Humane Trapping Standards – description of the state of the art of research, science and application of humane trapping standards referred to in the 'Agreement on International Humane Trapping Standards' (AIHTS) and described in Commission proposal COM (2004) 532 final, in view of identifying the trapping standards which reduce unnecessary pain, distress and suffering of trapped animals as much as technically possible[1]

[1] Citation to use for this document: Talling J.C. & Inglis I.R. (2009) Improvements to trapping standards.DG ENV, websiteaddress.

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We are very grateful for the constructive help and advice given us by the many people whose names are listed in the Acknowledgements.

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Executive Summary

The remit of this work is "to identify the best possible standards for killing and restraining trapping methods both from an animal welfare and efficiency angle… The identified trapping standards should reduce pain, distress and suffering of trapped animals as much as technically feasible. However the standards must be economically realistic and technically achievable." In addition, the final report should "thoroughly and objectively address the described issues and present sound conclusions incorporating operational recommendations with regard to the humane trapping standards referred to in the Agreement on International Humane Trapping Standards (AIHTS)[2] and contained in the Commission proposal."

A detailed questionnaire primarily designed to gather information on trapping methods and the certification of traps for the trapping of species listed in the AIHTS was distributed to persons with trapping expertise in all 27 EU Member States, Canada, the Russian Federation and the USA. Within the EU the level to which trapping of mammals is practiced and the methods used varies widely between Member States; but trapping is generally subject to specific legal provisions and rules that cover the types of trap, the conditions under which these may be used, the methods required to avoid capture of non-target species, and the regular inspection of traps. Of restraining traps box/cage traps are used almost exclusively, whilst spring traps are the most commonly employed killing traps; although dead-fall traps are used for pine marten and drowning traps for muskrat.

An internet survey of the public attitude to trapping within the EU was carried out and 9,571 completed questionnaires were received from residents of the Member States. Whilst the public accept that human and/or environmental needs can justify the killing of animals, they also believe that the welfare of animals caught in traps is important. As a result they want trapping within the EU to be regulated by legislation that covers all the species that can legally be

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[2] http://ec.europa.eu/world/agreements/downloadFile.do?fullText=yes&treatyTransId=1428

trapped, and the traps used to be tested and approved by an independent institute using clearly defined animal welfare guidelines. However, 71% of the respondents who currently use traps stated they were not prepared to pay more for a trap that had been tested and approved.

The current state of science with respect to killing traps is reviewed and new Improved Standards, more strict than the AIHTS, are proposed to improve the welfare of trapped animals. These Improved Standards specify three Welfare Categories (i.e. A, B and C) of trap that differ in the times to irreversible unconsciousness (TIU) of animals caught in the trap. Welfare Category A requires that at least 80% of trapped animals have a TIU not exceeding 30 seconds, and that at least 90% have a TIU not exceeding 180 seconds (both at 90% confidence). Welfare Category B requires that at least 80% of trapped animals have a TIU not exceeding 180 seconds, and that at least 90% have a TIU not exceeding 300 seconds (both at 90% confidence). Traps in Welfare Category C must meet the current AIHTS standard for most species, i.e. produce a TIU in the trapped animal not exceeding 300 seconds for at least 80% of a minimum of 12 animals tested. It is argued that drowning traps should be treated no differently than other forms of killing trap and should be subject to the same TIU limits. In order to encourage the development of better traps it is proposed that where killing traps of different Welfare Categories are available to control the same species only those traps of the highest welfare category will be used.

Experimental studies were carried out to determine the onset and length of distress in muskrats caught in cage-type drowning traps. The initial study, looking at the behaviour and physiology of captured muskrats, found little evidence of distress prior to unconsciousness apart from the onset of a behaviour that involved biting the mesh of the underwater cage of the drowning trap. A second study found that being held in the underwater cage for 120 seconds after the onset of this biting behaviour did not result in subsequent avoidance of the drowning trap; indicating that this experience was not sufficiently stressful to result in aversion learning. If the TIU for muskrats killed in underwater drowning traps is conservatively measured from the point of the onset of biting behaviour plus 120 seconds, then it is less than the 300 seconds limit of both the

AIHTS and Welfare Category C of the Improved Standards. However, there is still a need to develop alternative multi-capture muskrat traps that can meet the requirements of the higher Welfare Categories of the Improved Standards.

The current state of science with respect to restraining traps is reviewed and new Improved Standards, more strict than the AIHTS, are proposed to improve the welfare of trapped animals. These standards specify three Welfare Categories (i.e. A, B and C) of trap that differ in the degree and types of injury shown by animals caught in the trap. Welfare Category A requires that at least 80% of trapped animals suffer an injury class no greater than 'mild', and that at least 90% suffer an injury class no greater than 'moderate' (both at 90% confidence). Welfare Category B requires that at least 80% of trapped animals suffer an injury class no greater than 'moderate', and that at least 90% suffer an injury class no greater than 'moderately severe' (both at 90% confidence). Welfare Category C is identical to the current AIHTS, which requires that no more than four animals out of a minimum sample size of 20 have 'unacceptable' injuries. It is concluded that insufficient information currently exists on the normal variation within wild populations of putative behavioural and physiological indices of welfare to be able to interpret any changes found in them during trap testing in terms of the welfare of the animal. In order to encourage the development of better traps, it is proposed that where restraining traps of different Welfare Categories are available to control the same species only those traps of the highest welfare category will be used.

Four approaches to reduce the level of animal suffering involved in trap testing are considered. These are a) measuring the mechanical forces exerted by a trap, b) using anaesthetised animals that do not recover consciousness, c) developing computer models that predict from the mechanical features of a trap whether it will meet specified welfare standards, and d) improved experimental designs incorporating 'stopping rules' that enable the testing to be halted as soon as the results gathered thus far provide strong evidence (i.e. $p<0.05$) that the trap will not meet the required trap standards.

The importance of 'best practice' information, not only on the welfare of the trapped animal but also on trap efficiency and selectivity is considered. It is

proposed that a series of species-specific Best Practice Guides be developed for all the species that can be legally trapped within the EU. Also, rather than try to deal with the issues of trap efficiency and selectivity by incorporating efficiency and selectivity criteria in the Improved Standards, it is proposed that these issues are addressed in the Best Practice Guides that can be modified to take account of local conditions. It is also suggested that the Improved Standards include the minimum requirement that both restraining and killing traps (apart from drowning traps where the death of the trapped animal is assured) should be inspected once every 24 hours. However, killing traps that meet the higher Welfare Categories A and B of the Improved Standards could be made exempt from this requirement in order to encourage the development and uptake of these categories of trap.

A Technical Workshop on International Trapping Standards was held between October 28th and 30th 2008 at the Central Science Laboratory, York, UK. The aims of the Workshop were a) to review the various welfare assessment methodologies and standards for killing and restraining traps in the light of new research, b) to discuss the proposed Improved Standards for killing and restraining traps used within the EU, and c) to consider the welfare of animals caught in drowning traps; particularly with regard to the control of muskrats. The Workshop was attended by members of the Contract Consortium, by international experts on trapping and/or animal welfare, and by a member of the European Commission.

On the basis of the results of this study, which reflect the current state of science, it is proposed that in order to improve the welfare of trapped animals a) additional welfare standards, more strict than the AIHTS, covering the use of both killing and restraining traps be adopted, and b) a series of species-specific Best Practice Guides be developed.

Summary

Introduction.

The aims of this chapter are:

a) **to give the remit of the Negotiated Procedure ENV.E.2/2006/D(10248) under which the research covered by this report was conducted.**
b) **to present the background to the Agreement on International Humane Trapping Standards (AIHTS),**

a) Remit of Negotiated Procedure. The main objective of the work is to identify improved trapping standards that will reduce unnecessary pain, distress and suffering of trapped animals as much as technically possible. The final report should "present sound conclusions incorporating operational recommendations with regard to the humane trapping standards referred to in the AIHTS and contained in the Commission proposal." The key tasks involved: a) reviews of scientific papers and other literature on trap testing, trapping methods and trapping best practice, b) identifying improved trapping standards (called the Improved Standards) for killing and restraining traps within the EU, c) identifying traps that could meet the proposed Improved Standards for the species of major interest to the EU (i.e. muskrat, pine marten, raccoon, raccoon dog, badger and ermine), d) identifying trap testing methods that reduced the use of conscious animals, e) collecting data on the state of art with regard to trapping methods used in the 25[3] Member States of the EU, as well as in the parties to the AIHTS and in the USA, f) conducting an internet survey to discover the public attitudes to trapping within the EU, and g) convening a Technical Conference on International Trapping Standards during which the Improved Standards would be discussed.

b) Background. In order to pursue an agreement on international humane trapping standards the EU together with the three main trapping nations Canada, the USA and the Russian Federation set up a working group consisting of scientific experts in 1995. Subsequently, the Agreement on International Humane Trapping Standards (AIHTS) was concluded with Canada and the Russian Federation and was approved by Council

[3] At the 'kick off' meeting it was agreed to extend this to cover 27 Member States.

Decision in 1998. A substantially similar agreement concerning the standards was reached in the form of an Agreed Minute with the USA.

Trapping methods and legislation within the EU, Canada, Russia and the USA.

The aims of this chapter are:

a) **to present information on the current trapping methods and legislation within the 27 Member States of the EU,**
b) **to present information on the current trapping methods and legislation within Canada,**
c) **to present information on the current trapping methods and legislation within the Russian Federation,**
d) **to present information on the current trapping methods and legislation within the USA.**

a) The situation within the EU. Of the 19 mammal species[4] covered by the AIHTS 11 are found within the EU; wolf, European beaver, American beaver, European otter, European lynx, pine marten, European badger, ermine, raccoon dog, muskrat and raccoon. The distribution of these species varies throughout the 27 Member States, and they are absent from Cyprus and Malta. The level to which trapping of mammals is practiced and the methods used varies between Member States; as reflected in the number of trappers in each Member State that ranges from around 150,000 in France to 50 in Bulgaria. In most Member States the right to hunt also includes the right to trap certain mammal species which are classified as either "game" or "pests"; while in other Member States it is, partly or completely, a separate activity. The main motivations for trapping in the EU are for wildlife management and the control of pest species.

As some of these mammal species are predominantly nocturnal their populations are difficult to control using firearms, and therefore trapping is often the most appropriate method. In the EU trapping is generally subject to specific legal provisions and rules. These can include the types of trap, the conditions under which these may be used,

[4] i.e. coyote, wolf, American beaver, European beaver, bobcat, American otter, European otter, American lynx, European lynx, marten, fisher, sable, pine marten, American badger, European badger, ermine, raccoon dog, raccoon, muskrat.

methods required to avoid capture of non-target species (selectivity), as well as the elimination of avoidable suffering (regular inspections). Several Member States require that trappers must have taken and passed mandatory training courses in hunting and/or trapping. In addition, trappers are often required to obtain a valid trapping and/or hunting license along with landowner permission where they wish to trap.

Seven types of trap are used to catch mammals in the EU; three categories of restraining trap i.e. box/cage, non-killing snares and foot snares, and four categories of killing trap i.e. spring traps, dead-fall traps, drowning traps and killing snares. However, killing snares are not used to catch any of the 11 AIHTS species found in the EU. For restraining traps box or cage traps are used almost exclusively, with the exception of France where restraining snares can be used for raccoon dog and raccoon. Spring traps are the most commonly used killing traps; although dead-fall traps are used for pine marten and drowning traps are used for muskrat.

In countries where it is required to report captures along with hunting bag returns, it is not necessary to distinguish between animals which are shot and animals which are trapped, and this means it is difficult to make accurate estimates of the number of animals trapped. A notable exception is in France where detailed statistics are collected by UNAPAF (Union Nationale des Piégeurs Agréés de France). Figures are also available for governmental control programs for certain species; notably for muskrat (in Belgium, Germany, the Netherlands) which in the EU is the most intensively trapped of all the AIHTS species.

b) The situation within Canada. Trapping in Canada is allowed and the legislation is identical throughout the whole country with minor variations that take into account the southern and northern climates and management requirements in the provinces and territories. Since 2007 the legislation has been further harmonised by the first phase of the national implementation of the AIHTS which regulates the use of AIHTS certified traps and trapping systems. About 60,000 trappers are organised at national, regional and local level. The main motivations for trapping range from pest control and wildlife management, to obtaining of meat and fur, for research and educational reasons, and for the preservation of a cultural heritage. In Canada 12 of the 19 species listed in the AIHTS are present and trapping them is allowed within the existing legal framework: coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fischer, ermine muskrat, raccoon, and American badger. In 2006, 683000 pelts from these species were sold with a value of approximately $21 million Canadian Dollars.

c) The situation within the Russian Federation. The legislation for trapping in Russia is identical throughout the whole country with only minor local differences. There are an estimated 300,000 trappers who are mainly organized in hunting organisations. The main motivations for trapping are to control pest species, to obtain fur and skin, and for reasons of public health and civil protection. In Russia 12 of the 19 species listed in the AIHTS are present; wolf, European beaver, American beaver, European otter, European lynx, pine marten, sable, European badger, ermine, raccoon dog, muskrat, and raccoon.

d) The situation within the USA. In the United States the jurisdiction for trapping legislation is at State rather than Federal level, and as a consequence there are variations between states. There are about 150,000 trappers belonging to hunting associations at the national, regional or local level. Trappers in the US hunt for many reasons that range from pest control and wildlife management, the obtaining of meat and fur, research, for educational reasons, and for wildlife disease surveillance. 12 of the 19 species listed in the AIHTS are present in the United States; coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fisher, ermine, muskrat, raccoon, and American badger.

Public attitudes to trapping within the EU.

The aims of this chapter are:

a) **to describe the backgrounds of the respondents to the internet survey,**
b) **to describe the public attitude to the trapping of wild mammals and public knowledge of trapping within the EU,**
c) **to describe the public attitude to legislation governing trapping within the EU,**
d) **to describe the public attitude to animal welfare issues associated with trapping standards.**

a) Respondents' backgrounds. Of the 9,571 completed questionnaires from EU residents, 71% were from males. Very few of the respondents were either under 20 years or over 70 years; the remaining four age categories contain similar numbers of respondents. Most lived in towns or villages containing less than 20,000 inhabitants. The replies of the respondents showed that 52% were familiar with trapping/hunting activities, 21% were familiar with animal welfare/rights activities, 10% had a background in animal research or conservation, and the replies of the remaining 17% did not allow them to be reliably allocated to any one of these categories.

b) Respondents' attitudes to the trapping of wild animals and their knowledge of trapping within the EU. 72% of all respondents thought that human and/or environmental needs could sometimes justify the killing of wild animals. Shooting, killing traps and holding traps were perceived as the main methods (90%, 78%, and 85% respectively) used in the EU to control wild mammals, and these methods were also those most commonly cited as being acceptable control techniques (67%, 57% and 65% respectively). The main reasons for controlling wild mammals in the EU were perceived to be for reasons of human health and safety (75%), to prevent damage (77%), and for wildlife conservation (76%).

c) **Respondents' attitudes to legislation governing trapping within the EU**. 77% of respondents thought that trapping should be regulated by legislation. 72% of the respondents who had a background in trapping/hunting thought that such legislation should be left to Member States, whilst 80% of the respondents with a background in animal welfare/rights thought there should be binding, harmonised EU trapping standards. 46% of respondents thought that EU trapping legislation should cover all the species that can legally be trapped; as opposed to the 21% who believed the legislation should include only the species currently covered by the AIHTS. 79% of respondents with a background in trapping/hunting thought trap approval should be organised at the national level, whilst 72% of respondents with a background in animal welfare/rights wanted it to be organised at the EU level. Most respondents (36%) wanted an independent institute to conduct the testing and approval of traps, as opposed to the trap manufacturers, trapping organisations or animal welfare organisations. However, 71% of the respondents who currently use traps stated they were not prepared to pay more for a trap that had been tested and approved.

d) Respondents' attitudes to animal welfare issues associated with trapping standards. 57% of respondents agreed that traps in the EU should be tested and approved according to clearly defined wild animal welfare criteria. When asked what was for them the maximum acceptable period between capture by a killing trap and the unconsciousness and death of the captured animal, 29% of respondents stated that death should be instantaneous (i.e. zero seconds) and 26% said they would accept a maximum period of 30 seconds. Only 6% found the 300 seconds period contained in the AIHTS to be acceptable. 63% of the respondents placed most weight upon physical injuries (e.g. broken teeth) when assessing the welfare of animals in holding traps as opposed to behavioural (e.g. biting the bars of the cage) or physiological (e.g. high levels of stress hormones) signs of suffering.

Improved Standards for killing traps.

The aims of this chapter are:

a) **to consider what constitutes a humane killing trap,**
b) **to discuss the parameters used to assess the welfare of animals in killing traps,**
c) **to compare and contrast important killing trap standards,**
d) **to discuss the welfare of animals in drowning traps and consider whether such traps should be treated differently than other forms of killing traps,**
e) **to propose improved welfare standards for killing traps (referred to as the Improved Standards),**
f) **to identify current traps that meet the Improved Standards for the species of major interest to the EU,**
g) **to discuss possible design modifications of traps to improve the welfare of animals in killing traps.**

a) Humane killing trap. The ideal humane killing trap is one that kills without the captured animal experiencing any pain or suffering. Such a trap need not necessarily kill the captured animal instantaneously but it should produce instantaneous unconsciousness from which the animal does not recover prior to death.

b) Assessing the welfare of animals in killing traps. As an unconscious animal does not feel pain and does therefore not suffer, the time to irreversible unconsciousness

(TIU) following capture in a killing trap has most commonly been used as the key measure for assessing the welfare of the captured animal. One problem with this approach is that it assumes a simple relationship between the level of pain and suffering experienced by the trapped animal and the TIU; the shorter the TIU the less pain and suffering. However, as currently there appear to be no physiological, behavioural or pathological indices that can reliably be used to quantify the level of pain an animal in a trap experiences prior to death, it is reasonable to place the greatest weight on the TIU of the captured animal.

c) Welfare standards for killing traps. Three killing trap standards are compared and contrasted.

a) A draft ISO document circulated to members of ISO/TC191 in 1993 put forward a standard that required a killing trap to render at least 70% of trapped animals irreversibly unconscious within 180 seconds at a 90% confidence level. This standard also included a testing procedure that incorporated the use of so-called 'stopping rules' designed to reduce the number of animals required to test traps.

b) A killing trap meets the AIHTS when 80% or more of at least 12 test animals show TIU scores below limits that differ between target species: the ermine has a TIU limit of 45 seconds; the marten, the sable, and the pine marten have a TIU limit of 120 seconds; all the other species covered by the AIHTS currently have a TIU limit of 300 seconds with the goal of eventually lowering this on a species-by-species basis to 180 seconds.

c) The New Zealand National Animal Welfare Committee (NAWAC) Guideline 09 contains criteria for two welfare categories of traps (called "welfare performance classes (A or B)") based upon TIU scores, and for each of these categories there are two TIU thresholds. To qualify as a Class A trap a stated maximum number of animals having a TIU greater than 30 seconds must not be exceeded, and also a stated maximum allowable number of animals having a TIU greater than 180 seconds must not be exceeded. To qualify as a Class B trap a stated maximum number of animals having a TIU greater than 180 seconds must not be exceeded, and also a stated maximum number of animals having a TIU greater than 300 seconds must not be exceeded. These numbers are designed to give 90% confidence that the traps that pass the test will perform below the lower TIU threshold 70% of the time and below the upper TIU threshold 80% of the time

The three standards differ in the number of test animals required to implement them. The NAWAC Guideline allows the manufacturer to choose one of a number of possible sample sizes for the trap testing; from a minimum sample size of 10 up to a maximum sample size of 50. The AIHTS sets minimum sample size but it specifies no upper limit to the number of animals that may be used. The draft ISO standard has procedures that minimise the number of animals required because the trial can be stopped and the trap failed as soon as the probability of a successful outcome becomes too low.

d) Drowning traps. The welfare of animals in drowning traps is discussed in relation to the accounts of people who have survived drowning. Some people describe their last conscious moments as being calm with no pain, whereas others describe burning suffocation and scorching pain. In humans, and other terrestrial mammals, the build up of carbon dioxide in the blood and the lack of oxygen stimulates the brain's respiratory centre; this overrides any voluntary breath-holding and forces an inhalation of water. However, in aquatic mammals the diving reflex is thought to take priority, and it is unclear both at what point the motivation to breathe becomes more important and whether such animals would necessarily experience pain and distress before unconsciousness. It is concluded that there is no reason why drowning traps should not be subjected to the same TIU limits as other killing traps. However, a major problem (particularly as regards semi-aquatic mammals like muskrats) lies in deciding at what point the clock should start when recording the TIU of an animal in a drowning trap. With a spring trap the clock starts when the trap is sprung and animal is hit with the killing bar. There is not such an obvious starting point for an animal in a drowning trap. Distress is unlikely to occur immediately after entry into the drowning trap because mammals, and particularly semi-aquatic mammals, routinely spend some time underwater without experiencing distress or pain. For an animal in a drowning trap, distress and possibly pain, is more likely to start when it first attempts to, and thereby finds that it is unable to, come to the surface to breathe. Theoretically the clock should start then, and experiments designed to determine this point for muskrats are described in Chapter 5.

e) Improved Standards for killing traps. The proposed Improved Standards classify killing traps into one of three 'Welfare Categories', see Table 4.1. Traps in Welfare

Category A, the highest welfare category, must (at 90% confidence) produce a TIU not exceeding 30 seconds for at least 80% of trapped animals. Traps in Welfare Category B, the intermediate welfare category, must (at 90% confidence) produce a TIU not exceeding 180 seconds for at least 80% trapped animals. Traps in Welfare Category C, the lowest welfare category, must meet the current AIHTS standard for most species (i.e. produce a TIU in a trapped animal not exceeding 300 seconds for at least 80% of a minimum of 12 animals tested). In addition to the criteria that 80% of trapped animals must have a TIU below the specified limit for the particular welfare category, it is proposed that for Welfare Categories A and B there should also be a higher TIU limit that must not (at 90% confidence) be exceeded by at least 90% of trapped animals. The upper TIU limit for Welfare Category A is 180 seconds, and the upper limit for Welfare Category B is 300 seconds. Welfare Category C has no upper TIU limit so that traps that have already been tested and approved under the AIHTS would automatically be approved as Welfare Category C of the Improved Standards.

	Welfare Category A	**Welfare Category B**	**Welfare Category C**
Lower TIU limit, to be met by >80% of animals	30 seconds	180 seconds	300 seconds
Upper TIU limit, to be met by >90% of animals	180 seconds	300 seconds	No upper limit

Lower and upper TIU limits for Welfare Categories A, B; these limits are to be met at 90% confidence. Welfare Category C is the same as the AIHTS.

If these proposals were adopted it is envisaged that there may not be any immediate change in trap use within the EU as all the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. However, in order to encourage the rapid development of better traps there is in the Improved Standards the presumption that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be approved. This could be reinforced, for example, by additional regional or national incentives or legislative/administrative frameworks.

f) Traps that meet the Improved Standards. For the species of major interest to the EU a list of traps that meet the AIHTS, and hence also meet the TIU criteria for Welfare Category C of the Improved Standards, is provided. Although killing traps have not yet been tested to the higher welfare standards of Welfare Categories A and B of the Improved Standards, information is available from scientific studies that indicate that some traps would be allocated to these categories (eg Warburton et al, 2008)

g) Design modifications to improve killing traps. Possible ways to reduce the TIU scores of animals in killing traps are discussed (e.g. replacing the single strike bar by a mesh of strike bars greatly increases the chances of a neck strike). A promising future development is the use of computer models to develop a Trap Optimisation Program that can suggest effective design changes.

The time of onset and duration of distress prior to death in muskrats caught in cage-type drowning traps.

The aims of this chapter are

a) **to investigate whether the onset of distress of muskrats in a drowning trap can be objectively identified using behavioural and physiological responses,**
b) **to determine if being held in a drowning trap causes avoidance learning in muskrats,**
c) **to determine, using the information from the experimental studies, whether drowning traps meet the TIU limits contained within the AIHTS and the Welfare Categories of the Improved Standards for killing traps.**

a) Behaviour and physiological parameters to identify onset of distress in muskrats killed in drowning traps. Trials were carried out with wild-caught muskrats held in semi-natural experimental pens containing ponds. The animals voluntarily entered drowning traps placed on the ponds. Behaviour was recorded using underwater cameras, EEG and ECG were recorded via surgically-implanted biotelemetry transmitters, and serum corticosterone levels were measured after death. As some habituation to the experimental setup may have occurred whilst baseline levels of these parameters were being taken for the implanted animals, additional trials were conducted with naïve animals that had not been previously exposed to the test procedure. The mean time to unconsciousness after the muskrats had entered the underwater cage of the drowning trap was 448 seconds for the implanted animals and 361 seconds for naïve animals. After means of 61 and 76 seconds (for implanted and naïve animals respectively) the muskrats started biting the wire mesh of the cage. Heart rate decreased from a mean of 258 bpm at 60 seconds before entering the underwater cage of the drowning trap to a mean of 56 bpm for the period between entering the water and unconsciousness. Serum corticosterone concentration in post mortem blood samples taken from the heart of the drowned muskrats was found to be eight times higher than the basal serum corticosterone concentration.

b) Aversion to the drowning trap. A learning paradigm was used to determine whether any aversion to the drowning trap resulted from the muskrats being held in the underwater cage for varying periods before being released. No aversion to re-entering the trap was found in muskrats that had been kept underwater until the onset of biting behaviour, nor in animals that had been kept underwater for 120 seconds after the onset of the biting behaviour. These results indicate that 120 seconds after the onset of biting may be taken as a conservative indicator of the onset of distress.

c) Do the drowning traps meet the standards of the AIHTS and Welfare Category C of the Improved Standards? If the results of the two studies are accepted then the period between onset of distress and irreversible unconsciousness for muskrats in a drowning trap is within the 300 seconds limit specified in the AIHTS and Welfare Category C of the Improved Standards. Nevertheless it is important to develop new muskrat traps that can meet the criteria of Welfare Categories A and B of the Improved Standards.

Improved Standards for restraining traps

The aims of this chapter are:

- **a) to discuss the use of injury scales to assess the welfare of animals in restraining traps,**
- **b) to compare and contrast important restraining trap standards,**
- **c) to discuss the use of possible behavioural and physiological indices of welfare to assess the welfare of animals in restraining traps,**
- **d) to propose improved welfare standards for restraining traps (referred to as the Improved Standards),**

e) **to identify current traps that meet the Improved Standards for the species of major interest to the EU,**
f) **to discuss possible design modifications of traps to improve the welfare of animals in restraining traps.**

a) Injury scales. Injury or trauma scales have been commonly employed to assess the welfare of animals in restraining traps. Three main types of injury scales have been used to assess the suffering of trapped animals. First, there is the simple and relatively crude ‘yes/no’ process in which a list of “unacceptable” injuries is compiled and the presence of one of these in the trapped animal is sufficient to fail the trap. Second, each type of injury can be assigned a number of points and the points for all the injuries suffered by the trapped animal are added up and compared with a maximum value that must not be exceeded if the trap is to meet the welfare standard. The third approach entails the grouping of injury types into severity levels such as mild, moderate and severe, and then, after deciding upon a minimum sample size, defining a frequency of occurrence for each severity level whereby a trap would be deemed as unacceptable if this were exceeded. The pros and cons of each system are discussed.

b) Welfare standards for restraining traps based upon injury scales. Three existing welfare standards for restraining traps based on injury scales are considered. The draft ISO humaneness standard for restraining traps focused on injuries thought to cause pain and it combined both an injury scale for “potentially acceptable injuries” and a list of “unacceptable injuries”. Under this scheme the most severe injuries were termed “unacceptable” and a single instance of this class was sufficient to fail the trap. Injuries of lesser severity, i.e. “potentially acceptable injuries”, can occur singly or in a very large number of combinations. To deal with this problem there is a point system for potentially acceptable injuries that is both cumulative and multiplicative, and where higher points are assigned to those injuries considered more severe. An animal passes the required “injury threshold value” if it has a) no unacceptable injuries, and b) a total injury score for the potentially acceptable injuries of less than or equal to 75. The restraining trap passes the welfare requirements of this proposed standard if at least 80% of 25 or more captured animals meet the injury threshold value.

The AIHTS provides a list of injuries "recognised as indicators of poor welfare in trapped animals". No scores are assigned to the above injuries; rather they are treated as unacceptable injuries in that at least 80% of the animals tested must show none of them if the trap is to pass. One problem with this approach is that it cannot cope with the compound welfare effect of a number of lesser injuries.

Under the New Zealand NAWAC trap approval system each injury sustained by an animal caught in a restraining trap is classified into one of four trauma categories: namely mild trauma, moderate trauma, moderately severe trauma, and severe trauma. The numbers of each of these trauma categories are then combined to produce the overall Trauma Class for each animal. There are four Trauma Classes; namely Mild, Moderate, Moderately Severe and Severe. Each of these Trauma Classes can be made up of different combinations of the various trauma categories and in this manner the NAWAC Guideline deals with the problem of multiple and diverse injuries (http://www.biosecurity.govt.nz/animal-welfare/nawac/policies/guideline09.htm).

c) Behavioural and physiological indices of adverse welfare. Possible behavioural and physiological indices of distress that could be used to assess the welfare of animals in restraining traps are discussed. It is concluded that it is very difficult not only to measure these parameters in wild species but also to interpret what any changes in them as the result of trapping signify for the welfare of the trapped animal. Furthermore, as the recent Welfare Quality project has demonstrated that different welfare indicators are required even for different production systems involving the same domestic species, it is thought unlikely that a robust animal-based welfare measure incorporating more than injury indicators could be devised covering all the trapped wild species. Whilst behavioural and physiological measurements are useful in comparative studies they are not currently reliable welfare indices in the context of a stand-alone assessment.

d) Improved Standards for restraining traps. The proposed Improved Standards for restraining traps involve four classes of injury severity (i.e. mild, moderate, moderately severe and severe) and three Welfare Categories, A B, and C of restraining traps; Welfare Category C would be the existing AIHTS standard whilst the injury scales of Welfare Categories A and B are taken from the NAWAC Guideline that is successfully being used in New Zealand. Thus for Welfare Category

A, at least 80% of the trapped animals must suffer a trauma class no greater than mild and at least 90% must suffer a trauma class no greater than moderate; both pass rates being at the 90% confidence level. For Welfare Category B at least 80% of the trapped animals must suffer a trauma class no greater than moderate and at least 90% a trauma class no greater than moderately severe; again both at the 90% confidence level. For Welfare Category C the maximum allowable number of animals (i.e. 4 out of the minimum sample size of 20 specified in the AIHTS) with the indicators for poor welfare listed in the AIHTS must not be exceeded.

If these proposals were adopted it is envisaged that there may not be any immediate change in trap use within the EU as all the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. Furthermore, box/cage traps are the most commonly used form of restraining trap within the EU and the available evidence indicates that such traps fall within Welfare Category A of the Improved Standards. However, in order to encourage the rapid development of better traps there is in the Improved Standards the presumption that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks.

e) Traps that meet the Improved Standards. There is much information on the welfare of leg-hold traps but these are not used in the EU. Unfortunately very little trap testing data are available covering the other forms of restraining traps that are used to capture the species of interest to the EU. However, box/cage traps are the most commonly used form of restraining trap within the EU and the available evidence-(eg Woodruffe et al. 2005) indicates that such traps fall within Welfare Category A of the Improved Standards.

f) Design modifications to improve restraining traps.

Possible modifications that can improve the welfare of animals in restraining traps are discussed. For example, tooth damage can be reduced by reducing the mesh size of cage traps and covering metal surfaces with smooth coatings can lessen the chance of skin abrasions.

Methods to reduce the level of animal suffering involved in trap testing.

The aims of this chapter are:

a) **to discuss the methods of measuring the impact and clamping forces exerted by killing traps and how to relate the forces recorded to the minimal forces required in order to meet the specified TIU limit for a given species,**
b) **to consider the pros and cons of using animals under terminal anaesthesia in trap testing,**
c) **to discuss computer models developed by the Fur Institute of Canada that are being used to determine whether a spring trap meets the killing trap requirements of the AIHTS,**
d) **to discuss the value of incorporating 'stopping rules' into the experimental designs used for trap testing.**

a) Mechanical testing of traps. Spring powered killing traps kill through a combination of the impact force of the strike bar of the trap on the captured animal, and the clamping force exerted on the animal by the trap after the strike. If the minimum impact and clamping forces necessary to result in a TIU shorter for a given target species than that specified in the trap standard are known, then it becomes possible to conduct mechanical tests to see if traps designed for the same species are capable of producing these minimum forces. When a spring trap is triggered the potential energy of the spring is converted into kinetic energy and the kinetic energy created can be used as a standard welfare criterion for traps. A rough estimate of the kinetic energy a trap could exert can be gained by measuring the average force required to extend, compress or wind the spring(s) and multiplying it by the distance through which the spring arm(s) moved. However much of the potential energy in the spring is used to overcome friction and is thus lost as heat energy. The pros and cons of measuring either a) the strike momentum generated by the trap, or b) the impact force directly using forces transducers are discussed. Measuring the mechanical forces exerted by a trap is of little use unless these forces can be compared to the minimal forces that are required in order to meet the specified TIU for the target species. These minimal forces have been obtained by placing anaesthetised animals within specially constructed trap simulators, and examples are given of the sorts of results that can be obtained from such devices.

b) The use of anaesthetised animals. Whilst the use of anaesthetised animals ensures that the subjects do not suffer, questions have been asked about the effect the anaesthetic might have on the TIU values obtained. A study involving a wide range of mammals found no significant correlations between the TIU scores obtained from anaesthetised animals and those obtained from unanaesthetised animals, although other work has found significant correlations for some species. As the TIU for an anaesthetised animal is usually less than the TIU for an unanaethetised animal, it has been argued that whilst results from tests using anaesthetised animals cannot be used in isolation to determine whether a trap meets the required trap standard, they can nevertheless be used on their own to determine whether a trap fails the standard. The validity and usefulness of this approach is discussed; particularly in relation to traps that kill by reducing blood flow through the carotids.

c) Computer models. Computer models that determine whether a trap design meets the killing trap requirements of the AIHTS have been developed by using the extensive database covering 15 years of live animal trap testing held by the Fur Institute of Canada. Mechanical characteristics of the trap and the anatomical strike locations together with the size of the animal and how the trap is set are the factors included in the logistic regression model used to fit the data. The probability that the trap will cause an animal to lose sensibility within the TIU limit specified for that species within the AIHTS is calculated. The obvious benefits of using computer models are a) they reduce the number of animals required to test trapping devices (in Canada it is estimated that to date 1200 fewer animals have been used), and b) they currently cost 85% less than the compound testing of traps.

d) Experimental designs incorporating stopping rules. Bayesian Sequential Stopping Rules (BSSRs) for trap assessment trials have been developed that allow a trial to be halted before the maximum number of test animals specified in the trap standard have been used. The BSSRs enable a trial to be stopped on the basis of the results gathered thus far as soon as there is either a) strong evidence (i.e. $p<0.05$) that the trial will end with the trap failing, or b) strong evidence (i.e. $p<0.05$) that the trial will end in the trap passing. In this manner the minimum number of animals are used in the trap assessment trial. It is proposed that the Improved Standards for both killing and restraining traps adopt a sequential testing procedure such that a) only the minimum number of animals are tested on traps that are likely to fail the Improved Standards, and b) any trap that passes will perform similarly on animals in the wild.

Best Practice in the use of traps

The aims of this chapter are:

a) **to consider how information on trapping best practice should be disseminated,**
b) **to discuss the setting of criteria for trap efficiency,**
c) **to discuss the setting of criteria for trap selectivity,**
d) **to consider how the length of time between trap inspections affects the welfare of trapped animals.**

a) Best Practice Information. How a trap is used is crucial to the welfare impact it has on the target species, to the non-target risk it poses, and to its efficiency. A criticism that has been levelled at the AIHTS is that it concentrates too heavily on the trap itself and does not deal sufficiently with such issues as trap efficiency, non-target risk, and the training and registration of trappers. However, the EU encompasses a wide range of both habitats and non-target species, and the best way to minimise non-target risk and maximise efficiency under the local conditions found in one Member State may not be best practice under the local conditions of another Member State. Similarly Member States differ in their legislative requirements for trapper training and/or trapper registration. Rather than try to deal with the complexity of these issues through legislation at the EU level, an arguably better way is through the production of a series of species-specific Best Practice Guides. Whilst an expert committee at the EU level could determine what sorts of information should be within such documents, the resulting templates could be amended at the national level to take into account local conditions. There would be a presumption that traps would be used according to the Best Practice Guides, and that they could be granted legal status by national governments if required. This is the policy successfully adopted in the USA where Best Management Practice documents (BMPs) have been developed for each species.

b) Trap efficiency. The large number of factors affecting trap efficiency means that it is very difficult to draw up efficiency standards that are applicable to all the species covered by the AIHTS and to the very wide range of habitats found within the EU. One way to tackle this problem is to compare the capture efficiency of the test trap with that of a control trap. A draft ISO standard suggested that the control trap should be the trap in most common use. However, the trap in most common use can differ between countries and, therefore, there is no single 'control trap' that can be specified and standardised internationally. Furthermore, as the control trap may vary in efficiency from one trapline to another, among years, and between trappers, it has been argued that the use of such an efficiency standard is arbitrary. Rather than try to define efficiency criteria in the Improved Standards it is proposed that advice on trap efficiency should be provided within the species-specific, Best Practice Guides that take into account local conditions.

c) Trap selectivity. Trap selectivity criteria have been included in some national trap standards by comparison with the selectivity of a control trap. Unfortunately the use of a control trap means that the problems discussed above in relation to trap efficiency apply also to setting an international standard for trap selectivity. The selectivity of traps varies widely with trap type; with box/cage traps having the highest incidence of non-target captures and drowning traps the lowest. Non-target risk also varies not only with the type of trap but also with how the trap is set, the bait used and the season. Again, rather than try to define selectivity criteria in the Improved Standards it is proposed that practical advice on ways to reduce non-target risks should be provided within the species-specific, Best Practice Guides.

d)Time between trap inspections. Whilst increased periods of confinement in leg-hold traps are associated with more struggling and consequently greater injuries, the strength of the correlation between injury and time in a restraining trap varies with species. A daily inspection regime (i.e. once every 24 hours) appears to be the minimum accepted standard in most countries. With some exceptions (e.g. UK) inspection times are not usually specified for killing traps because it is assumed that all the captured animals are killed by the trap. It is suggested that the Improved Standards include the minimum requirement that both restraining and killing traps (apart from drowning traps where the death of the captured animal is assured) should be inspected once every 24 hours, but that killing traps that meet the higher Welfare Categories A and B could be made exempt from this requirement.

Technical Workshop on International Trapping Standards

The aims of this chapter are:

a) **to present summaries of the lectures and discussions that took place on Day 1 of the Workshop which was spent discussing the methods of testing, and the trap standards applied to, restraining traps,**

b) **to present summaries of the lectures and discussions that took place on Day 2 of the Workshop which was spent discussing both the methods of testing and the trap standards applied to killing traps, and new approaches to trap testing,**

c) **to present summaries of the lectures and discussions that took place on Day 3 of the Workshop which was spent discussing the welfare of animals caught in drowning traps; particularly with regard to the control of muskrats.**

a) Day 1: Restraining traps. On the morning of Day 1 of the Workshop there was an initial lecture on the history of ISO Technical Committee 191 (ISO TC191) concentrating on the debates that took place during the development of draft ISO Standards for restraining traps. Subsequently there were lectures and discussions on the current restraining trap standards and trap-testing methodologies being used in New Zealand, the USA and Canada. Improved EU standards for restraining traps were then proposed that would enhance the standards currently contained in the AIHTS. The afternoon was spent discussing the proposed improvements to restraining trap standards and trap-testing methodology; including the potential use of behavioural and physiological indices of welfare.

b) Day 2: Killing traps and new approaches to trap testing. The initial lecture on Day 2 of the Workshop gave the history of ISO TC191 concentrating on the debates that took place during the development of draft ISO Standards for killing traps. This was followed by lectures and discussions on the current killing trap standards and trap-testing methodologies being used in New Zealand and Canada. Improved EU standards for killing traps were then proposed that would enhance the standards currently contained in the AIHTS. The afternoon was spent discussing the proposed improvements to killing trap standards and trap-testing methodology; including ways (e.g. use of stopping rules, computer models) to minimise the numbers of animals required for such testing.

c) Day 3: Drowning traps. Drowning traps were discussed on Day 3 of the Workshop. After a lecture illustrating the serious problems that muskrats can cause and the current methods used in the EU for their control, there was a lecture and discussion on the experiments being conducted by the Consortium to assess the welfare of muskrats in drowning traps; particularly with regards to measuring the TIU of muskrats in drowning traps.

Improved trapping standards within the EU

The aims of this chapter are:

a) **to bring together all the proposals set out in this report for improving trapping standards within the EU i.e. the Improved Standards,**
b) **to discuss the trapping implications of adopting the Improved Standards,**
c) **to discuss the financial implications of adopting the Improved Standards.**

a) Improved Standards. On the basis of the results from this study, which reflect the current state of the relevant science, it is proposed that:

a) the adoption of two new welfare standards (i.e. Welfare Categories A and B), that are more strict than the welfare standard currently within the AIHTS and cover the use of both killing and restraining traps, would improve the welfare of trapped animals,
b) only traps that clearly meet the requirements of the resulting Improved Standards should be used in the EU,
c) drowning traps should be subject to the same welfare standards as other forms of killing trap, i.e. the Improved Standards,
d) wherever possible trap testing should not involve the use of conscious animals, and where conscious animals are required then sequential stopping rules should be used to minimise the number of animals tested,

e) where traps of different Welfare Categories are available for the same target species then only traps of the highest Welfare Category should be used in order to encourage the improvement of traps,
f) any new measures adopted by the Member States should cover all the species that can legally be trapped because there is no scientific basis for not including all species,
g) all persons who trap animals should be appropriately trained.
h) an, EU-wide, website providing information to the public on approved traps, training and Best Practice Guides should be developed.

b) Trapping implications of adopting the Improved Standards. The immediate implications of adopting the Improved Standards for traps within the EU are that a) killing traps are already available that meet the Improved Standards for the six species of most interest to the EU but only at the Welfare Category C level, and b) the majority of the restraining traps currently in use will meet Welfare Category A of the Improved Standards.

c) Financial implications of adopting the Improved Standards. The financial implications of accepting the Improved Standards vary greatly depending on the methods used to assess a trap; for example, the cost of testing a trap using an existing computer program is around €3,500, development of a new computer program could cost as much as €90,000, whilst a complete programme of pen and field trials would cost approximately €65,000. As the Improved Standards involve sequential testing procedures and stopping rules, the costs incurred when assessing a trap that fails the Improved Standards will be far less than those incurred testing a trap that passes these Standards.

Contents

1 Introduction

1.1 Negotiated Procedure ENV.E.2/2006/D(10248).

"Humane Trapping Standards – description of the state of the art of research, science and application of humane trapping standards referred to in the 'Agreement on International Humane Trapping Standards' (AIHTS) and described in Commission proposal COM (2004) 532 final, in view of identifying the trapping standards which reduce unnecessary pain, distress and suffering of trapped animals as much as technically possible".

The main objective of the work is to identify improved trapping standards that reduce unnecessary pain, distress and suffering of trapped animals as much as technically possible. However, the standards must be economically realistic and technically achievable. The following key tasks should be completed (primarily in relation to the species of major interest to the EU; namely muskrat, pine marten, raccoon, raccoon dog, badger and ermine).

1: Collecting worldwide data by undertaking a review of the existing worldwide scientific literature and other publications on trap testing, trapping methods, and trapping best practice.

2: Collecting data on the state of art with regard to trapping methods used in the 25[5] Member States of the EU as well as in the parties to the AIHTS and in the USA.

3: Review of methods for testing of traps and trapping methods for the animal species concerned.

4: Establishing the shortest possible technically achievable time limit (improved standards) concerning unconsciousness and insensibility with regard to killing trapping methods.

5: Identification of relevant indicators for restraining trapping methods to assess the welfare of trapped animals and establishing thereafter the improved standards for restraining trapping methods.

6: Identification of killing and restraining trap types meeting the standards for the animal species concerned.

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[5] At the 'kick off' meeting it was agreed to cover 27 Member States.

7: Identification of testing methods that reduce the use of live animals.
8: Organisation of a technical workshop presenting obtained scientific and technical results for discussion and evaluation.
9: Contributing to a stakeholder Internet consultation of which the results will be taken into account in the final report.

The final report should thoroughly and objectively address the described issues and present sound conclusions incorporating operational recommendations with regard to the trapping standards referred to in the AIHTS and contained in the Commission proposal. (N.B. The final report has been written in a logical order and structure, rather than in the order that the work was completed or following the exact structure of the key tasks.)

1.2 Background

In 1983 the Gambia tabled a draft resolution at the conference of the parties to CITIES to prohibit trade in animal products deriving from cruel and painful trapping devices "including, but not limited to, a trapping device of the 4-steel-jaw leghold (gin) type trap". This proposal failed because it was beyond the scope of the Convention but it moved Canada to request the establishment of a Technical Committee of the International Standards Organisation (ISO) to deal with the humane trapping issue (Harop 2000). The resultant committee, ISO TC/191, began work in 1987 to develop humane trapping standards. Also in 1987, following public concerns about trapping methods used in the EU and in some other countries, the European Parliament called for a prohibition on the use of leghold traps throughout the EU and for an import ban on furs obtained by the use of the leghold trap. As a result the EU passed the Council Regulation (EEC) No 3254/91. This Regulation, popularly known as the Leghold Traps Regulation, prohibits both the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or other trapping methods that do not meet international humane trapping standards.

The ISO process to develop international humane trapping standards proceeded for almost ten years but unfortunately no consensus was reached on key thresholds for animal welfare standards; such as the time to irreversible unconsciousness for killing traps, or the severity of injuries for animals caught in restraining traps. It became clear that standards that could be used as the basis for derogation from the European ban would not be forthcoming, and the work of ISO/TC191 changed in 1997 when it was agreed that the committee would issue standards for trap testing methodology rather than for humane trapping standards. ISO standard ISO 10990-4 1999 was subsequently issued covering the methodology to be used to assess the humaneness of killing traps, and ISO standard ISO 10990-5 1999 was issued covering the testing of restraining traps.

In order to pursue an agreement on international humane trapping standards the EU together with the three main trapping nations Canada, the USA and the Russian Federation set up a working group of scientific experts in 1995. Subsequently, an Agreement on International Humane Trapping Standards (AIHTS 1998a, Harop 1998) was concluded with Canada and the Russian Federation and was approved by Council Decision in 1998. A substantially similar agreement concerning the standards was reached in the form of an Agreed Minute with the USA (AIHTS 1998b). These agreements allowed the import ban under Council Regulation (EEC) No 3254/91 not to apply to Canada, the Russian Federation and the US.

The Agreement and the Agreed Minute form an integral part of EU law and are therefore binding on the Institutions and the Member States. Accordingly, in the absence of proper implementation of the Agreement at EU level the EC would be in infringement of its obligations and international responsibility versus the other Parties once the Agreement is in force. On 30 July 2004 the Commission submitted a proposal for a Directive of the European Parliament and of the Council introducing humane trapping standards for certain animal species (COM (2004) 532 final) with the objective to implement the international obligations and commitments arising from the AIHTS. This proposal followed the scope and content of the AIHTS and aimed to ban the use of traps not meeting the agreed international trapping standards for catching animals belonging to the 19 species listed in the AIHTS. Whilst it established a harmonised system within the EU to evaluate available traps and to ensure that the best possible trapping methods are used, it also left intact the possibility for EU Member states to introduce stricter standards at the national level.

As the use of all leghold traps (even those that meet the humane trapping standards) remained prohibited within the EU, the new directive applied to traps other than leghold traps.

This proposal was submitted to the other institutions for adoption by co decision. However, the draft directive was rejected by the European Parliament for a variety of reasons. In particular it was argued that, as the trapping standards in the proposal resulted from work conducted by the expert group in 1996-1997, the standards were not necessarily based on the latest science. The Commission took note of the rejection of the proposal and undertook steps to address the concerns expressed. As part of this process the Commission commissioned studies (under Negotiated Procedure ENV.E.2/2006/D(10248) Humane Trapping Standards)

2 Trapping methods and legislation within the EU, Canada, Russia and the USA.

This chapter describes the trapping methods and legislation currently used within the 27 Member States of the EU, Canada and Russia (the other parties to the AIHTS), and the USA. A detailed questionnaire primarily designed to gather information on trapping methods and the certification of traps for the trapping of species listed in the AIHTS was distributed to persons with trapping expertise in all 27 EU Member States, Canada, Russia and the USA (see Acknowledgements). Within the EU the level to which trapping of mammals is practiced and the methods used varies widely between Member States; but trapping is generally subject to specific legal provisions and rules that cover the types of trap, the conditions under which these may be used, methods required to avoid capture of non-target species, and regular inspections. Of restraining traps, box/cage traps are used almost exclusively, whilst spring traps are the most commonly used killing traps; although dead-fall traps are used for pine marten and drowning traps for muskrat.

Summary

The aims of this chapter are:

a) **to present information on the current trapping methods and legislation within the 27 Member States of the EU,**
b) **to present information on the current trapping methods and legislation within Canada,**
c) **to present information on the current trapping methods and legislation within the Russian Federation,**
d) **to present information on the current trapping methods and legislation within the USA.**

a) The situation within the EU. Of the 19 mammal species covered by the AIHTS 11 are found within the EU; wolf, European beaver, American beaver, European otter, European lynx, pine marten, European badger, ermine, raccoon dog, muskrat and raccoon. The distribution of these species varies throughout the 27 Member States, and they are absent in Cyprus and Malta. The level to which trapping of mammals is practiced and the methods used also varies between Member States; as reflected in the number of persons trapping in each Member State that ranges from 150,000 in France to 50 in Bulgaria. In most Member States, the right to hunt also includes the right to trap certain mammal species which are classified as either “game” or “pests”; while in other Member States it is, partly or completely, a separate activity. The main motivations for trapping in the EU are for wildlife management and the control of pest species.

As some of these mammal species are predominantly nocturnal their populations are difficult to control using firearms, and therefore trapping is often the most appropriate method. In the EU, trapping is generally subject to specific legal provisions and rules. These can include the types of trap, the conditions under which these may be used, methods required to avoid capture of non-target species (selectivity), as well as the elimination of avoidable suffering (regular inspections). Several Member States require that trappers must have taken and passed mandatory training courses in hunting and/or trapping. In addition, trappers are often required to obtain a valid trapping and/or hunting license along with landowner permission where they wish to trap.

Seven types of trap are used to catch mammals in the EU; three types of restraining trap, i.e. box/cage, non-killing snares and foot snares, and four categories of killing trap, i.e. spring traps, dead-fall traps, drowning traps and killing snares. However, killing snares are not used to catch any of the 11 AIHTS species found in the EU. For restraining traps, box or cage traps are used almost exclusively, with the exception of France where restraining snares for raccoon dog and raccoon can be used. For killing traps, spring traps are the most commonly used; although dead-fall traps are used for pine marten, and drowning traps are used for muskrat in Belgium, Germany, France and the Netherlands.

In countries where it is required to report captures along with hunting bag returns, it is not necessary to distinguish between animals which are shot and animals which are trapped, and this means it difficult to make accurate estimates of the number of animals trapped. A notable exception is in France where detailed statistics are collected by UNAPAF (Union Nationale des Piégeurs Agréés de France). Figures are also available for governmental control programmes for certain species; notably for the muskrat (in Belgium, Germany, the Netherlands), which is the most intensively trapped of all the AIHTS species in the EU.

b) The situation within Canada. Trapping in Canada is allowed and the legislation is identical throughout the whole country with minor variations that take into account the southern and northern climates and management requirements in the provinces and territories. Since 2007 the legislation has been further harmonised by the first phase of the national implementation of the AIHTS which regulates the use of AIHTS certified traps and trapping systems. About 60,000 trappers are organised at national, regional and local level. The main reasons for trapping range from pest control and wildlife management, to obtaining meat and fur, for research and educational reasons, and for the preservation of a cultural heritage. In Canada 12 of the 19 species listed in the AIHTS are present and trapping them is allowed within the existing legal framework: coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fisher, ermine muskrat, raccoon, and American badger.

c) The situation within the Russian Federation. The legislation for trapping in Russia is identical throughout the whole country with only minor local differences. There are an estimated 300, 000 trappers who are mainly organized in hunting organisations. The main motivations for trapping are to control pest species, to obtain fur and skin, and for reasons of public health and civil protection. In Russia 12 of the 19 species listed in the AIHTS are present and trapping them is allowed within the existing legal framework; wolf, European beaver, American beaver, European otter, European lynx, pine marten, sable, European badger, ermine, raccoon dog, muskrat, and raccoon.

d) The situation within the USA. In the United States the jurisdiction for trapping legislation is at State rather than Federal level, and as a consequence there are variations between states. There are about 150,000 trappers belonging to hunting associations at the national, regional or local level. Trappers in the US hunt for many reasons that include pest control and wildlife management, the obtaining of meat and fur, research, for educational reasons, and for wildlife disease surveillance. 12 of the 19 species listed in the AIHTS are present in the United States; coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fisher, ermine, muskrat, raccoon, and American badger.

2.1 Introduction

To collect information on the state of art of trapping methods, persons with trapping expertise (i.e. the national 'Focal Points') were identified in all 27 EU Member States, Canada, Russia and the USA. In May 2007, after the contacts had been established, a detailed questionnaire (in English, French and German; see Appendix 1) was distributed to the Focal Points. This questionnaire was primarily designed to gather information on trapping methods and the certification of traps for the trapping of species listed in the AIHTS. The information gathered was compiled and presented as a draft report at a meeting held at the Central Science Laboratory (CSL) on 10-11th September 2007. At the end of October 2007 the Focal Points were sent the results for their countries in order to verify the correctness of the information and to identify any possible errors. In this chapter the information received from the EU Member States is presented first, followed separately by the information collected from Canada, Russia and USA.

2.2 Situation in the EU

Legal framework for trapping / Permission for trapping. Trapping is allowed within the existing legal framework in almost all Member States; in Greece and Italy trapping might only be permitted under special licence on a case-by-case basis. The legislation that allows trapping is usually the same throughout the entire country except for Germany, Austria, United Kingdom, Netherlands, and Spain. For example, in Germany the situation differs between the Federal States, whilst in the Netherlands to use killing traps or live traps in the field (i.e. outside premises) the province has to give authority. In most Member States any person (whether hunter, trapper, landowner or other) can trap if they have the permission to do so. In France all persons using traps must register with the authorities of the department in which they reside. After registration (for which prior training is obligatory, see below) a numbered certificate is issued and the number on this certificate must then be permanently marked on all traps used by the individual. Some Member States require a valid hunting licence and training to obtain special qualifications or even a special licence for trapping (Latvia), whereas in others (Denmark) anyone above 18 years is allowed to trap and this requires no special licence. In Belgium (Flanders) there is a legal requirement (art. 5 of Koninklijk Besluit of August 10th 2005) that every responsible person[6] must carry out the control of species causing damage (e.g. muskrat). In Romania trapping was prohibited by law between 1996 and 2006. In December 2006 a new law entered into force (No. 407) that allowed the possibility to trap using authorised traps; however there is limited information on the implementation of this law and few details of which traps are approved.

Definition / Organisation / Number of trappers. A definition, recognised by national legislation, for "trapper" only exists in France and Belgium-Wallonia; where a trapper is defined as an authorised person who is specialised in the control of, for example, predators. Trappers are usually represented through the national hunters' associations in the EU. The number of trappers in each Member State varies greatly, ranging from only 50 trappers in Bulgaria to 150,000 in France. In France trappers are organised/associated at local, regional and national level, with UNAPAF (Union Nationale des Piégeurs Agréés de France) being the national organisation that represents almost all departmental associations of registered trappers.

Main motivations for trapping. The main motivations for trapping in the EU are wildlife management and the control of pest species. In Austria and Sweden trapping is considered as a form of hunting.

Species listed in the AIHTS. The situation for the species listed in the AIHTS is very different throughout the EU. Of the 19 species listed in the AIHTS 11 are present in the Member States (See Table 2.1).

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[6] Responsible people are: the owner, the renter, the user, the person who publicly or privately, in whatever circumstances, has the right to cultural grounds, empty grounds, forests or wilderness, or any other terrain in which are included the grounds of industry institutions, buildings, warehouses, transport vehicles and every other object that can be a carrier of damaging organisms.

Table 2.1. Species listed in the Agreement (AIHTS) in the EU

Country	*Canis lupus* **Wolf**	*Castor canadensis* **American beaver**	*Castor fiber* **European beaver**	*Lutra lutra* **European otter**	*Lynx lynx* **European lynx**	*Martes martes* **Pine marten**	*Meles meles* **European badger**	*Mustela erminea* **Ermine**	*Nyctereutes procyonoides* **Raccoon dog**	*Ondatra zibethicus* **Muskrat**	*Procyon lotor* **Raccoon**
AT	☒●	●	☒●	●	●	✘●	✘●	✘●	✘●	✘●	✘●
BE									✘(F) ●	✘●	✘(F) ●
BG	✘●						✘●		✘●	✘●	
CY											
CZ						✘●	✘●		✘		✘
DE					●	✘●	✘●	✘●	✘●	✘	✘●
DK											
EE	●		✘●		●	✘●	●		✘●	✘●	
ES	●										

<u>Legend:</u>

Grey: Presence in the Member State

✘ Trapping is legal within the existing legal framework

☒ Trapping might be permitted under derogation on a case-by-case basis

● Huntable

Country	*Canis lupus* **Wolf**	*Castor canadensis* **American beaver**	*Castor fiber* **European beaver**	*Lutra lutra* **European otter**	*Lynx lynx* **European lynx**	*Martes martes* **Pine marten**	*Meles meles* **European badger**	*Mustela erminea* **Ermine**	*Nyctereutes procyonoides* **Raccoon dog**	*Ondatra zibethicus* **Muskrat**	*Procyon lotor* **Raccoon**
FI	●	✘●	✘☒●	✘☒●	✘●	✘●	✘●	✘●	✘●	✘●	●
FR			☒			✘●	☒●	●	✘ ●	✘ ●	✘ ●
GR						☒●					
HU							✘●		●	●	●
IE				☒		☒	☒				
IT	☒			☒	☒	☒	☒	☒			
LT	☒		✘☒			✘☒	✘☒		✘☒	✘☒	
LU									✘●?	✘●?	✘●?
LV	●		✘●		●	✘●	✘●		✘●	✘●	

Legend:

Grey: Presence in the Member State

✘ Trapping is legal within the existing legal framework

⌧ Trapping might be permitted under derogation on a case-by-case basis
● Huntable

Country	*Canis lupus* **Wolf**	*Castor canadensis* **American beaver**	*Castor fiber* **European beaver**	*Lutra lutra* **European otter**	*Lynx lynx* **European lynx**	*Martes martes* **Pine marten**	*Meles meles* **European badger**	*Mustela erminea* **Ermine**	*Nyctereutes procyonoides* **Raccoon dog**	*Ondatra zibethicus* **Muskrat**	*Procyon lotor* **Raccoon**
MT											
NL		✘●	⌧	⌧	⌧	⌧	⌧	⌧	✘●	✘●	✘●
PL						●	●		●	●	●
PT											
RO						●	●	●	●	●	
SE	⌧		✘⌧●	⌧	✘⌧●	✘●	✘⌧●	⌧	⌧●	✘●	⌧●
SI						✘⌧	⌧			✘⌧	
SK	●					● ✘	● ✘		●	● ✘	●
UK				⌧		⌧	⌧	✘●			

<u>Legend:</u>
Grey: Presence in the Member State

✘ Trapping is legal within the existing legal framework

☒ Trapping might be permitted under derogation on a case-by-case basis

● Huntable

The American beaver is only present in Finland and can be legally trapped there. The species that are huntable, and for which hunting is legal within the existing legal framework, are predominantly pine marten, European badger, raccoon dog, muskrat and raccoon. But there are also a considerable number of Member States where the trapping of certain species might be permitted under derogation on a case-by-case basis. In the case of Italy and Ireland (and possibly Romania) all of the listed species might be trapped under derogation. In addition, several species that are not listed in the AIHTS are being trapped within the 27 Member States; in particular the red fox, beech marten, European polecat and American mink.

Categories of traps. For the purpose of the questionnaire, traps were classified as either restraining traps (three categories) or killing traps (four categories). The restraining traps mostly used in the EU are box and cage traps. The killing traps used most often fall into the spring trap category. For muskrat and raccoon some Member States also use drowning traps (see table 2.2)

Authorization and Approval of traps. In most Member States restraining traps (mainly box and cage traps) do not need to be approved, whilst approval is often required for killing traps (spring traps). Approval for a particular type of killing trap can be refused for technical reasons (e.g. it does not exert sufficient impact and/or clamping forces). The sale of non-approved traps is not possible in Slovenia and Bulgaria. In France, Germany, Belgium-Flanders, Austria, Hungary, Slovakia, Sweden, Denmark, Finland, United Kingdom, Netherlands and Spain non-approved traps can be sold but not used. In France before any trap is authorised a consultation process between hunters and animal welfare groups must take place to discuss several criteria like selectivity, risks of suffering for the animal etc. The authorised trap has then a specific number engraved upon it. Approved traps are identified with the reference “PHE” (Piège Homologué Environnement) and the authorisation number that has been allotted to it by ministerial decree. In Austria authorised traps are also marked with a number. In Estonia, France and Sweden traps may be traced back to the user by means of a permanent marking (e.g. licence or registration number).

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Table 2.2. Catagories of traps

	Restraining traps			Killing traps			
	Box and cage traps	**Stopped/free-running snares**	**Foot snares**	**Spring traps**[7]	**Dead fall traps**	**Drowning traps**	**Self-locking snares**
Canis lupus **Wolf**	**AT, IT, SE**						
Castor canadensis **American beaver**	**AT, FI**			**FI,**			
Castor fiber **European beaver**	**FI, FR, LT, NL, SE,**			**EE, FI, LT, LV, SE,**			
Lutra lutra **European otter**	**FI, IE, IT, NL, SE**			**FI**			
Lynx lynx **European lynx**	**FI, IT, NL, SE**						
Martes martes **Pine marten**	**AT, CZ, EE, FI, FR, GR, IE, IT, LT, NL, SK**			**AT, DE, EE, FI, FR, LT, SE, SI,**	**AT, DE, FR, SE, SI**		
Meles meles **European badger**	**AT, CZ, DE, FI, HU, IE, IT, LT, NL, SE, SK**			**AT, DE, FI, LT**	**AT, DE**		
Mustela erminea **Ermine**	**AT DE, IT, FI, NL, SE, UK,**			**FI, UK**			

Categories of traps (continued)

	Restraining traps			Killing traps			
	Box and cage traps	**Stopped/free-running snares**	**Foot snares**	**Spring traps**[8]	**Dead fall traps**	**Drowning traps**	**Self-locking snares**
Nyctereutes procyonoides **Raccoon dog**	**AT, CZ, DE, EE, FI, FR, HU, LT, NL, SE,**	**FR**	**FR**	**AT, DE, FI, FR**	**AT**		
Ondatra zibethicus **Muskrat**	**AT, BE, CZ, FI, FR, HU, LT, NL, SE, SK,**			**AT, BE, DE, EE, FI, FR, LT, NL, SI,**	**AT, DE**	**FR, BE, NL**	
Procyon lotor **Raccoon**	**AT, BE-F, CZ, DE, FR, HU, NL, SE,**	**FR**	**FR**	**AT, FR**	**AT**	**FR**	

Training. Specific training for trappers exists in Austria, France, Germany, the Netherlands, Spain, Sweden and United Kingdom. The training is usually performed by special institutes or hunting associations. In order to use killing traps in some Member States specific training, or even the successfully passing of a test, is mandatory. In others training is only mandatory for the use of certain types of traps; Austria (dead fall traps) and Sweden (Conibear for European beaver). In France mandatory training is required for all species except for the trapping of muskrat and nutria using cage traps. The time period for the training ranges from several hours to two days in Germany, but up to half a year or one year for muskrat and nutria trappers in the Netherlands. The training in almost all cases contains both a theoretical and practical part. In Finland and the UK specific training exists but is not mandatory. For example, in the UK training is organised by the British Pest Control Association (BPCA), Game Conservancy Trust (GCT) and Agricultural Development Advisory Service (ADAS). Courses are also run by private individuals and training companies.

Restrictions on trapping. In France, Portugal, (and in the future Romania) a mandatory trapping declaration, or an indication of the trapping area, is required before a trap can be set. In many Member States traps can be placed anywhere but for some there are restrictions; for example, killing traps (spring traps, dead fall traps) must be set in France at least 200 m from any habitation, and in the UK spring traps are only allowed to be set inside a real or artificial tunnel. In some Member States (France, Austria, Belgium-Flanders) the area where the trap is set must be indicated with a sign, whilst in others (e.g. Czech Republic, Latvia) it is only allowed to set traps on the hunting ground during the hunting season and only for certain target species outside their reproduction period.

Control / Follow up of traps / Report of captures. Around half of the Member States follow up and control the traps and the number of captures. This activity is performed mainly by hunting associations (e.g. in France), but can also be conducted by forestry or agricultural ministries (e.g. in Latvia, Slovakia, Bulgaria, Portugal). If there is a requirement to report captures (in France, Estonia, Latvia, Bulgaria, Denmark, Finland, Slovenia, Portugal, the Netherlands, and Spain) then in most cases this information is sent to the regional or provincial authorities at the end of the trapping season. Often the number of mammals trapped is included in the national game bag statistics, but there is no distinction between the proportion trapped and the proportion taken by shooting. It is therefore very difficult to determine the importance of trapping for the six European species commonly caught in traps. Separate figures are available for governmental control programmes for certain species; notably for muskrat (in Belgium, Germany, and the Netherlands). Detailed information is collected in France on numbers of mammals trapped; temporally, spatial (by department) and by the type of trap used. This work is coordinated centrally by UNAPAF. For example, an overview of numbers of individuals of AIHTS species trapped in France in 2008 (by those affiliated to UNAPAF) is as follows.

- pine martin:18,985 (classed as a pest species in 47 départements)
- muskrat: 165,998 (classed as a pest species in 86 départements)
- raccoon: 731 (classed as a pest species in 31 départements). (Almost all of these captures were recorded in the département of l'Aisne)
- raccoon dog: 1

Although the catch size has come down from about one million individuals during the 1990s to about 500.000 today, muskrats are still the most trapped of the mammals on the AIHTS in the EU. This is followed by the raccoon dog, for which it is estimated that approximately 100,000 individuals are trapped annually. Estimates for both pine marten and badger are approximately 45,000 trapped annually. Badgers are caught in box/cage traps and the pine marten in a variety of killing traps, as well as in restraining traps. Current information suggests that approximately 26,000 stoats and 6,500 raccoon are captured in traps annually within the EU. For most of the species hunted or trapped national data on the numbers controlled are unavailable. The one mammal controlled more often than the muskrat is the red fox which is not on the AIHTS; estimates suggest that annual culls can reach 780,000 within the EU although this figure includes all those animals that were shot in addition to those trapped.

Trapping methods and selectivity to minimise suffering. Most Member States (Austria, France, Germany, Hungary, Sweden, Denmark, Finland, Italy, United Kingdom, Ireland, Portugal, Netherlands, Spain and Romania) have an obligation for the user to regularly check their traps at least once, or in some cases several times, a day. In the remaining countries this requirement is operated as a code of good practice.

For both killing traps and restraining traps, technical characteristics (e.g. maximal/minimal dimension, minimum weight on trap) and specific setting conditions (e.g. size of entrance) of the traps are defined by law to maximise the chances that only the target species will be caught with as little suffering as possible. If a decoy is used, then this is mainly done with eggs, meat or flavoured baits to ensure trap selectivity. Live decoys (e.g. birds) have to be handled in a way that does not harm them (e.g. the decoy is put in a separate box where it cannot get hurt). For the killing of the captured animal either a firearm or a powerful blow to the head is generally used. Where a firearm is employed a hunting licence is also required. In the UK, where a hunting licence does not exist, a firearms certificate is required.

2.3 Situation in Canada

Legal framework for trapping / Allowance of trapping. Trapping in Canada is allowed and the legislation is identical throughout the whole country with minor variations that take into account the southern and northern climates and management requirements in the provinces and territories. The legislation was further harmonised in 2007 through the first phase of the national implementation of the AIHTS, thereby regulating the use of AIHTS certified traps and trapping systems.

Definition / Organisation / Number of trappers. A special definition for trapper does not exist. About 60,000 trappers are organised at national, regional and local level.

Main motivations for trapping. Trappers in Canada hunt for many reasons that range from pest control and wildlife management, to obtaining of meat and fur, for research and educational reasons, and for the preservation of a cultural heritage. Statistics from the Canadian government indicate that the value of all wildlife pelts sold in 2004 was over $24 million Canadian dollars (€16 million).

Species listed in the AIHTS. In Canada 12 of the 19 species listed in the AIHTS are present and trapping them is allowed within the existing legal framework. These species are: coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fischer, ermine, muskrat, raccoon, and American badger. In addition, 14 non-listed species are also trapped: Arctic fox , red fox, grey fox (for conservation only), mink, red squirrel, grey squirrel, Richardson ground squirrel, opossum, black bear, groundhog, wolverine, skunk, rabbit and hare.

Categories of traps. Restraining traps and killing traps are thought to be used to approximately the same extent. Restraining traps that are used include box and cage traps, and leghold traps. Conibear-type traps are thought to be the most common killing traps in use.

Authorization and approval of traps. Beginning in 1983, Canada established an extensive trap research facility for the sole purpose of improving the effectiveness of trapping systems as they relate to the welfare of mammals captured for various purposes. From 1960 through 1997 the competent authorities established incremental regulations related to the use of various traps and trapping systems intended to address animal welfare concerns and the management of furbearers. Since the signing of the AIHTS in 1997 by Canada, the EU and Russia, the research has focused on testing and developing species-specific trapping systems to meet its requirements. In 2007 the 10 Canadian provinces and three territories (they are the competent authorities under the terms of the AIHTS) introduced Phase I of regulatory changes; this requires the use of only traps that have been certified as meeting the AIHTS animal welfare requirements for six of the 12 Canadian AIHTS listed furbearer species. While certain species-specific traps have been certified for four other of the listed furbearers, their use will not be mandatory until further traps have been identified in Phase II and Phase III of the implementation initiative. Nonetheless, certified traps are being promoted in trapper education programmes and are used by Canadian trappers. Research and testing will continue to further identify traps for certification.

The Canadian competent authorities have developed a national trap certification programme. Once species-specific traps have successfully completed the required AIHTS testing process, manufacturers must have their devices certified through one of the competent authorities and must permanently affix a special certification number on each trap. Manufacturers must also include proper trap-setting instructions to ensure capture as per conditions of certification. Trap identification sheets have been produced to assist conservation officers and trappers to determine which traps have been certified. Complaints from trappers or conservation officers about traps being ineffective, due to a reduction in manufacturing quality or other problems, can result in these traps being recalled for new tests. When appropriate, trap certification can be withdrawn with both trappers and distributors being made aware of the withdrawal.

Canada is on course toward full implementation of the AIHTS and will continue to seek improvements in trapping technologies through a) its ongoing trap research programme, b) development of Computer Simulation Models to permit the testing of traps without the need to use live animals for rating trap performance (see 7.3), c) trapper education programmes, and d) ongoing dialogue at meetings of the Joint Management Committee set up under the terms of the AIHTS.

Training. Training (both theoretical and practical) is mandatory before a license is issued, and veteran trappers are required to take a refresher course. A National Trappers Education Curriculum Guide “Focus on Trapping” has been established.

Restrictions on trapping. Trappers need to be in possession of either a hunting or trapping license or authorisation. They do not need both unless they intend to hunt while trapping. A trapping license is mandatory; with an exception for some aboriginal trappers when trapping for subsistence or traditional cultural purposes. The traps do not have to be marked in order to identify their user. Neither is a “trapping declaration” (except for certain bear traps) before the setting of the trap nor an indication of the trapping area necessary. However, in the case of fur trappers most jurisdictions have registered trap-line areas. Traps can not be placed everywhere;

there are distance requirements in urban areas, limitations on agricultural land, posted no trespassing signs, restricted federal lands etc. Traps can not be used all year round. For fur trapping, depending on species and whether in north or south Canada, trapping takes place from October to April, although for other purposes trapping may be authorized outside this period.

Control / Follow up of traps / Report of captures. Furbearer harvests are tracked, at least annually, by direct reporting by harvesters and/or by the requirements for export permits.

Trapping methods and selectivity. There is an obligation to regularly check the traps in the field. The hunting license is not mandatory, but there are certain jurisdictional variations. For both killing traps and restraining traps users must make use of technical characteristics that meet the requirements of the AIHTS and use specific setting conditions of the traps to try to ensure that only the target species will be caught with as little suffering for the animal as possible. The use of decoys is not permitted. Killing is typically performed with a firearm when restraining traps are used; however the majority of AIHTS listed species are captured in killing traps.

2.4 Situation in Russia

Legal framework for trapping/ Allowance of trapping. Trapping in Russia is allowed and the legislation is identical throughout the whole country with minor local differences.

Definition / Organisation / Number of trappers. A definition for trapper does not exist in the national legislation. There are an estimated 300,000 trappers who are mainly organized in hunting organisations.

Main motivations for trapping. Trapping is mainly used to control pest species, to obtain fur and skin, and for reasons of public health and civil protection.

Species listed in the AIHTS. In Russia 12 of the 19 species listed in the AIHTS are present and trapping them is allowed within the existing legal framework. These species are: wolf, European beaver, American beaver (very few), European otter, European lynx, pine marten, sable, European badger, ermine, raccoon dog, muskrat, and raccoon (very few). In addition nine non-listed species are also being trapped; Arctic fox, red fox, squirrel, hare, polecat, mink, kolinsky, stone marten, wolverine.

Categories of traps. In Russia, trappers extensively use killing traps. The most commonly used spring trap is the Conibear-type, but leghold drowning traps and self-locking snares are also used.

Approval of traps. Approval of traps is required as the AIHTS has been ratified in the Russian Federation. Although leghold traps (i.e. "steel jaw") are prohibited in 12 Russian regions, in other regions regional hunting/trapping rules or law allow their use.

Training. A mandatory training course for wildlife managers exists, containing both theoretical and practical parts.

Restrictions on trapping. The possession of a hunting licence is sufficient. The traps do not require to be marked in order to identify their user, and neither a "trapping declaration" before the setting of the trap nor an indication of the trapping area is necessary. Traps can not be placed anywhere or used all year round.

Control/Follow up of traps/ Report of captures. The regional hunting authorities control and follow up traps and bags. After the trapping season the captures must be reported.

Trapping methods and selectivity. If a firearm is used to kill captured animals then the hunting licence is mandatory. Users must have regard to the technical characteristics that meet the requirements of the AIHTS and use specific setting conditions of the traps to try to ensure that only the target species will be caught with as little suffering for the animal as possible.

2.5 Situation in the USA

Legal framework for trapping/ Allowance of trapping. Trapping in the United States is allowed and the relevant legislation varies between states.

Definition / Organisation / Number of trappers. A specific definition of a trapper does not exist. There are about 150,000 trappers belonging to hunting associations at the national, regional or local level.

Main motivations for trapping. Trappers in the US hunt for many reasons that include pest control and wildlife management, the obtaining of meat and fur, for research and educational reasons, and for wildlife disease surveillance.

Species listed in the AIHTS. 12 of the 19 species listed in the AIHTS are present in the country and trapping them is allowed within the existing legal framework. These species are: coyote, wolf, American beaver, bobcat, American otter, American lynx, marten, fisher, ermine, muskrat, raccoon, and American badger. In addition, 16 non-listed species are also trapped, namely: bassarisk, bear, gray fox, kit fox, marmot, mountain lion, mountain beaver, mink, nutria, opossum, prairie dog, pocket gopher, red fox, swift fox, striped skunk, and wolverine.

Categories of traps. Wildlife management is conducted at the state level in the United States, and they do not collect nor maintain national data on the harvest of furbearers by trap type. Both restraining traps and killing traps are used to catch furbearers in the US. Restraining traps that have been approved include box/cage traps, stopped/free running snares, foot-snares and leghold traps.. Spring traps (i.e. Bodygrip and Conibear) and self-locking snares are thought to be the most commonly used killing traps. Self-locking snares are only used in Alaska to trap wolf and American lynx. Drowning traps are used to trap beaver, otter, muskrat and raccoon. Dead-fall traps are not used.

Authorization and approval of traps. All trap types must be approved. No traps can be authorized without approval. State and wildlife agencies are consulted for approval and regulations and laws are in place to ensure that the traps are correct. Trap approval can be rejected or withdrawn for reasons of state laws and regulations, state wildlife regulations, and the state constitution. State laws and regulations identify those traps that may be used; i.e. any trap can be sold but only those approved may be used. To identify the user the traps are marked with the name and address of trapper, license number, or agency identification (variable by state).

Training. A "Trapper Education Program" is mandatory in many States, and is provided by State wildlife agencies and state trapper associations. The training covers skills, regulations, and wildlife management, with a strong focus on the responsible treatment of animals, legal methods, safety, selectivity, and ethical trapper behavior. The Trapper Education Program was developed by the International Association of Fish and Wildlife Agencies (IAFWA). The IAFWA has also produced number of Best Management Practice Guides for trapping of certain species (see chapter 8 and the link
http://www.fishwildlife.org/furbearer_resources.html**)**

Restrictions on trapping. Trappers need to have a hunting licence as well as a trapping licence. Traps need to be marked in a way that they identify their user. Before setting any trap a "trapping declaration" is mandatory and it is necessary to indicate the areas where the traps will be set. It is not permitted to place traps everywhere; the rules vary between states but typically certain traps can not be placed within set distances of public roads or human dwellings. 'Authorized land' is private land, and government land when trapping is permitted there (again variable by state).

Control/Follow up of traps/ Report of captures. Control and yearly sample surveys are conducted by the state wildlife agencies.

Trapping methods and selectivity. There is an obligation to regularly check the traps in the field. The use of live decoys is authorized. The methods to improve selectivity and to minimise suffering to the trapped animal, range from specified technical characteristics for the traps (e.g. size of trap, trigger configurations) to special places/areas where traps can be set, and species-specific decoys to ensure that only the target species is captured.

2.6 *Conclusion*

Trapping in the EU is subject to specific legal provisions and rules at Member State level; these cover the types of trap, the conditions for use, and methods to improve selectivity and eliminate avoidable suffering. Several Member States require that trappers must have taken and passed training courses in hunting and/or trapping. In addition, trappers are often required to obtain a valid trapping and/or hunting license along with landowner permission. The level of monitoring of trapping practices and governance structure is generally in proportion to the extent of use within a Member State. For example in France which has the highest number of trappers, or in the Netherlands where there is a specific government programme to control muskrat, there is a good level of knowledge and traceability of use (which types of traps are used, number of captures etc.). Equally there is a well organised structure of governance at local, regional, and national level. Progress could however be made in the testing and approving of traps. In order to proceed with such testing it would be useful to have better information on the numbers of animals caught with different types of trap at the species level. Currently the number of mammals trapped is included in the national game bag statistics, but there is no distinction between the proportion trapped and the proportion taken by shooting. This would be necessary in order to best prioritise the work required under the AIHTS.

3 Public attitude to trapping within the EU.

This chapter describes the findings of an internet survey of the public attitude to trapping within the EU. 9,571 completed questionnaires were received from residents of countries within the EU, and 457 responses were received from residents of non-EU countries. Only the completed questionnaires of EU residents have been analysed for this report. The survey results clearly show that whilst the public accept that human and/or environmental needs can justify the killing of animals, they also believe that the welfare of animals caught in traps is important. As a result they want trapping within the EU to be regulated by legislation that covers all the species that can legally be trapped, and the traps used to be tested and approved by an independent institute using clearly defined animal welfare guidelines. However, 71% of the respondents that currently use traps stated they were not prepared to pay more for a trap that had been tested and approved.

Summary

The aims of this chapter are:

a) **to describe the backgrounds of the respondents to the internet survey,**
b) **to describe the public attitude to the trapping of wild mammals and their knowledge of trapping within the EU,**
c) **to describe the public attitude to legislation governing trapping within the EU,**
d) **to describe the public attitude to animal welfare issues associated with trapping standards.**

a) Respondents' backgrounds. Of the 9,571 completed questionnaires from EU residents, 71% were from males. Very few of the respondents were either under 20 years or over 70 years; the remaining four age categories contain similar numbers of respondents. Most lived in towns or villages containing less than 20,000 inhabitants. The replies of the respondents showed that 52% were familiar with trapping/hunting activities, 21% were familiar with animal welfare/rights activities, 10% had a background in animal research or conservation, and the replies of the remaining 17% did not allow them to be reliably allocated to only one of these categories.

b) Respondents' attitudes to the trapping of wild animals and their knowledge of trapping within the EU. 72% of all respondents thought that human and/or environmental needs could sometimes justify the killing of wild animals. Shooting, killing traps and holding traps were perceived as the main methods (90%, 78%, and 85% respectively) used in the EU to control wild mammals, and these methods were also those most commonly cited as being acceptable control techniques (67%, 57% and 65% respectively). The main reasons for controlling wild mammals in the EU were perceived to be for reasons of human health and safety (75%), to prevent damage (77%), and for wildlife conservation (76%).

c) Respondents' attitudes to legislation governing trapping within the EU. 77% of respondents thought that trapping in the EU should be regulated by legislation. 72% of the respondents who had a background in trapping/hunting thought that such legislation should be left to Member States, whilst 80% of the respondents with a background in animal welfare/rights thought there should be binding, harmonised EU trapping standards. 46% of respondents thought that EU trapping legislation should cover all the species that can legally be trapped; as opposed to the 21% who believed the legislation should include only the species currently covered by the Agreement on International Humane Trapping Standards (AIHTS). 57% of respondents agreed with the proposition that traps in the EU should be tested and approved according to clearly defined animal welfare criteria. 79% of respondents with a background in trapping/hunting thought trap approval should be organised at the national level, whilst 72% of respondents with a background in animal welfare/rights wanted it to be organised at the EU level. Most respondents (36%) wanted an independent institute to conduct the testing and approval of traps, as opposed to the trap manufacturers, trapping organisations or animal welfare organisations.

d) Respondents' attitudes to animal welfare issues associated with trapping standards. 57% of respondents agreed that traps in the EU should be tested and approved according to clearly defined wild animal welfare criteria. When asked what was for them the maximum acceptable period between capture by a killing trap and the unconsciousness and death of the captured animal, 29% of respondents stated that death should be instantaneous (i.e. zero seconds) and 26% said they would accept a maximum period of 30 seconds. Only 6% found the 300 seconds period contained in the AIHTS to be acceptable. 63% of the respondents placed most weight upon physical injuries (e.g. broken teeth) when assessing the welfare of animals in holding traps as opposed to behavioural (e.g. biting the bars of the cage) or physiological (e.g. high levels of stress hormones) signs of suffering.

3.1 Analysis of the responses to the questionnaire

To investigate the publics' attitude to trapping within the EU an internet questionnaire (http://ec.europa.eu/environment/consultations/trapping_en.htm) was placed on the web from 16/12/2008 until 16/03/2009. The questionnaire asked questions about the respondent's background, knowledge of trapping techniques within the EU, opinion on trapping legislation, and opinion on various animal welfare aspects of trapping. Appendix 2 gives the questions contained in the questionnaire. 9,571 completed questionnaires were received from residents of countries within the EU, and 457 responses were received from residents of non-EU countries. Only the completed questionnaires of EU residents have been analysed for this report. Of the non-EU residents 385 came from Norway and were familiar with hunting and trapping, whilst the remaining 44 came from a large number of countries and could not be classified into one of the respondent categories (see below). Completed questionnaires were imported into an Access database and the responses were interpreted according to the background of the respondent.

3.2 Number of respondents

Residents of Member States completed 9,571 questionnaires. Only the completed questionnaires from people living within the EU have been included in the following analyses. The overwhelming majority of these came from France (4,562), Germany (2,678), Finland (835), Belgium (537), Sweden (381) and the United Kingdom (275). The number of responses from each the EU Member States was as follows:

Austria 86

Belgium 537

Bulgaria 1

Cyprus 0

Czech Republic 11

Denmark 8

Estonia 4

Finland 835

France 4562

Germany 2678

Greece 6

Hungary 4

Ireland 46

Italy 22

Latvia 4

Lithuania 0

Luxembourg 21

Malta 2

The Netherlands 39

Poland 0

Portugal 15

Romania 1

Slovakia 1

Slovenia 0

Spain 32

Sweden 381

United Kingdom 275

A number of replies came from the countries party to the AIHTS, namely: Canada 8, Russian Federation 2, and the USA 18. Of the remaining 429 questionnaires that were received from other non-EU countries 385 came from Norway; the remaining 44 came from a large number of countries.

3.3 __Background of the respondents__

There were far more male respondents (6,838; 71.4%) than female respondents (2,733; 28.9%). Table 3.1 gives the percentage of the respondents that fall into the various age categories given in the survey. Very few of the respondents are either under 20 years or over 70 years; the remaining four age categories contain similar numbers of respondents. The majority of the respondents live in towns or villages containing less than 20,000 inhabitants (see Table 3.2).

Age (years)	**Number of respondents**
Under 20	398 (4.2%)
20 – 30	1975 (20.6%)
31 – 40	2112 (22.1%)
41 – 50	2268 (23.7%)
51 – 70	2642 (27.6%)

Over 70	176 (1.8%)

Table 3.1: Age of respondents

Number of inhabitants	**Number of respondents**
Over 100,000	1974 (20.6%)
20,000 to 100,000	1856 (19.4%)
1,000 to 20,000	3113 (32.5%)
Under 1,000	2628 (27.5%)

Table 3.2: Size of city/town/village

The survey asked respondents if they were replying on behalf of themselves, or on behalf of various organisations. The vast majority (8869; 92.7%) stated that they were replying on behalf of themselves. Of those stating that they were replying on behalf of organisations, 435 (0.05%) replied on behalf of an organisation for hunting, trapping or other forms of sustainable use of wildlife, 108 (0.01%) on behalf of an organisation for animal welfare or animal rights, 97 (0.01%) on behalf of an organisation for wildlife conservation, and 62 (0.01%) on behalf of an organisation that did not fall into any of these categories.

Respondents were presented with a range of activities relevant to the issues surrounding trapping and asked to choose those with which they were familiar (up to three activities could be chosen). The options were: a) Trapping for meat, fur and/or skins; b) Trapping for regulating (overabundant) species causing damage; c) Trapping for research, conservation, reintroductions etc.; d) Trap manufacturing and development; e) Research in the domain of wild animal ecology, behaviour, physiology etc.; f) Recreational hunting; g) Wildlife conservation and management; h) Animal protection / welfare / rights; i) None of the above. The numbers of times the various activities were chosen are given in Table 3.3.

Type of activity	Number of times chosen
a. Trapping for meat, fur and/or skins	2935
b. Trapping for regulating (overabundant) species causing damage	5148
c. Trapping for research, conservation, reintroductions etc.	799
d. Trap manufacturing and development	139
e. Research in the domain of wild animal ecology, behaviour, physiology etc.	718
f. Recreational hunting	2305
g. Wildlife conservation and management	4737
h. Animal protection/welfare/rights	4546
i. None of the above	492

Table 3.3: Familiarity with activities relevant to the trapping issue.

These replies were used to assign each respondent to one of the following four categories: a) ‘Trapping/hunting’, i.e. those familiar with trapping or hunting activities and/or were replying on behalf of hunting/trapping organisations; b) ‘Animal welfare/rights’, i.e. those familiar with animal welfare or animal rights activities and/or were replying on behalf of animal welfare/rights organisations; c) ‘Research/conservation’, i.e. those familiar with animal research or wildlife conservation activities and/or were replying on behalf of organisations for animal research/conservation; d) ‘Mixed’, i.e. those that could not be allocated to just one of the above categories because they had replied on behalf of themselves and were familiar with the activities associated with two or three of the above categories. These four categories of respondents have been used when analysing the replies to the other questions in the survey. Of the 9,571 completed questionnaires from EU residents, 4,991 (52%) fell into the Trapping/hunting category, 2,024 (21%) into the Animal welfare/rights category, 976 (10%) into the Research/conservation category, and the remaining 1,580 (17%) were placed into the Mixed category.

3.4 The respondents' attitudes to the need to kill wild animals

The respondents were asked whether they accepted **in principle** that human or environmental needs (including the prevention of serious damage and for human health and safety reasons) could justify the killing of wild animals. Table 3.4 gives, for all categories together and for each of the categories individually, the number of cases choosing each option and that number expressed as a percentage of the total number of cases. Overall 72% of respondents agreed that human or environmental needs could justify the killing of wild animals whilst 26% disagreed. However there were clear differences between the replies of the respondents within the Animal welfare/rights category and those of the other categories. 86% of the Animal welfare/rights respondents did not agree that human or environmental needs could justify the killing of wild animals.

	Trapping/ hunting	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
No	165 (3.3%)	1732 (85.6%)	202 (20.7%)	420 (26.6%)	2519 (26.3%)
Yes	4796 (96.1%)	229 (11.3%)	755 (77.4%)	1124 (71.1%)	6904 (72.1%)
Do not know	30 (0.6%)	63 (3.1%)	19 (1.9%)	36 (2.3%)	148 (1.5%)

Table 3.4: Can human or environmental needs justify the killing of wild animals?

3.5 The respondents' knowledge and opinions of wildlife management techniques.

The respondents were asked what, to their knowledge, are the main methods used in the EU to control the wild animal populations targeted by this consultation. The respondents could choose as many options as they wished from the following list: a) Shooting; b) Traps that kill the animal; c) Box or cage traps that hold the animal until the operator kills it or releases it elsewhere; d) Traps that result in the drowning of the animal; e) Killing snares, i.e. wire loops that kill the animal; f) Holding snares, i.e. wire loops that hold the animal; g) Poisoned bait; h) Poison gas; i) Immuno-contraceptives that result in sterility; j) Do not know. Table 3.5 gives, for each category and for all categories together, the number of times a particular method was chosen and this figure expressed as a percentage of the total number of cases within that category.

Shooting, killing traps and restraining traps (i.e. box and cage traps) were most commonly, and correctly, quoted by the respondents in all categories as the main methods of control used to kill wild animals within the EU. However, there were marked differences between the categories in how some of the other methods were viewed. In particular, a large percentage of the Animal welfare/rights category believed that the use of poison baits, poison gas and immuno-contraceptives are major methods of control within the EU; whereas the use of poison baits is largely confined to the control of rodents, poison gassing is rarely employed, and the use of immuno-contraceptives is still at the experimental stage.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a. Shooting	4725 (94.7%)	1674 (82.7%)	863 (88.4%)	1381 (87.4%)	8643 (90.3%)
b.Killing traps	4252 (85.2%)	1468 (72.5%)	702 (71.9%)	1057 (66.9%)	7479 (78.1%)
c.Box or cage traps	4566 (91.5%)	1416 (70.0%)	834 (85.5%)	1290 (81.6%)	8106 (84.7%)
d. Drowning traps	424 (8.5%)	962 (47.5%)	217 (22.2%)	346 (21.9%)	1949 (20.4%)
e. Killing snares	454 (9.1%)	542 (26.8%)	135 (13.8%)	216 (13.7%)	1347 (14.1%)
f. Holding snares	1593 (31.9%)	1041 (51.4%)	512 (52.5%)	720 (45.6%)	3866 (40.4%)
g. Poison bait	352 (7.1%)	1198 (59.2%)	265 (27.2%)	410 (25.9%)	2225 (23.2%)
h. Poison gas	199 (4.0%)	573 (28.3%)	107 (11.0%)	194 (12.3%)	1073 (11.2%)
i. Immuno-contraceptive	257 (5.1%)	1009 (49.9%)	226 (23.2%)	402 (25.4%)	1894 (19.8%)
j. Do not know	57 (1.1%)	176 (8.7%)	30 (3.1%)	74 (4.7%)	337 (3.5%)

Table 3.5: The perceived main methods used in the EU to control wild animals.

Respondents were also asked what they thought are the main reasons for the trapping of wild animals in the EU. They could choose as many options as they wished from the following list: a) To obtain furs and skins; b) To protect human health and safety (e.g. from flooding due to muskrat damage); c) To prevent damage to property; d) Conservation of other species; e) To obtain meat; f) Scientific research; g) Do not know. Table 3.6 gives, for each category and for all categories together, the number of times a particular reason was chosen and this figure expressed as a percentage of the total number of cases within that category. Again there are differences between the categories of respondent. In particular, the Animal welfare/rights category listed the reason to obtain furs or skins and the reason to obtain meat far more frequently than did the other categories.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. To obtain furs or skins	2898 (58.1%)	1595 (78.8%)	351 (36.0%)	626 (39.6%)	5470 (57.2%)
b. Human health/safety	4135 (82.8%)	1146 (56.6%)	734 (75.2%)	1163 (73.6%)	7178 (75.0%)
c.To prevent damage	4101 (82.2%)	1342 (66.3%)	788 (80.7%)	1133 (71.7%)	7364 (76.9%)
d. Wildlife conservation	4339 (86.9%)	1012 (50.0%)	739 (75.7%)	1184 (74.9%)	7274 (76.0%)
e. To obtain meat	706 (14.1%)	1266 (62.5%)	218 (22.3%)	407 (25.8%)	2597 (27.1%)
f. Scientific research	2042 (40.9%)	1078 (53.3%)	369 (37.8%)	492 (31.1%)	3981 (41.6%)
g. Do not know	27 (0.5%)	109 (5.4%)	17 (1.7%)	49 (3.1%)	202 (2.1%)

Table 3.6: The perceived main reasons why wild animals are trapped in the EU.

The respondents were given a list of methods used to control wild animals in the EU and were asked to choose those that were, in their opinion, acceptable. They could choose as many methods as they wished from the following: a) Shooting; b) Killing traps; c) Box or cage holding traps; d) Traps that result in the drowning of the animal; e) Killing snares; f) Holding snares; g) Poison bait; h) Poison gas; i) Contraception; j) Any method as long as it ensures the death of the animal without avoidable pain, suffering and distress; k) None of the methods listed; l) Do not know. Table 3.7 gives, for each category and for all categories together, the number of times a particular reason was chosen and this figure expressed as a percentage of the total number of cases within that category. The least acceptable methods were those that killed the animal by drowning or by poisoning. The use of snares that hold the animal was far more acceptable than the use of snares that kill the animal. The respondents within the

Animal welfare/rights category differed from the rest in that the majority of them thought contraception was the only acceptable method.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. Shooting	4577 (91.7%)	160 (7.9%)	626 (64.1%)	1006 (63.7%)	6369 (66.5%)
b. Killing traps	4167 (83.5%)	76 (3.8%)	458 (46.9%)	748 (47.3%)	5449 (56.9%)
c. Holding traps	4267 (85.5%)	265 (13.1%)	687 (70.4%)	1028 (65.1%)	6247 (65.3%)
d. Drowning traps	466 (9.3%)	7 (0.3%)	72 (7.4%)	143 (9.1%)	688 (7.2%)
e. Killing snares	641 (12.8%)	12 (0.6%)	67 (6.9%)	136 (8.6%)	856 (8.9%)
f. Holding snares	1721 (34.5%)	35 (1.7%)	347 (35.6%)	499 (31.6%)	2602 (27.2%)
g. Poison baits	420 (8.4%)	20 (1.0%)	47 (4.8%)	121 (7.7%)	608 (6.4%)
h. Poison gas	253 (5.1%)	6 (0.3%)	30 (3.1%)	60 (3.8%)	349 (3.6%)
i. Contraception	495 (9.9%)	1579 (78.0%)	388 (39.8%)	612 (38.7%)	3074 (32.1%)
j. One with no avoidable pain/suffering	681 (13.6%)	73 (3.6%)	193 (19.8%)	207 (13.1%)	1154 (12.1%)
k. None of the above	26 (0.5%)	275 (13.6%)	43 (4.4%)	57 (3.6%)	401 (4.2%)
l. Do not know	3 (0.1%)	20 (1.0%)	8 (0.8%)	18 (1.1%)	49 (0.5%)

Table 3.7: What is an acceptable method to control wild animals within the EU?

3.6 The regulation of trapping within the EU

The respondents were asked whether they thought the techniques and practices used to trap wild animals in the EU should be regulated. They could choose one of the following options: a) Yes, by voluntary codes of conduct or best practice by trappers' organisations; b) Yes, by legal regulation by national authorities, adapted to local conditions; c) Yes, by EU regulation harmonised for all 27 Member States; d) No; e) Do not know. Table 3.8 gives, for each category and for all categories together, the number of cases choosing a particular reason and this figure expressed as a percentage of the total number of cases within that category. 77% of the respondents thought that trapping should be regulated by legislation. However, there was disagreement between the categories over the level at which such legislation should occur; 66% of the Trapping/hunting category choose legislation at the national level adapted to suit local conditions, whilst 86% of the Animal welfare/rights category favoured EU regulation harmonised for all 27 Member States. Opinion in the other two categories was more evenly divided between these two options.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. Yes, voluntary regulation	937 (18.8%)	30 (1.5%)	114 (11.7%)	295 (18.7%)	1376 (14.4%)
b. Yes, national legislation	3285 (65.8%)	180 (8.9%)	431 (44.2%)	618 (39.1%)	4514 (47.2%)
c. Yes, EU legislation	243 (4.9%)	1734 (85.7%)	381 (39.0%)	509 (32.2%)	2867 (30.0%)
d. No	497 (10.0%)	55 (2.7%)	45 (4.6%)	137 (8.7%)	734 (7.7%)
e. Do not know	24 (0.5%)	24 (1.2%)	2 0.2%)	18 (1.1%)	68 (0.7%)

Table 3.8: Should trapping in the EU be regulated?

In addition, respondents were asked what would be their suggestions to the decision-makers at the EU level on the possible regulation of trapping. They could choose up to two of the following options: a) Binding, harmonised EU trapping standards which aim to improve the welfare of trapped animals; b) Voluntary, harmonised EU trapping standards which aim to improve the welfare of trapped animals; c) Recommendations to Member States to adopt, when required, measures to better regulate trapping and establish trapping standards; d) Leave it to Member States to fulfil their obligations under the AIHTS; e) None of the above; f) Do not know. Table 3.9 gives, for each category and for all categories together, the number of times a particular suggestion was chosen and this figure expressed as a percentage of the total number of cases within that category. 47% of all respondents preferred the option whereby Member States were left to fulfil their obligations under the AIHTS. However this preference was primarily the result of the high number of respondents within the Trapping/hunting category who favoured this option. 80% 0f the respondents within the Animal welfare/rights category chose binding and harmonised EU trapping standards; whilst the respondents within the other two categories were more evenly split between these two options.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All caregories**
a. Binding, harmonised EU standards	308 (6.2%)	1626 (80.3%)	384 (39.3%)	524 (33.2%)	2842 (29.7%)
b. Voluntary harmonised EU standards	424 (8.5%)	71 (3.5%)	77 (7.9%)	143 (9.1%)	715 (7.5%)
c. EU recommendations to Member States	1051 (21.1%)	60 (3.0%)	195 (20.0%)	316 (20.0%)	1622 (16.9%)
d. Leave to Member States to adopt AIHTS	3584 (71.8%)	96 (4.7%)	354 (36.3%)	627 (39.7%)	4661 (48.7%)
e. None of the above	286 (5.7%)	203 (10.0%)	62 (6.4%)	114 (7.2%)	665 (6.9%)

f. Do not know	111 (2.2%)	60 (3.6%)	17 (1.7%)	57 (3.6%)	245 (2.6%)

Table 3.9: Suggestions on trapping regulations to EU decision-makers.

The respondents were asked who they thought should be authorised to conduct trapping in the EU. They could choose up to three from the following options: a) Persons who have the legal right to do so under national law; b) Persons who have been properly trained or have the relevant experience; c) Persons who can demonstrate their competence according to legal requirements; d) Specialised private companies; e) Government Authorities; f) None of the above; g) Do not know. Table 3.10 gives, for each category and for all categories together, the number of times a particular option was chosen and this figure expressed as a percentage of the total number of cases within that category. ‘Persons who have the legal right to do so under national law’ was the most chosen option, both overall and by three of the four categories of respondent. The replies of the Animal welfare/rights category differed from the others in that here ‘Government Authorities’ was the preferred option. Also this category, unlike the others, frequently listed the option ‘None of the above’; probably because a high percentage of respondents in this category did not agree with trapping *per se*.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. National law	4284 (85.8%)	185 (9.1%)	538 (55.1%)	841 (53.2%)	5848 (61.1%)
b. Properly trained	2347 (47.0%)	208 (10.3%)	492 (50.4%)	755 (47.8%)	3802 (39.7%)
c. Show competence	1756 (35.2%)	185 (9.1%)	398 (40.8%)	545 (34.5%)	2884 (30.1%)
d. Private companies	68 (1.4%)	18 (0.9%)	59 (6.0%)	37 (2.3%)	182 (1.9%)
e.Government authorities	279 (5.6%)	1341 (66.3%)	347 (35.6%)	465 (29.4%)	2432 (25.4%)
f. None of the	75	400	40	79	594

above	(1.5%)	(19.8%)	(4.1%)	(5.0%)	(6.2%)
g. Do not know	11 (0.2%)	36 (1.8%)	8 (0.8%)	19 (1.2%)	74 (0.8%)

Table 3.10: Those who should be authorised to conduct trapping in the EU.

Respondents were asked how they thought trapping expertise should best be obtained. They could select one of the following options; a) Mandatory training harmonised for all 27 Member States; b) Voluntary training; c) Practical experience, no special training; d) Do not know. Table 3.11 gives, for each category and for all categories together, the number of cases choosing a particular reason and this figure expressed as a percentage of the total number of cases within that category. The 'Voluntary training' option was the most chosen over all the respondents. However this preference was primarily the result of the high number of respondents within the Trapping/hunting category who strongly (66.1%) favoured this option. The 'Mandatory EU training' was the preferred option for all the other categories.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a.Mandatory training	645 (12.9%)	1782 (88.0%)	517 (53.0%)	679 (43.0%)	3623 (37.9%)
b. Voluntary training	3298 (66.1%)	63 (3.1%)	355 (36.4%)	583 (36.9%)	4299 (44.9%)
c. No special training	951 (19.1%)	26 (1.3%)	76 (7.8%)	255 (16.1%)	1308 (13.7%)
d. Do not know	92 (1.8%)	152 (7.5%)	25 (2.6%)	60 (3.8%)	329 (3.4%)

Table 3.11; How trapping expertise should be obtained.

The survey investigated the wildlife species that should be included in any trapping regulations. Respondents were asked at what level, in their opinion, is the list of species, to be covered by trapping legislation, best determined. They could choose one of the following options: a) International level; b) EU level on a harmonised list; c) National level adapted to local conditions; d) Do not know. Table 3.12 gives, for each category and for all categories together, the number of cases choosing a particular reason and this figure expressed as a percentage of the total number of cases within that category. 'National level adapted to local conditions' was most chosen option overall and also within three of the four categories. The Animal welfare/rights category differed from the others in that here the 'EU level on a harmonised list' option was chosen by 70%.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a.International level	596 (11.9%)	331 (16.4%)	164 (16.8%)	129 (8.2%)	1220 (12.7%)
b. Harmonised EU level	219 (4.4%)	1407 (69.5%)	305 (31.3%)	426 (27.0%)	2357 (24.6%)
c. National level	4126 (82.7%)	200 (9.9%)	498 (51.0%)	988 (62.5%)	5812 (60.7%)
d. Do not know	45 (0.9%)	85 (9.9%)	6 (0.6%)	34 (2.2%)	170 (1.8%)

Table 3.12: The level at which the list of species to be covered by trapping legislation should be determined.

The survey enquired about the species that should be covered by trapping regulations within the EU. Respondents could choose up to three of the following options: a) Species listed in the Agreement on International Humane Trapping Standards (AIHTS); b) Species trapped for wildlife management and/or pest control; c) Species trapped to obtain fur, skin or meat; d) Species for scientific research; e) All species that can be legally trapped; f) No species; g) Do not know. Table 3.13 gives, for each category and for all categories together, the number of times a particular option was chosen and this figure expressed as a percentage of the total number of cases within that category. 'All species that can legally be trapped' was the most chosen option; both overall and within three of the four categories. The Trapping/hunting category differed from the others in that here the ‘No species’ option was the most chosen option (42%) followed by the “All species that can legally be trapped’ option (31%).

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a. Species on AIHTS list	1133 (22.7%)	228 (11.3%)	288 (29.5%)	350 (22.2%)	1999 (20.9%)
b. Wildlife management	1364 (27.3%)	230 (11.4%)	362 (37.1%)	577 (36.5%)	2533 (26.5%)
c. Fur, skin or meat	740 (14.8%)	157 (7.8%)	136 (13.9%)	220 (13.9%)	1253 (13.1%)
d. Scientific research	648 (13.0%)	173 (8.5%)	238 (24.4%)	275 (17.4%)	1334 (13.9%)
e. All legal species	1535 (30.8%)	1472 (72.7%)	564 (57.8%)	873 (55.3%)	4444 (46.4%)
f. No species	2060 (41.3%)	332 (16.4%)	126 (12.9%)	204 (12.9%)	2722 (28.4%)
g. Do not know	132 (2.6%)	35 (1.7%)	10 (1.0%)	41 (2.6%)	218 (2.3%)

Table 3.13: The species that should be covered by trapping regulation in the EU.

Assuming new trapping standards incorporating effectiveness, selectivity and safety were established in the EU, the respondents were asked what they thought should happen if none of the current traps met the new standards. They could choose one of the following options: a) Use what you believe are the best available traps; b) Use whatever traps are available; c) Stop trapping until traps that do meet the new standards become available; d) Use firearms instead; e) Use poison instead; e) None of the above; f) Do not know. Table 3.14 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. The majority of all respondents (53%) believed that if there were currently no traps that met the new standards then you should use what you believe are the best available traps. However there are differences in opinion between the categories of respondent. 76% of Trapping/hunting respondents held the view that the best available traps should be used, whilst 76% of Animal welfare/rights respondents believed that trapping should cease until traps that do meet the new standard became available. The majority of respondents in the other two categories supported the continuing use of the best available traps; although in both categories a sizable minority believed that trapping should stop until new traps that met the new standards became available.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a.Best avail. trap	3808 (76.3%)	58 (2.9%)	492 (50.4%)	722 (45.7%)	5080 (53.1%)
b.Any avail. trap	279 (5.6%)	6 (0.3%)	22 (2.3%)	94 (5.9%)	401 (4.2%)
c. Stop trapping	277 (5.5%)	1547 (76.4%)	319 (32.7%)	480 (30.4%)	2623 (27.4%)
d. Use firearms	406 (8.1%)	26 (1.3%)	64 (6.6%)	139 (8.8%)	635 (6.6%)
e. Use poison	13 (0.3%)	3 (0.1%)	2 (0.1%)	6 (0.4%)	24 (0.3%)
f. None of the above	92 (1.8%)	338 (16.7%)	54 (5.5%)	82 (5.2%)	566 (5.9%)
g. Do not know	110 (2.2%)	45 (2.2%)	20 (2.0%)	54 (3.4%)	229 (2.4%)

Table 3.14: What should happen if none of the current traps meet the new trapping standards?

Respondents were asked, if they trapped animals themselves, how much more would they be prepared to pay for a trap that had been tested and approved. They could choose one of the following options: a) No upper limit; b) Double; c) 50% more; d) 25% more; e) Nothing more; f) Do not know; g) Not applicable. Table 3.15 gives, for each category, and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. 2453 of the respondents (26% of the total number) stated that this question did not apply to them because they did not trap animals themselves, and this was the case for 75% of the Animal welfare/rights category. 71% of those that did trap were not willing to pay any more for a trap that had been tested and approved.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a.No upper limit	106 (2.1%)	198 (9.8%)	90 (9.2%)	70 (4.4%)	464 (4.8%)
b. Double	29 (0.6%)	48 (2.4%)	37 (3.8%)	32 (2.0%)	146 (1.5%)
c. 50% more	80 (1.6%)	39 (1.9%)	35 (3.6%)	44 (2.8%)	198 (2.1%)
d. 25% more	521 (10.4%)	36 (1.8%)	102 (10.4%)	145 (9.2%)	804 (8.4%)
e. Nothing more	3839 (76.9%)	72 (3.6%)	428 (43.9%)	730 (46.2%)	5069 (53.0%)
f. Do not know	141 (2.8%)	110 (5.4%)	68 (7.0%)	105 (6.6%)	424 (4.4%)
g. Not applicable	269 (5.4%)	1520 (75.1%)	213 (21.8%)	451 (28.5%)	2453 (25.6%)

Table 3.15: If you trap animals yourself, how much more are you willing to pay for a trap that has been tested and approved?

3.7 The testing and approval of traps within the EU.

The survey asked at what level the testing and approval of traps within the EU would be best organised. Respondents could choose one of the following options: a) At international level; b) At EU level; c) At national level adapted to local conditions; d) Do not know. Table 16 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. 57% of all respondents thought that the testing and approval of traps was best organised at the national level. However there were differences in preference between the categories of respondent. Whilst 80% of the Trapping/hunting category chose regulation at the national level, 72% of the Animal welfare/rights category wanted regulation at the EU level. Regulation at the international level received relatively little support from the respondents of any category.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a.International level	581 (11.6%)	378 (18.7%)	184 (18.9%)	162 (10.3%)	1305 (13.6%)
b. EU level	339 (6.8%)	1449 (71.6%)	350 (35.9%)	499 (31.6%)	2637 (27.6%)
c. National level	3976 (79.7%)	135 (6.7%)	427 (43.8%)	881 (55.8%)	5419 (56.6%)
d. Do not know	41 (0.8%)	49 (2.4%)	8 (0.8%)	26 (1.6%)	124 (1.3%)

Table 3.16: The level at which trap testing and approval in the EU should be organised.

Assuming that traps within the EU were to be tested and approved in the EU, the survey asked who should develop the criteria to be used in the testing and approval process. Respondents could choose one of the following options: a) Manufacturers; b) Recognised trappers' associations; c) Recognised animal welfare organisations; d) Recognised independent institute or body; e) National authorities; f) EU level; g) Do not know. Table 3.17 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. There was very little support for having either the manufacturers or the EU develop the criteria. The other options received similar levels of support, although there are clear differences between the categories of respondent in the option most favoured. 46% of the Trapping/hunting category wanted national authorities to draw up the criteria, whilst 73% of the Animal welfare/rights category wished these criteria to be developed by a recognised animal welfare organisation. Most (31%) of the Research/conservation category wanted an independent institute to compile the criteria, whilst the Mixed category were divided between having a trappers organisation (21%) or an animal welfare organisation (22%) to conduct this task.

Option	Trapping/ hunting	Animal wefare/rights	Research/ conservation	Mixed	All categories
a.Manufacturers	194 (3.9%)	11 (0.5%)	31 (3.2%)	79 (5.0%)	315 (3.3%)
b. Trappers' organisations	1321 (26.5%)	36 (1.8%)	217 (22.2%)	451 (28.5%)	2025 (21.2%)
c.Animal wefare organisations	153 (3.1%)	1476 (72.9%)	162 (16.6%)	354 (22.4%)	2145 (22.4%)
d.Independent institute	877 (3.1%)	281 (13.9%)	303 (31.0%)	283 (17.9%)	1744 (18.2%)
e. National authorities	2277 (45.6%)	44 (2.2%)	141 (14.4%)	284 (18.0%)	2746 (28.7%)
f. EU level	70 (1.4%)	115 (5.7%)	106 (10.9%)	89 (5.6%)	380 (4.0%)
g. Do not know	93 (1.9%)	60 (3.0%)	13 (1.3%)	37 (2.3%)	203 (2.1%)

Table 3.17: Who should develop the criteria to be used in the testing and approval of traps?

Given that the criteria for the testing and approval of traps have been developed, the survey asked who should conduct the testing of, and give the approval for, specific traps. The respondents could choose one of the following options: a) Manufacturers; b) Accredited trappers' organisations; c) Accredited animal welfare organisations; d) Independent institute or body; e) Competent authorities; f) Do not know. Table 3.18 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. Most respondents (36%) wanted an independent institute to conduct the testing and approval of traps. An independent institute was also the most chosen option in both the Trapping/hunting (48%) and the Research/conservation (41%) categories of respondent. However, 74% of the Animal welfare/rights category wished the testing to be conducted by an accredited animal welfare organisation. Respondents in the Mixed category were more equally divided between the three options; i.e. trappers organisation 21%, animal welfare organisation 22%, independent institute 18%.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a.Manufacturers	548 (11.0%)	14 (0.7%)	42 (4.3%)	138 (8.7%)	742 (7.8%)
b.Trappers' organisations	1223 (24.5%)	39 (1.9%)	227 (23.3%)	455 (28.8%)	1944 (20.3%)
c.Animalwelfare organisations	153 (3.1%)	1492 (73.7%)	148 (15.2%)	359 (22.7%)	2152 (22.5%)
d. Independent institute	2411 (48.3%)	298 (14.7%)	396 (40.6%)	366 (23.2%)	3471 (36.3%)
e. Competent authorities	538 (10.8%)	123 (6.1%)	149 (15.3%)	222 (14.1%)	1032 (10.8%)
f. Do not know	112 (2.2%)	57 (2.8%)	11 (1.1%)	37 (2.3%)	217 (2.3%)

Table 3.18: Who should test and approve traps in the EU?

3.8 Animal welfare criteria for the testing and approval of traps

The survey contained questions concerning the sorts of animal welfare criteria that should be used to test and approve traps. Respondents were asked whether they agreed that traps in the EU should be tested and approved according to clearly defined wild animal welfare criteria. As table 3.19 indicates, the majority of all respondents (57%) agreed with this statement; as did the majority of the respondents within three of the four categories. The exception was the Trapping/hunting category where the majority (59%) disagreed with the statement.

Option	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a. No	2939 (58.9%)	107 (5.3%)	204 (20.9%)	515 (32.6%)	3765 (39.3%)
b. Yes	1918 (38.4%)	1839 (90.0%)	709 (72.6%)	991 (62.7%)	5457 (57.0%)
c. Do not	128	77	60	71	336

know	(2.6%)	(3.8%)	(6.1%)	(4.5%)	(3.5%)

Table 3.19: Should traps in the EU be tested and approved according to clearly defined animal welfare criteria?

The respondents were also asked how important to them is the welfare of the trapped animals compared to concerns over preventing damage, protecting health or managing wildlife? They could choose one of the following options: a) More concerned about the welfare of the trapped animal than about preventing damage, protecting health or managing wildlife etc.; b) Less concerned about the welfare of the trapped animal than about preventing damage, protecting health or managing wildlife etc.; c) Equally concerned about the welfare of the trapped animal as about preventing damage, protecting health or managing wildlife etc.; d) Do not know. Table 3.20 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. 60% of all respondents were equally concerned about the welfare of the trapped animals compared to concerns over preventing damage, protecting health or managing wildlife; as were the majority of respondents within three of the four categories. Respondents within the Animal welfare/rights category were the exception in that here 73% were more concerned about the welfare of the trapped animals than about preventing damage etc.. In all categories only a few respondents stated that they were less concerned about the welfare of the trapped animal than about preventing damage etc.

Option	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. More concerned	318 (6.4%)	1475 (72.9%)	194 (19.9%)	399 (25.3%)	2386 (24.9%)
b. Less concerned	816 (16.3%)	26 (1.3%)	134 (13.7%)	314 (19.9%)	1290 (13.5%)
c. Equally concerned	3763 (75.4%)	484 (23.9%)	633 (64.9%)	836 (52.9%)	5716 (59.7%)
d. Do not	88	38	12	28	166

know	(1.8%)	(1.9%)	(1.2%)	(1.8%)	(1.7%)

Table 3.20: Are you more, less, or equally concerned about the welfare of the trapped animals compared to concerns over preventing damage, protecting health or managing wildlife?

Respondents were asked whether they would give most weight to behavioural, physical or physiological indicators of welfare when assessing the welfare of an animal caught in a holding trap like a box or cage trap. They could choose one option from: a) Behavioural signs e.g. biting the bars of the trap; b) Physical injuries e.g. damaged skin or broken tooth; c) Physiological indicators, e.g. high levels of stress hormone; d) Do not know. Table 3.21 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. There was widespread agreement among the respondents of all categories that, when assessing the welfare of animals in holding traps, most weight should be placed upon the incidence of physical injuries.

Option	**Trapping/ hunting**	**Animal Wefare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a.Behavioural signs	577 (11.6%)	146 (7.2%)	138 (14.1%)	220 (13.9%)	1081 (11.3%)
b.Physical injuries	3286 (65.8%)	1400 (69.2%)	550 (56.4%)	789 (49.9%)	6025 (63.0%)
c.Physiological indicators	451 (9.0%)	219 (10.8%)	150 (15.4%)	198 (12.5%)	1018 (10.6%)
d. Do not know	671 (13.4%)	258 (12.7%)	135 (13.8%)	370 (23.4%)	1434 (15.0%)

Table 3.21: When assessing the welfare of an animal caught in a holding trap should most weight be given to behavioural, physical or physiological indicators of welfare?

The criteria for humane killing traps within the AIHTS are based upon the period that elapses between an animal being captured in the trap and it losing consciousness and dying. The AIHTS sets out the length of time between capture and unconsciousness to death (this time varies between species but for most is 300 seconds) that must not be exceeded. The survey investigated the longest length of time between capture and death that is acceptable to the public. The respondents were asked "Assuming that a killing trap is very effective, selective and safe for catching specific pest animals (for example mice in your home) but does not kill them immediately, what in your opinion is the longest time from an animal welfare point of view between the trap catching an animal and it becoming unconscious and dying?" Respondents could chose one of the following options: a) Zero seconds, i.e. instantaneous death; b) 30 seconds; c) 1 minute; d) 3 minutes; e) 5 minutes; f) Any length of time; g) None of the above; h) Do not know. Table 3.22 gives, for each category and for all categories together, the number of cases choosing a particular option and this figure expressed as a percentage of the total number of cases within that category. Most respondents (29%) thought that killing traps should kill the trapped animal instantaneously, with slightly fewer (26%) thinking a time between capture and death of 30 seconds was acceptable. The Animal welfare/rights category differed from the other categories in that 54% found none of the options were acceptable; this was presumably the case because 86% of the respondents in this category were against the killing of wild animals *per se*. One clear finding is that very few respondents from any category found the 300 seconds period between capture and unconsciousness/death specified in the AIHTS for most species to be acceptable.

Options	**Trapping/ hunting**	**Animal welfare/rights**	**Research/ conservation**	**Mixed**	**All categories**
a. Zero seconds	1211 (24.3%)	658 (32.5%)	368 (37.7%)	555 (35.1%)	2792 (29.2%)
b. 30 seconds	2022 (40.5%)	44 (2.2%)	174 (17.8%)	229 (14.5%)	2469 (25.8%)
c. 1 minute	519 (10.4%)	18 (0.9%)	111 (11.4%)	127 (8.0%)	775 (8.1%)
d. 3 minutes	208 (4.2%)	3 (0.1%)	59 (6.0%)	50 (3.2%)	320 (3.3%)
e. 5 minutes	427 (8.6%)	3 (0.1%)	53 (5.4%)	79 (5.0%)	562 (5.9%)
f. Any time	234 (4.7%)	166 (8.2%)	45 (4.6%)	153 (9.7%)	598 (6.2%)
g. None of	215	1086	118	295	1714

the above	(4.3%)	(53.7%)	(12.1%)	(18.7%)	(17.9%)
f. Do not know	149 (3.0%)	45 (2.2%)	45 (4.6%)	89 (5.6%)	328 (3.4%)

Table 3.22: The maximum acceptable period between capture by a killing trap and the unconsciousness and death of the captured animal.

The respondents were asked what, in their opinion, are acceptable methods to kill an animal found alive in a trap or snare. They could choose as many options as they wished from the following: a) Shooting; b) Heavy blow to the head; c) Drowning; d) Lethal injection; e) All the above as long as the methods ensure death of the animal without avoidable pain, suffering and distress; f) None of the above; g) Do not know. Table 3.23 gives, for each category and for all categories together, the number of times a particular method was chosen and this figure expressed as a percentage of the total number of cases within that category. Shooting and a heavy blow to the head were the most commonly chosen methods (60% and 42% respectively). Very few respondents in any category thought that drowning was an acceptable method. As the majority of the Animal welfare/rights category did not accept the need to kill wild animals *per se*, it is not surprising that 75% of the respondents in that category thought that none of the options were acceptable.

Options	Trapping/ hunting	Animal welfare/rights	Research/ conservation	Mixed	All categories
a. Shooting	4129 (82.7%)	181 (8.9%)	587 (60.1%)	887 (56.1%)	5784 (60.4%)
b. Blow to the head	3095 (62.0%)	71 (3.5%)	290 (29.7%)	544 (34.4%)	4000 (41.8%)
c. Drowning	284 (5.7%)	11 (0.5%)	39 (4.0%)	78 (4.9%)	412 (4.3%)
d. Lethal injection	507 (10.2%)	251 (12.4%)	187 (19.2%)	227 (14.4%)	1172 (12.2%)
e. Any if no suffering	1267 (25.4%)	121 (6.0%)	305 (31.3%)	402 (25.4%)	2095 (21.9%)
f. None of the above	129 (2.6%)	1509 (74.6%)	141 (14.4%)	357 (22.6%)	2136 (22.3%)

g. Do not know	16 (0.3%)	60 (3.0%)	32 (3.3%)	32 (2.0%)	140 (1.5%)

Table 3.23: Acceptable methods to kill an animal caught alive in a trap or snare.

3.9 Conclusions

The majority of the public accepted in principle that human or environmental needs could justify the killing of wild animals; although this was not the opinion of a large majority of respondents who had a background in Animal welfare/rights (see Table 3.4). A possible factor contributing to this divergence of opinion is that, judging by their responses, respondents with a background in Animal welfare/rights have an inaccurate idea of the purposes of trapping within the EU. As discussed in Chapter 2, the majority of trapping within the EU is for purposes of pest control and wildlife management in order a) to protect human health and safety, b) to prevent damage, and c) for the conservation of other species. However, the majority of the Animal welfare/rights respondents believed that the main reason for trapping in the EU was to obtain furs or skins (see Table 3.6). Another possible factor leading to the opinion that there was no justification to kill wild animals was the perception by Animal welfare/rights respondents that immunocontraception is one of the main methods currently being used in the EU to control wild animals (see Table 3.5); they strongly supported contraception as an acceptable wildlife management technique (see Table 3.7). However, the use of immunocontraception as a control method is currently only at the research stage. In summary, an injectable immunocontraceptive vaccine is now available for practical application in some species for which capture, vaccination and release is a feasible management option. The next stage would be the development of oral immunocontraceptive vaccines that generate long-term infertility after delivery via species-specific baiting systems, thereby broadening the scope of potential applications. In the absence of such techniques practical application of immunocontraception is not currently feasible for species with high potential intrinsic rates of population increase, such as muskrats. Furthermore, even if such techniques become available, there will be circumstances where culling would still be necessary. For instance, to produce rapid and substantial reductions of high density populations posing immediate threats to human interests, e.g. by acting as disease reservoirs or undermining flood defences.

Whilst accepting the need for lethal control measures the public were strongly of the opinion that the welfare of trapped animals should be of equal importance as concerns over preventing damage, protecting health or managing wildlife (see Table 3.20).

Also they were strongly in favour of regulating trapping within the EU by legislation; although there was some disagreement between the categories of respondent whether this should be achieved by EU regulation harmonised for all 27 Member States or by legislation at the national level adapted to suit local conditions (see Table 3.8). The majority of the public thought that anyone who had the legal right to trap under national law should be allowed to do so (see Table 3.10) but that such people should receive training (see Table 3.11).

Most respondents thought that the list of species to be covered by trapping legislation should be decided at the national level; although Animal welfare/rights respondents strongly believed that the species should be decided at the EU level on a harmonised list (see Table 3.12). There was a consensus among all the categories of respondent that all the species that can legally be trapped should be covered by trapping regulation; as opposed, for example, to restricting the list to those species currently covered by the AIHTS.

The majority of respondents thought that traps used in the EU should be tested and approved according to clearly defined animal welfare criteria (see Table 3.19). There was a consensus that most weight should be given to physical injuries when assessing the welfare of an animal in a holding trap; as opposed to behavioural and physiological indices of welfare (see Table 3.21). Also when considering the welfare of animals caught in killing traps 29% of respondents thought that death should be instantaneous and 26% thought it acceptable to be within 30 seconds; only 6% thought the 300 seconds limit for the time to unconsciousness and death specified within the AIHTS was acceptable. Although there was disagreement between the categories of respondent as to who should develop the welfare criteria to be used in approving traps (see Table 3.17), there was general agreement that an independent institute or body should be responsible for the testing and approval of traps (see Table 3.18).

The survey results clearly show that the public think that the welfare of animals caught in traps is important. They want trapping within the EU to be regulated by legislation and all traps employed to be tested and approved by an independent institute using clearly defined animal welfare guidelines. Nevertheless, of the public that currently use traps 73% stated that they were not prepared to pay more for a trap that had been tested and approved (see Table 3.15).

4 Improved Standards for killing traps.

This chapter describes new Improved Standards for killing traps. These standards specify three Welfare Categories (i.e. A, B and C) of trap that differ in the times to irreversible unconsciousness (TIU) of animals caught in the trap; with Welfare Category A traps resulting in the shortest TIU and Welfare Category C the longest. It is argued that drowning traps should be treated no differently than other forms of killing trap and should be subject to the same Improved Standards. It is proposed that where traps of different Welfare Categories are available to control the same species only traps of the highest welfare category will be used.

Summary

The aims of this chapter are:

a) **to consider what constitutes a humane killing trap,**
b) **to discuss the parameters used to assess the welfare of animals in killing traps,**
c) **to compare and contrast important killing trap standards,**
d) **to discuss the welfare of animals in drowning traps and consider whether such traps should be treated differently than other forms of killing traps,**
e) **to propose improved welfare standards for killing traps (referred to as the Improved Standards),**
f) **to identify current traps that meet the Improved Standards for the species of major interest to the EU,**
g) **to discuss possible design modifications of traps to improve the welfare of animals in killing traps.**

a) Humane killing trap. The ideal humane killing trap is one that kills without the captured animal experiencing any pain or suffering. Such a trap need not necessarily kill the captured animal instantaneously but it should produce instantaneous unconsciousness from which the animal does not recover prior to death.

b) Assessing the welfare of animals in killing traps. As an unconscious animal does not feel pain and does therefore not suffer, the time to irreversible unconsciousness

(TIU) following capture in a killing trap has most commonly been used as the key measure for assessing the welfare of the captured animal. One problem with this approach is that it assumes a simple relationship between the level of pain and suffering experienced by the trapped animal and the TIU; the shorter the TIU the less pain and suffering. However, as currently there appear to be no physiological, behavioural or pathological indices that can reliably be used to quantify the level of pain an animal in a trap experiences prior to death, it is reasonable to place the greatest weight on the TIU of the captured animal.

c) Welfare standards for killing traps. Three killing trap standards are compared and contrasted.

a) A draft ISO document circulated to members of ISO/TC191 in 1993 put forward a standard that required a killing trap to render at least 70% of trapped animals irreversibly unconscious within 180 seconds at a 90% confidence level. This standard also included a testing procedure that incorporated the use of so-called ‘stopping rules’ designed to reduce the number of animals required to test traps.

b) A killing trap meets the standard of the Agreement on International Humane Trapping Standards (AIHTS) when 80% or more of at least 12 test animals show TIU scores not exceeding limits that differ between target species: the ermine has a TIU limit of 45 seconds; the marten, the sable, and the pine marten have a TIU limit of 120 seconds; all the other species covered by the AIHTS currently have a TIU limit of 300 seconds with the goal of eventually lowering this on a species-by-species basis to 180 seconds.

c) The New Zealand National Animal Welfare Committee (NAWAC) Guideline 09 contains criteria for two welfare categories of traps (called “welfare performance classes (A or B)”) based upon TIU scores, and for each of these categories there are two TIU thresholds. To qualify as a Class A trap a stated maximum number of animals having a TIU greater than 30 seconds must not be exceeded, and also a stated maximum allowable number of animals having a TIU greater than 180 seconds must not be exceeded. To qualify as a Class B trap a stated maximum number of animals having a TIU greater than 180 seconds must not be exceeded, and also a stated maximum number of animals having a TIU greater than 300 seconds must not be exceeded. These numbers are designed to give 90% confidence that the traps that pass the test will perform below the lower TIU threshold 70% of the time and below the upper TIU threshold 80% of the time

The three standards differ in the number of test animals required to implement them. The NAWAC Guideline allows the manufacturer to choose one of a number of possible sample sizes for the trap testing; from a minimum sample size of 10 up to a maximum sample size of 50. The AIHTS sets minimum sample size but it specifies no upper limit to the number of animals that may be used. The draft ISO standard has procedures that minimise the number of animals required because the trial can be stopped and the trap failed as soon as the probability of a successful outcome becomes too low.

d) Drowning traps. The welfare of animals in drowning traps is discussed in relation to the accounts of people who have survived drowning. Some people describe their last conscious moments as being calm with no pain, whereas others describe burning suffocation and scorching pain. In humans, and other terrestrial mammals, the build up of carbon dioxide in the blood and the lack of oxygen stimulates the brain’s respiratory centre; this overrides any voluntary breath-holding and forces an inhalation of water. However, in aquatic mammals the diving reflex is thought to take priority, and it is unclear both at what point the motivation to breathe becomes more important, and whether such animals would necessarily experience pain and distress before unconsciousness. It is concluded that there is no reason why drowning traps should not be subjected to the same TIU limits as other killing traps. However, a major problem (particularly as regards semi-aquatic mammals like muskrats) lies in deciding at what point the clock should start when recording the TIU of an animal in a drowning trap. With a spring trap the clock starts when the trap is sprung and animal is hit with the killing bar. There is not such an obvious starting point for an animal in a drowning trap. Distress is unlikely to occur immediately after entry into the drowning trap because mammals, and particularly semi-aquatic mammals, can routinely spend some time underwater without experiencing distress or pain. For an animal in a drowning trap distress, and possibly pain, is more likely to start when the animal first attempts to, and thereby finds that it is unable to, come to the surface to breathe. Theoretically the clock should start then, and experiments designed to determine objectively this point for muskrats are described in Chapter 5.

e) Improved Standards for killing traps. The proposed Improved Standards classify killing traps into one of three 'Welfare Categories', see Table 4.1. Traps in Welfare Category A, the highest welfare category, must (at 90% confidence) produce a TIU not exceeding 30 seconds for at least 80% of trapped animals. Traps in Welfare Category B, the intermediate welfare category, must (at 90% confidence) produce a TIU not exceeding 180 seconds for at least 80% trapped animals. Traps in Welfare Category C, the lowest welfare category, must meet the current AIHTS standard for most species (i.e. they produce a TIU not exceeding 300 seconds for at least 80% of a minimum of 12 animals tested). In addition to the criteria that 80% of trapped animals must have a TIU below the specified limit for the particular welfare category, it is proposed that for welfare categories A and B there should also be a higher TIU limit that must not (at 90% confidence) be exceeded by 90% of trapped animals. The upper TIU limit for welfare category A is 180 seconds, and the upper limit for welfare category B is 300 seconds. Welfare category C has no upper TIU limit so that traps that have already been tested and approved under the AIHTS would automatically be approved as welfare category C of the improved standards.

	Welfare Category A	**Welfare Categfory B**	**Welfare Category C**
Lower TIU limit, to be met by >80% of animals	not exceeding 30 seconds	not exceeding 180 seconds	Not exceeding 300 seconds
Upper TIU limit, to be met by >90% of animals	not exceeding 180 seconds	not exceeding 300 seconds	No upper limit

Table 4.1: Lower and upper TIU limits for Welfare Categories A, B; these limits are to be met at 90% confidence. Welfare Category C is the same as the AIHTS.

If these proposals were enacted it is envisaged that there may not be any immediate change in trap use within the EU without additional incentives or a legislative/administrative framework. All the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. However, in order to encourage the rapid development of better traps there is in the Improved Standards the presumption that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks. The financial implications of adopting the Improved Standards will depend upon exactly how they are implemented; for example in Canada a trap has to be tested and shown that it meets the AIHTS before it can be used, whilst in New Zealand it is assumed that a trap meets the NAWAC Guideline and hence it can be used until it is tested and shown that it does not.

f) Traps that meet the Improved Standards. For the species of major interest to the EU a list of traps that meet the AIHTS, and hence also meet the TIU criteria for Welfare Category C of the Improved Standards, is provided. Although killing traps have not yet been tested to the higher welfare standards of Welfare Categories A and B of the Improved Standards, information is available from scientific studies that indicates that some traps could be allocated to these categories.

g) Design modifications to improve killing traps. Possible ways to reduce the TIU scores of animals in killing traps are discussed (e.g. replacing the single strike bar by a mesh of strike bars greatly increases the chances of a neck strike, offsetting the jaws of rotating-jaw traps can enhance performance without the need to increase power). A promising future development is the use of computer models to develop a Trap Optimisation Program that can suggest effective design changes.

4.1 Types of killing trap.

Killing traps may be divided into the following main categories (e.g. FACE 1998, Proulx 1999, Garrett 1999):

a) 'Conibear- type' spring trap (named after Frank Conibear who developed the first prototype); consists of two metal frames hinged at the center point and powered by two torsion springs that create a scissor-like action. One jaw has a trigger that can be baited whilst the other has a catch that holds the trap open. These traps are designed to kill by crushing a vital region of the body, usually the neck and head.

b) 'Mousetrap-type' spring trap; has one, or more, strike bars powered by a coiled spring that is energized when the animal contacts a trigger plate. Again these traps are designed to kill by crushing a vital region of the body, usually the neck and head.

c) Dead fall trap; uses a heavy weight(s) to kill the animal by crushing the skull and/or other vital region of the body.

d) Killing snare; a wire noose that incorporates a ratchet mechanism and kills by asphyxiation caused by the animal continually tightening the snare around its neck as it tries to free itself.

e) Power snare; a wire noose that is tightened quickly around the neck of the animal by a powerful spring and kills by asphyxiation.

f) Drowning trap; a holding device (e.g. cage) that restrains the animal underwater until death is caused by hypoxia.

Currently killing snares are not used in the EU; the two types of spring traps (a and b) and drowning traps are the most commonly used killing traps (see Chapter 2).

4.2 *What is a humane killing trap?*

The ideal killing trap, as far as animal welfare is concerned, is one that kills without the captured animal experiencing any pain or suffering. Such a trap need not necessarily kill the captured animal instantaneously but it should produce instantaneous unconsciousness from which the animal does not recover prior to death. In order to produce an unconscious state, some brain malfunction must be produced. This can be caused by trauma producing severe concussion as a result of a blow on the skull; a skull fracture with massive haemorrhage into the brain is a sufficient injury. Similarly a blow resulting in cervical dislocation of the spinal cord behind the skull immediately affects brain function and leads to unconsciousness. Brain malfunction may also be caused by a large reduction in the blood supply to the brain. This could result from cardiac arrest, or from the rupture or constriction of the major blood vessels supplying the brain. Interference with the respiratory system may also result in a sufficient brain malfunction. Mechanical interference with the passage of air down the trachea, or the prevention of normal lung function through damage or constriction can result in defective oxygenation of the blood in the lungs leading to hypoxia affecting oxygen levels in the brain. As the brain becomes anoxic unconsciousness occurs; the rapidity of onset depending on the degree of obstruction or constriction.

Some experts in animal welfare argue that only when a trap results in the instantaneous and irreversible unconsciousness of the captured animal can it be called a humane trap. Others use the term humane in a comparative manner such that one trap can be described as more humane than another, and for these the answer to what comprises a humane killing trap varies widely. For example Noseworthy (1992) proposed that a trap may be considered humane if it can kill an animal more rapidly than the normal natural causes of death for that species. On the other hand Manser (1992) argued that the criteria for a humane trap should be the same as that laid down in European law for the humane killing of animals in slaughterhouses, animal shelters, fur farms and laboratories, i.e. that the time between capture and death should not be more than 10-20 seconds; although in these situations the animals are under restraint in controlled environments. The wide divergence of views on what constitutes a humane trap led the Fourth Plenary meeting of the ISO committee TC/191 to debate whether the term “humane’ should be removed from title of the draft ISO Standard on Humane Mammal Traps. It was argued that humane be replaced by a preamble that stated: “The purposes of this standard are to consider performance criteria for humaneness; to encourage the ongoing development of humane traps and hence to improve the welfare of animals caught in traps”. The word humane was also included in the title of the subsequent AIHTS (1998a,b), and this revived the controversy over the meaning of this term.

Rather than debate the meaning of humane, and what is a humane trap, it is preferable simply to concentrate on the level of welfare of the captured animal prior to death, i.e. the degree of pain and suffering it experiences. An unconscious animal does not feel pain or suffer and, therefore, the time to irreversible unconsciousness (TIU) following capture in a killing trap has commonly been used (see below) as the key measure for assessing the welfare of the captured animal. One problem with this approach is that it assumes a simple relationship between the level of pain and suffering experienced by the trapped animal and the TIU; the shorter the TIU the less pain and suffering. Although there is likely to be a strong correlation between these variables, it is possible that an animal may experience less pain and suffering after capture in a trap with a TIU of, for example, 60 seconds that when trapped in a trap with a TIU of 30 seconds. However, as currently there appear to be no physiological, behavioural or pathological indices that can reliably be used to quantify the level of pain an animal in a trap experiencs prior to death (see Chapter 6) it is reasonable to place the greatest weight on the TIU of the captured animal.

The time to unconsciousness is used to compare various methods of stunning domestic animals prior to killing. The degree of pain experienced during this period of consciousness is not considered. Whilst some methods of stunning that are deemed to be acceptable are instantaneous (e.g. electric current) other methods (e.g. gaseous inhalation) take many seconds before unconsciousness occurs. Recent studies (Llonch et al. 2009**)** examining electroencephalographs (EEG) indicated that unconsciousness in pigs did not occur until 140 seconds after initial immersion in carbon dioxide; although it is thought that in the majority of cases with 90% carbon dioxide stunning, unconsciousness occurs within 73 seconds (Hartung et al. 2002).

By using TIU scores it is possible to assign killing traps to different 'welfare categories'. A hierarchy of categories of trap can thereby be constructed with the highest welfare category having the traps with the shortest TIU scores, the next highest welfare category having traps with longer TIU scores, and so on. In such a scheme the description 'humane trap' would only be applied to traps having a TIU score of 0 seconds, i.e. to traps that caused instantaneous and irreversible unconsciousness in the captured animal. However, the highest welfare category of trap should not be restricted to such traps because there can be practical reasons why detecting a trap with a TIU of 0 seconds is not possible. For example, a reliable, and the most commonly employed, indicator of loss of consciousness is the absence of brainstem reflexes like the corneal and palpebral reflexes (e.g. Horton 1980). However, in compound trials of killing traps it is often not physically possible to reach the trapped animal and test for such reflexes until around 30 seconds have passed after the strike. Therefore although the trap may indeed be humane and have a TIU of 0 seconds the physical constraints of the experimental set-up mean that it can only be assigned to a welfare category based upon a TIU score greater than zero.

4.3 Welfare standards for killing traps based on TIU scores.

Several experts have argued that welfare standards for killing traps should be based upon the TIU. For example, Proulx & Barrett (1994) proposed a definition of what they termed 'state-of-the-art' killing traps. They defined such traps as devices with the potential, at 95% confidence, to render 70% or more of the target animals irreversibly unconscious within 180 seconds. The use of TIU scores, where the TIU is usually taken as the time to loss of corneal or palpebral reflexes, has been incorporated into trap standards underpinning actual or proposed legislation to control the licensing of killing traps on welfare grounds. Three examples of such standards are now discussed.

A draft ISO document circulated to members of ISO TC/191 in 1993 put forward a standard that required a killing trap to render at least 70% of trapped animals (under anaesthesia) irreversibly unconscious within 180 seconds at a 90% confidence level. This standard also included a testing procedure that incorporated decision points designed to reduce the number of animals required (the use of so-called 'stopping rules' is discussed in detail in 6.4). After various numbers of animals had been tested it was possible to determine whether the data thus far gathered were sufficient to fail the trap, or whether it was necessary to conduct further testing. For example, the draft standard states that "traps that kill humanely (i.e. result in a TIU of less than 180 seconds) only 3 or fewer of 5 animals (2 or more failures), or 7 or fewer of 10 animals (3 or more failures), or 11 or fewer of 15 animals (4 or more failures), or 16 or fewer of 20 animals (4 or more failures) have failed and further testing must not be conducted."

The AIHTS (1998a) states that "A killing trapping method would meet the Standards if: the number of specimens of the same target species from which the data are derived is at least 12; and at least 80% of these animals are unconscious and insensible within the time limit, and remain in this state until death." The AIHTS has different TIU criteria for different target species: the ermine has a TIU limit of 45 seconds; the marten, the sable, and the pine marten have a TIU limit of 120 seconds; all the other species covered by the AIHTS currently have a TIU limit of 300 seconds with the goal of eventually lowering this on a species-by-species basis to 180 seconds.

Objections have been raised by welfare organisations and others (e.g. IFAW 2005, Iossa et al. 2007) to the killing trap standards contained in both the AIHTS and in the Commission's proposed Directive to implement the obligations and commitments arising from the AIHTS. In particular it has been argued that the proposed 300 seconds TIU limit contained in the Directive and the AIHTS is too long and fails to take into account the current state-of-the-art of killing traps. Some killing traps can cause TIUs in the target species well below 300s (e.g. a TIU around 50 seconds for the Bionic trap when used against fisher, Proulx & Barrett 1993; a TIU around 30 seconds for the Leprich trap when used against muskrats, Inglis et al. 2001). Furthermore, as discussed below, the trap approval system developed by the National Animal Welfare Committee (NAWAC) in New Zealand uses the shorter TIU limits of 30 seconds and 180 seconds for the certification of traps. Several of the traps that have been certified (by the trap testing program administered by the Fur Institute of Canada) as meeting the 300 seconds TIU requirement of the AIHTS may produce TIU scores in the target species well below 300 seconds; however, the relevant data are not publically available.

Another criticism of the AIHTS is that it considers killing traps to be humane if the specified TIUs are achieved in a minimum of 80% of the test animals and this implies that “for the remaining 20% or less of trapped animals any level of welfare is acceptable” (Iossa et al. 2007, p 347). As discussed below, this danger is addressed in the NAWAC trap certification process by having two TIU limits, a lower and an upper, for each welfare category of trap.

The AIHTS makes no distinction between spring traps that kill by crushing a vital region of the body, usually the neck and head, and drowning traps that kill by keeping the animal underwater until death is caused by hypoxia. However some welfare organizations believe that “the use of submersion traps should be banned” (IFAW 2005) for two reasons. First, drowning traps are mainly used to kill semi-aquatic species (e.g. muskrat) and many of these species show physiological adaptations to aquatic life (e.g. bradycardia) that enable them to stay under water for far longer than the 300 seconds limit specified within the AIHTS (e.g. up to 22 minutes for the otter, Conroy & Jenkins 1986). Second, hypoxia-induced death cannot be considered to be humane and the paper of Ludders et al. (1999) is quoted in support of this statement. The drowning of animals is an emotive subject; when asked to choose an acceptable method to kill animals found alive in traps drowning accounted for only 4% of the options chosen by members of the public (see Table 3.23). The important issue of the welfare of animals in drowning traps is discussed below in section 4.4, and experiments assessing the welfare of muskrats in drowning traps are described in Chapter 5.

The New Zealand National Animal Welfare Committee (NAWAC) Guideline 09 http://www.biosecurity.govt.nz/animal-welfare/nawac/policies/guideline09.htm is particularly interesting in that: a) it contains criteria for two welfare categories of traps (called “welfare performance classes (A or B)”) based upon TIU scores, and b) for each of these categories there are two TIU thresholds. The choice of the number of animals to be tested (the possible sample sizes vary from 10 to 50 animals in steps of 5) must be made by the person submitting the trap before the tests start, “with the understanding that the lower sample sizes have a greater risk of an effective trap being rejected”.

To qualify as a Class A trap the maximum allowable number of animals retaining corneal reflexes after a lower TIU threshold of 30 seconds must not be exceeded, and also the maximum allowable number of animals retaining corneal reflexes after a higher TIU threshold of 180 seconds must not be exceeded. To qualify as a Class B trap the maximum allowable number of animals retaining corneal reflexes after a lower TIU threshold of 180 seconds must not be exceeded, and also the maximum allowable number of animals retaining corneal reflexes after a higher TIU threshold 300 seconds must not be exceeded. For each of the possible sample sizes Table 4.2 gives the maximum allowable number of animals retaining corneal reflexes after the lower threshold, and the maximum number after the higher threshold. These numbers are designed to give 90% confidence that the traps that pass the test will perform at or below the lower TIU threshold 70% of the time and the upper TIU threshold 80% of the time (for an example of the use of the NAWAC guideline see Warburton et al. 2008).

Sample size	Maximum allowable number of animals with corneal reflex greater than lower threshold.	Maximum allowable number of animals with corneal reflex greater than upper threshold.
10	0	0
15	2	0
20	3	1
25	4	2
30	5	2
35	6	3
40	7	4
45	9	5
50	10	5

Table 4.2: Specification of criteria for NAWAC welfare classes of trap.

Comparisons of the draft ISO standard, the AIHTS and the NAWAC guideline can be made, see Table 4.3. The true basis of the draft ISO standard is that the trap will pass the test less than 10% of the time if the trap performs to the acceptable standard less than 70% of the time. Whilst the NAWAC Guideline always gives a lower 90% confidence interval for a probability of a satisfactory performance on an individual test (*p*) that is greater than 0.7, it sometimes has a greater than 10% probability of passing a trap with a *p* of less than 0.7. Thus the draft ISO standard is stricter than the NAWAC guideline. Unlike the other two, the AIHTS test is entirely empirical and becomes stricter the more animals are tested.

	Draft ISO	**AIHTS**	**NAWAC Category A**	**NAWAC Category B**
Required % of test animals that meet the TIU limit	>70%	>80%	>70% lower TIU limit. > 80% upper TIU limit	>70% lower TIU limit. > 80% upper TIU limit
Confidence level	90%	Varies with the sample size	90%	90%
Lower TIU limit	180 seconds all species	45 seconds ermine, 120 seconds marten, sable, pine marten, 300 seconds other species.	30 seconds all species	180 seconds all species
Upper TIU limit	No upper limits	No upper limits	180 seconds all species	300 seconds all species

Table 4.3: Comparison of the draft ISO, AIHTS and NAWAC trap standards.

The three standards described above differ in the number of test animals required to implement them. The NAWAC Guideline allows the manufacturer to choose one of a number of possible sample sizes for the trap testing; from a minimum sample size of 10 up to a maximum sample size of 50. The AIHTS sets minimum sample size but it specifies no upper limit to the number of animals that may be used. Only the draft ISO standard has procedures that enable flexibility in the number of animals used after the testing has started. In this manner the number of animals required is minimized because the trials can be stopped and the trap failed once the probability of a successful outcome becomes too low during the trial. The development of stopping rules is discussed in Section 7.4.

4.4 Drowning traps

Some scientists state that drowning traps should not be used to control wild animals because drowning is inherently inhumane (e.g. Iossa et al. 2007), and the paper of Ludders et al. (1999) is often quoted to support this position. However, Ludders et al. (1999) makes the more specific point that drowning should not be classed as a form of euthanasia and this does not necessarily mean that drowning should not be used as a wildlife control method. The welfare of animals in drowning traps should be judged objectively alongside the welfare of animals caught by other killing devices within the context of wildlife management. When assessing the animal welfare implications of drowning an objective assessment should be made using all relevant information; for example, interviews and reports from persons who have survived drowning experiences should be considered.

The objection to drowning traps on the grounds that drowning is inherently inhumane was raised in the Opinion of the Scientific Veterinary Committee (Animal Welfare Section) on the draft ISO standards for humane animal traps (unpublished document, 1994). The committee concluded that terrestrial mammals usually inhale water when drowning and that this is an extremely stressful experience. In addition, they stated that the struggling of semi-aquatic mammals caught in traps indicates suffering. However, these conclusions were challenged at the time by some members of the ISO TC/191 who considered they were not scientifically based.

Drowning traps, as apposed to the drowning experiences reported by people, involve the animal being held continuously under the water with no opportunity to breathe air. In contrast the majority of the people in danger of drowning are at or near the surface of the water and they can prolong the time to full immersion by pushing their heads out of the water with their arms. It is during this period that panic and fear are reported to be greatest (Noble and Sharp 1963). After total submersion there follows a period of apnea (i.e. breathing stops or is markedly reduced) (Noble and Sharpe 1963); the duration of which is dependant on the water temperature and the capability of the individual (Datta and Tipton 2006). Eventually the build up of carbon dioxide triggers the breathing reflex and an attempt is made at inspiration. Water is then either freely inhaled or causes laryngospasm (i.e. a closure of the larynx that blocks the passage of air to the lungs). Unconsciousness is thought to occur within a matter of seconds.

The response to the inspiration of water affects both the processes leading up to and the ultimate cause of death, and it is thought that the pain experienced during drowning may be affected by this. For those people and animals where fresh water is freely inhaled, the water is quickly absorbed into the circulation (Modell 1978) causing ventricular fibrillation (i.e. an uncoordinated series of very rapid and ineffective contractions of the ventricles) and consequently heart failure. In people, and probably other terrestrial mammals, this response is found in 85 to 90 % of drownings (Golden et al. 1997).

Individuals that react with laryngospasm upon the inhalation of water, will have similar responses during drowning to those aquatic animals that show the “mammalian diving response” upon immersion. Eventually the animals become hypoxic (i.e. insufficient oxygen supplied to the body tissues) and asphyxia will occur. Asphyxia in terrestrial mammals and humans causes unconsciousness within 2-3 minutes, followed by cardiac arrest (Stone 1999). Before unconsciousness occurs ‘air hunger’ is experienced. This is triggered either by hypoxia or hypercapnia (i.e. an excess of carbon dioxide in the blood), which are perceptually indistinguishable (Moosavi et al. 2003). Hypercapnia was reported during this study to have unpleasant non-respiratory effects. However, it is thought that pain receptors in the nasal mucosa are responsible for these effects and carbon dioxide rich air would not be passing over these receptors during drowning as a result of apnea.

Investigations involving human free-divers have found that some individuals experienced neither pain nor distress at the limit of their breath holding capacity

(Joulia et al. 2002). In fact, drowning in free-divers is a known risk because unconsciousness can occur before any of the normal reflexes that cause an immediate rise to the surface have been triggered (Pollock 2008). Humans can through training reduce their metabolic rate and achieve breath holding of over 10 minutes (Lindholm & Lundgren, 2009). Training guides for lifeguards indicate that such persons do not struggle before unconsciousness. The feelings of people who have survived drowning are rarely documented. In the few reports that are available some people describe their last conscious moments as being calm with no pain, whereas others describe burning suffocation and scorching pain (Stone 1999). In humans, and other terrestrial mammals, the build up of carbon dioxide in the blood and the lack of oxygen stimulates the brain's respiratory centre; this overrides any voluntary breath-holding and forces an inhalation. However, in aquatic animals the diving reflex (see below) is thought to take priority, and it is unclear at what point the motivation to breathe becomes important and whether animals in which the diving reflex is common would necessarily experience pain and distress before unconsciousness. Ludders et al. (1999) argue that the length of suffering is an important part of euthanasia; however for semi-aquatic mammals the point of onset of pain or distress, or whether pain or distress is necessarily felt at all, during drowning is unknown.

All aquatic and semi-aquatic mammals, and some terrestrial mammals, show the "diving response" (also called the diving reflex) that is stimulated on immersion of the nose in cold water. The diving response causes apnoea, peripheral vasoconstriction and bradycardia (i.e. slowing of the heart rate)(Butler & Jones 1997). Semi-aquatic mammals such as the muskrat are adapted to diving, and can dive for significant periods (e.g. Mohr 1954, Errington 1963). Central and peripheral chemoreceptors are stimulated by the developing hypoxia and hypercapnia during apnea; this reinforces the response in forcibly submerged birds and mammals. It has been suggested that the time at which hypoxia and hypercapnia become critical could be calculated from blood oxygen concentrations, known as the aerobic dive limit (ADL). However, this measure is very likely to be inaccurate due to the unknown rate at which many of the body's tissues and organs use oxygen during diving. Many aquatic species have developed the oxygen carrying capacity of their bodies to enhance their dive times (Butler and Jones 1997). The ADL might give a conservative estimate of the maximal time that an animal can remain submerged. However, the

ADL calculated for muskrats ranges from 40.9 seconds to 57.9 seconds (Macarthur 1990, Macarthur et al. 2001, 2003), whilst muskrats have average dive times of 5 minutes (Eble 1955, Hoffman 1958) and can have dive times as long as 12-17 minutes (Mohr 1954, Errington 1963).

Escape dives where the muskrat dives to the bottom of the water and lays motionless, have been observed but the maximum duration of such dives has not been accurately determined. Recent experiments investigating the physiology of diving showed that muskrats can dive without any detrimental effects for 5.5 minutes (Shereshkov et al. 2006). The underwater survival time of forced-dived, unrestrained muskrats was found to be 5 minutes (Macarthur 1990). In the study of Gilbert and Gofton (1982) the duration of the struggling of animals in a drowning trap was not reported, but it was significantly longer than 3 minutes 35 seconds. It appears that heart rate responses during escape dives are different than those found during feeding dives. Heart rate decreased to 73 beats/min during escape dives, but only to 111 beats/min during feeding dives (Macarthur and Karpan 1989).

In principle there is no reason why drowning traps should not be subjected to the same welfare criteria (i.e. the TIU) as other killing traps. A major problem, however, lies in deciding at what point the clock should start when recording the TIU of an animal in a drowning trap. With a spring trap the clock starts when the trap is sprung and animal is hit with the killing bar. There is not such an obvious starting point for an animal in a drowning trap. Distress is unlikely to occur immediately after entry into the drowning trap because, as discussed above, animals, and particularly semi-aquatic animals, can routinely spend some time underwater without experiencing distress or pain. For an animal in a drowning trap distress, and possibly pain, may start when the animal first attempts to, and thereby finds that it is unable to, swim to the surface to breathe. Theoretically the clock should start at this point. Chapter 5 describes experimental investigations that were conducted to assess the welfare of muskrats in drowning traps and to determine the point at which the clock should start when measuring the TIU for this species in a drowning trap.

4.5 Proposed Improved Standards for killing traps.

Having reviewed the different trap testing methodologies and standards in use internationally, it is clear that although there are traps that can meet higher welfare standards than those in the AIHTS very few traps have been tested to higher standards. Furthermore, as new traps take both many years to develop and a large investment by the manufacturer, the Improved Standards should encourage the development of better traps whilst ensuring in the interim that traps are still available for pest control and wildlife management within the EU. 53% of the public thought that if none of the current traps meet the improved trapping standards then trapping should continue with the best available trap; as opposed to 27% who thought trapping should stop until better traps became available (Table 3.14).

The proposed Improved Standards for killing traps have elements of both the draft ISO standard and the NAWAC Guideline. TIU scores are used to assign killing traps to one of three welfare categories; where the highest welfare category has the traps with the shortest TIU scores, the next highest welfare category has traps with longer TIU scores, and the last welfare category contains traps with still longer TIU scores. In such a scheme the description 'humane' trap could be applied to traps having a TIU score of 0 seconds, i.e. to traps causing instantaneous and irreversible unconsciousness in the captured animal. However, there can be practical reasons why detecting a trap with a TIU of 0 seconds is not possible. A reliable, and the most commonly employed, indicator of loss of consciousness is the absence of brainstem reflexes like the corneal and palpebral reflexes. In compound trials of killing traps it is often not physically possible to reach the trapped animal and test for such reflexes until around 30 seconds have passed since the strike, and therefore even 'humane' traps can only be assigned to a welfare category based upon a TIU score greater than zero. Where the skull of the trapped animal is crushed by the strike of the trap it may be legitimate to assume that the onset of unconsciousness had been instantaneous.

In the Improved Standards traps in Welfare Category A, the highest welfare category, must produce a TIU not exceeding 30 seconds for at least 80% of trapped animals. In the survey of public attitudes to trapping within the EU 37% of those respondents who selected a time for the maximum acceptable TIU chose zero seconds, and 33% 30 seconds; only 7% thought that the 300 seconds limit contained in the AIHTS was acceptable (see Table 3.22). Traps in Welfare Category B, the intermediate welfare category, must have a TIU not exceeding 180 seconds for at least 80% of trapped animals (i.e. the TIU limit that the AIHTS aspires to for all species). Traps in Welfare Category C, the lowest welfare category, must meet the current AIHTS standard for most species (i.e. they must have a TIU not exceeding 300 seconds for at least 80% of the minimum of 12 animals tested). If an animal escapes the trap during a trial then the TIU limit of 300 seconds for that trial is judged to have been exceeded.

As well as the TIU limits specified above, it is also necessary to set the confidence level for accepting that the required standards have been meet. The confidence level chosen greatly affects the number of tests that need to be conducted in order to assign a trap to one or other of the welfare categories; the higher the confidence level, the greater the sample size required. Both the draft ISO and the NAWAC standards chose a 90% confidence level as a reasonable compromise between the needs a) to maximise the confidence that the pass requirements have been met, and b) to minimise the number of animals required to test the traps. The Improved Standards similarly incorporate a 90% confidence level.

A trap could, for example, pass the requirements for Welfare Category A despite the fact that up to 20% of animals tested may have TIU scores very much longer than the 30 seconds limit. One way to mitigate this danger is, in addition to the criteria that 80% of trapped animals must meet the TIU limits discussed above, to also have higher TIU limits that must not be exceeded by more than 80% of trapped animals. This is the procedure successfully adopted by the NAWAC Guidelines which state that 70% of animals must not exceed the lower TIU limit and 80% must not exceed the higher TIU limit. A similar procedure is adopted in the Improved Standards where 90% of trapped animals must have TIU scores not exceeding an upper TIU limit of 180 seconds for a Welfare Category A trap, or an upper TIU limit of 300 seconds for Welfare Category B trap. Welfare Category C would have no upper TIU limit and thus remain identical to the current AIHTS; this allows traps that have been tested and approved under the AIHTS to be approved automatically as Welfare Category C traps of the Improved Standards. However, adding the requirement that 90% of trapped animals must have, at 90% confidence, TIU scores not exceeding these upper TIU limits can increase the number of animals needed for trap testing (see below).

The NAWAC Guideline requires persons submitting a trap for testing to select, before the assessment begins, the number of animals to be used in the tests (the possible sample sizes can vary from 10 to 50 animals in steps of 5). In order to reduce the cost of testing, manufacturers tend to select the smaller sample sizes (B. Warburton pers. comm.) despite being warned in the Guideline that “the lower sample sizes have a greater risk of an effective trap being rejected”. In contrast the AIHTS only specifies that a minimum number of 12 test animals must be used and, as discussed above, this means that the AIHTS standard becomes stricter the more animals are tested. In contrast with both the NAWAC and AIHTS standards, the Improved Standards specify a maximum sample size of 30 for trap testing but then use ‘stopping rules’ to minimise the number of animals tested; in this way, as discussed below, a trap could be failed on the basis of a trial involving just six animals. It is also envisaged that mechanical tests and computer models could where appropriate be used instead of animal tests to assess traps (as discussed in Chapter 7).

In order to assign a trap to welfare categories A or B of the Improved Standards at least 80% of animals must have TIU scores not exceeding the lower TIU limit of the particular category and at least 90% not exceeding the upper TIU limit of the category, and there must be 90% confidence that both criteria have been meet. Table 4.4 shows the implications of these requirements on the number of animals required for trap assessment when different numbers of failures (i.e. animals that fail to meet either the lower or upper TIU limits) are allowed. Column 1 shows the sample size (i.e. the number of animals used in the trial) and columns 2 and 3 give the maximum allowable number of failures in a trial of that sample size so that the trial demonstrates with 90% confidence (calculated using a Modified Jeffreys Interval, Brown et al. 2001) that the true rate of failures is less than 20% (i.e. the lower TIU limit) in column 2, and is less than 10% (i.e. the upper TIU limit) in column 3. Thus no failures are allowed with a sample size of 11 animals, but with a sample size of 22 two animals are allowed to fail the lower TIU limit. A sample size of 30 is required before a single failure of the upper TIU limit is allowed, and a sample size of 45 is required if two animals are to be allowed to fail the upper limit. As even under controlled experimental conditions it is possible that unforeseen circumstances unrelated to the trap can result in a failure (see example in 8.1), it was thought reasonable in the Improved Standards to allow one failure to occur, and in order to allow one failure of the upper TIU limit a sample size of at least 30 is required. The Improved Standards therefore specify a sample size of 30 that allows up to three failures of the lower TIU limit and one failure of the upper TIU limit.

Minimum sample size required	Allowable number of animals with TIU greater than lower limit	Allowable number of animals with TIU greater than upper limit
11	0	0
15	1	0
22	2	0
29	3	0
30	3	1
35	4	1
42	5	1
45	5	2
48	6	2

Table 4.4: The effects on the required minimum sample size of allowing different numbers of animals to fail either the lower or upper limits TIU limits given that the Improved Standards require an 80% pass rate at the lower limit and a 90% pass rate at the upper limit, both at 90% confidence.

The specified sample size of 30 is a maximum because Bayesian Sequential Stopping Rules (BSSRs, see 6.4 for detailed discussion) have been developed to ensure that wherever possible fewer animals will be tested. The BSSRs enable a trial to be stopped before the maximum number of animals have been tested when there is either a) strong evidence (i.e. $p<0.05$) that the trial will end with the trap failing, or b) strong evidence (i.e. $p<0.05$) that the trial will end in the trap passing. The rules for failing a trap according to the Improved Standards are as follows. A trap fails as soon as there is a second failure to meet the upper TIU limits. In addition if there are two failures of the lower TIU limit on or before the 6th animal is tested, or three failures of the lower TIU limit on or before the 13th animal is tested, then the trial can also be stopped because there is strong evidence that the trap will fail. Similar rules can be derived for passing a trap on the basis of its meeting the lower TIU limits. If 11 animals have been tested and there have been no failures, or if after the 21st animal has been tested there has been no more than one failure, or if after the 27th animal has been tested there have been no more than two failures, then the trial can be stopped because there is strong evidence that the trap meets the lower TIU limits. However, all 30 animals have to be tested before it is possible to be 90% confidant that a trap meets the upper TIU limits. Thus having an upper TIU limit that has to be met by 90% of animals at 90% confidence greatly increases the number of animals required to pass good traps (i.e. traps that do in reality meet the Improved Standards). On the basis of the lower

TIU limits a good trap could be passed after 11 animals have been tested, however a further 19 animals will have to be tested before it can pass the upper TIU limits. It is debateable whether it is more important in welfare terms a) to have the upper TIU limits in order to mitigate the potential danger that up to 20% of animals could in the field endure suffering for much longer than the lower TIU limits specified, or b) not to have the upper TIU limits in order that fewer animals are used in trap testing. Although it is not clear which is the better option, in light of the fact that many member states of the EU do not require killing traps to be inspected daily, it is suggested that the Improved Standards should incorporate the upper TIU limits.

The proposed Directive to implement the AIHTS has been criticised (e.g. IFAW 2005) because, under Article 6, traps that do not comply with the proposed standards can be used for an unspecified length of time whilst humane traps are being developed. However, as the vast majority of trapping within the EU is conducted for wildlife management and pest control purposes (see Chapter 2) it is vital that such activities (e.g. the control of muskrats) are not suspended until better traps have been developed. Whilst 27% of the respondents to the trapping survey (see Table 3.14) thought that trapping should stop if none of the current traps met new trapping standards, 53% believed that the best available traps should continue to be used. Nevertheless the trap certification process should incorporate mechanisms that encourage the rapid development of traps that can meet the new standard. Hence incorporated in the Improved Standards is the presumption that, where traps of different Welfare Categories are available for a given species, only the traps of the highest available Welfare Category will be approved.

If these proposals were adopted it is envisaged that there may not be any immediate change in trap use within the EU without additional incentives or a legislative/administrative framework. All the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. However, as stated above, there is in the Improved Standards the presumption that where traps of different Welfare Categories are available for a given species then only the traps of the highest available Welfare Category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks. Although there is the presumption that this will occur there may be good grounds why it should not happen. For example, a Welfare Category C trap may pose less risk to non-target species in the areas where it is to be used than does the alternative Welfare Category B trap. Thus although there would be a presumption that withdrawal of the lower category traps will occur, individual Member States could put forward arguments why this should not occur according to their local circumstances. Nevertheless the proposed licensing structure should encourage trap manufacturers to provide traps that meet the standards of Welfare Categories A and B; in many cases this might be achieved by simply re-submitting existing traps for testing to the more stringent welfare criteria. It was confirmed at the Technical Workshop (see Chapter 9) that in principle the Canadian databases used to develop the predictive computer models for trap testing to the AIHTS criteria (see 7.3) could be used to develop computer models for trap testing to the proposed new welfare categories.

4.6 Current traps that meet the Improved Standards for the species of major interest to the EU

No traps have been specifically tested to the criteria of the Improved Standards proposed in this report. However, the criteria of Welfare Category C of the Improved Standards have been deliberately made the same as the criteria within the AIHTS, and therefore the many killing traps that have been approved as meeting the AIHTS by the Fur Institute of Canada are also Welfare Category C traps. In many cases it may be that the TIU data gathered during the testing of a trap to the AIHTS are such that the trap meets the criteria of Welfare Categories A or B. However the data gathered during trap testing for the AIHTS are not publically available. Some trap testing data are available for the Leprich (Inglis et al 2003) and DOC traps (Warburton et al 2008) and in both cases these data indicate the traps are potentially Welfare Category A traps when used against muskrat and ermine respectively. Table 4.5 gives the names of current traps that meet the Improved Standards for the species of major interest to the EU.

	Category A	Category B	Category C
Muskrat	(Lieprich, meets the lower TIU limit but as the trap was being tested to the AIHTS criteria there are no data on the upper TIU limit.	No data available.	Cage-type underwater drowning trap (see chapter 5), Belisle Super X 120 (on land), Bmi 120 (onland), BMI 120 Magnum, BMI 126 Magnum, Bridger 120, LDL B120 Magnum, Rudy 120 Magnum, Sauvageau C120 Magnum, Duke 120, Karo Muskrat, Sauvageau 2001 – 5, Triple M, Sauvageau C120 ‘Reverse Bend’, Woodstream Oneida Victor Conibear 110, Woodstream Oneida Victor Conibear 120, Any jaw type with clamping force underwater
Pine Marten	No data available.	No data available.	S1; Trapper, mard 90. S2 Trapper, mard 180. S3 Kirunafällan, modifierad. S4 Lazzefällan, mård (trampgillen). S5 Lazzefällan, mink (trampgillen), S9 Dörarpsfällan. S10 Trapper, mink 90. S11 Ihjäl, mård. S12 Ihjäl, mink, S14 Trapper, mink 180. S16 Gävleborgsfällan, mård (trampgillen). S17 Gävleborgsfällan, mink (trampgillen). S19 Stockfällan, S20 Le-Ho-fällan. S30 Sidensjöfällan. S31 Lazzefällan, mård, (betesgillen). S33 Hasselafällan M/Larsson. S34 Slagfälla M/KJ. S35 Selåfällan. S37 Gävleborgsfällan, mink M/Sösdala. S42 Gävleborgsfällan M/Sidensjö. S43 Vålsjöfällan. S49 Mangsfällan
Raccoon	No data available.	No data available.	Belisle Super X 160, Belisle Super X 160, Belisle Super X 220, Belisle Classic 220, BMI 160 Body Gripper, BMI 220 Body Gripper, BMI 280 Body Gripper, BMI 280 Magnum Body Gripper, Bridger 160, Bridger 220, Duke 160, Duke 220, LDL C160, LDL C220, LDL C220 Magnum, LDL C280 Magnum, Rudy 160, Rudy 160 plus, Rudy 220, Sauvageau 2001-6, Sauvageau 2001-7, Sauvageau 2001-8, Species-Specific 220 Dislocator Half Magnum, Woodstream Oneida Victor

			Conibear 110, Woodstream Oneida Victor Conibear 120
Raccoon Dog	No data available.	No data available.	No data available.
Badger	No data available.	No data available	No data available. (In practice restraining traps are used for this species)
Ermine	DOC 250 meets lower TIU limit but as this trap was being tested to the NAWAC criteria there are no data on the upper TIU limit.	No data available	

Table 4.5: Current traps that meet the Improved Standards for the species of major interest to the EU.

4.7 Testing of a trap to the Improved Standards for use to kill raccoon dogs.

Raccoon dogs are an invasive species in all of Europe and can be legally caught in killing traps in several Member States. In particular, they are increasing in numbers at an alarming rate in Sweden and Finland. Raccoon dogs are having a devastating effect on endemic populations of environmentally important species, especially ground nesting birds, and methods for controlling them are essential to preserve the habitats in Sweden and Finland. Raccoon dogs are not found within continental America or Australasia and no traps have been tested for this species. The testing of killing traps for this species was therefore identified as an objective of the project. A meeting was held in Helsinki, Finland, to discuss trials of killing traps for raccoon dogs. Attendees at the meeting were the consortium members Mr Tommy Svenson and Dr Janet Talling, Dr Christian Krogell (the Deputy Director-General for the Ministry of Agriculture and Forestry, Finland), Mr Kai Pelkonen (Senior Veterinary Officer, Ministry of Agriculture and Forestry, Finland) and Mr Ilkka Ala-Ajos (Field Manager, Hunters' Central Organization, Finland). At this meeting it was reported that over 90,000 raccoon dogs are captured each year, and that around 99% of these are caught in cage traps. Hunters do not like to use killing traps because several of their small hunting dogs have been killed in such traps. Emails were then sent to representatives from Poland, Estonia, Latvia, Germany, and Lithuania (i.e. the only other Member States where it is believed that significant numbers of raccoon dogs are controlled) to see to what extent killing traps are used for raccoon dogs in these countries. The replies from all these countries confirmed that cage traps rather than killing traps are used, but also that raccoon dogs are mostly hunted with dogs and then shot. As the evidence from Member States confirmed that killing traps are rarely used to control raccoon dogs, it was decided that there was no urgent need to test killing traps for this species to the Improved Standards.

4.8 Financial implications of implementing the Improved Standards

The financial implications of implementing the Improved Standards are also affected by the testing methodology used (see Chapter 7), the adoption of best management guides (Chapter 8) and the legislation used. The financial implications will therefore be outlined in Chapter 10.

4.9 Improving trap design to enhance the welfare of animals caught in killing traps.

Chapter 8 discusses how the welfare of animals in traps can be greatly improved by ensuring Best Practice in how a trap is used and set; here how changes in the design of the trap itself can help are briefly considered. In general, increasing the impact and clamping forces of a spring trap is likely to decrease the TIU in the trapped animal, but the increase in power may also result in increased risk for the user. Improving strike precision by avoiding hits on the back and targeting the neck and skull can reduce the impact force required to produce a short TIU (e.g. Nutman et al. 1998, Warburton et al. 2002). Alternatively the single strike bar can be replaced by a mesh of strike bars thereby greatly increasing the chances of a neck strike, as in the traps developed by the New Zealand Department of Conservation. Offsetting the jaws of rotating-jaw traps may also enhance performance without increasing power (e.g. Zelin et al. 1983). For many species a trap designed to stop the blood supply to the brain will result in a shorter TIU than will a trap designed to suffocate an animal by clamping its torso (e.g. Proulx & Barrett 1991, Philips 1996); the Nooski trap is a novel design that creates a short TIU in small rodents through the use of a constricting rubber ring around the neck.

A promising future development for the improvement of trap design is the development by the Fur Institute of Canada of a Trap Optimisation Program. Species-specific computer models have been developed that, using various physical parameters of traps, can accurately predict whether a particular type of trap will meet the AIHTS standards (Hiltz & Roy 2000; see 7.3). A type of sensitivity analysis of the model parameters enables the most important features of the traps with respect to the TIU of the trapped animal to be identified. It is then possible to examine possible ways to enhance these parameters.

4.10 Conclusions

The use of the word humane in the context of trap testing is not helpful because of the diverse ways in which it has been interpreted. Rather it is more productive to focus solely on the welfare of an animal caught in the killing trap. As an unconscious animal can not feel pain or distress the time to irreversible unconsciousness (TIU) is the major indicator of the welfare of an animal in a killing trap; particularly since there are currently no reliable ways to assess the degree of suffering such an animal experiences prior to death. The Improved Standards for killing traps are, therefore, based upon differences in TIU scores.

Of the three trap standards considered (i.e. a draft ISO standard, the AIHTS, and the NAWAC Guideline) the AIHTS is the least satisfactory. The TIU limit of 300 seconds specified by the AIHTS for most species is longer than the limits required by the other two standards. The AIHTS specifies only the minimum number of animals to be used in the trap assessment and therefore, unlike the other two standards where there is a 90% confidence the trap has passed the criteria, it becomes stricter the more animals are tested. The AIHTS does not, like the draft ISO standard, incorporate stopping rules that minimise the number of animals used in trap testing by stopping the trial as soon as the probability of a successful outcome becomes too low. Also the AIHTS does not, like the NAWAC Guideline, have upper TIU limits that help prevent the situation whereby a trap could meet the AIHTS standards despite up to 20% of the animals tested having TIU scores well above 300 seconds. The proposed Improved Standards aim to rectify these drawbacks.

The Improved Standards classify killing traps into one of three Welfare Categories. Traps in Welfare Category A, the highest Welfare Category, must (at 90% confidence) produce a TIU not exceeding 30 seconds for at least 80% of trapped animals. Traps in Welfare Category B, the intermediate Welfare Category, must (at 90% confidence) produce a TIU not exceeding 180 seconds for at least 80% trapped animals. Traps in Welfare Category C, the lowest Welfare Category, must meet the current AIHTS standard for most species (i.e. they produce a TIU not exceeding 300 seconds for at least 80% of a minimum of 12 animals tested). In addition to the criteria that 80% of trapped animals must have a TIU below the specified limit for the particular Welfare Category, it is proposed that for Welfare Categories A and B there should also be a higher TIU limit that must not (at 90% confidence) be exceeded by at least 90% of trapped animals. The upper TIU limit for Welfare Category A is 180 seconds, and the upper limit for Welfare Category B is 300 seconds. Welfare Category C has no upper TIU limit so that traps that have already been tested and approved under the AIHTS would automatically be approved as Welfare Category C of the improved standards.

All the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards, and it is envisaged that if these proposals were adopted there may not be any immediate change in trap use within the EU without additional incentives or a legislative/administrative framework. However, in order to encourage the rapid development of better traps there is in the Improved Standard the presumption that where traps of different Welfare Categories are available for a given species only the traps of the highest available Welfare Category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks.

It is concluded that drowning traps should be subjected to the same TIU limits as other killing traps. However, a major problem (particularly as regards semi-aquatic mammals like muskrats) lies in deciding at what point the clock should start when recording the TIU of an animal in a drowning trap. Distress is unlikely to occur immediately after entry into the drowning trap because mammals, and particularly semi-aquatic mammals, can routinely spend some time underwater without experiencing distress or pain. For an animal in a drowning trap distress, and possibly pain, is more likely to start when the animal first attempts to, and thereby finds that it is unable to, come to the surface to breathe. Theoretically the clock should start then, and experiments designed to determine objectively this point for muskrats are described in Chapter 5.

5 The time of onset and duration of distress prior to death in muskrats caught in cage-type drowning traps.

This chapter describes research that was carried out to try and determine the onset and length of distress in muskrats caught in cage-type drowning traps. The initial study, looking at the behaviour and physiology of captured muskrats, found little evidence of distress prior to unconsciousness apart from the onset of a behaviour that involved biting the mesh of the underwater cage. A second study found that being held in the underwater cage for 120 seconds after the onset of this biting behaviour did not result in subsequent avoidance of the drowning trap; indicating that this experience was not sufficiently stressful to result in aversion learning. If the time to irreversible unconsciousness (TIU) for muskrats killed in drowning traps is conservatively measured from the point of the onset of biting plus 120 seconds then it is less than 300 seconds; thereby meeting the TIU limit within both the AIHTS and Welfare Category C of the Improved Standards. However, there is still a need to develop alternative multi-capture muskrat traps that can meet the requirements of the higher Welfare Categories of the Improved Standards.

Summary

The aims of this chapter are

a) to investigate whether the onset of distress in muskrats caught in a drowning trap can be objectively identified using behavioural and physiological responses.

b) to determine if being held in a drowning trap causes avoidance learning in muskrats.

c) **to determine, using the information from the experimental studies, whether drowning traps meet the TIU limits contained within the AIHTS and the Welfare Categories of the Improved Standards for killing traps.**

a) Behaviour and physiological parameters to identify onset of distress in muskrats caught in drowning traps. Trials were carried out with wild-caught muskrats held in semi-natural experimental pens containing ponds. The animals voluntarily entered drowning traps placed on the ponds. Behaviour was recorded using underwater cameras, EEG and ECG were recorded via surgically-implanted biotelemetry transmitters, and serum corticosterone levels were measured after death. As some habituation to the experimental setup may have occurred whilst baseline levels of these parameters were being taken for the implanted animals, additional trials were conducted with naïve animals that had not been previously exposed to the test procedure.

The mean time to unconsciousness after the muskrats had entered the underwater cage of the drowning trap was 448 seconds for the implanted animals and 361 seconds for naïve animals. After means of 61 and 76 seconds (for implanted and naïve animals respectively) the muskrats started biting the wire mesh of the cage. Heart rate decreased from a mean of 258 bpm at 60 seconds before entering the underwater cage of the drowning trap to 56 bpm for the period between entering the water and unconsciousness. Serum corticosterone concentration in post mortem blood samples taken from the heart of the drowned muskrats was found to be eight times higher than the basal serum corticosterone concentration. During the period from the onset of biting the mesh of the underwater cage to unconsciousness, the rate of swimming did not increase but the rate of biting increased markedly after 150 seconds.

b) Aversion to the drowning trap. A learning paradigm was used to determine whether any aversion to the drowning trap resulted from the muskrats being held in the underwater cage for varying periods before being released. Once each muskrat had voluntarily entered its homebox the homebox was placed into the top of the drowning trap. The only exit from the top of the drowning trap was the hole into the underwater cage. The latencies to enter the water on subsequent trials were used as an indication of the degree of aversion caused by previous periods of restraint in the underwater cage. No aversion to re-entering the trap was found in muskrats that had been kept underwater until the onset of biting behaviour, nor in animals that had been kept underwater for 120 seconds after the onset of the biting behaviour. These results suggest that 120 seconds after the onset of biting may be taken as a conservative indicator of the onset of distress.

c) Do the drowning traps meet the standards of the AIHTS and Welfare Category C of the Improved Standards? If the results found in the two studies are accepted then the period between onset of distress and irreversible unconsciousness for muskrats in the drowning trap is within the 300 seconds limit specified in the AIHTS and Welfare Category C of the Improved Standards. Nevertheless it is important to develop new muskrat traps that can meet the criteria of Welfare Categories A and B of the Improved Standards.

5.1 Introduction

Muskrats are the most commonly trapped European species of those included in the AIHTS. The choice of trap used to control them is very dependent on the environment, time of the year, size and age of the animals (e.g. subadults can pass through Conibear killing traps without being trapped). However, the vast majority of muskrat control in the EU is dependent on multi-capture, cage-type drowning traps (e.g. 80% of muskrats caught in Germany) and the absence of these traps would have severe implications for the effectiveness of muskrat trapping, particularly in coastal areas of the EU. Members of the Dutch, Belgian (Flanders) and German (Lower Saxony) muskrat control organisations argue that an abandonment of drowning traps would reduce trapping efficiency of muskrats to one fourth. Once a low density of muskrats has been achieved it is thought that the population could then be kept at this level using alternative forms of trapping; however decreasing the population to such a level is believed to be impossible without utilising drowning traps. It is also thought that an increased use of killing traps on land would increase the number of non-target captures. In areas where it is inappropriate to trap on land (e. g. in nature reserves due to non-target hazards) there is currently no economically viable alternative to drowning traps.

Due to the importance of the drowning trap for muskrat control within the EU it is important to investigate the welfare of muskrats captured in such traps. Muskrats can have dive times as long as 12-17 minutes (Mohr 1954, Errington 1963), and therefore drowning traps are unlikely to meet the AIHTS TIU threshold of 300 seconds if this interval is measured from the time the animal first enters the underwater cage of the drowning trap. However, as muskrats are semi-aquatic mammals and have a physiology adapted to this way of life, distress is unlikely to begin as soon as the animal enters the underwater cage (see 4.4). The TIU should, therefore, not be measured from when the animal first enters the underwater cage but rather from when the animal begins to experience distress, perhaps after finding it cannot surface to breathe. The onset of distress may also depend upon how the animal reacts to restraint under water. Gersdorf (1971) observed two different coping-strategies in muskrats drowned in laboratory trials; some animals struggled and died within 5 minutes, whilst others remained still and stayed alive for far longer. It is possible that muskrats show the so-called "shallow-water-black-out" (Modell et al.1999) that is thought to result in the animal losing consciousness and drowning very calmly with relatively little suffering.

The experiments described in this chapter were carried out to try to determine the point of onset of distress in muskrats caught in a drowning trap, and to see whether such traps meet the criteria of the AIHTS or Welfare Category C of the Improved Standards.

5.2 ***Experiment 1 – Physiological and behavioural responses to capture in a drowning trap.***

The aim of this experiment was to use the behavioural and physiological changes shown by muskrats in a drowning trap to determine objectively the onset of distress in order that an assessment of the drowning trap could be made using the TIU thresholds specified within the Improved Standards for killing traps (see 4.5).

5.2.1 Methods

Animals. The muskrats used in the study were caught by professional muskrat trappers in Lower Saxony using floating or land-based cage/box traps. They were then transferred to the Julius Kühn-Institut in Münster, and prior to testing were housed individually in outdoor ´housing pens´ (approx. 1m x 2m). Each pen contained a straw-filled, wooden ´house´ (the home box) and a small water tank that allowed the muskrat to bathe. The animals were provided with grass, carrots and apples to eat. A total of 15 male muskrats were used; weight range 860 to 990 g. Seven muskrats were implanted with biotelemetry transmitters. As the gathering of baseline readings from these animals meant that they had to be exposed to the unactivated drowning trap prior to the drowning trial (i.e. they were therefore to some extent habituated to the trap prior to the drowning trial) the procedure was repeated with a further eight animals that were not implanted with transmitters and that did not have to be exposed to the trap prior to the drowning trial.

Test pens. The test pens were constructed around a large pond (Figure 5.1) and were separated from each other by a 1 m high wire mesh fence (mesh size: 4cm x 4cm). The animals dug burrows for themselves in the banks and the pens allowed them to show most of their normal behaviour.

Figure 5.1: One of three test pens constructed around the pond and separated by wire mesh fences (1 m height, mesh size 4 x 4 cm).

Drowning trap. The drowning trap had two parts, a floating cage with an entrance above water, and an underwater cage (Figure 5.2). The floating cage was baited with carrots or apples and the muskrat was able to enter it via two doors. After entering the floating cage the only way out was to descend into the underwater cage. The underwater cage had three doors that could be opened and closed remotely. Two receivers for the EEG and ECG signals from the implanted transmitters were housed in waterproof boxes on the floating platform. The muskrat's behaviour was recorded using four cameras (waterproof 1/3" CCD-camera, s/w, 600 TVL, Sony); one placed at each corner of the underwater cage. Synchronous recording of all four cameras was achieved by using the software "Multicam Surveillance System 8.11".

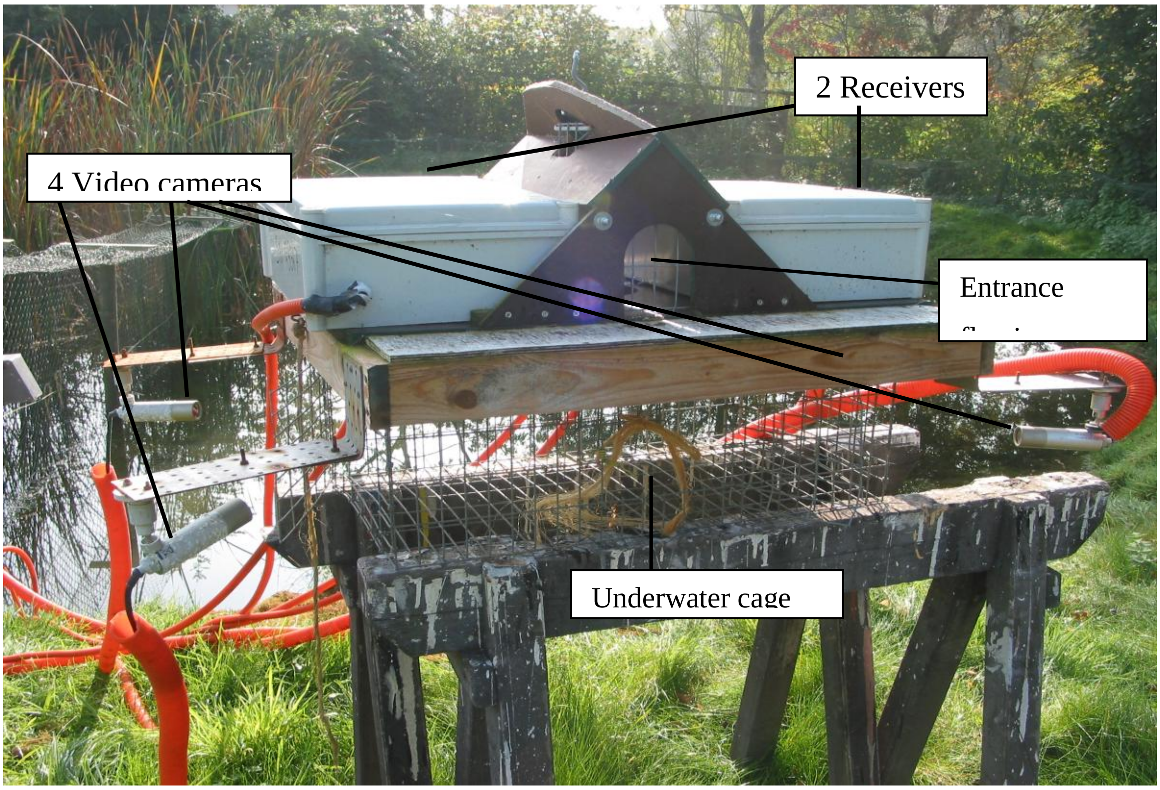

Figure 5.2: Experimental drowning trap

EEG and ECG. Seven muskrats were implanted with Data Science International (DSI) transmitters (Dataquest™ models TL10M3-F50-EET, TL10M2-F50-EE, TL11M2-F40-EET) that were configured to record EEG and ECG. The signals received were processed and analysed using DSI software (Dataquest™ A.R.T. TM 3.0, DSI™ and DSI™ Ponemah ECG Analysis Software). After implantation the muskrats were returned to their housing pens for 2-3 days for recovery. When the implantation scars had closed the animals were then transferred to the test pens.

Blood samples. Blood samples were taken while the muskrats were acclimatizing to the test pens and when the dead muskrats were retrieved from the water after the drowning trials. While the muskrats were in the test pens they were caught in restraining traps and then immediately constrained in wire mesh cones in order to take a blood sample. Pilot studies were undertaken to ensure that blood samples could be taken quickly enough to prevent any corticosteroid response due to the collection procedure contaminating the samples. To collect the blood the end of the tail was carefully pulled through the wire mesh, a cream (Finalgon extra-stark, Dr. Karl Thomas GmbH, D – Biberach) that increased blood circulation was rubbed onto the tail skin, and then blood was quickly collected from the tail vein using coagulation-inhibiting micro-pipettes (Waldeck GmbH & co KG, D-Muenster) and transferred into Eppendorf-tubes. The samples were centrifuged at room temperature; first for 30 minutes at 3.000 rpm and then the supernatant was transferred to a fresh tube and centrifuged for 5 minutes at 13.000 rpm. This last step was repeated until no red or whitish pellet was visible. The serum was then frozen at -20°C until analysis. The corticosterone concentration was determined using a corticosterone Enzymeimmunoassay (Enzymeimmunoassay for the quantitative determination of corticosterone in mouse and rat serum or plasma, Immunodiagnosticsystems (IDS)).

Procedure. After the muskrats had recovered from the surgery, they were placed in the test pens for a minimum of two weeks before any trials were undertaken. The baited drowning trap was placed in the pond within the muskrat's pen on the day of the trial. Muskrats are curious animals and they tended to enter the trap relatively quickly. For the muskrats that had been implanted with the transmitters, EEG and ECG reference values were collected in the inactivated drowning trap (i.e. the doors of the underwater cage were open). Although the muskrats could swim out of the inactivated drowning trap they had to find an open door and this kept them underwater for sufficient time to obtain baseline data. As a result, at the time of the actual drowning trial these animals had had prior experience of the trap, which obviously would not happen in the wild. To ensure that any results obtained were relevant to muskrats captured in the wild, the experiment was repeated with a second group of animals that had had no prior experience of the trap.

All the trials were remotely observed by the experimenters; with only one animal being tested at any one time. Thirty minutes after the muskrat was observed to be motionless it was taken out of the water and death was confirmed. Water temperature was then measured and a blood sample was taken. *Post mortems* were carried out on all animals by a forensic pathologist.

Behavioural analysis. The video recordings were used to analyse the behaviour shown from the time when the muskrat first put its head into the water until it had been motionless for 30 minutes. The behavioural repertoire of the muskrat in the underwater cage was severely limited; only four behaviours were observed, *Swimming, Biting, Motionless* and *Tremor* (see below). Duration and frequency were recorded for the behaviours *Biting* and *Motionless.* The rate of *Swimming*, and the events *Descent* and *Tremor* were also recorded. The various behaviours were defined as follows:

Biting: The animal quickly moves its head and its mouth encloses the wire mesh of the cage. This behavioural pattern ends when *Biting* stops for more than one second or another behavioural pattern is shown.

Motionless: The animal stops moving the head, body or limbs for longer than one second. As soon as any movements occur *Motionless* ends.

Rate of Swimming: The underwater cage was divided into four equal sized areas using a guide pattern superimposed on the monitor during analysis. Every time the animals' body crossed a line separating two areas *Swimming* was recorded.

Descent: The first time the animal puts its head in the water and descends into the underwater cage.

Tremor: The time at which the animal's body becomes uncoordinated and shakes irregularly.

5.2.1 Results

Data were obtained from trials with all 15 muskrats. Where differences were found between 'naïve' animals (i.e. those with no prior experience of the drowning trap) and 'experienced' animals (i.e. those that had experienced the drowning trap when baseline physiological data were obtained) these have been highlighted.

Identification of the onset of irreversible unconsciousness. A power analysis of the EEG traces indicated that they had been contaminated (possibly as a result of muscle movements and the inappropriate placement of the electrodes) and could not be used to identify the onset of the Delta waves that are indicators of unconsciousness. However, the EEG traces could still be used to indicate the onset of iso-electric brain death (i.e. a flat EEG trace). During each drowning trial there was a point prior to the onset of a flat trace when all of the animals showed a distinctive behaviour; namely *Tremor*, the uncoordinated movements of the whole body. These movements were observed from 10 seconds before iso-electric brain death to up to 66 seconds before iso-electric brain death. In other species it is thought that the animal is unconscious when showing this behavioural response and examination of the EEG traces led an expert forensic pathologist (T. Fracasso pers. comm.) to conclude that the muskrats were unconscious when *Tremor* occurred (see Figure 5.3 and Table 5.1) (Tedeschi et al, 1977, Keil, 2003, Ponsold, 1967). It was therefore decided to use this behaviour as an indicator of the onset of unconsciousness.

Figure 5.3 shows an example EEG trace (from muskrat 7). Mark c indicates the onset of *Tremor* and d the onset of an isoelectric EEG trace (i.e. brain death). In this case an isoelectric trace began 15 seconds after *Tremor* was first observed.

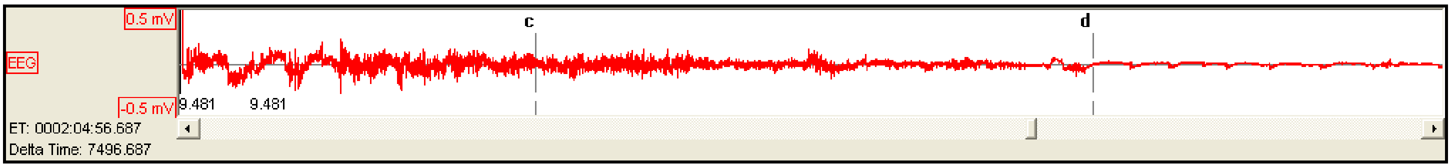

Figure 5.3: EEG of Muskrat 7: c=Tremor, d=onset of an isoelectric EEG trace

	Time delay [s]
Muskrat 1	46
Muskrat 2	16
Muskrat 3	38
Muskrat 4	66
Muskrat 5	10
Muskrat 6	42
Muskrat 7	15
Mean	33
Se	7.7

Table 5.1: Time delay between the onset of *Tremor* and the onset of iso-electric EEG trace.

Time from descent into the underwater cage to irreversible unconsciousness. The time from when the muskrats first entered the water until *Tremor* was observed ranged from a minimum of 271 seconds up to a maximum of 566 seconds (Table 5.2).

Experienced muskrats took significantly longer between *Descent* and *Tremor* than naïve animals (t-test, t= 2.14 p= 0.02)

Trial number	Experienced muskrats (s)	Naïve muskrats (s)
1	271	357
2	423	494
3	477	316
4	566	362
5	446	288
6	514	332
7	442	336
8		408
Mean	448.4286	361.625
se	34.88543	22.65103

Table 5.2: Time in seconds between *Descent* and *Tremor* for naïve and experienced muskrats.

Time from *Descent* to *Biting*. After some time in the underwater cage all the muskrats displayed biting behaviour (N.B. this behaviour has been described as struggling in previous studies). The earliest that this occurred was 34 seconds after descent and the latest it was observed was 117 seconds after descent. There was no significant difference in the time that biting commenced between experienced and naïve muskrats (Table 5.3, t-test, t= 1.07, p=0.15)

Trial number	Experienced muskrats (s)	Naïve muskrats (s)
1	34	95
2	93	84
3	62	63
4	71	112
5	50	117
6	79	39
7	38	29

8		72
Mean	61	76
se	8	11

Table 5.3: Time in seconds between *Descent* and the onset of *Biting* for naïve and experienced muskrats

Heart rate. For all muskrats bradycardia was observed when they entered the water. The heart rate dropped from an average of 258 bpm during the 60 seconds prior to entering the water to 56 bpm measured in the water before the onset of *Biting*. There was no significant difference in these heart rate responses between the values obtained during the reference dives and the values during the drowning dives. There was no significant difference between the heart rate before and after *Biting* (paired t-test (*Descent-Biting* vs. *Biting-Tremor*), p=0.85). Figure 5.4 gives an example ECG trace (from muskrat 1) where each amplitude is a heart beat. 60 seconds before the animal dived into the underwater cage the heart beat was 242 bpm and it then reduced to 71 bpm (*Descent-Biting*) and 59 bpm (*Biting-Tremor*) respectively. Table 5.4 shows the reduction in heartrate for the implanted animals after entering the underwater cage.

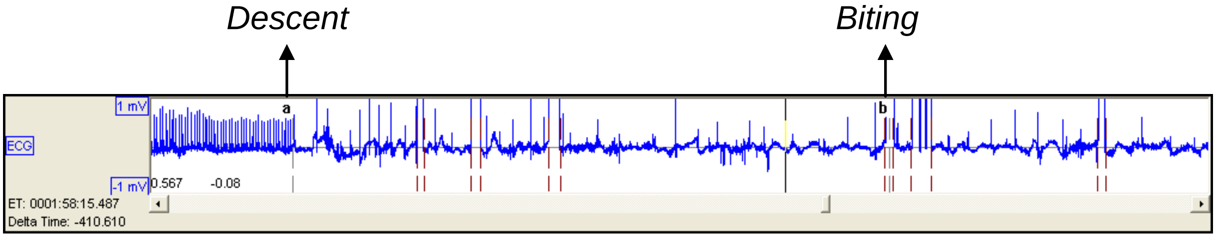

Figure 5.4: Example of an ECG trace (from muskrat 1) illustrating the points of *Descent* and the onset of *Biting*

	Heart rate (bpm)				
	Reference dives		Drowning dives		
	60 s before *Descent*	*Under water swimming*	60 s before *Descent*	*Descent-Biting*	*Biting-Tremor*
Muskrat 1	240	74	242	71	59
Muskrat 2	298	72	211	46	50
Muskrat 3	266	56	261	42	52
Muskrat 4	219	47	251	40	54
Muskrat 5	265	57	246	65	55
Muskrat 6	330	58	293	68	52
Muskrat 7	310	56	305	61	65
Mean	**275**	**60**	**258**	**56**	**55**
se	**14**	**3**	**12**	**5**	**2**

Table 5.4: Heart rate (bpm) recorded at 60 seconds before *Descent*, and the mean heartrate for the periods *Descent* to *Biting*, and *Biting* to *Tremor*.

Time from biting to irreversible unconsciousness. *Biting* may indicate the onset of distress and therefore the time taken from the onset of *Biting* to irreversible unconsciousness (as indicated by *Tremor*) was calculated to allow comparisons to be made with the TIU threshold of the AIHTS and of a Welfare Category C killing trap of the Improved Standards for killing traps (see 4.5). The time from when the muskrats first showed *Biting* until the first *Tremor* ranged from a minimum of 171 seconds up to a maximum of 495 seconds. Table 5.5 shows that this duration was over 100 seconds shorter in naïve animals compared to experienced animals (t-test, p=0.02).

Trial number	Experienced muskrats (s)	Naïve muskrats (s)
1	237	262
2	330	410
3	415	253
4	495	250
5	396	171
6	435	293
7	404	307
8		336
mean	387	285
se	31	24

Table 5.5: Time from *Biting* to *Tremor* for all muskrats

Corticosterone analysis. For both naïve and experienced muskrats the basal serum corticosterone concentration taken from the tail of an animal in a cage trap did not significantly differ from the values taken from the tail of a drowned animal in the drowning trap (paired t-test: experienced p=0.99; naive p=0.52). However, these samples were contaminated with lymph, and therefore in the second experiment blood was taken from the hearts of the drowned animals.

Analysis of activity. To investigate whether muskrats showed an active or passive response to containment in the drowning trap, the percentage time spent *Motionless* and the *Swimming* activity scores of the muskrats were examined in relation to the TIU scores (see Table 5.6). There were no significant correlations between the time spent *Motionless* or the activity scores and the TIU scores.

	Motionless (s)	*Motionless (%)*	*Activity* [fields]	*TIU (s)*
Muskrat 1	41	17.3	50	237
Muskrat 2	0	0.0	135	330
Muskrat 3	32	7.7	67	415
Muskrat 4	34	6.9	185	495
Muskrat 5	0	0.0	133	396
Muskrat 6	57	13.1	122	435
Muskrat 7	6	1.5	97	404
Muskrat 8	26	9.9	107	262
Muskrat 9	2	0.5	174	410
Muskrat 10	25	9.9	110	253
Muskrat 11	0	0.0	144	250
Muskrat 12	0	0.0	99	171
Muskrat 13	7	2.4	71	293
Muskrat 15	11	3.3	125	336

Table 5.6: The time spent *Motionless* and the rate of *Swimming* activity in relation to the TIU score for each muskrat.

The rate of *Swimming* prior to *Biting* was determined and compared for each 30 second interval after *Biting* had commenced up until the onset of *Tremor*. The results (see Figure 5.5) suggest that *Swimming* activity does not increase after *Biting* has started, although of course to some extent *Swimming* and *Biting* are mutually exclusive.

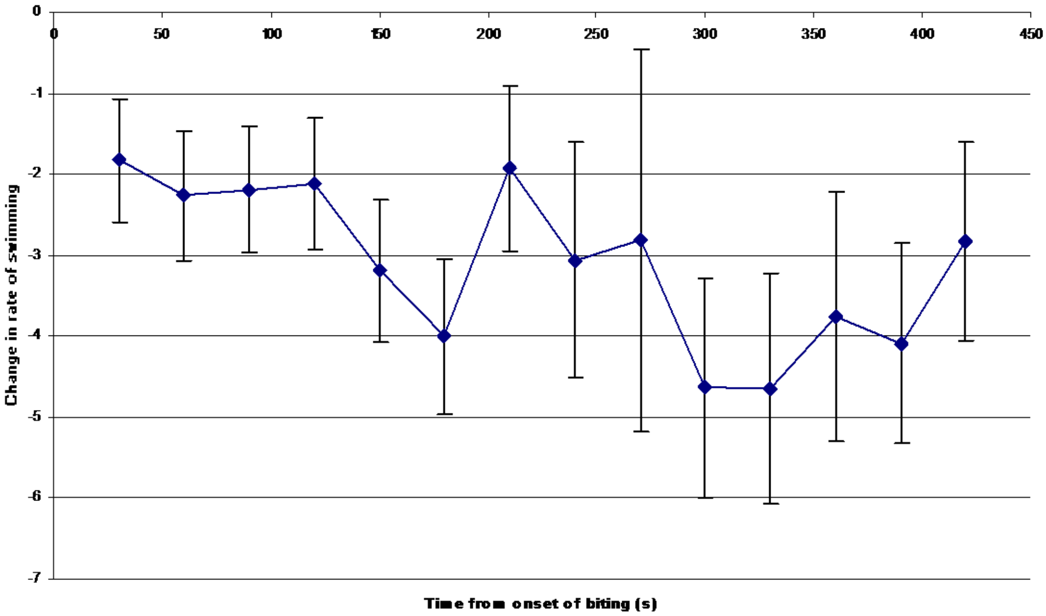

Figure 5.5: *Swimming* activity measured every 30 s after *Biting* had started compared to *Swimming* activity before the start of *Biting*.

Biting behaviour. During the trials used to obtain baseline physiological data swimming was the only behaviour shown by the muskrats in the inactivated underwater cage. However, during the drowning trials all animals started biting the mesh of the cage. Once this behaviour had commenced it was observed until *Tremor* occurred. The amount of *Biting* varied greatly between muskrats. One muskrat only displayed 5 bouts of *Biting* over a 210 seconds period, whereas another muskrat performed 155 bouts over 390 seconds. The mean amount of *Biting* appeared to be relatively constant from the onset until approximately 150 seconds later at which point it increased (Figure 5.6). This higher level of *Biting* continued for many seconds. When the proportion of time from onset of *Biting* to *Tremor* was analysed, it was found that the muskrats spent a mean of 22% (SE=4%) of their time *Biting*.

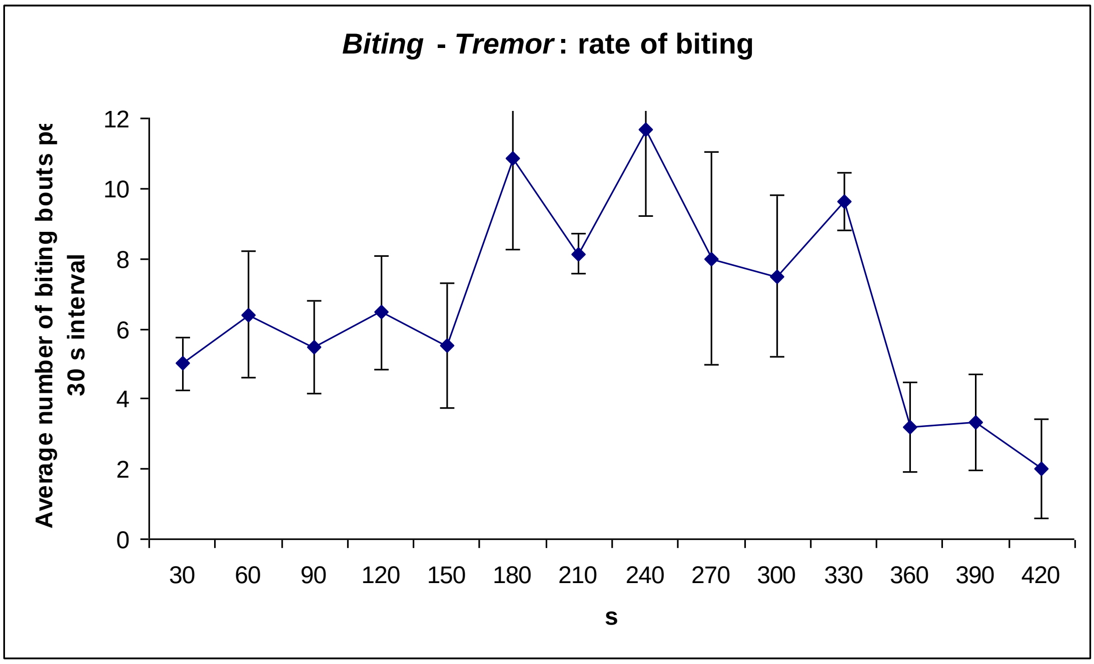

Figure 5.6: Mean (+/- SE) of bites observed in each 30 seconds period until *Tremor* for each muskrat.

Influencing factors. No significant correlations were found between either the body weight of the animal or the water temperature and the times between *Descent* and *Tremor* and *Biting* and *Tremor* (see Table 5.7).

	Descent to *Tremor*		*Biting* to *Tremor*	
	Experienced	Naïve	Experienced	Naïve
Body weight	-0.76	-0.43	0.68	-0.39
Water temperature	-0.55	-0.33	-0.65	-0.07

Table 5.7: Pearson Product Moment Correlation Coefficients for the relationships between body weight and water temperature ,and the TIU.

Post mortem. Table 5.8 gives the results of the *post mortem* examinations. There was a large degree of variation between animals in the conditions found at the anatomical sites examined.

Table 5.8 Findings of the post mortem examinations and of the behavioural analyses.

	Brain structure	Lung emphysema	Lung congestion	Lung edema	Foam	*Descent-Tremor* [s]	*Biting-Tremor* [s]	*Motionless* [s]	*Activity* [fields]
Muskrat 1	light edema	severe acute	severe	severe	abundant	271	237	41	50
Muskrat 2	Normal	light acute	severe	moderate, foamy	abundant	423	330	0	135
Muskrat 3	light edema	severe acute	moderate	moderate	abundant	477	415	32	67
Muskrat 4	light edema	severe acute	light	severe	no	566	495	34	185
Muskrat 5	light edema	light acute	moderate	severe	no	446	396	0	133
Muskrat 6	Normal	Moderate acute	severe	severe	few	514	435	57	122
Muskrat 7	light edema	light acute	light	moderate, foamy	no	442	404	6	97
Muskrat 8	light edema	light acute	light	moderate, foamy	no	357	262	26	107
Muskrat 9	Normal	light acute	light	moderate	no	494	410	2	174
Muskrat 10	moderate edema	light acute	light	light foamy	few	316	253	25	110
Muskrat 11	-	-	-	-	-	362	250	0	144
Muskrat 12	Normal	Moderate acute	no	light	no	288	171	0	99
Muskrat 13	Normal	Moderate acute	no	modest	no	332	293	7	71
Muskrat 14	Normal	severe acute	no	no	no	336	307	(bad view)	156
Muskrat 15	Normal	Moderate acute	no	modest	no	408	336	11	125

Fields highlighted in grey are from the naive muskrats.

5.3 ***<u>Experiment 2- The degree of aversion learning generated by capture in a drowning trap.</u>***

The level of aversion shown by an animal to a particular set of circumstances can be used as an indication of the amount of distress the animal had previously experienced in the same situation. The level of aversion can be measured using behavioural techniques; for example, experimental designs measuring the latency to complete a runway task and the latency to exit a start box have both been used to assess aversion to various farm animal management procedures (Abeysinge et al. 2000, Grigor et al. 1996). In addition, similar designs have been utilised to assess the aversiveness of carbon dioxide stunning in pigs and rats (Raj and Gregory 1996, Niel & Weary, 2008). In this experiment an aversion-learning paradigm was used to try to determine when distress first occurs for a muskrat caught in a drowning trap; again with the aim of deciding when the clock should start for the purposes of measuring the TIU.

5.3.1 Methods

Animals. A total of eight muskrats were used for this study. The muskrats were obtained from the same source as previously and housed in the same outdoor test pens.

Drowning trap design. An experimental drowning trap was constructed that combined a home box (i.e. a wooden box in which the muskrat sheltered) and a drowning trap. The home box was placed on land, but after a muskrat had entered it the box could be carried to and fixed onto the drowning trap. The drowning trap consisted of an above water enclosed area (the top platform) and an underwater cage. After the home box containing the muskrat had been attached to the top platform the only way the muskrat could leave the platform was by diving into the underwater cage. The exit from the home box and the walls of the underwater cage could be opened remotely (see Figure 5.7). Six cameras (waterproof 1/3” CCD-camera, s/w, 600 TVL, Sony) were used to record and observe the behaviour of the muskrats in the home box, the top platform and the underwater cage.

Procedure. Each muskrat was fed daily in the home box on land for two weeks, by which time the animal regularly entered the box. Due to growth of vegetation in their pens two muskrats (nos 6 & 8) did not consistently enter their home boxes. On the day of the trial, the home box containing the muskrat was placed next to the top platform of the drowning trap with the exit door adjacent to this platform. Once the disturbed water of the pond had cleared, the exit from the home box was opened remotely (Figure 5.8). A small piece of carrot was placed on the top platform to encourage the muskrat to exit the home box. If a muskrat had stayed on the top platform for longer than two hours without diving into the water the test would have been stopped, but this never happened.

An aversion trial consisted of three tests carried out over three consecutive days. For the first test the muskrat was contained in the underwater cage until *Biting* was observed, at which point the doors of the underwater cage were immediately opened. For the second test the muskrat was contained in the underwater cage until 120 seconds had elapsed after *Biting* was first observed. For the third test the muskrats were not released from the underwater cage (see Table 5.9). For muskrats 6 and 8, due to them not consistently entering the home box, there was a 3 and 1 day break between tests 2 and 3, respectively. Blood samples for analysis of corticosteroid were taken from the heart after death, rather than from the tail vein as in the earlier experiment.

1st test	2nd test	3rd test
Home box → Top platform → Underwater cage → exit opens at *Biting*	Home box → Top platform → Underwater cage → exit opens 120 seconds after *Biting*	Home box → Top platform → Underwater cage
Latencies represent naïve, base line values	Latencies represent aversion to being held in cage until *Biting*	Latencies represent aversion to being held in cage until *Biting* plus 120 seconds

Table 5.9: Summary of procedure

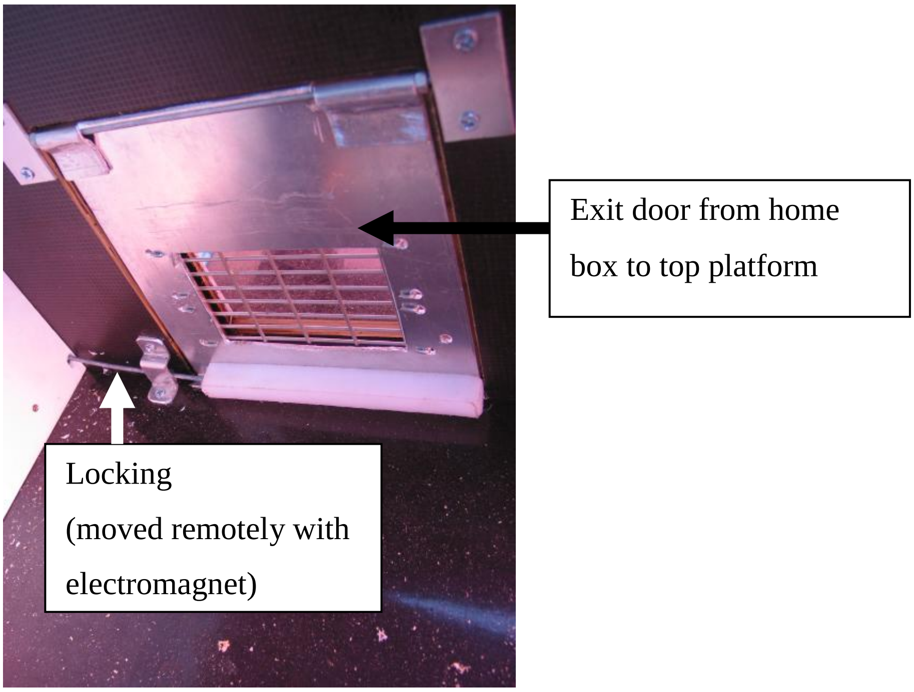

Figure 5.7: Detail view of exit door between home box and top platform

Behavioural parameters. The behaviour of the muskrats in the underwater cage was analysed using the behavioural categories described previously. In addition, a detailed analysis of the muskrats' behaviour in the home box and on the top platform was carried out. The recorded behavioural patterns were later assigned to functional categories for further analysis. All the described behavioural patterns ended when the behaviour stopped for more than one second or another pattern was observed.

Food intake: The animal shows chewing movements with its jaws and swallows the carrots and / or the animal holds the carrots in its front paws.

Grooming: Front or back paws contact body or head with fast movements. The head moves towards the body, the mouth touches the body.

Exploratory behaviour:
Rear: The animal stands on its hind legs. The snout is oriented upwards.
Sniff: Nose is in contact with the wall, the ground or is moved into the air.
Sniff entry: Nose is in contact with the entry door of the homebox,

Sniff exit: Nose is in contact with the exit door between the homebox and the top platform. The muskrat can either be in the home box or on the top platform.

Sniff descent gate: Nose is moved towards the descent gate of the top platform and the head may dunk into the water surface for a few seconds and is then withdrawn. Front paws stay on the top platform.

Locomotion:

Movement: The animal's body moves from one point to another.

Motionlessness: The animal's body stays at one position.

Escape attempt

Nudging entry: Animal pushes its snout against the entry door of the home box.

Nudging exit: Animal pushes its snout against the exit door between home box and top platform.

Biting entry: The mouth and the teeth enclose mesh wire or the metal border of the entry door.

Biting exit: The mouth and the teeth enclose mesh wire or the metal border of the exit door.

Blood samples. Two minutes after *Tremor* had been observed on the third day of the aversion trials, the muskrats were retrieved from the drowning cage and transferred to the laboratory. Blood samples were taken from the heart, 5, 10 and 30 minutes after death to investigate whether degradation processes influenced the concentration of corticosterone. The blood was taken using cannulas and single-use-injections and transferred into Eppendorf-tubes. The samples were centrifuged and stored as described previously.

5.3.2 Results

Latency to exit the home box. The time from when the home box was placed onto the top platform until the exit door was opened could not be standardised because it was necessary to wait until the water in the pond had cleared before the test could begin. As the latency to exit the home box may have been influenced by this time, the latency to exit the home box was not used to assess aversion.

Latency to dive into the underwater cage. The time taken for the muskrats to dive into the water when they were naïve varied from 5 seconds up to 1320 seconds (Table 5.10). A similar range in latencies were found after the muskrats had been contained in the drowning trap and no significant differences in latency were found after the potentially aversive event (i.e. near drowning) had been experienced (Kruskal-Wallis-Test, n.s.).

	Previous experience		
Muskrat	**Naïve (s)**	**Trapped until biting (s)**	**Trapped until biting plus 120 s (s)**
1	1320	8	4
2	25	28	1638
3	5	4	3
4	7	289	39
5	53	841	23
6	8	8	5
7	449	11	138
8	5	2	3
Mean	**234**	**149**	**232**
Se	**164**	**105**	**202**

Table 5.10: Time taken (seconds) to dive into the water after exiting the home box onto the top platform.

Latency *Descent – Biting.* As the tests progressed the time between *Descent* and *Biting* decreased, such that the latency during test 3 was significantly lower than the previous two (Kruskal-Wallis-Test, $P < 0.001$, Figure 5.8).

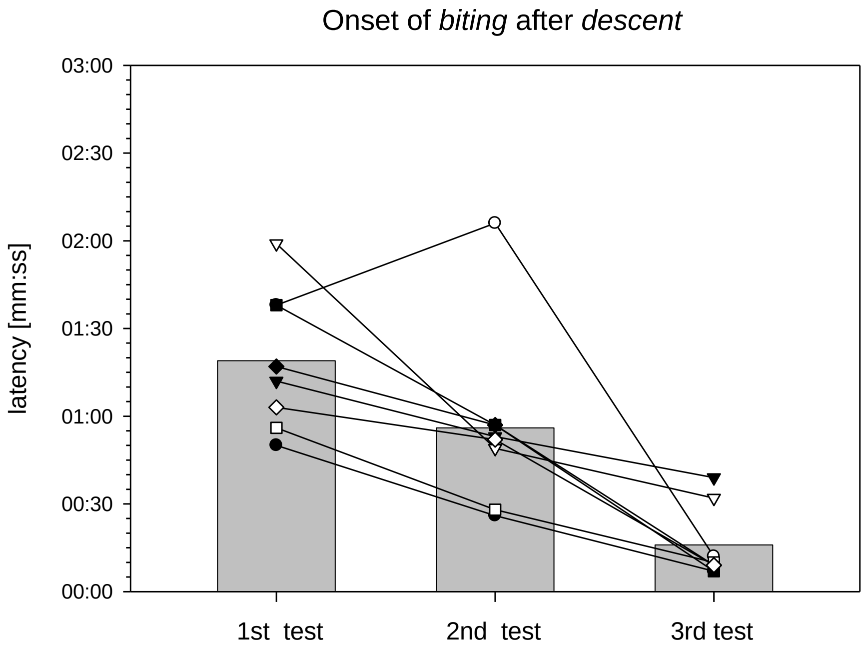

Figure 5-8: Latency between *Descent* and onset of *Biting*. Values are given as means (bars) and single values (single dots). Matched data are connected with a straight line. Kruskal-Wallis-Test: p < 0,001.

Latency *Biting* – *Tremor*. Five of the muskrats drowned at the end of the third test were used to obtain blood samples for corticosteroid analysis. The time taken from when they first started *Biting* behaviour until *Tremor* was observed was measured (Table 5.11). The durations ranged from a minimum of 357 seconds and a maximum of 496 seconds, these were similar to the times recorded from the experienced animals in experiment one (Table 5.5).

Muskrat	***Biting* – *Tremor***
1	442
2	357
3	496
5	373
6	378
mean	**409.2**
se	**26**

Table 5.11: Latency between *biting* and *tremor* for muskrats drowned at end of aversion trials

Swimming activity. The levels of swimming *Activity* pre- and post- the onset of *Biting* were compared. The time from *Descent* to onset of *Biting* was used as the standard duration over which swimming activity was calculated. *Activity* did not differ significantly with the day of trial or the muskrat (Anova, p= 0.196 and p= 0.573 respectively). But *Activity* was significantly higher before than after the onset of first *Biting* (Anova, p= 0.027). This increase in *Activity* amounts to 7% on the second test of the trial and 32% on the third test; as in experiment 1, the decrease in swimming *Activity* after the onset in *Biting* may simply be due to the fact an increase in *Biting* reduces the time the muskrats have available for swimming.

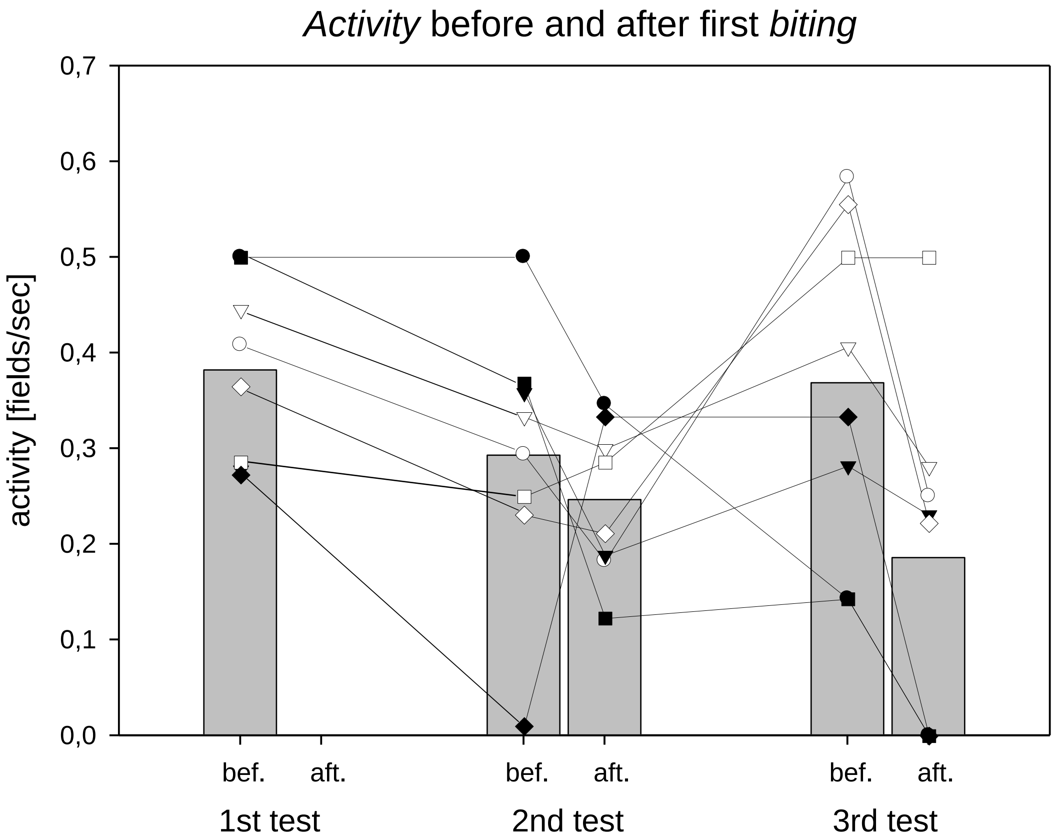

Figure 5-9: Swimming *Activity* in number of fields per second before (bef.) and after (aft.) the onset of *Biting*. After the first test the muskrats were released immediately after the onset of *Biting*. Values are given as means (bars) and single values (single dots). Matched data are connected with a straight line. *Activity* before *Biting* was significantly higher than *Activity* after *Biting* (Anova, p= 0.027), test number did not effect *Activity* (Anova, n.s.).

Behaviour on top platform. Exploration was the most frequent behaviour recorded (Figure 5.10). The proportion of time spent performing each behaviour did not vary as the trial progressed.

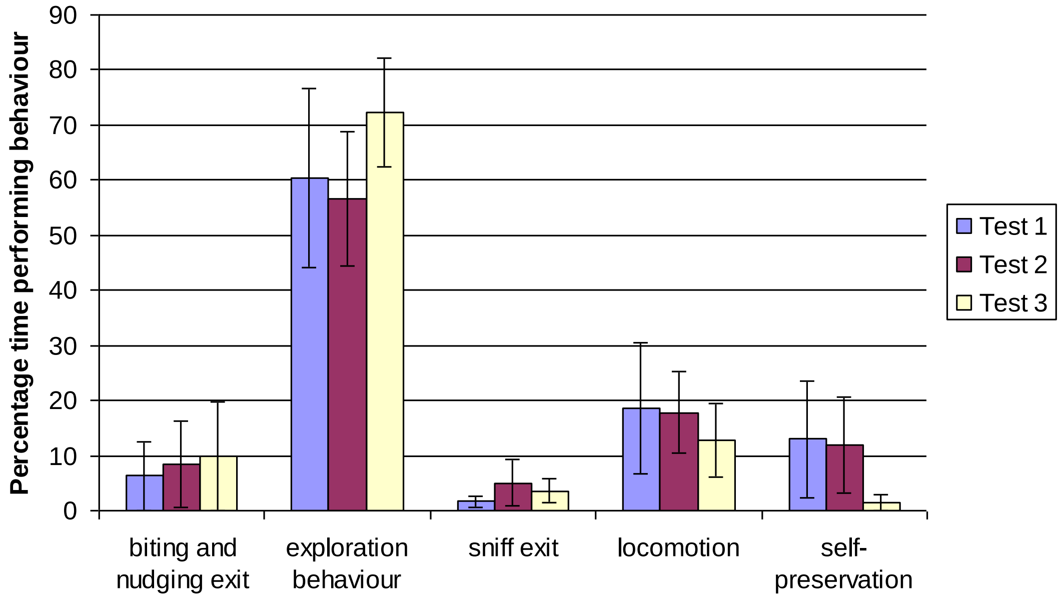

Figure 5-10: Mean (+/-se) percentage of time on platform spent performing different behavioural categories.

Blood samples. The corticosteroid concentrations measured in the muskrats after drowning were significantly higher than the basal serum corticosteroid concentrations. (Kruskal-Wallis-Test: $p = 0.014$, Figure 5-11). Delaying the time from death until the blood sample was taken had no significant effect upon the corticosteroid concentration (multiple comparison on ranks: $p > 0.05$).

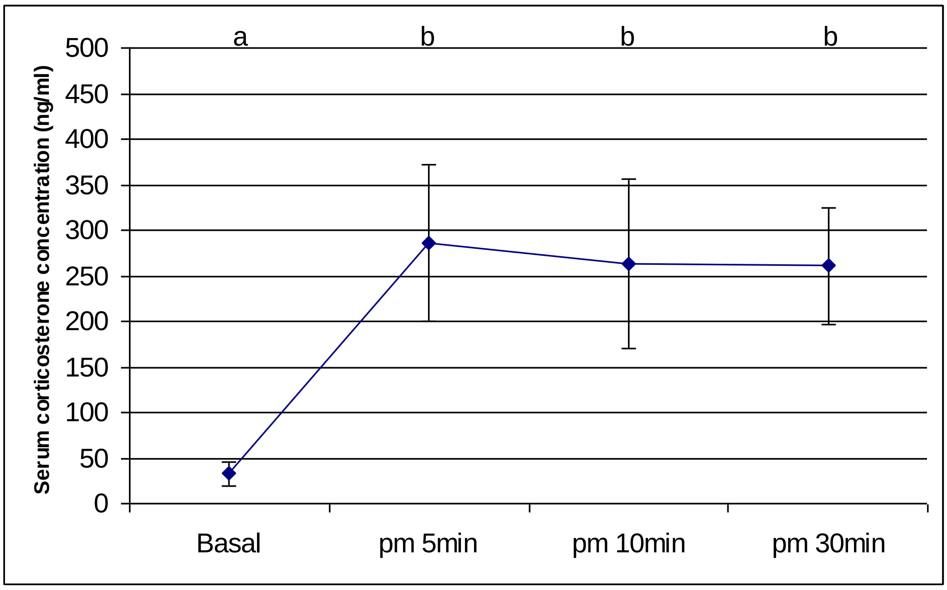

Figure 5-11: Mean (+/-) serum corticosterone concentrations in muskrats after drowning compared with basal values. Significant differences are indicated by different letters (Kruskal-Wallis-Test: p = 0.014).

5.4 Discussion and Conclusions

There was no evidence in the animals tested of the so-called “passive” coping strategy where the animal caught in the drowning trap remains still and quietly looses unconsciousness prior to death; rather all the muskrats actively bit the mesh of the underwater cage. It is possible that previous observations of muskrats lying passively in the underwater cages of drowning traps may have been the result of animals responding to the presence of a human observer, whether the trapper or experimenter, with a freezing response. In the current experiments the animals were observed via underwater cameras and hence they did not see a human.

In the wild, muskrats will experience a drowning trap only when they are being drowned. As demonstrated in experiment 1, prior experience of the drowning trap had a significant effect on the time taken to become unconscious. It is difficult to duplicate conditions in the wild in an experimental set-up; however, the trials carried out with the naïve muskrats did closely replicate the wild situation and therefore the results from these animals may be used in any assessment of the drowning trap against the Improved Standards for killing traps.

In order to assess the drowning trap against the Improved Standards for killing traps it is necessary to know both the time of the onset of distress and the TIU. The experimental data indicate that the point of unconsciousness can be identified by the onset of *Tremor*. If the onset of distress is taken to begin immediately the muskrat dives into the underwater cage then the drowning trap does not meet the 300 seconds TIU requirement for the minimum welfare category, i.e. Welfare Category C, of the Improved Standards. However, as discussed above, the period of adverse welfare should rather be measured from the onset of distress to insensibility if the onset of distress can be objectively observed.

The heart rates of the muskrats did not suggest that the animals were distressed prior to drowning because the heart rates remained relatively stable and low throughout the whole of the underwater period. However, the heart rates measured during the drowning trials were similar to, but lower than, those reported during escape dives in previous studies (MacArthur 1990). This indicates that the responses of muskrats to distress when underwater may be very different to terrestrial mammals and therefore caution needs to be taken when extrapolating findings between these two situations. The corticosterone concentrations found after death in the second experiment were similar to those found previously when muskrats were restrained in cage traps on land (197 ng/ml) and also when they were confronted with an unknown male conspecific (213 ng/ml) (Inglis et al. 2001). Thus the level of corticosteroid measured at the end of drowning suggests that the animal's distress was no more than that experienced during a normal social encounter.

The onset of distress is likely to be indicated by a change in behaviour, and when muskrats were held in the underwater cage a new behaviour was observed; namely biting the mesh of the cage. In previous experimental studies of muskrats in drowning traps (Gilbert & Gofton, 1982) biting the mesh of the cage has been described as struggling behaviour. If the onset of biting behaviour is taken as the onset of distress then the drowning trap still does not meet either the AIHTS standard or that of the Welfare Category C of the Improved Standards for killing traps because three of the eight naïve animals tested in experiment 1 became unconscious after the TIU threshold of 300 seconds.

A more detailed behavioural examination was made of the time from onset of *Biting* to *Tremor*. As the time in the underwater cage increases so should the motivating force for escaping the cage also increase (i.e. the increase in carbon dioxide or decrease in oxygen stimulating the response is also increasing) and, therefore, both the intensity of *Biting* behaviour (measured by rate and total duration) and *Swimming* activity should increase over time if indeed these measures are indicators of distress. The rate of *Swimming* during the period from onset of *Biting* to the onset of *Tremor* showed no such increase. The rate of *Biting* showed a large step-increase after 150 seconds.

During the first few minutes after the onset of *Biting* this behaviour may be related to normal escape behaviour, during which a relatively low level of distress might be experienced. A similar pattern has been observed in beaver captured in submarine traps; they show an initial low level of biting behaviour then become motionless for several minutes before resuming with a much higher rate of biting behaviour just before becoming unconsciousness (M O'Brien, pers. comm.). When muskrats are foraging underwater they may at times become entangled in vegetation, and then biting at the vegetation could help free them and allow them to reach the surface. When muskrats are held in cage traps on land they also perform escape orientated behaviours, such as biting at the mesh of the cage (Inglis et al. 2001). Such biting was found to occur on average 80 times per hour, ranging from under 25 per hour to over 200 per hour. This equates on average to once per 45 seconds. The rate of biting seen underwater is higher, perhaps indicating a stronger motivation to escape. It may be that the initial level of *Biting* shown by muskrats in the underwater cage involves a normal escape response to entanglement with little additional distress but that the subsequent increased level of *Biting*, that begins after approximately 150 seconds in the underwater cage, signals the onset of distress. If this is indeed the case and, therefore, the clock is started at this point for the purposes of measuring the TIU then the drowning trap would meet the standards of the AIHTS and of the Welfare Category C of the proposed Improved Standards.

As the observations from the first experiment indicated that the onset of distress could either occur at the onset of *Biting* or approximately 150 seconds later, it was decided to conduct the second experiment and use the aversion-learning paradigm to assess how the muskrats themselves perceived these two time points during their time in the underwater cage. Aversion trials have been carried out with domestic species to determine the aversiveness of gaseous chemicals used in euthanasia (Raj and Gregory 1995, Neil & Weary, 2007). In one trial gaseous stunning with carbon dioxide was compared to electric prodders (Jongman,et al. 2000). The results of this trial showed that pigs developed a strong aversion to the electric prodder but still tolerated exposure to the carbon dioxide. The authors speculated that the loss of consciousness after exposure to the carbon dioxide may have interfered with the learning process; although in a separate study it was found that pigs forgo water for 72 hours rather than re-enter a place where they had previously been stunned with carbon dioxide (Cantieni 1976).

With wild animals it is more difficult to obtain a stable base line against which to assess any aversion than it is with domestic animals (e.g. rats, Neil & Weary 2008; chickens Abeysingha 2001). The presence of humans in the vicinity of the test environment is known to influence the behaviour and the responses of muskrats. However, aversion trials have successfully been completed with red deer to compare management procedures and here the latency to leave the start box rather than the time taken to complete the raceway was used as an indicator of aversion (Grigor, et al. 1998).

The current experimental design hypothesised that if the muskrats found the drowning experience aversive then the time taken to dive into the drowning cage from the top platform should either increase with progressive tests or the animals should avoid the drowning cage altogether (in the experiment if the muskrat had not entered the water after 120 minutes the test would have been stopped). However, if they did not find the previous near-drowning experience very aversive then the time taken to enter the water would remain approximately the same, or decrease as neophobia to the trap decreased, as the trial progressed.

Latency to onset of *Biting* in the underwater cage decreased as the trial progressed. This could indicate either that a) the muskrats became distressed remembering that they had been held underwater for longer than they would like to be, or b) they had learned that biting the cage bars resulted in the cage doors opening and their subsequent release. Which explanation is correct cannot be determined from the results. If the muskrats had been distressed by being held in the underwater cage it might be expected that they would not re-enter the water. This did not happen. It is unlikely that the muskrats were unable to remember or associate the underwater cage with what happened to them the previous day; the fact that the latency to onset of *Biting* decreased as the trial progressed indicates that they remembered something of what had happened previously. Mendl et al. (2001) have argued that the more distressing an event the more likely it is to be remembered. In trials where domestic pigs were exposed to carbon dioxide until they became unconscious in an area containing their only source of water they avoided that area for 72 hours (Cantieni, 1976).

The conclusion from the aversion trials is that the muskrats did not experience sufficient distress from being held underwater for up to 120 seconds after biting behaviour was first observed, to trigger an aversive response to the underwater cage.

If this point (i.e. 120 seconds after onset of *Biting*) is conservatively assumed to indicate the onset of distress and therefore the TIU is measured from there, then the TIU scores for all eight of the naïve muskrats are less than 300 seconds. On this basis the drowning trap meets the criteria of the AIHTS and Welfare Category C of the Improved Standards for killing traps. However, new muskrat traps that meet the requirements of the higher Welfare Categories needs to be developed. Moreover, the vast majority of the respondents to the internet survey did not support the use of drowning traps (see Table 3.7).

The consortium members held meetings with staff of the muskrat control services in Belgium, The Netherlands and Germany to discuss the possible development of new muskrat traps. In addition to meeting high welfare standards, it was concluded that a new trap would need to be:

a) capable of catching at least five muskrats,
b) reliable and relatively easy to use
c) not too heavy or cumbersome
d) not too expensive
e) made of materials that last in wet environments.

Several ideas for new muskrat traps were discussed and some examples are briefly described here:

a) A design in which muskrats swim into an underwater tunnel which then rises out of the water and becomes a box containing killing traps. A few prototypes had already been built and tested in the field. Although this design worked well, was relatively species-specific, and allowed a muskrat to escape unharmed if all the killing traps had previously been triggered, it was too cumbersome to be practical.
b) A box maintained half-under and half-above the water level. The muskrats would enter the box via an underwater entrance and the space within the box above the water level would be filled with an inert gas or with carbon dioxide gas. It was thought that such a design would be practically very difficult to use, and also that there were some welfare problems associated with carbon dioxide gas.

c) Existing floating cage traps might be modified to incorporate killing traps based on the Nooski rat trap (www.nooski.com), This trap releases an elastic rubber latex ring around the rodent's neck and kills the animal by asphyxiation within 80 seconds. Preliminary trials have been undertaken by the consortium to determine if this device had the potential to meet the TIU thresholds for either Welfare Category A or B of the Improved Standards for muskrats. Four anaesthetised, young muskrats were killed using a Nooski ring designed for rats and the times to death ranged from 27 to 48 seconds. Discussions have since been held with the manufacturers of the trap about the possible development of a version for muskrats. The Nooski Design and Development Team anticipated that such a device would take up to 18 months to develop and cost in the region of £100,000 (€109,000)[9]. Animal testing of prototype traps would cost approximately £50,000 (€55,780)..The company would not be able to cover such costs alone in the present economic climate.

Muskrat management strategies have also been considered. By comparing the catch sizes of countries that employ different muskrat control systems, it becomes obvious that the number of muskrats trapped is strongly dependent on the control system applied. This was particularly evident in the data from Flanders, where the trapping system was reorganized in 1993 and the number of trapped muskrats fell markedly as a result; from over 120,000 animals in 1993 to about 10,000 in 2007. Thus in Flanders the number of muskrats was reduced by more than 90% from 200 muskrats per km^2 to 10 per km^2 by the reorganisation. The killing traps were rebuilt to prevent non-target species from entering, the bait was changed from apple to carrot to increase selectivity, and the toxic (chlorophacinone) bait was no longer used. In addition the muskrat trappers had to follow a standard trapping procedure of only placing traps close to muskrat dens or routes (i.e. active trapping) rather than distributing them randomly (i.e. passive trapping) as was done previously, and as a result the muskrat trappers had to learn how to detect the presence of muskrats. Working in teams also improved results. However, the most important change with regard to the efficiency of the system was the implementation of an accurate evaluation system of trapping success. Whilst the control system in the Netherlands also seems to be quite efficient

[9] Exchange rate of 1.11 on 8 March 2010

in keeping muskrat numbers low, the system in Germany (Lower Saxony) probably does not result in a significant reduction in muskrat numbers and it is questionable whether a commensurable reduction of damage is achieved. Of course the amount of money spent on the trapping system is of vital importance. It would be beneficial to compare the muskrat trapping systems used in France, Belgium, The Netherlands and Germany with regard to efficiency in keeping numbers low, prevention of damage and cost effectiveness.

The lower muskrat numbers become, the less trapping is required and the fewer individuals need to be caught in drowning traps. However, the use of drowning traps is also said to be essential for determining if muskrats are beginning to re-colonise a previously cleared area; i.e. the traps are also used for monitoring the presence of muskrats. Within the UK a simple raft that records animal tracks has been developed to perform the same task for mink, and it may be suitable for use with muskrat. The mink raft contains a layer of wet clay that is kept constantly damp and is covered by a tunnel. Any mammal visiting the raft, and this would have to be a semi-aquatic mammal, leaves an imprint of their feet in the clay (for full details see the GWCT website http://www.gwct.org.uk/documents/gct_mink_raft_guidelineslr.pdf). It is possible that these rafts could be a humane alternative to using drowning traps for monitoring purposes.

6 Improved Standards for restraining traps

This chapter describes new Improved Standards for restraining traps. These standards specify three Welfare Categories (i.e. A, B and C) of trap that differ in the degree and types of injury shown by animals caught in the trap; with Welfare Category A traps resulting in the lowest level of trauma and Welfare Category C the highest. These Improved Standards are based upon injury scales being used for trap approval in New Zealand. Insufficient information currently exists on the normal variation within wild populations of the putative behaviourl and physiological indices of welfare to be able to interpret any changes found in them during trap testing in terms of the welfare of the animal It is proposed that where traps of different Welfare Categories are available to control the same species then only traps of the highest welfare category will be used.

Summary

The aims of this chapter are:

- **a) to discuss the use of injury scales to assess the welfare of animals in restraining traps,**
- **b) to compare and contrast important restraining trap standards,**
- **c) to discuss the use of possible behavioural and physiological indices of welfare to assess the welfare of animals in restraining traps,**
- **d) to propose improved welfare standards for restraining traps (referred to as the Improved Standards),**
- **e) to identify current traps that meet the Improved Standards for the species of major interest to the EU,**
- **f) to discuss possible design modifications of traps to improve the welfare of animals in restraining traps.**

a) Injury scales. The degree of injury (as indicated by the amount of tissue damage) often gives an approximation for the amount of expected pain suffered by the animal.

Injury or trauma scales have been commonly used to assess the welfare of animals in restraining traps. Three main types of injury scales have been used to assess the suffering of trapped animals. First, there is the simple and relatively crude 'yes/no' process in which a list of "unacceptable" injuries is compiled and the presence of one of these in the trapped animal is sufficient to fail the trap. Second, each type of injury can be assigned a number of points and the points for all the injuries suffered by the trapped animal are added up and compared with a maximum value that must not be exceeded if the trap is to meet the welfare standard. The third approach entails the grouping of injury types into severity levels such as mild, moderate and severe, and then, after deciding upon a sample size, defining a frequency of occurrence for each severity level whereby a trap would be deemed as unacceptable if this were exceeded. The pros and cons of each system are discussed.

b) Welfare standards for restraining traps based upon injury scales. Three existing welfare standards for restraining traps based on injury scales are considered. The draft ISO humaneness standard for restraining traps focused on injuries thought to cause pain and combined both an injury scale for "potentially acceptable injuries" and a list of "unacceptable injuries". Under this scheme the most severe injuries were termed "unacceptable" and a single instance of this class was sufficient to fail the trap. Injuries of lesser severity, i.e. "potentially acceptable injuries", can occur singly or in a very large number of combinations. To deal with this problem there is a point system for potentially acceptable injuries that is both cumulative and multiplicative, and where higher points are assigned to those injuries considered more severe. An animal passes the required "injury threshold value" if it has a) no unacceptable injuries, and b) a total injury score for the potentially acceptable injuries of less than or equal to 75. The restraining trap passes the welfare requirements of this proposed standard if at least 80% of 25 or more captured animals meet the injury threshold value.

The AIHTS provides a list of injuries "recognised as indicators of poor welfare in trapped animals". No scores are assigned to the above injuries; rather they are treated as unacceptable injuries in that at least 80% of the animals tested must show none of them if the trap is to pass. One problem with this approach is that it cannot cope with the compound welfare effect of a number of lesser injuries.

Under the New Zealand NAWAC trap approval system each injury sustained by an animal caught in a restraining trap is classified into one of four trauma categories: namely mild trauma, moderate trauma, moderately severe trauma, and severe trauma. The numbers of each of these trauma categories are then combined to produce the overall Trauma Class for each animal. There are four Trauma Classes; namely Mild, Moderate, Moderately Severe and Severe. Each of these Trauma Classes can be made up of different combinations of the various trauma categories and in this manner the NAWAC Guideline deals with the problem of multiple and diverse injuries.

c) Behavioural and physiological indices of adverse welfare. Possible behavioural and physiological indices of distress that could be used to assess the welfare of animals in restraining traps are discussed. It is concluded that it is very difficult not only to measure these parameters in wild species but also to interpret what any changes in them as the result of trapping signify for the welfare of the trapped animal. Furthermore, as the recent Welfare Quality project has demonstrated that different welfare indicators are required even for different production systems involving the same domestic species, it is thought unlikely that a robust animal-based welfare measure incorporating more than injury indicators could be devised covering all the trapped wild species. Whilst behavioural and physiological measurements are useful in comparative studies they are currently not reliable welfare indices in the context of a stand-alone assessment

d) Improved Standards for restraining traps. The proposed Improved Standards for restraining traps involve four classes of injury severity (i.e. mild, moderate, moderately severe and severe) and three Welfare Categories, A B, and C of restraining traps; Welfare Category C is the existing AIHTS standard whilst the injuries used to define Welfare Categories A and B are taken from the NAWAC Guideline that is successfully being used in New Zealand. Thus for Welfare Category A, at least 80% of the trapped animals must suffer a trauma class no greater than mild and at least 90% must suffer a trauma class no greater than moderate; both pass rates being at the 90% confidence level. For Welfare Category B at least 80% of the trapped animals must suffer a trauma class no greater than moderate and at least 90% a trauma class no greater than moderately severe; again both at the 90% confidence level. For Welfare Category C the maximum allowable number of animals (i.e. 4 out of the minimum sample size of 20 specified in the AIHTS) with the welfare indicators listed in the AIHTS must not be exceeded.

If these proposals were implemented it is envisaged that there may not be any immediate change in trap use within the EU without additional incentives or a legislative/administrative framework. All the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. However, box/cage traps are the most commonly used form of restraining trap within the EU and the available evidence indicates that such traps fall within Welfare Category A of the Improved Standards. Furthermore, in order to encourage the rapid development of better traps there is in the Improved Standard the presumption that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks. The financial implications of adopting the Improved Standards will depend upon exactly how they are implemented; for example in Canada a trap has to be tested and shown that it meets the AIHTS before it can be used, whilst in New Zealand it is assumed that a trap meets the NAWAC Guideline and hence it can be used until it is tested and shown that it does not.

e) Traps that meet the Improved Standards. There is much information on the welfare implications of leghold traps but these are not used in the EU. Unfortunately very little trap testing data are available covering the other forms of restraining traps that are used to capture the species of interest to the EU. Box/cage traps are the most commonly used form of restraining trap within the EU and the available evidence (eg Woodruffe et al. 2005) indicates that such traps fall within Welfare Category A of the Improved Standards.

f) Design modifications to improve restraining traps.

Possible modifications that can improve the welfare of animals in restraining traps are discussed. For example, tooth damage can be reduced by reducing the mesh size of cage traps and covering metal surfaces with smooth coatings can lessen the chance of skin abrasions. The incidence of lacerations and other injuries when using snares may be reduced by having a plastic coating around the wire and by increasing the diameter of the wire. Reducing the breaking tension of the cable and/or adding a breakaway link can enable stronger non-target species to escape from the snare. The addition of swivels to free-running snares allows a greater range of movement to the captured animal and makes it less likely that the snare will become entangled or twisted.

6.1 ***Types of restraining trap.***

Restraining traps may be divided into the following main categories (e.g. FACE 1998, Proulx 1999):

a) Free-running snare; a wire noose that can loosen as well as tighten and may incorporate a ‘stop’ that determines the minimum diameter of the noose. Snares can be: a) neck snares that are set vertically and tighten around the neck of the animal, b) body snares that are also set vertically but are larger and tighten around the body of the animal, c) leghold snares that are set horizontally and tighten around the leg of the animal.

b) Leghold trap; a device designed to restrain or capture an animal by means of jaws which close tightly upon one or more of the animal's limbs, thereby preventing withdrawal of the limb or limbs from the trap (from Council Regulation 3254/91) Box or cage trap; a box (i.e. solid sides) or cage (i.e. mesh sides) that can be constructed from a range of materials. The animal is attracted by a bait to enter the box/cage via a raised door and thereby triggers a mechanism (e.g. treadle) that closes the door behind it.

d) Pitfall trap; a smooth-sided container set into the ground of a size (usually < 40 cm deep) such that small rodents are unable to get out once they have fallen in.

Currently leg-hold traps may not be used in the EU. Box/cage traps and leghold snares are the most commonly used of the remaining types of restraining trap (see Table 2.2).

6.2 ***Welfare standards for restraining traps***

The ideal restraining trap would be one that leaves the captured animal free from injury, pain and distress. As discussed below, various trauma scales have been used to assess the degree of pain and injury the trapped animal is suffering, and several behavioural and physiological indices have been proposed to measure the degree of distress.

Working Group 3 of ISO TC/191 was tasked with developing the proposed ISO standard for ‘Humane Animal (mammal) Traps, Restraining’. The potentially harmful events that could occur when a mammal is held in a restraint trap were reviewed by this Working Group to determine which ones could be used to assess objectively the welfare of the trapped animal. The harmful events that were considered were thought to result in one or more of the following states: psychological distress (i.e. fear), physiological distress (i.e. a high level of stress), pain, and physical injury. It was recognised that these states are interrelated; for example, physical injury can cause pain that in turn triggers psychological and physiological distress; whilst psychological or physiological distress can occur without a painful or injurious event.

Working Group 3 concluded that, in relation to restraining traps, psychological distress, physiological distress, and pain could not be readily measured. It was thought that the behavioural changes used to assess psychological distress and pain, and the physiological parameters employed to measure physiological distress had not been sufficiently defined to be predictive. The Working Group decided that in most cases fear, distress and pain rapidly subside upon release from restraining traps because studies involving the capture of wild mammals in restraining traps had found that after release uninjured animals quickly return to their normal patterns of behaviour with no obvious ill effects; indeed the same individuals could be repeatedly caught in the same trap. The type of physical injury caused by a restraining trap was therefore chosen as the best indicator of the welfare of animals caught in that trap. The Working Group noted that further justification for the use of this parameter included:

a) that fear, distress and pain may to a large degree be caused by injury

b) that injuries can have a prolonged or permanent effect on the animal, and

c) that injuries are tangible events that can be measured and described by persons trained in pathology.

A similar conclusion was reached by the New Zealand National Animal Welfare Committee (NAWAC) when drawing up the national guideline for assessing the welfare of animals caught in restraining traps (www.biosecurity.govt.nz/animal-welfare/nawac/policies/guideline09.htm).The NAWAC guideline specifically "confines the measurement of animal welfare associated with the use of traps to physical trauma, and does not include psychological and physiological distress". This is because insufficient information exists on what physiological parameters to measure and, for any one parameter, what levels could be considered as the minimum."

In the survey of public attitudes to trapping within the EU the public were asked, when assessing the welfare of an animal caught in a holding trap, whether they would give most weight to a) behavioural signs (e.g. biting the bars of the trap), or b) physical injuries (e.g. damaged skin or broken teeth), or c) physiological indicators (e.g. high levels of stress hormones). 74% of those expressing an opinion stated that they would give most weight to the extent of physical injuries. Furthermore, this strong preference was of the same order whether the respondent had a background in hunting/trapping or in animal welfare/rights (see Table 3.21).

6.3 The development of trauma/injury scales.

Many studies have devised injury scales to assess the humaneness of restraining traps (e.g. van Ballenberg 1984; Tullar 1984; Olsen et al. 1986, 1988; Linhart et al. 1988; Onderka et al. 1990; Hubert et al. 1996, 1997; Phillips et al. 1992, 1996). Whilst the various authors have used different injury categories and scores in their systems the general concepts are similar.

The relative lack of objective criteria for interpreting the impact of injuries on animals necessitates the use of scales based upon human experience (Kirkwood et al. 1994). Iossa et al. (2007) reviewed a number of injury scales and concluded that, regardless of the actual scoring system, injuries that had the potential to reduce the survival of released animals always receive a high score. In this regard such scales are similar to human trauma scales that are used to score life-threatening injuries (e.g. Greenspan et al. 1985). However, there are problems with this approach. First, as the majority of trapping conducted within the EU is for pest control purposes, injuries that threaten the survival of the target species are not often relevant because the animal will be killed when the trap is inspected. Such injuries only become important if the captured animal manages to escape or is deliberately released because, for example, it is a non-target species (issues associated with trap efficiency and selectivity are discussed in Chapter 8). Second, whilst these trauma scales may accurately assess injuries that reduce survival the resultant scores may not reflect the level of pain the animal is suffering; separate scales are used to assess human pain (e.g. Turk & Melzack 1992). For example, Iossa et al. (2007) note that broken teeth are given relatively low scores in the trauma scales they reviewed and yet orofacial pain is rated highly on human pain scales (e.g. Tandon et al. 2003). Recent research has indicated that in humans trauma to the external areas of the body, such as cuts and grazes require the least analgesic treatment, whereas trauma to abdomen, the chest and lower limbs required the most (Calil and Pimenta 2009). In accident and emergency departments of hospitals it is recognized that moderate and intense pain commonly result from injuries such as fractures, contusions, torsions, traumatic amputations and lacerations (Kelly 2001, Chao 2006). It is therefore very important when assessing the welfare of animals caught in restraining traps that the injury scales used concentrate on measuring the degree of pain the animal may be suffering.

Although the relationship between pain and injury is variable (Wall 1979) increasing injury does very often result in increased pain, and the degree of injury (as indicated by the amount of tissue damage) often gives an approximation for the amount of expected pain. As well as the extent of injury, the anatomical site of the injury is very important when assessing the resulting degree of pain because the various tissues of the body differ in their sensitivity to pain. For instance, the following list is arranged in order of putatively decreasing sensitivity to pain: cornea, dental pulp, testicles, nerves, spinal marrow, skin, serous membrane, peritoneum and blood vessels, viscera, joints, bones, and encephalic tissue (Baumanes et al. 1994, Martini et al. 2000).

Matthews (2000) has provided lists of anticipated pain following various operations, illnesses and injuries. However, as Rutherford (2002, p46), states, “It is important to remember that pain may be greater or less than estimated in this way and fine scales for pain assessment are required to truly meet an animal’s pain–relief requirement”. An example of a finer numerical rating scale is that developed by Firth & Haldane (1999) for use in dogs following ovariohysterectomy. This scale includes various physiological and behavioural parameters such as heart and respiration rates, and changes in temperament, posture and vocalization. Whilst this method can be used to discriminate between different analgesic treatments, Rutherford (2002) points out that the usefulness of the scale for assessing pain experienced by individual animals is very limited because, whilst there is good agreement between observers at the treatment-group level, the potential difference in pain scores assigned to individual animals is large in comparison to the treatment differences. Furthermore many of the parameters rely upon comparison with pre-treatment values and this creates great practical difficulties when trying to develop similar scales for use in assessing the pain suffered by wild animals in restraining traps.

Typically injury scales are numerical tallies assigned by an observer to the injuries of the captured animal. The scoring system may concern only injuries sustained to the part of the animal's body caught in the trap, i.e. usually a limb, or it may concern injuries sustained to other areas, e.g. damage to the mouth. Different points are awarded for different types of injury based upon considerations of pain, loss of function, severity of injury and its potential for recovery, and whether an animal could reasonably be released back into the wild if desired. Thus when the trapped animal is examined, the point values assigned to each injury are summed for all injuries to that animal. The resulting total can then be compared with a pre-defined threshold score such that traps with totals above this threshold value are deemed to have failed.

Engeman et al. (1997) examined the use of injury scales to rate restraining traps: in particular they measured a) the consistency between observers for scoring injuries to the limbs of trapped mammals, and b) the observers' perceived "acceptability" of injuries as compared to "acceptability" based upon a pre-defined threshold for the injury score. In addition they considered alternative quantitative approaches for addressing the question of the welfare of animals in restraining traps. Engeman et al. (1997) analysed data derived from the evaluations made by six experts in veterinary pathology on the limbs of 47 trapped foxes. Each expert evaluated the injuries to the limbs by two methods: a) application of the injury scale of Olsen et al. (1986), and b) the expert's own perception of the severity of injury to the limb. It was found that there were strong differences ($p < 0.005$) between the experts in the proportion of limbs they scored as unacceptable (i.e. in the proportion having a score >75). In addition, for four of the six experts there was a significant difference (range $p=0.005$ to $p=0.046$) between the proportion of limbs perceived by the expert to have unacceptable injuries and the proportion scored as unacceptable. Human trauma patients have long been assessed using injury-scoring systems (e.g. the Injury Severity Scale, Baker et al. 1974) and here also a lack of reliability between the scores individuals assign to the same injuries has been recognized (e.g. Barancik & Chatterjee 1981).

Engeman et al. (1997, p. 126) noted that “A scoring system is not a direct measure of the severity of injuries.” They point out that, for example, on the scale of Olsen et al. (1986) a limb having an “edematous swelling and haemorrhage” and a “cutaneous laceration < 2 cm” and a “tendon and ligament laceration” would be assigned a score of 30. This collection of injuries is thereby considered to be the same level of severity as a single “compression fracture above or below carpus or tarsus” which is also assigned a score of 30; yet there is no way of knowing whether this is correct. Similarly, there is no evidence that the increase in pain and suffering signaled by the increase in the injury score of 10 from “cutaneous laceration > 2 cm” to “tendon and ligament laceration” is equivalent to the increase in the score of 10 that results from going from “tendon and ligament laceration” to “joint subluxation”. As Engeman et al. (1997, p.126) state “Values for injury categories are somewhat arbitrary numerical assignments, and injury scores are abstractions of the severity of the combined injuries to an animal with many possibilities for obtaining a particular score. Therefore, it is inappropriate to treat them as one-to-one measurements of the severity of injuries.” Furthermore, a comparison of scores between the many different injury scales in the literature is uncertain at best. For example, an amputation of a digit would score 400 on the scale of Olsen et al. (1986) but, depending on the exact nature of the amputation, could score as little as 30 on the scale of Onderka et al. (1990).

Engeman et al. (1997) suggested that a better approach involves more-directly quantifying whether a trap causes unacceptable injuries to the captured animal. Thus injuries would be categorized into those that are acceptable and those that are not, and the frequency of occurrence of unacceptable injuries used as the welfare criterion. They also proposed that the observing veterinarian should be allowed the flexibility to include severity, or number, of injury type into the determination of injury acceptability. For example “a laceration may be acceptable unless an excess amount of dirt had been ground into the wound.” Engeman et al. (1997) considered two ways in which such a system could be implemented. In the first, decisions would be made for each type of injury on the frequency of occurrence that would define a trap as unacceptable. Thus the occurrence of some injuries may be sufficient to fail a trap whilst for other injuries a frequency of, for example, less than 1 in 10 might be deemed acceptable. The second way would involve grouping injury types into severity levels such as negligible, moderate and severe. Then, after deciding upon a sample size, a frequency of occurrence could be defined for each injury level whereby a trap would be deemed to be unacceptable. Engeman et al. (1997, p.127) were of the opinion that the second option "requires fewer decisions at fewer steps and appears easier to implement into practice". As discussed below, both options have been used in welfare standards developed for legislative purposes.

6.4 Welfare standards for restraining traps based on injury scores.

The use of injury scores has been incorporated into trap standards underpinning proposed or actual legislation to control the licensing of restraining traps on welfare grounds. Three examples of such standards are now discussed.

Draft ISO standard for restraining traps. A draft ISO standard for restraining traps was developed in 1993 by the Working Group 3 of ISO TC/191 and it combines both an injury scale for "potentially acceptable injuries" and a list of "unacceptable injuries". The Working Group focused on injuries thought to cause pain. Under this scheme the most severe injuries were termed "unacceptable" and a single instance of this class was sufficient to fail the trap. Injuries of lesser severity, i.e. "potentially acceptable injuries", are more difficult to evaluate because they can occur singly or in a very large number of combinations. For example, "a cut in the skin, a lacerated extensor tendon of a toe, a minor periosteal abrasion, and a fractured toe are events that can occur alone or in various combinations. Thus, for these 4 injuries, there are 14 possible events that might have slightly different effects on the animal. To further complicate the problem, multiple injuries of the same type can occur, e.g. 2 cuts, 3 lacerated tendons, 4 periosteal abrasions, etc." (unpublished ISO draft 1993). To try to deal with this problem the Working Group developed a point system for potentially acceptable injuries that is both cumulative and multiplicative, and where higher points are assigned to those injuries considered more severe. It was decided that a score in excess of 75 points was a failing score. Thus an animal has met the required "injury threshold value" if it has a) no unacceptable injuries, and b) a total injury score for the potentially acceptable injuries of less than or equal to 75. The restraining trap then passes the welfare requirements of this proposed standard if at least 80% of 25 or more captured animals meet the injury threshold value. In the case of species for which 25 captures is difficult to achieve, the trap also meets the requirements of the standard if at least the following number of captured target animals meet the injury threshold value:

5 of 5 animals (0 failure)

or 9 of 10 animals (1 failure)

or 13 of 15 animals (2 failures)

or 17 of 20 animals (3 failures).

The unacceptable injuries and their relevance to welfare assessment were listed as follows:

a) simple fracture (a partial or complete fracture that does not involve fragmentation of the bone or breakage of the skin) above carpus or tarsus. A painful injury resulting in disuse of the limb.

b) joint luxation above carpus or tarsus (a partial dislocation or malalignment of metacarpal/tarsal phalangeal joints between the metatarsi and phalanges or interphalangeal joints with, usually, the rupture of the joint capsule). A painful injury resulting in the disuse of the limb.

c) compound (the broken bone is exposed and infection usually occurs) or comminuted (the bone is splintered or crushed and usually does not reunite) fracture at, above or below carpus or tarsus. Painful injuries resulting in disuse of the limb.

d) spinal cord injury (this is usually a crushing injury but can be secondary to dislocation and separation of the vertebrae) the outcome of which varies with the location of damage. If the injury is at the cervical vertebra 3 or above then sudden death is likely to occur. Injuries below that level cause paralysis of the entire body and all four limbs, or paralysis of the hind legs depending upon the level of the damage. It is difficult to assess the degree of pain associated with spinal injuries because of the paralytic effect on one hand and strictly reflex responses on the other. A clear severance of the spinal cord is likely to be less painful than the crushing of the cord, as the latter would also involve very painful damage to the surrounding bone and soft tissue.

e) amputation above the digits. This is the total transaction of bone and soft tissue, although the distal portion of the limb may still be attached by skin or tendons. This is a painful injury causing disuse of the limb. Some repair to the stump can occur through fibrosis and carnivores have been observed with a well-healed amputated limb that did not appear to impede their ability to hunt.

f) severe internal organ damage (internal bleeding). This is defined as the crushing or rupture of the heart, lung, liver, spleen, kidney, intestinal tract or bladder, and is to be differentiated from bruising that can result in a small localized haemorrhage. Rupture of the heart causes instantaneous death. Severe injuries to the lung will result in intrapulmonary and/or extrapulmonary harmorrhage or pneumothorax, with increased impairment of breathing that can result in asphyxiation. Rupture of liver or spleen usually results in severe haemorrhage causing shock. Rupture of the kidney can also result in severe haemorrhage causing shock if it is near the centre of the kidney where the major blood vessels supply that organ. Rupture of the intestine or bladder will result in peritonitis. Apart from cardiac rupture, all these injuries cause severe distress and lead to shock.

g) amputation of three or more digits. This is the severance of the digits although some may remain attached by skin or ligaments. These are painful injuries that cause the temporary disuse of the limb but often heal without inflammation through extensive fibrosis, (N.B. amputation of less than three digits is a "potentially acceptable injury", see below).

h) severance of a major tendon or ligament. Major tendons and ligaments are defined as those above carpi or tarsi and are therefore involved in the flexing or extending of the entire limb. This results in the permanent disuse of the distal limb with likely secondary injuries resulting from dragging and abrasions. Clinical signs are related primarily to the physical impairment rather than to discomfort and pain.

i) compound rib fractures. These are fractures where bone fragment(s) pierce the skin and are lesions that result in changes in breathing and the avoidance of respiratory efforts as may be required during running. There is also a chance that one of the sharp fragments may pierce the thoracic pleura causing pneumothorax and/or pulmonary laceration and haemorrhage.

j) death. Death is counted as an unacceptable injury for a restraining trap even though the manner of the death caused by the trap may involve only a very short period of pain and suffering. For example, neck snares are meant to restrain but for some species (e.g. rabbit) the animal can enter the noose at such a speed that its neck is broken (DEFRA 2005).

The injury scale developed by ISO TC/191 for the potentially acceptable injuries was as follows:

a) cutaneous laceration >2 cm = 10 points

b) permanent tooth fracture exposing pulp cavity = 10 points

c) minor periosteal abrasion = 10 points

d) minor tendon or ligament severance (each) = 20 points

e) amputation of 1 digit = 25 points

f) major (>2 cm) subcutaneous soft tissue maceration or erosion = 30 points

g) joint luxation (i.e. partial dislocation) below carpus or tarsus = 30 points

h) compression fracture = 30 points

i) major periosteal abrashion = 30 points

j) simple rib fracture = 30 points

k) simple fracture at or below carpus or tarsus = 50 points

l) comminuted fracture = 50 points

m) amputation of 2 digits = 50 points

The Working Group concluded that this system "will readily reject traps that cause severe injuries and only accept restraining traps that minimize psychological and physiological distress and pain".

Agreement on International Humane Trapping Standards (AIHTS). The AIHTS provides a list of injuries "recognised as indicators of poor welfare in trapped animals". These are:

a) fracture

b) joint luxation proximal to the carpus or tarsus

c) severance of a tendon or tarsus

d) major periosteal abrasion

e) severe external haemorrhage or haemorrhage into an internal cavity

f) major skeletal muscle degeneration

g) limb ischaemia

h) fracture of a permanent tooth exposing pulp cavity

i) ocular damage including corneal laceration

j) spinal cord injury

k) severe internal organ damage

l) myocardial degeneration

m) amputation

n) death.

No scores are assigned to the above injuries; rather they are treated as unacceptable injuries in that at least 80% of the animals tested (and the data have to be gathered from at least 20 animals) must show none of them if the trap is to pass. One major problem with this approach is that it cannot cope with the compound welfare effect of a number of lesser injuries.

NAWAC Guideline 09. Under the New Zealand NAWAC trap approval system (www.biosecurity.govt.nz/animal-welfare/nawac/policies/guideline09.htm), each injury sustained by an animal caught in a restraining trap is classified into one of four trauma categories: namely mild trauma, moderate trauma, moderately severe trauma, and severe trauma. These categories are taken from the injury scale (again developed by ISO TC/191) published in the ISO Standard dealing with methods for testing restraining traps (ISO 1999b). However, the scores assigned in the ISO scale to the various injuries are not used; instead the trauma categories are employed in the manner recommended by Engeman et al. (1997).

The pathological observations of trauma included in each of the trauma categories are as follows:

Mild trauma:

a) No identified trauma

b) Claw loss

c) Oedematous swelling or haemorrhage

d) Minor cutaneous laceration

e) Minor subcutaneous soft tissue maceration or contusion

f) Major cutaneous laceration, except on foot pads or tongue

g) Minor periosteal abrasion

Moderate trauma:

a) Severance of minor tendon or ligament

b) Amputation of one digit

c) Permanent tooth fracture exposing pulp cavity

d) Major subcutaneous soft tissue maceration or contusion

e) Major laceration on foot pads or tongue

f) Severe joint haemorrhage

g) Joint luxation below carpus or tarsus

h) Major periosteal abrasion

i) Simple rib fracture

j) Eye lacerations

k) Minor skeletal muscle degeneration

Moderately severe trauma;

a) Simple fracture at or below carpus or tarsus

b) Compression fracture

c) Comminuted rib fracture

d) Amputation of two digits

e) Major skeletal muscle degeneration

f) Limb ischaemia

Severe trauma:

a) Amputation of three or more digits

b) Any fracture or joint luxation on limb above carpus or tarsus

c) Any amputation above the digits

d) Spinal cord injury

e) Severe internal organ damage

f) Compound or comminuted fracture at or below carpus or tarsus

g) Severance of major tendon or ligament

h) Compound rib fracture

i) Ocular injury resulting in blindness of an eye

j) Myocardial degeneration

k) Death

The numbers of each of these trauma categories are then combined to produce the overall Trauma Class for each animal. There are four Trauma Classes, and these are defined as follows:

Mild Trauma Class = 1 mild trauma

Moderate Trauma Class = 1 moderate trauma,
or 3 mild traumas

Moderately Severe Trauma Class = 1 moderately severe trauma
or 2 moderate traumas
or 1 moderate + 2 mild traumas
or 5 mild traumas

Severe Trauma Class = 1 severe trauma,
or 1 moderately severe + 1 moderate +2 mild traumas
or 1 moderately severe + 1 moderate + 2 mild traumas
or 1 moderately severe + 2 moderate traumas
or 1 moderately severe + 5 mild traumas
or 3 moderate traumas
or 2 moderate + 4 mild traumas
or 10 mild traumas

In this manner the NAWAC Guideline deals with the problem of multiple and diverse injuries. However, the numerical manner in which some of the trauma categories are combined to derive the Trauma Classes is debatable. For example, from the definition of the Moderate Trauma Class it appears that 1 moderate trauma is equivalent to 3 mild traumas, whilst 2 moderate traumas are equivalent to 5 mild traumas rather than to 6 mild traumas in the definition of the Moderately Severe Trauma Class.

A restraining trap must meet the welfare criteria that define either a ‘Class A Restraining Trap’, or a ‘Class B Restraining Trap’. A range of possible sample sizes can be used for the testing of the trap, and for each sample size there is a detailed specification of the acceptable level of injury for each Class of trap. For example, in order for a restraining trap to meet the highest welfare criteria of the Class A Restraining Trap there must, from a sample of 25 animals, be no more than eight animals with a 'Trauma Class' more severe than 'mild' and no more than two animals a 'Trauma Class' more severe than 'moderate'. There are, therefore, both lower and upper injury thresholds, and these are analogous to the lower and upper TIU thresholds used in determining the welfare category of killing traps (see 4.4). The system is designed to give 90% confidence that those traps that pass the test will perform below the lower injury threshold 70% of the time and below the upper injury threshold 80% of the time (for an example of the use of the NAWAC guideline see Warburton & Poutu 2008).

6.5 *The use of behavioural and physiological welfare indicators.*

The emotions of fear and anxiety have biological importance to wild animals in that the life expectancy of animals can be increased if danger is avoided (e.g. Boissy 1995). Fear and anxiety are thought to motivate defensive or avoidance behaviours and associated biochemical responses as a way to protect animals from potentially harmful situations. Animals can cope with fear and anxiety, but if these states are excessive in either intensity or duration, distress will occur and the welfare of the animal will be compromised (Webster, 2005). The major negative emotions, likely to be experienced by animals during restraint in a trapping device are pain, fear and anxiety. The strength of these emotions in animals has to be inferred from behavioural and physiological responses that can be very variable.

In ISO TC/191/N 121 ' Methods for testing restraining traps' and in the AIHTS a number of behavioural, physiological and pathological measures thought to be indicative of distress were listed as potential indicators of the welfare of animals caught in restraining traps. The possible behavioural measures were changes in feeding, grooming, sleeping, vocalisation (including ultra- and infrasound emissions), respiration, the frequency of escape attempts, self-mutilation and the frequency of stereotypic behaviour. It was also suggested that an aversion test could be performed in which the distress caused by capture in a restraining trap is assessed by measuring the latency before that individual re-enters the trap. The potential physiological indices included concentrations in blood and/or saliva of adrenaline, glucocorticoids, prolactin, creatine kinase, lactate dehydrogenase, iso-enzyme 5 and beta endorphin. In addition it was recommended that heart rate be monitored. However no agreement could be reached regarding which behavioural and physiological indicators it should be mandatory to measure, and thus only pathological measures were finally included in the Standards.

All the measures used to assess whether restraining traps meet specific minimum welfare standards need to be valid, reliable, feasible and applicable to all the wild species covered by the trapping legislation. The current scientific knowledge on behavioural and physiological measures of welfare is examined below to determine which, if any, could be used as indicators in the Improved Standards.

Behavioural indicators of welfare in wild animals.

Time budgets. Changes in time budgets have been suggested as behavioural indicators of welfare. Significant changes in time budgets attributable to different management practices have been reported in many domestic species during welfare studies (e.g. cattle Gonzalez et al. 2008). Animals that are injured or infected by disease tend to have a reduction in general activity and increased sleeping (e.g. (Millman 2007)). However, in animals with no clinical basis for such changes there is still debate as to how they should be interpreted and whether any conclusions about the animals' welfare can be inferred from them. A common conclusion is that if the animal is not being prevented from carrying out a motivated behaviour and it is healthy, then welfare is not compromised (Alvino et al. 2009).

In the absence of any diagnosed clinical condition the welfare implications of changes in time budgets over a period of hours rather than days is unknown. Animals change their behaviour to adapt to new circumstances and the motivation for this behaviour is very often likely to be fear and anxiety (e.g. McFarland 1989). For example, domestic animals when first placed in captivity or confined environments change their time budgets and may also perform specific behaviours that could be described as escape behaviour (e.g. pacing around the perimeter of the enclosure, Gregory 2005). During the period when adaptation to the new management procedures is occurring the welfare of the animal is not thought to be sufficiently compromised that it should not be subjected to such procedures. However, if after several days the animal has still not adapted to the new situation (e.g. gestation crates) then the welfare of that animal would generally be thought of as being compromised (Jarvis et al. 2006).

In addition to the problem of interpreting any changes in time budget, there is the practical problem of measuring the normal behaviour of a wild animal. Devices can be attached to wild animals to track them as they move through their habitat. However, such equipment is not sophisticated enough to determine remotely the full range of behaviour shown by the animal. This raises the question as to whether wild behaviour can be replicated under the controlled conditions of a captive environment. Many zoo environments attempt to do this, but often the relevance of the data obtained can not be verified due to the lack of reliable information on behaviour in the wild. For example, activity data collected during radio tracking studies in the field with wild Norway rats indicate that many individuals are active for a large proportion of the dark period of any day and can travel considerable distances (Lambert et al. 2008). However, whilst studying the cage trapping in wild rats housed in a compound Talling & van Driel (2009) found that the rats spent the vast majority of their time inactive. Bu using a very extensive and natural captive environment far from human habitation, the wild behaviour of the coyote, a solitary living animal, has been replicated in captivity (Shivik et al. 2009). Unless very large compounds are used it is unlikely that wild species less adapted to living in close proximity to humans than wild rats, would perform a natural behavioural repertoire and time budget in captivity.

Nocturnal Research (2008) suggest that as activity has been correlated with extent of trauma and that trauma is used to measure welfare, then activity level can be a good indicator of welfare. However, if this argument is accepted, as the pathological examination of trauma gives equivalent results to activity scores and as pathological examination of trauma is easier to conduct than the monitoring of activity during restraint, the additional recording of activity is not a useful independent welfare indicator; unless it was used to determine the level of escape motivation, as discussed below.

Excessive immobility is the only behavioural indicator of unacceptable welfare recognised in the AIHTS. Excessive immobility is only likely to occur when there is metabolic failure, and muscle myopathy. As it is not generally believed to be motivationally driven, even though it is described as a behaviour, it is perhaps better to categorise it as a pathological condition. It is unknown whether the animal will be feeling pain, fear or distress while in this state, however something life threatening must have occurred for the state to arise. In previous assessments of restraining devices such states have only been described when animals have been restrained in unstopped neck snares (e.g. Lloyd 1979). If the cause of the immobility is partial asphyxiation, this is likely to cause brain damage in the long term but more importantly pain and distress while asphyxiation is occurring. Asphyxiation that occurs gradually is reported as being very unpleasant and distressing in humans (Stone 1999a). As this behavioural state does not appear to be a reliable indicator of pain, fear and distress it is not thought to be suitable for inclusion in the Improved Standards.

Specific behaviours. Changes in specific behaviours have been shown to be associated with the emotional experience of pain (Weary et al 2006); these changes can be subtle and are frequently confused with signs of fear and/or anxiety. Typically prey species tend to show less overt signs of pain than predator species (Seksel, 2008) and this is likely to be more pronounced in wild species. In addition, the source of the pain can also determine the behavioural response. For example, indicators of pain that had been developed for rodents after abdominal surgery were found not to be appropriate for detecting pain during experimental development of animal cancer models (Roughan et al. 2005). A very detailed analysis of the behaviour of several individuals exposed to the painful trauma was required before the appropriate behavioural indicators were identified. These studies, which utilised analgesics developed for humans, have confirmed that injuries and tissue trauma in animals do indeed cause the animals to perceive pain. However, the wide variation in the behavioural responses to pain (Jordan 2005) means that the most robust measure of pain caused by a restraining trap device is still the pathological examination of injury and tissue damage. The recent Welfare Quality project (Keeling 2009), looking at possible welfare indicators for chickens, cows and pigs, came to the conclusion that as injury scores were the most reliable indicator for assessing absence of injuries they were the crucial indicator of welfare; a similar conclusion to that reached earlier by Whay et al (2003) for dairy cattle.

The other negative emotional states associated with restraining devices are a result of fear and anxiety. Although fear and anxiety have not been extensively studied in wild animals, much work has been completed using laboratory rodents and domestic animals. Yet even here there is still disagreement over the appropriate methodology for assessing levels of fear and anxiety. In rodents the plus-maze has been adopted as the standard model of anxiety despite being heavily criticised (Hogg, 1996); whilst the Welfare Quality project (Keeling 2009) has identified the novel object test as being the most robust test of general fear in farm animals. Laboratory rodents and domestic farm animals have been bred in captivity for many generations and are likely to have a smaller variation in behavioural response to fear or anxiety evoking stimuli than wild species. Nevertheless, even within domesticated species kept in identical environments, a wide variation of individual responses has been found; ranging from extreme panic to no obvious response at all. This diversity in behavioural response is likely to be greater in wild species and also be significantly different between species (e.g. it may be more important for prey species to be vigilant to changes in the environment compared with predators).

The level of escape behaviour (e.g. biting the bars of the cage) shown by a trapped animal has been identified in previous work as a potential welfare indicator for wild species (e.g. Inglis et al, 2001); a low level might be acceptable but excessive performance of escape behaviour could be a welfare indicator. However, wide inter-species variation has been found in the pattern of when, and how much, escape behaviour is performed. In studies looking at the behaviour of wild species in cage traps (Talling et al. 2009) it was found that the escape behaviour of Norway rats changed little over the 16 hour capture period and accounted for approximately 50% of the time. In contrast, squirrels performed escape behaviour for over 80% of the first hour of capture but then for less than 10 % of the remaining time in captivity, and badgers showed escape behaviour for approximately 40% of the time in the first hour of capture but then for less than 15 % for the rest of the time. In other studies foxes performed escape-type behaviours for 36% of the total time restrained in a box trap

(White et al 1991), compared with 13% and 18% of the time restrained in padded and unpadded foothold traps respectively (Kreeger et al. 1990). Escape behaviour in box/cage traps appears to vary depending on whether or not the trap is covered; covering the trap reduces escape behaviour (UK Forestry Commission unpublished data). These escape behaviours have been labelled as transient stereotypies (Mason 1993). It is thought that the stereotypies of voles in laboratory cages arise from escape attempts (Odberg 1986). However, to classify a behaviour as a stereotypy it must be repetitive, rigid and have no apparent function, and under this definition escape behaviour would not be classified as a stereotypy. Further studies, in particular looking at inter-species variability, are required to determine if escape behaviour could be used as a reliable and robust indicator of welfare within any trapping standard.

Self-mutilation is included in the AIHTS as a behavioural indicator of poor welfare. The effects of self-mutilation have been observed in animals that have been caught in leghold traps and on sticky board traps, where it is reported that they have bitten off part of their trapped limb to try and free themselves. It is unlikely that the behaviour causing the self-mutilation would be observed; when a trap is inspected the trapped animal will usually show either escape or freezing behaviour triggered by the approach of the trapper. The welfare effects of the injuries caused by self-mutilation can be assessed in a similar manner to other injuries resulting from restraint in the trap.

Avoidance learning. Negative emotions such as pain, fear and anxiety, motivate avoidance of the situation that triggered such emotions. If, therefore, animals avoid being trapped a second time then their first trap experience was sufficiently negative to result in avoidance learning. For example, avoidance learning has been used to determine the relative aversiveness of different types of handling in sheep and cattle (e.g. Rushen 1996). It has been found with studies involving domestic species that many factors can influence the results and that it is sometimes impossible to be certain that all relevant factors have been accounted for. This variability is likely to be much greater with wild species. In order to measure aversion it is essential to have a robust baseline with which to compare the subsequent responses of the animal, and in essence this means that the same animal must be consistently visiting a particular area of its environment. Although this can be achieved by using bait, in the wild it is not usually possible to control either the amount of other food available to the test individual or that it is the same animal visiting the test site on every occasion. Greater control can be achieved if the aversion tests are carried out in a captive environment, where, although the behavioural repertoire of the animal will not mirror exactly that in the wild, visitation by a specific individual to a specific place can be achieved. In compound trials Talling et al. (2006) measured the time that it took a wild Norway rat to enter a cage trap both before and after a period of restraint in the trap. The results were affected by the motivation of the animal to obtain the bait within the trap. When alternative food was available, it took significantly longer for the animal to first enter the trap, compared to the time it took to re-enter the trap after a period of restraint of 16 hours. However, when there was no alternative food, the trap was entered quicker initially but then it took far longer to re-enter the trap; although the rats did not avoid the trap altogether. It is well known that for many wild species a certain proportion of the population will avoid cage traps altogether whereas another proportion will gladly re-enter cage traps on several occasions (Kenttämines et al 2002). Re-captures are not only restricted to cage traps. Several occurrences of recaptures have been reported in leghold traps where the target animal has been anaesthetised before release (O Brien per comm.). Clearly if an animal is willing to re-enter a trap then the welfare consequences of a period of restraint in that trap can not be so great.

Physiological indicators of welfare in wild animals.

Corticosteroids. In animals measures of emotion attributable to fear and anxiety are limited to a relatively simple range of biochemical responses (e.g. Moberg 1985). One of the main physiological responses to a stressor is release of corticosteroid hormones after activation of the hypothalamic-pituitary axis. This biochemical pathway is similar to most other body systems in that the hormone is not either present or absent, but rather the amount released is relative to the degree of threat perceived by the animal. The measurement of corticosteroid hormones has been one of the most commonly used indicators of stress in comparative studies. Faecal and salivary sampling (see Lane 2006) have enabled concentrations to be determined independent of approach and restraint artifacts (e.g. Touma and Palme 2005). However, corticosteroids are only used as an independent standalone measurement for chronic stress. When used as a diagnostic tool for humans samples from several days are measured to ensure that daily variation is accounted for. Corticosteroids are not used to identify whether a specific event is ‘too’ stressful; instead verbal communication of very negative feelings and avoidance of these situations is used to identify if there is a specific trigger. The very flexible nature of the production of these hormones and also the degree in which they can be controlled by the central nervous system suggests that they are an unlikely to form a reliable and robust independent indicator of welfare (Mormede et al. 2007). Furthermore it is not clear what concentration of corticosteroid indicates a welfare problem, and hence what would be appropriate as a maximum concentration in any trapping standard. For example, trials with muskrats (Inglis et al. 2001) showed that the corticosteroid concentrations measured at the end of 16 hours in a cage trap were similar to those found when the muskrat was exposed to an unknown male conspecific for a few minutes, and both these values were significantly lower than the concentration recorded during an ACTH challenge.

How to interpret any changes found in corticosteroid levels in terms of the animal’s welfare is a major problem; particularly when the normal degree of variation within the free-living population is not known. Although techniques are now available to determine corticosteroid concentrations in faeces and other body fluids that can be collected non-invasively, the samples do have to be fresh and identifiable. If samples are exposed to air and moisture the corticosterone is broken down and the measured concentration is affected (Fera unpublished data); therefore any samples collected in the wild need to be as fresh as possible and certainly collected within 24 hours of being deposited. For some of the species covered by the AIHTS suitable faecal material is relatively straightforward to collect; for example, badgers have well established and identifiable latrines. However for others it will not be possible to collect fresh faecal material in the wild; for example muskrats defaecate in water and this causes dilution and rapid disintegration of the samples. Currently the natural variation of cortiscosteroid concentrations in wild populations of the species that would be covered by the Improved Standards are not known.

Other biochemical indicators. The other biochemical indices of welfare suggested by the ISO TC/191 and other scientists (e.g. Iossa et al. 2007) are not obviously associated with any emotional states. As a result no methodology is currently available for determining at what concentrations these biochemical compounds indicate a state of distress in the animal. Clinical reports from humans can potentially provide information on the likely emotional states associated with elevated levels of biochemical compounds but, unfortunately, for all the putative biochemical indices of welfare that have been suggested no clinical symptoms have been described in humans. Elevations of these compounds are usually only detected when blood is screened for some other reason, and it has been found that there is wide inter-individual variation and that the levels of the compounds are affected by a multitude of factors (www.nhs.uk/). Nevertheless significant increases in many of these indices have been shown to occur in response to stressors thought to be similar to trapping (see Table 6.1).

The putative biochemical indices of welfare could in theory be incorporated into a trapping standard by simply categorising any significant increase in them from established norms as unacceptable. However, this would result in restraining traps like box/cage traps being disallowed and this is unreasonable; not only because it would run counter to welfare assessments derived from injury scales but also because many individuals of many species appear content to re-enter such traps. Again information is required on the normal variation of these compounds found in the free-living populations of each species before it is possible to understand what the levels of them found in trapped animals mean; a valid interpretation of the levels in terms of animal welfare is essential before these putative biochemical indices of welfare could be incorporated into a legal trapping standard.

SPECIES	STRESSOR	BR	UR	Na	Gl	Ca	Glob	Cr	K	LDH	CK	AST	ALT	ALP	Chl	Reference
American elk *Cervus elaphus*	Capture	H							H	H	H	H				Millspaugh *et al.* 2000
Black bear *Ursus americanus*	Capture				H					H	H	H	H	H		Powell 2005
Eurasian otter *Lutra lutra*	Capture		H							H		H	H	H		Fernandez-Moran *et al.* 2004
Flying fox *Pteropus hypomelanus*	Restraint				H	L	L		H						L	Heard & Huff 1998
Grizzly bear *Ursus arctos*	Capture			H	H	L		L	L		H	H	H			Cattet *et al.* 2003
Mice *Mus musculus*	Restraint									H	H	H	H			Sanchez *et al.* 2002
River otter *Lutra canadensis*	Translocation										H	H				Hartup *et al.* 1999
River otter *Lutra canadensis*	Capture					L					H	H	H	H		Kimber & Kollias 2005
Roe deer *Capreolus capreolus*	Capture & transport		H					H	H		H					Montane *et al.* 2002
Red fox Vulpes vulpes	Trapping	H									H	H	H			Kreeger *et al.* 1990

Table 6.1: Major blood biochemistry values measured in various species in response to stressors and their concentration as higher (H) or lower (L) relative to established normals, control or placebo populations (BR = bilirubin, UR = urea, Na = sodium, Gl = glucose, Ca = calcium, Glob. = globulin, Cr = creatinine, K = potassium, LDH = lactate dehydrogenase, CK = creatine kinase, AST = aspartate aminotransferase, ALT = alanine aminotransferase, ALP = alkaline phosphatase, Chl. = cholesterol).

6.6 Development of welfare standards for domestic animals.

One of the objections to the AIHTS from MEPs was that behavioural and physiological indices of fear and distress had not been incorporated into standards for assessing the welfare of animals in restraining traps. It is valuable, therefore, to consider how physiological and behavioural indices of welfare have been implemented into specific standards for domestic animals. The welfare of domestic animals has until recently been based on a set of recommendations rather than being assessed against a standard. The Welfare Quality project, funded by the EU, had the aim of developing robust, animal-based, measures of welfare that could be used on domestic animals from the farm through to slaughter (Welfare Quality 2009). It has involved over 150 scientists from several Member States of the EU. The project has also examined what animal welfare meant to a wide range of stakeholders and has incorporated the findings into the welfare assessment. The work covered three domestic species (chickens, cows and pigs) and five food products (chicken meat, eggs, milk, beef and pork). Early on it became apparent that different stages of some production systems required separate welfare assessment systems and now, by the end of 2009, the project team hopes/d to have nine different welfare assessment systems for: sows and piglets, fattening pigs, dairy cows, beef cattle, dairy heifers and calves, veal calves, laying hens, broiler chickens and buffalo. Before this project there had been many hundreds of scientific studies on each of these production systems investigating likely animal-based welfare indicators involving behaviour, physiology, biochemistry and health. The main component of the work under the Welfare Quality project was to determine which indicators could be robustly measured *in situ* in highly variable environments. Although the results of this project come from very different species to those listed in the AIHTS, they are very relevant for assessing which behaviour, biochemical and physiology indicators could be useful for assessing the welfare of animals in restraining traps because they represent the scientific and technical state-of-the-art with respect to animal-based welfare monitoring (Spoolder et al 2009).

The areas of welfare concern that were identified by all the stakeholders were: 1) Absence of prolonged hunger, 2) Absence of prolonged thirst, 3) Comfort around resting, 4) Thermal comfort, 5) Ease of Movement, 6) Absence of injuries, 7) Absence of disease, 8) Absence of pain induced by management procedures, 9) Expression of social behaviours, 10) Expression of other behaviours, 11) Good human-animal relationship, 12) Absence of general fear. The majority of these are also of concern for animals held in a restraining trap. Many can be avoided by how the trap is used rather than being an inherent property of the device itself, and this re-affirms the importance of training and best management information for ensuring welfare (see Chapter 8). It is notable that the measurement of any physiological or biochemical parameters is absent from the list. The conclusion was reached that whilst physiological and biochemical measurements are useful in comparative studies they are not a reliable measure in the context of a stand-alone assessment (Mormede et al. 2007).

Although many papers have claimed that the ISO and AIHTS standards have unjustly neglected the use of physiology and behaviour to assess the welfare of animals in restraining traps (e.g. Harrop 2000, Iossa et al 2007, Nocturnal Research, 2008), none of these papers have suggested how an absolute measure of these indicators could be incorporated into a relevant standard. The Welfare Quality project has demonstrated that different welfare indicators are required even for different management systems involving the same domestic animal. Therefore it seems unlikely that a robust animal-based welfare measure incorporating more than injury indicators could be devised that would cover all the 19 wild species on the AIHTS list. Nevertheless, comparative studies measuring changes in behaviour and physiology in combination with assessments of trap effectiveness and non-target impacts should be completed. Such studies would enable Member States to make decisions regarding acceptable wildlife management policies on the basis of welfare in addition to economic and conservation factors.

6.7 Proposed Improved Standards for restraining traps.

For the reasons discussed above, our state of knowledge is currently inadequate to allow behavioural and physiological indices of welfare (with the exception of excessive immobility which usually has pathological connotations) to be incorporated into trap legislation. The Improved Standards are therefore based upon injury scores. The injury scales used in the AIHTS and the NAWAC Guideline were derived from discussions held within the ISO TC/191. The members of ISO TC/191 compiled their trauma scale using data collected by the ISO Working Group on Restraining Traps who conducted an extensive literature search and documented every trap-caused injury that was identified in papers, reports and articles. The majority of the studies investigating injuries to animals in restraining traps involved the use of leghold traps (e.g. Berchielli & Tullar 1980, Novak 1981, Englund 1982, Kuehn et al. 1986, Olsen et al. 1988, Meek et al. 1995, Hubert et al. 1996, Fleming et al. 1998). A working seminar was also held that included wildlife veterinary pathologists from the USA, Canada, and Sweden. They examined over 100 coyote and fox limbs that had been caught in different leghold traps. The Working Group on Restraining Traps circulated the ISO trauma scale and relative 'pain' points system to eminent veterinary pathologists for opinion, and with a few amendments they were accepted.

Within the EU leghold traps are banned. Instead box/cage traps are by far the most commonly used restraining traps; snares are used in a few Member States (see Table 2.2) but generally not for the species currently listed in the AIHTS. As a result many of the categories of injury listed in the standards discussed above are not relevant to the current situation within the EU. Typically animals caught in box/cage traps show only a few minor injuries (e.g. Mowatt & Rivard 1994, Copeland et al. 1995, Inglis et al. 2001, Way et al. 2002, Kolbe et al. 2003, Woodroffe et al. 2005). Nevertheless it would be unwise to develop an injury scale based only on those injuries that result from the use of box/cage traps. In the internet consultation the public were asked which species should be covered by trapping regulation in the EU. They could chose various options and the option 'All species that can legally be trapped' was by far the most frequently chosen option (see Table 3.13); probably because there is no ethical justification for just banning the use of inhumane traps for some species as opposed to protecting all species that can be legally trapped. Thus although box/cage traps do not cause the major limb injuries sometimes found in animals restrained in leghold traps and snares, the Improved Standards should include injuries caused by trapping methods that may be employed against species not currently on the list of species covered by the AIHTS. For example, there have been calls to add the red fox to the list of species covered by the AIHTS, and if this were to happen the Improved Standards would have to take account of the injuries sometimes caused by the neck snares that are used in a few Member States (e.g. UK) to control this species.

Three main types of injury scales have been used to assess the suffering of trapped animals. First, there is the simple and relatively crude ‘yes/no’ process in which a list of “unacceptable” injuries is compiled and the presence of one of these in the trapped animal is sufficient to fail the trap. This system does not address the possibility that an animal experiencing several of the “acceptable” injuries may suffer as much pain as an animal suffering from one of the “unacceptable” injuries. Second, each type of injury can be assigned a number of points and the points for all the injuries suffered by the trapped animal are added up and compared with a maximum value that must not be exceeded if the trap is to meet the standard. Whilst such a system can cope with the problem of multiple injuries, as discussed above the points awarded for different types of injuries are somewhat arbitrary numerical assignments and the total injury score is an abstraction of the severity of the combined injuries to an animal; it allows numerous possibilities for obtaining a particular score. The third approach is that adopted in the NAWAC Guideline; namely the grouping of injury types into severity levels such as mild, moderate and severe trauma and then, after deciding upon the number of animals to be used in the test, the defining of a frequency of occurrence for each severity level whereby a trap would be deemed as unacceptable if this were exceeded. The NAWAC approach can take account of multiple injuries, requires fewer decisions at fewer steps and is the easiest to implement into practice.

The Improved Standards for restraining traps are made by the addition of the injury scales of the NAWAC Guideline (see 6.4) to the existing AIHTS standard. There are four classes of trauma namely, mild, moderate, moderately severe and severe; and these trauma classes are exactly as described above (see 6.5) for the NAWAC Guideline. The Improved Standards have three welfare categories of restraining trap, i.e. A B, and C. Welfare Category C is the existing AIHTS standard whilst the injury scales used in Welfare Categories A and B are taken from the NAWAC Guideline. Welfare Categories A and B each has a lower and a higher level of trauma class that must not be exceeded. As with the Improved Standards for killing traps (see 3.5), the Improved Standards for restraining traps require a maximum sample size of 30 animals and incorporate BSSRs to minimise the number of animals actually used in the trap assessment. For Welfare Category A no more than three animals must exhibit a trauma class more severe than mild, and no more than one animal must show a trauma class more severe than moderate. For Welfare Category B no more than three animals must exhibit a trauma class more severe than moderate, and no more than one animal must show a trauma class more severe than moderately severe. If these criteria are met this means that for Welfare Categories A and B at least 80% of animals, at 90% confidence, have a trauma class less than that specified by the lower trauma threshold, and at least 90%, at 90% confidence, have a trauma class less than that specified by the upper trauma threshold. Welfare category C is the AIHTS standard which requires that no 'unacceptable injuries' (see 6.5 for the list of unacceptable injuries) be found in at least 80% of a minimum of 20 animals tested.

The BSSRs used in the Improved Standards for restraining traps are the same as those employed by the Improved Standards for killing traps. They enable a trial to be stopped before the maximum number of animals have been tested when there is either a) strong evidence (i.e. $p<0.05$) that the trial will end with the trap failing, or b) strong evidence (i.e. $p<0.05$) that the trial will end in the trap passing the criteria for Welfare Categories A and B. The rules for failing a trap are as follows. A trap fails as soon as there is a second failure to meet the upper trauma thresholds. In addition if there are two failures of the lower trauma thresholds on or before the 6th animal is tested, or three failures of the lower trauma thresholds on or before the 13th animal is tested, then the trial can also be stopped because there is strong evidence that the trap will fail. Similar rules can be derived for passing a trap on the basis of its meeting the lower trauma thresholds. If 11 animals have been tested and there have been no failures, or if after the 21st animal has been tested there has been no more than one failure, or if after the 27th animal has been tested there have been no more than two failures, then the trial can be stopped because there is strong evidence that the trap meets the lower trauma thresholds. However, as already discussed (see 3.5) all 30 animals have to be tested before it is possible to be 90% confidant that a trap meets the upper trauma thresholds.

As with the Improved Standards for killing traps, there is in the Improved Standards for restraining traps the presumption (see 3.5) that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be used.

6.8 Current traps that meet the Improved Standards for the species of major interest to the EU

No traps have been specifically tested to the criteria of the Improved Standards proposed in this report. However, the criteria of Welfare Category C of the Improved Standards are the same as the criteria within the AIHTS, and therefore the restraining traps that have been approved as meeting the AIHTS by the Fur Institute of Canada are also Welfare Category C traps. Many types of leghold traps have been tested but this form of trap can not be used in the EU according to EU legislation, namely, Council Regulation 3254/91. In some cases it may be that the injury data gathered during the testing of a trap to the AIHTS criteria are such that the trap meets the criteria of Welfare Categories A or B. However the injury data gathered during trap testing for the AIHTS are not publicaly available. The data available for cage traps indicate that these traps are Welfare Category A traps when used to capture badgers or muskrats (Woodruffe et al 2005 and Inglis et al 2003, respectively). Table 6.2 gives the current traps that would meet the proposed Improved Standards for the species of major interest to the EU.

	Category A	**Category B**	**Category C**
Muskrat	**Cage trap**	. No alternative restraining method used	
Pine Marten	No data available.	No data available.	No data available.
Raccoon	No data available.	No data available.	No data available.
Raccoon Dog	No data available	No data available.	No data available.
Badger	**Cage trap**	No alternative restraining method used	
Ermine	No data available	No data available	No data available

Table 6.2: Current restraining traps that meet the Improved Standards for the species of major interest to the EU. (N.B. much information exists on the welfare implications of many types of leghold trap but this form of trap can not be used in the EU).

6.9 Financial implications of adopting the Improved Standards

The financial implications of adopting the Improved Standards are affected by the type of testing methodology used (see Chapter 7), development of Best Practice Guides (see Chapter 8) and how the Standards are implemented. The financial implications are outlined in Chapter 10.

6.10 Possible modifications to improve the humaneness of restraining traps.

The welfare of animals caught in leghold traps has long been of concern in North America (e.g. Gentile 1987). This lead to the padding of the steel jaws of such traps and the development of better devices such as the Victor Soft-catch trap. Padded traps have been found to cause less physical trauma than the traditional steel-jawed, foot-hold traps (e.g. Olsen et al. 1986, 1988, Liscombe & Wright 1988, Linhart et al. 1988, Meek et al. 1995, Hubert et al. 1997, Flemming et al. 1998, Lemieux & Czetwertynski 2006, Frame & Meier 2007). The addition of chain springs can also reduce injuries (Linhart et al. 1981, Warburton & Poutu 2008). Furthermore it has been shown that a range of biochemical, serological and endocrinological changes indicative of stress and injury are reduced when padded leghold traps were used instead of steel-jawed traps (e.g. Dorner et al. 1974 . Kreeger et al. 1990). However, padded traps still do not prevent tooth damage, exertional myopathy, and anxiety, and to reduce such effects tranquilliser trap devices (TTDs) have been used. Balser (1965) first attached TTDs (consisting of squares of semi-rotten cloth coated with petroleum jelly containing the drug diazepam) to leghold traps and found that this reduced injuries in captured coyotes. Sahr & Knowlton (2000) have reported that ingestion by wolves of TTDs fixed to leghold traps reduced the number and severity of limb injuries. The addition of TTDs to Victor Soft-catch traps was thought by Marks et al. (2004) to reduce the anxiety and distress in dingoes associated with prolonged captivity. However, the TTDs did not eliminate tooth damage and Marks et al. (2004) argue that, rather than use a tranquilliser, priority should be given to the selection of an appropriate toxicant; i.e. one that causes rapid and humane euthanasia and is of low risk to field staff. Given the nature of the powerful drugs used in TTDs it is likely that such techniques would only be licensed for use in experimental or other highly controlled wildlife management operations.

Box and cage traps are the most commonly used restraining traps within the EU and, although they typically result in little injury to the captured animal (see above), there are ways by which they may be improved. Tooth damage can be reduced by reducing the mesh size of cage traps (e.g. Arthur 1998, Powell & Proulx 2003) and making the trap itself from natural materials (e.g. Copeland et al. 1995). Covering metal surfaces with smooth coatings can lessen the chance of skin abrasions (e.g. Woodroffe et al. 2005).

The incidence of lacerations and other injuries when using snares may be reduced by having a plastic coating around the wire (Englund 1982), and by increasing the diameter of the wire (Garrett 1999); although this can decrease the flexibility of the noose and thereby reduce capture efficiency (Fera, unpublished data). Reducing the breaking tension of the cable and/or adding a breakaway link can enable stronger non-target species to escape from the snare (e.g. Garrett 1999, Fisher & Twitchell 2003, DEFRA 2005). The addition of swivels to free-running snares allows a greater range of movement to the captured animal and makes it less likely that the snare will become entangled or twisted (e.g. Nellis 1968, Logan et al. 1999, DEFRA 2005). Pruss et al. (2002) modified neck snares by attaching TTDs to them. They found that this reduced facial and oral lacerations in the captured coyotes because when the diazepam in the TTDs was ingested the animals were less active and chewed the surrounding vegetation rather than the snare cable

The addition of electronic systems that signal when the trap has been triggered will reduce the length of time an animal is restrained in the trap and thereby enhance its welfare (e.g. Kaczensky et al. 2002, Potocnik et al. 2002). For example, the device developed by Larkin et al. (2003) notifies the operator via cellular telephone when an animal is caught in a trap; it includes discrimination of false alarms (i.e. when the trap is sprung but no animal is caught) and emits regular so-called ‘heartbeat’ signals to indicate that the system is still operational.

6.11 Conclusions

Standards for restraining traps should be based upon injury scales that rank the trauma in terms of the pain it is thought the trapped animal is suffering. Although there have been calls to include putative behavioural and physiological indices of welfare within such standards this is not possible at present. Not only is it very difficult to measure these behavioural and physiological parameters in wild species but also with the current state of knowledge it is not possible to interpret what any changes in them as the result of trapping signify for the welfare of the trapped animal. As the recent Welfare Quality project (http://www.welfarequality.net) has demonstrated that different welfare indicators are required even for different production systems involving the same domestic species, it is thought unlikely that a robust animal-based welfare measure incorporating more than injury indicators could be devised covering all the trapped wild species. Whilst behavioural and physiological measurements are useful in comparative studies they are not reliable indices in the context of a stand-alone assessment

Of the three trap standards considered (i.e. a draft ISO standard, the AIHTS, and the NAWAC Guideline) the AIHTS is the least satisfactory. The AIHTS list of unacceptable injuries can not, unlike the injury scales used by the other two standards, cope with the cumulative adverse welfare effects of several less serious injuries. In addition, the AIHTS specifies only the minimum number of animals to be used in the trap assessment and therefore, unlike the other two standards where there is a 90% confidence the trap has passed the criteria, it becomes stricter the more animals are tested. Also the AIHTS does not, like the NAWAC Guideline, have upper trauma limits that help prevent the situation whereby a trap could meet the AIHTS standards despite up to 20% of the animals tested having more severe injuries. The proposed Improved Standards aim to rectify these drawbacks.

The proposed Improved Standards for restraining traps involve four classes of injury severity (i.e. mild, moderate, moderately severe and severe) and three Welfare Categories, A B, and C of restraining traps; Welfare Category C would be the existing AIHTS standard whilst Welfare Categories A and B use injury scales taken from the NAWAC Guideline that is successfully being used in New Zealand. Thus for Welfare

Category A, 80% of the trapped animals must suffer a trauma class no greater than mild and 90% must suffer a trauma class no greater than moderate; both pass rates being at the 90% confidence level. For Welfare Category B 80% of the trapped animals must suffer a trauma class no greater than moderate and 90% a trauma class no greater than moderately severe; again both at the 90% confidence level. For Welfare Category C the maximum allowable number of animals (i.e. 4 out of the minimum sample size of 20 specified in the AIHTS) with the indicators of poor welfare listed in the AIHTS must not be exceeded.

If these proposals were adopted it is envisaged that there may not be any immediate change in trap use within the EU without additional incentives or a legislative/administrative framework. All the traps that currently meet the AIHTS would also meet the Welfare Category C requirements of the Improved Standards. Furthermore, box/cage traps are the most commonly used form of restraining trap within the EU and the available evidence indicates that such traps fall within Welfare Category A of the Improved Standards. However, in order to encourage the rapid development of better traps there is in the Improved Standard the presumption that where traps of different welfare categories are available for a given species only the traps of the highest available welfare category will be approved. This could be reinforced, for example by additional regional or national incentives or legislative/administrative frameworks.

7 Methods to reduce the level of animal suffering involved in trap testing.

This chapter discusses four ways to reduce the level of animal suffering involved in trap testing; these ways are a) measuring the mechanical forces exerted by a trap, b) using anaesthetised animals that do not recover consciousness, c) developing computer models that predict from the mechanical features of a trap whether it will meet specified welfare standards, and d) improved experimental designs incorporating 'stopping rules' that enable the testing to be halted as soon as the results gathered thus far provide strong evidence (i.e. $p<0.05$) that the trap will not meet the required trap standards.

Summary

The aims of this chapter are:

a) **to discuss the methods of measuring the impact and clamping forces exerted by killing traps and how to relate these to the minimal forces required in order to meet the specified TIU limit for a given species,**
b) **to consider the pros and cons of using animals under terminal anaesthesia in trap testing,**
c) **to discuss computer models developed by the Fur Institute of Canada that are being used to determine whether a spring trap meets the killing trap requirements of the AIHTS,**
d) **to discuss the value of incorporating 'stopping rules' into the experimental designs used for trap testing.**

a) Mechanical testing of traps. Spring powered killing traps kill through a combination of the impact force of the strike bar of the trap on the target animal, and the clamping force exerted on the animal by the trap after the strike. If the minimum impact and clamping forces necessary to result in a TIU shorter for a given target species than that specified in the trap standard are known, then it becomes possible to conduct mechanical tests to see if traps designed for the same species are capable

of producing these minimum forces. Such mechanical tests would not involve the use of animals. When a spring trap is triggered the potential energy of the spring is converted into kinetic energy and the kinetic energy created can be used as a standard welfare criterion. A rough estimate of the kinetic energy a trap could exert can be gained by measuring the average force required to extend, compress or wind the spring(s) and multiplying it by the distance through which the spring arm(s) moved. However much of the potential energy in the spring is used to overcome friction and is thus lost as heat energy. The pros and cons of measuring either a) the momentum generated by the trap, or b) the impact force directly by using forces transducers are discussed. Measuring the mechanical forces exerted by a trap is of little use unless these forces can be compared to the minimal forces that are required in order to meet the specified TIU for the target species. These minimal forces have been obtained by placing anaesthetised animals within specially constructed trap simulators, and examples are given of the sorts of results that can be obtained from such devices.

b) The use of anaesthetised animals. Whilst the use of anaesthetised animals ensures that the subjects do not suffer, questions have been asked about the effect the anaesthetic might have on the TIU values obtained. A study involving a wide range of mammals found no significant correlations between the TIU scores obtained from anaesthetised animals and those obtained from unanaesthetised animals, although other work has found significant correlations for some species. As the TIU for an anaesthetised animal is usually less than the TIU for an unanaethetised animal, it has been argued that whilst results from tests using anaesthetised animals cannot be used in isolation to determine whether a trap meets the required trap standard, they can nevertheless be used on their own to determine whether a trap fails the standard. The validity and usefulness of this approach is discussed; particularly in relation to traps that kill by reducing blood flow through the carotids.

c) Computer models. Computer models that determine whether a trap design meets the killing trap requirements of the AIHTS have been developed by using the extensive database covering 15 years of live animal trap testing held by the Fur Institute of Canada. Mechanical characteristics of the trap and the anatomical strike locations together with the size of the animal and how the trap is set are the factors included in the logistic regression model used to fit the data. The probability that the trap will cause an animal to lose sensibility within the TIU limit specified for that species within the AIHTS is calculated. The obvious benefits of using computer models are a) they reduce the number of animals required to test trapping devices (in Canada it is estimated that to date 1200 fewer animals have been used), and b) they currently cost 85% less than the compound testing of traps.

d) Experimental designs incorporating stopping rules. Bayesian Sequential Stopping Rules (BSSRs) for trap assessment trials have been developed that allow a trial to be halted before the maximum number of test animals specified in the trap standard have been used. The BSSRs enable a trial to be stopped on the basis of the results gathered thus far as soon as there is either a) strong evidence (i.e. $p<0.05$) that the trial will end with the trap failing, or b) strong evidence (i.e. $p<0.05$) that the trial will end in the trap passing. In this manner the minimum number of animals are used in the trap assessment trial. It is proposed that the Improved Standards for both killing and restraining traps adopt a sequential testing procedure such that a) only the minimum number of animals are tested on traps that are likely to fail the Standards, and b) any trap that passes will perform similarly on a theoretically infinite number of animals in the wild.

7.1 Mechanical testing of spring powered killing traps

Spring powered killing traps kill through a combination of a) the impact force of the strike bar of the trap on the target animal, and b) the clamping force exerted on the animal by the trap after the strike. Once the minimum impact and clamping forces necessary to result in a TIU shorter for a given target species than that specified in the trap standard are known (see below) then it becomes possible to conduct mechanical tests to see if traps designed for the same species are capable of producing these minimum forces. Such mechanical tests would not involve the use of animals.

When the trap is triggered the potential energy of the spring is converted into kinetic energy and the kinetic energy created can be used as a index for measuring the welfare implications of a trap. Kinetic energy is defined as: K.E. = $\frac{1}{2} mv^2$, where m = mass of moving body and v = velocity of moving body. A rough estimate of the kinetic energy a trap could exert can be gained by measuring the average force required to extend, compress or wind the spring(s) and multiplying it by the distance through which the spring arm(s) moved. However some of the potential energy in the spring will be used to overcome friction and is thus lost as heat energy. Frictional losses can be large; for example Yi (1974) found that as much as half the potential energy in some traps is lost to friction. To get a more accurate measure of a trap's effectiveness it is necessary to measure the velocity of the strike bar (Newcombe 1981). Unfortunately, the velocity of the strike bar will generally be different at each point of its travel and hence velocity should be measured continuously during trap closure and a plot of velocity against closure obtained. Such data can be obtained by the use of high-speed cameras or, more accurately, by putting an accelerometer on the trap jaw. The output from the accelerometer can be integrated to give a graph of velocity against trap closure. Once accurate information has been obtained on the velocity of the strike bar, the equivalent mass of the strike bar must be calculated in order to arrive at a figure for the kinetic energy. However, as the strike bar is often part of a larger U-shaped structure "it is necessary to imagine an equivalent point mass that is concentrated at the striking point that has the same striking power as the whole U-shaped jaw'' (Newcombe 1981, p.1622). The effective mass depends on the configuration of the trap. Often the trap jaws rotate about an axis and it then becomes necessary to calculate the rotational inertia; which is a measure of how a rotating mass resists changes in velocity. Once the effective mass has been calculated it is possible, in conjunction with the velocity graph, to calculate the kinetic energy at any point during trap closure: the maximum energy output typically will occur at full closure. For those traps whose jaws do not have a simple rotational movement (e.g. Fenn traps) it is not possible to calculate accurately the effective mass.

The momentum generated by the trap is measured in Canadian trap certification procedures. Momentum (M) is defined as: M = mv, where m = mass of moving body and v = velocity of moving body. Momentum is related to the impact force (F) that the strike bar can deliver to the object; thus M = mv = Ft, where t is the duration of the impact. Newcombe (1981, p.1623-1626) argues that using momentum as the main trap output criterion has a major disadvantage in that "If a designer is designing a spring to give a specific momentum in his trap, he must first convert back into kinetic energy to design the spring, because this is the measure for spring output…..Now suppose that the amount of energy (i.e. to attain the required momentum) requires a very large spring; the designer would naturally search for ways of reducing spring size. He could select a striking bar with greater mass". The momentum criterion could be attained by increasing the effective mass at the expense of the velocity, but if this is carried to the limit you could have a trap with a very large mass and a very low strike velocity. Therefore "unless a limiting mass for the striking bar is also specified the manufacturers will be able to meet momentum thresholds with traps that are basically underpowered. Such traps will not develop sufficient clamping force or a high enough velocity in the striking bar". Specifying a minimum clamping force criterion (see below) would also prevent manufacturers from meeting momentum thresholds with underpowered traps.

Newcombe (1981) argued that measuring the impact force itself would be "an ideal trap output criterion if it could be measured with any accuracy and consistency". It is also the only criterion that can be employed for those traps where for various reasons (e.g. the complex movements of the trap jaws) it is not possible to accurately calculate the effective mass, and for this reason it is the measure used for trap testing in the UK. Force transducers are available that can directly measure the impact forces exerted by all but the most powerful spring traps. However one problem with this measure is that

"A small change in the impact time will greatly affect the value of impact force and the impact time depends on the nature of the object being hit. If the object is hard, the impact time will be short. The softer the object, the greater will be the impact time, thus absorbing the impact force over a longer interval and reducing its peak value drastically" (Newcombe 1981, p.1621). It is therefore necessary to relate measurements of impact forces to a standard substrate. A bar of lead of a fixed thickness can be used as the standard substrate. Thus the depth of the indentation(s) created in the lead bar by the trap should equal or exceed the indentation(s) caused when the lead bar is hit with the minimal impact force required to render the target animal irreversible unconscious within the specified TIU. This minimal impact force can be calculated using a trap simulator (see below). One advantage of this method is that trap manufacturers could be supplied with samples of the standard lead bar and given the minimal indentation depth required for a particular species; thereby enabling them to check during development that their traps have the required power.

The clamping force is the static force that the animal receives after the strike has occurred and the strike bar(s) stop(s) bouncing. Clamping force is achieved by having some compression or wind-up in the spring when the trap is closed. A high clamping force lessens the bounce-back of the striking bar causing it to continue into the animal after the hit thereby compressing and holding the animal more firmly in the trap. Benn (1981) investigated the effects of clamping force being applied together with impact force on anaesthetised mink and found that the addition of the clamping force resulted in a faster death. Similarly Zelin et al. (1983), working with muskrats, raccoons and beaver, concluded that the addition of a clamping force reduced the required momentum threshold. Thus, as Newcombe (1981, p.1627) argued, the clamping force "provides an extra degree of insurance that a humane kill will be affected". It can be measured by placing load cells between the trap jaws. For example, in the Canadian trap certification procedure the clamping force measurements are taken from the largest to the smallest opening of the trap jaws; whilst in the UK the clamping force measurement is taken at a standard opening determined by the dimensions of a force transducer that not only measures the clamping force but is also used to measure the impact force.

Measuring the mechanical forces exerted by a trap is of little use unless these forces can be compared to the minimal forces that are required in order to meet the specified TIU for the target species. These minimal forces have been obtained by placing anaesthetised animals within specially constructed trap simulators. Gilbert (1976) made the first attempt to establish minimal force criteria for evaluating humane traps. His trap simulator was a device consisting of a killing bar attached to a variable number of weights that fell vertically onto the anaesthetised test animal. In this way it was possible to deliver a pre-calibrated energy that was a simple function of weight x distance of the fall until the bar came to rest on the test animal. Gilbert (1976) measured the minimal impact forces required to cause death by blows in the neck or chest region in anaesthetised raccoons, mink, muskrats and beavers. He considered only the effect of impact and lifted the striking bar from the animals immediately after impact. The effect of clamping force, as would be obtained with most traps of a body-gripping design, was ignored. Other forms of trap simulator have been energised by compressed air. Here the striking bar is attached to a piston within a pneumatic cylinder and it can be accelerated from rest to a predetermined velocity. Furthermore, in these simulators immediately the striking bar has hit the anaesthetised animal a switching system enables an adjustable constant clamping force to be applied to the animal. This type of trap simulator was first developed by Abdinoor et al. (1977) and used, for example, in the studies of Benn (1981) and Zelin et al. (1983).

Figure 7.1: Trap simulator operated by compressed air

Figure 7.1 shows a compressed air, trap simulator used in the trap assessment procedures conducted in the UK. This machine can precisely deliver impact forces in the range of 10-800 KgF and clamping forces in the range 5-500N. Animals that have been administered with both a neuroleptic anaesthetic and an analgesic are placed in the simulator and struck with a specified combination of impact force and clamping force. The simulator is fired so that the killing bar strikes the animal on the neck (i.e. the optimal position for a quick kill) and the TIU is measured by changes in the EEG and the loss of the palpebral reflex. If the animal is not rendered permanently insensible before the target TIU it is humanely dispatched by a further dose of anaesthetic. In this manner a spread of data points is collected covering a range of combinations of impact and clamping forces. As soon as the TIU for each impact/clamping force combination has been gathered it is entered into the statistical program that determines whether the data so far added are sufficient to produce a statistically robust model, or whether extra force combinations need to be tested. Once the data are sufficient to produce a model with a statistically significant fit then no more animals are tested and a probability contour plot is produced giving the probability of a TIU within the required TIU threshold for each combination of impact and clamping force. Figure 7.2 gives such a contour plot for the rabbit.

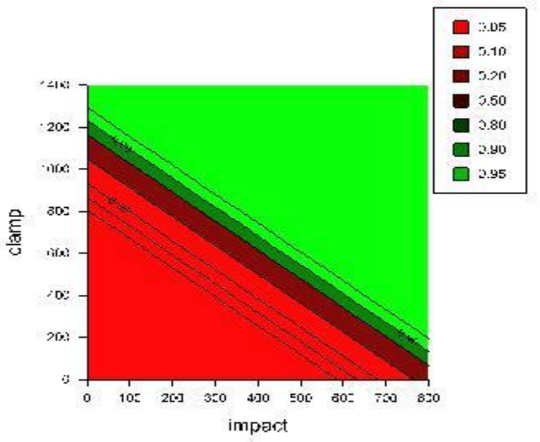

Figure 7.2: Contour graph that gives the probabilities that various combinations of impact and clamping forces will result in a TIU not exceeding 300 seconds for the rabbit.

7.2 <u>The use of anaesthetised animals</u>

The use of anaesthetised animals in the testing of killing traps was initiated in Canada in the 1970s (see Report of the Federal Provincial Committee for Humane Trapping 1981, Canadian Wildlife Service, Ottawa, Ontario, Canada) and anaesthetised animals of many species have been used in trap testing procedures; i.e. Arctic fox, Canadian lynx, ermine, fisher, marten, mink, muskrat, red squirrel, beaver and raccoon (e.g. Gilbert 1976, Zelin et al. 1983, Hiltz & Roy 2001). Similarly in other countries anaesthetised animals have been used in trap testing procedures (e.g. brushtail possums in New Zealand, Warburton & Hall 1995; Norway rat, house mouse, grey squirrel and rabbit in the UK, Fera unpublished data; muskrat in Germany, Inglis et al. 2001).

Whilst the use of anaesthetised animals ensures that the subjects do not suffer, questions have been asked about the effect the anaesthetic might have on the threshold values obtained. Gilbert (1976) argued it may be assumed that the anaesthetic will result in the animal's muscles being in a relaxed condition, and that this might lessen resistance to the blow compared to a tensed muscle mass. However, he thought that a test situation involving anaesthetised animals probably more accurately reflected what might be anticipated when an animal is hit unexpectedly by a trap device in its normal environment than would thresholds determined for unanaesthetised, restrained animals. The ISO standard for testing killing traps (ISO 10990-4, 1999) specifically requests laboratory trials involving anaesthetised animals; nevertheless it also cautions that the effect of trap forces on anaesthetized animals cannot always be directly related to their effect on live, conscious animals. The important questions therefore are: a) does the use of anaesthetics significantly affect the TIU threshold values obtained, and b) if this is the case does this mean that anaesthetised animals should not be used for trap testing?

Hiltz & Roy (2001) analysed trap testing data (gathered between 1985 and 1997 at the Alberta Research Council facility in Canada) to determine whether the TIU scores resulting from tests on anaesthetised animals were predictive of the TIU scores resulting from tests on unanaesthetised animals. They reported that the relationship between anaesthetised animal tests and unanaesthetised animal tests is not predictive, and as a result they did not recommend the use in trap testing of anaesthetised animals. However, Warburton & Hall (1995) found that the force threshold for the effective killing of anaesthetised brushtailed possum was predictive of the results obtained from tests involving unanaesthetised animals. Furthermore Hilz & Roy (2001) did find that the results from the two types of test were indeed similar for the Arctic fox and the Canadian lynx. There are, therefore, differences between species in the relationship between the data derived from anaesthetised and unanaesthetised animals. Nevertheless this does not necessarily mean that tests involving anaesthetised animals cannot be useful in trap testing procedures. The data of Hiltz & Roy (2001) show that for those species where there was no predictive relationship between the two types of test, the best linear unbiased TIU for anaesthetised animals was always less that that for unanaesthetised animals. This suggests that although results from tests using anaesthetised animals cannot always be used to determine whether a trap meets the required trap standard, they might, as Hiltz & Roy (2001) themselves argue, be used to determine whether the trap fails the standard. Unfortunately, subsequent work (M. Hiltz, pers. comm.) has found that for some types of killing trap anaesthetised raccoons take longer to die than do unanaesthetised animals. These particular traps kill by clamping the animal’s neck and restricting the flow of blood through the carotids, and it is thought that unanaesthetised raccoons die the quicker because they can struggle and thereby more rapidly diminish the oxygen level in the brain.

As no animal suffering is involved it is valuable, wherever possible, to have an initial stage of trap testing that uses anaesthetised animals. However, it should be stressed that a) the mode of action of the trap must be taken into account (i.e. whether it reduces blood flow through the carotids) when deciding whether to fail a trap solely on the basis of trials involving anaesthetised animals, and b) if a trap passes trials involving anaesthetised animals then further work involving conscious animals must be conducted to confirm that the trap does indeed meet the required standard. Experts in this field suggest that for a trap to have the potential to kill within 300 seconds with conscious animals, anaesthetised animals should loose consciousness within 10 minutes. It is therefore suggested that only traps that cause TIU under 10 minutes in anaesthetised animal trials, are progressed to pen trials. Using the Bayesian sequential stopping rules outlined below (see 7.4) it can be calculated that if all animals tested have a TIU of less than 10 minutes then a maximum of seven animals would be required.

7.3 The use of computer models.

The AIHTS permits the substitution of trap testing on live unanaesthetized animals by “any other scientifically proven suitable substitute parameter”. By using its extensive database covering 15 years of live animal trap testing, the Fur Institute of Canada has developed computer models to determine whether a trap design meets the killing trap requirements of the AIHTS. The obvious benefits of using computer models are a) they reduce the number of animals required to test trapping devices (in Canada it is estimated that to date 1200 fewer animals have been used), and b) they cost much less than the compound testing of traps (in Canada it is estimated 85% less). The computer models designed to classify the TIU scores are based primarily upon certain mechanical characteristics of the traps and the anatomical strike locations on the target species (Hiltz & Roy 2000).

In developing a computer model the velocity and momentum of each trap were determined at the trap's critical jaw displacement (which is 1/2 displacement for rotating jaw traps, 2/3 displacement for planar traps, 1/2 displacement for mouse trap style traps that rotate through 90 degrees, and 3/4 displacement for mouse trap style traps that rotate through 180 degrees; Canadian General Standards Board 1996). The clamping forces at 5 mm increments of jaw openings were also measured. For traps with double strikes, the clamping force at the larger of the two openings was chosen. The data used in the model came from animal tests that involved only strikes on a vital region of the animal; defined as anywhere from the back of the eyes to the distal end of the thorax. The mechanical characteristics of each trap design used in the models included clamping forces at trap openings, velocity of strike, shape of strike bar, trap type (i.e. rotating jaw, planar, mouse), equivalent mass, momentum, kinetic energy, and strike type (i.e. single or double). Other factors incorporated in the models included anatomical position of strike, animal size and how the trap was set. Logistic regression models were used to fit the data, with model selection based on prediction ability, R-squared values, significance of variables in the model, and collinearity diagnostics. In this way the probability that an animal lost sensibility within the TIU limits specified for it within the AIHTS was modeled. A jack-knifing approach to cross-validation was used to minimise the bias of classifying the same data from which the classification criterion was originally derived (see Hiltz & Roy 2000).

Computer simulations were then applied to the resulting models. 10,000 simulations were run to determine the percentage of passes for a particular trap design on a particular species. Each run consisted of random sampling a jaw opening from the original trap-testing database for that species. The probability of having a TIU score less than the AIHTS species limit was calculated from the clamping force, momentum, velocity and strike location. The percentage of passes out of the 10,000 tests was determined by counting the number of tests which had a higher predicted probability of passing than failing. If more than 80% of the 10,000 runs were passes then the trap design was predicted to meet the requirements of the AIHTS. Hiltz & Roy (2000) developed models for the marten, fisher and raccoon. These models proved to be a valid alternative to testing with live animals due to the high levels of safe prediction accuracy (88%, 86% and 92% for marten, fisher and raccoon respectively). Models have now been developed for rating killing devices for marten, fisher, raccoon, muskrat, beaver, mink and otter against the standards within the AIHTS; in addition, models for rating killing traps for lynx and weasel are currently under development. To date 89 killing trap designs have been rated against the AIHTS using computer models. In a similar manner a model for rating restraining traps for coyote is also being built. The original datasets used in constructing computer models for the trap standards within the AIHTS could equally well be used to develop new models for any higher welfare standards that might be adopted; including the proposed Improved Standards.

An important additional benefit of the development of a computer model has been the development by the Fur Institute of Canada of a Trap Optimisation Program. A type of sensitivity analysis of the model parameters enables the most important parameters with respect to TIU scores to be identified. It is then possible specifically to examine possible ways to enhance these parameters. All trap components act synergistically (e.g. whilst a heavier killing bar may increase momentum or clamp force it might also reduce the velocity of strike) and using a computer model takes away a lot of the trial and error experimentation that would otherwise be involved.

7.4 ***Improved experimental designs to minimize the number of animals required for trap testing.***

Experimental designs that use Bayesian Sequential Stopping Rules (BSSRs) can minimise the number of animals required for trap testing. These experimental designs are produced in two stages:

a) a trial size (i.e. maximum number of tests to be performed) and a maximum number of incidents (i.e. adverse welfare effects such as TIU scores over the limit, or unacceptable injuries) in the tested animals consistent with a maximum acceptable rate of incidents in trapped animals (at 90% confidence) is selected.

b) stopping rules are derived for the trial whereby the trial is ended and a pass/fail decision is made before the maximum number of tests has been undertaken if, given the current observations, there is a high probability (>95%) of the trial ending in passing the trap, or a high probability (>95%) of the trial ending in failing the trap. Or, to describe it in a different way, there is a probability of less than 0.05 that continuing the trial to that maximum number of tests will result in a conclusion that is counter to the current indication.

The trial sizes and maximum number of incidents are derived by calculating a one-tailed 90% interval for the probability of incidents given X incidents in N tests using a Modified Jeffries Interval (Brown et al. 2001). For a given number of incidents X=0, X=1, X=2 etc. the trial size (N) is selected so that the upper 90% one-tailed confidence interval for the binomial proportion X/N is below the target rate (e.g. 10%, 20% or 30%) and N is mimimised. Table 7.2 Shows the upper limit (with 90% confidence, calculated using a Modified Jeffreys Interval (Brown et al 2001)) for the incident rate associated with a trap given an observed number of incidents in a number of tests. Hence, if we require that a trial should demonstrate that the rate of incidents associated with a trap is less than 20% then we can use a trial based on 20.

The sequential stopping rules are derived by asking (and answering) the question if x incidents have been observed in the n tests conducted thus far, what is the probability that by the end of the trial (i.e. after conducting N-n further tests) there will be no more than X incidents in total (i.e. there will be no more than X-x further incidents) and, hence, that the trap will pass. This question can be answered by calculating the posterior probability of observing X-x incidents in N-n tests. The Jeffreys prior for inferences on p (i.e. the probability of an incident in a trapping event) is given by $\text{Beta}(0.5, 0.5)$ (Lee) and the posterior probability density function for p is given by $\text{Beta}(x + 0.5, n - x + 0.5)$ given n previous tests with x positive results (Brown et al, 2001). (Beta distributions are standard conjugate priors for binomial distributions). Hence, the probability (p_s) of observing X-x or fewer incidents in N-n future tests, given x incidents observed in n tests, is given by the beta-binomial distribution function (Evans et al. 1993) shown in Equation 1.

$$p_s = \sum_{i=0}^{i=X-x} \binom{N-n}{i} \frac{\mathrm{Beta}(x+0.5+i, n-x+0.5+N-n-i)}{\mathrm{Beta}(x+0.5, n-x+0.5)} \qquad \text{Equation 1}$$

Where *B(a,b)* is the Beta function which can be calculated using gamma functions:

$$B(a,b) = \frac{\Gamma(a)\Gamma(b)}{\Gamma(a+b)}$$

And

$$\binom{N}{i} = \frac{N!}{i!(N-i)!}$$

How such experimental designs operate can be seen by consideration of BSSRs for the welfare standards within the AIHTS. Table 7.1 shows estimates of the probability of a trap passing the restraining trap standard in the AIHTS (i.e. 4 or fewer failures within the minimum of 20 trials) if between 0 and 4 failures have been previously observed. For example, if 3 injuries occur within the first 6 captures then the probability of a successful outcome over 20 trials is only 0.03. Thus if the criterion for halting the trials is a probability of success of less than 0.05, the trials may be halted and the trap failed. If this probability is used as the minimum probability of success compatible with the continuation of the study then the following stopping rules can be derived from Table 7.1.

BSSR rules: Stop the trial if:

2 or more incidents are observed within the first 5 captures,

3 or more incidents are observed within the first 9 captures,

4 or more incidents are observed within the first 13 captures,

5 or more incidents are observed within the 20 captures.

			Failures (x)		
Trials (n)	0	1	2	3	4
1	0.595	0.044			
2	0.740	0.160	0.006		
3	0.831	0.289	0.031	0.001	
4	0.890	0.417	0.077	0.004	0.000
5	0.929	0.535	0.141	0.013	0.000
6	0.956	0.640	0.220	0.030	0.001

7	0.973	0.730	0.310	0.057	0.003
8	0.984	0.805	0.407	0.096	0.007
9	0.991	0.865	0.506	0.148	0.015
10	0.995	0.911	0.604	0.213	0.027
11	0.998	0.944	0.696	0.291	0.046
12	0.999	0.968	0.779	0.381	0.073
13	1.000	0.984	0.850	0.481	0.111
14	1.000	0.993	0.907	0.586	0.164
15	1.000	0.998	0.950	0.693	0.234
16	1.000	0.999	0.978	0.796	0.326
17		1.000	0.994	0.887	0.444
18			1.000	0.959	0.591
19				1.000	0.775
20					1.000

Table 7.1: Probability of a successful trial according to AIHTS standard for restraining traps given *x* incidents in *n* tests

One effect of using a BSSR is to slightly change the probability of a trap passing compared to the probability of the trap passing if the trial was continued up to the maximum number of tests. There is a trade-off and by not completing 20 tests the risk of failing a good trap (i.e. one that does meet the standard) is increased slighly. Nevertheless the level of animal suffering is reduced and the probability of accepting only good traps is increased. The probability of failing a good trap is greatest for those traps closest to a welfare threshold, i.e. there is very little effect on the likelyhood of passing a 'very good' trap. For example Figure 7.2 shows the relation between the probability of a trap passing a test based on AIHTS criteria and BSSR derived from table 7.1.

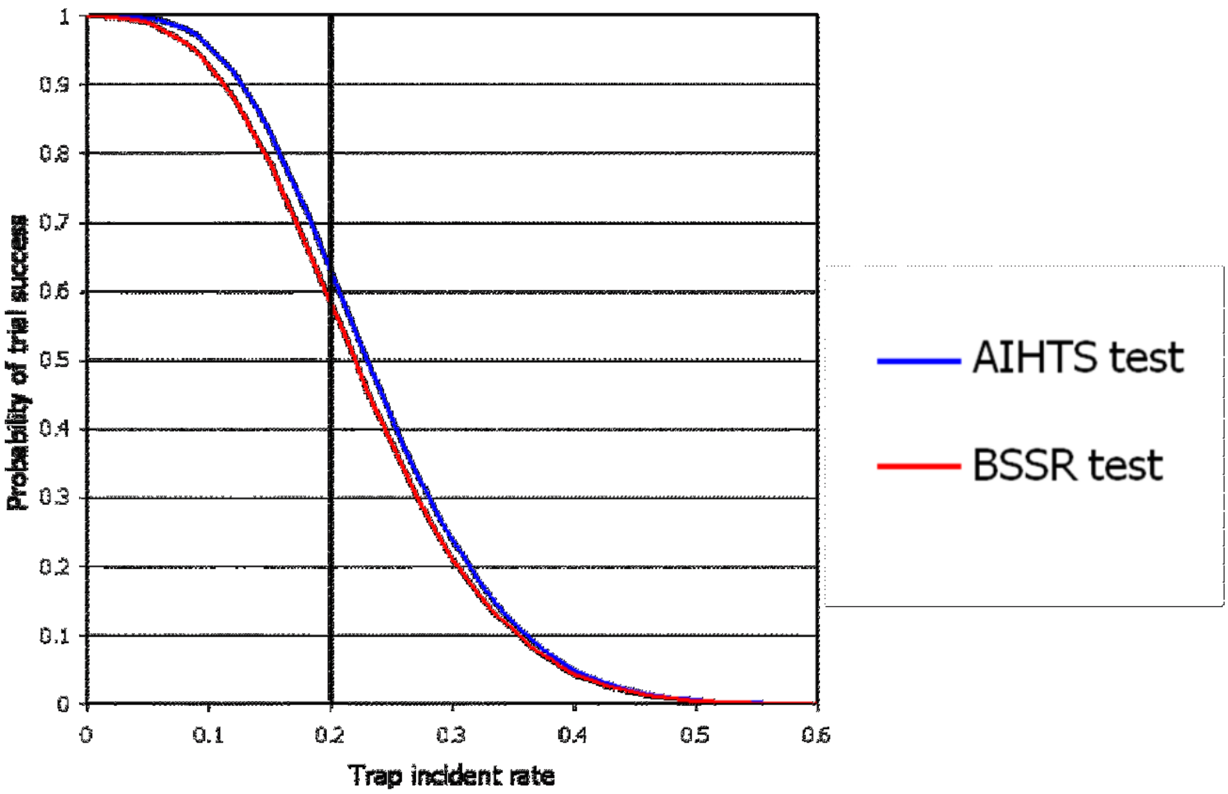

Figure 7.2: Relation between the probability of passing a trial and trap incident rate for a trial based on AIHTS criteria and a trial based derived BSSR criteria.

As already mentionned, the use of such rules can markedly reduce the average number of trials required to fail a trap (Figure 7.3) and the number of in-trial incidents (Figure 7.4).

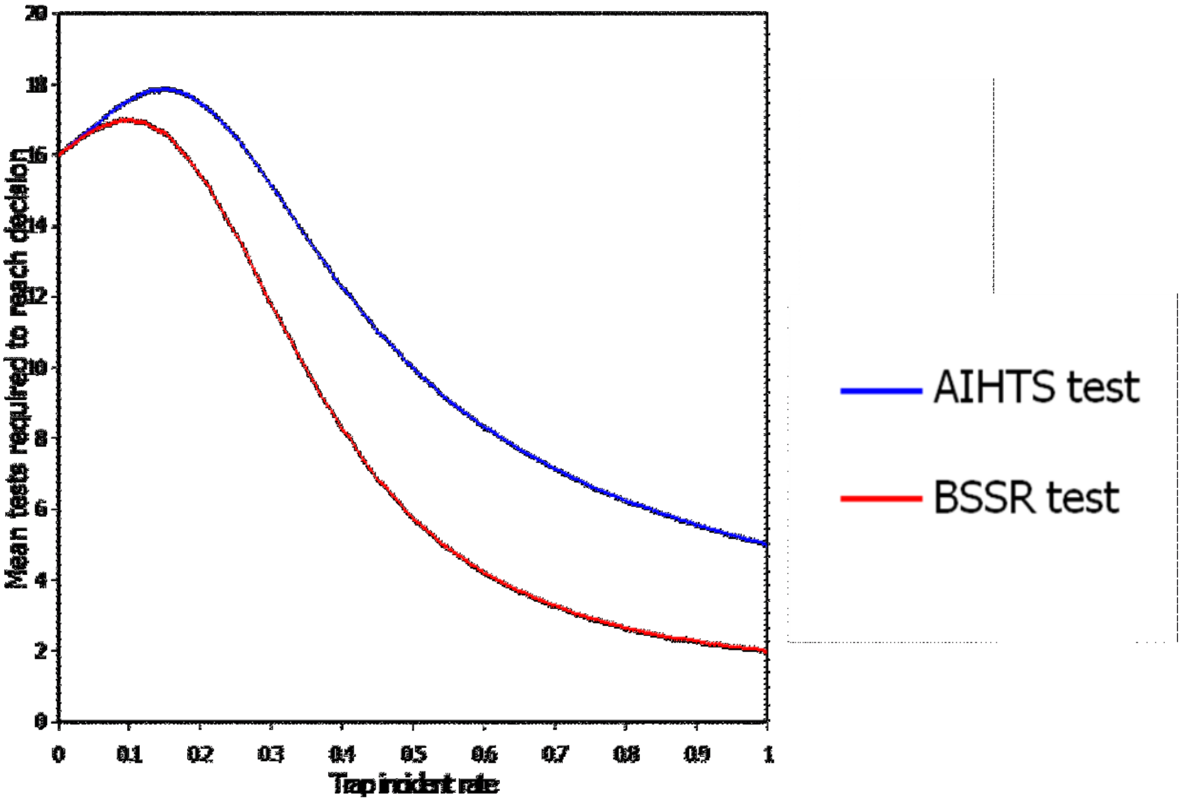

Figure 7.3: Relation between the number of tests required to reach a decision and trap incident rate for a trial based on AIHTS criteria and a trial based derived BSSR criteria.

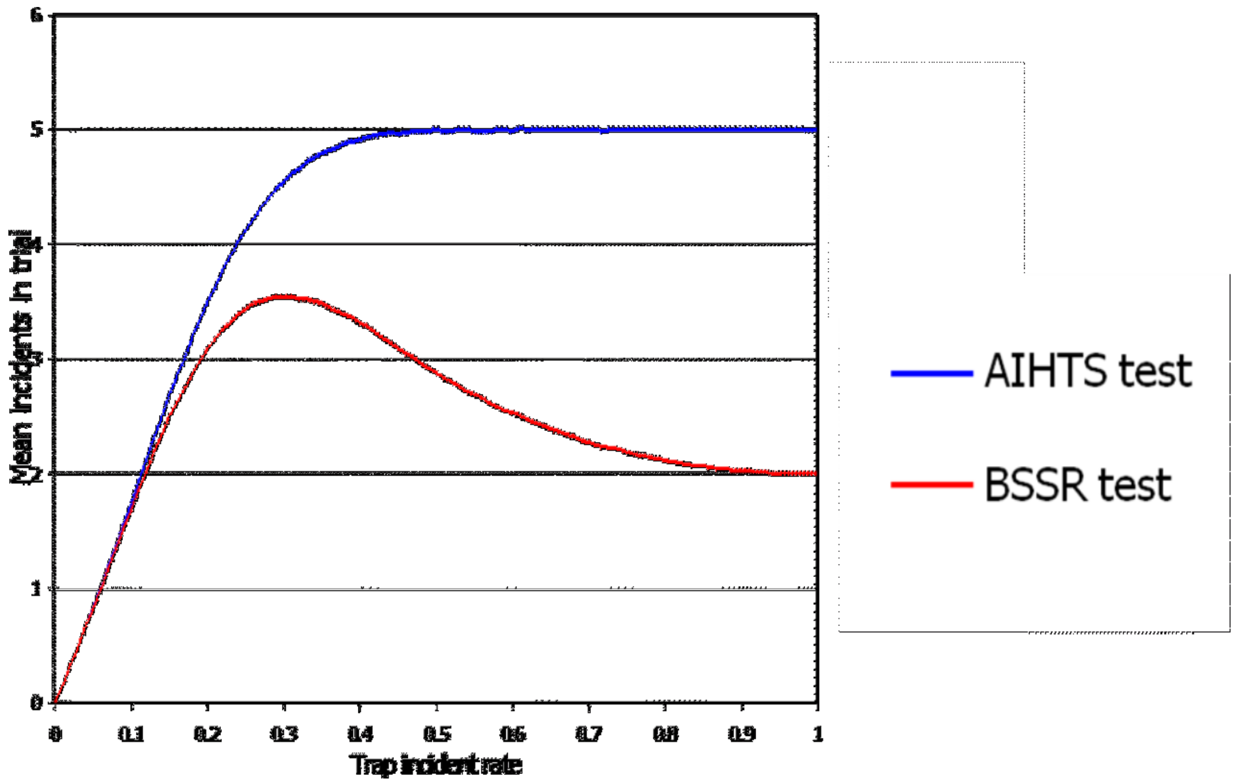

Figure 7.4: Relation between the number of in-trial incidents and trap incident rate for a trial based on AIHTS criteria and a trial based derived BSSR criteria

The effect of using BSSRs on the outcomes of trials has been assessed for a number of scenarios (see Appendix 3) by estimating the effect of trial design on four quantities, two economic and two welfare, that describe the efficacy of a trap assessment study.

The two economic quantities are:

1) the expected proportion of traps that will be rejected by a study,

2) the number of tests required to reach an accept/reject decision;

and the two welfare quantities are:

3) the expected number of in-study incidents,

4) the expected mean rate of incidents for accepted traps.

The effects of using BSSRs appear to be generally benign as shown in Appendix 3. For the scenarios reported in Appendix 3, the effects of using study plans that are designed to detect early evidence of failure (i.e. using BSSRs) on estimates of the four outcomes were a) an increase in the proportion of traps that fail by approximately 2%,

b) a reduction in the number of tests required to reach a decision by approximately 40%, c) a reduction of the number of in-study incidents by approximately 50%, and d) a reduction of the mean incident rate of accepted traps by approximately 2%.

Tables giving BSSR stopping rules are presented below (Tables 7.2, 7.3, 7.4). They are suitable for the assessment of traps against upper limits of incident rates for trapped animals of 10, 20, and 30%, all at 90% confidence. In addition to providing stopping rules to react to early evidence of failure they give rules for reacting to early evidence of success. The rules for reacting to early evidence of failure can be used without using the rules for reacting to early evidence of success and vice versa.

Columns 1 and 2 of Table 7.2, Table 7.3 and Table 7.4 show the trial size and maximum tolerable number of incidents in a trial so that the trial demonstrates (with 90% confidence calculated using a Modified Jeffreys Interval, Brown et al. 2001) that the true rate of incidents is less than 30, 20 and 10%. The tables also give the number of tests associated with the BSSR for ending a trial before the maximum number of tests have been completed when there is strong evidence ($p<0.05$) that the trial will end with a pass (i.e. the observed number of incidents ≤ tolerable number of incidents at maximum number of tests), or there is strong evidence ($p<0.05$) that the trial will end in failure (i.e. the observed number of incidents > tolerable number of incidents at maximum number of tests). An *ad hoc* rule has also been incorporated; namely that the BSSR is not applied where the observed number of incidents, or maximum allowed number of incidents, is less than two. This is to avoid pass/fail decisions being made after a very small number of tests; for example after an incident in the first test.

The tables are to be used as follows. Table 7.3 gives a trial designed to ensure that the rate of incidents associated with accepted traps is less than 20%. For a given trial size (e.g. 30) the table shows the maximum tolerable number of incidents after 30 tests (3 in this case). Then for ‘0 incidents’ the pass column has a value of 11 tests; this means that if the 11th test is completed without observing any incidents then there is strong evidence that the trap will pass the trial (i.e. there will be no more than 3 incidents in 30 tests). Similarly if the 21st test is completed after having observed no more than 1 incident, or the 27th test is completed after having observed no more than 2 incidents then there is strong evidence ($p<0.05$) that the trap will pass the trial. The fail columns give similar guidance on when to fail traps. For the 30-test trial size Table 7.4 says that if the 2nd incident is observed on or before the 6th test, or the 3rd incident is observed on or before the 13th test then there is strong evidence ($p<0.05$) that the trap will fail the trial.

The rules described by the tables can be used to ensure that trials are continued for only as long as there is a reasonable chance that further testing will generate new information. The rules allow those who are undertaking trials to react to information as it is generated so that the number of tests that are actually used are the minimum required to come to a reasonable decision, given the performance observed so far, rather than a larger fixed trial size decided before any information about trap performance is available.

Tests	Observed number of incidents									
	0	1	2	3	4	5	6	7	8	9
10	0.21	0.27	0.39	0.50	0.60	0.69	0.77	0.85	0.92	0.97
11	0.19	0.25	0.36	0.46	0.56	0.64	0.72	0.80	0.86	0.92
12	0.17	0.23	0.34	0.43	0.52	0.60	0.68	0.75	0.81	0.88
13	0.16	0.22	0.31	0.40	0.48	0.56	0.63	0.70	0.77	0.83
14	0.15	0.203	0.29	0.38	0.45	0.53	0.60	0.66	0.73	0.79
15	0.14	0.19	0.28	0.36	0.43	0.50	0.56	0.63	0.69	0.75
20	0.11	0.15	0.21	0.27	0.33	0.39	0.44	0.49	0.54	0.59
25	0.09	0.12	0.17	0.22	0.27	0.32	0.36	0.40	0.45	0.49
30	0.07	0.0997	0.15	0.19	0.23	0.27	0.31	0.34	0.38	0.41
35	0.06	0.09	0.13	0.16	0.198	0.23	0.27	0.30	0.33	0.36
40	0.06	0.08	0.11	0.14	0.17	0.205	0.23	0.26	0.29	0.32
45	0.05	0.07	0.099	0.13	0.16	0.18	0.21	0.24	0.26	0.29
50	0.05	0.06	0.09	0.12	0.14	0.17	0.19	0.21	0.24	0.26
55	0.04	0.06	0.08	0.11	0.13	0.15	0.17	0.19	0.22	0.24
60	0.04	0.05	0.07	0.097	0.12	0.14	0.16	0.18	0.198	0.22

Table 7.2: Upper limit (at 90% confidence) to the incident rate given an observed number of incidents

Trial size	Tolerable number of incidents	0 incidents		1 incident		2 incidents		3 incidents		4 incidents		5 incidents		6 incidents		7 incidents		8 incidents		9 incidents		10 incidents	
		fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass
7	0	na	7	7	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
10	1	na	10	na	10	10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
14	2	na	7	na	12	4	14	14	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
19	3	na	7	na	13	4	17	8	19	19	na	na	na	na	na	na	na	na	na	na	na	na	na
23	4	na	7	na	14	3	18	7	21	12	23	23	na	na	na	na	na	na	na	na	na	na	na
27	5	na	7	na	14	3	18	7	22	11	25	16	27	27	na	na	na	na	na	na	na	na	na
31	6	na	7	na	14	3	19	6	23	10	26	15	29	20	31	31	na	na	na	na	na	na	na
35	7	na	7	na	14	3	19	6	23	10	27	14	31	18	33	24	35	35	na	na	na	na	na
39	8	na	7	na	14	3	19	6	24	9	29	13	32	17	35	22	37	28	39	39	na	na	na
43	9	na	7	na	14	3	19	6	24	9	28	13	32	17	36	21	39	26	41	32	43	43	na
47	10	na	7	na	14	3	20	6	24	9	29	12	33	16	37	20	40	25	43	30	45	36	47

Table 7.3: Trial size, tolerable number of incidents and BSSR for trials designed to ensure incident rate of less than 30%

Trial size	Tolerable number of incidents	0 incidents		1 incident		2 incidents		3 incidents		4 incidents		5 incidents		6 incidents		7 incidents	
		fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail	pass
11	0	na	11	11	na	na	na	na	na	na	na	na	na	na	na	na	na
15	1	na	15	na	15	15	na	na	na	na	na	na	na	na	na	na	na
22	2	na	11	na	18	7	22	22	na	na	na	na	na	na	na	na	na
29	3	na	11	na	20	6	26	13	29	29	na	na	na	na	na	na	na
30	**3**	**na**	**12**	**na**	**21**	**6**	**27**	**13**	**30**	**30**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
35	4	na	11	na	21	5	27	11	32	18	35	35	na	na	na	na	na
42	5	na	11	na	22	5	29	10	35	16	39	25	42	42	na	na	na
48	6	na	11	na	22	5	29	9	36	15	41	22	45	31	48	48	na

Table 7.4: Trial size, tolerable number of incidents and BSSR for trials designed to ensure incident rate of less than 20%

Trial size	Tolerable number of incidents	0 incidents		1 incident		2 incidents		3 incidents		4 incidents	
		fail	pass	fail	pass	fail	pass	fail	pass	fail	pass
22	0	na	na	na	na	na	na	na	na	na	na
30	1	na	na	na	na	na	na	na	na	na	na
45	2	na	22	na	38	14	45	45	na	na	na
59	3	na	23	na	41	11	52	25	59	59	na

Table 7.5: Trial size, tolerable number of incidents and BSSR for trials designed to ensure incident rate of less than 10%

7.5 Conclusions

For both killing traps and restraining traps it is proposed that the Improved Standards incorporate the following sequential testing procedures that try to ensure a) that only the minimum number of conscious animals are tested on traps that are likely to fail the Improved Standards, and b) that any trap that passes will perform similarly on animals in the wild.

Killing traps.

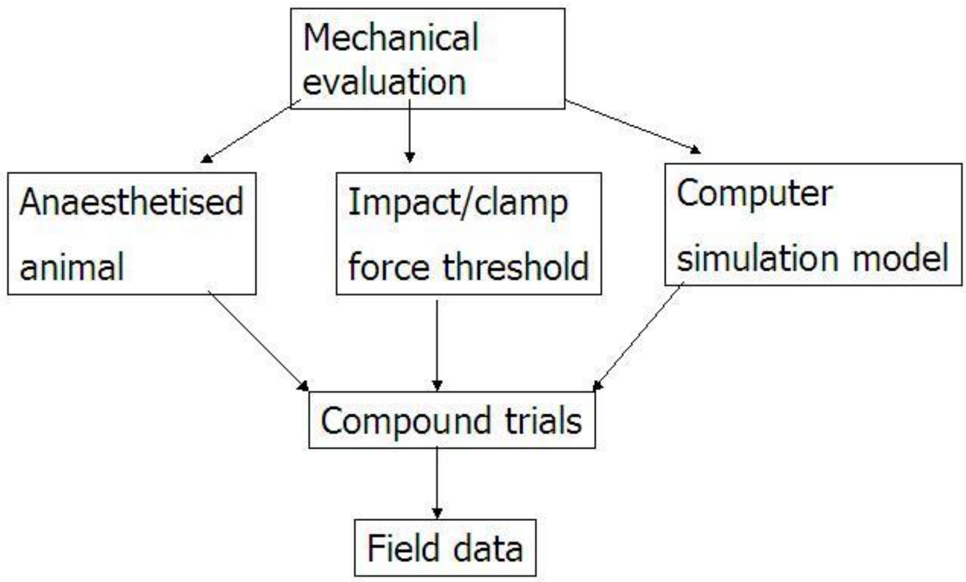

Figure 7.6: Flow chart of testing protocol for killing traps.

It is proposed that if killing traps of an identical mechanical construction to some already tested are being assessed, then only comparison of mechanical impact and clamping forces need to be carried out. For traps where a computer model has been developed and validated for the target species, assessment would be undertaken using this computer model. For traps that already meet the AIHTS only pen trails would be required to determine the time to TIU.

For novel designs of trap, for a new target species, and for situations where there is no computer model, tests with anaesthetised animals would initially be undertaken. Only if the TIU scores in such tests were under 10 minutes, would live captive animal trials be carried out. If the TIU is less than the Welfare Category threshold for that particular species in > 80% of tested animals, then field trials would be undertaken. To determine selectivity and effectiveness (see chapter 8), field trials would need to be carried out in the range of habitats that the proposed trap would be used in.

Restraining traps

As captive animal trials do not adequately replicate the animal-trap interaction found in the wild (unless the test compound are large and accurately mirror the normal habitat), it is proposed that only seven tests involving captive animals are carried out for any new restraining device. As long as no severe injuries are found in these tests, then field trials should be conducted in the habitats where the device will potentially be used. For the assessment of traps that are already in widespread use data should be obtained from normal usage in the field. Experimental staff should accompany experienced trappers while they are using the device on test to obtain the relevant data because trapper experience can have significant impacts on the results obtained (see Chapter 8).

8 Best Practice in the use of traps

This chapter considers the importance of 'best practice' information, not only on the welfare of the trapped animal but also on trap efficiency and selectivity. It is proposed that a series of species-specific Best Practice Guides be developed, similar to the system of Best Management Practice documents used in the USA. Also, rather than try to deal with the issues of trap efficiency and selectivity by incorporating efficiency and selectivity criteria in the Improved Standards, it is proposed that these issues be addressed in Best Practice Guides that take account of local conditions. It is also suggested that the Improved Standards include the minimum requirement that both restraining and killing traps should be inspected once every 24 hour. However killing traps that meet the higher Welfare Categories A and B of the Improved Standards have safeguards that should avoid any animals surviving longer than the upper limits, and could be made exempt from this requirement.

Summary

The aims of this chapter are:

e) **to consider how information on trapping best practice should be disseminated,**
f) **to discuss the setting of criteria for trap efficiency,**
g) **to discuss the setting of criteria for trap selectivity,**
h) **to consider how the length of time between trap inspections affects the welfare of trapped animals.**

a) Best Practice Information. How a trap is used is crucial to the welfare impact it has on the target species, to the non-target risk it poses, and to its efficiency. A criticism that has been levelled at the AIHTS is that it concentrates too heavily on the trap itself and does not deal sufficiently with such issues as trap efficiency, non-target risk, and the training and registration of trappers. However, the EU encompasses a wide range of both habitats and non-target species and the best way to minimise non-target risk and maximise efficiency under the local conditions found in one Member State may not be best practice under the local conditions of another Member State. Similarly Member States differ (see Chapter 2) in their legislative requirements for trapper training and/or trapper registration. Rather than try to deal with the complexity of these issues through legislation , an arguably better way is through the production of a series of species-specific Best Practice Guides. Whilst an expert committee could determine what sorts of information should be within such documents, the resulting templates could be amended at the national level to take into account local conditions. There would be a presumption that traps would be used according to the Best Practice Guides, and they could be granted legal status by national governments if required. This is the policy successfully adopted in the USA where Best Management Practice documents (BMPs) have been developed for each species.

b) Trap efficiency. The large number of factors affecting trap efficiency means that it is very difficult to draw up efficiency standards that are applicable to all the species covered by the AIHTS and to the very wide range of habitats found within the EU. One way to tackle this problem is to compare the capture efficiency of the test trap with that of a control trap. The draft ISO standard suggested that the control trap should be the trap in most common use. However, the trap in most common use can differ between countries and, therefore, there is no single ‘control trap’ that can be specified and standardised internationally. Furthermore, as the control trap may vary in efficiency from one trapline to another, among years, and between trappers, it has been argued that the use of such an efficiency standard is arbitrary. Rather than try to define efficiency criteria in the Improved Standards, it is proposed that advice on trap efficiency should be provided within species-specific, Best Practice Guides that take into account local conditions. Trap efficiency is to some degree automatically included in the Improved Standards in that if an animal escapes from a trap during testing then that test is classed as a failure.

c) Trap selectivity. Trap selectivity criteria have been included in some national trap standards by comparison with the selectivity of a control trap. Unfortunately the use of a control trap means that the problems discussed above in relation to trap efficiency apply also to setting an international standard for trap selectivity. The selectivity of traps varies widely with trap type; with box/cage traps having the highest incidence of non-target captures and drowning traps the lowest. Non-target risk also varies with how the trap is set, the bait used and the season. Again, rather than try to define selectivity criteria in the Improved Standards it is proposed that practical advice on ways to reduce non-target risks should be provided within the species-specific, Best Practice Guides.

d) Time between trap inspections. Whilst increased periods of confinement in leghold traps are associated with more struggling and consequently greater injuries, the strength of the correlation between injury and time in a restraining trap varies with species. A daily inspection regime (i.e. once every 24 hours) appears to be the minimum accepted standard in most countries, and checking in the early morning is thought to be best in order reduce the level of injury suffered by the captured animal. With some exceptions (e.g. UK) inspection times have not been specified for killing traps because it is assumed that all captured animals are killed by the trap. It is proposed that the Improved Standards include the minimum requirement that both restraining and killing traps (apart from drowning traps where the death of the trapped animal is assured) should be inspected once every 24 hours. Killing traps that meet the higher Welfare Categories A and B have been through a testing procedure that safeguards against any animals surviving for longer than the upper time limits and therefore could be made exempt from such frequent inspections. This may encourage the development and uptake of these categories of trap.

8.1 The importance of advice on how best to use traps

How a trap is used is crucial to the welfare impact it has on the target species, to the non-target risk it poses, and to its efficiency. Even apparently innocuous changes in the way a trap is used can have a large effect upon the outcome. For example, Inglis et al. (2001) conducted trials of a spring trap to kill muskrats. Good reports had been received about the trap and the experimenters were surprised when the first animal tested had to be humanely killed because its TIU had reached the AIHTS limit of 300 seconds. Work was suspended whilst more information about the trap was sought from experienced muskrat trappers. It was discovered that the pieces of apple used as bait by the most experienced trappers were smaller than the piece of apple that had been used in the experimental trial. When the size of the apple bait was made smaller in the subsequent experimental trials the TIU scores were greatly reduced to around 30 seconds. Video records showed that the size of the bait had a marked effect on the muskrats' behaviour. An animal faced with a small piece of apple stretched out its body and neck to try to remove the apple from the trap, and as a result was struck on the back of its neck. However, when faced with the large piece of apple the first muskrat tested showed a different behaviour; it attempted to eat the bait *in situ* and as a result was struck on its back. This example clearly indicates the vital importance of so-called 'Best Practice' information.

A criticism that has been levelled at the AIHTS is that it concentrates too heavily on the trap itself and does not deal sufficiently with such issues as trap efficiency, non-target risk, and the training and registration of trappers. However, the EU encompasses a wide range of both habitats and non-target species and the best way to minimise non-target risk and maximise efficiency under the local conditions found in one Member State may not be best practice under the local conditions of another Member State. Similarly Member States differ (see Chapter 2) in their legislative requirements for trapper training and/or trapper registration. Rather than try to deal with the complexity of these issues through legislation , an arguably better way is through the production of a series of species-specific Best Practice Guides adapted to local conditions. This is the policy successfully adopted in the USA where Best Management Practice documents (BMPs) have been developed for each species.

8.2 Best Management Practice (BMP) documents in the USA

The goals of the BMP programme in the USA are;

(see http://fishwildlife.org/furbearer_resources.html)

a) to promote regulated trapping as a modern wildlife management tool,

b) to identify practical traps and trapping techniques that continue to improve efficiency, selectivity, and the welfare of trapped animals,

c) to provide specifications for traps that meet BMP criteria for individual species in the various regions of the United States,

d) to provide wildlife management professionals with information to evaluate trapping systems in the United States

e) to instil public confidence in, and maintain public support for, wildlife management and trapping through the distribution of science-based information

The BMP framework provides a structure and criteria for identifying and documenting trapping methods and equipment that improve both trapping efficacy and selectivity, and the welfare of the trapped animal. All BMPs are available via the internet and can be revised in the light of fresh information. As well as trappers, BMPs also go to the people in each state who are responsible for policy and regulations, and in some states BMPs have legal standing. There is a high acceptance of BMPs by trappers in the United States, and their use is expected to increase over time.

To date BMP documents have been completed for 15 species. Each fur bearing species in the USA was allocated to a high, medium or low priority category for the purposes of conducting trap research. The priority given to a species is based upon a) its range, b) its wildlife conservation and management significance (e.g. used for fur, a major pest animal), and c) the difficulty in acquiring data on it. The High Priority category contains the raccoon, coyote, red fox, nutria, muskrat, gray fox, mink and American marten. The Medium Priority category contains the beaver, bobcat, opossum, striped skunk, gray wolf, badger, river otter, swift fox, kit fox and fisher. The Low Priority category contains the Canadian lynx, ringtail, Arctic fox, wolverine and weasel. The selection of the traps to be included in the research programme is determined by a) the most commonly used trap types based upon surveys, b) the most promising, commercially available traps expected to demonstrate little or no injury, and c) commercially available modifications that are known to be contributors to injury. A total of 90 trap types have been tested and this has involved 300,000 trap nights. The USA has been divided into five geographic regions and traps are tested in all five regions; not only because of the very distinct environmental conditions encountered in each geographic area but also because trappers place most value on the results of research conducted in an area like their own.

The sort of information contained within each BMP can be illustrated by considering the contents of the BMP on the trapping of mink in the USA. As well as text, many diagrams and photos are used to illustrate the advice provided. There is an initial section providing general information about the mink under the headings: a) characteristics, b) range, c) habitat, d) food habits, e) reproduction, and f) populations. This is followed by an overview of those traps that meet the BMP criteria for trapping mink; the traps are classified into coil-spring, long-spring, bodygrip set under water only, and bodygrip set on land or underwater. The next section is entitled ‘General considerations when trapping mink’. It contains practical advice such as “Loosening pan tension so that the pan moves freely may improve efficiency”, and “Should be set so that the rotating jaws capture the animal by closing on the top and bottom of the captured animal’s neck”. A section on operator safety describes how to handle the traps safely and how to use appropriate safety devices such as a ‘setting tool’ and a ‘safety gripper’. The largest section contains the specifications of each trap that meets the BMP criteria for trapping mink in the USA. Trap names are used to identify specific traps but the information “is provided for information purposes only, and does not imply an endorsement of any manufacturer”. A mechanical description (e.g. inner jaw spread, jaw width, whether the base plate is reinforced, whether there is a pan stop) of each trap is given, together with additional information such as the chain attachment that was used in testing and what features the trap has to improve selectivity.

8.3 <u>Trap efficiency</u>

The way a trap is set affects its efficiency. Trap efficiency is the rate at which a trap catches the target species and has frequently been expressed as the number of captures per 100 trap-nights (e.g. Novak 1987). Defining a capture rate based upon the number of target animals caught divided by the number of times the trap has sprung may not be useful since it is often difficult to tell if a trap is sprung by a target or a non-target animal if it escapes. Another component of trap efficiency involves the time and effort required to set the trap (Boggess et al. 1990) but little information has been published on this issue.

Pawlina & Proulx (1999) have classified the factors affecting trap efficiency into:

a) Trapping Methods: trap type, trap set, bait and lure, rebaiting, number of traps per unit area, visitation rate, trapper's experience, and trap use learning curve.
b) Environmental variables: seasons, habitat, and weather.
c) Biological variables: population density, behavioural variation within species, and intra- and inter-specific olfactory communication.

The large number of factors affecting trap efficiency means that it is very difficult to draw up efficiency standards that are applicable to all the species covered by the AIHTS, and to the very wide range of habitats and climates found within the EU. One way to tackle this problem is to compare the capture efficiency of the test trap with that of a 'control trap'. For example, the NAWAC Guideline in New Zealand states that the capture efficiency of the test trap, when used in accordance with the manufacturers instructions, "shall be at least 80 per cent of the control trap's capture efficiency before the test trap can be considered as a replacement for an existing trap (that is, the existing trap can be considered for prohibition)." In the draft ISO standard the test trap had to be at least 75% as efficient as the control trap. A major problem with this approach concerns the selection of the control trap. The draft ISO standard suggested that the control trap should be the trap in most common use. However, the trap in most common use can differ between countries and, therefore, there is no single 'control trap' that can be specified and standardised internationally. Furthermore, as Pawlina & Proulx (1999, p108) state, "Knowing that a control trap may vary in efficiency from one trapline to another, among years, and between trappers, and after considering all the factors [listed above] that may impact on capture success, we believe that the use of such an efficiency standard is arbitrary and improper."

Rather than try to define efficiency criteria in the Improved Standards, it is proposed that advice on trap efficiency should be provided within the species-specific, Best

Practice Guides that take into account local conditions. If required, trap efficiency could then be assessed using a different but appropriate control trap within each Member State. It should also be remembered that trap efficiency is to some degree automatically included in the Improved Standards in that if an animal escapes from a trap during pen or field trials then that test is classed as a failure.

8.4 Trap selectivity

Trap selectivity is usually measured as the number of animals of the target species caught relative to the number of captured animals from non-target species. Trap selectivity criteria have been included in some trap standards. For example, the NAWAC Guideline states that "the selectivity of the trap [when used with the manufacturers instructions] should not be less than the control trap" but adds the rider that "Consideration needs to be given to whether the actual, and likely, non-target animals are protected animals or other pest species. Greater leniency should be given where non-target animals are pest species." Unfortunately the use of a control trap means that the problems discussed above in relation to trap efficiency apply also to setting an international standard for trap selectivity.

Iossa et al. (2007) conducted a review and found that the selectivity of traps varies widely with trap type. Box/cage traps had the highest incidence of non-target captures (e.g. 93%, Way et al. 2002) and drowning traps the lowest (e.g. 1.5 – 7.4%, Crasson 1996). Non-target risk also varies not only with the type of trap but with how the trap is set, the bait used and the season (e.g. Novak 1987). Changing the pan tension of the trap is one of the most practical and inexpensive ways to increase target-specificity (e.g. Turkowski et al. 1984). Olfactory baits (e.g. Robbins et al. 2007) made from blends of biological tissues and fluids have been found to increase both capture rates (e.g. Turkowski et al. 1983) and trap selectivity (e.g. Shivik & Gruver 2002) for some species (e.g. coyotes). Many killing traps are set in tunnels and here physical excluders can be used to increase target specificity. For example Short & Reynolds (2001) found that a grid placed across the tunnel entrances did not decrease stoat or weasel capture rates but did substantially reduce the capture of grey squirrels, Norway rats and hedgehogs.

Again, rather than try to define selectivity criteria in the Improved Standards it is proposed that advice on reducing non-target risks should be provided within the species-specific, Best Practice Guides. If required, trap selectivity could then be assessed using a different but appropriate control trap within each Member State.

8.5 Trap inspection times

Increased periods of confinement in leg-hold traps are associated with more struggling and consequently greater injuries (Powell & Proulx 2003); for example, when leghold traps to catch Arctic foxes were inspected daily, 2% of captured target animals were dead, compared with 24% when inspection times were longer (Proulx et al. 1994). However, the strength of the correlation between injury and time in the trap varies with species; for example, the majority of activity in captured dingoes (Marks et al. 2004) and European badgers (DEFRA unpublished data) occurs shortly after capture and that is when trauma such as tooth damage is most likely to occur.

Unfortunately, the time an animal has been caught in a trap is usually based upon the period between inspections and is, therefore, imprecise. Although most studies employ a daily inspection regime, some have had inspection times of 48 hours (e.g. Stevens & Brown 1987) and others have used an irregular inspection pattern (e.g. Fleming et al. 1998). Furthermore, as several authors have pointed out (e.g. Fox & Papouchis 2004, DEFRA 2005, Iossa et al. 2007) a daily inspection of traps could involve inspection at dawn on one day followed by an inspection at dusk on the following day, thereby allowing some 36 hours to elapse. It is commonly thought that increasing human presence at the trap site by increasing the frequency of trap inspections will reduce trapping success. Whilst this is likely to be the case with short inspection times there are no studies that quantify the degree to which increased frequency of inspection reduces trapping success. One solution to the problem of minimising both the length of time an animal is in a trap and the degree of human disturbance resulting from trap inspections, is to use a trap-signalling device (Marks 1996, Larkin et al. 2003) that transmits a signal to the operator when the trap is sprung.

In most Member States (with some exceptions e.g. UK) and other countries outside of the EU inspection times are not specified for killing traps because it is assumed that all captured animals are killed by the trap. A daily inspection regime for restraining traps is a requirement in many Member States (see Chapter 2), as it is in countries outside the EU (e.g. New Zealand) and some 33 states of the USA. In Sweden traps must be inspected not less than twice per day, and this may partly account for the low injury scores reported by Englund (1982) for foxes caught in leg-hold traps and snares. Daily (i.e. once every 24 hours) appears to be the minimum accepted standard for checking restraining traps, and checking in the early morning is thought to be best in order to reduce the level of injury suffered (e.g. Andelt et al. 1999). In circumstances it may be necessary to inspect more frequently than once a day; for example in times of intense heat (Logan et al. 1999).

It is proposed that the Improved Standards include the minimal requirement that both restraining and killing traps (apart from drowning traps where the death of the captured animal is assured) should be inspected once every 24 hours. However, it is also suggested that killing traps that meet the higher Welfare Categories A and B could be made exempt from the requirement to carry out a daily inspection as this would encourage the development and uptake of these categories of trap.

8.6 Conclusions

Rather than try to deal with the issues of trap efficiency and selectivity by incorporating formal efficiency and selectivity criteria based upon comparisons with control traps into the Improved Standards, it is proposed that these issues be addressed within species-specific Best Practice Guides. It is proposed that an expert committee should determine what sorts of information should be within such documents, but that the resulting template Best Practice Guides could be amended at the national level to take into account local conditions. Member States would also be free to impose more strict inspection regimes than those specified in the Improved Standards, and these could be specified within the Best Practice Guides distributed within each Member State. There would be a presumption that traps would only be used according to the Best Practice Guides, and that they could be granted legal status by national governments if required.

9 Technical Workshop on International Trapping Standards

This chapter presents summaries of the presentations and discussions that took place during a Technical Workshop on International Trapping Standards held between October 28th and 30th 2008 at the Central Science Laboratory, York, UK. The aims of the Workshop were a) to review the various welfare assessment methodologies and standards for killing and restraining traps in the light of new research, b) to discuss draft proposals for improved animal welfare standards for killing and restraining traps used within the EU, and c) to consider the welfare of animals caught in drowning traps; particularly with regard to the control of muskrats. The Workshop was attended by members of the EU Contract Consortium, by international experts on trapping and/or animal welfare, and by a member of the European Commission (see Acknowledgements).

Summary

The aims of this chapter are:

- **d) to present summaries of the lectures and discussions that took place on Day 1 of the Workshop which was spent discussing the methods of testing, and the trap standards applied to, restraining traps.**
- **e) To present summaries of the lectures and discussions that took place on Day 2 of the Workshop which was spent discussing both the methods of testing and the trap standards applied to killing traps, and new approaches to trap testing.**
- **f) To present summaries of the lectures and discussions that took place on Day 3 of the Workshop which was spent discussing the welfare of animals caught in drowning traps; particularly with regard to the control of muskrats.**

a) Day 1: Restraining traps. On the morning of Day 1 of the Workshop there was an initial lecture on the history of ISO Technical Committee 191 (ISO TC/191) with regards to the debates that took place during the development of draft ISO Standards for restraining traps. Subsequently there were lectures and discussions on the current restraining trap standards and trap-testing methodologies being used in New Zealand, the USA and Canada. Improved Standards for restraining traps were then proposed that would incorporate the standards currently contained in the AIHTS. The afternoon was spent discussing the proposed improvements to restraining trap standards and trap-testing methodology; including the potential use of behavioural and physiological indices of welfare.

b) Day 2: Killing traps and new approaches to trap testing. The initial lecture on Day 2 of the Workshop gave the history of ISO TC/191 with regards to the debates that took place during the development of draft ISO Standards for killing traps. This was followed by lectures and discussions on the current killing trap standards and trap-testing methodologies being used in New Zealand and Canada. The Improved Standards for killing traps were then proposed that would incorporate the standards currently contained in the AIHTS. The afternoon was spent discussing the proposed improvements to killing trap welfare standards and trap-testing methodology; including ways (e.g. use of stopping rules, computer models) to minimise the numbers of animals required for such testing.

c) Day 3: Drowning traps. Drowning traps were discussed on Day 3 of the Workshop. After a lecture illustrating the serious problems that muskrats can cause and the current methods used in the EU for their control, there was a lecture and discussion on the experiments being conducted by the Consortium to assess the welfare of muskrats in drowning traps; particularly with regards to measuring the time to irreversible unconsciousness (TIU) of muskrats in drowning traps.

9.1 *Programme of the Technical Workshop on International Trapping Standards*

Held at Central Science Laboratory, York,
28th to 30th October 2008

1) Welcome and Introductions

2) Background to, and aims of, the Technical Workshop

3) Restraining traps

i) The development of the ISO standards.
ii) Current trap standards and trap-testing methodology in:
  a) New Zealand.
  b) USA.
  c) Canada.
iii) Proposed EU Improved Standards.
iv) Discussion of proposed standards and testing methodology for restraining traps.

4) Killing traps

i)The development of the ISO standards.
ii) Current trap standards and trap-testing methodology in:
  a) New Zealand.
  b) Canada.
iii) Proposed EU Improved Standards.
iv) Discussion of proposed standards and testing methodology for killing traps.

5) New approaches to trap testing

i)Statistical methods to reduce animal use in trap testing.
ii) Risk assessment approach to the trap certification

6) Drowning traps

i)The types of damage caused by muskrats in the EU.
ii) Research carried out on muskrat drowning traps.
iii) Discussion of issues surrounding submersion traps.

7) Round-up of Workshop

9.2 Summaries of Presentations

The participants were welcomed to the Central Science Laboratory, and it was explained that the aims of the Workshop were:

a) to review the various welfare assessment methodologies and standards for killing and restraining traps in the light of new research,
b) to discuss draft proposals for improved animal welfare standards for killing and restraining traps within the EU (referred to as the Improved Standards), and
c) to consider the particular issue of the welfare of animals caught in drowning traps; particularly with regard to the control of muskrats.

The organisation of the Workshop was as informal as possible in order to encourage discussion. The three days of the Workshop were divided into: Day 1 presentations and discussion concentrating on restraining traps, Day 2 presentations and discussion concentrating on killing traps, and Day 3 presentations and discussion on submersion traps; particularly drowning traps for muskrats. [N.B. where appropriate the speakers split their presentation into two parts, giving a talk concentrating on restraining traps on day 1 and a talk focussing on killing traps on day 2; however, for the purposes of this report a single summary is given.]

9.3 Introduction.

The Agreement on International Humane Trapping Standards (AIHTS) between Canada, the Russian Federation and the EU was approved by Council Decision in 1998. A substantially similar understanding concerning the standards was also reached in the form of an Agreed Minute with the USA. In 2004 the European Commission submitted a proposal for a Directive of the European Parliament introducing welfare standards related to trapping for certain animal species with the objective to implement the obligations and commitments arising from the AIHTS and the Agreed Minute. However, during the first reading the draft directive was rejected for a variety of reasons by the European Parliament. Some of the reasons for the rejection were contradictory but the main objection was that, after taking account of the time passed since the AIHTS was negotiated, the science incorporated into the AIHTS might not be the best possible and most relevant today. The Commission took note of this objection and accordingly instigated a Study Contract to review the current state of scientific research in regard to trapping with the view to identifying improved trapping standards and traps that reduce pain suffering and distress as far as possible. The Technical Workshop formed one component of this contract.

9.4 The development of the ISO (International Organization for Standardization) trap standards; How ISO works and doesn't work.

Interest in developing an ISO Standard defining 'humane' traps was first expressed at the 1983 meeting of CITES when Canada requested such a standard and offered to provide funding for the Secretariat responsibilities of a Technical Committee established to develop such a standard. A Technical Committee was established (i.e. ISO TC/191 "Humane animal (mammal) traps") and met for the first time in 1987. TC/191 initially formed two main Working Groups, one on Restraining Traps and one on Killing Traps, and later a third was established on Submersion Traps. In addition several *ad hoc* groups were formed to deliberate on specific issues that arose in the discussions of the Working Groups.

The objective of TC/191 was to develop international trap performance standards to provide a) welfare thresholds for traps, b) a framework for future technical developments, and c) the requirements for product certification. Right from the beginning there was a major problem associated with the term 'humane', which was included in Council Regulation 3254/91. This regulation prohibited the import into the EU of fur from wild-caught animals of 13 species (none of which occurred in the EU) unless a) the producers banned the use of leg hold traps as defined in the Regulation, or b) the producers used trapping methods that met internationally agreed humane trapping standards. From around 1989 through to 1994 the number of anti-fur campaigns in EU member states increased markedly. Anti-fur proponents saw the ISO attempt to develop international humane trapping standards as a loophole in EU Regulation 3254/91 that would enable fur imports into the EU to continue. Proponents for and against the import of furs therefore increased their involvement with the ISO process. In 1993 the Eurogroup for Animal Welfare, the European Federation for

Nature and Animals, European Commission - Environment Directorate, the World Society for Protection of Animals, and the International Fur Trade Federation joined TC/191 not as Members but as Category A Liaison Groups; which meant they enjoyed full participation in the meetings but had no voting rights. However, pro- and anti- fur proponents were able to influence the voting process by joining the various national standards ISO groups of the nations that were Members and hence had voting rights.

In 1994 draft trap standards were put forward and the Committee Chairman proposed that discussion of the meaning of the term humane be postponed until after discussion of the draft standards. However, this proposal was overturned and TC/191 debated the meaning of the term 'humane' continuously for four days. At that time the EU Commission's representative considered that a reference to the term 'humane' in relation to the provisions in Council Regulation 3254/91 was important. . Within TC/191 a consensus emerged to drop the term 'humane' from the title and the body of the draft. Debate then passed on to the draft standards.

The ISO draft standard for restraining traps involved: a) a table of 13 injuries, each with an associated point scale based upon severity of the injury and a trap had to score less than the maximum allowable score of 75 in order to pass, b) a table of unacceptable injuries, for which none could be caused by the trap in order for it to pass, c) a strategy relating to Transitional Traps (i.e. traps that were not in full compliance with the standard), and d) a statement to the effect that more research was needed on the reliability and interpretation of behavioural and physiological indices of stress before these could be incorporated into the standard.

The killing trap draft standard involved a) a stepwise testing procedure with initial laboratory tests on anaesthetised animals and subsequent compound trials with conscious animals, b) three killing thresholds based upon the time to irreversible unconsciousness (TIU) and subsequent death of the captured animal, and c) a strategy for Transitional Traps.

A killing threshold of 180 second TIU had been arrived at as a result of trap research and testing carried out in Canada by a Federal/Provincial Committee for Humane

Trapping (FPCHT) from 1975-1981. Tests using rotating jaw, planar striking bar and mousetrap type devices indicated that a 180 second TIU was achievable for several species from mink to beaver. This was also based on predetermined species-specific kill thresholds developed using non-lethal animal/trap approach studies, anaesthetized animal/trap studies and the synergistic application of a trap's impact and clamping forces. The final 1995 ISO TC/191 Standard suggested two other TIU thresholds of 30 seconds and 60 seconds with applicable levels of performance

Unfortunately, no consensus could be reached within TC/191 on the welfare thresholds within the draft standards. As a result the Chairman drafted and circulated to TC/191 participants a 'testing methods document' that omitted the welfare thresholds and concentrated instead solely on the methods that should be used to test a trap; i.e. on how to gather the data needed to assess the animal welfare aspects of trap performance, and not on how to interpret the data thus gathered. In 1995 a last attempt was made to get consensus on the welfare thresholds and when this failed it was agreed to suspend work on the three-part 'humane' trap standard. Instead *ad hoc* groups were established to develop draft trap testing standards. In 1996 consensus was reached on the new draft standards and in 1999 the ISO published them. The term 'animal welfare' was retained in the Introduction and Scope of the Standard for testing restraining traps and in the Introduction of the Standard for testing killing traps. This was to ensure that the ISO TC/191 reflected the attitude of caring, kindness and humaneness as an integral part the committee's deliberations.. ISO TC/191 is on 'Standby Status' and is due to be reviewed in November 2009. For an ISO Member to re-open this committee in order to add welfare thresholds to the existing trap testing standards would require significant funds and courage.

With the failure of ISO to develop internationally agreed "humane trapping standards" containing welfare thresholds, in 1998 the AIHTS was negotiated between the EU, Canada, and the Russian Federation, and a substantially similar understanding concerning the standards was also reached in the form of an Agreed Minute with the USA. However the trap testing Guidelines within the AIHTS state that "for assessment of conformity of [AIHTS] trapping methods the ISO procedures shall be used as appropriate". Thus the answer is both no and yes to the question was the ISO initiative successful? Any attempt to re-open the ISO process in order to agree welfare thresholds would require a fresh supply of money.

9.5 New Zealand's trap testing procedures.

The Animal Welfare Act 1990 provided the legislative framework covering trapping in New Zealand. Although Section 176 of the Act exempts the hunting and killing of wild animals or pests, Section 32 allows the restriction or prohibition of traps that cause "unreasonable pain or distress". The Act does not require traps to be tested and approved before sale; i.e. traps are innocent until proven guilty. The National Animal Welfare Advisory Committee (NAWAC) oversees the trap-testing guidelines and makes recommendations for the restriction or prohibition of traps to the Minister of Agriculture. The NAWAC Guideline 09 'Assessing the welfare performance of restraining and kill traps' is based upon draft ISO standards developed by TC/191 for restraining and killing traps. The Guideline does not deal with submersion traps because New Zealand has no semi-aquatic species. It has pass/fail criteria and provides guidelines for testing capture efficiency, target specificity and operator safety. The introduction of the NAWAC trapping standards has encouraged the development of new traps, and for most target species there are now several killing traps available that meet these standards.

For restraining traps there has to be a minimum of 25 captures and at least 10 traps have to have at least one capture. A wildlife pathologist must examine the bodies and injuries are classified following a standardised table of traumas rather than by using a score system whereby different injuries are assigned different numbers of points. The pathological observations of trauma are categorised into: a) Mild Trauma consisting of seven types of injury, b) Moderate Trauma consisting of eleven types of injury, c) Moderately Severe Trauma consisting of six types of injury, and d) Severe Trauma consisting of eleven types of injury. These trauma categories are then amalgamated to obtain severity ratings for the trap. The Mild severity rating is where the trapped animal exhibits no more than one mild trauma. The Moderate rating comprises one moderate trauma or three mild traumas. The Moderately Severe rating comprises one moderately severe trauma, or two moderate traumas, or one moderate and two mild traumas, or five mild traumas. The Severe rating comprises one severe trauma, or one moderately severe plus one moderate and two mild traumas, or one moderately severe plus two moderate traumas, or one moderately severe plus five mild traumas, or three moderate traumas, or two moderate plus four mild traumas, or ten mild traumas. In this way an account can be taken of the accumulated effects of several different injuries.

A restraining trap has to fall into one of two categories of trap. These categories differ in the degree of trauma sustained by the captured animal with Class A traps causing less trauma than Class B traps. For Class A traps there is a table specifying, for the number of animals used in the test, a) the maximum allowable number of animals with trauma more extreme than mild, and b) the maximum allowable number of animals with trauma more extreme than moderate. If these thresholds are exceeded then the trap fails to meet the criterion for a Class A trap. Similarly for Class B traps there is a table specifying, for the number of animals used in the test, a) the maximum allowable number of animals with trauma more extreme than moderate, and b) the maximum allowable number of animals with trauma more extreme than moderately severe. If these thresholds are exceeded then the trap fails to meet the criterion for a Class B trap. In each case the upper and lower threshold sample sizes are designed to give 90% confidence that traps which pass the test will perform below the lower threshold 70% of the time and below the upper threshold 80% of the time.

Two main types of restraining trap are used in New Zealand; leg-hold traps and cage/box traps. Cage/box traps cause so few and mild traumas that it is not worth testing them; i.e. they would all pass. Trauma ratings for different types of leg-hold traps and for leg-hold traps that had or had not been fitted with chain springs were given, and the leg-hold traps that had been prohibited following testing were listed.

Section 32 of the Animal Welfare Act allows traps to be restricted or prohibited if they cause unreasonable distress. Field trials were conducted to try to measure the stress caused to possums by capture in a cage trap and in two types of leg-hold trap (the Lanes Ace and the No 1 Soft Catch). Possums were shot from distance at either 30 minutes or 8 hours post-capture. Blood was taken from these animals and tested for a range of physiological parameters. The blood taken from remotely shot, free-moving, ‘non-stressed’ possums was also analysed. The level of cortisol was around 25nmol/l in the free-moving animals. Animals restrained in a cage trap had double, and possums caught in the leg-hold traps ten or more times, this level of cortisol concentration. There was no obvious relation between the level of cortisol and the time the animal had been in the trap. It had been found that some cortisol levels were higher than the supposedly maximum values that result from an ACTH challenge test. This could be because the ACTH test gives the level of synthesised cortisol in a relatively short period prior to the test. Thus if the animal had been in a calm environment when the ACTH test was given it could provide a lower value than when the animal had previously been in a stressful environment like a cage trap. Serum levels of creatine kinase were elevated in the animals captured for eight hours in the leghold traps. Such increases can be caused by bruising and muscle damage, or by rapid and vigorous muscle movements without damage. Thus capture in leg-hold traps resulted in raised stress hormone levels, and in physiological responses to physical exertion. There were no detectable differences between padded and unpadded traps. However there was such a high degree of variability between individuals that the statistical power resulting from the sample sizes used was too low to differentiate between treatments.

In New Zealand far more research has been conducted on killing traps than on restraining traps. As practically all the mammals in New Zealand have been introduced and have had a major impact on the native flora and fauna, the vast majority of the trapping is for pest control purposes (there is only a small industry based on possum fur). Killing traps are used to control brushtail possum, ferret, stoat, hedgehog, rat and mouse.

The killing trap standards are based upon the draft ISO standards. However, there are no initial trials involving anaesthetised animals; rather testing begins with compound trials in which acclimatised animals are allowed to enter the trap freely whilst being remotely monitored. Once caught the TIU is measured by the time to loss of the blinking reflexes. Air is puffed into the eye of the caught animal and if there is no response the loss of blink reflexes is checked by touching the eye. There are two welfare categories of killing traps (Class A and Class B) based upon TIU measures, and for each of these categories there are two TIU thresholds. To qualify as a Class A trap the maximum allowable number of animals retaining eye blink reflexes after a lower TIU threshold of 30 seconds must not be exceeded, and also the maximum allowable number of animals retaining corneal reflexes after a higher TIU threshold of 180 seconds must not be exceeded. To qualify as a Class B trap the maximum allowable number of animals retaining corneal reflexes after a lower TIU threshold of 180 seconds must not be exceeded, and also the maximum allowable number of animals retaining corneal reflexes after a higher TIU threshold 300 seconds must not be exceeded. Any animal still conscious after 300 seconds is humanely killed. If an animal manages to escape then that trial is judged to have exceeded the 300 seconds limit.

The choice of the number of animals to be tested (i.e. the possible sample sizes vary from 10 to 50 animals in steps of 5) must be made before the test starts by the person submitting the trap. Although it is explained to them that the lower sample sizes have the greater risk of unjustifiably rejecting a trap, manufacturers practically always opt for the lowest sample size of 10 animals. Nevertheless, for each of the possible sample sizes there is set a maximum allowable number of animals retaining eye blink reflexes after the lower threshold, and a maximum number after the higher threshold. These numbers are designed to give 90% confidence that the traps that pass the test will perform below the lower TIU threshold 70% of the time and below the upper TIU threshold 80% of the time. The trials are stopped once these maximum numbers have been exceeded.

The results of trap tests of many different traps against a range of species were presented. Loss of consciousness within about 40 seconds is due to carotid occlusion, whilst TIUs of between 120 and 180 seconds are usually caused by restriction of breathing. It can take around 10 seconds to reach the animal in the compound after it has been struck by the trap, and TIUs of less than 10 seconds caused from cranial fracture probably resulted in instantaneous death. The anatomical strike location is a vital factor in determining the welfare impact of a trap and for long, fast-moving species like ferrets it is very difficult to get a consistent strike. DOC traps are very good in this regard because instead of a single killing bar they have a grid of killing bars thereby greatly increasing the chances of a head/neck strike.

The capture efficiency of a trap is assessed by comparing the number of captures achieved per 100 trap-nights with the number achieved using a “control” trap. The capture efficiency of the test trap must be at least 80% of that of the control trap before the test trap can be considered as a replacement for an existing trap. It is difficult to assess a trap’s target selectivity as this differs between sites because of varying distribution and abundance of non-target animals. However, recording the capture of non-target animals when assessing trap efficiency in the field provides some information on selectivity. The selectivity of the test trap should not be less than that of the control trap. Rodents and hedgehogs are the major non-target species and traps are also tested to ensure that they can kill them within the required time limits.

On the whole the New Zealand certification system is working well. The Animal Welfare legislation under which traps fall, assumes that all traps meet the standards, until there is some evidence to the contrary. From field data government employees have been able to rate with respect to humaneness all the traps that are commonly in use. The New Zealand Government funds testing of a certain number of traps each year (equivalent to around £80,000), with the worst traps undergoing testing first. However, they also assess efficiency and that does affect whether a trap is withdrawn or not.

9.6 Canadian implementation of the AIHTS.

The AIHTS applies to trapping methods and the certification of traps for the trapping of the following species that occur in Canada: coyote, bobcat, marten, fisher, lynx, N. American badger, N. American otter, N. American beaver, raccoon, wolf, ermine and muskrat. The trapping of these species is conducted for the purposes of wildlife management (including pest control), conservation, and the obtaining of fur, skin or meat. The actions of Canada to meet its obligations under the AIHTS have been: a) 1998, the issuing of certificates of origin for fur and fur products, b) 2000, the prohibition of jaw-type leg-hold traps for seven of the listed species, c) 2001, the prohibition of conventional steel-jawed leg-hold traps for five of the listed species, d) 2004, the testing of traps to determine their compliance with the AIHTS, e) 2005 establishing a National Trapper Education Program , f) 2007, the establishment of a

Trap Certification Program and the prohibition of traps not certified as meeting the standards in the AIHTS.

The facilities of the Fur Institute of Canada (FIC) were described. These included large testing compounds, outdoor landscaped enclosures to simulate the natural habitats of various species, smaller housing facilities for study specimens, mechanical testing laboratory, computing laboratory, and workshops. The main trap types tested are leg-hold restraining traps and three categories of killing trap, i.e. rotating jaw, ‘mouse trap’ and planar.

Several examples of the different types of killing traps used to capture a range of species were provided. Killing traps are assessed using a mixture of a) mechanical evaluation, b) compound tests and/or c) computer modelling. Mechanical evaluation involves measuring the dimensions of a trap and the forces (i.e. impact and clamping) it produces. Since 1985 over 450 traps have been evaluated. Mechanical evaluation enables different trap designs to be compared and, by repeated testing, ensures consistent manufacturing standards. The mechanical details obtained are also required for the computer modelling of trap performance. Mechanical data for a wide range of restraining and killing traps, and examples of the degree of variation found within the same trap design, were presented.

The AIHTS permits the substitution of trap testing on live unanaesthetized animals by “any other scientifically proven suitable substitute parameter”. By using its extensive database the FIC has developed computer models to determine whether a trap design meets the requirements of the AIHTS. The process of developing computer simulation models for rating traps against humane standards was initiated in 1995, however it took a few years of research and detailed data investigation before the first model was completed in 1998. An extensive review and validation by the scientific community was done on the modeling system before it was approved as a valid alternative to compound testing for rating traps against AIHTS standards.

The models take into account the variability within the trap design as well as between animal variations. Each time the trap is fired there are variations in the applied forces and the models take into account this variability. To date, models have been built for rating killing devices for marten, fisher, raccoon, muskrat, beaver, mink and otter against the AIHTS. Models for rating killing traps for lynx and weasel and restraining devices for coyote are currently under development. The rating of a device is done by running 10,000 simulations, which represent a particular species of animal entering the trap 10,000 times, and calculating the percentage of times that the insensibility criteria are met. If the criteria are met in at least 80% of the 10,000 simulations then the trap is considered to meet the AIHTS requirements for that particular species. The standard compound test, as set out in the AIHTS, is based on a small sample size of 12 animals whilst the computer simulation is equivalent to running 10,000 animal-based compound tests. This, in addition to the fact that the models are built on data from many tests, indicates that the models are a more powerful decision making tool than the compound testing.

The main benefits of using computer models are a) it reduces the number of animals required to test trapping devices (it is estimated that to date 1200 fewer animals have been used), and b) it costs 85% less than compound testing (there has been a saving of around $3.5 million Canadian through the use of models).

An important additional benefit of the development of a computer model is the production of a Trap Optimisation Program. A type of sensitivity analysis of the model parameters enables the most important parameters with respect to TIU to be identified. It is then possible to specifically examine possible ways to enhance these parameters. All trap components act synergistically (e.g. whilst a heavier killing bar may increase momentum or clamping force it might also reduce the velocity of strike) and using a model takes away a lot of the trial and error experimentation that would otherwise be involved. The original datasets used in constructing the current models could be used to develop new models to fit higher welfare standards than the AIHTS.

The ‘approach testing’ of killing traps is conducted to establish the anatomical strike position of the killing bar. The trap is set up so that it can fire but is not able to hit and harm the animal. High-speed video recordings are used to determine where the killing bar would have struck the animal. This procedure allows the testing of different trigger configurations without injuring animals. Five out of six tests must result in correct strike locations.

A restraining trap passes the criteria in the AIHTS if data are collected on the capture at least 20 of the target species and at least 80% (16 out of 20) of these animals do not show any injury from a list of proscribed injuries. The type and severity of injuries caused by a restraining trap are assessed from animals caught in the field under actual trap line conditions. All target animals captured are necropsied by qualified veterinarians, and the results compared to the AIHTS requirements. 689 restraining trap samples have been obtained; of which 48% involved coyote, 16% fox, 15% lynx, 13% raccoon, 4% bobcat and 4% wolf.

Restraining traps for specific species were then considered. Under the AIHTS competent authorities may provide “design approved” approval for home-made devices, without the requirement for testing. At the time of the negotiation of the AIHTS it was determined that the AIHTS standard could only be applied to manufactured devices. However, some testing has been conducted to determine generic design specifications and there has been a workshop of interested parties to complete generic model development. Four restraining traps for the capture of lynx, including the most commonly used Victor#3 Soft Catch, were regulated as meeting the AIHTS in 2007. Three coyote restraining traps meet the AIHTS. A computer model for this species is under development and should be completed by 2010. One wolf restraining trap (the Belisle foot snare) meets the AIHTS and field testing of five other traps is ongoing. One bobcat restraining trap (the Belisle foot snare) meets the AIHTS and field testing of three others is in progress. The results demonstrate that the welfare thresholds within the AIHTS are effective in eliminating poorly performing traps in that 87% of the restraining traps tested failed.

The new format of the Canadian Certified Trap List was described[10].

9.7 ***Trap research in the United States.***

In the USA all matters of trap research and wildlife management are settled at the State level. All the States are different and hence it is not practical to give an overview

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[10] http://www.fur.ca/index-e/trap_research/index.asp?action=trap_research&page=traps_certified_traps

of the situation in the country as a whole. There is a general emphasis in the USA on research assessing the welfare impacts of restraining traps, and the intention is to conduct research on all the fur-bearing species. Research on killing traps in the US is largely informed by research conducted in Canada, and the assessment of the welfare impact of a killing trap is based in large part upon the trap assessment data obtained in Canada.

Between 1997 and 2008 the total expenditure on trap research was US $7.5 million. The Federal funds include US $4.5 million for trap testing (covering the costs of project management, field trials and post mortem analyses) and US $1 million for Outreach grants (covering workshops, surveys and the harvest data base). The States contribute US $2 million to fund such things as professional time, travel, supplies, and office and warehouse space. Approximately 1,000 volunteer trappers and technicians have been involved; along with 50 state agency biologists. Forty states in all five US geographic regions have participated in the US trap research program. A total of 90 trap types have been tested and this has involved 300,000 trap nights.

Each fur bearing species in the USA has been allocated to a high, medium or low priority category for the purposes of conducting trap research. The priority given to a species is based upon a) its range, b) its wildlife conservation and management significance, e.g. used for fur, or a major pest animal, and c) the difficulty in acquiring data on it. The High Priority category contains the raccoon, coyote, red fox, nutria, muskrat, gray fox, mink and American marten. The Medium Priority category contains the beaver, bobcat, opossum, striped skunk, gray wolf, badger, river otter, swift fox, kit fox and fisher. The Low Priority category contains the Canadian lynx, ringtail, Arctic fox, wolverine and weasel.

The purpose of the work is to improve trapping, especially in the area of animal welfare. The Association of Fish and Wildlife Agencies and state governments are distributing information to trappers throughout the country. These reports are called Best Management Practise documents (BMPs) and to date 15 BMP documents have been completed. These are all available via the Internet at http://fishwildlife.org/furbearer_resources.html. BMPs can be revised in the light of fresh information. As well as trappers, BMPs also go to the people in each state who are responsible for policy and regulations. BMPs have legal standing in some states. There is a high acceptance of BMPs by trappers in the United States, and their use is expected to greatly increase over time.

The selection of the traps to be included in the research programme is determined by a) the most commonly used trap types based upon surveys, b) the most promising, commercially available traps expected to demonstrate little or no injury, and c) commercially available modifications that are known to be contributors to injury reduction (e.g. modifications to the trap jaws (including padded, offset, double and laminated jaws), to the tension of the pan, to the base-plate, and to the chain by the addition of swivels and shock springs). The USA is divided into five geographic regions and it is important that traps are tested in all five regions; not least because trappers place most value on the results of research conducted in an area like their own, and because of the very distinct environmental conditions encountered in each geographic area. In many projects three or four states participate within a region. Up to 16 trappers have been involved in a single study in one year. In addition between 40 and 80 volunteer trapper teams are involved annually; all the volunteer trappers are experts in trapping. The volunteer trappers conduct the trapping trials on their usual trap lines during the regulated trapping season. Traps are randomly selected and set in pairs of similar traps.

Each trapper is accompanied by a technician who is responsible for collecting 25 different types of data (e.g. habitat, weather, type of set, strike location) and for preparing the carcasses for shipment to professional wildlife veterinary pathologists, who conduct full-body necropsies. Two different injury scales are used to assess the welfare impact of a trap. One is the scale used in the ISO document where each type of injury is given a certain number of points, and the other assigns types of injuries to various trauma classes (i.e. none, mild, moderate, moderately severe, and severe). Typically a trap will either pass or fail both scales; only rarely has a trap passed on one scale and failed on the other. The post mortem of the trapped animal involves a full body examination, i.e. not just the trapped limb, and all traumas are described in detail.

There has been good progress in the last 10 years and this has resulted in the gathering of data on 21 of the 23 furbearers that occur in the USA. Examples of the trap data obtained and of the BMPs developed were given.

9.8 Proposed Improved Standards.

The aims of the proposed Improved Standards are a) to improve welfare in relation to trapping in the EU, and b) to develop a trap certification process that will result in the development of improved traps. Having reviewed the different trap testing methodologies and standards in use internationally, the Consortium's general conclusion was that, although there may be traps that meet higher standards than those in the AIHTS, few traps have been tested to higher standards. Furthermore, because a) new traps take both many years to develop (e.g. certain rotating jaw, planar jaw and mouse trap type traps in Canada took several decades) and a large financial investment, and b) the vast majority of trapping within the EU is conducted for the purposes of wildlife management and pest control, the Improved Standards should encourage the development of traps that meet the higher standards whilst ensuring in the interim that traps are still available for the commonly trapped species within the EU.

Restraining traps. As far as restraining traps are concerned, all leg-hold traps are banned in the EU and box/cage traps are by far the most commonly used type for the species listed in the AIHTS (see Chapter 2). Although box/cage traps do not cause the major limb injuries sometimes found in animals restrained in leg-hold traps, the view was taken that the new Improved Standards should be widely applicable to all species and all types of trap. Thus the Improved Standards for restraining traps should also be able to cover the use of wire snares that are used as restraining traps in some Member States; but generally not for the species currently listed in the AIHTS.

The welfare of an animal in a restraining trap can be improved if it is free from a) pain and injury, and b) fear and distress. Various trauma scales have be used to assess the degree of pain and injury the trapped animal is suffering, and various behavioural and physiological indices have been proposed as putative measures of fear and distress. Whilst the use of injury scales is widely accepted there are still major problems of interpretation associated with the suggested behavioural and physiological welfare indices.

Experimental studies of the behaviour of Norway rats and grey squirrels caught in cage traps were described. 55% of the rats' time in the trap was spent trying to escape from the cage (i.e. in biting and clawing the mesh), 21% eating, 12% inactive, 7% grooming, and 5% looking out whilst sitting. The incidence of escape behaviour did not decline over the 13 hours spent in the trap. In contrast the squirrel spent 60% of the time inactive and only 27% was spent in escape behaviour; with 3% eating, 5% grooming and 2% sitting comprising the other behaviours shown. Also, unlike the rat, the incidence of escape behaviour fell rapidly throughout the 13 hours spent in the trap; declining from 85% in the first hour to 10% after 5 hours and then remaining at this low level for the remainder of the time in the trap. The behaviours of the animals in their home pens before and after restraint in a cage trap were compared. The home pen had a small wooden box that acted as a refuge and the rats spent significantly more time in this box after being released from the cage trap. The rats' activity levels significantly decreased after restraint whilst there were no significant differences in the times spent eating and drinking. However, there were no significant changes in home pen behaviour of squirrels following the period of restraint in the cage trap. Thus, although the intensity of escape behaviour could be an indicator of fear and distress, interpreting the meaning of a given level of this behaviour is certainly not straightforward. There are significant differences between species not only in the incidence of escape behaviour shown but also in how it changes over time. Was the period of restraint most stressful for the squirrel because of the very high initial level of escape behaviour shown, or for the rat because a) the lower level of escape behaviour did not decline over the period of restraint and b) the restraint did result in subsequent behavioural change in the home pen? These results indicate that detailed analyses of the behaviours shown by animals in restraining traps must be conducted separately for each of the species concerned, and that it is not valid to try to set a behavioural pass/fail threshold applicable for all combinations of species and traps.

The most commonly used physiological indices of welfare are lactate dehydrogenase, creatine kinase, and cortisol or corticosterone. Of these cortisol or corticosterone are thought to be most closely related to the emotions of fear and distress. Faecal corticosterone samples were taken from rats in order to see if restraint in a cage trap increased corticosterone levels. It was found that there was a significant increase in corticosterone during restraint and, although this fell following release back into the home pen, corticosterone level the day after release was still significantly higher than the pre-trap level. This finding supports the behavioural observations and indicates that the rats found the restraint stressful. However, an experimental study with muskrats was then described to indicate how difficult it can be to interpret the meaning of such an increase. Although plasma corticosterone level increased significantly when muskrats were restrained in a cage trap, it was found that this elevated level was not significantly different than the level that resulted when the muskrat encountered a strange muskrat in its home pen. Thus restraint in the trap appeared to be no more stressful than a social interaction that occurs frequently in the wild. As with the behavioural indices, not only must detailed analyses of the changes shown in the various physiological measures be conducted separately for each of the species concerned but also information on the natural fluctuations of these measures in free-living populations of each species must be available. It is not valid to try to set a pass/fail threshold applicable for all combinations of species and traps based upon changes in these indices.

In theory a good method of determining an animal's reaction to restraint in a trap is to measure its aversion to entering that trap a second time; i.e. to conduct an aversion test. However, data from trials completed on wild Norway rats indicate that changes in the methodology chosen to determine aversion can have a significant impact on the result. For example, when food was available outside the trap as well as within it, the rats showed no significant aversion to a cage trap after being restrained within it for 16 hours. However, when the only source of food was within the trap, the rats took longer to re-enter after they had been restrained; suggesting that under these conditions the restraint was aversive. Another practical problem with aversion testing using wild species is that it can be very time consuming; for example each of the aversion trials involving wild rats took on average 8 days to complete. Clearly before aversion tests can be included in any standard to assess the welfare of animals in traps details of the testing procedure to be used must be developed and standardised for each species. The time and effort required to establish the optimal test procedure for each species will be great.

For the reasons discussed above the Consortium believed that the current state of knowledge does not to allow behavioural and physiological indices of suffering to be incorporated into the Improved Standards for restraining traps. This leaves the approach adopted by the AIHTS, NAWAC and ISO guidelines in this regard; namely a system based upon trauma/injuries. The pain of a trapped animal is caused by injury resulting from its capture; injury equates with pain. However, there are complex relationships between the nature of the injury and the degree of pain experienced.

Three main types of trauma scales have been used to assess the suffering of trapped animals. First, there is the simple and relatively crude ‘yes/no’ process in which a list of “unacceptable” injuries is compiled and the presence of one of these in the trapped animal is sufficient to fail the trap. This system does not address the possibility that an animal experiencing several of the “acceptable” injuries may experience as much pain as an animal suffering from one of the “unacceptable” injuries. Second, each type of injury can be assigned a number of points and the points for all the injuries suffered by the trapped animal are added up and compared with a maximum value that must not be exceeded if the trap is to meet the welfare standard. Whilst such a system can cope with the problem of multiple injuries, the points awarded for different types of injuries are somewhat arbitrary numerical assignments (for example; an amputation of a digit scores as high as 400 on one scale but, depending on the exact nature of the amputation, as little as 30 on another), and the total injury score is an abstraction of the severity of the combined injuries to an animal with numerous possibilities for obtaining a particular score. The third, and it was argued by the Consortium the best, approach is that adopted in the NAWAC Guidelines; namely grouping injury types into severity levels such as mild, moderate and severe, and then, after deciding upon a minimum sample size, defining a frequency of occurrence for each severity level whereby a trap would be deemed as unacceptable if this were exceeded. This system can cope with diverse combinations of injuries, requires fewer decisions at fewer steps, and is the easiest to implement into practice.

It is proposed that this third option be adopted in the Improved Standards, and that the latter should be modelled on the NAWAC Guidelines successfully being used in New Zealand. There would be four categories of injury severity (i.e. mild, moderate, moderately severe and severe) and three Welfare Categories, A B, and C of restraining traps. For Welfare Category A: the maximum allowable number of animals with trauma more severe than mild must not be exceeded, and the maximum allowable number of animals with trauma more severe than moderate must not be exceeded. For Welfare Category B: the maximum allowable number of animals with trauma more severe than moderate must not be exceeded, and the maximum allowable number of animals with trauma more severe than moderately severe must not be exceeded. For Welfare Category C: the maximum allowable number of animals with the injuries listed in the AIHTS must not be exceeded. Given this structure further consideration is required on a) the sample sizes to be used given the required pass rate and confidence levels, and b) whether changes need to be made to the types of injuries allocated to the broad severity levels.

Killing traps. It is proposed that a system incorporating different Welfare Categories of trap also be applied for killing traps; as was proposed in the draft ISO standard and is being used in the NAWAC Guidelines. The Welfare Categories would be defined by different upper and lower limits for the TIU. It is proposed that the lowest Welfare Category C would be equivalent to the AIHTS in that a killing trap would pass if 80% or more of the animals tested had a TIU below 300 seconds. The requirement for Welfare Category B would be that 80% or more animals would have a TIU below 180 seconds and also that 90% of animals would have a TIU within 300 seconds. The requirement for the highest Welfare Category A would be that 80% or more of animals would have a TIU below 30 seconds and also that 90% would have a TIU within 180 seconds. It was shown how the confidence levels placed upon such criteria make a huge difference to the number of animals required for trap testing. It is proposed that there be a 90% confidence level in both the lower and upper TIU thresholds (i.e. a 90% confidence that at least 80% of animals have a TIU within the lower threshold, and that at least 90% have a TIU within the upper threshold). This would require a maximum sample size for testing of 30 animals; however stopping rules had been developed to ensure only the minimum number of animals would be tested, and these allow a trap to be failed after only six animals have been tested.

It was further proposed that where traps of different Welfare Categories are available for a given species then only the higher Welfare Category traps would be licensed.

However, exceptions could be made in particular circumstances; for example if a high welfare category trap was less species-specific than a lower category trap the latter could be used in areas where protected, non-target species were present.

Best practice. How a trap is set is crucial to the welfare impact it has on the target species, as well as to other factors like its efficiency and the non-target risk it poses. However, as the EU covers a wide range of habitats and non-target species rather than try to deal with such issues in detail in the Improved Standards it was argued it is better to follow the approach adopted in the USA and develop Best Practice Guides for each species. It was proposed that an expert committee at the EU level would determine what sorts of information should be within such documents but that these templates should then be amended at the national level to take into account local conditions. There would be a presumption across the EU that traps would be used according to the Best Practice Guides, and they could be granted legal status by Member States if required.

9.9 Reducing the number of animals used in trap testing.

Statistical measures could be used to reduce the number of animals required for trap testing. Two questions were considered:

1) How can we design objective rules to stop trials when they show early evidence of failure?
2) How can we provide evidence that can be used to guide the setting of thresholds for failure?

1) Early evidence of failure It was proposed that the basic rule in trap testing should be to continue the trial only for as long as there is a reasonable chance of success; otherwise stop the trial and fail the trap. Conceptually, this is like going back to an Ethics Committee after each test result and asking whether it is justifiable to continue testing. A procedure for deriving stopping rules, called “Bayesian Sequential Stopping Rules” (BSSRs), was then described using the testing of restraining traps to the standards of the AIHTS as an example. Under the AIHTS testing of restraining traps should continue for as long as there is a reasonable chance that 20 tests will be reached with four or fewer failures (i.e. a trap that causes one or more of the unacceptable injuries listed in the AIHTS). If there is, for example, one failure in the first 4 tests then the probability of reaching 20 tests with 4 or fewer failures can be calculated using a beta-binomial distribution. The probability of 0 failures in the next 16 tests is 0.082, of 1 failure is 0.107, of 2 failures is 0.114, and of 3 failures is 0.113. The probability of success is the summation of these probabilities, i.e. 0.583, and on this basis we would continue testing. However if the next two tests are failures so that we have 3 failures within the first 6 tests then the probability of failure over 20 tests (i.e. another two failures within the next 14 tests) becomes 0.97, and therefore the trial should be abandoned and the trap failed.

The pros and cons of using BSSRs were discussed. Using BSSRs reduces both the number of tests per trial and the number of adverse welfare incidents per trial. However, fewer tests mean the conclusions will of necessity be slightly less reliable than if full 20 tests had been completed. There is a trade-off and by not completing 20 tests the risk of failing a good trap is increased slightly. Nevertheless the degree of animal suffering is reduced and the probability of only accepting good traps is increased. Furthermore, it is important to note that the probability of failing a good trap is highest for those traps closest to the welfare threshold; i.e. there is very little effect on the likelihood of passing a 'very good' trap.

2) Evidence that can improve the experimental designs used in trap testing. Four major outcomes that determine the efficacy of an experimental design for trap testing were discussed; the aim being to develop the most efficient experimental design for a given set of welfare thresholds whatever those thresholds are. The four important parameters are:

a) the number of tests required to reach a decision; which should be as low as possible;
b) the proportion of good traps that pass; which should be as high as possible
c) the number of adverse welfare incidents during the trial; which should be as low as possible, and
d) the rate of adverse welfare incidents associated with traps that pass the trial, which should also be as low as possible.

Mathematical methods to estimate values of the four outcomes for different experimental designs were presented, and a range of experimental designs for the testing of a number of trap-types were then assessed against these four criteria. It was found that in order to calculate sufficiently precise estimates of the values of the four outcomes more information is required on the population of traps that have already been tested. The talk ended with a request for such data.

9.10 Guide for scoring welfare hazards in relation to the killing of pest animals.

A risk assessment approach similar to that used by the European Food Safety Authority (EFSA) could be applied to the assessment of the welfare of animals in traps. There is a clear distinction between risk assessment and risk management. In the context of the trapping of animals, risk assessment involves calculating the probability that adverse welfare will occur when animals are trapped, whilst risk management entails putting in place arrangements, such as new legislation, to ensure that trapped animals have minimal exposure to poor welfare. Once those activities associated with trapping that cause adverse welfare have been identified, the risk assessment process then involves two main processes: a) characterising the nature of the adverse effect at the level of the individual animal, e.g. the level of pain caused, and b) assessing at the population level the likelihood that the hazard will be encountered, i.e. how many animals will experience a particular level of poor welfare? For example, in spring traps an adverse effect is severe pain, but we are unsure of how many will experience this.

How to conduct a risk assessment was described using the example of travelling to work by car. Car travel gives rise to a number of hazards that cause poor welfare; one hazard is a traffic jam causing stress and another hazard is a traffic accident resulting in trauma. Each of these hazards is treated separately. The traffic jam causes delays of differing length and the probability of stress resulting from a delay increases with the delay time. The delay times can be allocated to three different categories, e.g. less than 5 minutes, between 5 and 30 minutes, and over 30 minutes. For each of these categories the probability of stress resulting is assessed, the severity of the stress resulting is measured on a qualitative scale (e.g. negligible, mild and moderate stress), and also the duration of stress is calculated. The next stage is to conduct an exposure assessment for the traffic jam hazard by calculating for each category of delay time, the probability that that delay category will occur and its average duration. A similar analysis can be conducted for road traffic accidents, the other hazard. Here the adverse welfare effect can again be split into three categories e.g. mild injuries like whiplash, moderate injuries like severe bruising, and severe injuries like fractures that require surgery. The probability and duration of each category are then assessed. The exposure assessment of the hazard is then calculated using the probability that in an accident the mild, moderate or severe injuries will occur and their likely duration (which in an accident will be very short for all off them).

Intensity and duration of adverse effect can be combined into broader categories of adverse welfare. Thus if the intensity of the adverse effect is severe and it goes on for a long time the resultant degree of adverse welfare is greater than if the intensity is moderate and it persists for less time. In this way the various cells in a matrix of the duration against the intensity of the adverse effect can be assigned to different categories of adverse welfare (e.g. negligible, minor, moderate, severe). A Risk Score can also be obtained by combining the probability that an adverse effect will occur when the hazard is encountered with the intensity and duration of that adverse effect, and the probability that the hazard will be encountered. Often the intensity, unlike the duration, of the adverse effect has to be measured on an ordinal rather than an interval scale (e.g. the intensity of stress caused by a traffic jam). Risk scores can then be used to compare the risks associated with different activities; e.g. the risk score of going to work by car can be compared to the risk score of going to work by bus.

In many cases key data required to conduct a risk assessment may be lacking, and then it may be necessary to canvas and use the opinions of experts in the risk assessment; with an associated drop in reliability of the resultant risk score. The uncertainty surrounding the risk assessment should also be assessed. Low uncertainty would exist where there are complete data, considerable experience from consistent observations, and agreement among experts. High uncertainty would exist where the data are scarce or not available, there are few observations and expert opinion varies considerably.

It was argued that a risk assessment approach involving the comparisons of risk scores for different trap systems could be applied to the assessment of the welfare implications of using different types/makes of traps. As an example of this the culling of seals was discussed and tables of risk scores were compared for the use of the hakapic (i.e. a tool used to kill seals) in good weather and good habitat as opposed to its use in bad weather and bad habitat. A big advantage of using the risk assessment approach is that it enables perceived wisdom to be challenged. Trappers frequently argue that the traps they use and the manner in which they use them comprise the best trapping practice, likewise anti-trapping organisations argue that all traps are inhumane and cruel. The use of a transparent, objective and quantifiable technique such as risk assessment would enable entrenched opinion to be challenged.

9.11 Muskrat control in the Netherlands

The numbers of muskrat that are captured on an annual basis in the EU were given to indicate the importance of their continued management, (e.g. at least 500,000 in 2007). In addition, it was pointed out that in areas of dense muskrat populations drowning traps are used for 80% of these captures. Examples of the type and intensity of muskrat damage were presented together with illustrations of the types of trap and management techniques used. Muskrats tunnel into dykes and banks, and erosion by the water eventually causes collapse. Many of the banks are topped by roads, and muskrat damage can make some roads impassable to vehicles. In addition the dykes are required to prevent the land from flooding.

The benefits of muskrat drowning traps are that they are multi-catch and that they rarely catch non-target animals. They can also be left in areas that have been cleared of muskrats to catch any immigrating animals, thereby alerting the trapper that reinvasion has occurred. Using drowning traps enables a single trapper to catch several hundred animals and this would be unobtainable with any other type of currently available trap. In Holland it has been found that changing the management of the trappers had a large impact on the efficiency of the trapping and has resulted in a marked reduction of the muskrat population. Drowning traps tend to catch animals that have not already established a territory; unlike killing traps set on land that target different individuals of the population. It was stressed that there is still a need for drowning traps to control muskrats.

9.12 Research carried out on muskrat drowning traps.

Experimental investigations measuring the TIU of muskrats caught in drowning traps were presented. Natural outdoor pens surrounding a large pond were used for experiments involving muskrats caught from the wild by experienced trappers. The first cohort of seven muskrats was implanted with biotelemetry equipment to measure ECG and EEG. After obtaining baseline data for the EEG and ECG of muskrats when underwater, drowning trials were undertaken where the animals were caught in drowning traps. The animals were videoed when they were in the underwater cage of the drowning trap; in addition EEG and ECG recordings were made and blood samples were taken 30 minutes after unconsciousness was first observed (i.e. to ensure that the animals were dead and did not recover). Analysis of the behavioural records indicated that the point at which the animal starts to bite the mesh of the underwater cage might be a good indicator of the onset of distress. The heart rate of the muskrats was significantly higher after the onset of biting, reinforcing this hypothesis. The EEG analysis showed that uncontrolled muscle tremors were a good predictor of the onset of unconsciousness, which occurred on average 33 seconds before there was a flat EEG trace indicating brain death. A analyses of the behaviour and the EEG traces showed that the muskrats took longer than 300 seconds (the TIU threshold within the AIHTS) from the onset of biting behaviour to reach unconsciousness. In order to obtain baseline ECG and EEG readings it was necessary to expose the muskrat to the inactivated drowning trap (i.e. the underwater cage had openings allowing the animal to escape) and it was thought that this exposure of the animals to the experimental setup might have influenced the time from biting to unconsciousness. Therefore, further trials were carried out muskrats that had no prior experience of the drowning trap before the test trial (i.e. these animals not fitted with biotelemetry equipment). Although the second batch of animals did indeed have a shorter time from onset of biting to unconsciousness the TIUs for three of the eight animals were still longer than 300s required by the AIHTS.

None of the muskrats showed a passive response to being captured in the drowning trap as had been suggested by anecdotal reports of muskrat trappers; where the passive response may have been due to the presence of a human observer rather than to any variation in the response to drowning. This possible influence of a human observer was the reason why the experimental trials were filmed with underwater cameras; i.e. any possible response to an observer could be eliminated. It was initially thought that differences in response to drowning, (i.e. passive versus active) might be detected in differences in *post mortem*. However, as these different responses were not observed during the experiments it was not surprising that no differences were found between animals in the post mortems. Brain structure oedema and lung oedema ranged from none visible to severe. In summary, using the criteria that the onset of biting indicates the onset of distress, the drowning trap does not meet the 300 seconds minimum TIU criteria under the AIHTS, however further research was done to establish if this criteria was correct. [Results from the further trials indicated that distress was not experienced until at least 120 seconds after the onset of biting, and using this evidence the drowning traps could meet the 300 second TIU limit for a category C trap (see chapter 5).]

9.13 Discussion topics

The informal structure of the Workshop enabled discussion to take place during the actual presentations as well as throughout the periods set aside for discussion after completion of the lectures. The various points raised have been summarised below under main topic headings.

9.14 Differences between the standards for killing traps contained in the AIHTS and the standards proposed in the earlier ISO proposals.

The ISO welfare categories for killing trap (which were very similar to those being proposed in the Improved Standards) were positively considered at the time by those national delegations that were not opposed to the fur trade. Even though it was unknown (except for the 180 seconds threshold) whether species-specific traps could perform to the higher standards of 30 and 60 seconds at the levels of confidence suggested, these higher TIU standards could be considered because the ISO Standard was voluntary. However the AIHTS is binding . The 300 seconds in the AIHTS was proposed because animal tests had previously been monitored to that time and, therefore, it was an appropriate timeframe to suggest for the other species for which killing traps are used. There was a general agreement at the time of the ISO discussions that with voluntary standards it was possible to put forward high standards as goals, but with mandatory standards it was felt that you had to be sure that products were available to meet the performances decided upon. The Fur Institute of Canada list of certified traps now confirms that many species-specific traps are available and perform at the current AIHTS welfare performance levels.

9.15 Interaction between the AIHTS and the proposed Improved Standards

It was stressed that the Improved Standards were not being proposed in opposition to, or as a replacement for, the AIHTS but rather as an addition to that agreement; which has been signed and is awaiting implementation by all parties. The members of the European Parliament (MEPs) rejected a draft EU directive to implement the AIHTS on the grounds that the trap welfare standards currently within the AIHTS were not high enough. The Improved Standards provide additional welfare criteria to those contained in the AIHTS whilst still retaining the current AIHTS standards. It is proposed by the Consortium that there should be a hierarchy of three welfare thresholds. For example, for killing traps the lowest threshold, Welfare Category C, uses the TIU criteria currently within the AIHTS for most species, Welfare Category B is a higher welfare category based upon the TIU criteria that the AIHTS aspires to adopt in the future, and Welfare Category A is a yet higher welfare category with a still shorter TIU determined by the practical constraints of measuring this index in compound tests of free-moving animals. It was noted that the development of improved animal welfare standards related to trapping is specified as one of the aims of the AIHTS.

In conjunction with the three welfare thresholds there is the presumption that, where traps of different welfare categories are available for a given species, the traps of a higher welfare category are granted approval for use at the expense of the traps of a lower welfare category. Rather than withdrawing Welfare Category C traps once traps of a higher welfare category became available, other ways by which the development and use of higher welfare traps could be encouraged were discussed. For example, it was suggested that use of higher category traps, where available, could be encouraged by more lenient setting/inspection requirements, or by favourable financial/tax considerations.

If the Improved Standards were enacted it was envisaged that there would be no immediate change in trap use within the EU in that all the traps that currently meet the AIHTS would be equivalent to the Welfare Category C requirements of the Improved Standards. However, once traps that meet Welfare Categories A or B have been identified then Welfare Category C traps for the same target species could be withdrawn from use. There would be a presumption that this would occur, but there could be grounds why it should not happen. For example, a Welfare Category C trap might be far more efficient and/or pose far less risk to non-targets in the areas where it is to be used than a higher welfare category trap. Thus there would be a general presumption that withdrawal of the lower category trap would occur, but individual Member States could put forward arguments why this should not occur. Nevertheless it was thought that the proposed licensing structure would encourage trap manufacturers to provide traps that meet the new higher welfare categories. In many cases this could be achieved by simply re-submitting existing traps for testing to the criteria of the higher welfare categories; it is clear from existing data that several currently-available traps meet the criteria for Welfare Category B and a few also do so for Welfare Category A. It was confirmed that the Canadian databases used to develop the predictive computer models for trap testing to the AIHTS criteria could also potentially be used to develop computer models for trap testing to the proposed new welfare categories.

Another criticism of the AIHTS by MEPs is that it concentrates too heavily on the trap itself and does not deal sufficiently with such aspects as ways to minimise non-target risk. How a trap is set is crucial to the welfare impact it has on the target species, as well as to other factors like its efficiency and the non-target risk it poses. However, the EU encompasses a wide range of both habitats and non-target species and, therefore, rather than try to deal with such issues at the EU level in the Improved Standards it is argued that it is better to follow the approach adopted in the USA and develop Best Practice Guides for each trap for each species. It is proposed that whilst experts would determine what sorts of information should be within such documents, these templates could subsequently be amended at the national level to take into account local conditions. There would be a presumption that traps would be used according to the Best Practice Guides, and that they could be granted legal status by Member States if required.

9.16 The use of trauma scales

The ISO TC/191 compiled their trauma scale using data collected by the ISO Working Group on restraining traps through an extensive literature search and by documenting every trap caused injury that was identified in papers, reports and articles. A working seminar was held that included wildlife veterinary pathologists from the USA, Canada, and Sweden. They examined over 100 coyote and fox limbs that had been caught in different jaw type limb-hold traps in western states. Furthermore, the Working Group on restraining traps circulated the ISO trauma scale and relative ‘pain’ points system to eminent veterinary pathologists for opinion, and with a few amendments they were found reasonable. Two documents were produced from this process “Definitions of Pathological Observations within the Trauma Scale” and “Relevance of the Pathological Observations to the Clinical Welfare of the Animal”. At the Workshop it was suggested that useful information could also be gathered from clinicians on the degree of pain humans experience from a range of injuries. During the discussion of this suggestion it was pointed out that in humans the degree of pain associated with an injury can vary markedly with the environmental context surrounding the injury, e.g. there have been examples of sportsmen continuing to play with bone fractures. It was also noted that the trauma scales used in Accident and Emergency Departments of hospitals are primarily related to survival rather than to pain because analgaesics/anaesthetics are administered to control the pain resulting from the trauma.

As the vast majority of trapping within the EU is conducted for pest control purposes the trapped animal will be killed when it is discovered in the trap. The incidence of injuries that might affect the long-term survival of the target species is, therefore, not important providing that the trap is effective in holding the animal. In practice, however, most restraining traps will also sometimes catch non-target species and therefore any injuries on these species that impact on long-term survival should also be assessed within any proposed trauma scale. It was agreed that the main emphasis of a trauma scale should be on improving the welfare of the trapped animal during its period of restraint, but that non-target captures should also be assessed.

As steel jaw leg-hold traps are not allowed in the EU it was suggested that many of the injuries on the current trauma scales may not be relevant for the situation within the EU. The delegates were asked to check their records to determine if all of the injuries specified on the trauma scales still occurred with the traps currently in use, and also to list those injuries that are commonly found on animals captured in cage traps.

The use of tranquillizer tabs to sedate animals caught in restraining traps was briefly discussed and the consensus was that this general approach is not feasible because the drugs involved mean that the technique would be illegal in most countries.

9.17 Physiological and behavioural indices of stress.

There was a discussion of a number of physiological indices that might be used to assess the stress of restrained animals and of the great advancements that have been made in techniques to measure them. However, there was a consensus that a major problem remained surrounding the interpretation of the results. The significance of a certain rise in, for example, the level of cortisol in a particular species is very difficult to determine in the absence of information on the normal variability in the cortisol level of the free-ranging wild population. Some information on variability can be obtained from animals housed in compounds but simply being in captivity may well raise the level of stress hormones well above that in the free-living population; indeed there can be a ‘ceiling effect’ that masks the physiological changes that result from the period of restraint. Once detailed information on the normal variability of the various physiological indices within the wild population of a particular species has been obtained it may be possible to specify that a certain rise in a particular physiological index should not be exceeded in that species. It was suggested that measuring faecal corticosteroid levels in faeces taken from the wild might be a way to start to acquire the required information; although for many species (e.g. muskrats) it was very difficult to obtain fresh faeces.

There was no consensus on the utility of physiological parameters when used within the constraints of a formal standardised trap testing protocol. It was pointed out that, as well as differences between species, there is often great inter-individual variation in the putative indices of stress and that, as a result, large sample sizes are required in order to obtain an acceptable statistical power in trap testing experiments. This obviously runs counter to the goal of reducing the number of test animals.

During a discussion on possible behavioural signs of stress it was suggested that it might be possible to use the time spent eating the bait within a cage/box trap as an indication of the stress of the animal because an inverse correlation would be expected between the time spent feeding and the degree of stress. However, the hunger level of the animal upon entering the trap would also be a major factor and this could not be known in field trials.

9.18 The use of compound trials

There are problems associated with the testing of wild animals in compounds; in particular it is very difficult to obtain a stable behavioural baseline within a reasonable period of time. Even after behaviour patterns had apparently been stabilised, small and peripheral environmental changes could elicit large and persistent behavioural changes. Conducting tests on wild animals in captivity is very different from conducting the same tests with domestic animals. It had to be remembered that for the captive wild animal the whole environment was novel and not just those aspects of it that the experimenter was manipulating. This lack of a familiar/novel dimension could have a major impact on the responses shown to a trap. An example was given involving compound trials of a restraining body snare against badgers. As the snare had resulted in only minor injuries in compound tests subsequent field trials were conducted. However, serious injuries were found in animals caught in the field because when restrained in their familiar home range the animals struggled far more than they had when restrained in the novel compounds. Despite such drawbacks it was generally thought that compound trials were valuable particularly when used to establish whether a trap had the potential to cause serious injuries; animals in the compounds could be swiftly and humanely killed if this happened, which was usually not possible under field conditions. Thus compound trials should be used to screen new traps before starting field trials.

9.19 The use of computer models

There was a discussion on the validity of using computer models to assess traps. It was stressed that the models have been reviewed extensively by the scientific community to guarantee their scientific credibility; in particular an in-depth, independent peer-review of the models was completed in 1999 following development of the first two models. In addition, many forms of cross-validation have been completed on the models built to date. One form of cross-validation involved the use of jack-knifing in order to reduce the bias of classifying the same data from which the classification was originally derived. The conclusion was that the models are highly accurate (i.e. safe prediction accuracy between 83% and 95% for the models built to date). In order to further test the accuracy of the marten model (which was the first model completed) three additional sets of compound tests were done between 1998 and 1999. For all compound tests the marten model correctly predicted in advance whether or not the trap met the requirements of the AIHTS. Some traps have been rated against the AIHTS using data derived from compound tests, and others were rated against the AIHTS using computer models. There have been a few cases where a trap has failed based upon a compound test in which there was an array of different strike locations but passed on the basis of a computer model that was run for specific strike locations only; these strike locations being those that will occur if the trap is correctly set.

The accuracy of a model is not correlated with the number of compound test results that were used to build the model. The sample size requirements for each species depends upon the range in trap styles and trap sizes for which the models are to be applied, as well as to the degree of within-species variation. For some species (e.g. the otter) a large sample size was required in order to obtain sufficient accuracy.

The sets used for compound testing varied considerably between species and trap types. Although a large number of traps were set in cubbys in the compound, not all were. Some were trail sets, vertical pole or tree sets, and running pole sets. The variation in strike locations obtained from the compound tests on each species are incorporated into the computer simulation model runs.

9.20 The welfare of animals in drowning traps

After presentation of the results from the drowning trap experiments there was much debate as to whether the onset of biting the bars of the underwater cage was a reliable indicator of the onset of distress. There was a general consensus that the results from the trials carried out so far were not conclusive as to whether the onset of biting indicated the point at which distress started. Other semi-aquatic species have been observed to start biting in drowning traps but then to stop this behaviour for several minutes before eventually performing it again at a higher intensity just prior to cessation of all movement.

Conducting aversion trials to determine onset of distress was raised by the Consortium as a means to obtain further information on the welfare of animals in drowning traps. Determining the aversiveness of procedures such as gaseous euthanasia has been used successfully with laboratory animals, and it was felt that this methodology could be a very useful and appropriate way forward with the muskrat research. However, as muskrats are wild animals and find being in the vicinity of humans distressing, it could be difficult to design an appropriate experimental protocol for such aversion experiments. These difficulties may increase the variability of the results and therefore necessitate a large number of replicates before any firm conclusions could be reached. The ability of muskrats to remember aversive events was raised. However, it was thought that there were no reasons to expect that muskrats would differ greatly from other mammals in their ability to remember painful and distressing events. It was concluded that the proposal to conduct aversion trials was worth pursuing, and that as many trials as possible should be completed by the end of the project.

9.21 Conclusions

The Improved Standards put forward by the Consortium were in general well received; the new Welfare Categories contained in the Improved Standards were accepted as being welfare improvements to the AIHTS.

There was general agreement that the Workshop had provided a valuable opportunity to discuss the welfare of trapped animals in an informal and purely scientific context; the Workshop was contrasted to the formal meetings that are held in the context of the AIHTS. It was suggested that further informal meetings that concentrated upon the science involved in trap development and assessment, as opposed to political and legal considerations, should be organised.

It was agreed that the participants would, where possible, supply data to assist in the further development of the Bayesian Sequential Stopping Rules. [The required data were subsequently sent to the Consortium.]

It was stated that a summary of the proceedings of the Workshop would be circulated to all participants for their comments prior to it being included in the Contract Report of the Consortium to the EU Commission. [A draft of this chapter was sent to all participants and the text has been amended in the light of the comments received.]

10 Improved trapping standards within the EU

This chapter brings together the various proposals for improving EU trapping standards that have been made throughout this Report. It also addresses some of the financial and trapping implications of adopting the proposed Improved Standards.

Summary

On the basis of the results from this study, which reflect the current state of the relevant science, it is proposed that:

a) **the addition of two new welfare standards (i.e. Welfare Categories A and B), that are more strict than the welfare standard currently within the AIHTS and cover the use of both killing and restraining traps, would improve the welfare of trapped animals.**
b) **only traps that clearly meet the requirements of the resulting Improved Standards shall be used in the EU,**
c) **drowning traps should be subject to the same welfare standards as other forms of killing trap, i.e. the TIU limits in the Improved Standards,**
d) **wherever possible trap testing involves the use animals, sequential stopping rules should be used to minimise the number of animals tested,**
e) **where traps of different Welfare Categories are available for the same target species then only traps of the highest Welfare Category shall be used in order to encourage the improvement of traps,**
f) **any new measures adopted by the Member States should cover all the species that can legally be trapped because there is no scientific justification for not including all species,**
g) **all persons who trap animals should be appropriately trained.**
h) **an, EU-wide, website providing information to the public on approved traps, training and Best Practice Guides should be considered.**

The immediate implications of adopting the Improved Standards for traps within the EU are that a) killing traps are already available that meet the Improved Standards for the six species of most interest to the EU but only at the Welfare Category C level, and b) the majority of the restraining traps currently in use will meet Welfare Category A of the Improved Standards.

The financial implications of accepting the Improved Standards vary greatly depending on the methods used to assess a trap; for example, the cost of testing a trap using an existing computer program is around €3,500,developing a new computer program would cost approximately €90,000, whilst a complete programme of pen and field trials would cost approximately €65,000. As the Improved Standards involve sequential testing procedures and stopping rule, the costs incurred when assessing a trap that fails the Improved Standards will be far less than those incurred testing a trap that passes these Standards.

10.1 Improved Standards for killing and restraining traps.

It is proposed that two new welfare standards, more strict than the welfare standard currently within the AIHTS, should be applied for the use of both killing and restraining traps within the EU Member States. Rather than have a single 'humane trap' category, traps would be classified into one of the three Welfare Categories (i.e. A, B or C) of the proposed Improved Standards, where Welfare Category C is the same as the AIHTS. It is proposed that no trap should be used until it has been shown that it meets the requirements of one of these Welfare Categories.

Killing traps. Killing traps will, on the basis of the time to irreversible unconsciousness (TIU), be assigned to one of three Welfare Categories (see 4.5). Traps in welfare category A, the highest welfare category, must (at 90% confidence) produce a TIU not exceeding 30 seconds for at least 80% of trapped animals. Traps in welfare category B, the intermediate welfare category, must (at 90% confidence) have a TIU not exceeding 180 seconds for at least 80% trapped animals. Traps in welfare category C, the lowest welfare category, must meet the current AIHTS standard for most species; i.e. they must have a TIU not exceeding 300 seconds for at least 80% of the animals tested. In addition to the criteria that 80% of the trapped animals must have a TIU not exceeding the above specified limit for the particular welfare category, it is proposed that there should also be a higher TIU limit that must not (at 90% confidence) be exceeded by 90% of trapped animals. The upper TIU limit for welfare category A is 180 seconds, and the upper limit for welfare category B is 300 seconds. Welfare category C has no upper TIU limit so that traps that have already been tested and approved under the AIHTS would automatically be approved as Welfare Category C of the Improved Standards. Although a trial could involve a maximum of 30 animals, the use of Baysean Sequential Stopping Rules (see below) will ensure that the minimum number of animals would be tested.

Restraining traps. Restraining traps, will on the basis of the injuries caused by the trap, also be assigned to one of three Welfare Categories (see 6.6). It is proposed that the Improved Standards for restraining traps be made by the addition to the existing AIHTS standard, of two trap welfare categories similar as to those of the NAWAC Guidelines being used in New Zealand. There will be four categories of injury severity (i.e. mild, moderate, moderately severe and severe) and three Welfare Categories (i.e. A, B and C) of restraining traps. Welfare Category C will be the existing AIHTS standard whilst Welfare Categories A and B will be similar to the NAWAC Guidelines. Thus for Welfare Category A, 80% of the trapped animals must suffer trauma no greater than mild and 90% must suffer trauma no greater than moderate; both pass rates being at the 90% confidence level. For Welfare Category B 80% of the trapped animals must suffer trauma no greater than moderate and 90% trauma no greater than moderately severe; again both at the 90% confidence level. For Welfare Category C the maximum allowable number of animals (i.e. 4 out of the minimum sample size of 20 specified in the AIHTS) with the injuries listed in the AIHTS must not be exceeded. Although a trial could involve a maximum of 30 animals, the use of Baysean Sequential Stopping Rules (see below) will ensure that the minimum number of animals would be tested.

Trap inspection periods. A daily inspection regime (i.e. once every 24 hours) for restraining traps appears to be the minimum requirement that is accepted in most countries. With some exceptions (e.g. UK) inspection times have not been specified for killing traps because it is assumed that all captured animals are killed by the trap.

It is proposed that the Improved Standards include the minimum requirement that both restraining and killing traps (apart from drowning traps where the death of the animal is assured) should be inspected once every 24 hours. Killing traps of the higher Welfare Categories A and B have safeguards within the testing protocol to ensure that animals do not survive for longer than the upper TIU limits and therefore have a much higher level of animal welfare and may not require such frequent inspections.

10.2 Drowning traps.

After reviewing relevant literature on mammalian drowning (see 4.4) it is proposed that drowning traps should be subject to the same welfare criteria (i.e. the same TIU limits) as other forms of killing trap. However, as many of the species captured in drowning traps are semi-aquatic (e.g. muskrat) it is argued that the TIU should not be measured from the time the animal first enters the underwater cage of a drowning trap but rather from when it later begins to suffer distress. Chapter 5 describes experimental investigations that use behavioural and physiological measures to indicate the onset of distress. From this work it appears that the TIU for muskrats in drowning traps (i.e. from the onset of distress to the point of irreversible unconsciousness) is less than 300 seconds; thus these experimental results indicate that muskrat drowning traps meet the criteria of both Welfare Category C of the Improved Standards and the AIHTS. Nevertheless there is an urgent need a) to develop new muskrat traps that meet the criteria of Welfare Categories A and B, and b) to adopt management strategies (see 5.4) that can lead to a sustained reduction in muskrat population levels.

10.3 Trap testing procedures.

Procedures for killing traps. If killing traps of an identical mechanical construction to some already tested are being assessed, then only comparison of the relevant mechanical impact and clamping forces need to be carried out. Assessment can be undertaken using a computer model (see below) if the model has been developed and validated for both the same target species and the same trap type as the trap being tested. For traps that already meet the AIHTS (and therefore also Welfare Category C of the Improved Standards), only pen trails involving sequential stopping rules (see below) would be required to determine the time to TIU. For novel designs of trap, or for new target species, trials with anaesthetised animals would initially be undertaken to determine if the trap has the potential to cause irreversible unconsciousness. Only if the TIU scores were under 10 minutes, would subsequent pen trials involving conscious animals be carried out. If the TIU scores obtained from the pen trials are less than the thresholds for the various Welfare Categories of the Improved Standards then field trials would be undertaken. To assess trap selectivity and efficiency field trials should be carried out in the range of habitats where the proposed trap would be used.

Procedure for restraining traps. As pen trials do not adequately replicate the animal-trap interaction in the wild (unless the pens are large, away from human disturbance and contain the full range of natural vegetation) only a small number of captive animal trials, involving the use of stopping rules (see below), would be carried out to ensure that the device did not cause severe injuries to the target species. If there are no severe injuries, then field trials would be conducted in the habitats where the trap will potentially be used. For the re-assessment of traps that are already in widespread use, data should be obtained directly from the field.

Stopping rules. For both killing and restraining traps Bayesean sequential stopping rules (BSSRs, see 7.4) developed for the Improved Standards should be used during all testing procedures involving conscious animals in order to minimise the number of animals required for trap assessment and testing. The BSSRs enable a trial to be stopped before the maximum number of 30 animals have been tested when there is strong evidence (i.e. $p<0.05$) that the trial will end with the trap failing. When assessing traps against the criteria within the Improved Standards, the BSSRs for failing a trap are as follows. A trap fails as soon as there is a second failure to meet the upper TIU (for killing traps) or injury (for restraining traps) thresholds. In addition, if there are two failures of the lower TIU or injury thresholds on or before the 6th animal is tested, or three failures of the lower TIU or injury thresholds on or before the 13th animal is tested, then the trial can also be stopped because there is strong evidence that the trap will fail.

10.4 <u>The licensing and improvement of traps.</u>

The vast majority of trapping within the EU is conducted for wildlife management and pest control purposes (see Chapter 2) and such activities (e.g. the control of muskrats) can not be suspended until better traps have been developed that can meet the stricter criteria of Welfare Categories A and B of the Improved Standards. Nevertheless the trap certification process or other administrative measures should encourage the rapid development of traps that meet these higher standards. Hence it is important to ensure that if killing or restraining traps of different Welfare Categories are available for a given species then only the traps of the highest available Welfare Category will be used. This could be reinforced, for example, by additional regional or national incentives or legislative/administrative frameworks. Although there is this presumption, there may be good grounds why it should not happen. For example, a Welfare Category C trap could pose less risk to non-target species in the areas where it is to be used than an alternative Welfare Category B trap. Thus although there would be a presumption that withdrawal of the lower category traps will occur, individual Member States could put forward arguments why this should not occur according to their local circumstances. Nevertheless such a licensing system should encourage trap manufacturers to provide traps that meet the standards of Welfare Categories A and B; in many cases this might be achieved by simply re-submitting existing traps for testing to the more stringent welfare criteria.

10.5 <u>Species covered by the Improved Standards.</u>

It is proposed that all traps that can be used against any species that can legally be trapped within the Member States should be covered by the Improved Standards. There are no scientific or ethical reasons why some species should be afforded protection from inhumane traps and others should not. Several Member States, such as Sweden and the UK, already have trapping legislation covering more species than those listed by the AIHTS that occur in Europe. The list of species that the Improved Standards cover could be extended in a stepwise manner according to the frequency with which any particular species is trapped.

10.6 The training and licensing of trappers.

Several countries within the EU already have legislation requiring the licensing and training of all trappers, and it is proposed that appropriate training should be made available in all Member States. The degree of training will vary to some extent with the type of trap and the context in which it is used. For example, the training required to set a mousetrap within a house where there is usually negligible non-target risk is clearly different from that needed in order to set a snare in the countryside in a way that minimises both injury to the target species and the risk to non-target species. It is suggested that the appropriate training for the latter situation should involve attending a formal course and, as a result, becoming licensed as a trapper. However, it is not necessary to require every housekeeper who wishes to set a mousetrap in their home to attend a formal training course and become a registered trapper. In this case whilst the mousetrap itself should be tested to the criteria of the Improved Standards, the appropriate training could be given by providing detailed written instructions with every mousetrap sold. The required level of training could be indicated within the species-specific Best Practice Guides; together with information on where appropriate training can be obtained.

It is suggested that the best way to promote the use of traps in a manner that meets high welfare standards is by requiring that all people using traps are trained according to the Best Practice Guide for the target species. For some species this could be achieved by issuing ‘licenses to trap’ only to those individuals that have undergone formal training, and by making it mandatory for trappers to have a licence; but, as argued above, for other species it may be sufficient simply to provide detailed instructions with the trap on how it should be used and how to access the website (see below) containing the Best Practice Guides. Such training and, if necessary, licensing should be organised at the national level so that the programmes can be tailored to fit the local conditions of each Member State. For the purposes of wildlife management and conservation it would be very valuable if trappers annually reported the numbers of animals that they have captured; both target and non-target captures.

10.7 Website containing lists of approved traps and Best Practice Guides.

New Zealand, the US and Canada all have publicised websites where information relating to all trapping activities in their jurisdiction is accessible to all. Provision of such websites not only provides help to trappers but also educates the general public (who can have mistaken ideas about how and why trapping occurs, see Table 3.6) and increases awareness of the welfare issues surrounding trapping. It is proposed that an EU-wide website similar to those current in New Zealand, the USA and Canada be developed. This website should include: a series of species-specific Best Practice Guides; the list of tested and approved traps available for each species; details of the Improved Standards and the welfare assessment criteria required for each Welfare Category of trap; the procedure for submitting a trap for testing; contacts for acquiring a licence and for the providers of training.

10.8 Implications of adopting the Improved Standards for traps within the EU.

Currently there are killing traps available that meet the Improved Standards for the six most commonly captured species within the EU[11] that are covered by the AIHTS (see Table 4.5), but only at the Welfare Category C level. This does not mean that the currently available traps are not also capable of meeting the higher welfare criteria of Welfare Categories A and B of the Improved Standards. Rather it is that the data required to assign traps to these higher welfare categories either have not been collected, or are not available to the public. The computer models already available to assess certain types of trap to the standards of the AIHTS (see 7.3) could be redeveloped to test killing traps to the Improved Standards. However, these models have been developed for North American species and hence models are not available for all the species that are trapped in the EU.

Box/cage traps are by far the most commonly used restraining traps within the EU and the data gathered on these types of trap indicate that typically they cause fewer and more minor injuries than other restraining traps such as leg snares, and the leghold traps that are prohibited in the EU. As a result, in New Zealand box/cage traps for all

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[11] Raccoon, raccoon dog, ermine, badger, muskrat, pine marten

species have been assigned to Welfare Category A without any further testing. It may be possible to come to a similar conclusion for the species captured in box/cage traps within the EU. Available data on injuries and welfare sustained by animals in box/cage traps should be examined with a view to categorizing such traps as automatically meeting (when used according to Best Practice) the Welfare Category A of the Improved Standards. The other restraining traps, like neck snares, that are sometimes used within the EU would require additional testing.

10.9 Financial implications of adopting the Improved Standards.

The financial implications of implementing the Improved Standards will depend upon exactly how they are implemented. For example, in Canada a trap has to be tested and shown that it meets the AIHTS before it can be used. The Canadians have spent over $18 million Canadian dollars (€12.5 million) on trap testing and trap research to date, and over 50 previously commonly used traps are no longer used because they fail the AIHTS. However, in New Zealand it is assumed that a trap meets the NAWAC Guideline and hence it can be used until it is tested and shown that it does not. The New Zealand Government spends $10,000 NZ dollars per annum on trap testing and to date no traps have been withdrawn from use. The New Zealand approach however, seems to be less appropriate for the EU as it is not in line with the requirements of the AIHTS. Therefore the costs of implementing the Improved Standards using a similar model to Canada will be further outlined.

The main cost of introducing the Improved Standards would be in testing traps to the higher welfare criteria. To reduce the impact on individual trappers introduction of new welfare standards could be phased in over a period of years; as has occurred in Canada where it appears to have been successful. For all the various trap-assessment methodologies proposed there are common costs that would be incurred; these are outlined first.

a) Holding and testing facilities.

To obtain the required data the first requirement is to have suitable holding (i.e pens and compounds) and testing facilities (e.g. trap simulator) available for the species concerned. Few such facilities are available for wild animals within the EU. The UK has a permanent facility at the Food and Environment Research Agency (Fera, formally known as the Central Science Laboratory (CSL), see Inglis et al. in press) and there is also a permanent facility in Germany at the Julius Kühn-Institut (JKI), but this is not permanently staffed. The charge for use of these facilities is expected to be in the region of £400 (€443) per week. Although trap testing has been carried out in Sweden there are no dedicated facilities.

b) Procuring and transporting animals to the test facilities.

The cost of procuring animals and transporting them to the testing facility is very dependent on the particular species. For example, it cost approximately $1000 Canadian (€630) for each beaver that was required to obtain data for the development of a computer model for beaver traps. The cost incurred in catching any species is obviously very dependent on the population density and the ease with which it can be trapped. However, in most instances individual animals should be acquired for less than £200 (€220).

c) Personnel.

The collection of the required data from wild animals requires skilled personnel, and if there is not a dedicated testing facility it is difficult to ensure that appropriately trained staff are always available. The other nations that have a trap testing programme (e.g. New Zealand, Canada, Russia and the USA) all have dedicated staff and facilities.

d) The testing of killing traps

Mechanical testing. Mechanical testing is appropriate where previously assessed traps of the same design are available. It can only ensure that a new trap is identical in all relevant respects, especially with regard to clamp and impact force, to another. Sophisticated equipment, e.g. using pressure transducers that are capable of withstanding the impact forces of the traps, must be used for this testing. Such equipment is likely to cost in the region of £15000 (€16600) and is currently available in the UK (Fera; see Figure 7.1) and Canada. A full mechanical evaluation of a particular trap design costs approximately $3000 Canadian (€1900) or £2000 (€2200).

Computer simulation models. Where there is already a computer model for a specific species and type of trap, the program could be modified to assess traps to the criteria of the Improved Standards. Currently the Fur Institute of Canada together with the Alberta Research Council have computer models that fit the TIU thresholds specified in the AIHTS for beaver, fisher, marten, mink, muskrat, otter and raccoon, and models for weasel and lynx are nearing completion. Modifying these models to fit the TIU thresholds specified in the Improved Standards would cost in the region of $25000 Canadian (€16000) per model. This cost assumes there is an appropriate distribution of data across the thresholds from the compound testing of traps done to date in order to accurately estimate the trap ratings. If the existing data are insufficient then additional compound testing would have to be completed prior to the development of the modified model. If, for example, a TIU of 180 seconds was tested for a particular species and there were very few compound tests where the animals lost sensibility prior to 180 seconds then it would not be possible to obtain a good model fit using the existing data; more testing would be required. The Fur Institute of Canada already has mechanical values for several of the traps used in the EU and also some data gathered from compound tests.

The development of a new simulation model would require gathering data from a minimum of 35 animals (for some species many more have been required) on a range of trap designs for the particular species. Data from compound tests based upon a range of trap designs as well as mechanical evaluations of the trap designs are required prior to the development of the species-specific model. The cost of the appropriate compound tests at the Fur Institute of Canada varies significantly between species, starting at around $25000 Canadian (€16600) and rising to $100000 (€65000). Once all the necessary data have been gathered the actual development of the new model costs in the order of $40,000 Canadian (€25,000); this price would be greater for models that cover both land and underwater conditions (e.g. traps for beaver). The cost of testing a trap using the computer model once it has been developed is around €3500. Using wherever possible computer models to assess traps represents significant savings (particularly when there are many traps of the same type, e.g. rotating jaw) and far fewer animals are required. However, where there are very few models of any one type of trap (e.g. DOC traps) or there is a unique design of trap (e.g. Nooski trap) then computer models can not be developed, and pen and field trials have to be undertaken.

Of the six species of particular interest to the EU, computer models have already been developed for muskrat and marten and these could be modified to fit the criteria of the Improved Standards. Of the remaining species, killing traps are generally not used to control raccoons, raccoon dogs or badgers. However, they are used extensively to control ermine, and a new model would have to be developed for this species.

Anaesthetised animal trials. Trap testing involving anaesthetised animals would require a minimum of seven animals for each trap assessed (using the Bayesian sequential stopping rules). It is estimated that such a testing regime would cost in the region of £4000 (€4400) for the animals, facilities and skilled staff required to carryout the assessments. However, it has to be remembered that a trap can not pass the Improved Standards on the basis of anaesthetised trials alone (although it may fail them solely on this basis, see 7.2), and these would need to be followed up by pen and field trials.

Pen trials. The total costs of pen trials are naturally very dependent on the number of animals that have to be tested. A trap could be failed on the basis of data from as few as six animals. However in order to ensure that a trap has passed the required upper TIU thresholds of the Improved Standards 30 animals would have to be tested and this could cost approximately £35000 (€39000) per trap.

Field trials. The purpose of field trials is a) to ensure that the trap's killing bar(s) hits similar anatomical positions when set in the natural environment as when used during pen trials, b) to assess numbers of non-target captures, and c) to assess trap efficiency. The type of habitat a trap is used in will influence population density and behaviour of the target species, and data should be gathered from each type of habitat. Field data are best obtained by having scientists accompanying skilled trappers, rather than by training scientific personnel in trapping techniques. Field data should be gathered on a minimum of 20 individuals. The cost will vary enormously between species but is thought to average out over all species at approximately £18000 (€20000).

e) The testing of restraining traps.

Field trials. Data for existing restraining traps data are obtained from field trials because this ensures that the animals are behaving normally. As with the field trials of the killing traps, the most efficient method of collecting these data would be for scientific personnel to accompany skilled trappers. To test a trap against the Improved Standards data from a minimum of 20 individuals would be required. Although the costs will vary with the species, it is estimated that an average cost per trap would be in the region of £24000 (€27000). However, it is proposed that existing data derived from the use of box/cage traps be examined to see if this design of trap can automatically be assigned to Welfare Category A; as has happened in New Zealand.

Pen trials. It is recommended that any new design of trap be first tested in a captive environment to ensure that a) there is a very low occurrence of severe injuries, and b) animals do not escape from the device. A minimum of 7 animals (using the Bayesian sequential stopping rules to pass a trap early) would be required for such pen trials, and the cost (which covers animals, facilities and staff) is estimated to be in the region of £8000 (€8800). Subsequent field trials, as described above, would also be required for traps that pass the pen trials. Therefore the total cost of testing a new design of restraining trap would be around €35800.

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Acknowledgements

This report would not have been possible without the cooperation, help and advice of the numerous people and organisations listed below. We are very grateful.

National Contacts for trap use survey

Dr. P. Lebersorger, Landesjagdverbande, Austria.

Thomas Ceulemans, Flemish Hunting Organisation, Belgium.

Dr. Ing. Josef, Mendel Universitat Brno, Czech Republic.

M. Hojsgaard, Danmarks Jaegerforbund, Denmark.

Dr. I. Ala-Ajos, Hunters Central Organisation, Finland.

Jean-Claude Saulnier, Le Barry Pradieres, France.

Prof. K. Pohlmeyer, Institut fur Wildtierforschung, Germany.

Nikolaos Papadomimas, Helenic Hunters Confederation, Greece.

Hungarian Hunters' National Association, Hungary.

Italo Fanton, Italian Delegation FACE, Italy.

Elmars Svede, Latvian Hunters' Association, Latvia.

Eugenijus Tijusas, Lithuanian Hunters' & Fishermen Association, Lithuania.

Francois Jacobs, Federation Saint-Huberts des Chasseurs du Grand-Duche, Luxembourg.

Fred Barends, Dutch Muskrat Control Service, The Netherlands.

Armenio Lanca, Confederation Nacional des Chasseurs Portugais, Portugal.

Prof. Ing Neculai Selaru, Association Generale des Chasseurs et des Pecheurs Sportifs de Roumanie, Romania.

Dr. Imrich Suba, SLKvak Hunting Union, Slovakia.

J. Bernad danzberger, Real Federation Espanola de Caza, Spain.

Anders Grahn, Swedish Hunters' Association, Sweden.

Stewart Scull, British Association for Shooting and Conservation, United Kingdom.

Dr. Jury Domskiy, Russian Research Institute for Hunting Industry and Fur Farming, Russian Federation.

Dr. Sergey Minkov, Russian Research Institute for Hunting Industry and Fur Farming, Russian Federation.

Dr. Vladimir Melnikov, Department of Hunting Industry, Ministry of Agriculture, Russian Federation.

Robert Cahill, Fur Institute of Canada, Canada.

Bryant White, Association of Fish and Wildlife Agencies, USA.

Technical Workshop participants

Irene Planck, DG Environment, European Commission.

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Gordon Batcheller, N.Y.S. Department of Environmental Conservation, USA.

Neal Jotham, Chairman of ISO TC/191, Fir Institute of Canada, Canada.

Dr. Mike O'Brien, Nova Scotia Dept. of Natural Resources, Canada.

Dr. Bruce Warburton, Landcare Research, New Zealand.

Margreet van Willegen, Dutch Muskrat Control Service, The Netherlands.

Fred Barends, Dutch Muskrat Control Service, The Netherlands.

Prof. David Morton, University of Birmingham, UK.

Dr. James Kirkwood, Universities Federation for Animal Welfare, UK.

Prof. Don Broom, University of Cambridge, UK.

Technical Workshop organisation

Matt Gomm, Food and Environment Research Agency, UK.

Statistical Assistance

Dr. Michelle Hiltz, Alberta Research Centre, Canada.

Willem Roelofs, Food and Environment Research Agency, UK.

David Wikinson, Food and Environment Research Agency, UK.

Literature searches

Jonathan Stein, Food and Environment Research Agency, UK.

Muskrat experiments

Sabine Kruse, University of Munster, Germany.

Evelina Utrata, University of Munster, Germany.

Dr. Susanne Pape, Veterinarian, Munster, Germany.

Dr. med. Tony Fracasso, University Hospital of Munster, Germany.

Ralf Schlieper, Julius Kühn-Institut, Germany.

Engelbert Kampling, Julius Kühn-Institut, Germany.

Henning Thiele, Julius Kühn-Institut, Germany.

Hubert Hanses, Julius Kühn-Institut, Germany.

Expertise on muskrat control

Tim Eiler, Muskrat Control Service for Lower Saxony, Germany.

Lukas Hoffman, Muskrat Control Service for Lower Saxony, Germany.

Harald Dirks, Muskrat Control Service for Lower Saxony, Germany.

Karl Martens, Muskrat Control Service for Lower Saxony, Germany.

Karl Klattenberg, Muskrat Control Service for Lower Saxony, Germany.

Jaap Gerkes, Dutch Muskrat Control Service, The Netherlands.

Hans van Poelwijk, Dutch Muskrat Control Service, The Netherlands.

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Karel Zanderink, Dutch Muskrat Control Service, The Netherlands.

Fred Barends, Dutch Muskrat Control Service, The Netherlands.

Margreet van Willegen, Dutch Muskrat Control Service, The Netherlands.

Dr. Jan Stuyck, Research Institute for Nature and Forest, Belgium.

Dr. Kristof Baert, Research Institute for Nature and Forest, Belgium.

Appendix 1. Survey of trap use.

Questionnaire on trapping

A) General questions

A1 Is trapping allowed in your country? yes ☐ no ☐

If yes, is the legislation identical in the whole country? yes ☐ no ☐

A2 Does a definition for “trapper” exist in your national legislation? yes ☐ no ☐

If yes, give details?

……

……

A3 What is the estimated number of trappers in your country? ……………………………………………..

Are they joined in an association? yes ☐ no ☐

At which level?

National ☐

Regional ☐

Local ☐

A4 Which are the main motives/motivations for trapping?

- wildlife management ☐
  - including control of pest species ☐
- obtaining fur, skin or meat ☐
- capturing for conservation needs ☐
- public health and civil protection ☐
- research, education, re-stocking, re-introduction, breeding, etc… ☐
- use of traditional traps for the preservation of cultural heritage ☐

- others (specify)
☐

A5 Who is allowed to trap (*several answers are possible)*?

Hunter	**Trapper**	**Governmental staff**	**Gamekeeper**	**Landowner**	**Other (specify)**
yes ☐ no ☐	yes ☐ no ☐	yes ☐ no ☐	yes ☐ no ☐	yes ☐ no ☐	

B) Species listed in the Agreement (AIHTS)

B1

Legal status / *Species*	Present in the country	Trapping authorized in the legal framework	Trapping authorized with derogation on a case by case basis	Huntable
Canis lupus **Wolf**				
Castor canadensis **American beaver**				
Castor fiber **European beaver**				
Lutra lutra **European otter**				
Lynx lynx **European lynx**				
Martes martes **Pine marten**				
Meles meles **European badger**				
Mustela erminea **Ermine**				
Nyctereutes procyonoides **Raccoon dog**				
Ondatra zibethicus **Muskrat**				
Procyon lotor **Raccoon**				

B2 Other mammal species trapped in your country:

....

C) Categories of traps

C1 Types of traps used and animals concerned by these traps

Types of traps / ***Species***	**Restraining traps**			**Killing traps**			
	Box and cage traps	**Stopped/free-running snares**[12]	**Foot snares**	**Spring traps**[13]	**Dead fall traps**[14]	**Drowning traps**	**Self-locking snares**
Canis lupus **Wolf**							
Castor canadensis **American beaver**							
Castor fiber **European beaver**							
Lutra lutra **European otter**							
Lynx lynx **European lynx**							
Martes martes **Pine marten**							
Meles meles **European badger**							
Mustela erminea **Ermine**							
Nyctereutes procyonoides **Raccoon dog**							
Ondatra zibethicus **Muskrat**							
Procyon lotor **Raccoon**							

[12] Stopped/free-running trap (including Collarum™ type)

[13] Spring traps: specify the type of trap (conibear, egg-trap, kill trap…)

[14] Dead fall traps: specify the type, raised or ground level.

C2 Do you use other types of traps that are not appearing in table C1? Which ones?

Species concerned by AIHTS	Traps used

D) Approval of traps

D1 Do traps need to be approved in your country?

yes ☐ no ☐

D2 What types of traps need to be approved in your country?

……..

……..

D3 What types of traps can be authorized without approval?

……..

……..

D4 What organisation is consulted and issues the approvals? Following which procedure?

……..

……..

……..

D5 For which motive(s) the approval of a trap can be rejected or withdrawn?

……..

……..

D6 How are the approved traps identified?

……..

……..

D7 Can non-approved traps be sold?

yes ☐ no ☐

If yes, which ones?

……..

……..

E) Use of the traps, legislation and restrictions/constraints

E1 Does a specific training for trapping exist in your country?

yes ☐ no ☐

If yes, is it mandatory and what is its duration?

………

E2 Which organisation(s) give(s) this training?

………..

………..

E3 Does this training contain:

- a theoretical part (biology of the species…) ☐
- a practical part (handling of the traps…) ☐
- a practical part and a theoretical part ☐

E4 Do the trappers need to have:

- the hunting license:

yes ☐ no ☐

- a trapping license or authorization:

yes ☐ no ☐

- both:

yes ☐ no ☐

E5 Do the traps require to be marked in order to identify their user?

yes ☐ no ☐

If yes, in which form?

……

E6 Is it mandatory for trappers to make a "trapping declaration" before setting up their traps?

yes ☐ no ☐

E7 Is it necessary to indicate the trapping areas?

yes ☐ no ☐

If yes, how?

………..

………..

E8 Can traps be placed everywhere?

yes ☐ no ☐

If not, fill in the table

Categories of traps for which there is an area restriction	Authorized area(s)

E9 Can traps be placed all year round?

yes ☐ no ☐

If not, indicate the time of the year when trapping is permitted:

……

E10 During the time of year when trapping is permitted, are there restrictions for certain days (e.g. week-ends)?

yes ☐ no ☐

If yes, please fill in the table:

Categories of traps for which there is a time restriction	Authorized period(s)	Restrictions (days, hours…)

E11 Do you “control” or follow-up traps and bags in your country?

yes ☐ no ☐

If yes, which organisation or structure carries out these controls?

……..

E12 Does an assessment/report of the captures need to be provided?

yes ☐ no ☐

If yes, when (at which frequency) and to which authority(ies)?

……..

……..

F) Trapping methods and selection

F1 Is there an obligation to regularly check the traps in the field?

yes ☐ no ☐

If yes, specify:

……..

……..

F2 How is the killing of the captured animals performed?

……..

……..

F3 If a firearm is used for the killing, is the hunting license mandatory?

yes ☐ no ☐

F4 Which measures concerning the setting up of the traps are taken in order to ensure public security?

……..

……..

F5 Is the use of live decoys authorized?

yes ☐ no ☐

If yes, under which conditions?

……..

……..

F6 For each type of trap, which are the methods used to improve the selectivity?

Killing traps	**Technical characteristics defined by law**	**Setting conditions**	**Baits used**	**Other methods**
Spring traps				
Dead fall traps				
Drowning traps				
Self-locking snares				
Others :				

F7 For each type of trap, what methods are used to minimise suffering to the trapped animal?

Restraining traps	**Technical characteristics defined by law**	**Setting conditions**	**Other methods**
Box-cage traps			
Stopped snares			
Foot snares			
Others :			

Appendix 2. Survey for public internet consultation.

Questionnaire - for the public consultation

Title: Your attitude towards the regulation of trapping in the EU

Useful links - background information:

Council Regulation (EEC) No 3254/91 of 4 November 1991 prohibiting the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or trapping methods which do not meet international humane trapping standards [Official Journal L 308, 11.9.1991]

Council Decision 98/142/EC of 26 January 1998 concerning the conclusion of an Agreement on international humane trapping standards between the European Community, Canada and the Russian Federation and of an Agreed Minute between Canada and the European Community concerning the signing of said Agreement [Official Journal L 42, 14.2.1998]

The Habitats Directive - Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

Introduction

Following concerns expressed by some interest groups about trapping methods used in the EU and in some third countries, the EU passed the Council Regulation (EEC) No 3254/91. This Regulation, popularly known as the Leg-hold Traps Regulation, prohibits both the use of leg-hold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch these animals by means of leg-hold traps or trapping methods that do not meet international humane trapping standards. A leg-hold trap is defined in its Article 1 as a device designed to restrain or capture an animal by means of jaws which close tightly upon one or more of the animal's limbs, thereby preventing withdrawal of the limb or limbs from the trap.

In order to agree on such international humane trapping standards, the Community, together with the three main trapping nations Canada, the USA and the Russian Federation, set up in 1995 a working group consisting of scientific experts. Subsequently, an agreement on international humane trapping standards was concluded with Canada and the Russian Federation (the AIHTS) and was approved by Council Decision in 1998. A substantially similar agreement concerning the standards was reached in the form of an Agreed Minute with the USA. These agreements allowed the Community not to apply to Canada, the Russian Federation and the US the import ban under Council Regulation (EEC) No 3254/91. The Agreement entered in to force 22 July 2008 following the deposit of the ratification by the Russian Federation.

The Agreement and the Agreed Minute form an integral part of European Community (EC) law and therefore binding on the Institutions and the Member States. The Commission has asked on several occasions for information from Member States on how the obligations of the Agreement are implemented through existing legislation in the Member States but it seems that not all Member States have adjusted their legislation to implement the Agreement. Accordingly, in the absence of proper implementation of the Agreement at EU level, the EC is not fulfilling its obligations and international responsibility versus the other Parties.

On 30 July 2004 the Commission submitted a Proposal for a Directive of the European Parliament and of the Council introducing humane trapping standards for certain animal species (COM (2004) 532 final) with the objective to implement the international obligations and commitments arising from the Agreement signed by the EC, Canada and the Russian Federation, and the Agreed Minute on the same subject with the USA. The Proposal follows the scope and content of the Agreement and aims to ban the use of traps not meeting the agreed international trapping standards for catching animals belonging to the 19 species listed in the Agreement; such as wolf, beaver, otter, lynx, sable, muskrat, raccoon dog, badger, coyote, fisher, ermine, marten, pine marten and bobcat. Thus a harmonised system would need to be established within the EU to evaluate available traps and to ensure that the best possible trapping methods are used.

However, it would leave intact the possibility for EU Member states to introduce stricter standards at the national level. The use of all leg-hold traps, even those that are in conformity with the humane trapping standards, will remain prohibited within the EU. Accordingly, the new Directive would therefore only apply to traps other than leg-hold traps, and only for the species listed under the Agreement, in so far that their trapping is in conformity with other EU legislation (in particular the "Habitats" Directive).

This Proposal was submitted to the other institutions for adoption under the co-decision procedure. During the First reading of this procedure the Proposal was, however rejected for a variety of reasons by the European Parliament. While some Members of the European Parliament criticised it because the trapping standards in the Proposal are the result of work conducted in 1996-1997 by the expert group and therefore are not necessarily based on the latest science, others expressed doubts about the EU competence to legislate in the domain of the welfare of wild animals. The Commission took note of the rejection and decided to consider further steps to address the concerns expressed in relation to the Proposal.

Accordingly, taking account of the time passed since the Agreement was negotiated and since the time the independent experts finished their work, the Commission is now examining, by means of a study, the state of art of research and science with regard to trapping with the view to identify trapping standards according to current science. In this context the Commission would also like to consult the European public in relation to trapping, and the need for further harmonised rules such as the introduction of trapping standards.

This consultation is based on an online questionnaire containing 27 closed questions. It should then take you app. 15 minutes to fill in all the questions.

The results of the consultation will be summarised in the final report of the above-mentioned study in 2009.

I. Background of the respondent

1. Gender

Female
Male

2. Age

under 20	20-30	31-40	41-50	51-70	Over 70

3. Do you live in:

in a city or town over 100,000 inhabitants
in a city or town between 20,000 and 100,000 inhabitants
in a town, or village of less than 20,000 inhabitants
in a rural village of less than 1,000 inhabitants

4. Country of residence

<u>In the EU:</u>
Austria
Belgium
Bulgaria
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovak Republic
Slovenia
Spain
Sweden
United Kingdom,

Outside the EU:

Canada Norway Russian Federation USA Other

5. Do you reply on behalf of:

Yourself
An organisation for wildlife conservation
An organisation for animal welfare / rights
An organisation for hunting, trapping or other forms of sustainable use of wildlife
Another organisation, institution or body, governmental or non-governmental

6. Which of the following activities are you familiar with: (maximum three)

Trapping for meat, fur and/or skins
Trapping for regulating (overabundant) species causing damages
Trapping for research, conservation, reintroductions, etc.
Trap manufacturing and development
Research in the domain of wild animal ecology, behaviour, physiology, etc.
Recreational Hunting
Wildlife conservation and management
Animal protection / welfare / rights
None of the above

7. Do you accept <u>in principle</u> that human or environmental needs (including prevention of serious damage or for public health and safety reasons) justify killing of wild animals?

Yes No Do not know

II. Respondent's knowledge of practical wildlife management

8. What are, <u>to your knowledge</u>, the main methods used the EU to control wild animal populations targeted by this consultation? (Select as many options as you wish)

Shooting,
Traps that kill the animal,
Box or cage traps that hold the animal until the trap operator kills it (or releases it elsewhere)

Traps that result in the drowning of the animal,
Killing snares, i.e. wire loop that kills the animal
Holding snares, i.e. wire loop that holds the animals
Poisoned bait
Poisoned gassing
Immuno-contraception
Do not know

9. What are, <u>to your knowledge</u>, the main reasons for the trapping of wild animals in the EU? (Select as many options as you wish)

To obtain furs and skins
To protect human health and safety (e.g. from flooding due to muskrat damage)
To prevent damage to property
Conservation of other wild species
To obtain meat
Research
Do not know

III. Respondent's opinion on regulating trapping

10. Do you think that the techniques and practices used to trap wild animals in the EU should be regulated? (Select one option)

Yes, by voluntary codes of conduct or best practice by trappers' organisations
Yes, by legal regulation by national authorities, adapted to local situations
Yes, by EU regulation harmonised for all 27 Member States (*in addition* to EU regulation already in place)
No
Don't know

11. Who do you think should be authorised to conduct trapping in the EU? (Select up to three options)

Persons who have the legal right to do so under national law
Persons who have been properly trained or have the relevant expertise
Persons who can demonstrate their competence according to legal requirements
Specialised private companies
Government Authorities/bodies
None of the above
Do not know

12. How do you think trapping expertise should best be obtained in the EU? (Select one option)

Mandatory training harmonised for all 27 Member States
Voluntary training
Practical experience, no special training required
Do not know

13. Which of these species do you think should be covered by regulated trapping in the EU? (Available answers: yes / no / don't know)

The species listed in the *Agreement on international humane trapping standards* (AIHTS)
Species trapped for pest control and / or wildlife management
Species trapped to obtain, fur, skin or meat
Species trapped for scientific research
All animal species that can be legally trapped

14. At what level, in your opinion, is the list of species, to be covered by regulated trapping, best determined? (Select one option)

At international level
At EU level, on a harmonised list
At national level, adapted to local situations
Do not know

IV. Respondent's opinion on testing / approving of traps

15. Do you think that traps in the EU should be tested and approved according to clearly defined wild animal welfare criteria?

No Yes Do not know

16. If traps were to be tested and approved in the EU, should this be done by: (Select one option)

The manufacturers
Accredited trappers' organisations
Accredited animal welfare organisations
An independent institute or body
Competent authorities
Do not know

17. At what level, in your opinion, would such testing and approval be best organised? (Select one option)

At international level
At EU level
At national level, adapted to local situations
Do not know

18. If traps were to be tested and approved in the EU, who do you think should develop the criteria (such as effectiveness, selectivity and safety): (Select one option)

Manufacturers
Recognised Trappers' organisations
Recognised Animal welfare organisations
Recognised Independent institute or body
National authorities
f) EU level
g) Do not know

19. At what level, in your opinion, should such criteria be established?

At international level
At EU level, on a harmonised list
At national level, adapted to local situations
Do not know

20. If you trap animals yourself (including mice, rats, moles, etc.), how much more would you be ready to pay for one trap that had been tested and approved? (Select one option)

No upper limit
Double
50 % more
25 % more
Nothing more
Do not know
Not applicable

V. Respondent's opinion on animal welfare aspects

21. With regard to trapping animals, how important is their welfare compared to your concerns over preventing damage, protecting health or managing wildlife? (Select one option)

More concerned about welfare of the trapped animal than about preventing damage, protecting health or managing wildlife.

Less concerned about welfare of the trapped animal than about preventing damage, protecting health or managing wildlife.

Equally concerned about animal welfare compared to preventing damage, protecting health or managing wildlife.

Do not know

22. Which of the following methods to control wild animals in the EU are in your opinion acceptable? (Select as many options as you wish).

Shooting,
Traps that kill the animal,
Box or cage traps that hold the animal until the trap operator kills it, (or releases it elsewhere)

Traps that result in the drowning of the animal,
Killing Snares, i.e. constricting wire loops, that kill the animal,
Holding Snares, i.e. constricting wire loops, that hold the animal until the snare operator kills it, (or releases it elsewhere)
Poisoning,
Poisoned gassing
Contraception
All of the above (excluding contraception) as long as those methods ensure death of the animal without avoidable pain, suffering and distress
None of the above
Do not know.

23. Which of the following methods to kill an animal that was caught alive in a trap or snare are in your opinion acceptable? (Select as many options as you wish).

Shooting
Heavy blow to the head or neck of the animal
Drowning
Lethal injection
All of the above as long as those methods ensure death of the animal without avoidable pain, suffering and distress
None of the above
Do not know

24. If new trapping standards incorporating effectiveness, selectivity and safety were established in the EU, but none of the current traps met these standards, would you suggest to: (Select one option)

Use what you believe are the best available traps
Use whatever traps are available
Stop trapping until traps that do meet the new standards become available
Use firearms instead
Use poison instead

None of the above
Do not know

25. Assuming that a killing trap is very effective, selective and safe for catching specific pest animals (for example mice in your home) but does not kill them immediately, what is your opinion of the longest time acceptable from an animal welfare point of view between the trap catching an animal and it becoming unconscious and dying? (Select one option)

Zero seconds, instantaneous death
30 seconds
1 minute
3 minutes
5 minutes
Any length of time
None of the above
Do not know

26. When assessing the welfare of an animal caught in a holding trap, which one of the following indicators do you think should be given the <u>most</u> weight? (Select one option)

Behavioural signs (e.g. biting the bars of the trap)
Physical injuries (e.g. damaged skin or broken tooth)
Physiological indicators (e.g. high levels of stress hormones)

27. What would be your suggestions to the decision-makers at the EU level on the possible regulation of trapping? (Up to two statements can be selected).

Binding, harmonised EU trapping standards, which aim to improve welfare of trapped animals
Voluntary EU trapping standards, which aim to improve welfare of trapped animals
Recommendation to Member States to adopt, when required, measures to better regulate trapping and establish trapping standards
Leave it to the Member States to fulfil their obligations under the *Agreement on international humane trapping standards* (AIHTS)
None of the above
Do not know

Appendix 3: Analysis of study designs for the assessment of traps

Summary

The aim of this study is to provide information on how well different study plans for testing traps against welfare criteria in pen-trials perform. In particular, the effects of using study plans that are designed to identify poorly performing traps quickly are examined.

The performance of a trap is assumed to be characterised by a true probability that an incident (i.e. an adverse welfare event that causes the trap to fail the trapping standard; e.g. a TIU too long or injury too severe) will occur in an individual trapping event. The performance of study designs was estimated by simulating studies on traps taken from a profile that describes a population of traps with a range of incident probabilities. A population profile was estimated from the "relative placements" of marten traps. The relative placement is a measure derived from the computer simulation models of Hiltz & Roy (2000) and is the mean probability, derived from 10,000 simulations, that a trap meets the requirements of the AIHTS; it is a useful tool for comparing the welfare impacts of traps. Further theoretical profiles were used to assess the robustness of conclusions. Estimates of four outcomes were used to assess study designs: the mean probability of an incident for traps that 'pass', the estimated number of in-study incidents, the estimated number of tests required to reach a decision and the proportion of traps that 'fail'. The performance of study plans based on a fixed number of tests (10 to 50) and a maximum acceptable number of incidents (10% to 30%) is reported.

Two further types of study plans are introduced that are designed to detect early evidence of failure. The first type of study plan 'fails' a trap as soon as, given the results so far, the probability that the true rate of incidents is acceptable falls below 5%. The second type 'fails' a trap as soon as the probability that the study would ultimately 'pass' the trap falls to below 5%

The effect of using study plans that are designed to detect early evidence of failure on estimates of the four outcomes for marten traps was an increase in the proportion of traps that fail by approximately 2%, a reduction in the number of tests required to reach a decision by approximately 40%, a reduction of the number of in-study incidents by approximately 50%, and a reduction of the mean incident rate of accepted traps by

approximately 2%. Effect size was dependent on the study size. The performance of the two study designs for detecting early evidence of failure was very similar. Hence, there may be a trade off to be made between the benign effects of using "early evidence of failure plans" (i.e. the reduction in the number of tests required to reach a decision and the reduction of in-study incidents) and a less favourable effect (i.e. the increase in traps that fail). This study provides information that can be used to decide whether the trade-off is worthwhile.

An assessment of the robustness of the estimates of study outcomes to different profiles of trap populations suggests that trade-offs will be remain as favourable as those reported here for profiles that are 'flat' or weighted to higher incident rates. Trade offs for profiles that are weighted to lower incident rates (i.e. more traps with a low incident rate than a high incident rate) will be less favourable than those reported here.

Study plans

Base tests

A set of 15 'base plans' were used: undertake up to 10, 20, 30, 40 and 50 tests; for each study size a trap passes when no more than 10, 20 or 30% of tests result in an incident. These study plans were used to explore that space around the AIHTS study plan for restraining traps that uses 20 tests and passes a trap for which no more than 4 out of 20 tests (20% of tests) result in an incident. Hence, the 'stopping rules' for the AIHTS study plan are:

> Stop a study and fail the trap if five incidents have been observed at any time.
>
> Stop a study and pass the trap if no incidents have been observed after 16 tests, or one incident after 17 tests, or two incidents after 18 tests or three incidents after 20 tests or four incidents after 20 tests.

The general rule for these tests is:

> Given a study of N tests and a pass decision only if no more than X incidents are observed, then declare a failure if X+1 incidents are observed at any time

Declare a pass if (X-x) ≥ (N-n), where x is the number of incidents observed so far and n is the number of tests undertaken so far.

Bayesian sequential stopping rules for studies

Other study plans can be used. It might be desirable to use a study plan that reacts quickly to hopeless cases rather than soldiering on until the X^{th} incident has occurred. For example, if the first four tests in an AIHTS plan (no more than four incidents out of 20) have given four incidents, is it either reasonable, or ethical to continue the study? What if three tests out of three have resulted in incidents? What about three out of four? One approach to answering these questions is to consider the information given to us by the test results 'so far' on the underlying true rate of incidents associated with a trap, such as the probability that the underlying true rate of incidents associated with a trap is less than or equal to a maximum acceptable rate r_{max}. This forms the basis of the 'inference on r test', and may be thought of as a test of how reasonable it is to continue a study. Another approach is to estimate the probability of the study ending with a favourable assessment of the trap, and to stop the study when the probability becomes too low (or when the probability that more incidents will be observed and the trap will fail anyway becomes too high). This forms the basis of the 'probability of success test', and again can be thought of as a test of how ethical it is to continue a study.

The 'inference on r test'

Given x incidents out of n tests then the estimated rate of incidents is given by the binomial proportion x/n. Beta distributions are standard conjugate priors for binomial distributions. The Jeffreys prior (Brown et al. 2002) for *inferences on r* (true independent probability of an incident for a single test) is given by $\mathrm{Beta}(0.5,0.5)$ and the posterior probability density function for r is given by $\mathrm{Beta}(x+0.5, n-x+0.5)$ (Brown et al. 2002). Hence, the probability that the true rate of incidents, r, is less than or equal to r_{max} is given by the by the value of the cumulative distribution function $\mathrm{Beta}(x+0.5, n-x+0.5)$ at r_{max}. Table 1 shows the probability that $r \leq r_{max}$ where r_{max} is set to 20% (which is implied by the AIHTS criterion of no more than 4 incidents out of 20 tests). The table can be used to define a new set of stopping rules whereby the study continues only for as long as the results are reasonably consistent with a true underlying rate of incidents of no more than 20%. If 'reasonably consistent' is taken to mean 'with a probability of at least 5%' then the following new stopping rules are suggested:

Stop study and fail the trap if the first test gives an incident.

Stop the study and fail the trap if the second incident occurs on or before the fourth test, or the third incident occurs before the seventh test, or the fourth incident occurs before the 10^{th} test, or the fifth incident occurs before the 13^{th} test etc.

Stop the study and pass the trap if $(4\text{-}x) \geq (20\text{-}n)$, as in the base test.

These rules can be called "the inference on r test"

The effect of study size and the 'probability of success test'

The 'inference on r test' is based on estimating the probability that the true underlying rate on incidents r is less than r_{max}. Another way of thinking about this test is to describe r as the value of x/N (observed proportion of incidents at the end of a study) when the study size N is *very* large. Then, the probability used in the inference on r test is giving a prediction about the likely value of x/N at the end of a study that uses an infinite number of tests given what we have observed so far. However, we never use an infinite number of tests. It is more usual for a maximum study size to be 20, i.e. the minimum in the AIHTS for restraining traps. Once the maximum test size has been reached a decision *must* be made based on the observed number of incidents and tests. Inevitably, the decision will be 'pass if no more than X out of N tests resulted in an incident and fail if X+1 incidents were observed. The probability of passing this kind of test given the results observed so far can be estimated. The probability (p_s) of observing (X-x) or fewer positives in (N-n) future tests, given x positives observed in n tests, is given by the beta-binomial distribution function (Evans et al. 1993) shown in Equation 1.

$$\sum_{i=0}^{i=X} \binom{N}{i} \frac{Beta(x + 0.5 + i, n - x + 0.5 + N - i)}{Beta(x + 0.5, n - x + 0.5)}$$

Equation 1

Table 2 shows an example of the application of 'the probability of success test', using Equation 1, to the AIHTS study plan of passing a trap that gives no more than four incidents in 20 tests, or 20% of 20 tests. The values in Table 2 give the probability that we will observe no more than 20% of incidents in 20 tests given our observations so far. In general the values are similar to those in shown in Table 1 which give an inference about the true rate of incidents for a trap, effectively the probability that we will observe no more than 20% of incidents in an infinite number of tests given our observations so far.

The main practical difference between the approaches occurs where the observed number of incidents is close to the critical value (‘5’ for Table 2). For example where we have observed 4 incidents out of 11 Table 1 says that it may still be reasonable (probability=0.09) to suppose that the true rate of incidents could be less than 20%, but Table 2 says that, given the maximum size and critical value of our trial, it is unlikely (probability≤0.05) that the trap will receive a favourable assessment because it is unlikely that the remaining nine tests will be completed without an incident. Hence, an ethical question is raised, should we continue the study when it is very likely that further incidents will occur and thus the trap will fail anyway? If a threshold of (probability≤0.05) for the trap reaching the end of the study successfully is applied then the following stopping rules are suggested:

Stop study and fail the trap if the first test gives an incident.

Stop the study and fail the trap if the second incident occurs before the fourth test, or the third incident occurs before the seventh test, or the fourth incident occurs before the 12^{th} test, or the fifth incident occurs before the 20^{th} test.

Stop the study and pass the trap if $(4-x) \geq (20-n)$, as in the base test.

Study plans were examined in this paper

45 study plans were examined in this paper: 15 base study designs for study sizes of 10 to 50 with no more than 10 to 30% observed incidents to pass, 15 ‘inference on r’ study plans, and 15 ‘probability of success’ study plans each based on the 15 base study plans. The differences between plans, for a given study size and threshold for acceptable traps, lay in the rules used to stop a study and fail a trap. The same rules were used to stop and study and pass a trap for all kinds of study plans.

Each set of “inference on r” and “probability of success” stopping rules were constructed using tables analogous to Tables 1 and 2 for different study sizes and thresholds. The critical probability for inferences on r and probability of success was set to 5%. One important modification was introduced: the case where probability tables suggested that studies should be stopped if the first test gave an incident was not applied. A general rule that a trap should fail only after a minimum of two incidents was introduced. This had the effect of making studies more robust against ‘false positives’ caused by problems with implementation. Also, the coverage of the binomial confidence interval on which the ‘inferences on r’ and ‘probability of success’ is based is not very good where ‘x=n’ (Brown et al. 2001). One failure in one trial is the only case where we would rely on the such a probability being correct because for all the other case where we fail a trap after n failures in n tests, we would also fail the trap after n-1 failures in at least n tests.

Tables 3 to 5 show the stopping rules for the base plans, Tables 6 to 8 show the stopping rules for the ‘inference on r’ plans, and Tables 9 to 11 show the ‘probability of success plans. They are to be read along rows for each study size. For example Table 11, the “Reject trap if probability “that x≤X after N trials, where X/N=0.3” is less than 5%” plan, says that for a study size of 20 tests the study should be halted and the trap failed if 2 incidents (x) occur in the first 2 tests (n), or if 3 incidents occur in the first 4 tests or if 5 incidents occur in the first 9 tests, or if 6 incidents occur in the first 13 tests, or if 7 incidents occur at any time. The study should halt and the trap should pass if the number of remaining tests is no greater than the number of remaining ‘allowed’ incidents.

Methods

Assessment of pen-trial study designs

Study designs were assessed by estimating the values of four quantities that describe the efficacy of studies: two economic

1) the expected proportion of traps that will be rejected by a study,

2) the number of tests required to reach a accept/reject decision;

and two welfare

3) the expected number of in-study incidents,

4) the expected mean rate of incidents for accepted traps.

Given a population of traps described by a probability density function f(r), where r is the rate of incidents per trapping event, then the proportion of traps P that will pass an assessment is given by

$$P = \int f(r).\,y(r).\,dr,$$

Equation 2

the mean number of tests required to reach a decision to accept or reject a trap is given by

$$M = \int f(r).\,n(r).\,dr,$$

Equation 3

the mean number of incidents in a study is given by

$$I = \int f(r).r.n(r).dr,$$

Equation 4

and the mean rate of incidents associated with traps that are accepted by studies is given by

$$R = \frac{\int f(r).r.y(r).dr}{\int f(r).y(r).dr}$$

Equation 5

Where y(r) is the probability of a trap with incident rate r will achieve a favourable assessment, and n(r) is the average number of tests required for a decision to be made. Hence, in principle, study designs can be assessed using equations 2 to 5. In this study values of P, M, I and R were estimated by simulation. Using the following algorithm

For each study design

1 Pick a population of traps from those that are consistent with the set of relative placements.

2 Pick a trap from the population by selecting a value of r

3 Simulate studies to get estimates of P, M, I, R for that trap

4 Repeat 2 and 3 to get estimates of the mean of P, N, I, R for that population

5 Repeat 1,2,3,4 to get a range of estimates of the mean of P, M, I, R that cover the range of populations that are consistent with the set of relative placements.

In order to assess the effect of changing a study plan, for example by increasing the study size, or moving from a base plan to a ‘probability of success plan’ an additional step was inserted “3a Simulate alternative studies and record P,M,I,R as a proportion of the original study”. This approach was used because it was considered likely that the effect of the uncertainty about the population of traps on estimates of P,M,I,R was likely to by correlated between different study designs. Hence that the uncertainty associated with the effect of changing a design may be less than the uncertainty associated with estimate of performance of a particular design. For this purpose the AIHTS minimum sample size plan of “pass if no more than 4 out of 20 tests give an incident" was used as a reference plan to compare other base plans against. Also, base plans were used as reference plans against which to compare "inference on r" plans and "probability of success plans".

For both approaches, calculation or simulation, it is necessary to have an estimate of the profile of the population of traps that are submitted for assessment. For this report a profile was estimated using a set of 'relative placements' of marten trap designs (personal communication, Fur Institute of Canada, 23rd June 2009) (Table 12) submitted for assessment by a modelling method (Hiltz & Roy 2000). Relative placements were used as estimates of the probability of an individual trapping event *not* resulting in an incident. The profile of the probability of a trapping event resulting in an incident for the population of marten traps was estimated as a beta distribution (v=1.7421, w=1.1823, s.e.(v)=0.5098, s.e.(w)=0.3255, correlation=0.7185). The profile and its uncertainty is shown in Figure 1. The profile is quite uniform: according to this profile between 0.4 and 14% of traps have an incident rate (r) up to 10%, between 2.5 and 25% of traps have an r up to 20% and between 6.6 and 35% have an r up to 30%.

The central estimate of the profile of traps is that 7.4% of traps will have an r up to 20%. Hence a perfect study plan designed to test traps against a threshold of 20% 'should' pass 7.4% of traps from a population described by the profile.

Finally the performance of study plans when testing traps taken from some particular populations (flat: beta(1,1), triangular with maximum at r=zero: beta(1,2), and triangular with maximum at r=1: beta(2,1)) was estimated.

Results

Performance of base plans applied to marten traps

Tables 13 to 15, and Figures 2 and 3 show the performance of study designs estimated by simulation. Two strong and intuitively obvious trends are that the number of tests required to reach a decision, and the number of in-study incidents, are closely related to the maximum study size. More useful observations are that the estimates of the mean incident rate of accepted traps tends to be higher for small study sizes, as does the estimated proportion of traps that are accepted. Also, the central estimate of the proportion of accepted traps is higher than the proportion of traps that would be accepted by a perfect study. For example for an incident rate threshold of 20% a perfect study would accept no traps with an incident rate > 20% and accept all traps with an incident rate ≥ 20%. For the central estimate of the population profile used in this study 7.4% of traps should be accepted at this threshold. However, a study based on 10 tests is estimated to accept 14% of traps, and a study based on 20 tests is estimated to accept 10% of traps. Studies based on 50 tests appear close to ideal performance (8% accepted).

The uncertainty associated with the estimated performance of studies is quite large compared to the variation between different study designs. The uncertainty comes from the range of profiles of the population of traps that are consistent with 12 reported relative placements.

Performance of base plans compared to a reference plan

The uncertainties associated with the estimated performance of plans may make it difficult to choose between different study designs. However the uncertainty associated with estimated performance compared to a reference plan (for example, the AIHTS minimum size study "no more than 4 incidents in 20 tests") is less than the apparent uncertainty associated with individual studies. For example, 95% confidence intervals for the mean incident rate of traps accepted by base study plans with 20 and 30 tests per study and a threshold of no more than 20% incidents overlap almost completely (Table 14, Figure 2), but the estimated effect of increasing from a study size of 20 to 30 is for the incident rate of accepted traps to be reduced to a proportion between 0.84 to 0.97, best estimate 0.91, of the 20-test study size (Table 23, Figure 4).

Performance of 'inference on r' and 'probability of success plans'

Estimates of the performance of the 'inference on r' plan and 'probability of success' plan for each study-size and threshold are very similar (Tables 16 to 22). This reflects the similarity of the practical implementation of the plans expressed as stopping rules Tables 6 to 11. The general pattern of the performance of the two plans performance compared to their analogous base plans (Tables 25 to 30, Figures 6 to 9) is similar across the sample-sizes and thresholds examined in this study: there is a small increase in the estimated proportion of traps rejected, a larger decrease in the number of tests required to reach a decision and a disproportionately (compared to the number of tests) larger decrease in the number of incidents per study. For example the estimated effect of moving from AIHTS "no more than 4 out of 20" plan, to an analogous "probability of success" plan (plan rules Table 10, estimates of performance Table 28) is to increase the number of rejected traps to a proportion of 1.01 of the base plan (range 0.99 to 1.02), to decrease the mean incident rate of accepted traps to a proportion of 0.98 (range 0.92 to 1.06) to reduce the number of tests per study to a proportion of 0.65 (range 0.56 to 0.76) and to decrease the number of in-study incidents to a proportion of 0.55 (range 0.50 to 0.61). In general the positive effects of using the two plans designed to detect early evidence of failure are proportionally greatest for large study sizes (Figures 10 to 13).

The robustness of estimates of performance to changes in trap population profile

Estimates of the relative performance of “probability of success plans” for three population profiles are shown in Tables 31 to 33. The performance of “probability of success study plans, relative to base plans, applied to traps with a flat population profile is similar to that estimated for marten traps. For example, for a study size of 20 and a threshold of 20% incidents, the relative proportion of rejected traps is 1.01, and the relative number of in-study incidents is 0.59. For a ‘worse’ population profile (triangular with a maximum at r=1) the relative performance of “probability of success plans” is better than that estimated for a flat population profile. For a ‘better’ population profile (triangular with maximum at zero) the use of the “probability of success” plans is less favourable. For example, for a study size of 20 and a threshold of 20% incidents, the relative proportion of rejected traps is 1.03, and the relative number of in-study incidents is 0.69. Hence, the relative performance of the study plans designed to detect early evidence of failure estimated using the estimated profile of marten traps is applicable to population profiles which are flat or worse. Performance should be re-assessed for population profiles that are better than flat.

Table 1: Probability that true rate of incidents ≤20% given x incidents in n tests

Tests (n)	Incidents (x)					
	0	1	2	3	4	5
1	0.55	0.04				
2	0.69	0.14	0.01			
3	0.77	0.25	0.03	0.00		
4	0.83	0.36	0.08	0.01	0.00	
5	0.87	0.45	0.13	0.02	0.00	0.00
6	0.91	0.54	0.20	0.04	0.01	0.00
7	0.93	0.61	0.26	0.07	0.01	0.00
8	0.95	0.67	0.33	0.11	0.03	0.00
9	0.96	0.73	0.40	0.16	0.04	0.01
10	0.97	0.77	0.47	0.21	0.07	0.02
11	0.98	0.81	0.53	0.26	0.09	0.03
12	0.98	0.84	0.58	0.31	0.13	0.04
13	0.98	0.87	0.64	0.37	0.16	0.06
14	0.99	0.89	0.68	0.42	0.20	0.08
15	0.99	0.91	0.73	0.47	0.25	0.10
16	0.99	0.93	0.76	0.52	0.29	0.13
17	0.99	0.94	0.80	0.57	0.34	0.16
18	1.00	0.95	0.83	0.62	0.39	0.20
19	1.00	0.96	0.85	0.66	0.43	0.24
20	1.00	0.97	0.87	0.70	0.48	0.28

Table 2: Probability that four or fewer incidents will have occurred after 20 tests given x incidents in n tests (bold where probability that r≤20% is less than 0.05)

Tests(n)	Incidents(x) 0	1	2	3	4
1	0.60	**0.04**			
2	0.74	0.16	**0.01**		
3	0.83	0.29	**0.03**	**0.00**	
4	0.89	0.42	0.08	**0.00**	**0.00**
5	0.93	0.53	0.14	**0.01**	**0.00**
6	0.96	0.64	0.22	**0.03**	**0.00**
7	0.97	0.73	0.31	0.06	**0.00**
8	0.98	0.80	0.41	0.10	**0.01**
9	0.99	0.86	0.51	0.15	**0.01**
10	1.00	0.91	0.60	0.21	0.03
11	1.00	0.94	0.70	0.29	0.046
12	1.00	0.97	0.78	0.38	0.07
13	1.00	0.98	0.85	0.48	0.11
14	1.00	0.99	0.91	0.59	0.16
15	1.00	1.00	0.95	0.69	0.23
16	1.00	1.00	0.98	0.80	0.33
17		1.00	0.99	0.89	0.44
18			1.00	0.96	0.59
19				1.00	0.78
20					1.00

Base stopping rules

Table 3: No more than X incidents in N tests (X/N=0.1)

Study size	Fail if any of these conditions are met for x **and** n					Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	
10	n≤10					n=10
20		n≤20				2-x≥20-n
30			n≤30			3-x≥30-n
40				n≤40		4-x≥40-n
50					n≤50	5-x≥50-n

Table 4: No more than X incidents in N tests (X/N=0.2)

Study size	Fail if any of these conditions are met for x **and** n					Pass if this condition is met before fail condition
	x=3	x=5	x=7	x=9	x=11	
10	n≤10					2-x≥10-n
20		n≤20				4-x≥20-n
30			n≤30			6-x≥30-n
40				n≤40		8-x≥40-n
50					n≤50	10-x≥50-n

Table 5: No more than X incidents in N tests (X/N=0.3)

Study size	Fail if any of these conditions are met for x **and** n					Pass if this condition is met before fail condition
	x=4	x=7	x=10	x=13	x=16	
10	n≤10					3-x≥10-n
20		n≤20				6-x≥20-n
30			n≤30			9-x≥30-n
40				n≤40		12-x≥40-n
50					n≤50	15-x≥50-n

Inference on r stopping rules

Table 6: Reject trap if probability "that incident rate is less than 10%" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n					Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	
10	n≤10					n=10
20	n≤6	n≤20				2-x≥20-n
30	n≤6	n≤11	n≤30			3-x≥30-n
40	n≤6	n≤11	n≤17	n≤40		4-x≥40-n
50	n≤6	n≤11	n≤17	n≤23	n≤50	5-x≥50-n

Table 7: Reject trap if probability "that incident rate is less than 20%" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n										Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	x=7	x=8	x=9	x=10	x=11	
10	n≤3	n≤10									2-x≥10-n
20	n≤3	n≤6	n≤9	n≤20							4-x≥20-n
30	n≤3	n≤6	n≤9	n≤12	n≤16	n≤30					6-x≥30-n
40	n≤3	n≤6	n≤9	n≤12	n≤16	n≤19	n≤23	n≤40			8-x≥40-n
50	n≤3	n≤6	n≤9	n≤12	n≤16	n≤19	n≤23	n≤27	n≤30	n≤50	10-x≥50-n

Table 8: Reject trap if probability "that incident rate is less than 30%" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n															Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	x=7	x=8	x=9	x=10	x=11	x=12	x=13	x=14	x=15	x=16	
10	n≤2	n≤4	n≤10													3-x≥10-n
20	n≤2	n≤4	n≤6	n≤8	n≤11	n≤20										6-x≥20-n
30	n≤2	n≤4	n≤6	n≤8	n≤11	n≤14	n≤16	n≤18	n≤30							9-x≥30-n
40	n≤2	n≤4	n≤6	n≤8	n≤11	n≤14	n≤16	n≤18	n≤21	n≤24	n≤26	n≤40				12-x≥40-n
50	n≤2	n≤4	n≤6	n≤8	n≤11	n≤14	n≤16	n≤18	n≤21	n≤24	n≤26	n≤29	n≤32	n≤34	n≤50	15-x≥50-n

Probability of success stopping rules

Table 9: Reject trap if probability "that x≤X after N trials, where X/N=0.1" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n					Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	
10	n≤10					n=10
20	n≤6	n≤20				2-x≥20-n
30	n≤6	n≤13	n≤30			3-x≥30-n
40	n≤6	n≤12	n≤21	n≤40		4-x≥40-n
50	n≤6	n≤12	n≤20	n≤29	n≤50	5-x≥50-n

Table 10: Reject trap if probability "that x≤X after N trials, where X/N=0.2" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n										Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	x=7	x=8	x=9	x=10	x=11	
10	n≤3	n≤10									2-x≥10-n
20	n≤3	n≤6	n≤10	n≤20							4-x≥20-n
30	n≤3	n≤6	n≤10	n≤14	n≤19	n≤30					6-x≥30-n
40	n≤3	n≤6	n≤9	n≤13	n≤18	n≤23	n≤29	n≤40			8-x≥40-n
50	n≤3	n≤6	n≤9	n≤13	n≤17	n≤22	n≤27	n≤32	n≤38	n≤50	10-x≥50-n

Table 11: Reject trap if probability "that x≤X after N trials, where X/N=0.3" is less than 5%

Study size	Fail if any of these conditions are met for x **and** n															Pass if this condition is met before fail condition
	x=2	x=3	x=4	x=5	x=6	x=7	x=8	x=9	x=10	x=11	x=12	x=13	x=14	x=15	x=16	
10	n≤2	n≤5	n≤10													3-x≥10-n
20	n≤2	n≤4	n≤7	n≤9	n≤13	n≤20										6-x≥20-n
30	n≤2	n≤4	n≤6	n≤9	n≤12	n≤15	n≤18	n≤22	n≤30							9-x≥30-n
40	n≤2	n≤4	n≤6	n≤9	n≤11	n≤14	n≤17	n≤21	n≤24	n≤28	n≤32	n≤40				12-x≥40-n
50	n≤2	n≤4	n≤6	n≤9	n≤11	n≤14	n≤17	n≤20	n≤23	n≤26	n≤30	n≤34	n≤38	n≤42	n≤50	15-x≥50-n

Table 12: Relative placements of marten traps submitted for assessment

Relative Placement	Incident rate
0.04	0.96
0.08	0.92
0.09	0.91
0.15	0.85
0.17	0.83
0.18	0.82
0.19	0.81
0.23	0.77
0.26	0.74
0.28	0.72
0.30	0.70
0.37	0.63
0.43	0.57
0.47	0.53
0.52	0.48
0.54	0.46
0.61	0.39
0.61	0.39
0.64	0.36
0.69	0.31
0.74	0.26
0.97	0.03

Performance of base rules

Table 13: Results for "No more than X incidents in N tests (X/N=0.1)" rule

Study Size	Proportion of failing traps Estimate	Range[15]		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.92	0.79	0.97	0.18	0.11	0.24	4.0	3.3	5.2	1.9	1.7	2.0
20	0.95	0.80	0.98	0.14	0.07	0.18	6.3	5.1	8.9	2.9	2.6	3.0
30	0.96	0.81	0.99	0.11	0.06	0.15	8.6	6.9	12.5	3.9	3.5	4.0
40	0.96	0.84	0.99	0.10	0.06	0.13	11.0	8.7	15.9	4.9	4.5	5.0
50	0.96	0.86	0.99	0.09	0.06	0.12	13.9	10.5	18.9	5.9	5.4	6.0

Table 14: Results for "No more than X incidents in N tests (X/N=0.2)" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.86	0.64	0.93	0.21	0.14	0.30	5.3	4.6	6.3	2.7	2.2	2.9
20	0.90	0.70	0.95	0.19	0.12	0.24	9.3	8.2	11.7	4.7	4.0	4.9
30	0.90	0.74	0.96	0.18	0.11	0.21	13.8	11.3	16.7	6.7	5.8	6.9
40	0.91	0.72	0.96	0.16	0.10	0.20	17.8	14.9	22.0	8.6	7.4	8.9
50	0.92	0.75	0.97	0.15	0.10	0.19	21.7	18.3	27.5	10.6	9.2	10.9

Table 15 Results for "No more than X incidents in N tests (X/N=0.3)" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.79	0.60	0.87	0.27	0.18	0.34	6.3	5.7	6.9	3.5	2.8	3.7
20	0.83	0.64	0.91	0.24	0.16	0.29	12.0	10.5	13.3	6.3	5.4	6.7
30	0.83	0.64	0.91	0.22	0.15	0.27	17.4	15.2	19.6	9.1	7.7	9.6
40	0.83	0.64	0.92	0.22	0.15	0.26	23.1	19.9	25.7	11.9	10.1	12.5
50	0.84	0.62	0.92	0.21	0.14	0.25	28.2	24.8	32.7	14.7	11.9	15.5

[15] 'Range' is a 95% confidence interval

Performance of inference on r rules

Table 16: Results for "reject trap if probability "that incident rate is less than 10%" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range[16]		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.92	0.79	0.97	0.18	0.11	0.24	4.0	3.3	5.2	1.9	1.7	2.0
20	0.96	0.82	0.99	0.13	0.07	0.18	4.7	3.7	7.5	2.1	1.9	2.1
30	0.96	0.83	0.99	0.12	0.06	0.15	5.8	4.0	9.8	2.2	2.1	2.3
40	0.96	0.83	0.99	0.10	0.06	0.14	6.3	4.2	11.8	2.3	2.1	2.4
50	0.98	0.85	0.99	0.09	0.06	0.12	6.1	4.3	13.0	2.3	2.2	2.5

Table 17: Results for "reject trap if probability "that incident rate is less than 20%" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.86	0.69	0.93	0.23	0.14	0.29	4.6	3.7	5.8	2.2	1.9	2.2
20	0.90	0.72	0.96	0.18	0.12	0.23	6.3	4.6	9.1	2.6	2.4	2.7
30	0.91	0.75	0.97	0.17	0.11	0.20	7.7	5.2	11.7	2.9	2.5	3.2
40	0.92	0.75	0.97	0.16	0.10	0.19	8.8	5.9	14.6	3.2	2.7	3.5
50	0.91	0.75	0.97	0.15	0.09	0.19	10.2	6.4	17.5	3.4	2.8	3.9

Table 18: Results for "reject trap if probability "that incident rate is less than 30%" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.78	0.59	0.88	0.28	0.16	0.34	5.4	4.4	6.4	2.6	2.1	2.7
20	0.83	0.64	0.91	0.24	0.16	0.29	8.0	6.0	10.4	3.5	2.9	3.8
30	0.85	0.65	0.92	0.22	0.15	0.27	10.1	7.4	14.2	4.2	3.4	4.5
40	0.84	0.64	0.93	0.21	0.14	0.26	12.5	8.3	17.7	4.8	3.8	5.2
50	0.84	0.67	0.93	0.20	0.14	0.25	14.6	9.4	20.3	5.3	4.1	5.8

[16] 'Range' is a 95% confidence interval

Performance of probability of success rules

Table 19: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.1" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range[17]		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.92	0.79	0.97	0.18	0.11	0.24	4.0	3.3	5.2	1.9	1.7	2.0
20	0.95	0.82	0.99	0.13	0.08	0.17	5.0	3.8	7.6	2.1	2.0	2.1
30	0.96	0.83	0.99	0.10	0.06	0.15	5.5	3.9	9.6	2.2	2.1	2.2
40	0.97	0.85	0.99	0.10	0.06	0.13	5.8	4.1	11.0	2.2	2.1	2.4
50	0.97	0.82	0.99	0.09	0.05	0.12	6.3	4.4	14.4	2.3	2.1	2.4

Table 20: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.2" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.87	0.69	0.93	0.23	0.14	0.29	4.6	3.7	5.8	2.2	1.9	2.2
20	0.90	0.74	0.96	0.19	0.12	0.23	6.3	4.7	8.9	2.6	2.3	2.7
30	0.91	0.74	0.97	0.16	0.10	0.21	7.4	5.2	11.7	2.8	2.5	3.1
40	0.91	0.77	0.97	0.15	0.10	0.19	8.3	5.8	13.6	3.0	2.7	3.4
50	0.92	0.75	0.97	0.14	0.09	0.18	9.3	6.2	17.1	3.2	2.8	3.7

Table 21: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.3" is less than 5%" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	0.79	0.58	0.88	0.27	0.17	0.34	5.1	4.2	6.3	2.5	2.1	2.6
20	0.82	0.64	0.91	0.23	0.14	0.28	7.6	5.9	10.1	3.3	2.8	3.6
30	0.84	0.66	0.93	0.23	0.13	0.27	9.8	6.9	13.6	4.0	3.2	4.3
40	0.84	0.65	0.93	0.22	0.13	0.25	12.0	8.0	17.0	4.5	3.6	4.9
50	0.84	0.68	0.93	0.21	0.14	0.25	14.1	8.8	19.5	5.1	3.8	5.5

[17] 'Range' is a 95% confidence interval

Performance of base rules compared to "no more than 4 incidents out of 20" rule

Table 22: Results for "No more than X incidents in N tests (X/N=0.1)" rule expressed as a proportion of results for "no more than 4/20" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range[18]		Estimate	Range		Estimate	Range		Estimate	Range	
10	1.03	1.01	1.09	0.98	0.86	1.10	0.42	0.40	0.44	0.40	0.40	0.41
20	1.07	1.03	1.15	0.72	0.61	0.80	0.66	0.62	0.77	0.62	0.61	0.65
30	1.07	1.04	1.16	0.59	0.52	0.68	0.91	0.84	1.09	0.83	0.81	0.88
40	1.09	1.04	1.18	0.54	0.46	0.62	1.16	1.06	1.41	1.05	1.02	1.11
50	1.09	1.04	1.17	0.52	0.43	0.57	1.43	1.27	1.70	1.26	1.22	1.33

Table 23: Results for "No more than X incidents in N tests (X/N=0.2)" rule expressed as a proportion of results for "no more than 4/20" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range		Estimate	Range		Estimate	Range		Estimate	Range	
10	0.97	0.94	0.98	1.24	1.16	1.35	0.56	0.53	0.58	0.58	0.57	0.59
20	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
30	1.01	1.00	1.03	0.91	0.84	0.97	1.45	1.41	1.47	1.41	1.40	1.43
40	1.02	1.00	1.04	0.84	0.79	0.92	1.84	1.83	1.93	1.83	1.81	1.86
50	1.03	1.01	1.04	0.78	0.75	0.89	2.29	2.24	2.39	2.24	2.22	2.28

Table 24: Results for "No more than X incidents in N tests (X/N=0.3)" rule expressed as a proportion of results for "no more than 4/20" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range		Estimate	Range		Estimate	Range		Estimate	Range	
10	0.88	0.81	0.92	1.48	1.40	1.65	0.67	0.60	0.72	0.74	0.70	0.76
20	0.92	0.86	0.95	1.28	1.20	1.40	1.26	1.15	1.33	1.35	1.29	1.37
30	0.93	0.87	0.96	1.19	1.12	1.32	1.82	1.68	1.92	1.94	1.88	1.97
40	0.93	0.89	0.97	1.22	1.07	1.27	2.45	2.23	2.52	2.54	2.47	2.57
50	0.94	0.89	0.97	1.19	1.05	1.25	3.02	2.75	3.13	3.13	3.05	3.18

[18] 'Range' is a 95% confidence interval

Performance of inference on r rules compared to performance of base rules

Table 25: Results for "reject trap if probability "that incident rate is less than 10%" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.1)" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range[19]		Estimate	Range		Estimate	Range		Estimate	Range	
20	1.00	0.99	1.02	1.02	0.87	1.15	0.76	0.72	0.85	0.71	0.69	0.75
30	1.00	0.99	1.01	1.09	0.86	1.14	0.67	0.57	0.78	0.56	0.53	0.61
40	1.00	0.99	1.01	1.07	0.84	1.15	0.57	0.47	0.73	0.47	0.43	0.52
50	1.01	1.00	1.01	0.93	0.84	1.15	0.47	0.41	0.68	0.39	0.36	0.46

Table 26: Results for "reject trap if probability "that incident rate is less than 20%" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.2)" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range		Estimate	Range		Estimate	Range		Estimate	Range	
10	1.01	0.99	1.03	0.97	0.92	1.06	0.83	0.78	0.89	0.78	0.74	0.82
20	1.01	0.99	1.02	0.95	0.91	1.06	0.64	0.57	0.77	0.56	0.50	0.61
30	1.01	1.00	1.02	0.95	0.91	1.05	0.55	0.46	0.69	0.44	0.38	0.51
40	1.00	1.00	1.02	1.07	0.91	1.06	0.50	0.40	0.67	0.37	0.31	0.45
50	1.00	1.00	1.02	1.04	0.91	1.05	0.46	0.35	0.63	0.32	0.26	0.40

Table 27: Results for "reject trap if probability "that incident rate is less than 30%" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.3)" rule

Study	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
Size	Estimate	Range		Estimate	Range		Estimate	Range		Estimate	Range	
10	1.02	0.99	1.03	0.97	0.94	1.04	0.80	0.73	0.86	0.73	0.66	0.78
20	1.01	0.99	1.04	0.99	0.94	1.03	0.66	0.56	0.76	0.55	0.46	0.62
30	1.01	1.00	1.03	0.98	0.93	1.03	0.57	0.47	0.70	0.45	0.37	0.53
40	1.02	1.00	1.03	0.99	0.93	1.02	0.54	0.42	0.67	0.40	0.31	0.48
50	1.02	1.00	1.03	0.99	0.94	1.02	0.50	0.38	0.64	0.36	0.27	0.43

[19] 'Range' is a 95% confidence interval

Performance of probability of success rules compared to performance of base rules

Table 28: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.1" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.1)" rule

Study Size	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
	Estimate	Range[20]		Estimate	Range		Estimate	Range		Estimate	Range	
20	1.01	0.99	1.01	1.04	0.86	1.13	0.77	0.72	0.85	0.73	0.69	0.75
30	1.00	0.99	1.01	0.97	0.84	1.15	0.62	0.57	0.76	0.55	0.53	0.60
40	1.00	1.00	1.01	0.94	0.84	1.14	0.53	0.47	0.70	0.45	0.43	0.51
50	1.01	1.00	1.01	0.94	0.84	1.14	0.47	0.40	0.67	0.39	0.36	0.45

Table 29: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.2" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.2)" rule

Study Size	Proportion of failing traps			Accepted traps mean incident rate			Mean tests required to reach a decision			Mean incidents per study		
	Estimate	Range		Estimate	Range		Estimate	Range		Estimate	Range	
10	1.01	0.99	1.02	0.99	0.92	1.06	0.84	0.79	0.89	0.79	0.74	0.81
20	1.01	0.99	1.02	0.98	0.92	1.06	0.65	0.56	0.76	0.55	0.50	0.61
30	1.01	1.00	1.03	0.94	0.91	1.05	0.53	0.45	0.69	0.42	0.37	0.50
40	1.01	1.00	1.03	0.99	0.91	1.05	0.47	0.38	0.64	0.35	0.31	0.43
50	1.01	1.00	1.02	0.94	0.91	1.04	0.42	0.33	0.61	0.30	0.26	0.38

[20] 'Range' is a 95% confidence interval

Table 30: Results for "reject trap if probability "that x≤X after N trials, where X/N=0.1" is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests (X/N=0.1)" rule

Study Size	Proportion of failing traps Estimate	Range		Accepted traps mean incident rate Estimate	Range		Mean tests required to reach a decision Estimate	Range		Mean incidents per study Estimate	Range	
10	1.00	0.99	1.04	0.99	0.94	1.03	0.77	0.70	0.84	0.70	0.64	0.75
20	1.02	1.00	1.04	0.94	0.93	1.03	0.62	0.54	0.73	0.52	0.45	0.59
30	1.00	1.00	1.04	1.01	0.93	1.02	0.55	0.45	0.68	0.43	0.35	0.51
40	1.00	1.00	1.04	1.01	0.93	1.02	0.51	0.40	0.65	0.38	0.30	0.45
50	1.02	1.00	1.04	0.99	0.92	1.01	0.48	0.35	0.62	0.34	0.26	0.41

Table 31: Results for "reject trap if probability "that x≤X after N trials, is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests" rule for a flat population of traps

Maximum X/N	Study size	Proportion of failing traps	Accepted traps mean incident rate	Mean tests required to reach decision	Mean incidents per study
0.1	10	1.00	1.00	1.00	1.00
0.1	20	1.00	0.99	0.83	0.74
0.1	30	1.01	0.98	0.73	0.59
0.1	40	1.01	0.97	0.66	0.50
0.1	50	1.01	0.97	0.62	0.43
0.2	10	1.01	0.99	0.87	0.80
0.2	20	1.01	0.98	0.73	0.59
0.2	30	1.02	0.97	0.65	0.48
0.2	40	1.02	0.96	0.61	0.41
0.2	50	1.02	0.96	0.58	0.37
0.3	10	1.02	0.98	0.82	0.73
0.3	20	1.02	0.97	0.71	0.57
0.3	30	1.03	0.97	0.66	0.48
0.3	40	1.03	0.96	0.62	0.43
0.3	50	1.03	0.96	0.59	0.39

Table 32: Results for "reject trap if probability "that x≤X after N trials, is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests" rule for a worse population of traps

Maximum X/N	Study size	Proportion of failing traps	Accepted traps mean incident rate	Mean tests required to reach decision	Mean incidents per study
0.1	10	1.00	1.00	1.00	1.00
0.1	20	1.00	0.99	0.74	0.70
0.1	30	1.00	0.98	0.59	0.54
0.1	40	1.00	0.98	0.50	0.44
0.1	50	1.00	0.98	0.43	0.37
0.2	10	1.00	1.00	0.80	0.76
0.2	20	1.00	0.99	0.59	0.51
0.2	30	1.01	0.98	0.48	0.39
0.2	40	1.01	0.98	0.41	0.32
0.2	50	1.01	0.98	0.37	0.27
0.3	10	1.01	0.99	0.73	0.67
0.3	20	1.01	0.98	0.57	0.48
0.3	30	1.01	0.98	0.48	0.38
0.3	40	1.01	0.97	0.43	0.32
0.3	50	1.01	0.97	0.39	0.28

Table 33: Results for "reject trap if probability "that $x \leq X$ after N trials, is less than 5%" rule expressed as a proportion of the result of "no more than X incidents in N tests" rule for a better population of traps

Maximum X/N	Study size	Proportion of failing traps	Accepted traps mean incident rate	Mean tests required to reach decision	Mean incidents per study
0.1	10	1.00	1.00	1.00	1.00
0.1	20	1.01	0.98	0.87	0.79
0.1	30	1.01	0.98	0.79	0.65
0.1	40	1.01	0.97	0.74	0.57
0.1	50	1.01	0.97	0.70	0.51
0.2	10	1.02	0.99	0.92	0.86
0.2	20	1.03	0.98	0.82	0.69
0.2	30	1.03	0.97	0.76	0.59
0.2	40	1.03	0.96	0.72	0.53
0.2	50	1.04	0.96	0.69	0.49
0.3	10	1.04	0.98	0.89	0.82
0.3	20	1.05	0.97	0.82	0.69
0.3	30	1.05	0.97	0.78	0.63
0.3	40	1.06	0.96	0.75	0.58
0.3	50	1.06	0.96	0.73	0.54

Figure 1: Relative placement of traps

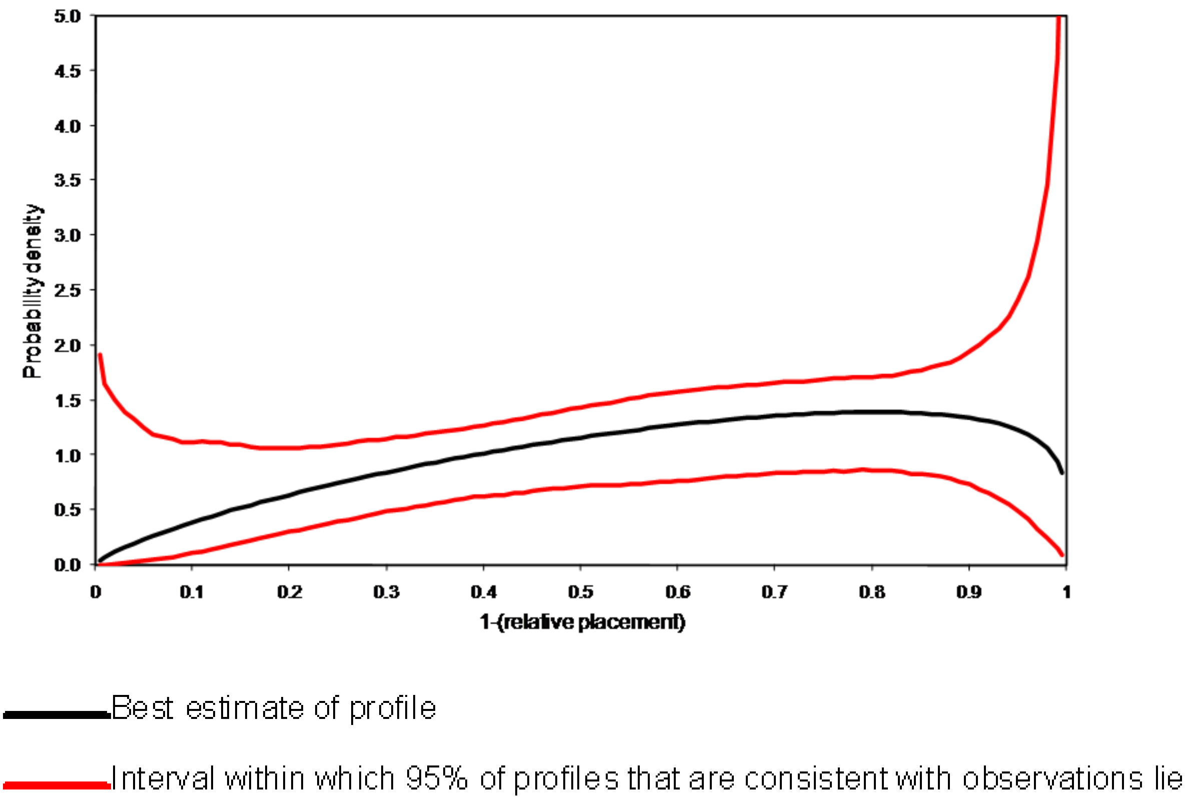


Figure 2: Measures of welfare associated with base plans

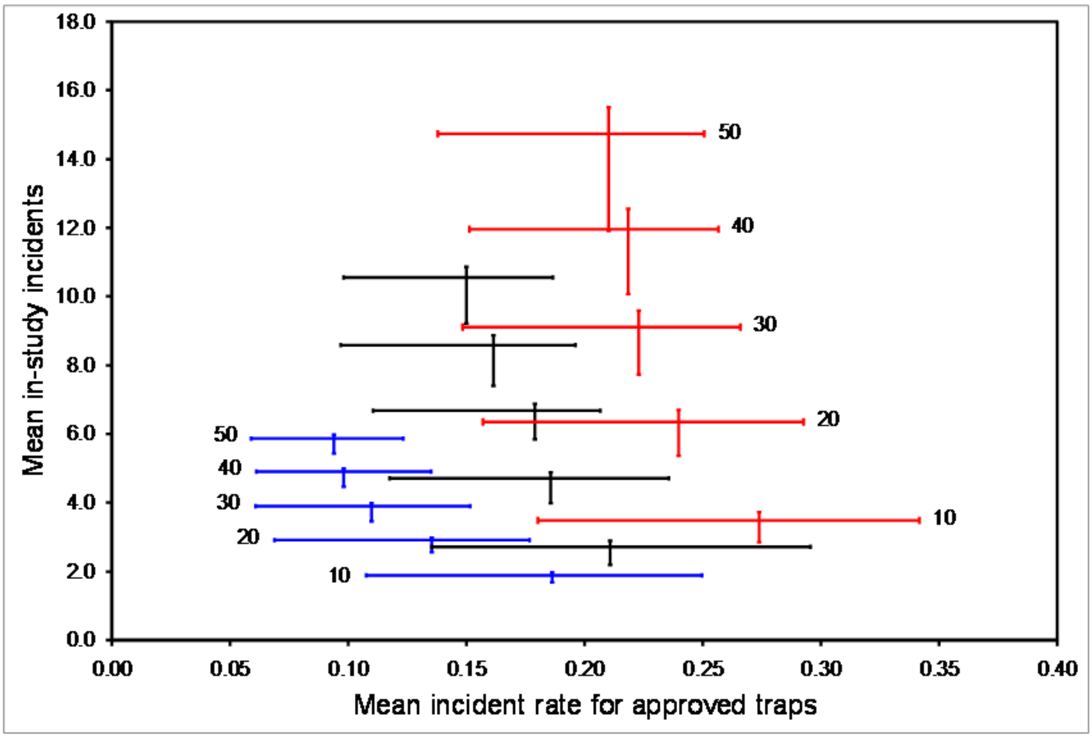


Figure 3: Costs associated with base plan

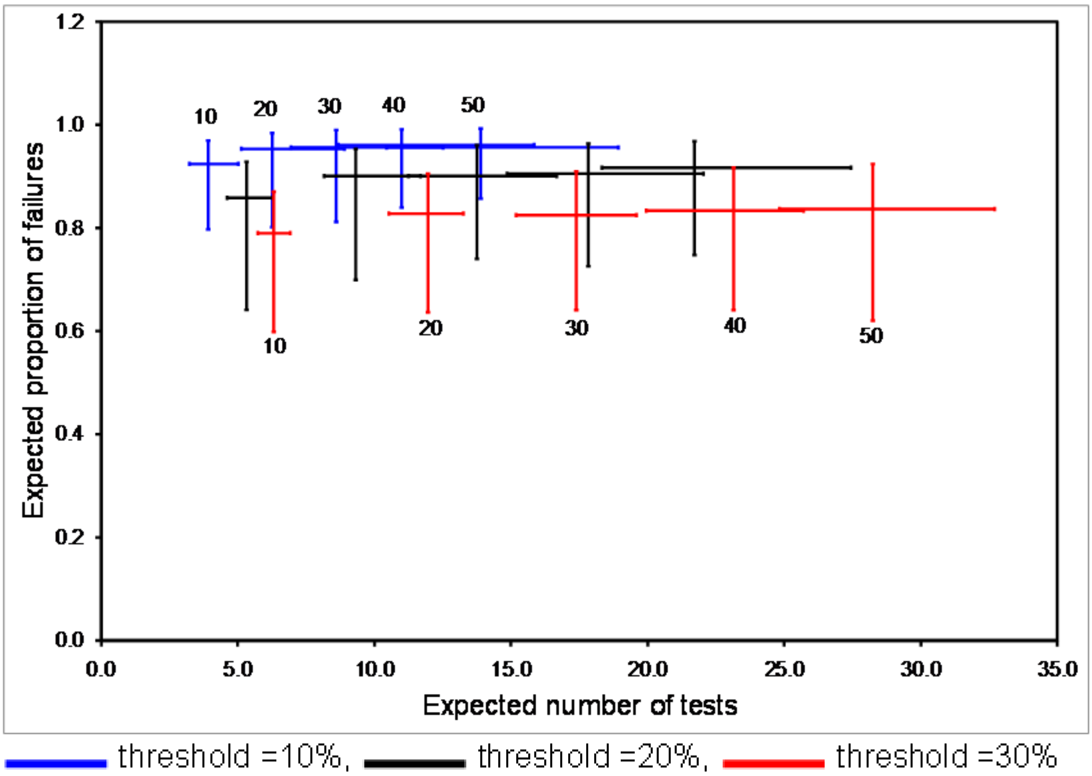


Figure 4: Measures of welfare as a proportion of the "4 out of 20" plan

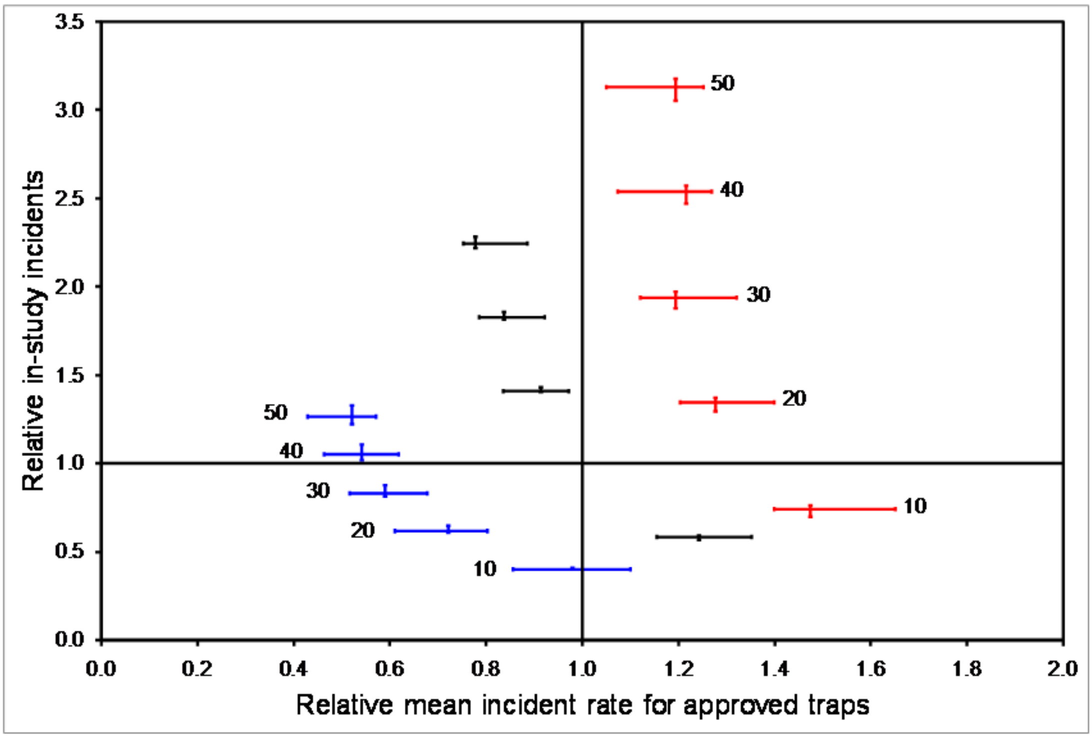


Figure 5: Costs as a proportion of the "4 out of 20" plan

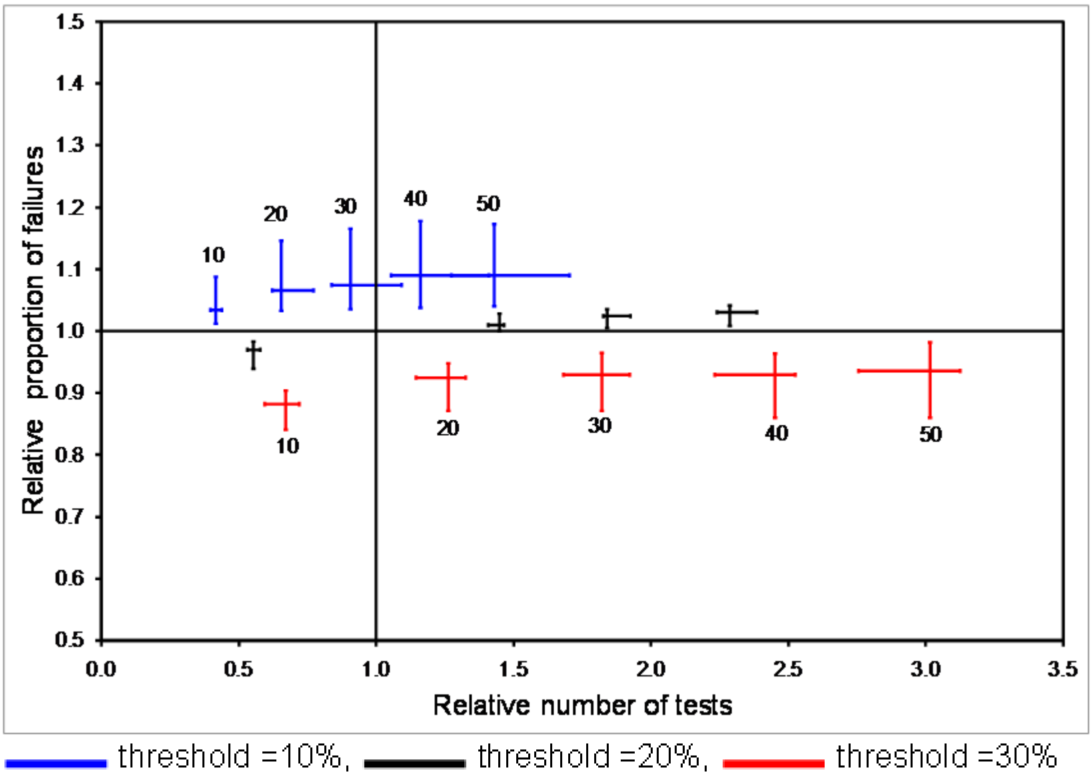


Figure 6: Measures of welfare for 'inference on p' plans expressed as a proportion of the base plan

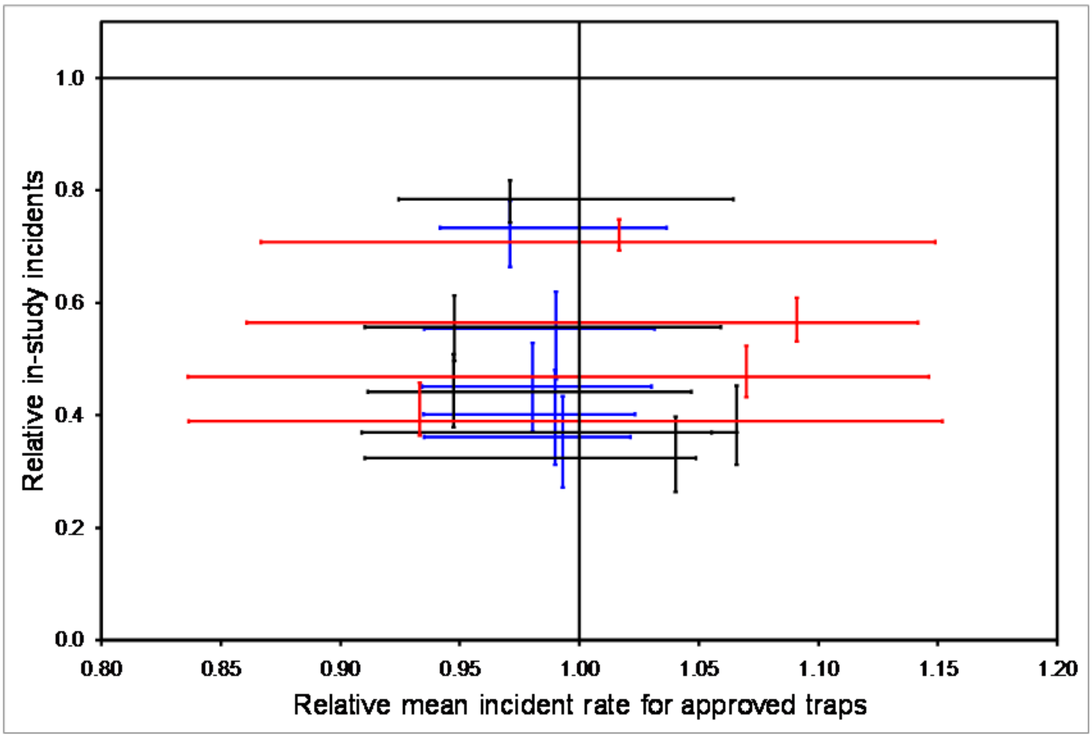


Figure 7: Costs for inference on p plans expressed as a proportion of the base plan

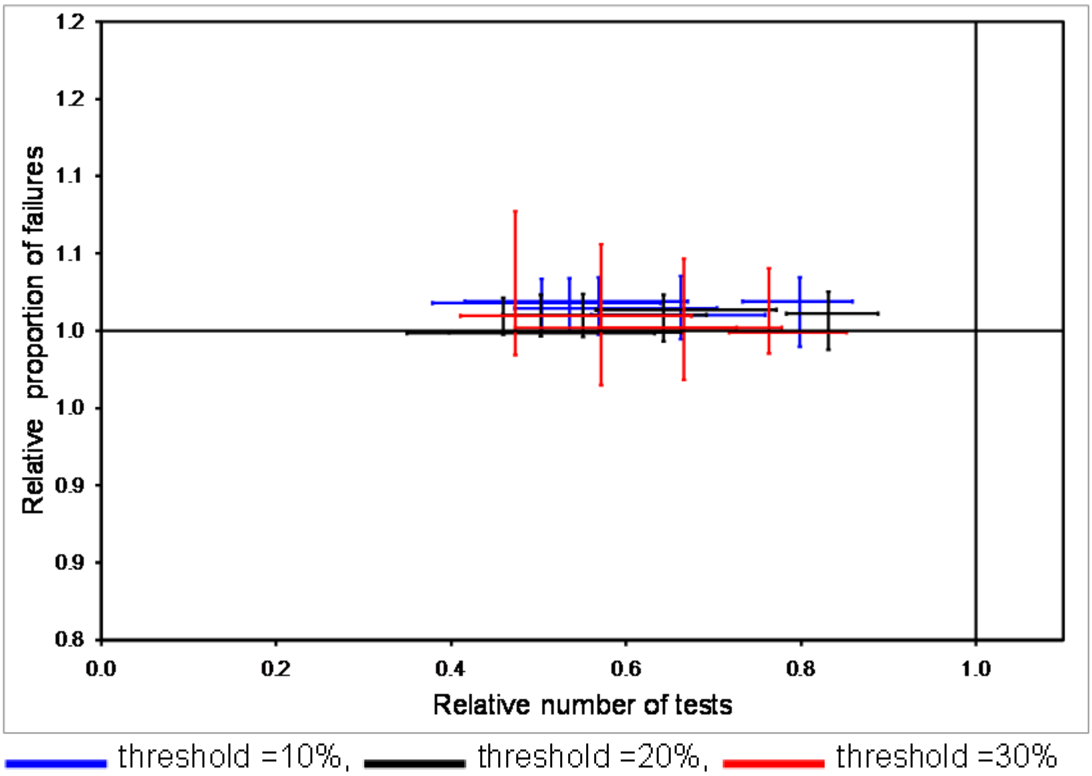


Figure 8: Measures of welfare for 'probability of success' plans expressed as a proportion of the base plan

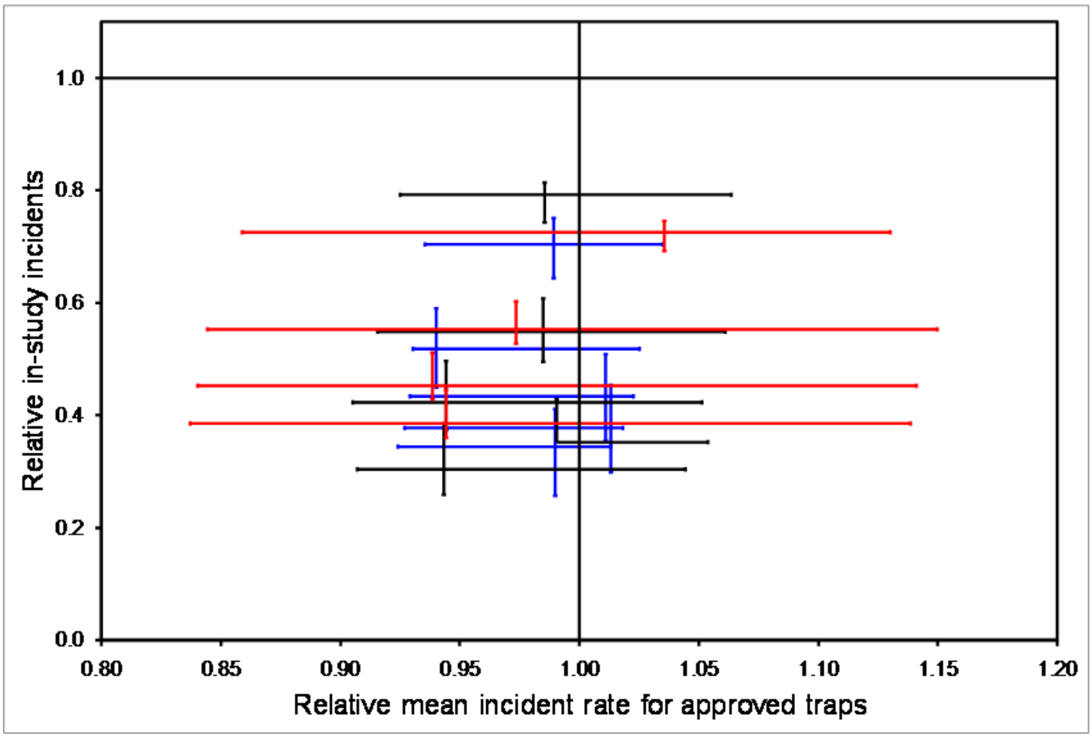


Figure 9: Costs for 'probability of success' plans expressed as a proportion of the base plan

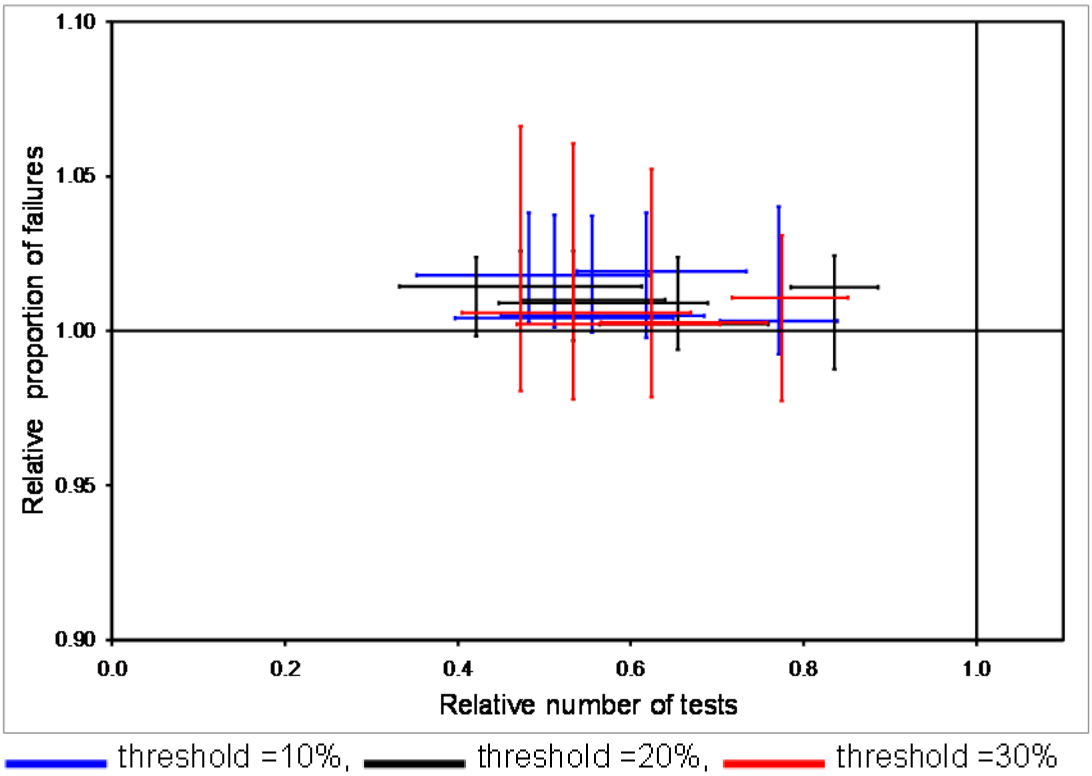


Figure 10: In-study incidents for 'probability of success' plans expressed as a proportion of the base plan

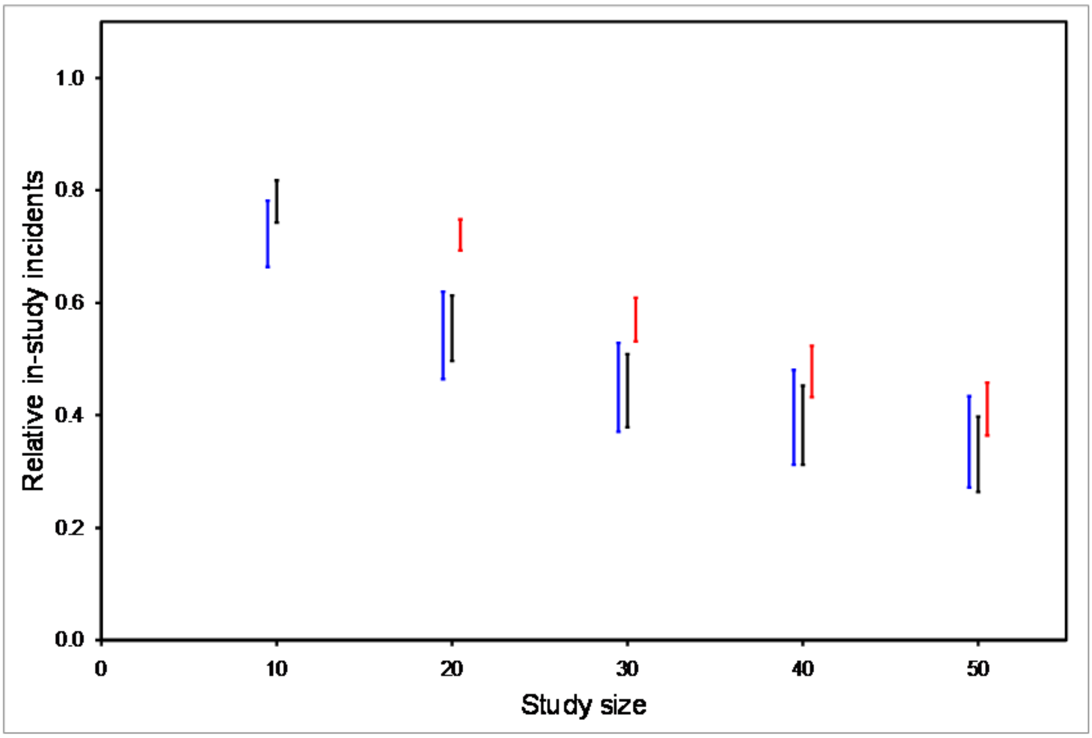
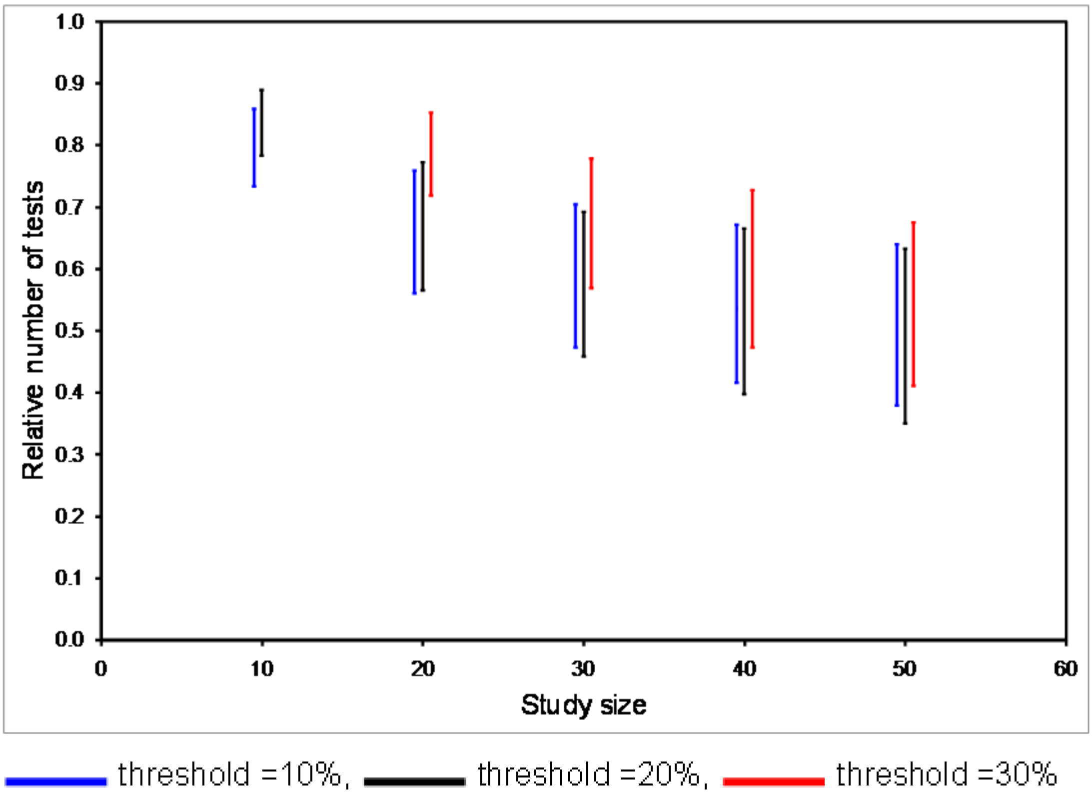


Figure 11: Cost of 'probability of success' plans expressed as a proportion of the base plan



Appendix 4 Latin classification of species.

American badger *Taxidea taxus*

American beaver *Castor canadensis*

American black bear *Ursus americanus*

American lynx *Lynx canadensis*

American mink *Mustela vison*

American otter *Lutra canadensis*

American red fox *Vulpes fulva*

Arctic fox *Alopex lagopus*

bassarisk *Bassariscus astutus*

Beech or stone marten *Martes foina*

bobcat *Felix rufus*

brown bear *Ursus arctos*

coyote *Canis latrans*

dingo *Canis lupus*

ermine *Mustela erminea,*

European badger *Meles meles,*

European beaver *Castor fiber*

European hare *Lepus europaeus*

European hedgehog *Erinaceus europaeus*

European lynx *Lynx lynx*

European mink *Mustela lutreola*

European otter *Litra lutra*

European polecat *Mustela putorius*

European red fox *Vulpes vulpes*

fisher *Martes pennanti*

grey fox *Urocyon cinereoargenteus*

grey squirrel *Sciurus carolensis*

groundhog *Marmota monax*

house mouse *Mus domesticus*

kit fox *Vulpes microtis*

kolinski *Mustela sibirica*

marmot *Marmota marmota*

marten *Martes americana*

mountain beaver *Aplodontia rufa*

mountain lion *Felis concolor*

muskrat *Ondatra zibethicus*,

Norway rat *Rattus norwegicus*

nutria *Myocastor coypus*

opossum *Didelphis marsupialis*

pine marten *Martes martes*,

pocket gopher Family *Geomyidea*

prairie dog Genus *Cynomys*

rabbit *Oryctolagus cuniculus*

raccoon *Procyon lotor*

raccoon dog *Nyctereutes procyonoides*,

red squirrel *Sciurus vulgaris*

Richardson ground squirrel *Spermophilus richardsonii*

sable *Martes zibellina*

stone or Beech marten *Martes foina*

swift fox *Vulpes velox*

striped skunk *Mephitis mephitis*

wolf *Canis lupus*,

wolverine *Gulo luscus*

Appendix 5 Literature Searches.

Initial searching of the literature was carried out on the Dialog® host; with a wide selection of databases in the bioscience, agricultural science, medicine engineering and other databases being searched simultaneously, namely:

File 2:INSPEC 1898-2007, (c) 2007 Institution of Electrical Engineers
File 5:Biosis Previews(R) 1926-2007, (c) 2007 The Thomson Corporation
File 10:AGRICOLA 70-2007(c)
File 50:CAB Abstracts 1972-2007 (c) 2007 CAB International
File 203:AGRIS 1974-2007 All rights reserved
File 34:SciSearch(R) Cited Ref Sci 1990-2007 (c) 2007 The Thomson Corp
File 71:ELSEVIER BIOBASE 1994-2007 (c) 2007 Elsevier B.V.
File 73:EMBASE 1974-2007 (c) 2007 Elsevier B.V.
File 76:Environmental Sciences 1966-2007 (c) 2007 CSA.
File 144:Pascal 1973-2007 (c) 2007 INIST/CNRS
File 155:MEDLINE(R) 1950-2007 (c) format only 2007 Dialog
File 185:Zoological Record Online(R) 1978-2007 (c) 2007 The Thomson Corp.
File 292:GEOBASE(TM) 1980-2007 (c) 2007 Elsevier B.V.

The initial search logic used was:

11.1.1.1 <u>Set Items Description</u>

S1 24848 (TRAP OR TRAPS OR TRAPPING)(S)(ANIMAL? OR MAMMAL? OR VERTEBRATE? OR FUR OR RODENT?)
S2 546 S1 AND REVIEW?/TI,DE
S3 231 S1 AND (HUMANE? OR TIME()TO()DEATH OR SUFFERING)
S4 404 RD S2 (unique items)
S5 127 RD S3 (unique items)
S6 122 S5 NOT S4
S7 328 S1 AND (HUMANE? OR TIME()TO()DEATH OR TIME()TO()KILL OR SUFFERING OR PAIN OR DISTRESS)

S8 183 RD S7 (unique items) all titles printed, and selected items were subsequently printed in full.

After all the retrieved references had been examined, a second search oriented more towards trap testing was carried out. The search logic for this additional search was:

11.1.1.2 Set Items Description

S1 25733 (TRAP OR TRAPS OR TRAPPING)(S)(ANIMAL? OR MAMMAL? OR VERTE-
BRATE? OR FUR OR RODENT?)

S2 554 S1 AND REVIEW?/TI,DE

S3 245 S1 AND (HUMANE? OR TIME()TO()DEATH OR SUFFERING)

S4 412 RD S2 (unique items)

S5 139 RD S3 (unique items)

S6 133 S5 NOT S4

S7 342 S1 AND (HUMANE? OR TIME()TO()DEATH OR TIME()TO()KILL OR SUFFERING OR PAIN OR DISTRESS)

S8 195 RD S7 (unique items)

S9 9 S8 AND REVIEW?/TI,DE

S10 1 S8/2007

S11 8 S8/2006:2007 - titles printed below

S12 838 S1 AND (TESTING OR TESTS OR TEST()METHOD?)

S13 464 RD S12 (unique items)

S14 448 S13 NOT S8 - all titles printed, and selected items were subsequently printed in full.

Searches were also carried out on other sources of information with the intention of identifying ‘grey literature’; the following sources were used:

- British Library Combined Catalogue
- Copac - merged online catalogues of University and National Libraries in the UK
- US Library Of Congress Catalogue
- GPO - Catalog of U.S. Government Publications
- University of British Columbia Library Catalogue

- University of Toronto Library Catalogue
- CISTI - Canada Institute for Scientific and Technical Information catalogue.

Further information was obtained from: a) the Fur Institute of Canada that coordinates the Canadian ‘Provincial and Territorial Trap Certification Program’, b) Landcare Research that tests traps in New Zealand under the ‘National Animal Welfare Committee Guideline 09: Assessing the welfare performance of restraining and killing traps’, and c) the American Association of Fish and Wildlife Agencies that is developing ‘Best Management Practices’ for trapping specified species throughout the USA. In addition, confidential UK Government files covering a) the meetings of the ISO Committee ISO TC/191, and b) trap testing conducted in the UK were examined.

Appendix 6. Reference documents

COUNCIL REGULATION (EEC) No 3254/91 of 4 November 1991 prohibiting the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or trapping methods which do not meet international humane trapping standards

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 113 and Article 130s thereof,

Having regard to the proposal from the Commission (1),

Having regard to the opinion of the European Parliament (2),

Having regard to the opinion of the Economic and Social Committee (3),

Whereas the Berne Convention of 19 September 1979 on the Conservation of European Wildlife and Natural Habitats, concluded by the European Economic Community by Decision 82/72/EEC (4), prohibits for certain species, the use of all indiscriminate means of capture and killing including traps, if the latter are applied for large-scale or non-selective capture or killing,

Whereas the abolition of the leghold trap will have a positive effect on the conservation status of threatened or endangered species of wild fauna both within and outside the Community, including species protected by Regulation (EEC) No 3626/82 (5); whereas research into the development of humane trapping methods is already in progress and whereas the Community will take into account the work being carried out by the International Standardization Organization;

Whereas, in order adequately to protect species of wild fauna and to avoid distortion of competition, it is necessary to ensure that external trade measures relating to them are uniformly applied throughout the Community;

Whereas, therefore, the use of the leghold trap within the Community should be prohibited and measures should be taken to enable the importation of furs of certain species to be prohibited when they originate in a country where the leghold trap is still used or where trapping methods do not meet internationally agreed humane trapping standards,

HAS ADOPTED THIS REGULATION:

Article 1

For the purposes of this Regulation: 'leghold trap': means a device designed to restrain or capture an animal by means of jaws which close tightly upon one or more of the animal's limbs, thereby preventing withdrawal of the limb or limbs from the trap.

Article 2

Use of leghold traps in the Community shall be prohibited by 1 January 1995 at the latest.

Article 3

1. The introduction into the Community of the pelts of the animal species listed in Annex I and of the other goods listed in Annex II, inasmuch as they incorporate pelts of the species listed in Annex I, shall be prohibited as of 1 January 1995, unless the Commission, in accordance with the procedure laid down in Article 5, has determined that, in the country where the pelts originate:

- there are adequate administrative or legislative provisions in force to prohibit the use of the leghold trap; or

- the trapping methods used for the species listed in Annex I meet internationally agreed humane trapping standards.

The Commission shall publish in the Official Journal of the European Communities a list of the countries which meet at least one of the conditions set out in the first paragraph.

2. The prohibition referred to in paragraph 1 shall be suspended for one year, expiring on 31 December 1995, if the Commission, in accordance with the procedure laid down in Article 5, has determined before 1 July 1994, as a result of a review undertaken in cooperation with the competent authorities of the countries concerned, that sufficient progress is being made in developing humane methods of trapping in their territory.

Article 4

Countries exporting or re-exporting to the Community after 1 January 1995 any of the goods listed in Annex II, inasmuch as they incorporate pelts of the species listed in Annex I, shall certify that such pelts originate in a country appearing in the list referred to in the second paragraph of Article 3 (1) or benefiting from a suspension in accordance with Article 3 (2).

The Commission, in accordance with the procedure laid down in Article 5, shall determine the appropriate forms for such certification.

Article 5

For the purposes of Article 3, the Commission shall be assisted by the committee established by Article 19 of Regulation (EEC) No 3626/82.

The representative of the Commission shall submit to the committee a draft of the measures to be taken. The committee shall deliver its opinion on the draft within a time limit which the Chairman may lay down according to the urgency of the matter. The opinion shall be delivered by the majority laid down in Article 148 (2) of the Treaty in the case of decisions which the Council is required to adopt on a proposal from the Commission. The votes of the representatives of the Member States within the committee shall be weighted in the manner set out in that Article. The Chairman shall not vote.

The Commission shall adopt the measures envisaged if they are in accordance with the opinion of the committee.

If the measures envisaged are not in accordance with the opinion of the committee, or if no opinion is delivered, the Commission shall, without delay, submit to the Council a proposal relating to the measures to be taken. The Council shall act by a qualified majority.

If, on the expiry of a period of three months from the date of referral to the Council, the Council has not acted, the proposed measures shall be adopted by the Commission.

Article 6

This Regulation shall enter into force on the day of its publication in the Official Journal of the European Communities. This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 4 November 1991. For the Council

The President

H. VAN DEN BROEK

(1) OJ No C 134, 31. 5. 1989, p. 5 and OJ No C 97, 13. 4. 1991, p. 10. (2) OJ No C 260, 15. 10. 1990, p. 24. (3) OJ No C 168, 10. 7. 1990, p. 32. (4) OJ No L 38, 10. 2. 1982, p. 1. (5) OJ No L 384, 31. 12. 1982, p. 1.

ANNEX I

List of species referred to in Article 3 (1)

Beaver: Castor canadensis Otter: Lutra canadensis Coyote: Canis latrans Wolf: Canis lupus Lynx: Lynx canadensis Bobcat: Felis rufus Sable: Martes zibellina Raccoon: Procyon lotor Musk rat: Ondatra zibethicus Fisher: Martes pennanti Badger: Taxidea taxus Marten: Martes americana Ermine: Mustela erminea

ANNEX II

Other goods referred to in Article 3 (1)

CN code Description ex 4103 Other raw hides and skins (fresh, or salted, dried, limed, pickled or otherwise preserved, but not tanned, parchment-dressed or further prepared), whether or not dehaired or split, other than those excluded by note 1 (b) or 1 (c) to chapter 41 ex 4103 90 00 Other ex 4301 Raw furskins (including heads, tails, paws and other pieces or cuttings, suitable for furriers' use), other than raw hides and skins of Code 4101, 4102, or 4103 ex 4301 40 00 Of beaver, whole, with or without head, tail or paws ex 4301 80 Other furskins, whole, with or without head, tail or paws ex 4301 80 50 Of wild felines ex 4301 80 90 Other ex 4301 90 00 Heads, tails, paws and other pieces or cuttings, suitable for furriers' use ex 4302 Tanned or dressed furskins (including heads, tails, paws and other pieces or cuttings), unassembled, or assembled (without the addition of other materials), other than those of code 4303: - whole skins, with ot without head, tail or paws, not assembled ex 4302 19 Other ex 4302 19 10 Of beaver ex 4302 19 70 Of wild felines ex 4302 19 90 Other ex 4302 20 00 Heads, tails, paws and other pieces or cuttings, not assembled ex 4302 30 Whole skins and pieces or cuttings thereof, assembled ex 4302 30 10 'Dropped' furskins Other ex 4302 30 35 Of beaver ex 4302 30 71 Of wild felines ex 4302 30 75 Other ex 4303 Articles of apparel, clothing accessories and other articles, of furskin ex 4303 10 Articles of apparel and clothing accessories ex 4303 10 90 Other ex 4303 90 00 Other

Council Decision 98/487/EC

COUNCIL DECISION of 13 July 1998 concerning the conclusion of an International Agreement in the form of an Agreed Minute between the European Community and the United States of America on humane trapping standards (98/487/EC)

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Articles 113 and 100a in conjunction with Article 228(2), first sentence and Article 228(3) first subparagraph thereof,

Having regard to the proposal from the Commission (1),

Having regard to the opinion of the European Parliament (2),

Having regard to the Council's Decision of June 1996 laying down negotiating directives and authorising the Commission to negotiate an agreement on humane trapping standards with Canada, the Russian Federation, the United States and any other interested country,

Having regard to the Council's Decision of 22 July 1997 approving the Agreement on international humane trapping standards between the European Community, Canada and the Russian Federation and calling upon the Commission to intensify its efforts to reach an agreement with the United States of America that is equivalent to the Agreement with Canada and the Russian Federation,

Whereas Regulation (EEC) No 3254/91 (3), and in particular the second indent of Article 3(1) thereof, refers to internationally agreed humane trapping standards with which trapping methods used by third countries that have not prohibited leghold traps must conform in order for those countries to be able to export pelts and products manufactured from certain species to the Community;

Whereas the Agreement's main purpose is to lay down harmonised technical standards offering a sufficient level of protection to the welfare of trapped animals and governing both the production and use of traps, and to facilitate trade between the Parties in traps, pelts and products manufactured from species covered by the Agreement;

Whereas implementation of the Agreement requires the establishment of a timetable of testing and certifying the conformity of traps with the standards laid down and for the replacement of uncertified traps;

Whereas the Agreement in the form of an Agreed Minute attached to this Decision is consistent with the negotiating directives referred to above; whereas it therefore satisfies the concept of internationally agreed humane trapping standards referred to in the second indent of Article 3(1) of Regulation (EEC) No 3254/91;

Whereas the International Agreement in the form of an Agreed Minute between the European Community and the United States of America on humane trapping standards should be approved,

HAS DECIDED AS FOLLOWS:

Article 1

The International Agreement in the form of an Agreed Minute between the European Community and the United States of America on humane trapping standards is hereby approved.

The text of the Agreement is attached to this Decision.

Article 2

The President of the Council shall notify to the United States of America the instrument of conclusion (4).

Done at Brussels, 13 July 1998.

For the Council

The President

W. SCHÜSSEL

(1) OJ C 32, 30. 1. 1998, p. 8.

(2) OJ C 210, 6. 7. 1998.

(3) Council Regulation (EEC) No 3254/91 of 4 November 1991 prohibiting the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or trapping methods which do not meet international humane trapping standards (OJ L 308, 9. 11. 1991, p. 1).

(4) The date of entry into force of the Agreement will be published in the Official Journal of the European Communities by the General Secretariat of the Council.

Council Decision 98/142/EC

COUNCIL DECISION of 26 January 1998 concerning the conclusion of an Agreement on international humane trapping standards between the European Community, Canada and the Russian Federation and of an Agreed Minute between Canada and the European Community concerning the signing of the said Agreement (98/142/EC)

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Articles 113 and 100a in conjunction with the first sentence of Article 228(2) and the first subparagraph of Article 228(3) thereof,

Having regard to the proposal from the Commission (1),

Having regard to the opinion of the European Parliament (2),

Having regard to the Council's Decision of June 1996 laying down negotiating Directives and authorising the Commission to negotiate an agreement on humane trapping standards with Canada, the Russian Federation, the United States of America and any other country interested,

Whereas Regulation (EEC) No 3254/91 of 4 November 1991 prohibiting the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or trapping methods which do not meet international humane trapping standards (3), and in particular the second indent of Article 3(1) thereof, refers to internationally agreed humane trapping standards with which trapping methods used by third countries that have not prohibited leghold traps must conform in order for them to be able to export pelts and products manufactured from certain species to the Community;

Whereas no international humane trapping standard had been established on 1 January 1996; whereas this situation meant that third countries had no way of guaranteeing that the methods used on their territory for trapping the species listed in Annex I to Regulation (EEC) No 3254/91 complied with internationally agreed humane trapping standards;

Having regard to the proposal for a Regulation amending Regulation (EEC) No 3254/91 forwarded to the Council on 12 January 1996;

Whereas the Agreement attached to this Decision is consistent with the negotiating Directives referred to above; whereas it therefore satisfies the concept of internationally agreed humane trapping standards referred to in the second indent of Article 3(1) of Regulation (EEC) No 3254/91;

Whereas the Agreement's main purpose is to lay down harmonised technical standards offering a sufficient level of protection to the welfare of trapped animals and governing both the production and use of traps, and to facilitate trade between the Parties in traps, pelts and products manufactured from species covered by the Agreement;

Whereas implementation of the Agreement requires a timetable to be established for testing and certifying the conformity of traps with the standards laid down by the Agreement and for the replacement of uncertified traps;

Whereas, pending the entry into force of the Agreement between the three Parties, it is necessary that the Agreement be applied as soon as possible between Canada and the European Community;

Whereas the Agreement on international humane trapping standards between the European Community, Canada and the Russian Federation and the Agreed Minute between Canada and the European Community concerning the signing of the Agreement should be approved,

HAS DECIDED AS FOLLOWS:

Article 1

The Agreement on international humane trapping standards between the European Community, Canada and the Russian Federation and the Agreed Minute between Canada and the European Community concerning the signing of the Agreement are hereby approved.

The texts of the Agreement and of the Agreed Minute are attached to this Decision along with the declarations to be lodged when the Agreement is signed.

Article 2

The President of the Council shall deposit the instrument of conclusion provided for in Article 17(2) of the Agreement.

Done at Brussels, 26 January 1998.

For the Council

The President

R. COOK

(1) OJ C 207, 8. 7. 1997, p. 14.

(2) OJ C 14, 19. 1. 1998.

(3) OJ L 308, 9. 11. 1991, p. 1.