensive view on the major ethical concerns over the quality of life of animals; an ideal definition would combine each of the three stated concepts.

1.2 Criteria for fish welfare

1.2.1 Five freedoms

To overcome the problems with producing a comprehensive definition of fish welfare, criteria were defined that should be fulfilled for an animal to experience good welfare. These “five freedoms” were elaborated by the Brambell Committee of the United Kingdom Parliament in 1965 and updated by the Farm Animal Welfare Council (1992):

1. freedom from hunger, thirst and malnutrition;
2. freedom from physical and physiological discomfort;
3. freedom from injury, disease and functional impairment;
4. freedom to express normal behaviour and social interactions;
5. freedom from fear and chronic stress.

The Fisheries Society of the British Isles (FSBI, 2002) reworked these “five freedoms” into a form more appropriate for fishes. These freedoms can be applied to all fish, although the details mentioned under each freedom depend on the species concerned, age, gender and reproductive condition.

1. *Thirst, hunger and malnutrition*.
   - Fish should have access to an adequate, nutritionally complete diet, taking into account the fact that fish vary greatly in their natural diet, that they do not need to maintain a constant body temperature and that in many cases they show marked differences in requirements with season and life history stage.
   - Fish should be presented with food in a manner that is appropriate to the natural feeding behaviour of the species concerned (e.g. pellets of the correct size) and that avoids undue competition.
2. *Physical and physiological discomfort*.
   - Fish should be kept under water quality, flow rates and temperature appropriate for the species concerned.
   - Seasonal and daily patterns of light intensity should be appropriate for the species concerned.
   - Fish should be provided with cover and shelter.
3. *Injury, disease and functional impairment*.
   - Disease should be prevented or rapidly diagnosed and treated when possible.
4. *Natural behaviour/social interactions*.
   - Fish should have sufficient space to allow a degree of freedom of movement, but the definition of "sufficient" will be species-specific.
   - For shoaling species, the company of their own kind is important for welfare, but for territorial species, this may not be true.
   - A degree of environmental complexity may be important, depending on the species concerned.
5. *Fear and chronic stress*.
   - Conditions that potentially produce unacceptable levels of anxiety, fear, distress, boredom, sickness, pain, thirst, hunger and so on should be minimised in fish, as in other vertebrates.

The fifth freedom in particular may be subject of debate, because the ability of fish to experience pain, fear and suffering is a highly contentious issue. Arguments have been made both to support and refute the claim that fish are capable of experiencing pain and suffering. Rose (2002) argues against the ability of fish to experience pain and suffering, based on the distinction between reaction to injury (nociception) and the psychological experience of pain (see section 1.2.2).

To comprehend this distinction it is important to understand the main components of the pain perception mechanism. Components of this mechanism in mammals are shown in Figure 1. In this figure the first component of experiencing pain is nociception. This term refers to the detection of noxious stimuli by the nervous system. Nociception is controlled by the spinal cord and brainstem. The two types of nociceptors are: A-delta fibres with thinly myelinated axons; and C-fibres with slowly conducting unmyelinated axons. The occurrence of these fibres in fish varies according to species groups:

- Elasmobranchs: Although nociceptors were found in several studies of elasmobranchs, the studies failed to detect pain in the studied fish species (Sneddon, Braithwaite and Gentle, 2003).
- Bony Fish: C- and A-delta fibres present in the peripheral nerves. Very few C-fibres, only around 4 percent of afferents are C-fibres. Primarily A-fibres.
- Hagfish: Nociceptors present, primarily C-fibres.

The occurrence of these fibres in bony fish and hagfish implies that these species groups must be able to react to injury. Consequently, without doubt both fishes and humans are capable of responding to noxious stimuli. For instance, a fish that has been hooked is responding to a stimulus. Likewise, if someone burns themself, he or she will very quickly respond to the stimulus, but this response occurs before one feels any pain.

1.2.2 Discussion on perception of pain by fishes

Rose (2002) stated that the difference in the perception of pain and fear of fishes and humans results from the different structure of the brains. The human brain has a massively developed cerebral cortex. Pain and fear in humans results from the stimulation of several regions of this cerebral cortex

(Bermond, 1997; Rose, 2002). The tiny cerebral cortex of fish brains lack these regions (Figure 2). Reaction to injury, therefore, does not necessarily mean that psychological pain is experienced.

Recent studies, however, have caused controversy in the scientific community by suggesting that fishes are capable of perceiving pain (Braithwaite, 2004). The results of these studies are based on similarities between fishes and higher vertebrates in their basic structure of neurones and their neuronal biochemistry. There are also similarities in stress responses and in behavioural and decision-making responses to tissue damaging, or potentially tissue damaging, incidents. Anatomical and electrophysiological studies further demonstrated that fishes are capable of nociception: the simple detection of a noxious, potentially painful stimulus and the reflex response to this. The pain-related behaviour that was observed, however, was not a simple reflex. Thus, the presence of a neocortex as a brain structure, may not necessarily be a prerequisite for the perception of pain by fishes (Sneddon, 2003; Braithwaite and Huntingford, 2004; Chandroo *et al*., 2004).

Modern brain imaging technology has made it possible to observe directly and quantify neural events that relate systematically with the subjective experience of pain (Broom, 2001). Although some of these methods (brain imaging technology), in principle, could be applied to fishes, according to Nickum *et al*. (2004) the effort would be fruitless due to fundamental differences between fish and human brain structure.

Sneddon (2003) stated: In a review concluding that fish are not capable of pain perception, Rose (2002) defined pain in terms of brain structure and stated that an animal must have the necessary brain structure, a neocortex, to perceive pain. With this definition only humans and primates are capable of experiencing pain and Rose (2002) ignored the bird and amphibian literature that has proven these animals are capable of pain and yet they do not have a neocortex.

The argument proposed by Rose (2002) is based on the observation that the cortical regions essential for human pain experience, are not present in the brains of fishes, and therefore the “human” experience of pain is a neurological impossibility. However, following this reasoning it can be argued that birds are blind, because they do not possess a visual cortex (FSBI, 2002). In the case of birds this task (processing of visual stimuli) is performed by the mid brain optic tectum. Other examples exist of similar functions being carried out by different parts of the brain in different animal groups (FSBI, 2002). It is therefore possible that parts of the brain other than the cerebral cortex have evolved the capacity for generating negative emotional states or suffering in non-mammalian vertebrates, including fish.

Statements and conclusions made in a review by Chandroo *et al*. (2004) of the perception of sentience, pain, fear and stress in fishes are summarized below:

<u>Fish behaviour and internal representations</u>:

- There is evidence that fish can remember, recognize and interpret the fighting skills of future opponents to assess their own probability of wining a future conflict, as well as signal their motivational state of familiar conspecifics.
- This forms a preliminary basis for suggesting that primary consciousness and cognition exists in fishes.

<u>Motivational affective</u>:

- Despite differences in ontogeny, there is a growing body of anatomical, behavioural and pharmacological evidence to suggest that the brain structures and neural systems associated with motivational affective states in tetrapods are present in fishes.
- Therefore, it is reasonable to suggest that motivational affective states could have developed at some level of fish evolution.

Harmful (noxious) stimuli such as chemicals, heat, pressure etc impinge on the animal.

↓

Activity passes through small nerve fibres in the spinal cord to the thalamus (part of the diencephalons) and then to the cerebral cortex. There are two partially separate systems, one responsible for the sensory discrimination of harmful stimuli and the other responsible for the conscious, emotional response to such stimuli.

↓

Sensory neurons for the detection of harmful stimuli (nociceptors) react to specific stimuli. There are two common types of nociceptors: myelinated, small, slow conducting A-delta fibres and smaller, slow conducting unmyelinatedC fibres. These are activated by specific nociceptive stimuli.

↓

Physiological responses to harmful stimuli include protective vegetative responses (inflammation and cardiovascular changes) and reflex avoidance responses. More complex, higher order responses include changes in physiology (secretion of natural opiates) and behaviour (avoidance of locations where harmful stimuli have been experienced).

Figure 1. The main components of the pain perception mechanisms in mammals (FSBI, 2002).

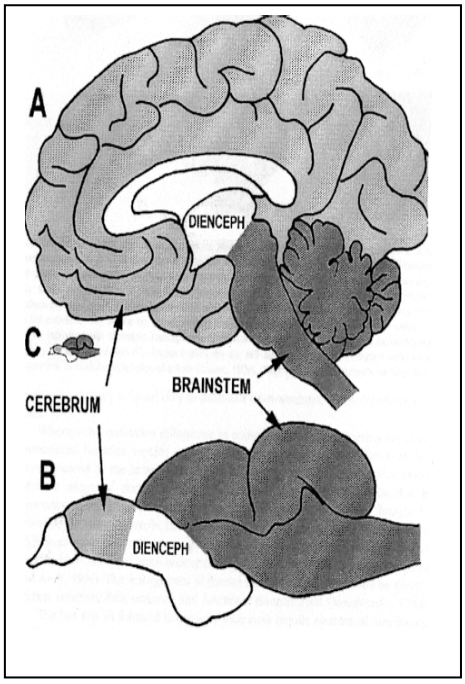

*Figure 2. Comparison of the structure of the human brain (A) and the trout brain (B). (C) Brain of a 30 cm rainbow trout (*Oncorhynchus mykiss*) shown at the same scale as the human brain diagram (Rose, 2002).*

Pain and the telencephalon:

- That pain in fish may be experienced in ways similar to tetrapods.
- The cytoarchitecture of the fish brain is one that permits integration of diffentiated pallial and sub-pallial regions, it is therefore reasonable to suggest that modern hypothesis pertaining to the neural basis of consciousness may apply to fish.
- Fish have the ability to construct cognitive representations of noxious events and are able to form expectancies of the noxious stimuli as a result (also suggested by Overmier and Hollis, 1990).
- It is conceivable that nociception (and other senses) in fish is consciously experienced, and is responsible for motivated behaviour.

Fear and anxiety:

- The cognitive neurophysiological and behavioural features of fear responses of fish suggest that they have some capacity to consciously experience fear.

Psychological aspects of stress:

- The neurobehavioral similarities between fish and other vertebrates with respect to social stress further supports the suggestion that fish have some capacity to experience psychological stress.

In another paper on fear reactions of the domesticated rainbow trout, Yue *et al*. (2004) concluded that: "This evidence suggests that trout can experience fear and that they can learn to avoid frightening stimuli. It implies that they are sentient animals, more complex than previously thought".

Arguments presented in support of the belief that fishes are capable of experiencing pain can be divided into three forms.

- *Arguments stating that behavioural reactivity to presumed noxious stimuli are evidence of pain perception*. A recent study by Sneddon *et al*. (2003) looked at the behavioural response of rainbow trout to administration of noxious substances (bee venom and acetic acid) to the lips. Both the physiology and behaviour of the fish were affected. A significant increase in opercular beat rate and the time taken to resume feeding were found. Furthermore, fish injected with venom and acid showed anomalous behaviour. Fish performed "rocking" where they moved from side to side balancing on either pectoral fin while resting on the gravel. Fish injected with acid also rubbed their lips into the gravel and against the tank walls. The affected physiology and behaviour of the fish over a prolonged period of time may suggest discomfort and pain. The authors concluded that they had proved that fish experience pain. This conclusion, however, implicitly starts from the assumption that the "human" brain is not necessarily the requirement for the perception of pain. Nickum *et al.* (2004) and Rose (2003) argue that until conscious reaction to injurious stimuli can be demonstrated, the behaviour demonstrated by the fish in this study is not proof of nociceptive behaviour.
- *Arguments stating that learning by fishes to avoid noxious stimuli or to develop Pavlovian conditioned responses to these stimuli are evidence of pain experience*. Several studies have been performed on common carp (*Cyprinus carpio*; Beukema, 1970; Raat, 1985) to support this argument. Carp, initially hooked once and then released, learned to associate the bait with the hooking experience and subsequently avoided the bait. Up to three years later, the previously hooked fish were more difficult to catch than naïve fish. Furthermore, the remaining fish also became progressively more difficult to catch as the others were caught, implying that the unhooked fish were able to learn from the hooked fish that the experience was aversive. However, thiis behaviour, also known as implicit learning, is a virtually universal capability of vertebrate and invertebrate animals, including those lacking brains (Macphail, 1998, cit. in Rose, 2002).
- *Arguments stating that the same or equivalent neural structures and neurochemicals mediating pain in humans are present in fish*. Ehrensing *et al.* (1982) performed a study to support this argument. The response (agitated swimming) of goldfish (*Carassius auratus*) to an electric shock was studied. Morphine was used to induce analgesia, and naloxone was used to reverse this analgesia. Increases in the concentration of morphine injected intracranially increased the intensity of shock needed to stimulate an agitated swimming response in a dose dependent way,

> and naloxone reversed this effect. The compounds thus behaved in a manner analogous to the way they would behave in a rat subjected to a similar experimental protocol. This implies that fish react to analgesics similarly, and may thus feel pain similarly. Opiates, such as morphine, are known to produce their anti-nociceptive effects by acting at subcortical brainstem and spinal cord sites (Prices, 1999, cit. in Rose, 2002). Thus, opiate effects on nociceptive processing are not evidence of a capacity for consciously perceived pain (Rose, 2002).

Braithwaite and Huntingford (2004) summarized the arguments for and against the ability of fish to perceive pain. They agreed with Rose (2002) that fish are unlikely to perceive pain in the same way that humans do. However, they believed that currently available evidence indicates that fish have the capacity for pain perception and suffering. As such, it would seem timely to reflect on the implications of fish pain and suffering, and to consider what steps can be taken to ensure the welfare of the fish that we exploit.

The arguments to support and refute the claim that fish are capable of experiencing pain and suffering currently largely depend on the definition of pain that is used. The definition of pain used by Bermond (1997), Rose (2002) and Nickum et al. (2004) implies that only humans and primates are capable of experiencing pain. When this line of reasoning is followed, even new born babies lack a capacity to perceive feelings (Spruijt, 1999). The alternative approach starts from the awareness that internal and external states of fishes are probably not an all or nothing phenomenon, but that they are rather graded or limited to a range of subject matter appropriate for the animal's ecology. The authors following this line of reasoning, provided evidence that suggests fish have a capacity to perceive feelings.

Finally it is important to remember that "absence of evidence is not evidence of absence" (Sherwin, 2001). In the future, further research is necessary to come to a solid robust conclusion about the ability of fishes to experience pain and suffering. Only then can an objective assessment of fish welfare be accomplished.

1.3 Indications of fish welfare

To determine if an animal's welfare is compromised, different aspects of an animal's condition can be studied. Stress physiology, behaviour, health status, pathological changes of intestines and, in the case of food fish, flesh quality are often used to assess the welfare status of an animal. These five indicators are related to the function-based and nature-based definitions of animal welfare. Indicators related to feeling-based definitions are not common because science cannot yet, and perhaps cannot in principle, give empirical answers to many ethically relevant questions regarding the subjective experience of animals (Fraser *et al*., 1997). The following section refers to the five indicator groups.

There is a consensus that no single parameter can provide adequate representation of an animals's welfare status, but there is no consensus on how to incorporate the different measurements into meaningful indices (B.N. North personal communication). Spoolder *et al*. (2003) summarized ways that this can be done for terrestrial animals. Principal Components Analysis (PCA) combines the strengths of univariate post-hoc interpretation and multivariate analysis to objectively indentify relative weightings of variables. It is difficult to apply systems for assessing welfare in terrestrial animals to fish. This has been particularly due to problems of observing fish especially in production systems. Here, measurements have been concentrated on individual aspects of welfare such as growth, stress or damage. However, these are influenced by factors other than welfare, thus they are often inprecise or noisy indicators of fish welfare. Turnbull *et al*. (2005) and North *et al*. (*Aquaculture* in press) used the statistical tool of multivariate analysis to combine simultaneously recorded measures of welfare on the basis of the observed statistical relationships among them. Turnbull *et al*. (2005) examined welfare in Atlantic salmon in cages on a commercial marine farm, exposed to different stocking densities over a period of 10 months Four commonly used measures of fish welfare (e.g. condition of body and fins and plasma concentrations of glucose and cortisol) were registrated from each cage and combined by multivariate analysis into one welfare score. North *et al*. applied the PCA to study the impact of stocking density on the welfare of rainbow trout in cages. Welfare was assessed by measuring a range of population (mortality, growth, size variation, FCR), individual morphometric (mass, fin condition) and physiological (haematocrit, plasma cortisol, lysozyme activity) indicators.

The studies suggested that while stocking density can influence the welfare of the fish in the cages, this is only one influence on the welfare and on its own cannot be used accurately predict or to control welfare.

1.3.1 Stress physiology

In fish, studies on stress responses play a prominent role in welfare research. A stress response is often seen as an indicator for impaired welfare. However, before relating the stress response of a fish to its welfare status, more information on the stress response of fish is required. Stress can be defined as a condition caused by external stimuli that disturbs the internal environment. To cope with these external stimuli a defence reaction, or stress response, is started. Stress responses can be divided into primary, secondary and tertiary stress responses.

- The *primary stress response* is characterised by a neurally stimulated release of adrenaline and noradrenaline from the chromaffin tissue and an activation of the hypothalamic-pituitary-interrenal axis (HPI). The hypothalamus is stimulated by a stressor to produce corticotropin releasing hormone (CRH) and thyrotropin-releasing hormone (TRH). Both hormones cause a release of pituitary peptides. The main peptides produced by the pituitary are adrenocorticotropic hormone (ACTH), α-melanocyte-stimulating hormone (α–MSH) and endorphin. ACTH is known to stimulate the release of cortisol from interrenal cells (Wendelaar Bonga, 1997).
- *Secondary stress responses* occur due to the neuroendocrine changes of the primary stress response. A number of physiological processes associated with metabolism and immune capacity are involved. Under hormonal control, including cortisol and catecholamines, energy compounds such as glucose and free fatty acids (FFA) are mobilized (Wendelaar Bonga, 1997), and ammonical products, such as urea and ureic acid, discharged. In addition to these metabolic changes, the immune capacity is affected by the HPI-axis activity (Weyts *et al*., 1999).
- *Tertiary stress responses* involve effects on the whole animal, disease outbreaks after prolonged stress, reduced growth rates and a lower reproductive capacity (Schreck *et al*., 2001; Snieszko, 1974). Although stress responses are related to animal welfare, it is important to realize that a physiological stress response does not necessarily mean that an animal is suffering. A short-term stress response is a natural reaction that may be beneficial for the fish, depending on the situation. In the case of tertiary effects such as reduced growth rate and reproductive capacity, it is possible that they do indicate a compromised welfare status.

1.3.2 Behaviour

The fourth freedom of the Brambell Committee (see 1.2) states that animals should be free to express their natural behaviour and social interactions. In animal welfare research, behavioural studies have always played an important role. These studies include the possibility to use specific behavioural responses as an indicator for impaired welfare (such as ‘freezing’ in presence of a predator, flashing to reduce ectoparasites). Furthermore, choice tests have been performed to allow animals to express their natural preferences. Behavioural elements relevant to welfare in fish are:

- *Feeding activity*. The initial reaction of a fish to impaired welfare is often a sudden drop in food consumption (Plumb, 1994).
- *Swimming*. This involves the integrated effects of numerous physiological processes (Schreck, 1990). Assessment of swimming ability can provide a sensitive index to general stress in fish. Different swimming abilities are observed between fish exposed to stressful conditions compared with those not subjected to stress. The pattern of swimming – swimming into shallow water, swimming lethargically at the surface, lying listlessly on the pond or tank bottom, floating downstream or swimming erratically – can be indicators (Plumb, 1994). Critical swimming speed and the length of time a certain swimming velocity can be maintained may be used as indicators of welfare. Swimming performance can also be used as an indicator in toxicity tests (e.g. Shingles *et al*., 2001; Wicks *et al*., 2002; McKenzie *et al*., 2003). From the viewpoint of aquaculture,

swimming behaviour offers a practical means by which farmers can assess the welfare of their stock e.g. crowding of fish around an inlet may indicate low dissolved oxygen.

- *Respiration* is also thought to be a useful indicator of fish welfare. A difference between resting and active metabolism can be quantified simply by counting breaths opercular beats per minute, or more precisely, by measuring respiratory gases. Respiratory movements and even oxygen consumption all provide measures of toxicological stress, which is related to welfare of the fish.

Other direct observations of behaviour, such as determination of a fish's ability to learn or remember a particular behaviour may also be a feasible indicator. However, considerable differences in behavioural responses between different fish species exist. Behaviour patterns may be used as a useful index of pain and can be validated if they are observed in groups exposed to noxious stimuli, but absent from untreated control groups.

1.3.3 Health status

Increased susceptibility to disease in fish may be the result of prolonged stress periods and is therefore an indicator of compromised welfare. The causes of diseases in fish are complex and the occurrence of diseases may indeed suppress the welfare status of an animal. However, diseases are not necessarily the result of poor environmental conditions and also occur in fish experiencing optimal conditions. Also the incidence of disease may not necessarily be caused by human mismanagement, since marked losses due to diseases also occur in populations of wild fish.

Stress physiology, behaviour and health status all provide information about the welfare status of an animal. However, it remains difficult to relate clearly each of these indicators to fish welfare. Preferably, all three aspects should be taken into account when assessing the welfare status of an animal.

1.3.4 Pathological changes

Chronic stress may also result in morphological and morphometric alterations. In European eels (*Anguilla anguilla*) it has been shown that stress can result in marked changes in the stomach (Peters *et al*., 1980. The findings demonstrate that the functional capability of the stomach is heavily interfered with when the eels are subjected to severe chronic stress. Analogous observations can be made in mammals and humans.

1.3.5 Product quality

For farmed fish species such as Atlantic salmon (*Salmo salar*; Byrne, 2002; Berg *et al*., 1997, Roth *et al*., 2002; Sigurgisladottir, 2001), trout (Azam *et al*., 1989, Byrne, 2002), eel (Morzel and Van de Vis, 2003) and turbot (Morzel *et al*., 2003), it is shown that reduced stress during slaughter has a positive influences on flesh quality. Freshness, which is a major product quality attribute in the opinion of consumers, can be improved by reducing stress and muscle activity during slaughter (Morzel and Van de Vis, 2003; Byrne, 2002). Thus, it is of interest to the fishing industry to improve welfare aspects of the processing of catching and killing fish, as this may not only has the potential to improve product quality, but also the image of the fish farming industry, as perceived by consumers, governments and animal welfare associations.

CHAPTER 2 EFFECTS OF FISHERIES

2.1 General aspects of commercial inland fisheries

Commercial freshwater fisheries in most EIFAC countries are generally small scale operations. The fisheries usually operate with fyke-nets, gillnets, seines, traps and trawls. Eels are usually captured with fyke-nets and electrofishing. In many countries, commercial fishermen often leave the nets unattended for long periods, which results in confinement of the fish under bad conditions, and the eventual death of many less hardy (than eel) fish species. The information in the following section is not only from small scale inland fisheries but encompasses a much wider perspective because the information about handling of fish is mainly available from large scale marine fisheries. Consequently, the information must be interpreted with care when applied to inland fisheries.

In recent years concerns have been raised about the possible negative effects of commercial fisheries on fish stocks. Most of these concerns have been about the escape and post-release mortality. This mortality has been acknowledged in several fisheries, e.g. fish escaping through the meshes of a bottom trawl, fish discarded from a hand-line fishery or slipping by purse seines. A number of factors affect the mortality of discarded bycatch. One main factor is the selected gear type (Table 1). Problems with trawled gear depend on tow duration, catch composition and weight of the catch (Pálsson *et al*., 2003). In catch and release fisheries problems depend on bait type, size of the fish and water temperature (Chopin and Arimoto, 1995). Defining escape and post-release mortality may be essential for stock assessments and for the improvement of fishing gear selectivity.

Table 1. Mortalities of fish escaping from fishing gears (based on Chopin and Arimoto, 1995)

Fishing gear	Species	Mortality (%)	Reference
Surrounding gear	*Scomber* sp.	0-90	Lockwood *et al*., 1983
Seine nets	Cod, haddock	0, <10	Soldal and Isaksen, 1993
Seine nets	Striped bass	1-17	Dunning *et al*., 1989
Seine nets	Freshwater drums	84.7	Fritz and Johnson, 1987
Trawls	Various	Varied	Wassenberg and Hill, 1989
Trawls	Haddock, whiting	9-27, 10-35	Sangster and Lehmann, 1989
Trawls	Gadoids	14-100	Main and Sangster, 1990
Trawls	Haddock, whiting	9-27, 10-35	Anonymous, 1993
Trawls	Cod, haddock	0, 1-32	Soldal *et al*., 1991
Trawls	King and Tanner crabs	21-22	Stevens, 1990
Trawls	Lobster	21	Smith and Howell, 1987
Trawls	Atlantic halibut	65	Nelson *et al*., 1989
Trawls	Herring	85-90, 75-85	Suuronen *et al.*, 1993
Trawls	Scup, flounder, cod	0-50, 0-15, 0	DeAlteris and Reifsteck, 1993
Trawls	Haddock, whiting	48-89, 60-86	Sangster *et al*., 1996
Trawls	Herring	30-72	Suuronen *et al*., 1996
Trawls	Sablefish, walleye pollock	0-25, 0-100	Olla *et al*., 1997
Dredges	*Pecten* sp.	78-88	McLoughlin *et al*., 1991
Dredges	*Placopecten* sp.	10-17	Caddy, 1973
Hoop nets	Paddlefish	35	Dieterman *et al*., 2000
Gillnets and entangling nets	Pacific salmon	80-100	Thompson *et al*., 1971
Gillnets and entangling nets	Pacific salmon	80	Thompson and Hunter, 1973
Gillnets and entangling nets	*Clupea* sp.	1.9	Hay *et al*., 1986
Gillnets and entangling nets	Coho salmon	35-70	Buchanan *et al*., 2002
Longlines	Pacific halibut	3-34	Kaimmer and Trumble, 1998
Handlines	Cod	32-54	Pálsson *et al*., 2003

In addition to escape and post-release mortality, other negative effects of commercial fisheries have been identified. Several capture methods induce stress responses. Striped bass (*Morone saxatilis*) caught in gill nets and fyke nets exhibit significantly increased lactate, glucose, potassium and P_{CO2},

but lowered blood pH. Both capture methods induced secondary stress responses, although responses were greater in gillnetted fish (Hopkins and Cech, 1992). Capture of sea bream (*Pagrus major*) by hook and line and trammel nets significantly elevated cortisol concentrations (Chopin *et al*., 1996).

2.2 Actions for commercial inland fisheries

With regard to the welfare of the fishes in commercial (inland) fisheries the following actions should be taken into account.

- All kinds of handling of landed fish on the vessel: sorting, discards, slaughtering. This not only refers to the mortality of the fishes, but also to the conditions in which the fishes are kept after capture (in tanks, buckets or alive without being kept in water), transported (density in tanks, temperature and oxygen conditions, tranquilizers) and brought to the market.
- The effects of the different fishing methods in respect to animal welfare. This refers to the optimization of fishing equipment and fishing methods to improve conditions for the captured fishes.

2.3 Fisheries management

Inland fisheries have a high degree of inter-relatedness with other users of the aquatic resource. In most areas of the world, the principal impacts on fisheries do not originate from the fishery itself, but from outside the fishery. Most aspects directed at the conservation and sustainability of the resource are under control of a wide range of interests with superior social and financial implications for society. The fishery has to be managed within the constraints imposed by otherl sectors and, while there is space for conventional management of fisheries, much attention is now paid to techniques for mitigation or rehabilitation of external impacts (FAO, 1997). In this context, the issue of fish welfare arises where the external activities have serious negative effects on fishes. These problems result from social and economic uses of river systems, and include:

- effects of hydro power plants;
- effects of damming on (migratory) species;
- flow regulation;
- river channelization;
- industrial and urban discharges (i.e. pollution);
- navigation;
- water abstraction.

Besides the negative effect on migratory movements within the river system, resulting in the disappearance of species like Atlantic sturgeon, salmon from rivers in Europe, the hydropower plants cause serious damage to down-stream migrating fish like eel.

Several measures in fisheries management affect fish welfare (Cowx and Gerdeaux, 2004; Cooke and Cowx, 2006). The well-being of individual fishes can be impaired and the reproductive potential of fish populations can be diminished. Several topics relevant to fish welfare can be identified in the management of recreational fisheries:

- Catch and release fisheries;
- Put and take fisheries;
- Stocking;
- Use of live bait fish;
- Keepnets;
- Harvest: the process of catching, handling and slaughter of wild fish;
- Protection from predators;
- Disease and parasites;
- Eradicating fish stocks (e.g. by poisoning);
- Biomanipulation of fisheries.

2.4 Catch and release fisheries

A growing public attention to animal welfare has been seen in the last decades. In recent years recreational fisheries has also become a subject of attention. In response to the growing practice of "Catch and Release" fishing, concerns have been raised about the physiological effects of angling and subsequent hooking mortality. Table 2 provides an overview of hooking mortality caused by angling in different fish species. Several studies investigated factors influencing fish welfare during angling. These factors can be divided in physiological factors, environmental factors and fishing method factors.

Table 2. Mortalities of angled fish (based on Chopin and Arimoto, 1995)

Fishing gear	Species	Mortality (%)	Reference
Hooks and lines	*Oncorhynchus* sp.	12-69	Vincent-Lang *et al*., 1993
Hooks and lines	*Oncorhynchus* sp.	34-52, 40-86	Parker *et al*., 1959
Hooks and lines	*Salmo* sp.	0	Wydoski, *et al.*, 1976
Hooks and lines	Rainbow trout	39, 3-5	Barwick, 1985
Hooks and lines	Cutthroat trout	0.3, 3	Schill *et al.*, 1986
Hooks and lines	Trout	0-8.6	Dotson, 1982
Hooks and lines	Smallmouth bass	0, 11	Clapp and Clark, 1989
Hooks and lines	*Esox* sp.	3	Schwalme and Mackay, 1985
Hooks and lines	Chinook salmon	9-32	Wertheimer, 1988
Hooks and lines	Pacific salmon	41	Milne and Ball, 1956

2.5 Physiological effects

Angling of a fish will result in a classical stress response characterised by an activation of the hypothalamus-pituitary-interrenal cells axis (HPI-axis), resulting in an increased plasma cortisol concentration (Ruane, 2002). Hooking and playing of red drum (*Sciaenops ocellatus*) resulted in increased plasma cortisol, plasma glucose, plasma lactate and plasma osmolality (Gallman *et al.*, 1999). Similar stress responses have been observed in blue mao mao (*Scorpis violaceus*; Lowe and Wells, 1996) carp (*Cyprinus carpio*; Pottinger, 1998), largemouth bass (*Micropterus salmoides*; Gustaveson *et al*., 1991) and kahawai (*Arripis trutta*; Davidson *et al*., 1997). Increased plasma adrenaline, plasma noradrenaline, haemoglobin concentration and haematocrit have also been observed (Lowe and Wells, 1996). Furthermore, cardiac output, heart rate and stroke volume may increase after hooking and playing during angling simulations (Schreer *et al.*, 2001).

Tertiary stress responses may result in growth retardation and impaired reproduction. Growth of smallmouth bass (*Micropterus dolomieu*) was negatively related to the number of hooking events (Clapp and Clark, 1989). However, this relationship was not noticeable among older fish. An effect on reproduction was found in snapper (*Pagrus auratus*). Angling significantly effects sex steroids 17β-estradiol, testosterone, cortisol and 17α-, 20β-dihydroxy-4-pregnen-3-one and suppresses ovulation (Carragher and Pankhurst, 1991). Suppressed estradiol levels were found in rainbow trout (*Oncorhynchus mykiss*; Pankhurst and Dedual, 1994).

Mortality of fish may occur after extreme physiological disturbance. Survival of the fish is dependent on the amount of stress caused by hooking and playing. Hooking location, water temperature and playing time are important factors affecting survival (Nelson, 1998; Thorstad *et al.*, 2003; Bettoli and Osborne, 1998). Hooking of fish in vital organs (oesophagus, gills) may result in high mortality. A mortality rate of 96 percent was found in deeply hooked Atlantic salmon (*Salmo salar*; Warner, 1979). In brown trout (*Salmo trutta*) highest mortalities were found in fish hooked in oesophagus or stomach (46.6 percent) or gills (39.6 percent) (Hulbert and Engstrom-Heg, 1980). In smallmouth bass (*Micropterus dolomieu*), 75 percent of the mortality resulted from fish being hooked in the oesophagus (Clapp and Clark, 1989).

Handling may also influence the welfare of fishes. Handling the fish will often result in air exposure, inhibiting oxygen and CO_2 exchange. The duration of handling will affect survival (Thorstad *et al.*, 2003). This duration depends on factors such as the experience of the angler, fish size and the type of

terminal tackle. Handling may take a relative long time when hooks are engorged or fish are manipulated for measurement of length and weight or for photographing. Besides oxygen deprivation, fish may lose scales and mucus.

Handling also induces physiological disturbances. In rock bass (*Ambloplites rupestris*), handling and air exposure resulted in increased hearth rate and stroke volume (Cooke *et al*., 2001). Recovery times varied between 2-4 hours depending on total air exposure. However, handling and air exposure did not lead to hooking mortality. Several other studies showed a minimal effect of handling stress on hooking mortality. No correlation was found between lake trout (*Salvelinus namaycush*) hooking mortality and the degree of handling (Loftus *et al*., 1988). No mortality was observed in fish kept out of the water for as long as five minutes. Similar results were found for spotted sea trout (*Cynoscion nebulosus*; Hegen *et al*., 1987). However, mortalities were found in rainbow trout (*Oncorhynchus mykiss*) after exposure to exercise and air (Ferguson and Tufts, 1992). In their study, no control fish died, 12 percent of exercised fish died and fish exposed to exercise and air exposures of 30 and 60 seconds, respectively, exhibited 38 percent and 72 percent mortality.

Different retention gears are used for storing the fish until release. Retaining rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*) and carp (*Cyprinus carpio*) in keepnets causes a significant stress response, resulting in an increased plasma cortisol, plasma glucose and disturbed osmoregulation (Pottinger, 1998; Ruane, 2002). However, in these studies no mortalities were observed after retention in keepnets. Long-term effects of keepnet retention were also studied. Growth and survival were not affected in carp (*Cyprinus carpio*), roach (*Rutilus rutilus*), bream (*Abramis brama*), rudd (*Scardinius erythrophthalmus*) and ide (*Leuciscus idus*) after a 4-hour retention (Raat *et al.*, 1997). Indirect mortality may occur due to fungal lesions associated with abrasion (Cooke and Hogle, 2000). Other factors affecting survival after keepnet retention are water temperature and changing water quality (Pottinger, 1997; Hartley and Moring, 1993; Cooke and Hogle, 2000). Other retention gears used, such as gill stringers, may cause gill damage, which affects survival (Cooke and Hogle, 2000). The literature on fishes kept in keepnets is reviewed in the papers by Schreckenbach and Wedekind (see Bibliography in Appendix).

2.6 Environmental effects

An environmental factor known to affect fish welfare during angling is temperature: mortality increases with temperature, and lower mortalities at lower temperatures are associated with lower metabolic rates and physiological activity. Hooking mortality of striped bass (*Morone saxatilis*) during catch and release angling was 14 percent in November and December (average temperature 15ºC) but 67 percent in July and August (average temperature 27–31ºC) (Bettoli and Osborne, 1998). Cooke and Hogle (2000) found an increasing mortality of smallmouth bass (*Micropterus dolomieui*) with increasing water temperature (reaching 61 percent at 21.8ºC). Comparable results were found in striped bass (*Morone saxatilis*; Nelson, 1998). Survival rates of angled Atlantic salmon (*Salmo salar*) were 20 percent at 20±2ºC, 100 percent at 16.5±1ºC and 100 percent at 8±1ºC (Anderson *et al*., 1998). Mortality of brook trout (*Salvelinus fontinalis*) caught on single- and treble-hook artificial lures was positively correlated to water temperature (ranging between 5.6-17.8ºC; Nuhfer and Alexander, 1992). However, Hegen *et al.* (1987) found similar mortalities of spotted sea trout (*Cynoscion nebulosus*) between summer (26.9 percent) and winter (16.9 percent). Furthermore, channel catfish (*Ictalurus punctatus*) mortality in reservoirs was unrelated to water temperature (Ott and Storey, 1993).

Another factor influencing the fish welfare during angling is dissolved oxygen. Anglers using boats tend to store their fish in boat live-wells. This may result in the storage of fish in these wells for long periods at high densities. Poor water quality (low dissolved oxygen) and metabolites (ammonia) resulting from these high fish densities may significantly affect the mortality of caught and released fish. These problems may be more severe during warmer periods of the year when the dissolved oxygen content of the water is even lower. High fish density is an important factor in largemouth bass (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieui*) mortality rates (Hartley and Moring, 1991). However, Schramm *et al*. (1987) did not find a relation between mortality rates and

fish density, although they reported initial, delayed and total mortalities of 9, 6 and 14 percent, respectively.

Salinity is a third factor to influence the welfare of angled fishes: hooking mortality in striped bass (*Morone saxatilis*) increases with decreasing salinity. Mortalities of striped bass (*Morone saxatilis*) caught using similar gear and techniques were 1.87, 38.81 and 70.39 percent at salinities of 8.0, 2.3 and 0.0 ppt., respectively (May, 1990).

2.7 Effects of fishing methods

Different types of hooks are used by anglers and they have differing effects. For example, longer handling times are expected in fishes caught on treble hooks because of multiple hook penetration, and added stress and difficulty associated with hook removal (Falk *et al*., 1974). However, hooking mortality varies between single and treble hooks in different taxonomic groups. Brook trout (*Salvelinus fontinalis*) mortality was significantly higher in fish caught on single hooks than fish caught on treble hooks (8.3 and 2.4 percent, respectively; Nuhfer and Alexander, 1992). Hooking mortality of cutthroat trout (*Oncorhynchus clarki lewisi*) was 59 percent for fish caught on single hooks against 35-48.1 percent for fish caught on treble hooks (Titus and Vanicek, 1988). Payer *et al*. (1989) found walleye (*Stizostedion vitreum*) mortality was significantly higher in fish caught on baited hooks compared with those caught on treble-hook artificial lures.

However, no differences in hooking mortality was found between single and treble hooks in other studies. Mortality of red drum (*Sciaenops ocellatus*) caught on single and treble hooks was similar (4.92-3.33 percent, respectively) Similar results were found for cutthroat trout (*Oncorhynchus clarki lewisi*) caught with treble-hook artificial lures and baited single hooks (Hunsaker *et al*., 1970) and for spotted sea trout (*Cynoscion nebulosus*) caught on single (4.69 percent) or treble (10 percent) hooks (Matlock *et al*., 1993).

CHAPTER 3 EFFECTS OF AQUACULTURE

Aquaculture has grown substantially since the early 1990s. In 2001, 31 percent of all fish eaten in the European Union was supplied by aquaculture (European Commission, 2001). In recent years, attention has focused also on animal welfare aspects of aquaculture. Several aspects of husbandry practices in aquaculture have the potential to impact on the welfare of cultured fishes (e.g. site selection, confinement, stocking density, water quality, slaughter). As discussed in section 1.3 no single parameter can provide adequate representation of an animal's welfare status.

3.1 Handling

In aquaculture, fish may be handled during weighing, grading, vacinating and comparable husbandry practices. This physical disturbance evokes physiological stress responses in several fish species (Pickering, 1998; Waring *et al*, 1996; Grutter and Pankhurst, 2000). There is also evidence showing that transportation can affect the disease resistance of a fish (Stangeland *et al*., 1996; Mazur and Iwama, 1993), probably as a result of the immunosuppressing effect of corticosteroids release during stress response. Additional affects may occur through confinement or transportation associated with handling practices.

Short-term crowding or confinement may be used in aquaculture during weighing, grading and comparable husbandry practices. Physical confinement has been shown to increases plasma cortisol and glucose levels in most commercially valuable fish species (Barnett and Pankhurst, 1998; Montero *et al*., 1999; Ortuño *et al*., 2001; Vijayan *et al*., 1997). Furthermore, it has an effect on the immune system of several species of fish (Garcia-Garbi *et al*., 1998; Mazur and Iwama, 1993; Vazzana *et al*., 2002). Reproduction is also negatively affected by confinement stress (Clearwater and Pankhurst, 1997). Finally, crowding can result in elevated fin erosion (Winfree *et al*., 1998; North *et al*. *Aquaculture* in press).

During transportation fishes are exposed to a range of stressful stimuli (handling, netting, loading at high densities, unloading, inadequate water exchange and poor water quality) that may cause adverse physiological reactions affecting essential life functions (Schreck *et al*., 1995; Erikson *et al*., 1997; Garcia *et al*., 2000; Paterson *et al*., 2003; Barton, 2000; Bandeen and Leatherland, 1997; Rouger *et al*., 1998; Iversen *et al*., 1998; Sandodden *et al*., 2001; Robertson *et al*., 1988). In 1986, EIFAC published a technical paper on the transport of live fish (Berka, 1986) containing guidelines. Prolonged recovery periods may be necessary after transportation. There is a need for safeguards in practise (e.g. water quality monitioring equipment) and standard operating procedures (e.g. starving fish before transport to minimise stress).

3.2 Stocking density

Stocking density is a factor in aquaculture that is commonly perceived to affect the welfare of fish. According to Ellis *et al*. (2002) and North (personal communication) it is almost certainly going to continue to be a major issue of contention that will be used against the aquaculture industry.

The rearing of fish under crowded conditions, such as high stocking density (defined as the weight per unit of volume, kg m^{-3}) or loading (defined as the weight per unit of flow rate, kg L^{-1} min), negatively affects growth (Pickering and Stewart, 1984; Procarione *et al*., 1999), and influences metabolite levels (Vijayan *et al*., 1990) and immune functions (Yin *et al*., 1995; Tort *et al*., 1996) in a number of fish species. This can be indirectly linked to increased competition for food, environmental factors such as deterioration in water quality, or more directly, due to an induction of a stress response through activation of the HPI-axis. Elevation of plasma cortisol and glucose levels was found for many fish species subjected to crowding (Yin *et al*., 1995; Tort *et al*., 1996; Rotllant and Tort, 1997; North *et al*., *Aquaculture* in press). However, not all fish species react negatively on increased stocking densities. Arctic charr (*Salvelinus alpinus*) and halibut (*Hippoglossus hippoglossus* L.) reacted positively to increased stocking densities (Jørgensen *et al*., 1993; Greaves, 2001; Alanärä and Brännäs, 1996). In addition, social interactions of fish strongly depend on stocking densities.

The review of Ellis *et al*. (2002) about the relationships between stocking density and welfare in farmed rainbow trout gives an insight in the key issues involved. Increased stocking density does not appear to cause prolonged crowding stress in rainbow trout. However, commonly reported effects of increasing density are reductions in food conversion efficiency, nutritional condition and growth, and an increase in fin erosion (North *et al*., *Aquaculture* in press). Such changes, and especially the effects of density on fin damage, which is the most consistently reported affect in most studies, are indicative of a reduced welfare status. According to the authors there is dispute as to the cause of the observed effects of increasing density, with water quality deterioration and/or an increase in aggressive behaviour being variously proposed. Turnbull *et al*. (2005) in a study on cage farmed Atlantic salmon concluded, that stocking density can influence the welfare of the fish in production cages. However, this is only one of the husbandry factors that have an influence on their welfare and density on its own cannot be used to accurately predict or to control welfare.

3.3 Water quality

Ellis *et al*. (2002) summarized the importance of water quality in aquaculture. This section is therefore mainly based on the review of these authors.

Water is the medium in which fish have to meet both their physiological and spatial needs. The water is the source of oxygen and serves to dilute and remove metabolic wastes. Theoretically, increasing density will degrade water quality because greater numbers of fish are respiring and metabolizing in a given volume of water. Attention has been drawn to oxygen and ammonia as the water quality parameters generating the observed effects of increasing density (e.g. Rosenthal *et al.*, 1984). However, with the increasing use of recirculating and oxygenation systems, it has been recognized that carbon dioxide and nitrogenous waste products other than ammonia can also have adverse effects. In addition, an increase in density will increase the amounts of suspended solids in the water column - due to both greater faecal production and more fish movement (which will prevent particles from settling). Alabaster and Lloyd (1980), Boyd (1982), Meade (1985) and Wedemeyer (1996) have comprehensively reviewed water quality in relation to freshwater fish.

3.3.1 Dissolved oxygen

Dissolved oxygen (DO) is essential for fish respiration. It is assumed that above a critical DO concentration, consumption is independent of concentration. However, below the critical level, oxygen consumption is increasingly restricted by concentration, until the fish can only extract that amount which is required for standard metabolism. Below this, asphyxia occurs at the lethal level. Recommendations for a minimum DO level for farmed trout to avoid sub-lethal effects are similar to levels recommended for warm water fish, typically 5 to 6 mg L^{-1} (e.g. Shepherd and Bromage, 1988). In contrast, Wedemeyer (1996) has suggested a minimum of between 7 and 9 mg L^{-1} depending upon temperature, and Alabaster and Lloyd (1980) suggested an annual 50 percentile value of 9 mg L^{-1} for wild salmonids.

3.3.2 Ammonia

Fish excrete nitrogen as ammonia, which reacts with water to form ammonium ions in an equilibrium reaction which is temperature and pH dependant (Boyd, 1982; Piper *et al.*, 1982).

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

The un-ionized ammonia (UIA) is highly toxic to fish, whereas ionized ammonium (IA) is considered relatively non-toxic (Alabaster and Lloyd, 1980; Boyd, 1982; Piper *et al.*, 1982). This difference in toxicity is thought due to the greater potential for UIA to difuse across the gill membrane (Smart, 1981). The two forms are not differentiated by analytical methods, which measure total ammonia. In order to gauge whether levels are likely to be detrimental to fish, total ammonia needs to be converted to UIA concentration using published tables of percentage UIA in relation to temperature and pH (Boyd, 1982; Piper *et al.*, 1982). Trout are amongst the most sensitive fish species to UIA (Alabaster and Lloyd, 1980). Reports of levels of UIA that affect rainbow trout are variable, being dependent upon environmental factors (e.g. DO and CO2 concentrations, temperature, concentration of other

ions, prior exposure), duration of exposure and the ontogenetic stage (Alabaster and Lloyd, 1980; Meade, 1985).

3.3.3 Effects of deterioration in water quality on welfare

The potential for water quality deterioration to lead to acute welfare infringement is well known. Increasing density increases the probability of episodic mortality when water supply, aeration or oxygenation systems fail and therefore requires greater supervision and appropriate back-up equipment (Piper, 1970; Pickering *et al.*, 1991). Water quality deterioration may also act chronically to reduce welfare status. There is evidence that both low DO and high UIA levels can act as chronic stressors to rainbow trout, elevating plasma cortisol levels (Scapigliati *et al*., 1999). Pickering *et al.* (1991) noted that plasma cortisol levels were raised in fish exposed to low DO levels, being higher in fish held at a higher density. Interpretation is complicated by the facts that plasma cortisol levels change with exposure duration (Swift, 1981), and various linked water quality factors (pH, UIA, DO, CO2) interact to affect the magnitude of the stress response (Donaldson, 1981).

Stress in fish farming can be associated with a variety of environmental conditions, such as reduced oxygen level (Wedemeyer, 1996;), abrupt variation in temperature (Wagner *et al*., 1997; Davis and Parker, 1990), appearance of contaminants (Wedemeyer, 1996) or elevated ammonia levels.

A common sublethal effect of ammonia is damage to the gills (Alabaster and Lloyd, 1980). Rosenthal *et al.* (1984) related a decrease in length of the primary gill lamellae to increasing ammonia and density. Soderberg *et al.* (1984) and Soderberg (1985) related observed pathologies of secondary gill filaments (epithelial oedema, blood filled aneurysms, hyperplasia, fusion) to UIA levels. Ammonia exposure has also been shown to decrease the number of erythrocytes (Alabaster and Lloyd, 1980). Such effects on the gills and blood may account for the increased ventilatory rate observed in response to ammonia (Alabaster and Lloyd, 1980). Soderberg *et al.* (1984) and Soderberg (1985) associated a reduction in vacuolation of liver hepatocytes with chronic exposure to ammonia, and suggested that this was due to a reduction in food intake. Reduced food intake would reduce growth rate, which is a common effect of chronic exposure to ammonia (see Soderberg *et al.*, 1983; Meade, 1985).

Bosakowski and Wagner (1994) correlated UIA levels with increasing fin erosion. Soderberg *et al.* (1983) correlated mortality with ammonia levels and suggested that exposure to ammonia predisposed the fish to infection by ectoparasitic protozoans. In an epidemiological survey of commercial farms, Ortega *et al.* (1996) demonstrated ammonia level as a factor affecting the risk of bacterial infection. Indeed low DO and elevated UIA levels are commonly associated with a range of diseases (Wedemeyer, 1996). Water quality deterioration therefore has the potential to reduce welfare status by reducing nutritional status and causing physiological stress, injury to gills and fins and increasing susceptibility to disease.

One of the possible secondary effects of poor water quality is the development of cataracts. Cataracts have been mainly studied in salmonids (Bjerkås *et al*., 2001; Bjerkås and Bjornestad, 1999; Iwata *et al*., 1987), but are also found in seabass and sea bream (Bjerkås *et al*., 2000). They can be caused by variations in water temperature (Bruno and Raynard, 1994; Bjerkås and Bjornestad, 1999; Bjerkås *et al*., 2001) or toxic agents in the water (Fraser *et al*., 1990). However, these cataracts may also be caused by nutritional deficiencies (Hargis, 1991), parasites (Ashton *et al*., 1969), exposure to sunlight (Cullen *et al*., 1994), hereditary factors (Kincaid, 1989) or rapid growth (Waagbø *et al*., 1996; Waagbø *et al*., 1998).

3.3.4 Effect of environmental factors on water quality deterioration

It is well recognized that the biomass of fish that any culture system can support depends upon environmental factors. Carrying capacity is determined by the rates of provision and consumption of DO, and the production, removal and toxicity of metabolic products (Piper, 1970). Hence carrying capacity is dependent upon factors such as water exchange rate, temperature, pH, fish size and feeding rate (Piper *et al.*, 1982). The quality and amount of inflow water will determine whether density results in water quality deterioration to sub-lethal or lethal levels. Natural water sources vary in DO,

NH3 and CO2, and the quality of inflow will be of greatest significance when farms reuse water, either via passage through successive systems or by recirculation. Inflow rate and system volume will determine the rate of water replacement, and hence provision of DO and dilution of metabolic wastes. The importance of inflow rate in a.ecting the biomass of fish that can be supported is well recognized (Piper *et al.*, 1982). Weight specific metabolic rate is well known to decrease with increasing fish size. DO consumption, therefore, has been reported to decrease with increasing fish size (Piper *et al.*, 1982). It is therefore commonly assumed that the physiological requirement for water decreases with increasing fish size. Temperature is a vital factor, determining the rate of metabolism of fish, solubility of DO, and the toxicity of ammonia (Alabaster and Lloyd, 1980). Temperature and fish size have been factored into estimates of carrying capacity (Piper, 1970). Similarly, pH will interact with density by altering the equilibrium of the two forms (IA, UIA) of ammonia (Israeli-Weinstein and Kimmel, 1998). Feeding reduces the DO level of the water (Wagner *et al.*, 1995). It has been suggested that densities may be constrained by limiting the amount of food that is fed (Wedemeyer, 1996). DO levels in the water are commonly increased by aeration and oxygenation. Traditionally, paddle wheels or air stones were used to aerate, although the addition of pure oxygen is now becoming increasingly common. Numerous recent studies have demonstrated that such supplemental oxygen enables trout rearing at higher densities thereby increasing the overall production potential of a system.

3.4 Social interaction

Ellis *et al*. (2002) in their review of 43 studies on the effects of density on production concluded that only inferential evidence exists that aggressive behaviour generates the observed effects of increasing density, whereas there is direct experimental evidence that water quality degradation is responsible. They also conclude that the potential for welfare to be detrimentally affected by non-aggressive behaviour interactions (abrasion, collision, obstruction) and low densities (due to excessive aggressive behaviour and a poor feeding response) have been largely overlooked. According to the authors legislation directly limiting stocking densities is likely to be unworkable, and a more practical option might be to prescribe acceptable levels of water quality, health, nutritional condition and behavioural indicators.

Social interactions have significant influence on the stress responses of fishes. Classification of stressors affecting behavioural, physiological and performance responses:

- Animal-related factors: genetics, coping styles, sex, age;
- Nutritional factors: composition, feeding strategy;
- Water quality related factors: temperature, pH, O2;
- Environmental factors: stocking density, photo-period, light intensity.

Indicators of behavioural stress reponses are:

- Swimming activity;
- Air breathing;
- Agonistic behaviour;
- Escaping behaviour;
- Feeding behaviour;
- Occurrence of stereotypes.

Hierarchies are formed, comprised of a group of dominant individuals at the top, followed by a number of sub-dominants and thereafter a number of subordinates with low rank positions in the hierarchy (Symons (1970). An elevation of plasma cortisol concentration is characteristic for subordinate fishes (Laidley and Leatherland, 1988; Pottinger and Pickering, 1992; Øverli *et* al., 1999). Other physiological changes shown by subordinate fishes are decreases in weight (Pottinger and Pickering, 1992), hepatic glycogen content (Ejike and Schreck, 1980), and disease resistance (Peters *et* al., 1988) and increases in interrenal cell activity (Noakes and Leatherland, 1977), plasma glucose concentration (Peters *et* al., 1988) and standard metabolic rate (Sloman *et al*., 2000). Furthermore, aggression among fishes may cause injury, especially when competition for food is strong (Greaves

and Tuene, 2001). North et al. (*Aquaculture* in press) demonstrated that stocking density had a significant effect on fin condition.

3.5 Light regime

In aquaculture lights are used to control smoltification of Atlantic salmon, promote growth (most salmonids), reduce maturation (salmon, cod, haddock) and brood stock management (most other species). Light plays an important role in the growth and development of fishes. Light can influence the behaviour of fishes, through variation in intensity, wavelength and photoperiod. This influence differs between species. Bromage *et al*. (2001) summarized the environmental regulation of maturation in farmed finfish with special reference to the role of photoperiod and melatonin. According to these authors current evidence indicates that photoperiod is the principal proximate cue in many fish and that this entrains an endogenous rhythm which in turn controls reproduction. This information is thought to be transmitted to the reproductive axis by diel and seasonal changes in melatonin. It is probably that temperature, nutritional status or size together with other factors act in a permissive way, possibly by gating mechanisms, to enable maturation to proceed.

Haddock larvae (*Melanogrammus aeglefinus*) showed better growth under higher light intensity (Downing and Litvak, 1999). By contrast, halibut (*Hippoglossus hippoglosus*) yolk-sac larvae developed abnormally in the presence of light (Bolla and Holmefjord, 1988). Studies on the effect of photoperiod on the growth and survival of fish larvae have produced mixed results. In a continuous light regime, rabbitfish larvae (*Siganus guttatus*; Duray and Kohno, 1988) and gilthead sea bream larvae (*Sparus aurata*; Tandler and Helps, 1985) grow and survive better while seabass (*Dicentrarchus labrax*; Barahona-Fernades, 1979) larvae exhibit reduced growth and survival.

According to North (personal communication) in terms of direct effects on fish welfare, there are studies that showed that lights can be used to adjust swimming depth and stocking density in Atlantic salmon (Juell and Fosseidengen, 2004). There are lots of aspects of welfare that are negatively affected when fish pass through sexual maturation, so if this can be controlled by lights there is the argument that lights can be used to promote welfare. North further commented that although there isn't much literature to date, the increased use of artificial lights in the industry and rapid developments in lighting technology are sure to make this an issue for the future.

3.6 Slaughter

All slaughter methods are stressful, but some are better than others (Robb *et al*., 2000). Fishes can be killed by injectable agents, external agents, carbon dioxide, physical methods or cooling. However, not all of these methods are used in commercial aquaculture. Methods used in aquaculture are:

- Percussive stunning by blow to the head: carried out manually using a hand-held club called a "priest" for stunning, followed by cutting of the gill arches to bleed the fish.
- Carbon dioxide stunning: fish are placed in a seawater bath saturated with carbon dioxide. This environment is highly avers with fish being observed to shake their heads and tails vigorously trying to escape (Robb *et al*., 2000). Movement ceases after 30 seconds, but sensibility may not be lost for 4 – 5 minutes (Robb *et al*., 1997). Bleeding after CO_2 stunning is essential to avoid fish recovering.
- Bleeding without prior stunning: gill arches are cut with a knife and fish bleed to death.
- Electrocution: electric current is passed through the water containing the fish. The electric current must be sufficient to stun and kill the fish, otherwise the fish are only paralysed and could suffer considerably. This method can also cause spinal fractures and haemorrhaging.
- Asphyxiation in air or on ice: fishes are hauled out of water and allowed to die through suffocation in air. Alternatively, they are removed from water into bins containing ice.

Many of the slaughter methods currently used for farmed fish (e.g. death in air, death in an ice slurry, freezing, bleeding, carbon dioxide narcosis in combination with bleeding) do not provoke immediate unconsciousness until death occurs (Robb and Kestin, 2002; Van de Vis *et al.*, 2003). When a fish is effectively stunned (immediate and permanent loss of consciousness) prior to killing, the slaughter process may be considered humane. It has been established that percussive stunning (a blow to the

head by using an instrument), captive needle stunning (injection of air under pressure into the brains) and the application of electrical current (provided that appropriate conditions are used) can provoke immediate and permanent loss of consciousness in fish (Robb and Kestin, 2002; Lambooij *et al.*, 2002; Van de Vis *et al*., 2003). Several researchers reported that various species recovered from the application of an electrical current for one second (Lambooij *et al*., 2002, Lines *et al*., 2002; Robb and Kestin, 2002; Van de Vis *et al*., 2003b). Recovery can be prevented when fish are exposed to to electricity for 10 seconds or more and subsequently a killing method, e.g. rapid cooling is applied. This combination of methods results in permanent loss of consciousness until death occurs.

In Australia, a chemical substance, eugenol, is added to the water to stun fish prior to killing. Eugenol is a food grade substance, which is based on clove oil. Barriers to its use in, for instance the United Kingdom, include the cost of overcoming the legislative requirements to introducing a new medication and the possible public response to eating fish that could be perceived as having been poisoned (Lines *et al*., 2003).

Small warm-water fishes, such as seabass, killed by chilling on ice water had lower plasma glucose and lactate levels and showed less marked behavioural responses than those killed by other methods, especially asphyxiation (Poli *et al*, 2002; Skjervold *et al*, 2001). Electrocution may be less harmful for larger fishes such as trout (FSBI, 2002).

For practical application of electrical methods one has to take into account the effect that water chemistry has on the requirements for current and voltage for stunning fish (North, personal communication). However, it is anticipated that electrical methods for stunning will be feasible for industrial application, as the large numbers of individual fish that need slaughtering after harvest make individual percussion or captive needle stunning and bleeding impractical. Percussive stunning of Atlantic salmon is an exception, as equipment for automated percussive stunning was developed, especially for this species by the Australian company Sea Food Innovations in collaboration with Marine Harvest, of the major producer of Atlantic salmon in Scotland. In 2002, Marine Harvest won a welfare award for introducing percussive stunning as a method for humane slaughter of Atlantic salmon (Anonymous, 2002). For other fish species, which differ substantially in anatomy and morphology, high-speed machinery to separate, orientate, percuss and bleed them would be complex and expensive (Lines *et al*., 2003), as the developed equipment for salmon is not been adapted to other species such as turbot. Moreover, for fish species such as gilt-head seabream and eel, percussive stunning is not feasible without severe damage to the head, which is not acceptable for the industry (Van de Vis *et al*., 2003). For fish species with a thick skull, such as African catfish, the application of percussive stunning does not result in immediate loss of consciousness and is therefore unfit for use (Van de Vis and Lambooij, unpublished results).

To date, at least one device is commercially available for electrical stunning of Atlantic salmon (Roth, pers. comm.). For rainbow trout a prototype for electrical stunning was developed (Lines *et al*., 2003). However, the stunners were designed primarily for Atlantic salmon and trout and it is unlikely that these stunners are suitable to use for other fish species such as, eel, tilapia, seabass and turbot. This is because the optimal conditions for electrical stunning with respect to immediate loss of consciousness and prevention of carcass damage depend on the fish species. Laboratory trials found that the optimal conditions for eel are an electric field strength of 1250 V/m for 1 s followed by 313 V/m for 5 min in combination with deoxygenation of the water (Lambooij *et al*., 2002; Morzel and Van de Vis, 2003), whereas the established optimal conditions for Atlantic salmon and trout are stunning for 6-12 s in a field of 75 V/m using sinusoidal 1000 Hz current (Robb and Roth, 2002; Roth, et al., 2002) and 60 s in a field strength of 250 V/m, using a sinusoidal 1000 Hz current (Lines *et al*, 2003), respectively. When a 50 Hz sinusoidal current is applied for salmon or trout, this will cause carcass damage, which is not observed if the same current is applied to eel (Morzel and Van de Vis, 2003) or African catfish (Van de Vis *et al*., 2003b). Similar to salmon and trout, applying a 50 Hz current for stunning of turbot also causes carcass damage (Morzel *et al*., 2003). The conditions for effective stunning of tilapia, seabass and turbot, whilst maintaining high product quality standards differ from those established for other species.

In Germany, only electrical stunning is the only permitted method of slaughter for eels (since April 1999). However, the method is not considered humane, according to prescribed conditions in the German legislation, as the eels are not rendered unconscious immediately (Lambooij *et al.*, 2002; Van de Vis *et al*., 2003), and most animals die of exhaustion during application of the electric field. These authors have also established that eel cannot be rendered unconscious permanently when only electricity is used, as prescribed in the German legislation. Equipment available for electrical stunning of eel on a commercial scale, which is designed to meet the demands of the German legislation, is therefore not suitable for humane slaughter. The current method for slaughtering of eel in the Netherlands involves desliming live eels using salt followed by gutting (evisceration). This is also not a humane method (Verheijen and Flight, 1997; Van de Vis *et al.*, 2001). Current industrial methods applied to the other species selected in the proposed research (tilapia, seabass and turbot) are described by Robb and Kestin (2002). For seabass and tilapia, the use of an ice/water slurry is the first step in the slaughter process. The rapid cooling does not result in an immediate loss of consciousness and is most probably stressful, as demonstrated in salmon, eel and gilt-head seabream (Lambooij *et al*., 2002b; Skjervold *et al*., 2001; Van de Vis *et al*., 2003). Tilapia is also killed by removing the fish from water, which results in asphyxiation. Temporary removal from the water is widely used as an experimental stressor in studies of the stress response of fish. Turbot is killed by gutting the gills or the caudal vein and subsequently placing the fish in an ice/water slurry. During the procedure, vigorous activity occurs, which may indicate stress (Morzel *et al*., 2003).

Stressful slaughter methods generally lead to fish flesh that is prone to gaping, with an unappealing colour, a soft texture and a low water holding capacity. More humane handling at slaughter, with reduced stress and physical activity immediately prior to death, results in better carcass quality (Robb and Kestin, 2002). For various farmed fish species, it has been observed that reduced stress at the process of slaughter has a positive influence on the flesh quality (Azam *et al*., 1989; Berg *et al*., 1997; Byrne, 2002; Kestin *et al*., 1995; Roth *et al*., 2002; Sigurgisladottir, 2001; Morzel and Van de Vis, 2003). Reduction of stress at slaughter by applying electrical stunning under specific conditions was found to be humane and generally promote better fish quality (Kestin *et al*., 1995; Lines *et al*., 2003; Morzel and Van de Vis, 2003; Robb and Kestin, 2002).

Research on electrical stunning of fish has resulted in a few patents in the area (Van de Vis, 2001, 2001b; Moller 2001). However, the parameters associated with electrical stunning are complex and a patent is not a protocol for effective electrical stunning with high standards of product quality for fish species. The patents do not contain details for optimal electrical stunning of eel, tilapia, seabass and turbot under various conditions. Major factors that determine whether electrical stunning is optimal (immediate loss of consciousness and high product quality) are the size, shape of the fish, fish species and the electrical conductivity of the fish and of the water). Hence, no satisfactory electrical stunning equipment exists for stunning of eel, tilipia, seabass and turbot on a commercial scale.

CHAPTER 4 FISH IN SCIENTIFIC RESEARCH

4.1 Research and monitoring of fish and fish ecology

Large numbers of fish are sampled or reared for scientific purposes throughout Europe. Only a very small proportion of these are used as experimental animals in the traditional sense (to test for effects of various treatments to predict effects on humans). Most fish are caught in the process of monitoring the status of stocks in rivers and lakes. This shows significant linkages to fish ecology studies and includes resource and stock assessment for studies on population dynamics. There has been some focus on the welfare of fish brought to the laboratories and kept for experimentation, and in most countries rules apply for the application of invasive tagging methods on fish. It is, however, also important to consider the ethical aspects of collecting fish in field studies, both in terms of numbers killed and the methods used.

4.2 Fields of interest

Special fields of interest relating to fish welfare in scientific studies are summarized below based on the discussion during the Workshop on Handling of Fishes in Utrecht, The Netherlands, 24-26 March 2004. Information about the welfare aspects for many of these topics is scarce in the literature.

- Tagging and marking. A relevant report of concerted action within the EU framework FAIR was published (Davenport *et al.*, 2002).
- Stunning and consciousness of fish.
  - Most anaesthetics and related chemicals used for stunning the fishes result in enhanced brain activity and increase in heart rate.
  - In most EIFAC member countries anaesthetics for fisheries use are not certified (in several countries, only MS 222 is certified).
  - There is a need for better understanding and certification of anaesthetics for use in fish handling and fish research (e.g. clove oil, benzocaine).
- Implantation techniques:
  - The practice of implantation differs widely in EIFAC member countries with regard to legislation, experience, procedures and protocols.
  - International cooperation in training for the use of invasive methods and techniques in EIFAC member countries is advisable. EIFAC should play a co-ordinating and stimulating role for initiatives for concerted action.
- Parasite infections.
- Sampling of fishes:
  - There is a need for more information on the fish welfare aspects of fishing methods (e.g. electrofishing, gillnetting).
  - Standardization of fishing methods should take into account basic information on fish welfare aspects.
  - In monitoring and sampling programmes, more attention should be paid to alternative methods, which leave the fishes in their natural environment (e.g. acoustic surveys).

4.3 Electric fishing

Concerns have also been raised about the possible negative effects of electric fishing. Electric fishing is a highly effective and widely used method for collecting fish in streams, rivers or lakes. Although this fishing method has some advantages over other, more conventional, methods it may pose some problems regarding the welfare of fish. Several studies showed that electric fishing causes haemorrhaging to varying degrees depending on species and type of current. Percentages of haemorrhages varied between 0-50 percent in crappies (*Pomoxis* sp.; Dolan *et al*., 2002), 60 percent in brown trout (*Salmo trutta*; Habera *et al*., 1999) and 78-92.4 percent in rainbow trout (*Oncorhynchus mykiss*; Schill and Elle, 2000). Furthermore, spinal injuries were observed in 9-45 percent of studied rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), cutthroat trout (*Oncorhynchus clarki lewisi*) and crappies (*Pomoxis* sp.) (Ainslie *et al*., 1998; Habera *et al*., 1999; Dwyer *et al*., 2001; Dolan *et al*., 2002).

Negative effects were also observed in early developmental stages. Mortality of 85 percent was observed in brook trout (*Salvelinus fontinalis*) eggs 21 days post-fertilization; at 37 days post-fertilization, 14 percent mortality was observed. Furthermore, 7-22 percent physical anomalies were observed (Keefe and Whitesel, 2000). A similar study on Arctic grayling eggs (*Thymallus arcticus*) showed that mortality was affected by electroshock, although the cost to the population was low (Roach, 1999). A study on chinook salmon (*Oncorhynchus tshawytscha*) showed 12-93 percent mortality, with highest mortalities in the early eyed stage (Cho *et al*., 2002).

Despite electric fishing being harmful for fish (and people), it is a good, non-lethal method to sample fish in small rivers and streams, if performed correctly under good conditions (Cowx and Lamarque, 1990). There are several cases where the same individuals are sampled again and again during repeated electric fishing, and recent telemetric studies where fish were caught by electric fishing did not show any negative effects of the capture method (Jepsen and Aarestrup, 1999; Jepsen and Berg, 2002). (The draft document Best Practice in Electric Fishing is posted on the EIFAC Web site at http://www.fao.org/WAICENT/FAOINFO/FISHERY/body/eifac/WGFishMon/default.asp.

CHAPTER 5 LEGISLATION AND REGULATION

To ensure the welfare of fish in aquaculture, commercial fisheries and recreational fisheries, sufficient legislation and regulation is necessary. In this chapter legislation and regulation concerning animal welfare in Europe are reviewed, and to some extent, also discussed with reference to handling of fishes.

5.1 International legislation and regulation

5.1.1 European Union

The European Commission, Directorate-General for Fisheries published a report on "Farmed fish and welfare" (Wolffrom, 2004). This report gives references to the present opinions and regulations on animal welfare and the relevance to fish culture and the various institutions involved in this issue. The following section is taken from this EC report.

Definitions (www.euabc.com)

Resolution: A resolution is a non-binding statement, which defines objectives and makes political declarations. The European Council's resolutions set out the direction of future policy initiatives. Resolutions may be used by the EU Court to interpret laws. They may be referred to as a form of "soft law".

Recommendation: A non-binding decision, which only urges Member States to comply. A Member State cannot be fined for the breach of recommendations.

Convention: Conventions are international legal instruments laying down ethical principles for the transport, the farming, the slaughtering of animals as well as for their use for experimental purposes and as pet. They have been used as a basis for and continue to influence all the relevant legislation in Europe.

Directive: Directives are to be transferred into national law through the Member States' parliaments and governments within 18 months. Through the years, the EU Court has proclaimed many directives to be directly applicable and even declared that countries are liable to pay compensation if they have not implemented a directive in time. Directives are normally transformed into national laws by the national parliaments or most often by the governments through delegated acts.

Decision: A EU decision is binding on the persons, companies or Member States mentioned in the decision. It is not generally binding, as is the case with a regulation.

Regulation: A EU decision that directly binds all Member States and citizens in the whole of the EU. Whereas directives need to be "transformed" into national law, regulations are directly applicable. It is therefore forbidden to change EU regulations when putting them into national laws.

EC legislation and regulations

European Convention for the protection of animals kept for farming purposes *Official Journal* L 323 , 17/11/1978 p. 0014 - 0022

78/923/EEC: Council Decision of 19 June 1978 concerning the conclusion of the European Convention for the protection of animals kept for farming purposes *Official Journal* L 323 , 17/11/1978 p. 0012 - 0013

Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes *Official Journal* L 221 , 08/08/1998 p. 0023 – 0027

2000/50/EC: Commission Decision of 17 December 1999 concerning minimum requirements for the inspection of holdings on which animals are kept for farming purposes (notified under document number C(1999) 4534) (Text with EEA relevance) *Official Journal* L 019 , 25/01/2000 p. 0051 – 0053

Council Directive 91/628/EEC of 19 November 1991 on the protection of animals during transport and amending Directives 90/425/EEC and 91/496/EEC *Official Journal* L 340 , 11/12/1991 p. 0017 - 0027

Council Directive 95/29/EC of 29 June 1995 amending Directive 91/628/EEC concerning the protection of animals during transport *Official Journal* L 148 , 30/06/1995 p. 0052 – 0063

Council Resolution of 19 June 2001 on the protection of animals during transport, Official Journal C 273 , 28/09/2001 P. 0001 – 0001

Council Regulation (EC) No 1040/2003 of 11 June 2003 amending Regulation (EC) No 1255/97 as regards the use of staging points Welfare of animals during transport (details for horses, pigs, sheep and cattle). *Report from the Scientific Committee on Animal Health and Animal Welfare*, adopted on 11 March 2002.
http://europa.eu.int/comm/food/fs/sc/scah/out71_en.pdf

Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare of animals during transport. Adopted 30 March 2004. http://www.efsa.eu.int/science/ahaw/ahaw_opinions/424/opinion_ahaw_01_atrans_ej 44_en1.pdf

Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. (Question N° EFSA-Q-2003-093). Adopted by the AHAW Panel on the 15th of June 2004.
http://www.efsa.eu.int/science/ahaw/ahaw_opinions/495_en.html

5.1.2 European Food Safety Authority (EFSA)

The European Food Safety Authority (EFSA) Scientific Panel on Animal Health and Welfare was asked by the Commission services to report on the welfare aspects of the main systems of stunning and killing in the main commercial species of animals with consideration of Directive 93/119/EC. Species referred to in the Opinion (ESFA, 2004)[3] are: cattle, sheep, pigs, poultry, horses and farmed fish. Welfare aspects of the systems for stunning other species, such as rabbits, deer, ratites or goats, have not been included in the opinion. Procedures appropriate to cattle, sheep, pigs, chickens, turkeys, farmed fish and horses and their related minimum requirements such that unconsciousness and insensibility are induced and poor welfare is minimised, are recommended.

5.1.3 Council of Europe

The European Union has adopted five Conventions drawn up by the Council of Europe (European Treaty Series: ETS) to control the use of animals by humans. The Conventions relate to animal welfare for animals handled during international transport (ETS 65, 1968), animals kept for farming purposes (ETS 87, 1976), animals for slaughter (ETS 102, 1979), animals kept as pet animals (ETS 125, 1987), and vertebrate animals used for experimental and other scientific purposes (ETS 123, 1986).

European Convention for the Protection of Animals During International Transport

The Convention sets compulsory norms for space, ventilation and hygiene, transportation means, food and water, loading and unloading of animals and veterinary assistance for the international transport of animals.

Article 46 of the Convention applies specifically to cold-blooded animals including fishes. It states ”cold-blooded animals shall be transported in such containers, under such conditions, in particular with regard to space, ventilation and temperature, and with such supply of water and oxygen as are considered appropriate for the species. They shall be transported to their destination as soon as possible”.

European Convention for the Protection of Animals Kept for Farming Purposes

This convention is a “framework convention”, which gives principles for the keeping, care and housing of animals, in particular in intensive breeding systems. The Convention applies to animals bred or kept for the production of food, wool, skin or fur or for other farming purposes. It concerns in particular animals in intensive stock-farming systems. In this Convention no special attention is paid to the welfare of fishes. Fish farmed for food are included within the scope of the EU Directive

[3] ESFA, 2004. Summary of Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals (Question number: EFSA-Q-2003-093). http://www.efsa.eu.int/science/ahaw/ahaw_opinions/495_en.html

concerning the protection of animals kept for farming purposes (Council Directive 98/58/EC). There is, however no specific EU regulation relating to the welfare of fish and the Annex to the Directive – which contains detailed provisions – is not applicable to fish. In addition the Council of Europe is developing a recommendation on the welfare of farmed fish. This recommendation is to be adopted under the Convention on the Protection of Animals Kept for Farming Purposes and, in due course, form the basis of detailed EU legislation but this is a long term prospect.

European Convention for the Protection of Animals for Slaughter

The main purpose of the Convention is to help harmonise methods of slaughter in Europe and make them more humane. The first set of provisions impose a number of obligations concerning the treatment of animals in slaughterhouses: use of suitable equipment for unloading animals; no brutalising or ill-treatment of animals, and in particular no striking of sensitive parts of their bodies; lairaging and care for animals which are not slaughtered immediately on arrival; provision of the requisite facilities at slaughterhouses. As regards the slaughter operation, the Convention stipulates that all animals must be stunned before being bled. Stunning of large animals must be effected by means of a pistol (an instrument which administers a blow or penetrates at the level of the brain), by electro-narcosis or by gas. The use of a poleaxe, hammer or puntilla is prohibited by the Convention. Furthermore, large animals must neither be suspended nor have their movements restricted before being stunned. Where there are exceptions to these rules (ritual slaughter, emergency slaughter, slaughter of poultry and rabbits, etc.), slaughter must be effected in such a way as to spare the animals any unnecessary suffering. These last provisions apply equally to slaughter in places other than slaughterhouses. This Convention only applies to the movement, restraint, stunning and slaughter of domestic solipeds, ruminants, pigs, rabbits and poultry. Therefore it does not apply to fishes.

European Convention on the Protection of Pet Animals

The Convention aims essentially at assuring the welfare of animals, and in particular, of pet animals kept for private enjoyment and companionship. Animals belonging to threatened species, and protected by other Conventions, in particular, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), opened for signature in Washington, on 3 March 1973, and the Convention on the Conservation of European Wildlife and Natural Habitats (ETS No. 104), opened for signature by the member States of the Council of Europe and non-member States which have participated in its elaboration and by the European Economic Community, in Bern, on 19 September 1979, are thus excluded from the provisions of this text. In this Convention no special attention is paid to the welfare of fish. Since this Convention only applies to pet animals it is beyond the scope of this report and will therefore not be discussed any further.

European Convention for the Protection of Vertebrate Animals Used for Experimentation and other Scientific Purposes

The Convention is designed primarily to reduce both the number of experiments and the number of animals used for such purposes. It encourages Parties not to experiment on animals except where there is no alternative. All research into alternative methods should be encouraged. Animals to be experimented on should be selected on the basis of clearly established quantitative criteria and must be well cared for and spared avoidable suffering whenever possible. To this end, the Convention lays down a number of principles that are to be considered only as a starting point. The Parties meet regularly to examine the application of the Convention and, if appropriate, to extend or strengthen its provisions. In Appendix A of this Convention, species specific provisions for fish are given. Here general considerations for water quality, health, housing and enrichment, feeding, handling and humane killing are provided. Specific recommendations are listed for rainbow trout, Atlantic salmon, tilapia, zebrafish, seabass, Atlantic halibut, cod, turbot and African walking catfish.

5.1.4 World Organisation for Animal Health (OIE)

In May 2002, the OIE has adopted a Resolution on Animal Welfare. The 167 member nations of the OIE have accepted to start the development of policies and guiding principles to provide a sound foundation from which to elaborate specific recommendations and standards. In developing these policies, the OIE will give priority to animal welfare issues regarding animals used in agriculture and aquaculture. In February 2004, OIE organized a global conference on animal welfare: an OIE

initiative. The proceedings of the conference are published and have contributions about pain, fear and distress (Duncan, 2004), injuries and diseases (Algers, 2004) and animal welfare issues relating to aquaculture (Håstein, 2004).
(http://europa.eu.int/comm/food/animal/welfare/international/2003_2073_3l_en.pdf).

5.2 National legislation and regulation

The following overview gives the data on legislation and regulation in various countries in Europe. A part of the information was obtained by the questionnaire that was sent to the EIFAC national correspondents in March 2003. Also information was obtained from participants of the EIFAC workshop in Utrecht (24-26 March 2004) and from various sources on the internet. Chapter 6 (Legislation) in Thorsteinsson (2002), gives an overview of the very variable legal position of fish tagging within Europe.

5.2.1 Austria

Regulations concerning fish welfare can be found in the 'Fischereigesetz'. Different Austrian states each have their own 'Fischereigesetz', but they all provide some regulations concerning the protection of individual fish as well as the fish population.

5.2.2 Finland

Finnish requirements concerning animal welfare are laid down in the Act on Animal Protection (1996), Statute on Animal Protection (1996), Statute on the Transport of Animals (1996) and Statute on Animal Experimentation (1985). More detailed provisions on requirements for the keeping, care, treatment and handling of animals have been laid down in several Decisions issued by the Ministry of Agriculture and Forestry. The Decisions concern the keeping of different animal species and activities and measures involving animals.

The objective of the Finnish Act on Animal Protection is to protect animals from suffering, pain and distress in the best manner possible and to promote the welfare and good treatment of animals. The Act concerns all animals, both wild animals and animals kept by humans, such as pets, domestic animals and farmed animals. It provides general regulations concerning general provisions, the keeping of animals, the transport of animals, import of animals, experiments with animals, the slaughter of animals. The Act does not provide specific regulations on fish.

5.2.3 France

The present animal protection legislation on animal experimentation in France (the decree of 19 October 1987 and the three ministerial orders of 19 April 1988) incorporates the European Directive 86/609, while maintaining all provisions of the previous national laws. The regulations apply only to living vertebrate animals. Experiments can only be performed after written justification.

Animal experimentation can only be performed under the responsibility of an individual holding a personal licence issued by the Ministry of Agriculture. The authorisation specifies the area of activity, the animal species utilised and the experimental protocols. Applicants must have a minimum education in the relevant biology and training in animal experimentation. In addition, specific training is required for any surgical procedures. The training in animal experimentation must be approved by the Ministry of Agriculture.

The facilities where animal experiments take place must be approved jointly by the Ministry of Agriculture and the ministries with administrative responsibility over the institution conducting or funding the experimentation. These facilities must be staffed with an adequate number of qualified personnel with appropriate training in accordance with their responsibilities in category I (persons responsible for the experiment), II (personnel participating in the experiment) or III (personnel in charge of caring for and husbandry of the animals) as defined in the regulations. In addition, the facilities must maintain amongst other items, a register of the animals obtained and sent out, visits to the animal units, animal housing and controlled environments.

The approval of the facilities includes details of the type of experimentation, the animal species to be used, protocols to be applied and requires statistics on animal numbers to be collected. To maintain wild animals or animals of wild origin requires a facility certificate of the Ministry of the Environment. The animals must be obtained from identified establishments. Cats, dogs and non-human primates must be individually identified by permanent means; the identification number of cats and dogs is tattooed and registered in a national file. The control of these regulations is the responsibility of the Ministry of Agriculture's Departmental Veterinary Services. Depending on the seriousness of any offences, sanctions can be administrative or through the courts.

The Commission Nationale de l'Experimentation Animale, presided over by a state counsellor, is an advisory body to the Ministries charged with giving opinions or making proposals on all aspects of the present legislation. This commission is also consulted regarding training and the development of 'alternative' methods.

5.2.4 Germany

In Germany, legislation to protect farmed eel at slaughter came into force in April 1999 (TierSchlV, 1997; 1999).

The German Animal Welfare Act dates back to 1934: This law was revised in 1972, again in 1986, 1993, 1997, 1998, 2000 and 2003. It covers all species of animals. Since 1 August 2002, animal welfare is defined as a national objective. The aim of the German Animal Welfare Act is the overall protection of animals as creatures under human responsibility. Nobody is allowed to address any pain, suffering or damage to an animal without a sound reason. The act provides regulations for animal husbandry, killing, operations on animals, experiments on animals, animal breeding and import, movement and keeping of animals. The sections applying to experimentation cover both vertebrates and invertebrates. However, licences are only required for the use of vertebrates. Reports have to be submitted on projects using invertebrates, although the number used does not have to be recorded. No application has to be made to kill animals for in vitro experimentation or for other reasons and this does not have to be reported. However, there are plans to start to record the numbers of animals killed for such purposes. In this act no special attention is paid to the welfare of fish. Additional acts are available on transportation and slaughter of animals. Both provide specific regulations on fish.

Further regulations concerning fish welfare can be found in the fisheries legislation. The German Länder each have their own "Fischereigesetz", but they all provide some regulations concerning the protection of individual fish as well as the fish population. Typical examples for restrictions are the use of live bait fish, keep nets, fishing gear, and the practice of "put and take" and "catch and release". Angling contests are in most cases forbidden.

Since 2004, a procedure for testing the toxicity of waste water has been changed: instead of young adults of the fish species "Goldorfe" (ide; *Leuciscus ide* L.), now only the use of fish eggs are allowed for the tests.

5.2.5 Ireland

National legislation
The Cruelty to Animals Act 1876
EC (Amendment to The Cruelty to Animals Acts of 1976)

Animal Remedies Act 1996
www.irishstatutebook.ie/ZZSI17Y1994.html

National regulations
Regulations of 1994, Statutory Instruments number 17 of 1994.

Ministry involved
Department of Communications, Marine and Natural Resources Health
Department of Agriculture

5.2.6 Netherlands

On 23 September 1992 the Animal Health and Welfare Act came into force in the Netherlands. The Act is based on the 'no, unless – principle', indicating that no handling of animals is allowed unless stated otherwise. It provides general rules concerning animal health, animal welfare, transportation, slaughter and housing. Furthermore, it provides regulations on biotechnology. In this act no special attention is paid to the welfare of fish.

On 5 February 1997 a revised Experiments on Animals Act came into force in the Netherlands. The main change introduced by the revised Act is to require that research plans must be approved by an ethical review committee, which has to consider the benefit to come from the experiments and whether this justifies the distress caused to the animals to be used. No maximum duration for a research plan is stipulated. Committees are required to give a decision on an application within three months and, if they do not approve the research plan, the applicant can appeal to the central animal review committee established under the previous legislation.

The structure of these committees is defined in the new Act, which requires that they have at least seven members made up from equal numbers of experts in animal experiments, alternative methods, animal welfare, and ethical assessment. At least two members must not be conducting animal experiments and at least three members, including the chairperson, must not be employed by a scientific institution applying to the committee. In this act, no special attention is paid to the welfare of fishes.

A third Act available for regulating fish welfare is the Fisheries Decree. There is scope in the Fisheries Decree for welfare regulations concerning the treatment of fishes that are not kept. This mainly concerns the methods used to catch the fishes. In connection with this, two measures have been taken:

- Live bait-fish may not be used for fishing since 1998;
- The Minister of Agriculture, Nature and Food Quality can forbid the use of devices for stunning, wounding or killing fish.

5.2.7 Norway

Animal welfare in Norway is regulated by the Animal Welfare Act of 20 December 1974. This Act applies to live mammals, birds, toads, frogs, salamanders (newts), reptiles, fish, and crustaceans. It provides general regulations concerning general provision on how animals should be treated, special provision concerning livestock and domestic reindeer, showing of animals, animal boarding, accommodation, trade in and hiring out of animals and animal use in teaching and research. Animal experimentation is also regulated through the Animal Welfare Act. Furthermore it provides special provisions concerning fish and crustacean. Chapter 3 of the Animal Welfare Act states that it is forbidden to suspend live fish on a rod, line, or hook or the like, which is stuck into or through the body of the fish. Furthermore, it is forbidden to keep fish in a net-cage in such a way that they are at risk of suffering needlessly and to place live fish or crustacean in a shop window.

5.2.8 Poland

Animal welfare in Poland is regulated by the Polish Animal Protection Act of 1997. This Act applies to domestic animals, farm animals, animals used for the purposes of entertainment, shows, films and sports and for special purposes, animals used in experiments, animals kept in zoological gardens, free living animals (wild) and animals not belonging to the domestic fauna. It provides general regulations concerning general provision on how animals should be treated, domestic animals, farm animals, animals used for the purposes of entertainment, shows, films and sports, animals in zoological gardens, animals living at large (wild), transport of animals, operations and animals and the killing of animals. Animal experimentation is also regulated through the Animal Protection Act. No specific regulations on fish are provided in this Act.

5.2.9 Sweden

The Swedish system of regulating animal welfare comes under a general law, the Animal Protection Act and the Animal Protection Ordinance, both of 1988. The Acts applies to the care and treatment of domestic animals. Furthermore it applies to animals kept in activity or used for scientific research or education, the diagnosis of disease, the manufacture of drugs or chemical products or other similar purposes. The Acts provide general rules concerning animal management and treatment, surgical procedures, slaughter, transportation, use of animals for scientific purposes, sporting events and exhibitions involving animals, etc. The Acts do not provide specific regulations on fishes.

All animal research projects require ethical committee approval, including feeding studies, experiments under terminal anaesthesia and the killing of animals to remove tissues for use in *in vitro* biomedical research.

5.2.10 Switzerland

The Swiss system of regulating animal welfare comes under the Act on Animal Protection (1978) and the Animal Protection Ordinance (1981). The Acts apply to vertebrates only. They provide general regulations concerning general provisions, the keeping of animals, the trade of animals and use of animals for advertising purposes, the transport of animals, surgical operations performed on live animals, experiments with animals, the slaughter of animals, etc. The Acts do not provide specific regulations on fish.

Further regulations concerning fish welfare can be found in the “Bündesgesetz über die Fischerei” (1991) and the “Verordnung zum the Bündesgesetz über die Fischerei” (1993). It provides regulations to protect caught fish against unnecessary damage and injury and it bans the use of live baitfish.

5.2.11 United Kingdom

In the United Kingdom animal welfare is covered by four types of legislation:

1. Legislation to protect animals from cruelty
    - The Protection of Animals Acts 1911-1988
    - The Veterinary Surgeons Act 1966
    - The Abandonment of Animals Act 1960
    - The Animals (Cruel Poisons) Act 1962
    - The Docking and Nicking of Horses Act 1949
2. Legislation to protect the welfare of animals kept in commercial enterprises
    - The Dogs Act 1973
    - The Breeding of Dogs Act 1973 and 1991
    - The Breeding and Sale of Dogs (Welfare) Act 1999
    - The Animal Boarding Establishments Act 1963
    - The Riding Establishments Acts 1964 and 1970
    - The Performing Animals (regulation) Act 1925
    - Agriculture (Miscellaneous Provisions) Act 1968
    - The Zoo Licensing Act 1981
3. Legislation to protect society from the nuisance of animals
    - The Animals Act 1971
    - The Dangerous Dogs Act 1989
    - The Dangerous Wild Animals Act 1976
4. Legislation to protect the welfare of animals involved in research
    - Animals (Scientific Procedures) Act 1986

Considering the scope of this report, important legislation in the United Kingdom to be discussed is the Protection of Animals Act 1911, the Agriculture (Miscellaneous Provisions) Act 1968 and the Animals (Scientific Procedures) Act 1986. The main and most important offences of cruelty to captive and domestic animals are set out in the Protection of Animals Act 1911 with respect England and Wales. Similar legislation covers Scotland and slightly different legislation is in force in Northern Ireland. Although the 1911 Act has been amended on a number of occasions s, its most significant language and features have remained untouched. Even though the 1911 Act is now over 90 years old and was itself considered a consolidating statute that drew on a number of nineteenth century statutes, it remains an imperfect, but nevertheless reasonably simple and effective, statute for the prosecution of persons who inflict unnecessary suffering on captive and domestic animals.

The Agriculture (Miscellaneous Provisions) Act 1968 is sometimes used in welfare cases, instead of the Protection of Animals Act 1911. On occasions, it is used to support cases brought under the 1911 Act. It is particularly useful where large numbers of animals are involved, as the offences are worded to cover more than one animal. It can only be used where the offence occurred on agricultural land. The offences provide for two levels of suffering, the more serious offence being "causing unnecessary pain" and the less serious, "causing unnecessary distress"

The British system for regulating the use of animals in experiments is defined by the Animals (Scientific Procedures) Act. The main principle of this law is the requirement for researchers to obtain personal and project licences and a certificate for the establishment where the animal experimentation is conducted. The legislation covers all vertebrate animals and has recently been extended to include the octopus.

National legislation United Kingdom
In England and Wales, the Environment Agency makes byelaws under Salmon and Freshwater Fisheries Act 1975 to control angling practice e.g. use of knotless netting for nets.

In Scotland, regulations governing fishing are administered by local fisheries boards and regulations governing the ways in which a fish can be taken are laid down in the Salmon and Freshwater Fisheries (Protection) (Scotland) Act 1951.

Legislation pertaining to the welfare of farmed fish:

- The Protection of Animals (Scotland) Act 1912 – prevents any unnecessary suffering to any domestic or captive animal.
- The Agriculture (Miscellaneous Provisions) Act 1968 – prevents unnecessary pain or unnecessary distress to any livestock (any creature kept for the production of food).
- The Welfare of Animals (Slaughter and Killing) Regulations 1995 –implements Council Directive 03/119/EC and applies to the movement, lairaging, restraint, stunning, slaughter and killing of animals bred and kept for the production of meat, skin, fur or other products.
- The Welfare of Animals (Transport) Order 1997 – this order requires that all animals, including fish, are transported in a way that does not, and is not likely to, cause injury or unnecessary suffering.
- The Welfare of Farmed Animals (Scotland) Regulations 2000 –implements Council Directive 98/58/EC and requires reasonable steps to be taken to ensure animals kept for farming purposes are not caused any unnecessary pain, suffering or injury.

National regulations
The Department for Environment, Food and Rural Affairs (DEFRA), in partnership with the Scottish Executive and the Welsh Assembly Government, are working to develop an all-inclusive and comprehensive long-term Animal Health and Welfare strategy for Great Britain. This project will be closely linked to the development of the Northern Ireland and Republic of Ireland "All Island" animal health programmes. (Currently, a new Animal Welfare Bill is progressing through the British Parliament (see http://www.defra.gov.uk/animalh/welfare/bill), but note that although fish are referred, to in the context of fish being kept, angling practices are excluded.)

Ministry involved
Fisheries Minister.

Departments involved
Department for Environment, Food and Rural Affairs (DEFRA), Nobel House, 17 Smith Square, London SW1P 3JR, United Kingdom. http://www.defra.gov.uk/

5.2.12 Denmark

The legislation on animal welfare is under the Ministry of Justice and is governed by the law for animal protection from 1991. This law applies mainly to pet and farm animals, and nothing is mentioned about fish. The use of vertebrate animals for experiments is ruled by the law on use of experimental animals from 1993. All vertebrate animal research projects that may cause pain, suffering, fear or permanent harm require approval from the ethical committee. For the use of fish in experiments, only invasive methods like surgical implantation of electronic tags require special permission, where the applicant must have attended a training course in handling of experimental animals. Furthermore veterinarian supervision is required. Regarding fish welfare in aquaculture, commercial fisheries and recreational fisheries, the only well-known rule is the prohibition of killing eels with salt or ammonia.

CHAPTER 6 CURRENT CODES AND GUIDELINES

6.1 Aquaculture

Several guidelines covering aspects of welfare of fishes in aquaculture are present today throughout the world:

- The Farm Animal Welfare Council (FAWC) in the United Kingdom has published the Report on the Welfare of Farmed Fish (FAWC, 1996). It offers guidelines about the farming of salmon (*Salmo salar)* and trout (*Oncorhynchus mykiss* and *Salmo trutta*). It also presents brief comments on carp (*Cyprinus carpio*). Furthermore, the welfare of species of wrasse used for parasite control during salmon farming (*Ctenolabrus rupestris*, *Centrolabrus exoletusis* and *Crenilabrus melops*) is also discussed.
- The British Columbia (Canada) Salmon Farmers Association has also produced a Draft Code of Practice for the salmon farming industry. Goal of this code of practice is to protect the safety and well being of employees, the natural environment and salmon stocks.
- The Federation of European Aquaculture Producers (FEAP) has published a Code of Conduct for European Aquaculture, prepared to promote the responsible development and management of a viable European aquaculture sector in order to assure a high standard of quality food production while respecting environmental considerations and consumers' demands.
- The Holmenkollen Guidelines for Sustainable Aquaculture 1998 call for "standards and practices which embody ethical principles for ensuring health and welfare of fish and shellfish and for slaughter practices" It provides some general policy recommendations and a statement of the ethical responsibilities of the industry.
- FAO Technical Guidelines for Responsible Fisheries No. 6: Inland Fisheries (FAO 1997).
- FAO Technical Guidelines for Responsible Fisheries No. 5.: Aquaculture Development (FAO 1997). Specifically: contains references and recommendations regarding:
  - stress management (p.28; under CCRF Article 9.4.2)
  - humane killing of fish (p.31; under CCRF Article 9.4.6)
  - ftp://ftp.fao.org/docrep/fao/003/W4493e/W4493e00.pdf.

6.2 Commercial fisheries

Codes of conduct concerned with the welfare of fishes in commercial fisheries are rare. The FAO Fisheries Department has published a Code of Conduct for Responsible Fisheries (CCRF).
http://www.fao.org/fi/agreem/codecond/ficonde.asp
ftp://ftp.fao.org/docrep/fao/005/v9878e/V9878E00.pdf

The CCRF provides a specific reference and recommendation to "the use of fishing gear and practices that increase survival rates of escaping fish should be promoted." CCRF Article 8.4.5 states that: "States, with relevant groups from industry, should encourage the development and implementation of technologies and operational methods that reduce discards. The use of fishing gear and practices that lead to the discarding of catch should be discouraged and the use of fishing gear and practices that increase survival rates of escaping fish should be promoted."

6.3 Angling

Several guidelines on the welfare of fishes in angling are published:

- Eleven national member associations of Recfish Australia have published the National Code of Practice for Recreational and Sport Fishing. The Code addresses four main areas of fishing responsibility. These include looking after our fisheries, protecting the environment, treating fish humanely and respecting the rights of others.
- The National Angling Alliance United Kingdom has published a Code of Conduct for Coarse Anglers. The Code was designed to complement the existing legislative framework and provides a commonsense guide to values and behaviour to which anglers should aspire.
- Central Fisheries Board Ireland Leaflet No. 1. *Catch and Release for Atlantic Salmon*.
- Several other small angling associations have produced general, local codes.

6.4 Ornamental fish

The ornamental fish sector has instituted a code of conduct that addresses, among other things, the welfare of aquarium fish (Davenport, 1993). Based on the Dutch Legislation on Animal Health and Welfare the Council of Animal Affairs has produced a document with a “positive list” based on welfare criteria of fish taxa which can be kept in aquaria. The Dutch Ministery of Agriculture, Nature Conservation and Food Quality, however, has not adopted the list because it is not feasible to enforce the regulation.

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CHAPTER 8 AVAILABLE INFORMATION ON THE INTERNET

8.1 Angling organizations

http://www.anglersnet.co.uk/saa/index.htm
Web site of the Specialist Anglers' Alliance (SAA). The SAA is an angling/conservation/political body, which is the umbrella organization representing specialist-angling groups, which are in SAA membership. The National Angling Alliance Code of Conduct can be found on their web site.

http://www.anglingfoundation.com/
The Angling Foundation of the United Kingdom provides a code for retaining nets.

http://www.recfishoz.com/
Web site of Recfish Australia, an organization with a mission to represent the interests of recreational and sport fishers at a national level to ensure quality of fishing in Australia. The national code of practice for recreational and sport fishing 2001 can be found on this web site.

http://www.ssaa.org.au/fish.html
A position statement of the Sporting Shooters Association of Australia, regarding animal welfare aspects of recreational fishing.

http://www.anglersnet.co.uk/saa/naa.htm
Sport fisheries organization: National Angling Alliance, Fishmongers' Chambers, 110 Upper Thames Street, London EC4R 3TW, United Kingdom.

http://www.fisheries.co.uk/ccfa/index.htm
Commercial fisheries organization: Commercial Coarse Fisheries Association, C/o Tingrith Fishery, Tingrith, Bedfordshire MK17 9EW, United Kingdom.

http://www.cfb.ie
Irish Central Fisheries Board
http://www.vdsf.de
Largest angler's organization in Germany, also providing a code of angling practice in concordance with animal welfare.

http://www.anglerverband.com/frame.htm
The web site of the German anglers association. It contains a code of honour ("Ehrenkodex") how to deal with fishes.

8.2 Animal rights organizations

http://www.animalfreedom.org/
Animal Freedom provides information about the impact of angling on the fish and the surrounding environment.

http://www.animalfrontline.nl/
Animal Frontline is against recreational fisheries, ornamental fish keeping and commercial sea fisheries.

http://www.anti-angling.com/
Web site of the Campaign for the Abolition of Angling, dedicated to banning angling. Details can be found regarding campaigns, a comprehensive fact sheet and the scientific evidence regarding fish and pain.

http://www.dierenbescherming.nl/:
The “Dierenbescherming” is a Dutch organisation that provides information about angling and the results of angling on the welfare of fish. The “Dierenbescherming” are against all forms of angling.

http://www.nofishing.net/
A site linked to PETA, which provides information against recreational and commercial fisheries and the consumption of fish.

http://www.pisces.demon.co.uk/welfare.html
The report “The Welfare of Fish and Aquatic Invertebrates” by the Submission of the Australian and New Zealand Federation of Animal Societies.

http://www.rspca.org.uk/
RSPCA Web site of the RSPCA (the Royal Society for the Prevention of Cruelty to Animals). The RSPCA focuses on promoting kindness and preventing cruelty to animals.

http://www.veganisme.non-profit.nl/
The “Nederlandse Vereniging voor Veganisme” provides information against the bio-industry.

http://www.vissenbescherming.nl/
The “Vissenbescherming” is a Dutch organisation that provides information about keeping goldfish in small bowls, commercial sea fisheries, eel fisheries and recreational fisheries. The “Vissenbescherming” would like to see a ban on goldfish bowls and recreational fisheries. Furthermore, they strive for improved slaughter methods for the commercial sea fisheries and eel fisheries.

8.3 Animal welfare organizations

http://www.awfc.ca/home.html
Web site of the Animal Welfare Foundation of Canada. The report “A Report on the Animal Welfare Aspects of Fish Farming” can be found on this Web site.

http://www.ciwf.co.uk/
Web site of “Compassion in World Farming”. Several reports dealing with the welfare of fish in aquaculture can be found on this web site.

http://www.fawc.org.uk/
Web site of the Farm Animal Welfare Council (FAWC) (5th Floor, 1A Page Street, London SW1P 4PQ, United Kingdom), an independent advisory body established by the Government in 1979. Its terms of reference are to keep under review the welfare of farm animals on agricultural land, at market, in transit and at the place of slaughter; and to advise the Government of any legislative or other changes that may be necessary. The report “Report On The Welfare Of Farmed Fish” can be found on this web site.

http://www.nal.usda.gov/awic/
Web site of the Animal Welfare Information Centre, which provides information for improved animal care and use in research, teaching, and testing. The publication “Responsible Care and Health Maintenance of Fish in Commercial Aquaculture” by T.E. Schwedler and S.K. Johnson can be found on this web site.

http://www.psyeta.org/
Web site of Psychologists for the Ethical Treatment of Animals (PSYETA). The publication “A Survey of Animal Care Considerations for Fish Handling**”** by Henrik Kreiberg can be found on this web site.

8.4 Aquaculture organizations

http://www.aquaculturecouncilwa.com/
Web site of the Aquaculture Council of Western Australia. The Guidelines on Aquatic Animal Welfare for the Aquaculture Industry in Western Australia can be found on this web site.

http://www.britishtrout.co.uk/bta.htm
British Trout Association, Bow Business Centre, London E3 2SE. United Kingdom.

Scottish Salmon Growers Association, Drummond House, Scott Street, Perth PH1 5EJ, United Kingdom.

www.ifa.ie
Irish Salmon Growers Association.

http://www.bim.ie
Bord iascaigh Mhara (Irish Sea Fisheries Board)

http://www.marine.ie
Irish Marine Institute

http://www.aquariumcouncil.org
Marine Aquarium Council

http://www.feap.info
Federation of European Aquaculture Producers. The FEAP has a position paper on animal protection in fish aquaculture (2003).

8.5 Fisheries organizations

http://www.fisheries.org/html/Public_Affairs/Sound_Science/Guidelines2004.shtml
American Fisheries Society, American Institute of Fisheries Research Biologists & American Society of Ichthyologists and Herpetologists (2004) *Guidelines for the Use of Fishes in Research*. American Fisheries Society: Bethesda.

http://www.ifm.org.uk/index.html
Web site of the Institute of Fisheries Management (IFM). It provides the “Stillwater Coarse Fisheries Code of Practice by the Institute of Fisheries Management (IFM)”. *The Management of Intensively Stocked Stillwater Coarse Fisheries Including the Codes of practice.* Nottingham: Institute of Fisheries Management, 39 pp.

http://www.le.ac.uk/biology/fsbi/
The FSBI (The Fisheries Society of the British Isles) is the premier Society in the British Isles, and increasingly in Europe, catering for the interests of professional fish biologists and fisheries managers. The Society is affiliated to the United Kingdom Institute of Biology and the Society for Science and Technology.

http://www.leicester.ac.uk/biology/fsbi/welfare.pdf
FSBI (2002) *Fish Welfare. Briefing Paper 2*. Cambridge: Fisheries Society of the British Isles

http://www.efishbusiness.co.uk/
eFishBusiness, England & Wales.

http://www.vet.ed.ac.uk/animalwelfare/
University of Edinburgh Animal Welfare Research Group, Easter Bush Veterinary Centre, Easter Bush, Roslin, Midlothian, EH25 9RG, U.K

http://www.vet.ed.ac.uk/animalwelfare/Fish%20pain/welfare.htm#FARMED
Web pages written by University of Edinburgh Animal Welfare Research Group M.Sc.students in 2002: WELFARE OF FARMED FISH and

http://www.vet.ed.ac.uk/animalwelfare/Fish%20pain/welfare.htm#ANGLED
WELFARE OF ANGLED FISH .

http://www.atc.stir.ac.uk/staq/
Institute of Aquaculture, University of Stirling, Stirling FK9 4LA, United Kingdom.

8.6 Governmental and intergovernmental organizations

http://www.fao.org/fi
Web site of the Food and Agriculture Organization of the United Nations (FAO) and FAO fisheries department. The FAO is one of the largest specialised agencies in the United Nations system and the lead agency for agriculture, forestry, fisheries and rural development. The Code of Conduct for Responsible Fisheries can be found on the web site of FAO's Fisheries Department: http://www.fao.org/fi/agreem/codecond/ficonde.asp.

The web site of the EIFAC – European Inland Fisheries Advisory Commission, FAO.
http://www.fao.org/fi/body/eifac/eifac.asp

http://europa.eu.int/comm/fisheries/policy_en.htm
Web site of the European Commission's Directorate-General for Fisheries. It provides the Common Fisheries Policy (CFP).

http://europa.eu.int/comm/fisheries/doc_et_publ/liste_publi/farmedfish_en.pdf
Report on "Farmed fish and welfare"produced by the directorate-general of Fisheries of the European Commission.

http://www.coe.int/ and http://www.coe.int/T/E/Legal_Affairs/
The site of the Council of Europe including information on the Standing Convention on the Protection of Animals.

http://www.efsa.eu.int/science/ahaw/ahaw_opinions/495_en.html.
Opinion of the European Food Safety Authority (EFSA) Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals.

http://www.defra.gov.uk/
Web site of the Department of Environment Food and Rural Affairs. It provides a wide variety of information on animal health and welfare. Amongst other things the report "Government Response to the Farm Animal Welfare Council's Report on the Welfare of Farmed Fish" is available on this web site.

http://www.defra.gov.uk/Science/Publications/Report%20of%20the%20Workshop%20on%20Farmed%20Fish%20Welfare.pdf
DEFRA Science Directorate (2002) *Report of the Workshop on Farmed Fish Welfare held on Monday 28th October 2002.* Department for Environment, Food and Rural Affairs. 37pp.

http://www.fawc.org.uk/reports/fish/fishrtoc.htm
FAWC (1996) *Report on the Welfare of farmed Fish*. The Farm Animal Welfare Council, 52 pp.

http://www.verbraucherministerium.de
Homepage of the German Ministry of Consumer Protection, Food and Agriculture

http://www.verbraucherministerium.de/englisch/tierschutzbericht/tierschutzbericht-2001.htm#03
Review of the German regulations and legislation on animal welfare.

http://www.minlnv.nl/
Web site of the Dutch Ministry of Agriculture, Nature Management and Fisheries. It provides information regarding the Dutch policy to commercial fisheries. It provides several publications on commercial fisheries in the Netherlands and on the welfare of fish.

http://www.nal.usda.gov/awic/pubs/Fishwelfare/fishwelfare.htm
Web site of the U.S. Department of Agriculture, Agricultural Research Service, National Agricultural Library, Animal Welfare Information Center, Beltsville, Maryland. It provides detailed information regarding fish welfare from 1970-2003 (Erickson, 2003).

http://www.homeoffice.gov.uk/comrace/animals/licensing.html
The Home Office of the United Kingdom Government operates the licensing and inspection systems according to the Animals (Scientific Procedures) Act 1986

In Ireland the following organizations are involved in Handling of fishes:

- Dept of Communication, Marine & Natural Resources www.dcmnr.gov.ie
- An Bord Iascaigh Mhara – commercial & aquaculture www.bim.ie
- Marine Institute – aquaculture and experimental www.marine.ie
- Central Fisheries Board www.cfb.ie
- Animal Welfare Committee, Veterinary Ireland www.veterinary-ireland.org
- Dept. of Agriculture & Food www.agriculture.gov.ie

8.7 Scientific organizations

http://www.ICES.dk
Web site of the International Council for the Exploration of the Sea.

http://199.245.200.110/
Web site of the American Society of Ichthyologists and Herpetologists. The American Society of Ichthyologists and Herpetologists is dedicated to the scientific study of fishes, amphibians and reptiles. The publication “Guidelines for Use of Fishes in Field Research” can be found on this web site.

http://oslovet.veths.no/
Web site of the Norwegian Reference Centre for Laboratory Animal Science & Alternatives. It provides the Norwegian Animal Welfare Act.

http://www.aps.uoguelph.ca/~aquacentre/
Web site of the Aquaculture Centre, a collaborative between the University of Guelph and the Ontario Ministry of Agriculture and Food. Amongst other things it provides a reference source of scientific literature on welfare of fish.

http://www.ifb-potsdam.de/
Web site of the Institut für Binnenfischerei in Potsdam near Berlin. Main objectives of the research work done by this institute are questions of the ecologically oriented fisheries management of waters as well as problem definitions of the environmental compatible and market-focused aquaculture; also questions of animal welfare in fisheries and aquaculture included. The Ifb does not represent the German Institut für Binnenfischerei. It is an Institut financed by several Länder of Germany.

http://www.curtin.edu.au/
Web site of the Curtin University of Technology. The Australian code of practice for the care and use of animals for scientific purposes can be found on this site.

http://www.hafro.is/catag/
http://www.nal.usda.gov/awic/pubs/Fishwelfare/Thorsteinsson.pdf
Site with information for those who want to obtain information on tagging or marking of fish. The CATAG (Concerted Action for Tagging of Fishes) group has collected information on: tags, tagging, experiments where tags are used, legislation concerning tagging, health and behaviour changes, which can be induced by tagging and models used to work on data from tagging experiments.

http://www.bfa-fisch.de
Homepage of the Federal Research Center for Fisheries. Information on animal welfare is included.

http://www.ntva.no/
The Norwegian Academy of Technological Sciences has the objective of promoting research and education in technology and related sciences. The Holmenkollen Guidelines for Sustainable Aquaculture 1998 can be found on their web site.

http://www.vet.ed.ac.uk/animalwelfare/animal_pain.htm
Web site of the Royal School of Veterinary Studies, providing information on the perception of pain in fish.

http://www.cefas.co.uk/homepage.htm#
The Fish Health Inspectorate, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB, United Kingdom

http://uwadmnweb.uwyo.edu/Zoology/faculty/Rose/Rose%20Rev%20Fish%20Sci.pdf
Paper by J.D. Rose (2002), The neurobehavioral nature of fishes and the question of awareness and pain. *Reviews in Fisheries Science* 10: 1-38.

8.8 Codes and guidelines

http://www.defra.gov.uk/animalh/welfare/fawc/fish/fishrtoc.htm
The Report on the Welfare of Farmed Fish by the FAWC.

http://www.geocities.com/b_c_aquaculture/code.html
Draft Code of Practice for the salmon farming industry by the B.C. Salmon Farmers Association.

http://www.anglersnet.co.uk/saa/Code2002.htm

The Code of Conduct for European Aquaculture by the Federation of European Aquaculture Producers (FEAP). the original web site for the Code of Conduct is:
http://www.feap.info/feap/code/default_en.asp
http://www.aquamedia.org

http://www.ntva.no/rapport/aqua/report.htm
The Holmenkollen Guidelines for Sustainable Aquaculture 1998.

http://www.fao.org/fi/agreem/codecond/ficond.asp
The Code of Conduct for Responsible Fisheries by the FAO Fisheries and Aquaculture Department.
ftp://ftp.fao.org/docrep/fao/005/v9878e/V9878E00.pdf

FAO Technical Guidelines for Responsible Fisheries No. 5: Aquaculture development (FAO 1997).
ftp://ftp.fao.org/docrep/fao/003/W4493e/W4493e00.pdf

http://www.recfishoz.com/CoP%20web%202001.htm
The National Code of Practice for Recreational and Sport Fishing by eleven national member associations of Recfish Australia.

http://www.intrafish.com/code-practise/conduct_eu_aqua.pdf
The Code of Conduct for Coarse Anglers by the National Angling Alliance.

http://www.fisheries.org/html/Public_Affairs/Sound_Science/Guidelines2004.shtml
The Guidelines for the Use of Fishes in Research (Nickum *et al*., 2004) were developed to help scientists develop realistic understandings of fish in the design and conduct of research on fish and fish habitats. The Guidelines provide a structure that ensures appropriate attention to valid experimental design and procedures while ensuring humane treatment of fish. Written by the 11-member Uses of Fishes in Research Committee, the Guidelines provide recommendations on field and laboratory activities, such as sampling, holding, and handling fishes; information on administrative matters, including regulations and permits; and advice on ethical questions such as perceptions of pain or discomfort that may be experienced by experimental subjects. The 53-page document now includes many listings of web sites of value.

The Guidelines have been developed for use by researchers within the United States; therefore, the roles, responsibilities, and information needs of Institutional Animal Care and Use Committees are given specific attention. However, the principles described in the Guidelines are applicable to research on fishes everywhere.

http://www.anglersnet.co.uk/code.pdf
Code of Conduct for Coarse Anglers. London: National Angling Alliance, 40 pp.

www.cfb.ie/fishing_in_ireland/CatchandRelease.htm
Catch and Release for Atlantic Salmon in Ireland, Central Fisheries Board Leaflet No. 1.

The Canadian Council on Animal Care has produced a detailed series of Guidelines on: the care of fish in research, teaching and testing (Griffin & Gauthier, 2003).

8.9 Other

http://www.cabi-publishing.org/Bookshop/ReadingRoom/085199296x.asp
An online version of “Animal Welfare And Meat Science” by N.G. Gregory, amongst other things dealing with the welfare aspects of commercial fisheries and aquaculture.

http://www.oie.int/eng/normes/fcode/A_summry.htm
An overview of international guidelines and recommendations on infectious, aquatic diseases.

http://www.primate.wisc.edu/pin/welfare.html
Overview of American regulations on animal welfare.

http://www.uni-giessen.de/tierschutz/

http://www.vetinfo.demon.nl/aw/flist.html
A reference source of scientific literature on welfare of fish.

http://www.vetmed.ucdavis.edu/CCAB/fish.htm
A reference source of literature on welfare of fish.

http://homepage.tinet.ie/~pnowlan/
LAST – Laboratory Animal Science & Teaching in Ireland.

APPENDIX

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This document presents the results of the EIFAC Ad Hoc Working Party on Handling of Fishes in Fisheries and Aquaculture, including the report of its workshop held from 24 to 26 March 2004 in Utrecht, Netherlands. The welfare of fishes has become a subject of attention in recent years. Concerns have been raised about the potential for infringed fish welfare in fisheries, aquaculture and fisheries research. The Ad Hoc Working Party agreed that handling of fishes must be carried out in a responsible way. Fishes show reactions to injurious stimuli. These stimuli result in physiological stress responses. Depending on the duration and intensity of the exposure to the stressor, the stress response varies from acute to chronic. Handling causing injuries and damage to the fishes should be avoided in fisheries, aquaculture and fisheries research. To ensure the welfare of fish in commercial fisheries, recreational fisheries and aquaculture, sufficient legislation and regulation is necessary. All EIFAC member countries discussed in this report have legislation and regulations concerning animal welfare. However, some of the legislation and regulations do not provide specific attention to fish welfare.

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