NAMMCO

NORTH ATLANTIC MARINE MAMMAL COMMISSION

REPORT OF

THE NAMMCO EXPERT GROUP MEETING ON BEST PRACTICES IN THE HUNTING AND KILLING OF SEALS

North Atlantic House Copenhagen, Denmark
24 – 26 February 2009

CONTENT

INTRODUCTION

The North Atlantic Marine Mammal Commission – NAMMCO – tasked its Committee on Hunting Methods to organise an Expert Group on best practices in sealing at its 17th annual meeting in Sisimiut, Greenland in September 2008.

Hunting conditions and techniques have always been a priority issue in NAMMCO. People's right to hunt and utilise marine mammals is a firmly established principle in NAMMCO. However, embedded in this right there is also an obligation to conduct the hunt in a sustainable way and in such a way that it minimizes animal suffering. The Committee on Hunting Methods was established in 1994 to facilitate NAMMCO's work in this field and to give advice on hunting methods to the NAMMCO Council and the member countries. The advice given is based upon the best scientific findings, technological developments and traditional knowledge with due considerations to hunters' safety and efficiency of utilisation.

In recent years a number of reports have been released that deal with sealing issues and in particular hunting practices for seals. Statements and recommendations emerging from these reports sometimes differ fundamentally. NAMMCO Council therefore tasked its Committee on Hunting Methods with organising an Expert Group on Best Practices in Sealing. In doing so NAMMCO aims to investigate state of the art in sealing today and possibly develop a set of recommendations to the NAMMCO member countries on best practices in killing of seals in the region.

Terms of reference for the Expert Group as provided by the NAMMCO Council:

- *The work should build upon the knowledge and experiences already gathered in previous workshops organised by the Committee on Hunting Methods and possible new developments emerging since the last workshop held in 2006.*

- *The work should be undertaken in a focussed group of specially invited experts with experience in seal hunting practices both from NAMMCO member countries as well as from other sealing nations and communities.*

- *The expert group will critically assess different seal hunting methods within their contexts, addressing such questions as:*

    - *The use of specific hunting methods and equipment in particular settings*
    - *Training requirements for hunters*
    - *Control and monitoring of hunting methods*
    - *Research needs to improve the basis for further assessment*

- *The expert group will develop recommendations on best practices based on state of the art in sealing today and identify where and how specific improvements can be made.*

- *As background information for the work of the expert group, the Secretariat, in cooperation with the Committee on Hunting Methods, will prepare a collation of relevant information and recommendations on seal hunting methods from previous NAMMCO workshops and other relevant and up-to-date sources of information on sealing practices.*

In setting up the Expert Group, the Committee on Hunting Methods identified a small group of qualified persons with extended experience and knowledge in general and/or marine mammal specific biology, physiology, anatomy and pathology and effects of different methods of killing animals in slaughterhouses, as wild game or in hunting. The Committee delimited the scope of work of the Expert Group as originally outlined by Council, to seal hunting today in the North Atlantic including the Baltic Sea. Moreover the Committee decided that walrus (*Odobenus rosmarus rosmarus*) hunting would not be considered, and that the issues of control and monitoring would not be discussed as these fell outside the competence of the Expert Group.

All members of the Expert Group were invited in a personal capacity as experts in fields related to the issue of killing mammals. No stakeholders or NGO's were invited because focus was on the scientific and technical aspects of the killing process and not on the politics of sealing i.e. whether seals should be killed or not.

The Chair of the Expert Group, in his introductory remarks, emphasised the importance of keeping to the agenda and set aside all personal opinions on seal hunting in the deliberations of the meeting.

The meeting agenda (Appendix 1) listing both fundamental and more peripheral issues was discussed in detail. To facilitate deliberations the Committee on Hunting Methods in cooperation with the NAMMCO Secretariat had prepared a document consisting of a collation of information on sealing today taken from several relevant and recent reports dealing with seal hunting (listed below). In addition members of the Expert Group had been asked to give short introductions to special issues. Summaries of some of these introductions are included in the report because of their general and essential nature pertaining to information on killing of animals and in particular seals.

On the last day of the meeting the report was discussed and the text of the conclusions and recommendations was dealt with point by point and adopted by consensus. The finalising of the full report was done afterwards by correspondence.

The Expert Group met under the chairmanship of Egil Ole Øen on 24 – 26 February 2009 in Copenhagen, Denmark. The present report summarises the discussions of the Expert Group and gives conclusions and recommendations on specific hunting methods and practices.

The Expert Group (Appendix 2):

Dr. Egil Ole Øen: *Wildlife Management Service, Norway/Sweden, chair of Expert Group**
Dr. Pierre-Yves Daoust: *Atlantic Veterinary College, University of Prince Edward Island, Canada*
Dr Jan Danielsson: *Swedish Board of Agriculture (SJV), Department for Animal Welfare and Health, Jönköping*
Dr. Lars Folkow: *Department of Arctic Biology, University of Tromsø, Norway*
Dr Jean Francois Gosselin: *Fisheries and Oceans Canada, Maurice Lamontagne Institute, Quebec*
Senior Advisor Ole Heinrich: *Agency of Fisheries, Hunting and Agriculture, Greenland Home Rule**
Dr Lasse Holm: *Danish Veterinary and Food Administration*
Dr. Siri Kristine Knudsen: *The Animal Department, Faculty of Medicine, University of Tromsø, Norway*

Dr. Elbert Lambooij: *Animal Science Group, Wageningen University and Research Center, Netherlands*
Head of Section Nette Levermann: *Department of Fisheries, Hunting and Agriculture, Greenland Home Rule**
Dr. Torsten Mörner: *Sweden's National Veterinary Institute (SVA, Upsala*
Senior Veterinarian Jústines Olsen: *Veterinary Service, Faroe Islands**
Game Management Officer Stefan Pellas: *Game Management District Swedish-speaking Ostrobothnia, Finland*
Senior Legal Advisor Hild Ynnesdal: *Norwegian Directorate of Fisheries**

The NAMMCO Secretariat, represented by General Secretary Christina Lockyer and Deputy Secretary Charlotte Winsnes acted as rapporteur. In addition Ms Susan Waters, Director of Marine Mammals and Anadromous Species in the International Fisheries Directorate in Canada was present as observer for Canada.

In particular the work of the Expert Group has built upon (see Appendix 3 for full reference list):

- The Report from the NAMMCO Workshop on hunting methods, Nuuk, Greenland, 1999.
- The Report from the NAMMCO Workshop on marine mammals: weapons, ammunition and ballistics. Sandefjord, Norway, 2001.
- The Report of the NAMMCO Workshop on hunting methods for seals and walrus. Copenhagen, Denmark, 2004.
- The Report of the NAMMCO Workshop to address the problems of "struck and lost" in seal, walrus and whale hunting. Copenhagen, Denmark, 2006.
- Scientific Opinion on animal welfare aspects of the killing and skinning in the Norwegian seal hunt. *Opinion of the Panel on Animal Health and Welfare of the Norwegian Scientific Committee for Food Safety* 2007. 71 pp.
- Scientific Opinion of the Panel on Animal Health and Welfare on a request from the Commission on the Animal Welfare aspects of the killing and skinning of seals. *The EFSA Journal* (2007) (EFSA Report) 610:1–123.
- Mörner, T., Malmsten, J., Bernodt, K., Lunneryd, S-G. A study on the effect of different rifle calibres in euthanization of Grey seals (*Halichoerus grypus*) in seal traps in the Baltic Sea. In press
- Pellas, S. and Øen, E.O. 2009. Skjuttest på bifångade döda sälar för att utvärdera olika vapen och ammunition som används på säljakt. (In English: Report from shooting trials on dead seals to examine the killing potentials of different rifle ammunition when used for seals.) *Trapper,* Vol. 3 (February) (ISSN: 1797-9773).

*Member of the NAMMCO Committee on Hunting Methods

BACKGROUND

Sealing takes place in many different regions of the world with a variety of weapons and methods depending on factors such as species and size of animal, hunting habitat and environmental conditions, cultural traditions, commercial availability of gear, legislation, economy, personal experiences and preferences, and animal welfare considerations.

For animal welfare reasons it is important to achieve instant or rapid insensibility to avoid unnecessary pain and reduce the risk of losing the animal. Thus the ideal weapon from an animal welfare point of view should render the animal instantly unconscious and insensible to pain.

Seals are hunted and stunned/killed on ice, on dry land and in the water using the following methods alone or in combinations: firearms, hakapik, clubs, nets and traps.

Criteria of death – some comparative aspects

Definition of death has changed over the centuries depending on cultural views as well as technological and biomedical advances. In biology, death was traditionally determined by behavioural signs such as termination of movement and respiration, and for a long period of time it was widely accepted that death equalled the absence of pulse and breathing i.e. the classical cardio-respiratory criteria of death (e.g. Knudsen 2005). Following the development of advanced technology in medicine, like the electroencephalogram (EEG), mechanical ventilator, advanced cardiopulmonary resuscitation (CPR) techniques, etc. *brain death* was introduced as a new concept of death in human medicine in the 1960s (Harvard Committee 1968) and was implemented in the legal system of the United States in 1980s following the publication of the ‘‘Uniform Determination of Death Act’’ which defined death as either “irreversible cessation of circulatory and respiratory functions *or* all functions of the entire brain, including the brain stem” (Anon 1981). Most countries that adopted brain death as a legal criterion of human death implemented the US definition (e.g. Baron *et al.* 2006).

Generally, the term *brain death* is not widely used in veterinary practice. However, it has been used in controlled laboratory situations for evaluation of stunning and killing efficiency of different methods especially for those applied on domestic slaughter animals. In a report by EFSA on welfare aspects of animal stunning and killing methods the definition of death was provided as: “…from slaughter or killing point of view, death can be recognised from the absence of cardiac activity (e.g. pulse or heart beat) when bleeding has ceased or destruction of brain” (EFSA 2004, “Determination of death”). Further, this EFSA report noted that spinal reflexes and automatisms, as those frequently reported in brain dead humans, may also occur in animals subjected to a stun/kill method or after bleeding or destruction of the brain in effectively stunned and slaughtered animals.

No official criteria of death have been formulated for animals except for whales. A definition was adopted by the International Whaling Commission (IWC) in 1980 and reiterated in 1992 (IWC 1980; 1992) to make a standard ruling to compare the efficiency of different hunting and killing procedures in the field as well as evaluation of research into new methods. As the exact time of death might be difficult to observe for animals dying in or under water the time of death was defined as “… the moment the mouth (was) slackened, the flippers (were) slackened (along the sides) and all movements (had) ceased”. However, neuropathological investigations of minke whale brains harvested and killed with penthrite grenades showed that the IWC criteria were not always met as whales with permanent brain damage of sufficient severity to account for instant or very rapid loss of sensibility and death still (like terrestrial mammals) could show uncoordinated movements for several minutes after they were dead (e.g. Knudsen 2005).

Also the American Veterinary Medical Association (AVMA 2007) provides a much generalised guideline: ‘‘death must be confirmed by examining the animal for cessation of vital signs, and consideration given to the animal species and methods of euthanasia when determining the criteria for confirming death’’.

Diving physiology of seals

Seals are diving mammals that can endure long duration breath-hold dives of up to 1-2 hrs due to several morphological and physiological adaptations. These include:

1. An ability to store substantial amounts of oxygen in a large blood volume with a high content of the O_2-binding protein hemoglobin (Hb), and in skeletal muscles that contain large concentrations of O_2-binding myoglobin (Mb). The lungs are less important as O_2 stores since most seals exhale prior to diving, thereby reducing buoyancy and avoiding decompression sickness after deep dives. The total capacity to store O_2 exceeds that of typical terrestrial (non-diving) mammals by a factor of 2-4, depending on species.

2. An ability to economize O_2 stores, thereby making them last longer. This is achieved through sometimes dramatic cardiovascular adjustments that may involve a massive but selective peripheral vasoconstriction (reduced tissue/organ blood perfusion), accompanied by profound bradycardia (reduced heart rate), which together leave tissues/organs that are not immediately and urgently needed during diving (e.g., selected skeletal musculature, gastrointestinal tract, kidneys) partially ischemic or “under-circulated”. The blood-borne O_2 is thereby reserved for the much more hypoxia-sensitive central nervous system, and to some extent also the heart. These cardiovascular adjustments may be graded depending on the expected duration of the dive, from modest in short dives, to maximum engagement during prolonged diving, thereby maximizing diving capacity. The rate at which O_2 is utilized may additionally be reduced through vascular-mediated body core cooling, where for example brain temperature may display a 3°C drop in connection with a 10 min dive, which slows the rate of O_2-consumption by the brain and also protects it from hypoxic damage (Odden *et al*. 1999).

3. An enhanced tissue hypoxia tolerance at the cellular level. This is in part related to a high capacity for anaerobic metabolism, and in part to hypoxia-induced cellular mechanisms that cause reduced tissue metabolic rates and hence, reduced O_2-consumption rates. Such protective mechanisms are also expressed by neural tissue of seals (Folkow *et al.* 2008). For a review of adaptations to diving, see e.g. Ramirez *et al*. (2007).

The adaptations outlined above do not have any consequences for killing times of seals vs. other mammals when killing tools that cause extensive brain damage (rifle shot, hakapik or similar weapon) are used, since such damages are equally fatal to a seal as to any other mammal. They do, however, explain why some tissues may maintain the capacity to display basal activity for quite extended periods after the death of the animal (e.g., reflex skeletal muscle contraction and cardiac activity, which may persist for almost one hour after death (Blix and Øritsland 1970)), and are sometimes misinterpreted as reflecting responses associated with life. Seals that are killed in ways that causes extensive brain damage may even on rare occasions display some coordinated activity, if those parts of the brainstem that are responsible for basal control of breathing and/or motor activity remain intact. In such case, even a brainless (i.e., decerebrated and consequently pain free) animal might actually continue to display breathing activity for several minutes (Blix and Øritsland 1970).

The adaptations do, however, imply that net-entangled seals may survive for prolonged periods before unconsciousness and death ensues, but documentations of responses of diving animals under such conditions are limited (Ronald 1982), although these in part may be predicted based on previous diving physiology studies involving forced experimental dives in the laboratory (e.g., Scholander 1940, Elsner *et al.* 1970, Kerem and Elsner 1973), and possibly also long duration dives in freely diving seals (e.g. Kooyman 1966, Kooyman *et al*.1983, Qvist *et al*. 1986).

Stunning

Mechanical stunning

Stunning and stun/kill methods are developed to induce, when applied correctly, pathological brain states that are incompatible with the persistence of consciousness and sensibility. The magnitude of deviation from the normal brain electrical activity can be determined using EEG or electrocorticogram (ECoG).

A blow on the head with a blunt instrument can be used to stun/kill animals by cerebral concussion, and the blow acts in a similar way as non-penetrating captive bolts.

Cerebral concussion is generally agreed to be a traumatically induced derangement of the nervous system, resulting in an instantaneous diminution or loss of consciousness without gross anatomical changes in the brain (EFSA 2004). Irrespective of the type of force which produces the traumatic depolarisation of the cell membrane, there is now evidence that powerful pressure waves are provoked within the cranial cavity by a blow on the head and that the frequency and force of the waves vary in different parts of the brain. It has been suggested that it is not the pressure as such developed by these waves that is the important factor, but the rapid oscillations in this pressure (Nilsson and Nordstrom 1977). Most investigations concerning the mechanism of concussion have been performed using laboratory animals. It is evident from these investigations that concussion does not always cause immediate loss of consciousness. In humans, amnesia occurs after a blow on the head. Successive severe blows result in prolonged loss of reflex activity and cause almost complete disappearance of all frequencies (iso-electric line) on the EEG (Nilsson and Nordstrom 1977).

The Panel on Euthanasia of the American Veterinary Medical Association (AVMA 2007) has stated that: "Euthanasia by a blow to the head must be evaluated in terms of the anatomic features of the species on which it is to be performed. A blow to the head can be a humane method of euthanasia for neonatal animals with thin craniums, such as young pigs, if a single sharp blow delivered to the central skull bones with sufficient force, can produce immediate depression of the central nervous system and destruction of brain tissue. When properly performed, loss of consciousness is rapid."

Missiles used for stunning and killing of slaughter animals are a bullet, a bolt, water jet and air pressure. Immediately after stunning the animals express a tonic spasm for approximately 10 sec prior to relaxation; however, excessive convulsions may occur. Directly after shooting, major changes (delta and theta waves tending to an iso-electric line) are seen on the EEG. It is assumed that the animal is unconscious by analogy to similar EEG changes described in man (Lambooij and Spanjaard 1981).

In general, the penetration of a missile into the brain can cause injury in the following three ways, depending on its velocity and shape:

a) by laceration and crushing at a relatively low velocity (< 100 m/s),
b) by shock waves at a higher velocities (about 100 to 300 m/s) and
c) by temporary cavitation at a very high velocity (> 300 m/s) (Hopkinson and Marshall 1967).

Captive bolt stunning is a mechanical method widely used for red meat farm animals. A cartridge with gunpowder, compressed air or a spring under tension is used to drive bolts (missiles) against or through the skull of the animals. In captive bolt stunning methods the most important factor is to cause tissue damage by transmitting the energy from the missile to the brain.

The captive bolt parameters required to achieve immediate loss of consciousness and sensibility in farm animals are well established (see EFSA 2004 scientific report for details). Penetrating and non-penetrating captive bolt guns are generally designed to use .22 or .25 calibre cartridges (1.25 to 3.0 grains in some countries) or compressed air. The bolts have different shapes to facilitate their use in various species and circumstances. The velocity of the commonly used bolts when shot into the air is estimated from 55 – 165 m/s (55 m/s: Grandin 2002, 90-100 m/s: Lambooij 1981 and 165 m/s: Finnie 1997) and their kinetic energy is estimated at 400 to 420 Joules. At this low velocity and with its shape, the bolt should crush the cortex and deeper parts of the brain either by the bolt itself or by forward shock waves (Lambooij 1982). The ideal shooting position is frontally on the head (Lambooij and Spanjaard 1981). With good equipment and ideal conditions unconsciousness should be instantaneous which means less than 1 s.

Captive bolts should be fired perpendicularly / at right angle to the frontal bones. When fired at an angle deviating from perpendicular, bolts tended to skid or slide along the skull surface and, as a consequence, failed to stun animals, at least in poultry (Raj and O'Callaghan 2001). The surface area of the blunt end of the metal ferrule on a hakapik is substantially larger than that of the striking end of a captive bolt, and therefore it is less likely to slide off the skull surface (broader in a seal than in a chicken) if the impact is at an angle. However, the angle of striking the skull of a seal will clearly influence the impact energy delivered to the brain.

It is generally known that the removal of inhibitory influences from higher centres of the brain before the spinal cord becomes anoxic, results in convulsive activity and enhancement of some spinal reflexes.

After the stunning procedure the animals may not die immediately depending on the degree of injury to the brain. Therefore, it is recommended to kill the animal by exsanguination or through pithing to damage the deeper parts of the brain and to prevent convulsions. When concussion by a blow to the head is incorrectly performed the animal may be injured and neither stunned nor killed.

The captive bolt has been suggested as alternative to the hakapik as both methods have certain similarities in their function - being to render the animal insensible - mainly by inducing brain concussion caused by the impact of the bolt. However, even in slaughterhouses there have been many variations in the stunning effect associated with use of captive bolts on domestic animals (Mickwitz and Leach 1977, Gregory *et al.* 1983, Hyttel and Biering-Sørensen 1988, Blackmore and Delany 1988, Kestin 1992). During a field observation the percentages of cattle stunned with 1 shot from a captive bolt stunner were 100% in 12% of processing plants, 99% in 24%, 95 to 98% in 54% of the plants and < 95% in 10% of the plants in the US in 1999. All cattle where the first shot missed were immediately re-stunned (Grandin 2002).

If captive bolts were to be tried on seals it would be essential for the captive bolt pistol to be held directly against the seal's head to be effective, but contact with the tool could cause the seal (pup) to retract its head back into the neck skin, which could cushion the impact and result in the bolt missing the brain. Perhaps, the greatest problem presently would be of a technical nature as this weapon is unlikely to function well under cold and wet conditions. The maintenance of the weapon is very important for its function even with indoor use and if the bolt is not cleaned regularly, it will not retract completely. When used on seals on the ice, where temperatures can be far below the freezing point, debris from blood and fat would immediately build up on the bolt and prevent its retraction, probably even after the first stunning attempt, resulting in poor stunning results for the next animal. It has been shown that even minor faults with the bolt will reduce velocity by 40 per cent (Daly 1987). A rough calculation shows that a 40 % velocity reduction will reduce the impact energy from the bolt by 60-70%, which would result in a considerable reduction in its stunning capacity.

The conclusion is that captive bolts, at least with their present design, should not be recommended for use on seals, especially outdoors in cold weather. Even if an effective captive bolt was designed that would overcome these disadvantages, it may still not be an appropriate method as the animal’s head cannot be stabilised and so it may not be possible to obtain an effective kill (EFSA 2007).

Stunning using firearms

<u>Basic effect of rifle shots</u>

Many factors may influence the effectiveness of a rifle bullet. The degree of damage to a target from a bullet (terminal ballistics) is influenced by factors such as the speed, weight, shape and design of core and jacket and the ability of expansion. A heavy projectile will generally penetrate farther into tissues than a lighter one. The projectile’s impact energy, which is the relationship between the projectile’s speed and its mass but also its sectional density (SD), which is the relationship between the weight and the cross-section of the projectile, has an important effect on the projectile’s penetration abilities and tissue damage potential. A general rule is that the higher the impact and SD, the better penetration and the greater tissue damage.

A full-jacketed projectile consists of a soft core of lead or a plumbiferous alloy, surrounded by a capsule (jacket) of hard metal with pointed, rounded or butt nose. A full-jacketed bullet is designed to penetrate the object without being damaged or deformed and is commonly used for sports and military use but is also commonly used for the hunting of large African game and to euthanize whales (Øen and Knudsen 2007). For the hunting of more conventional game species different types of soft-pointed or whole metal bullets are preferred.

In general, soft pointed bullets consist of a soft core of leaden material surrounded by a hard metal jacket, which is enclosed at the rear and open at the front, exposing the soft core. When soft-pointed or similar bullets hit an object, the jacket is torn open as the soft core is compressed and expands at penetration, changing the projectile into a mushroom-like shape and creating a wide wound canal. In addition to the tissue damage along the wound canal, the expanded projectile may cause violent shock and pressure waves, generating complex pressure changes in the surrounding tissues, as the energy is transferred (Harvey *et al.* 1962, Amato *et al.* 1974, Berlin *et al.* 1976, Charters and Charters 1976, Bellamy and Zajtchuk 1990) and the creation of a permanent, localized tract as a result of laceration and crushing of tissue. In addition, high radial forces imparted to the parenchyma produce a large temporary cavity that exists for only microseconds. In organs that have no room for expansion, such a sudden energy transformation causes an almost explosive rise in pressure (Bellamy and Zajtchuk 1990).

<u>Rifle shots in the brain</u>
The brain is un-elastic. In addition it is enclosed by rigid bones, which gives no opportunities for expansion (Bellamy and Zajtchuk 1990, Finnie 1993). The brain therefore becomes particularly vulnerable to hits by expanding bullets which will be grossly destructive to the brain tissue (Clemedson *et al.* 1973, DiMaio and Zumwalt 1977, Finnie 1993, Karger *et al.* 1998, Daoust and Cattet 2004, Øen and Knudsen 2007). When a bullet with high velocity passes through the brain or in close vicinity, the inside pressure will increase dramatically and the damage may be almost 'explosive' (Watkins *et al.* 1988) and the whole brain or parts of it might be blown away, (often named 'Krönlein' shots after Krönlein 1898, Betz *et al.* 1997, Thali *et al.* 2002), or pressed through natural openings like the sinuses or the foramen magnum (Harvey *et al.* 1962). The cranium might crack, and fractures and bone splints will cause secondary injuries to the brain tissue (Bellamy and Zajtchuk 1990, Thali *et al.* 2002).

When a projectile penetrates the cranium near the brain or in the upper cervical spinal canal, extensive gross intracranial haemorrhages have also been documented as a general phenomenon, as well as displaced skull fractures in minke whales (*Balaenoptera acutorostrata*) that were euthanized using rifle and round-nosed full jacket bullets. In these instances the brainstem and central areas of the brain were frequent sites of haemorrhages (Øen and Knudsen 2007). Vascular injuries in these vital areas are likely to cause serious and immediate effects ('brain stem effects') as also described in other studies (Crockard *et al.* 1977a; 1977b, Carey *et al.* 1989, Karger *et al.* 1998). Soft-pointed expanding bullets that mushroom on impact with the head should also destroy the brain, even if they are off-target to some degree, providing there is sufficient impact (Fackler 1988, MacPherson 1994; Daoust and Cattet 2004). Fragmenting bullets, e.g. Polymer tipped Varmint, on the other hand, are designed to break apart instantly on impact, and the kinetic energy from the bullet is transferred into the target in a very short period of time ("exploding") often resulting in the skull and brain being blown apart upon impact.

A sufficiently powerful projectile does not even have to hit the brain directly to cause a devastating injury (Øen 1995, Daoust and Cattet 2004, Øen and Knudsen 2007, Pellas and Øen 2009). For instance, shock waves created from an impact site close to the upper cervical spine, may be sufficient to cause bleeding and tissue disruption higher up in vital areas of the central nervous system. Similarly, shots through the upper part of the neck will usually completely destroy or transect the spine and cause instantaneous unconsciousness or very rapid death by causing major damage to the spinal cord and brainstem and by severing blood vessels to the brain (Øen and Knudsen 2007). A study of .22 magnum ammunition, using intact heads of harp seal beaters under controlled conditions, concluded that this type of ammunition was sufficiently powerful to kill beaters in a humane manner when they are hit directly in the brain case from a distance of 40 m or less (Daoust and Cattet 2004). The same conclusion was reached from shooting trials performed on dead grey and harbours seals (Pellas and Øen 2009). However, because of the less severe wound that such ammunition would cause, there is a higher chance that the animal would only be injured rather than irreversibly stunned or killed if hit elsewhere with such bullets (Malouf 1986, Daoust and Cattet 2004, Pellas and Øen 2009).

CONCLUSIONS AND RECOMMENDATIONS

General conclusions

The reasons for killing animals can roughly be divided into four main groups: (1) euthanasia of pets and other animals for animal welfare or other reasons, (2) slaughter of domestic animals, (3) hunting and (4) trapping. The slaughter of domestic animals is by far the largest group, followed by euthanasia and, finally, hunting and trapping.

The most common methods of euthanasia involve injections of some types of anesthetics, and shooting. More rarely the use of gas and electricity may be used to stun the animals before they are killed by other means. During euthanasia the animals are physically constrained and the drug or killing device can be applied directly into veins or other targeted areas (brain etc).

In the case of slaughtered domestic animals, stunning and killing is carried out in two steps: firstly the animal is stunned and then it is killed by bleeding out. The specialized equipment and techniques that are used also require the animal to be physically restrained and the operator to be physically close to the animal and the stunning device to be physically directed at selected areas like brain (mechanical and electricity) or lungs (CO_2).

Stunning and killing methods used for domestic animals cannot be applied to wild, free-roaming animals. Under normal hunting conditions of large terrestrial mammals the animals are killed at a distance and the stunning and bleeding out are as a rule, carried out in one and the same operation. The selected target area is usually the thorax with the lungs and the cardiovascular system, which constitutes a relatively much larger fatal hitting area than the brain /upper neck. The projectiles used aim to destroy the heart and large vessels in the thorax. Hits in these organs lead to a massive loss of blood causing rapid decline in blood pressure followed by unconsciousness and death. However, in some hunts, large terrestrial mammals are shot in the brain/upper neck. Such hits usually cause a direct trauma in the brain or upper spinal cord leading to instantaneous and severe destruction of vital parts of the central nervous system, and render the animal instantly unconscious/dead or in a state of immobility in which case re-shooting can be carried out, if necessary.

Trapped, live captured mammals can be regarded as physically constrained. Therefore the process of euthanasia/killing is carried out under much more controlled circumstances resembling those used in slaughterhouses. Trapped animals are usually shot directly in the head/brain.

The methods applied for stunning and killing seals belong somewhere between the methods used for free roaming mammals and some of the stunning and killing techniques used in slaughterhouses.

Most seals are killed using firearms. To prevent shot seals from entering into the water before consciousness supervenes they are regularly shot in the brain or upper neck with selected ammunition to render the seal instantly unconscious or immobile. When using the hakapik or club to stun young seals in the large scale seal hunt, the operator is situated very close to the animal and will, as in slaughterhouse operations, be able to stun the seal by directing the stunning device (blow) directly to the brain and then kill the animal by bleeding out.

In the ongoing public debate pertaining to killing methods used for hunting, direct comparisons are made between methods used in slaughterhouses and methods used to kill in hunting operations. Demands have been made that hunting methods used for killing wild animals should guarantee that all animals are killed instantaneously or within 1 second. With reference to what has been said above the, two situations - slaughterhouses and hunting in the wild – are not directly comparable. Also in general, there are no known killing methods that can guarantee a 100% instantaneous stun and kill of animals. Given that the primary focus is exclusively on the moment the animal is stunned or killed, i.e. when the stunning device hits the animal, it can be said that the risk of longer survival times will be greater for hunted animals shot remotely than for animals that are slaughtered or where the operator is situated closely to the animal. On the other hand, most hunted animals will be killed without realizing that they are being targeted, and they will usually not be subjected to the long-term stress caused by the 'handling' experienced by domestic animals that are slaughtered.

Death criteria

The Expert Group agreed that an animal is dead when the cortex and deeper parts of the brain are irreversibly damaged.

Firearms

The Expert Group discussed types of ammunition and calibres (e.g. expanding bullets, velocity, impact energy, terminal ballistics and external factors), animal- and gunner's platforms and gunner's position in relation to the animal, education and training and research needs.

Conclusions
Firearms are the most common tool used for killing seals of all age classes in seal hunting regions and countries, and a variety of weapons and ammunitions are used. No international standard exists.

Firearms have the potential capacity to cause sufficient brain damage, and to kill the animal without stressing it. Results of ammunition tests presented to the meeting showed that the bullets of small calibres tested had the capacity to kill a seal.

The position of the animal itself should not have any impact on the killing as long as there is a clear view of the target area (head or neck).

Shooting animals in water may involve an increased risk of struck and lost as compared to seals on ice or land.

Recommendations
Firearms and ammunitions used should have the capacity to achieve the intended effect.

Noting that new types of ammunition have been developed for hunting, the Expert Group recommends further studies on the use of ammunition for hunting seals of different species and age groups in order to determine their capacity to achieve the intended effect.

Hakapik and club

The Expert Group discussed different types of hakapiks and clubs, the use of hakapiks and clubs, hunter's position in relation to the animal, education and training and research needs.

Conclusions

Different types of hakapik and clubs exist and are used as primary tools for stunning and/or killing young seals (less than 1 year), and are known to be effective tools in this respect.

The hakapik is a multipurpose tool. The hunters are using it also for safety reasons with respect to falling into the water, defence against aggressive seals and for handling dead seals.

The environmental conditions and the nature of the hunt determine to a large extent whether the hakapik is being used as the primary tool or not. For example the use of the hakapik as the primary tool has been reduced due to poor ice conditions and changes in targeted age classes.

The position of the brain in relation to the shape of the head is important for determining the proper target for blows from a hakapik or a club that are aimed at causing multiple fractures and collapse of the skull. The shape of the head varies among seal species and age groups. The proper target is the midline of the calvarium, the latter being defined as the portions of the frontal, parietal and occipital bones covering the cerebral hemispheres.

Recommendations

When using the blunt projection of the hakapik the hunter's relative position to the animal is less important than a stable platform.

When using the spike of the hakapik it is recommended that the hunter is positioned behind the seal in order to achieve maximum effect. The intended effect of the curved spike is to penetrate and damage the deep parts of the brain (including the brainstem) in order to achieve irreversible damage to these vital areas.

The use of the hakapik and clubs on seals in water should only occur when the primary tool has not rendered the animal unconscious.

Different types of hakapiks and clubs are used and known to be effective tools to stun young seals. Factual information is required to explain the effectiveness of hakapiks and clubs as stunning tools, through evaluation of the force delivered in relation to the damage produced and the relative solidity of the skull, which may vary among species.

Netting and trapping

The Expert Group discussed netting and trapping of seals and noted that this is an important and widely used form of subsistence hunting in areas where there are no other alternatives during certain periods of the year.

It further noted that the limited data that exist on entanglement of seals do not allow assessment of the extent of suffering experienced by the seals or the cause of death. Factual information is required to explain the process of dying under these conditions.

Bleeding out

The Expert Group discussed different processes of bleeding out seals, and its significance in relation to the criteria for death.

Legislation pertaining to some large scale seal hunts requires bleeding as soon as possible after stunning/killing.

The Expert Group recognises that bleeding is a precautionary measure to ensure death in all animals.

Recommendation
The Expert Group recognizes the value of determining the duration (average and range) of bleeding in seals when axillary (brachial) blood vessels on both sides are cut, which represents the bleeding method currently and commonly used. This information should be available for different species as differences may exist. Other bleeding methods (e.g. carotid arteries and jugular veins) could also be investigated.

Combination of methods used for stunning and killing of seals

Canadian and Norwegian legislations both prescribe a three-step process for killing in their large scale hunts of seals.

In both countries firearms are the main primary tool to stun/kill seals in the large scale hunt. In both hunts the hakapik/club used as primary tool can only be used to stun/kill young seals (less than 1 year) and shooting in the brain/neck with firearms is the mandatory primary method for all seals older than 1 year (1+ year).

In the Norwegian large scale hunt when using the hakapik as primary tool, the young seal shall first be struck with the blunt part of the hakapik (step 1), then immediately after be struck with the spike of the hakapik (step 2) so that it penetrates deeply into the brain before the seal is bled (step 3). When the firearm is used as primary tool the seal is shot (step 1) and immediately reshot if necessary, then struck in the brain with the spike of the hakapik as soon as possible (step 2) and then bled (step 3).

In the Canadian large scale hunt Step 1 is the same as in the Norwegian hunt when the hakapik/club is used as primary tool. However, step 2 differs as it requires that the sealer immediately checks by palpation the cranium of the animal (step 2) to confirm that it is completely crushed by the primary tool before bleeding out for a period of one minute (step 3) as soon as possible after step 2. When the seal is shot (step 1) the sealer must observe the seal for directed movements and shoot the seal again if necessary, check by palpation the cranium of the animal (step 2) as soon as possible after step 1, and then bleed out for a period of one minute (step 3) as soon as possible after step 2.

Conclusion
The Expert Group recognises the value of a three-step killing process in large scale seal hunts.

Training and education

The Expert Group wishes to emphasis the fundamental importance of information, education and training for seal hunters and inspectors in order to carry out the hunt in an appropriate manner with respect to animal welfare. Important elements of such education could include: animal behaviour, anatomy, physiology, ballistics, ethics, legislation, handling of carcass, etc.

Appendix 1 - Agenda

1. INTRODUCTION BY CHAIR EGIL OLE ØEN

2. STUNNING AND KILLING METHODS

2.1 FIREARMS

2.1.1 Type of weapons and calibres

2.1.1.1 Smaller (fine) calibres (.22 - .223)
2.1.1.2 Larger (high) calibres (> calibres .223)

2.1.2 Type of sights

2.1.2.1 Optical
2.1.2.2 Mechanical

2.1.3 Type of ammunition

2.1.3.1 Soft and hollow pointed
2.1.3.2 Full metal
2.1.3.4 Full metal jacketed
2.1.3.5 Others

2.1.4 Animal's platform

2.1.4.1 On dry land
2.1.4.2 On fast ice
2.1.4.3 On ice floes
2.1.4.4 In water

2.1.5 Gunner's platform

2.1.5.1 Ground or fast ice
2.1.5.2 Large boats
2.1.5.3 Small boats (dinghies and kayaks)

2.1.6 Gunner's position in relation to the animal

2.1.6.1 In front of
2.1.6.2 Side
2.1.6.3 Behind

2.1.7. Impact of hits (Beaters and adults (1+ year))

2.1.7.1 In head
2.1.7.2 In neck
2.1.7.3 In thorax
2.1.7.4 Other regions

2.1.8. Discussion Point 2.1

2.1.8.1 Advantages and disadvantages of the use of firearms in seal hunting
2.1.8.2 Needs for education and training of marksmen and hunters
2.1.8.3 Research needs and/or needs for innovations

2.1.9 Conclusions and recommendations under Point 2.1

2.2 HAKAPIK

2.2.1 Type of hakapik
2.2.1.1 Hakapik with "long" hammer
2.2.1.2 Hakapik with "short" hammer
2.2.1.3 Slagkrok

2.2.2 Use of hakapik and slagkrok
2.2.2.1 Beaters
2.2.2.2 Adult (1+ year)

2.2.3 Animal's platform
2.2.3.1 On fast ice
2.2.3.2 On ice floes
2.2.3.3 In water

2.2.4 Hunter's position in relation to the animal
2.2.4.1 In front of
2.2.4.2 Side
2.2.4.3 Behind

2.2.5 Impact of hits
2.2.5.1 In head
2.2.5.2 In neck
2.2.5.3 Other regions

2.2.6 Discussion Point 2.2
2.2.6.1 Advantages and disadvantages of the use of hakapik in seal hunting
2.2.6.2 Needs for education and training of hunters
2.2.6.3 Research needs and/or innovation needs

2.2.7 Conclusions and recommendations under Point 2.2

2.3 CLUB

2.3.1 Type of clubs
2.3.1.1 Club with spike
2.3.1.2 Club without spike

2.3.2 Use of clubs
2.2.2.1 Beaters
2.2.2.2 Adult (1+ year)

2.3.3 Animal's platform
2.3.3.1 On fast ice
2.3.3.2 On ice floes
2.3.3.2 In water

2.3.4 Hunter's position in relation to the animal
2.3.4.1 In front
2.3.4.2 Side

2.3.4.3 Behind

2.3.5 Impact of hits

2.2.5.1 Head
2.2.5.2 Neck
2.2.5.3 Other regions

2.3.6 Discussion Point 2.3

2.3.6.1 Advantages and disadvantages of the use of clubs
2.3.6.2 Needs for education and training of hunters
2.3.6.3 Research needs and/or innovations

2.3.7 Conclusions and recommendations under Point 2.3

2.4 NETS AND TRAPS

2.4.1 Types and use of nets and traps

2.4.1.1 Nets under ice
2.4.1.2 Traps for live catches

2.4.2 Observations of animal reaction after entanglement

2.4.2.1 Time to death (TTD)

2.4.3 Discussion Point 2.4

2.4.3.1 Advantages and disadvantages of the use of nets and traps
2.4.3.2 Needs for education and training of hunters
2.4.3.3 Research needs and/or innovations

2.4.4 Conclusions and recommendations under Point 2.4

2.5 HARPOONS

2.5.1 Harpoon types and use of harpoons

2.5.1.1 Harpoon used as primary weapon
2.5.1.2 Harpoon used as secondary weapon

2.5.2 Observations of animal reaction after harpooning

2.4.2.1 Effects of harpooning
2.4.2.2 TTD

2.5.3 Discussion Point 2.5

2.5.3.1 Advantages and disadvantages of the use of harpoons
2.5.3.2 Needs for education and training of hunters
2.5.3.3 Research needs and/or innovations

2.5.4 Conclusions and recommendations under Point 2.5

3. COMBINATION OF METHODS USED FOR STUNNING AND KILLING OF SEALS

3.1 Current practices of combining methods

3.1.1 Shooting and use of hakapik

3.1.2 Shooting and use of clubs without spike
3.1.3 Shooting and harpooning
3.1.4 Harpooning and clubbing
3.1.5 Others

3.2 Discussion Point 3
3.2.1 Advantages and disadvantages of combining methods
3.2.2 Needs for education and training of hunters
3.2.3 Research needs and/or innovations

3.3 Conclusions and recommendations under Point 3.

4. BLEEDING OUT

4.1 Current practices of bleeding out seals
4.1.1 Immediate or as soon as possible after shooting/clubbing
4.1.2 Bleeding out on board ship
4.1.3 No bleeding out

4.2 Discussion Point 4
3.2.1 Advantages and disadvantages of bleeding out
3.2.2 Needs for education and training of hunters
3.2.3 Research needs and/or innovations

4.3 Conclusions and recommendations under Point 4.

5. GENERAL DISCUSSION AND RECOMMENDATIONS

6. ADOPTION OF REPORT

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