NORTH ATLANTIC MARINE MAMMAL COMMISSION

REPORT OF THE NAMMCO WORKSHOP ON HUNTING METHODS FOR SEALS AND WALRUS

North Atlantic House Copenhagen, Denmark
7 – 9 September 2004

Financial sponsorship was provided from:

norden
Nordic Council of Ministers

in addition to contributions from: the North Atlantic Co-operation (NORA), Indigenous Survival International Greenland and the Norwegian Ministry of Foreign Affairs

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NAMMCO WORKSHOP ON HUNTING METHODS FOR SEALS AND WALRUS

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At its 12th Annual Meeting in March 2003 the Council agreed to the recommendation from the Committee on Hunting Methods to hold a Workshop on Hunting Methods for Seals and Walrus. The Council approved the following terms of reference for the Workshop: The NAMMCO Council at its 12th Annual Meeting in March 2003 adopted the following Terms of Reference for the Workshop:

- To review existing seal and walrus hunting methods known
- To evaluate methods used in seal and walrus hunting in relation to killing efficiency and struck and loss rates
- To examine possibilities for technical innovation and further enhancement of efficiency and safety of hunting methods, with a view to providing recommendations for improvement, where relevant, and,
- If possible, determine minimum requirements for safe and efficient killing of different seal species and walrus, considering variations in hunting methods.

The Overall Goal for the Workshop was stated as: To ensure a safe and efficient hunt based on hunters' knowledge, science and the best available technology, and the **Workshop objective:** To formulate recommendations on best practice, minimum requirements, enhancements and technical innovations for weapons and ammunition.

1. APPOINTMENT OF CHAIR AND CO-CHAIR

Dr Egil Ole Øen from the Norwegian School of Veterinary Science, Section of Arctic Veterinary Medicine, Norway chaired the Workshop, while Mr Glenn Williams, Wildlife Advisor to the Wildlife Department of the Nunavut Tunngavik Incorporated (NTI), Canada served as co-chair.

2. APPOINTMENT OF RAPPORTEURS

Members of the NAMMCO Secretariat were appointed as rapporteurs.

3. INTRODUCTORY REMARKS

Jústines Olsen (Faroe Islands)**,** Chair of the NAMMCO Committee on Hunting Methods welcomed the participants to the Workshop, and noted that the Committee was very pleased to find that the topic of seal and walrus hunting methods was of interest to so many people from different parts of the world. Mr Olsen also expressed gratitude for the financial support to the Workshop from the Nordic Council of Ministers, the North Atlantic Co-operation (NORA), Indigenous Survival International Greenland and the Norwegian Ministry of Foreign Affairs. Finally he thanked the Representation Offices of Greenland and the Faeroes for hosting a reception on 7 September for the workshop participants.

Dr Egil Ole Øen (Norway), Chair of the Workshop in his introductory remarks noted that this was the third in a series of NAMMCO Workshops on hunting methods. The first was held in Nuuk, Greenland in 1999, and the second in Sandefjord, Norway in 2001. In addition he drew attention to the linkages between these Workshops and the NAMMCO Conference on User Knowledge and Scientific Knowledge in Management Decision Making held in Reykjavik, Iceland in 2003, in which a number of resource users from 11 countries discussed the important role of user knowledge in the management decision-making process. Dr Øen drew attention to the Terms of Reference for the Workshop and noted that the success of the Workshop was dependent upon an open exchange of knowledge amongst the participants. The participants were asked to evaluate, with an open mind, the various methods and look at possibilities for innovation, and finally suggest minimum requirements for safe and efficient killing methods. Dr Øen emphasised that the broad range of participants from other countries than the NAMMCO members would help the Workshop to achieve the best results.

4. PRESENTATIONS

4.1 Physical features, biology and behaviour of seals and walrus

In this introductory session the speakers described the anatomy and behaviour of significance for the choice of equipment and methods used in the hunt. The complete papers are included in Appendix 4.

Seals: Siri K. Knudsen, Norway

The family of pinnipeds consists of three sub-families: (1) the Family *Odobenidae* that only contains the walrus; (2) the Family *Otariidae*, which consists of the seal lions and the fur seals. The species in this family all have a visible external ear flap and are therefore often referred to as “eared seals”; (3) the Family *Phocida* are often referred to as true seals or “earless seals”.

All pinnipeds have much shorter limbs compared to terrestrial mammals of the same size. Phocids and otariids swim differently, which is reflected by some anatomical differences. Seals, as other diving mammals, have increased storage capacity for oxygen in their musculature, with the result that muscular movement can persist long after the animal is dead. The skeleton of all seals consists of the skull, the spinal vertebra, four limbs and the ribs. The skull of pinnipeds is characterised by a short snout and large orbits. During hunting, seals are usually shot in the head, with the brain being the main target. Consequently, for hunters this area is the most important. The thickness of the cranium varies in different part of the skull. It is generally thickest over the frontal and basal parts of the brain, where it may be several centimetres thick. It becomes thinner at the upper hind part and on the lateral sides. The thickness also varies to some extent among different species, but most importantly it varies between animals of different size.

The nervous system of pinnipeds is built and functions in the same manner as in other mammals. It consists of a central part, which is the brain and spinal cord, and a peripheral part which are the nerves and nerve cells in the rest of the body. The brain can be regarded as the true centre of the body responsible for survival, consciousness and the maintenance of physiological conditions. By consciousness we mean awareness of the world around and of the body. Thus, someone who is unconscious will not perceive pain. Generally it can be said that during seal hunting the same applies as for other mammals: in order to render the animal instantaneously unconscious some specific brain areas have to be put out of function, which includes the cerebral cortex, deep central parts of the cerebrum and/or the brain stem, which contain the centres for consciousness and control units for respiration and heart activity. It is the brain and spinal cord that are responsible for the reflexes and involuntary reactions in dead animals. Most of such reflexes do not require cerebral co-ordination and thus can be elicited in the insensible animal.

The major tasks of the heart and blood vessels are to transport oxygen rich blood from the lungs to all organs and tissues in the body - a job carried out by the arteries - and to remove carbon dioxide from these tissues and transport it through the veins to the lungs where it is breathed out. Physiologically, it is the circulatory system of seals that is most different compared to terrestrial animals and these adaptations are related to diving. The heart of pinnipeds is of normal mammalian construction, though it tends to be broader and flatter than the hearts of terrestrial mammals. Also the heart musculature has higher oxygen storage capacity than in terrestrial mammals. This is important for hunters, as the heart can carry on beating a long time after the animal is in fact dead. Optimal regulation of the blood pressure is essential. Too low blood pressure results in shock and eventually death. After severe injury the blood pressure will drop almost immediately and the animal will be unconscious, not immediately, but very rapidly. This may, however, be time enough for an animal that for instance is lying near the ice edge to haul itself into the water and sink. As most organs in marine mammals are similar to those of terrestrial mammals, their central blood supplies are also similar.

The respiratory system of seals is similar to other mammals, although the lungs tend to be larger than those of terrestrial mammals.

The thorax and abdomen are separated by the diaphragm, a thin muscular wall that is essential for respiration. It is traversed by the aorta, the vena cava caudalis and the oesophagus. The marine mammal liver is generally not too different from that of other mammals. It has a rich blood supply and is located immediately caudal to the diaphragm. The kidney typically lies against the musculature of the back.

At the end of the presentation an overview on the seals species that were most topical for the workshop was given, with special emphasis on important anatomical and behavioural differences.

Walrus: Joel Garlich-Miller, Alaska, USA

Walrus (*Odobenus Rosmarus)* have a discontinuous, although nearly circumpolar distribution around the perimeter of the Arctic Ocean and contiguous sub-arctic seas. Their distribution appears to be constrained by water depth and ice conditions. Walrus rely on floating pack ice as a substrate for resting and giving birth. They are gregarious animals and usually found in groups.

Walrus are specialised predators of benthic invertebrates. They use sensitive whiskers to locate food items on the sea floor and dislodge prey using powerful jets of water and suction.

Hunters usually prefer to target walruses hauled out onto large flat ice pans. The brain is normally targeted with the objective of killing the animal outright, on the ice, in place for butchering. Although the front of the skull is greatly enlarged to accommodate the tusks, the lateral walls of the cranium are relatively thin. When hunting in open water, injured animals are usually harpooned before a killing shot is made because walrus generally sink upon death. The lungs and spinal cord are frequently targeted. Accounts of struck and loss rates for modern walrus hunting practices range from less than 10 % to more than 50%. Loss rates can be minimised through appropriate target selection and by utilising suitable hunting practices and gear.

4.2 Weapons and other hunting equipment: ballistics and effects

In his opening remarks the Workshop co-chair Mr Glenn Williams noted that we need to know about ballistics and the effects of weapons and other hunting equipment in order to improve the hunters' hunting abilities and thus make the hunt itself more efficient. The complete papers are included in Appendix 4.

Ballistics: Egil Ole Øen, Norway

Ballistics is the science of the motion; the propulsion and the impact of a projectile. Although closely interrelated, it is commonly divided in internal, external and terminal ballistics. The term calibre is used to designate the diameter of the slug or weapon bore.

Internal ballistics (“interior ballistics”) covers the events that take place within the gun from the moment the primer ignites to the moment the bullet leaves the barrel. This is a complex system that involves the case and the primer characteristics, the propellant, bullet and the barrel characteristics.

External ballistics (“exterior ballistics”) is the science of the flight of the missile between the barrel muzzle and the target. External ballistics studies and predicts the projectile’s trajectory or path relative to a frame of reference. It is i.a. used to set up firing tables, which information includes the bullet path, its remaining velocity at any distance, and the time of flight at different ranges. By knowing this, the shooter can predict where the bullet will strike and decide how to “zero” the firearm for best results. By knowing the remaining velocity (and energy) of a projectile at any point along its path, the shooter can estimate its energy and thus its effectiveness at any distance.

Terminal ballistics (“target ballistics”) is the science of the stopping process of the projectile at the target. Penetration, wounding effect, energy dissipation, projectile formation and stability are all important processes covered by this branch of ballistics. The seriousness of the bullet wounds is often considered to be limited to the tissues in the direct path of the projectile, but the wounding potential of projectiles is much more complex.

The bullet’s ability of penetration is important because it usually must get well inside the animal to reach and disrupt the function of vital organs and bring the animal down. A number of factors are affecting the performance of penetration and killing like the projectile’s calibre, its kinetic energy (E), which is dependent of bullet velocity and mass, its sectional density (SD) which is the ratio of weight to the square of the bullet diameter, and the bullet design and other characteristics. For example will full-jacketed bullets generally promote greater penetration into the target than bullets that expand and/or flatten or mushroom on impact, and thereby increase the resistance during penetration and passage. For expanding bullets the expansion is affected by the type of tissues, thickness and strength of the jacket, hardness of the core, and the amount of core exposed.

Terminal ballistic: Siri K. Knudsen, Norway

Terminal ballistics describes the effect a projectile causes while striking the body as well as the effects upon the projectile. The main mechanisms of injury after gunshots were described, including cut, stretch, shock and heat. The typical characteristics of ballistic injuries to the skull and brain were given, and emphasis was put on which damages that causes instantaneously loss of consciousness. The typical features of ballistic injuries to the chest, abdomen and soft tissue were also presented.

Discussion

In response to a query as to whether a bullet would change direction upon impact with a relatively soft and thin skull, Knudsen indicated that the velocity and angle of impact of the bullet were most important in determining what would happen. Changes in direction were more likely with low velocity and/or high angle impacts.

Animal welfare and the Canadian Harp Seal hunt: Pierre-Yves Daoust, Canada

The annual harp seal (*Phoca groenlandica*) hunt in Atlantic Canada is the largest seal hunt in the world. However, it is the animal welfare issues surrounding this hunt that have dominated the public attention for decades. Since the mid 1980s, beaters (3-4 weeks old) have been the main age group targeted in this hunt.

The two types of weapons used to harvest these animals include the hakapik (see description page 29, article 5) and high-calibre rifles, the selection of these weapons being influenced in large part by ice conditions.

In order to adequately address whether various methods used to harvest wild animals are humane, the anatomic and physiologic bases for removal of pain perception (destruction of both cerebral hemispheres) and for causing rapid death (destruction of the brain stem) must be understood. In this context, this author believes that one or a few blows from a hakapik can rapidly and efficiently render a beater at least irreversibly unconscious and probably dead, because the top of the skull of these young animals is very thin and can easily be crushed. Subsequent verification that the skull of the animal is completely crushed and/or that its blinking reflex is absent, followed by immediate and rapid bleeding, will ensure that the process of humane killing is complete.

Some sealers have suggested that rifles authorised under the current Canadian Marine Mammal Regulations for the harp seal hunt are unnecessarily powerful. However, a recent ballistic study under controlled conditions by the author suggests that these Regulations should be upheld, although field observations are needed in order to confirm this conclusion.

The swimming reflex is a stereotypic, sometimes vigorous, movement of a recently killed seal. Attempts should be made to better understand the physiologic basis of this movement, as it has often been used by animal welfare groups as an indication that the animal harvested is still alive.

In conclusion, this author believes that the killing methods used at the Canadian harp seal hunt are appropriate from an animal welfare perspective, when properly applied, but that they could be further improved through careful application of some simple techniques. Monitoring of the hunt by independent observers should also continue in order to encourage compliance with proper hunting practices. Finally, this author recommends a return to the replacement yield as the basis for annual quotas at the hunt. This would ensure a sustainable harvest; it would also promote a less hurried hunt and, therefore, more opportunity for careful handling of individual animals.

<u>Discussion</u>
Based on their experiences the hunters in the Canadian seal hunt stated that the .22 Magnum is more effective than the .22 Rimfire. There are no regulations on maximum distance for firing a gun but the sealers rarely shoot from beyond 50 m to facilitate retrieval of the animals. The bleeding of the seals is good for the pelts and for the meat. In Canada the blunt end of the hakapik is used to crack the skull and the pick itself to move animal, while in Norway the blunt end is used first and then the pick is used to palpitate the brain. Palpation of the skull is a good method for determining death and is more reliable than observing reflexes. Most hunters prefer the hakapik to the rifle because the hakapik is more secure and also cheaper in use. However the hakapik is not advised for killing adult seals.

4.3 Video presentations

The following VIDEO presentations of hunting activities from different regions were presented during the Workshop:

- "Waiting at the Ice Edge", from Nunavut, Canada
- "But Seal is our daily bread", Seal hunting in Greenland

- Walrus hunting from Chukotka, the Russian Federation
- Harp and hooded seal hunting in the West Ice, Norway
- Coastal seal hunting for harbour seals in Norway
- Faroes Pilot Whaling
- Sealing in Iceland

John K. Boone gave a presentation on the Alaska Native Harbour Seal Commission.

4.4 Descriptions of seal and walrus hunting

WALRUS HUNTING

Vladilen Kavry, Chukotka, Russian Federation

The Chukchi and the Bering Sea are the habitat of the Pacific Walrus (*Odobenus rosmarus divergens*). The walrus come in the spring when the sea breaks up and leave in the late fall when the seas starts freezing. They are harvested on the Pacific coast from the spring until the fall, and on the Arctic coast in the summer and in the fall.

The walrus is harvested in all native villages located on the Pacific and Arctic coasts of Chukotka. Walrus hunting methods have been developing over many centuries and are maintained by the present generation. All along the thousand-kilometre coast the hunters apply practically the same methods with only seasonal differences.

Almost all marine mammal hunting settlements of Chukotka are located nearby the coastal walrus haulouts. The walrus appear on the haulouts only when the ice disappears from the sea. In the Bering Sea the summer coastal haulouts form in the middle of July, while in the Chukchi Sea the haulouts form at the end of August and in September. At these locations the walrus is slaughtered in fall when the walrus migrate from the north to the south. Usually the walrus rest on the haulouts for several days. The first walrus are very cautious but become less so as the beach fills. The experienced hunters and elders take the decision regarding the beginning of the slaughter. The hunters use long lances aiming at heart to kill the walrus. They do not use rifles because the sound of the shot would alert the walrus and cause them to stampede into the water.

The harvesting season starts in spring when the walrus migrate with the passing ice. The hunters approach the walrus herd very carefully and try not to make any noise. They try to approach unnoticed as closely as possible and kill the walrus with one shot. The gunners aim at the vital organs of the walrus (neck, brain *etc.*) to kill or immobilise instantaneously. The hunters use large-calibre rifles.

Ice haulouts are the favourite resting-place of the walrus. They choose mainly the edge of pack ice but sometimes female walrus with calves are found in the centre of pack. In large herds on the ice the walrus tend not to be so alert as when they are in smaller groups.

In an ideal situation the hunters debark on the ice-floe with walrus or on a neighbouring ice-floe. The walruses get anxious and will leave if provoked. If the hunter does not make any sudden movements and stays in the same place visible to the walrus, they relax and lie down to rest again. After 15 to 20 minutes the hunter makes the first shot at the chosen animal and then remains motionless. The sound of the rifle resembles that of ice cracking, and it frightens the animals. They become agitated again and will flee if provoked. They look around but, not seeing anything out of the ordinary, become calm and lie down again. In about 10 minutes after the first shot the hunter makes the second and again freezes. This pattern is repeated until the hunter has killed as many walrus as he needs. The remaining animals are then chased away from the haulout.

If the hunter cannot debark onto the ice, he must shoot the animals from the boat. The walrus is approached either very carefully and slowly, or, conversely, very quickly. In either case the objective is to harpoon the walrus before it escapes into the water. If the walrus cannot be harpooned at once, the hunters sometimes shoot the walrus first. In such a case they try not to kill the animal so that it does not sink. They then harpoon the animal and make the killing shot. This process can take 10 to 15 minutes.

At some locations the haulouts can be approached by boat. The hunt starts very early in the morning when the walrus are asleep. The sleeping walrus are approached with the outboards off. The sleeping walrus is harpooned and then killed using a long lance. Then the walrus is tugged away from the haulout. If these methods are used the walrus do not get frightened.

According to many researchers the struck and loss rates for the Pacific walrus can reach 40-50%. The loss rates depend on different factors and vary greatly. Loss rates are highest in the open-water hunt. If the walrus is harvested on the ice haulouts, the loss rate is reduced.

Charlie Brower, Alaska, USA

The Eskimo Walrus Commission (EWC) was established in 1978. The EWC represents coastal walrus hunting communities throughout Alaska, and is recognised as addressing issues of state-wide interests. Walrus (Walrus (*Odobenus rosmarus divergens)* are considered to be a cultural subsistence resource, a primary food source, and used in objects crafted from ivory and bones. The EWC currently has co-operative agreements, with the US Fish and Wildlife Service and with the Russians. Through extensive co-operation the Commission focuses on education, research, hunt monitoring, tagging of walrus and inspection of all boats carried out by monitors elected amongst the tribal organisations. Self-regulation and management are encouraged. The Commission gathers traditional knowledge on walrus conservation and management, and a book on traditional management practices has been published.

Walrus hunting takes place in July/August. Walrus on ice floes are preferred targets, therefore hunting is dependent upon favourable ice conditions. Open water hunts are much less successful. Also, killing the animal on the ice makes it much easier to butcher. The hunters use boats, harpoons, high-powered rifles, sharp knives and a come-along. The hunters can tell from the behaviour of the animal whether or not it is accompanied by a calf. The hunter shoots the animal behind the ear to hit the brain, at which point the brain is destroyed and the head falls down. The type of rifle used varies [.30-30, .30-06, .278, .22-250, .223] depending on how proficient the hunter is.

Walrus hunting is dangerous because of the ice and unpredictable weather. The current is also strong in the areas where walrus are hunted. Hunters tend to go to areas to the west of their villages, because there is a strong easterly current and by the time butchering is completed they will have drifted back towards their village. The hunters are trying to improve the struck and lost rates by using more high powered rifles, attach more floats to the animals, and by shooting at as close a range as possible. The hunters always approach the animals from the lee-ward side when the animals are lying on the ice floes, but the walrus often fall in the water after being shot, increasing the struck and lost rates.

<u>Discussion</u>

Although some Alaskan hunters use ammunition as small as .222 and .223 for walrus hunting, it was noted that the animal must be shot at close range and precisely for these light calibres to be effective. All hunters generally use full metal jacket bullets. Even hunters taking animals on the ice should have a harpoon ready, because injured animals are sometimes pushed into the water by other walrus.

Charlie Johnson, Alaska, USA gave a presentation of the Marine Mammal Protection Act (see Appendix 3 for a résumé).

Glenn Williams, Canada

Mr Glenn Williams gave the presentation on walrus (*Odobenus rosmarus rosmarus*) hunting in Nunavut on behalf of Ben Kovic the Chair of Nunavut Wildlife Management Board. The largest concentrations of walrus are found in Foxe Basin and northern Hudson Bay. Walrus hunting is a recognised right under the Nunavut Land Claims Agreement, and is governed by the Fisheries Act. Indians and Inuit can harvest up to 4 walrus without license per year, and in some cases community quotas are issued. Walrus are hunted in all the six seasons. The hunters are required to report harvests to the Department of Fisheries and Oceans. The average annual kill is 241 animals, with some reduction over the past 20 years. This may be because hunters no longer use large boats to access very remote areas, and other changes in equipment, rather than a reduction in the number of animals. The struck and loss rates vary with seasons, weather, location, animal behaviour and experience of hunters. Currently there are no reliable estimates of struck and loss rates.

Hunters in Nunavut use a combination of traditional methods and modern equipment, such as boats with outboard motors and snow machines with more traditional sleds. Harpoons with seal skin lines and floats are still very important, although hunters often find that the modern floats are more resilient. In most cases the rifles used for killing walrus are .30 calibre, .303 calibre or smaller, depending on what the hunters' have available to them. The .303 calibre is commonly used because the ammunition is widely available in the communities. In the last several years the .303 full metal jacket ammunition has become less available and has been replaced by soft point bullets.

Walrus are hunted from boats while they are on ice floes and while swimming in open water. Hunting them on ice floes is preferred because loss rates are lower and it is more convenient for butchering the animals. Animals on the ice are approached slowly and shot at as close a range as possible, with the objective of killing them outright before they can enter the water. When hunting in open water, the walrus is often slowed down with a body shot, allowing the hunters to get close enough to harpoon and secure the animal before administering the killing shot. This reduces loss rates.

Walrus hunting through the ice is done during the winter, by harpooning the walrus as it breathes through a hole in the thin young ice. Once harpooned the walrus is secured and held until it returns to breathe again, then shot through the roof of the mouth where the skull bone is thinner.

Nunavut Tunngavik Incorporated, the Nunavut Wildlife Management Board and the Department of Fisheries and Oceans have established a working group of experienced hunters to make recommendations on harvesting methods and equipment for marine mammals, and to also test new equipment and technologies. This past summer, hunters tested new rifle calibres and ammunition on walrus. Experienced hunters were supplied with 338 Win Mag and 375 H&H rifles. The test ammunition was hand loaded, round nose solids, round nose full metal jacket and solid Barnes XP bullets. The results of these tests are now being collated. The Working Group also identified training at the community level as important. Training materials are being developed and will be published in appropriate formats for dissemination in the communities.

Walrus is an important source of food and every edible part is utilised and distributed through the communities. The by-products from the walrus hunt, such as tusks for carving, are also important as a source of cash for the hunters.

Discussion

The hunters prefer full metal jacket ammunition because they find that with smaller guns (.303) they get better penetration, and it is readily available in the communities. The latter is important for determining the ammunition used. It may be better to use soft point bullets with bigger rifles, but this is currently being tested. There is concern about bullet deflection, which may be more acute for full metal jacket ammunition in smaller calibres. The bullets design and shape also influences deflection, and research into this problem is underway in Nunavut.

Leif Fontaine, Greenland

The hunting of walrus (*Odobenus rosmarus rosmarus*) in Greenland varies greatly both by region and season.

In North Greenland (Avanersuaq), walrus occur from October until April. When they first appear in October, they are hunted from motor boats and dinghies, and are shot first with a body shot to slow the animal, and then harpooned in order to prevent them from sinking. When the first ice appears in November, the walrus is harpooned from the floe edge, and the harpoon line is secured using a lance. The lance is thrust into the ice, thus “fastening” the walrus. When it surfaces it is shot using a calibre .30-06 rifle.

In northwestern Greenland, walrus occur infrequently in the fjords, and are therefore rarely hunted there. In recent years hunting walrus at the floe edge by means of dog sled has become more common, resulting in increased catch. Again the walrus is shot using a .30-06 calibre rifle.

In central western Greenland, walrus are found at the floe edge in February. In harsher winters with more ice, walrus can be seen in abundance, but leave the area in May. Due to the thinning of sea ice off Sisimiut in recent years, walrus tend to be further offshore and therefore harder to reach by boat.

Hunting walrus around Sisimiut is locally restricted to the months of March and April. Whenever harsh winters occur with more ice, walrus catches increase. Hunting walrus is practised utilising larger vessels since ice conditions and strong currents would make the use of very small vessels dangerous. Walrus can be hunted from smaller boats occurs only when sea ice is less dense. Calibre .30-06 rifles are commonly used in the hunt. As in other areas the walrus is shot while on the ice if possible, and in open water if not. In open water every effort is made to harpoon the animal before it is killed.

In Eastern Greenland, walrus appear rarely around Kuummiut from about May to July. Walrus are hunted in open water by shooting them first, then harpooning them to prevent them from sinking. .30-06, .30-30 and .243 calibre guns are commonly used.

Mr Fontaine emphasised that hunter safety was very important in walrus hunting. He also recommended the use of ear protection when hunting with rifles.

Discussion

It was clarified that full metal jacket, sharp point ammunition is the type most commonly used for walrus hunting in Greenland

SEAL HUNTING

Edward Zdor, Chukotka, Russian Federation

Seals are harvested in all villages on the Chukotkan Arctic and Pacific coasts. Four species other than walrus are hunted: ringed (*Phoca hispida*), ribbon (*Phoca fasciata*), bearded (*Erignathus barbartus*) and spotted seals (*Phocha largha*). The ringed seal is the most commonly hunted seal, and is taken on the ice or in open water at all times of the year. The other seal species appear in the spring when the sea ice breaks up and depart in the late fall when the sea freezes, and are harvested when they are present in the hunting areas.

Netting is a very commonly used method for taking seals in Chukotka. Several types of seal nets are used. The summer net is 15 to 20 m in length and is used in open water, in the same manner as a fishing net. It is most effective in darkness. The winter net is 5-6 m in length and is set across fractures in the ice. A special type of net, a square of about 2.5 m, is set beneath seal holes in the ice, hanging below the hole like a sack. The seal is able to come up the hole but gets stuck in the net when it tries to dive down again.

Seal traps are used on rivers where seals swim up the river following fish. The trap is a partially submerged mesh box with a trap door in the upper part which remains at the surface. When a seal hauls out on the box, it falls through the trap door into the trap.

Seals are also hunted using rifles and associated equipment to retrieve the seal. In the summer seals are shot from boats, floating ice, or hiding places on shore. In the spring and early summer seals are shot as they lie by their breathing holes. In the fall and winter seals are hunted from the ice edge or at open water leads. Some hunters also hunt seals at the breathing hole using traditional methods.

Bearded seals are large and very cautious animals and require specialised hunting methods. In the spring and summer bearded seals haul out on the ice and are hunted by carefully stalking the animal to within firing range. In the fall they haul out on the new ice edge and are hunted from boats. Open water hunting is difficult because the seals sink when killed. If they are killed outright they must be harpooned very quickly to ensure retrieval. If a bearded seal is shot and injured just before it submerges, the hunter waits at the spot where the seal went down. The seal tends to emerge at or near the same spot, at which point it is shot and harpooned.

John K. Boone, Alaska, USA

Mr Boone focussed on seal hunting in southeast Alaska, where 3 species are commonly taken: northern fur seals (*Callorhinus Ursinus*), Steller sea lions (*Eumetopias jubatus*) and harbour seals (*Phoca vitulina*). In addition sea otters are hunted.

The methods used in seal hunting are always dependent on the prevailing environmental conditions. There is little sea ice in southeast Alaska, but icebergs from glaciers are common in some areas. Shorelines are typically steep and the water is deep in most areas. Therefore it is common practice to shoot animals while they are on shore, or to herd them into shallow water before shooting them. These practices minimise the number that are struck and lost. If animals sink to the bottom in shallow water they can be retrieved using a grappling hook. Another way of minimising struck and lost is to shoot the animal just as it takes a breath: its lungs are then full of air which causes it to float.

The local knowledge held by hunters enables them to locate seals on a seasonal basis. Seals commonly follow their sources of food; therefore knowledge of fish migrations is very helpful in finding seals.

Equipment used in seal hunting is similar to that used in other areas. All equipment must be able to withstand a salt-water environment and hard use. To this end equipment maintenance is also crucial. The .222 calibre with full metal jacket ammunition is the most commonly used for seal hunting. Larger calibres are sometimes used for long range shooting from fixed positions. The full metal jacket bullet does not fragment upon impact and does less damage to the hide and meat. A club is used to kill injured seals. A grappling hook and rope is necessary to retrieve seals that sink in shallow water. Sharp stainless steel knives are used for skinning and butchering.

Some studies have estimated high struck and loss rates for open water seal hunting, but this is very dependent on environmental conditions and the skill and experience of the hunters. To minimise struck and loss, hunters should concentrate on one species at a time, and focus their hunting approach to that species. Seals that sink when shot should be hunted in shallow water, where they can be retrieved, whenever possible. Equipment should be well maintained, and rifles should be sited in regularly. Target practice is important even for experienced hunters, and it is especially critical to practice shooting from a boat.

Discussion
It was agreed that .222 and .223 calibre rifles using full metal jacket ammunition were excellent weapons for hunting smaller seals, as they gave good penetration and minimal damage to the skin and the meat. Soft point ammunition was acceptable for short and medium range shooting.

Mark Small, Canada, and additional information from Department of Fisheries and Oceans: Commercial harp seal (Phoca groenlandica) hunt
In Atlantic Canada, the typical professional sealer is an active fisherman who participates in the seal hunt for only a few weeks of the year. Both small vessels (<35 feet) and longliners (35-65 feet) participate in the hunt, but vessels larger than 65 feet participate as collector vessels only. The small vessels carry a crew of 2-5 sealers, operate close to shore, and usually land their catch daily. The larger vessels carry larger crews and may stay out for several days at a time.

There are presently over 15,000 licensed sealers in Atlantic Canada, of which over 9,000 are professional sealers. To become a professional sealer, a sealer must apprentice under a professional for 2 years. This ensures that the appropriate training and skills are passed on.

The hunt is strictly regulated and the Gulf and Front whelping areas have separate annual quotas. Weaned harp seal pups are most commonly taken. Very few hooded seals are taken because the hunting of bluebacks is prohibited in Canada. Harvests of harp seals over the past 9 years have averaged 256,000 animals. The hunt is profitable for participants and is not subsidised in any way.

The hakapik and club are the primary hunting tools used in the Gulf hunt, while rifles and shotguns are preferred at the Front, where ice conditions make it difficult to approach seals on foot. The exact specifications of the hakapik and club are specified by Canadian regulations (see Appendix 3). These regulations also specify that hunters must crush the skull with the hakapik or club, and then manually check the skull, or administer a blinking reflex test, to confirm that it is dead before proceeding to strike another seal. In addition, no person may start to skin or bleed a seal until a blinking reflex test has been administered, and it confirms that the seal is dead.

About 95% of the seals taken at the front are shot with rifles. The vessels steam through the ice shooting seals, recovering them using a small skiff. Under Canadian law a rifle and bullets that are not full metal-jacketed that produce a muzzle velocity of not less than 1,800 feet per second and a muzzle energy of not less than 1,100 foot pounds must be used in the seal hunt. Shotguns of 20 gauge or greater, with rifled slugs, may also be used. The most commonly used rifles are of calibres .243, .223 and .222.

Most seals are killed instantly. Recent studies have shown that the struck and loss rates for young seals taken on the ice varied from 0-1.9%, and from 0-10% when taken in the water. Loss rates were higher for older seals, but these are rarely taken.

Mr Small believed that, for the seal hunt to be considered ethically acceptable, the existence of the species must not be threatened, no unnecessary pain or cruelty should be inflicted, the killing should serve an important use, and should involve a minimum of waste. In his view most present day sealing activities satisfied these criteria.

Glenn Williams, Canada: Arctic seal hunts

There are five species of seals in Nunavut that are hunted. Ringed seals are the most common, with a distribution that is year round throughout Nunavut. This is the seal that is harvested the most, for its meat and skin by all communities in Nunavut (except Baker Lake). Bearded seals also have a year round distribution throughout Nunavut. Although this seal is not harvested as much, it is very important for its meat, and the skin is used for the making of soles for kamiks and skin ropes. Harp seals migrate annually between the Arctic and sub-Arctic regions. This seal arrives in Nunavut in June and July, returning to the east coast of Canada in October and November as the sea ice forms in the northern parts of its range. Harp seals are only harvested occasionally in Nunavut as a source of feed for dogs. Their skins are used in the sewing of traditional clothing. Hooded seals (*Cystophora cristata*) migrate annually from offshore areas to the near shore in the late fall. Hunters only harvest this seal occasionally, but the numbers and frequency of hooded seals being caught is increasing in the past few years. Harbor seals are found in the very southern parts of Nunavut, at the northern limit of their range. This seal is only taken occasionally, but the meat and skins of the young seals are prized by hunters.

Seal hunting is subject to the terms of the Nunavut Land Claims Agreement, and is legislated under the Marine Mammal Regulations of the Fisheries Act. There are currently no restrictions on the seasons or numbers of seals that can be harvested by an Inuk in Nunavut. Seals are harvested year round in Nunavut, but the migratory seal species are only hunted during open water seasons. Seal harvesting during the ice-covered seasons is restricted to ringed seals and bearded seals. It is estimated that 30 000 ringed seals, 1000-2000 bearded seals, 1000-2000 harp seals and less than 200-300 harbour and hooded seals are harvested annually in Nunavut.

The majority of seals are shot from a boat in the water. Occasionally, seals are shot while out of the water on ice or rocks. The shooting of ringed, harp, harbour and hooded seals in the water is done with a .22 calibre rifle, with a shot to the head. The seal is then either hooked with a long handled *niksik* (gaff), or harpooned.

During the first few weeks of the open water hunt, the loss due to sinking is slightly higher than during the remainder of the open water season. Hunters report that this is due to the physical condition of the seals (blubber thickness) and the lower salinity of the water due to melting ice and snow

The harvesting method used for bearded seals in open water is similar to that used for walrus. It is shot in the body first, then harpooned with a float attached and then shot in the head.

Jakob Petersen, Greenland

The availability of seals and the methods and weaponry used in seal hunting varies regionally and seasonally in Greenland.

In northern Greenland (Avanersuaq), during the winter when there is sea ice (during the dark period) ringed seals and bearded seals are hunted by their breathing holes in the ice and also by using nets closer to the shore. The seal is shot using a calibre .30-06 rifle, then using the *Iimaq* (lance), designed for winter use, to ensure a swift kill. During the spring (April to June) when seals are up on the ice, they are hunted using shooting screens with .222, .243 and .30-06 calibre rifles. During the summer and early fall (July to September), harp seals appear in the Qaanaaq region. Hooded seals have become rare in the Avanersuaq and are sighted infrequently, since the range of the sea ice is decreasing and moving further north due to the warming of the climate.

In northern West Greenland, ringed seals are to be encountered year round. Young and adult harp seals appear around June, and are hunted until November - December. Bearded seals appear in during the summer and can be seen until the sea ice appears. During the summer, smaller boats as well as larger vessels (up to 30 feet) are used in hunting seals. During the winter time hunting is conducted by using dog sledge and only ringed seals are caught using nets. Magnum .22, Sako .22 and .30-06 calibre rifles are commonly used in the hunt.

In central Western Greenland, Harp seals appear in June. By early fall some disappear, but numerous seals are to be encountered even in late fall. They disappear around March – April while they are breeding on the sea ice. Hunters catch the harp seals using dinghies and smaller vessels and the catch is sold at local meat and fish markets. Fishermen in larger fishing boats also hunt the seals for subsistence, as do recreational hunters. Younger harp seals appear by the end of June and disappear during March-April and are hunted primarily by hunters in dinghies, using calibre .22 Magnum and .222 rifles.

Hunters in the Maniitsoq region have noted that the frequency of appearance of younger harp seals can vary a great deal depending on ice conditions. Another factor, which is believed to be the cause of a recent decrease in the numbers of young seals seen, is the Southern Canadian hunt for baby seals which is believed to have an influence on the number of seals reaching Greenland.

Hooded seals appear in April and newborn seal pups of this species appear on the floe edge or in the drifting ice. In May their numbers decrease. Subsistence hunters using dinghies primarily hunt this seal using .222's up to .30-06's.

The fjords around Sisimiut no longer are covered with ice in the wintertime and as a consequence ringed seals rarely are encountered. In earlier years when the fjords were covered with ice, ringed seals could be encountered at the mouths of the fjords and were caught using nets. During the early spring in March – April as the sun grows stronger numerous seals would be basking in the sun on top of the ice, and they were hunted by walking on the ice or using dog sled. Now they are hunted using dinghies or smaller vessels. Calibre .222 up to .30-06 rifles are used in the hunt.

In southern Greenland, ringed and harp seals are to be encountered year round. They are hunted throughout the year, except during their moulting period in May and June, using dinghies. Calibre .22 Magnum and .222 rifles are used for the hunt. Hooded seals frequent the area of Nanortalik from the beginning of April until the end of June and are primarily hunted by subsistence hunters from dinghies, using calibre .30-06 and .222 rifles.

In east Greenland, young and adult harp seals, hooded seals as well as bearded seals and ringed seals are encountered and hunted year round. From January until April ringed seals are caught from the sea ice using nets. From May until December the seals are hunted by means of vessels. The hunting equipment used depends on the size of the seal. For larger seals Sako .222 rifles are used and for smaller seals .22 Magnum rifles are used.

Discussion
Greenlandic hunters have noted a more frequent occurrence of seals with patchy hair or without hair in their catch. This is also seen occasionally in Atlantic and Arctic Canada. The reasons for this are not known, and further research is needed.

Bjørne Kvernmo, Norway: East and West Ice commercial hunt
Today Norwegian sealing for harp and hooded seals is much less active than it used to be. In the last few years, only about 3 or 4 vessels have participated, with 2-3 going to the West Ice and 1 going to the East Ice. These are ocean going fishing vessels that participate in other fisheries at other times of the year. Each vessel has a crew of 13-15, as well as an inspector appointed by the Norwegian authorities. Each ship takes 2,000 to 5,000 seals in a trip. In recent years the emphasis has been on taking hooded seal pups (bluebacks) as these have the most valuable pelts.

The vessels cruise through the ice fields, with gunners stationed at the bow shooting seals. Seals are shot at a range of 30 to 70 m. Under Norwegian regulations (Appendix X), after being shot the seal must be struck with a club or hakapik, then bled. The seals are retrieved directly from the sealing vessel, or small boats are used. In slack ice conditions, shooting is sometimes conducted from small boats as well.

The minimum power of the rifles to be used for shooting adult seals and seal pups is restricted by Norwegian law (Appendix 3). The most common rifle for shooting seal pups is the calibre .222, while the 6.5 mm calibre is used for shooting adult seals. Expanding bullets (i.e. not full metal jacket) are used. Guns with 5 shot magazines are preferred. All shooters use rifles with telescopic sights, and the rifles are sighted in on a daily basis.

Sealers are required to take a one-day training course annually.

In general sealing in faraway waters is a complex and demanding operation that requires extensive planning and preparation. The weather is very unpredictable and harsh in the sealing areas. Safety considerations for the sealers and crew are very important.

Discussion
Norwegian hunters have found that the use of sound suppressors (silencers) on rifles enables them to take more adult seals from a patch, as the other seals don't become so alarmed at the sound of the shots.

Andreas Dunkley, Norway: Norwegian coastal seal hunt
The non-commercial hunt for coastal seals is concentrated on grey (*Halichoerus grypus*) and harbour seals, but ringed and harp seals are also sometimes taken.

Hunting is conducted from small boats so calm weather is necessary. Normally the shooter is set on land in an area where seals are known to be present. Seals are rarely shot from a boat. Ideally seals are shot when they are hauled out on land. If seals are shot in the water, this is done in areas of shallow water, so they can be retrieved if they sink. The shooting range is usually between 20 and 100 m.

The minimum size of rifles used in the hunt is restricted under Norwegian regulations (see Appendix 3). The use of expanding bullets is mandatory. Expanding bullets tend to disintegrate when they hit the water, reducing danger from ricochet. Many hunters use a bipod when shooting. Some hunters use a silencer, which reduces recoil and muzzle flash, and is safer for the hunter. Other important hunting equipment includes binoculars, a rangefinder, a gaff, a hook and line to retrieve sunken seals, and an underwater viewing apparatus to find sunken seals.

The seal is usually shot in the head, resulting in a quick kill. Animals tend to float in the winter months but some sink even then: for this reason it is best to shoot seals only in shallow water and have the equipment necessary to retrieve them.

All hunters are required to take a shooting test before participating in the seal hunt.

Pétur Guðmundsson and Árni Snæbjörnsson, Iceland
Only the harbour seal and grey seal are hunted in Iceland. The harbour seal breeds in the spring from May to July with its maximum breeding activity in the end of May and beginning of June. On the south coast the common seal breeds on sand dunes up in the glacier rivers and on the bare sandy beach, but on the west and the north coast on very small rocky islands. The grey seal starts breeding in the late September with its maximum activity in October/November and continues until February/March. Because of the breeding time the harbour seal is called the spring seal in Iceland and the grey seal the autumn seal.

Seal hunting in Iceland is focussed almost entirely on seal pups, mainly for the skin; but the meat, the blubber (fat) and the flippers played an important role for human consumption in the past. Pups are taken when they are a few weeks old, just towards the end of lactation. Annual takes range from 200 – 400 harbour seal pups and somewhat fewer grey seal pups. Harvests have declined in recent years because of the low market price of the skins. For a very long time before 1980 the catch was 4000 – 6000 harbour seal pups and 500 - 1000 grey seal pups per year. Seal hunting has a long tradition that goes back to when the island was first colonised. It is still the case that a land owner has the right to the seals on his land; therefore virtually all seal hunting is carried out by farmers on their own land, or with the land owner's permission. Seal farmers in Iceland have established the Seal Farmers Society with a membership of 100.

In Iceland the hunting methods have developed according to different circumstances from farm to farm, being different in the glacial rivers of the south coast during the spring, compared to the methods used on the rocky islands on the NW-coast during the autumn. Hunters choose a suitable hunting method according to the circumstances.

Net hunting is the most common method for hunting the harbour seal pup. The hunting takes place in the spring. To maximise the success of the hunt, it is necessary to be quiet around the whelping areas; therefore shooting is an unsuitable method. The nets are placed close to the small rocky islands or across creeks and channels. The bottom part of each net is made as heavy as necessary to keep it as close to the bottom as possible, to prevent the pup from lifting the net to the surface for air. This minimises the time it takes for the seal to drown. Every pup entangled in the net is caught, none escape wounded, and none suffer pain from their wounds. In the glacier rivers on the south coast, nets are pulled upstream between the riverbanks to catch pups. Then the pups are landed and put to death using a seal club or a rifle of .22 calibre.

The grey seal pups are almost entirely caught in the whelping areas, using either a seal club or a rifle of .22 calibre from a very short distance. For hunting of adult grey seals a rifle of calibre .222-.243 is used.

All seal pups skins are utilised. Harbour seal pup skins are tanned for fur coats and jackets and some of them are sold dry for export. The grey seal pups skins are tanned for the leather industry, and this is a very strong leather material. Icelanders have for centuries utilised the seal products completely, i.e. the skin, the meat, the blubber and the flippers. The meat is used fresh, salted or smoked. The blubber was used as a source of light, animal fodder or for human consumption. The very old tradition of singeing and pickling the flippers still exists. After 1980 the popularity of the seal products declined, but in the last few years it is increasing again.

Bjarni Mikkelsen, Faroe Islands

Seal hunting may have had a long tradition in the Faroes, in parallel with the tradition of utilising the whale resources around the islands. The hunt is fairly well described in historical records going back to the seventeen century. Two seal species formerly bred in the islands and were hunted - the harbour seal and the grey seal. By the mid-eighteen century the harbour seal became extinct, probably due to overexploitation. The grey seal hunt continued for another hundred years.

The main hunting season was during the breeding season when seals were on land. For harbour seals, this was May-June, on sandy shores and skerries in more sheltered areas. Grey seals were hunted during the whelping season in September-October, in caves and on rocky shores. The hunters approached the breeding sites by boat. In caves they sometimes had to use flares to illuminate the cave. Reaching shallow waters, the men jumped on land and equipped with wooden clubs they killed all adult seals present with a strike to the head. Afterward all pups were killed. Outside of the breeding season, a few seals were taken in special large mesh-sized seal nets put out in near-shore waters. Later, with the introduction of weapons, seals were also shot in shallow waters, mainly in the summer period.

With the termination of a four-year bounty hunt in 1967, reducing the grey seal stock significantly, and new weapons legislation in 1969, banning the possession and use of rifles as a hunting weapon, traditional seal hunting virtually ceased in the Faroe Islands.

Fish farms were introduced in the Faroes in the early 1980's. The farmers experienced problems with grey seals interacting with cages and disturbing the fish. They were given permission to possess rifles, with a minimum calibre of 6.5 mm, using hollow point bullets, and to shoot seals approaching the farm. The farmers shoot mainly from land, aiming at the head of the seal. A high portion, perhaps 70-90%, of grey seals killed in the water sink, even in the winter. The farmers have experienced problems with bullets ricocheting of the sea, posing a potential danger to people residing near the fish farms. Some farmers have started using shot guns and cartridges loaded with pellets to shoot the seals, which is illegal.

Farmers are not required to keep hunting logbooks or to retrieve the shot animals, even for scientific purposes. There is no longer any tradition to utilise seal meat and blubber or the fur in the Faroes.

Åke Granstrøm: Sweden and Finland

Harbour, ringed and grey seals are found in Swedish and Finish Baltic waters. Of these only the grey and ringed seals are hunted at present. The grey and ringed seal populations are now recovering after commercial over-harvesting in the first half of the 20th century, and a period of low reproductive success apparently caused by pollutants. Seal hunting was stopped entirely in Sweden in 1975 and in Finland in 1982, and only recently restarted in 2001 and 1997 respectively. There is an increasing problem with interactions between seals and commercial fisheries in both countries.

Seal hunting is strictly regulated in both countries (See Appendix 3). The hunting season for grey seals lasts from 16 April to 31 December, while that for ringed seals in Finland is divided into 2 periods from 16 April to 31 May and from 1 September to 15 October. There are quotas for both species. Hunting is forbidden in seal reserves, which include all the major resting-places for seals in the Baltic. Hunting from boats is not permitted. The minimum power of rifles to be used for seal hunting is also specified in the regulations.

During the spring period seals are hunted on the ice. Grey seals are usually found near the edge of the ice pack. The seals lie right next to the water, so the shot must be instantly lethal so the seal will not be lost. Hence they are always shot in the head.

During the open water season, hunting usually takes place around islands and skerries frequented by seals. Once seals are spotted, the hunter is landed close enough to get a shot at the seal. If the seal is shot while it is in the water it must be retrieved very quickly or it will sink. Hence hunters usually operate in teams, with a boat ready to go out and retrieve the seal immediately after it is shot. Seals sink quickly in the Baltic because the salinity of the water is very low. Also the water is not very clear, which makes retrieval of sunken seals difficult. Therefore hunters prefer areas of shallow water where sunken seals can be retrieved more easily.

The struck and loss rate was relatively high (42%) in Sweden in 2001, the first year the hunt was resumed. However the situation has improved and the struck and loss rate was only 5% in 2003. The full quotas have not been taken in either country, but seal hunting is becoming more popular.

Discussion

It was noted that pollution has been a problem in the Baltic and that there is some evidence that it has affected the reproductive rates of seals in the past. However the situation has improved in recent years, and seal populations are generally increasing. Hunters utilise the meat but not the blubber of seals.

SUMMARY OF WORKSHOP

Glenn Williams summarised some of the presentations and discussions during the Workshop. He noted that seal and walrus hunting are conducted in widely differing environments and under variable regulatory regimes. The equipment used is often restricted by the regulatory framework but is also adapted to the local conditions. Hunters from different areas have much to learn from one another, and should be open to new ideas, equipment and techniques, and willing to change their hunting methods if better methods are available. Hunters from different areas need to co-operate with one another to preserve their way of life. Hunters should have reason to be proud of what they do, and this requires that they be well educated and use the best available equipment and techniques.

Glenn Williams noted the following themes had been raised in the discussions, and suggested that they should be integrated into the recommendations from the Workshop:

- Hunters should aim for full utilisation of their catch;
- Hunters should acknowledge the importance of conservation and consider themselves as conservationists;

- Hunters do not agree that the results of some studies that show very high struck and loss rates for seal and walrus hunts can be applied to all hunts. Further research on struck and loss rates is required.
- Hunters need to find practical and effective measures to reduce struck and lost rates in some hunts;
- There is a need for more effective hunter training in some areas;
- There is a need for more research on the effectiveness of various rifles and bullet types for killing seals and walrus.

RECOMMENDATIONS

A Drafting Group composed of Glenn Williams, Mark Small, Niels Lange Nielsen, Siri K. Knudsen, Åke Granstrøm, Charles Brower, Daniel Pike and Grete Hovelsrud-Broda developed a set of draft recommendations based on the presentations and the discussions at the Workshop. These draft recommendations were then presented to the workshop participants and discussed one by one, revised if necessary, and adopted by consensus. These recommendations are for implementation by management authorities, hunters and researchers. In each case the hunts to which the recommendation most applies are identified.

Hunter training

The Workshop recognised the continuing importance of hunter training for the improvement of hunter safety, reducing unnecessary suffering to animals, minimising struck and lost, maximising utilisation of the harvest, and equipment selection, manufacture and maintenance. Hunter training should be a priority for all hunts.

1. The Workshop recommended training for inexperienced hunters in particular and that such training should be a continuous process for all hunters in general.
2. The Workshop recommended that information is provided to hunters on new and improved equipment that is presently available.

Struck and Lost Estimates

Workshop presentations and discussions demonstrated a lack of accurate and reliable estimates of struck and lost (S/L) for seal and walrus hunts. The Workshop recognised that reliable estimates of S/L are urgently required to allow better conservation and management and enable us to target hunts where S/L can be reduced. It was also recognised that reducing S/L benefits hunters because of potential higher catches, less unnecessary suffering to animals and better public image. Struck and lost estimates are a priority for open water seal and walrus hunts.

3. The Workshop recommended that studies of S/L should be done in co-operation between researchers and hunters.
4. The Workshop recommended the methods, techniques and equipment to reduce S/L should be developed and applied at the local level to ensure that these are appropriate to local conditions.

Minimise Animal Suffering

5. The Workshop recommended that the hunters should make every effort to reduce unnecessary suffering by hunted animals, through minimising killing times and avoid letting injured animals escape. Such efforts should have priority for all hunts.

Technical Innovation

The Workshop noted a lack of technical innovation in developing new equipment and hunting techniques to improve hunting efficiency and reduce struck and lost.

6. The Workshop recommended that development and research be undertaken in this area. Open water hunting for large seals and walrus were identified as priority areas.

Calibre and Bullets

The Workshop recognised that there is a need to establish minimum requirements for firearms and ammunition for seal and walrus hunts. It was further recognised that specific recommendations on selection of calibre and bullet types for different species and hunts are difficult to make because little information is available. These observations and recommendations apply to all hunts.

7. The Workshop therefore recommended that objective studies on terminal ballistics of various calibre and bullet types in seal and walrus hunting are carried out.
8. It was recommended that these studies be done in co-operation with the hunters.
9. There is a need to consider what types of firearms and ammunition are presently available in remote communities and the Workshop urged the stores to make available the ammunition determined to be appropriate for the various hunts.

Full Utilisation

The Workshop agreed that the fullest possible utilisation benefits hunters because of more returns from the harvest, preservation of traditional skills and a better public image. This applies to all hunts. The Workshop recommended the following:

10. That all hunting should occur within safe conservation limits.
11. That all hunts should work towards the fullest possible utilisation of harvested animals.
12. That new uses and markets for seal and walrus products should be pursued.

Hunter Safety

The Workshop recognised that the safety of the hunters should be a priority in all hunts.

13. The Workshop recommended that the safety of the hunters must be considered in any regulatory measures or technical innovations to equipment and techniques.
14. In particular the Workshop recommended special attention to: hearing loss due to noise and the need for ear protection, bullet ricochet endangering people and property and protective gear for extreme cold and harsh conditions.

WORKSHOP CLOSURE

The Chairman thanked the technical staff and all delegates for making the meeting a success. The Report from the workshop will be sent out to all attendants and presented to the Council of NAMMCO at their next meeting in March 2005. The Report will also be published in the NAMMCO Annual Report for 2004.

Appendix 1

PROGRAMME

TUESDAY 7 SEPTEMBER

0800-	Registration at the North Atlantic House
0900-0930	**OPENING SESSION** Welcome by Jústines Olsen**,** Chair of the NAMMCO Committee on Hunting Methods Introductory remarks by Egil Ole Øen**,** Chair of the Workshop
0930-1100	**SESSION I Physical features, biology and behaviour of seals and walrus** The anatomy and behaviour of significance for the choice of equipment and methods used in the hunt **Presenters:** Seals: Siri K. Knudsen, Norway Walrus: Joel Garlich-Miller, Alaska, USA Discussion
1030-1100	*Coffee break*
1100-1500	**SESSION II Weapons and other hunting equipment: ballistics and effects** **Presenters:**
1100-1130	Egil Ole Øen, Norway
1130-1200	Siri K. Knudsen, Norway
1200-1400	*Lunch*
1400-1430	Pierre-Yves Daoust, Canada Discussion
1445- 1500	Alaska Native Harbour Seal Commission: John Boone, Alaska, USA
1500-1530	*Coffee break*
1530-1800	**VIDEO presentations of hunting activities from different regions**
1800-	*Reception hosted by the Representations of the Faroe Islands and Greenland in Denmark in the North Atlantic House*

WEDNESDAY 8 SEPTEMBER

0900-1800	**SESSION III Descriptions of seal and walrus hunting**
0900-1130	**Walrus hunting** Chukotka, Russian Federation: Vladilen Kavry Alaska, USA: Charles Brower/Charlie Johnson Canada: Glenn Williams
1030-1100	*Coffee break*

1100-1130 Greenland: Leif Fontaine
Discussion

1130-1800 **Seal hunting**
1130-1230 Chukotka, Russian Federation: Vladilen Kavry
Chuktoka, Russian Federation: Rules and Regulations: Edward Zdor
Alaska, USA: Other seals: John K. Boone

1230-1400 *Lunch*

Canada: East Coast seal hunt: Mark Small
Canada: Arctic seal hunts: Glenn Williams
Greenland: Jakob Petersen
Norway: East – and West Ice seal hunt: Bjørne Kvernmo

1530-1600 *Coffee break*

1600-1700 Norway: Coastal seal hunt: Andreas Dunkley
Iceland: Pétur Guðmundsson and Árni Snæbjörnsson
Faroe Islands: Bjarni Mikkelsen
Sweden and Finland: Åke Granstrøm

1700-1800 Discussion and short summary of Workshop Sessions I, II, and III

THURSDAY 9 SEPTEMBER

0900-1030 **SESSION IV Evaluation**
Comparison of methods and efficiency.
Open forum discussion.

1030-1100 *Coffee break*

1100-1230 **SESSION V Recommendations**
Workshop summary and recommendations

Formulations of recommendations on best practice, minimum requirements, enhancements and technical innovations for weapons and ammunition.

1230-1300: **WORKSHOP CONCLUSIONS**
Chair and Co-chair will present their concluding remarks.
The meeting adjourns.

Appendix 2

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REGULATIONS GOVERNING SEAL AND WALRUS HUNTING

The following is a summary of regulations governing the hunting methods used for seals and walrus in several countries. Only regulations concerning hunting methods are included, not regulations concerning licensing, quotas, seasons, areas, etc. Some of the material was translated from Danish, Swedish and Norwegian by NAMMCO Staff and are not official translations.

FAROE ISLANDS

There is only one regulation governing the hunting of seals in the Faroe Islands. It is a part of the Animal Protection Regulations.

Parliamentary law No. 9 of March 9th 1985 on protection of animals, with amendments, latest from May 30th 1990.

§ 3. It is not allowed:

9.2 to shoot seals and other large sea animals with a shotgun.

GREENLAND

Regulations on the protection and hunting of walrus

Hunting methods and disposal of catch

§ 5. The minimum calibre of rifle to be used in hunting walrus is 7.62 mm (30.06), but rifles of calibre 5.64 mm (.222) can be used for killing harpooned or otherwise secured walrus.

Stk. 2. The use of explosives, harpoon cannons, shotguns and rifles (.22 Rimfire rifles) for walrus hunting is forbidden.

Stk. 3. Walrus that are shot and are in the water shall be harpooned before they are killed. The harpoon shall be secured to one or more floats so that hunting loss is avoided.

Seals

There are presently no regulations concerning hunting methods for seals.

ICELAND

There are presently no regulations that apply specifically to hunting methods for seals in Iceland. However, the 15. article of the law No 15/1994: "law on animal protection" (Lög um Dýravernd) deals with the hunting of all animals. :

"*Hunting of animals shall be carried out in a procedure that causes the minimum pain to the animal. Hunters are obliged to do everything in their power to kill animals they have wounded.*

NORWAY

Regulations on seal hunting in the West Ice and East Ice (i.e. harp and hooded seals)

§ 1 Main rule for the hunt

Hunters must show the highest respect and use hunting methods that avoid unnecessary suffering for animals. Injured animals shall be killed as soon as possible.

§ 4 Requirements for weapons and ammunition

Only rifles shooting ammunition with expanding bullets and an impact energy of at least 2,700 joules (275 kilogram-meter) for 9 gram bullets and 2,200 joules (225 kilogram-meter) for 10 gram bullets at a distance of 100 meters shall be used for shooting adult seals.

Only rifles shooting ammunition with expanding bullets and an impact energy of at least 981 joule (100 kilogram-meter) at a distance of 100 meters shall be used for shooting seal pups.

A rifle and ammunition approved for adult seals shall at all times be available at shooting locations on board during seal hunting.

Hunting rifles must be inspected and approved by a gunsmith before sailing and sighted in with the ammunition that will be used during the hunt.

§ 5 Specifications for the hakapik and the club-hook

1. The hakapik shall have a wooden shaft made of birch that is from 110 to 150 cm in length and with a diameter of 3 to 5 cm. The hakapik shall have an iron shoe that weighs at least 400 grams and is furnished with a slightly bent tip from 12 to 18 cm in length. The butt end of the iron shoe can have a hammer that shall not be more than 4 cm long. The iron shoe shall be firmly attached to the shaft. The tip of the hakapik shall be kept sharp at all times.
2. The club hook shall be 50 cm long, ½ inch thick and weigh at least 1,000 grams, of which the welded weight attached to the hook shall weigh at least 250 grams.
3. The design and construction of the hakapik and club shall be in accordance with the Seal Hunt Committee's prescription of 4 November 1970 and the drawing from the same date.

§ 6 Hunting restrictions

1. It is forbidden to hunt:
   a) seal species other than harp and hooded seals
   b) adult hooded seal females and adult harp seals in whelping patches.
   c) seals that are in the water.
2. It is forbidden to shoot seals under conditions such that they cannot be struck with the hakapik or club and bled on the ice. Exceptions to this are during hunting of seal pups when the conditions in § 10 are filled, and during the shooting of individual seals from the ship (*plukkfangst*) when the conditions in § 7 fifth part are filled.

§ 7 Killing procedures.

Killing shall proceed such that the animal does not suffer unnecessarily.

Adult animals shall be shot. Pups shall be shot or struck with the hakapik or club.

Animals that are shot shall be struck with the hakapik as soon as possible. For pups the club can also be used.

When using the hakapik or club the seal shall be struck on the skull. The seal shall first be struck with the tool's butt end or hammer so that the skull is crushed. After that the tool's tip shall be struck deep into the brain. With animals that are shot and lying still, it is sufficient to use the tool's point only.

Seals shall be bled on the ice immediately after the hakapik or club are used. During the shooting of individual seals from the ship (*plukkfangst*), bleeding can take place on board, if the animal is taken on board immediately and the conditions otherwise allow this.

Seals shall be bled by making a cut from the underside of the jaw to the end of the breast bone, then cutting the blood vessels to the foreflippers.

§ 8 Regulations for shooting seals from the ice and from a hunting boat.

Seals shot from the ice or from a hunting boat shall be struck with the hakapik and bled as soon as the ongoing hunt makes it possible.
During such hunting there shall at all times be at least one person assigned to each shooter to club and bleed animals that are shot.

§ 9 Fastening lines to seals

It is forbidden to fasten a line to animals on the ice before the animals have been struck with the hakapik or club and bled. An exception can be made for individual seals that are shot from the sealing vessel and that are obviously dead.

§ 10 Hooking of seals

It is forbidden to take seals that have not been bled on board using a hook.

Pups that are shot can be taken on board using a hook if they are undoubtedly dead and the ice conditions make it inadvisable to walk on the ice.

§ 11 Forbidden hunting methods
It is forbidden to

a) hunt or kill seals with the use of lines, nets or any form of trap
b) use a firearm with an unrifled barrel
c) use the hakapik on adult animals that have not been shot
d) use the club on adult animals
e) strike animals with the hakapik or club anywhere but on the skull
f) kill seals in artificial light.

§ 12 Use of airplanes
It is forbidden to use an airplane or helicopter for seal hunting. An airplane or helicopter can be used from land to scout the hunting areas.

§ 13 Exceptions from the regulations in emergency situations
The hunting regulations do not apply in cases where it is necessary

a) to kill animals that are injured
b) with respect to the safety of the hunters and the hunting vessel.

Regulations for the management of seals on the Norwegian coast

§ 10 Killing methods
Hunters must show the greatest respect and use humane killing methods to avoid unnecessary suffering for the animals.
The following apply to the killing of seals:

1. Only rifles shooting ammunition with expanding bullets and an impact energy of at least 2,700 joules (275 kilogram-meter) for 9 gram bullets and 2,200 joules (225 kilogram-meter) for 10 gram bullets at a distance of 100 meters shall be used for shooting seals.
2. It is forbidden to hunt or kill seals with the use of lines, nets or any form of trap. It is forbidden to use a firearm with an unrifled barrel or to use a hakapik or club-hook to kill seals.

CANADA

In Canada the management of marine mammals is a federal responsibility. Below find excerpts from the Marine Mammal Regulations of the Fisheries Act that concern hunting methods for seals and walrus.

Prohibitions

7. No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these Regulations.
8. No person shall attempt to kill a marine mammal except in a manner that is designed to kill it quickly.
9. No person shall fish for a marine mammal without having on hand the equipment that is necessary to retrieve it.
10. (1) No person who kills or wounds a marine mammal shall
    (*a*) fail to make a reasonable effort to retrieve it without delay; or
    (*b*) subject to section 33.1, abandon or discard it.
    (2) No person who kills a cetacean or walrus shall waste any edible part of it. SOR/2003-103, s. 3.

PART III WALRUS

25. No person shall fish for walrus with a firearm unless the person uses
    (a) a rifle and bullets that are not full metal-jacketed that produce a muzzle energy of not less than 1,500 foot pounds; or
    (b) a shotgun and rifled slugs that produce a muzzle energy of not less than 1,500 foot pounds.

PART IV SEALS
Prohibitions

28. (1) No person shall fish for seals, for personal or commercial use, in any of Sealing Areas 4 to 33 except with
    (a) a round club made of hardwood that measures not less than 60 cm and not more than 1 m in length and that, for at least half of its length, beginning at one end, measures not less than 5 cm and not more than 7.6 cm in diameter;
    (b) an instrument known as a hakapik, consisting of a metal ferrule that weighs at least 340 g with a slightly bent spike not more than 14 cm in length on one side of the ferrule and a blunt projection not more than 1.3 cm in length on the opposite side of the ferrule and that is attached to a wooden handle that measures not less than 105 cm and not more than 153 cm in length and not less than 3 cm and not more than 5.1 cm in diameter;
    (c) a rifle and bullets that are not full metal-jacketed that produce a muzzle velocity of not less than 1,800 feet per second and a muzzle energy of not less than 1,100 foot pounds; or
    (d) a shotgun of not less than 20 gauge and rifled slugs.
    (2) Every person who strikes a seal with a club or hakapik shall strike the seal on the forehead until its skull has been crushed and shall manually check the skull, or administer a blinking reflex test, to confirm that the seal is dead before proceeding to strike another seal.
    (3) If a firearm is used to fish for a seal, the person who shoots that seal or retrieves it shall administer a blinking reflex test as soon as possible after it is shot to confirm that it is dead.
    (4) Every person who administers a blinking reflex test on a seal that elicits a blink shall immediately strike the seal with a club or hakapik on the forehead until its skull has been crushed, and the blinking reflex test confirms that the seal is dead. SOR/2003-103, s. 6.
29. No person shall start to skin or bleed a seal until a blinking reflex test has been administered, and it confirms that the seal is dead. SOR/2003-103, s. 7.

SWEDEN

Shooting places
The main rule is that the hunting must be done from shore. When the weather is calm (windspeed <3m/s or <6 knots), and there are no waves, the hunting may be done from the ice or from a boat that is anchored (fast angjord) in the ice.

Hunting from a shooting tower or other similar construction is permitted as long as the construction is permanently placed or built on the seafloor or a similar construction with a size and anchored in such a way such that the hunting takes place as if it was on shore.

These rules applied for the 2003 season and may be changed. You may find the relevant laws and regulations on the WebPages of the “Naturvårdsverkets, Länsstyrelsens or Jägareförbundet”.

Notification and samples
When a seal has been shot this must be reported to “Kustbevakningen” before 21:00 at the latest on the same day that the hunt took place.

For the hunter to keep the seal it is necessary to take and send in samples from different parts of the seal’s body.

“Naturvårdsverket” decides which samples are necessary on an annual basis.

Hunting equipment
In the seal hunt you are only allowed to use a rifle (Class 1 Swedish). This requires ammunition with bullet weight of at least 9 grams and impact energy at a distance of 100 meters from the target with at least 2700 joules (J). The Ammunition must be loaded with a bullet that expands when hitting the seal (leaded bullet, plastic or full metal jacket).

FINLAND

Hunting methods
The impact energy of the bullet from a rifled barrel used to hunt seals must from a distance of 100 meter from the target be at least 800 joules and the bullet must have a weight of at least 3.2 grams. A

full metal jacket bullet is not allowed JF16§. A shotgun loaded with shotgun shells is not allowed. JF18§. Traps that capture living animals may be used in the seal hunt JF 11§.

All permanently settled persons in Finland have the right to hunt within the common (allment) water-areas of the sea JF7§. The police, border patrols, costumes and the inspectors from the different hunting associations (jaktvårdsföreningarnas jaktövervakare) shall within their respective areas of responsibility ensure that the law of the hunt is being respected JF88§.

A grey seal or a "vikare" caught dead in fishing equipment in the sea belongs to the owner of the fishing equipment JF83§.

Samples
Samples from hunted seals must be sent to the "game and fisheries research" (vilt och fiskeriforskningen).

ALASKA

While their are no explicit regulations under the Marine Mammal Protection Act (MMPA) regarding methods and means for the subsistence hunting of marine mammals, the law does prohibit taking marine mammals in a "wasteful manner." *Wasteful manner* is defined in the Code of Federal Regulations as: "Any taking or method of taking which is likely to result in the killing or injuring of marine mammals beyond those needed for subsistence purposes or for the making of authentic native articles of handicrafts and clothing or which results in the waste of a substantial portion of the marine mammal and includes without limitation the employment of a method of taking which is not likely to assure the capture or killing of a marine mammal, or which is not immediately followed by a reasonable effort to retrieve the marine mammal."

This definition provides restrictions on subsistence hunters with respect to minimum salvage requirements as well as hunting methods. Hunters can/have been cited for violations of the MMPA when they do not meet minimum salvage requirements (for example salvaging just the heads or tusks), or when they fail to make a reasonable effort to retrieve animals (for example shooting into a group of walrus in the water). Because of the lack of explicit guidelines regarding what constitutes a "wasteful take", potential violations must be investigated on a case by case basis.

The MMPA is due for re-authorisation. Under the current law, the subsistence harvest of marine mammals can only be regulated when a population becomes depleted. Over the past few years, the U.S. Fish and Wildlife Service and other government agencies have been working with the Alaska Native community to develop proposed changes to the MMPA that would allow for the regulation of subsistence harvest of marine mammals prior to depletion. Under the proposal, Native organisations could initiate and develop their own harvest management regimes. Upon adoption by the managing Federal agency, assistance in implementing and enforcing management provisions would become available. The proposal provides new responsibilities and a meaningful role for the Native community in resource management.

RUSSIAN FEDERATION

Legislation of the Russian Federation on marine mammal harvest, submitted by the Association of Traditional Marine Mammal Hunters of Chukotka (ATMMHC)

Structure of the Russian legislation

I Federal legislation

1. Constitution – the basic law
2. Federal acts
3. Presidential decrees and governmental resolutions
4. Resolutions and instructions of the ministries and agencies
5. GOSTs (national standards) and regulations

II Regional legislation

1. The Okrug law

2. Resolutions and orders of the Government of the Chukotsky Autonomous Okrug

The Constitution on marine mammal harvest
Article 72 1) Protection of the traditional living habitat and of the traditional way of life of the small ethnic communities

The Wildlife Federal Act
Chapter I. General provisions (pp.1-10)
Chapter II. Governmental management in the sphere of protection and use of the wildlife species (pp.11-17)
Chapter III. Protection of the wildlife species and their habitat (pp.18-29)
Chapter IV. Right and social protection of the officials authorized to prosecute protection of the wildlife species and their habitat (pp. 30-32)
Chapter V. Wildlife Use (pp.33-47)
Chapter VI. The traditional methods of protection and use of the wildlife species (pp. 48-49)
Chapter VII. The economic regulation of protection and use of the wildlife species (pp.50-54)
Chapter VIII. Responsibility for violation of the legislation of the Russian Federation on protection and use of the wildlife (pp.55-59)
Chapter IX. International conventions (p. 60)
Chapter X. Promulgation of the present Federal Act (p. 61)

Decrees and resolutions of the RF Government

Decree # 1644-r of November 12, 2003, Moscow

To approve the enclosed Total Allowed Catches of the Aquatic Biological Resources for the year 2004 in the internal fresh waters, the internal marine waters, in the national waters, on the continental shelf and in the exclusive economic zone of the Russian Federation, in the Azov and the Caspian Seas and in the lower reaches of the rivers flowing into the seas as well as in the Amur River.

M.Kasianov. Prime Minister of the Russian Federation

Comment: The Total Allowed Catch Limits on white whales, killer whales, bottle-nosed dolphins, pilot whales, walruses, Caspian and bearded seals (in the Barents, the Kara and the White Seas) are designated for the subsistent needs of the small indigenous peoples of the North, Siberia and Far East of the Russian Federation, for scientific, cultural and educative purposes.

The normative acts of the Federal Government, ministries etc.

- Resolution of the Council of Ministers of the Russian Federation # 728 of July 26, 1993 “Amateur and Sport Hunting in the Russian Federation”
- Resolution of the Government of the Russian Federation # 1574 of December 27, 1996 “The Procedure of Issuance of the Long-Term Licenses for the Use of the Wildlife Species”
- Order of the Russian Federation Ministry of Natural Resources # 134 of July 14, 1993 “Protection and Regulation of the Wildlife Resources Use”
- Order of the Russian Federation Ministry of Agriculture # 569 of June 26, 2000 “Approval of the
- Provisions on the Order of Issuance of the Long-Term Licenses” (with alterations of March 29, 2001)

GOSTs (national standards) and regulations

- GOST 17.1.2.04-77 Environmental protection. Hydrosphere. Environmental indicators and the regulations on evaluation of the fishery water bodies
- The regulations on harvest of the marine plants and the water invertebrates in the USSR basins. Approved by the order of the USSR Ministry of Fisheries # 17 of January 17, 1966 (with alterations and addenda)

- The regulations on fishing in the internal basins of the Far East. Approved by the order of the USSR Ministry of Fisheries # 524 of November 24, 1980 (with alterations and addenda)
- Standard regulations of the amateur and the sport fishing. Approved by the order of the USSR Ministry of Fisheries # 187 of April 13, 1983 (with alterations and addenda)
- The regulations on fishery, protection and use of the living resources of the economic zone of the USSR in the Black Sea for the Soviet fishing organizations and the fishing vessels. Approved by the order of the USSR Ministry of Fisheries # 321 of June 18, 1986 (with alterations and addenda)
- The regulations on fishery, protection and use of the living resources of the economic zone of the USSR in the Baltic Sea for the Soviet fishing organizations and the fishing vessels. Approved by the order of the USSR Ministry of Fisheries # 322 of June 18, 1986 (with alterations and addenda)
- The regulations on protection and harvest of marine mammals. Approved by the order of the USSR Ministry of Fisheries # 349 of June 30, 1986 (with alterations and addenda)
- The regulations on fishery, protection and use of the living resources of the economic zone of the USSR in the Barents Sea for the Soviet fishing organizations and the fishing vessels. Approved by the order of the USSR Ministry of Fisheries # 356 of July 1, 1986 (with alterations and addenda)
- The regulations on fishery in the economic zone, the national waters and on the continental shelf of the USSR in the Pacific and the Arctic Oceans for the Soviet fishing vessels, organizations and citizens. Approved by the order of the USSR Ministry of Fisheries # 458 of November 17, 1989 (with alterations and addenda)
- The basin (regional) regulations on fishery in the fishery waters

The regulations on protection and harvest of marine mammals is the basic specialized document regulating the harvest. The structure of the document:

a) The area covered by the regulations
b) General provisions
c) Protection, regulation and control over the stock condition
d) Responsibilities of the catchers
e) Limitations
f) The fishing areas
g) The Far East Catch Basin
h) The Northern Catch Basin
i) The Caspian Catch Basin
j) The Baikal Catch Basin
k) Responsibility for the violation of the regulations

The regional legislation as a basic assistance to the aboriginal marine mammal harvest

a) The Chukotsky Autonomous Okrug Act on the Government Regulation of the Marine Mammal Harvest in the Chukotsky Autonomous Okrug
b) The Program of Stabilization and Development of the Agroindustrial Sector of the Chukotsky Autonomous Okrug for the years 2003-2005

Scientific presentations on physical features, biology and behaviour of seals and walrus, and weapons and other hunting equipment: ballistics and effects

1. Seals: Dr Siri K. Knudsen
2. Walrus: Joel Garlich-Miller
3. Ballistics: Dr Egil Ole Øen
4. Terminal ballistics: Dr Siri K. Knudsen
5. Animal welfare and the Canadien Harp Seal Hunt: Dr Pierre-Yves Daoust

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Biology, behaviour and physiology of significance for methods and equipment used in seal hunt

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Section of Arctic Veterinary Medicine

World-wide there are 33 different species of seals. Seals in the broad sense are often referred to as “pinnipeds” which consists of three sub-families: (1) the Family *Odobenidae* that only contains the walrus; (2) the Family *Otariidae*, which consists of the seal lions and the fur seals. The 14 species in this family all have ears with a visible external ear flap and the otariids are therefore often referred to as “eared seals”; (3) the Family *Phocida* contains 18 species. These are often referred to as true seals or “earless seals” because the outer opening of the ear possesses no flap visible on the surface.

In the following a more detailed description of the anatomy of important organs and organ systems in pinnipeds will be given as well as an overview of some specific behavioural features of seals that are of particular relevance for the hunt.

Anatomically, pinnipeds are built like any other mammal: their skeletal is compromised of the same bone parts and the internal organs are the same and have the same relative position in the body.

Skeletal and muscular system. Locomotion.

All pinnipeds have much shorter limbs compared to terrestrial mammals of the same size. Phocids and otariids swim differently, which is reflected by some anatomical differences. The otariids use their fore flippers when swimming, very much in the same manner as a penguin. Consequently, otariids have their main muscle mass around their shoulders and the neck is very massive. The hind flippers of otariids usually play no part in sustained swimming and simply trail behind. The phocids move quite differently. They swim with their hind flippers, looking more or less like a fish, with the fore flippers held quite passively against their body sides. Therefore, phocids have a less defined neck than otariids.

The aquatic adaptations of the limbs of pinnipeds have leaded to that they have limited mobility on land. Otariids are, however, more agile when ashore and can walk by moving their fore flippers alternately. The phocids, on the contrary, crawl on their bellies when their on land, heaving themselves forward in a “humping” way. However, the phocids can travel much more economically on ice. This is important to take into consideration when seals that are lying near the ice edge are shot: If the animal is wounded, and not dead, it can move quite quickly into the sea.

Seals, as other diving mammals, have increased storage capacity of oxygen in their musculature, which leads to that muscular movement can persist long after the animal is dead. It may be observed as general muscular tremors in the flesh during skinning and slaughter. However, the movements can also be very violently and give the impression that the animal is still alive. In fact, movements gimmicking voluntary movements, including withdrawal of the head, back arching and gaping, may be observed in seal for a long time after their brains have been destroyed. This phenomenon, which is called reflex activity, is closely related to the central nervous system, and will be dealt with in some more detail under the nervous system.

The skeletal of all seals consists of the skull, the spinal vertebra, four limbs and the ribs. They have the standard mammalian seven cervical vertebras and 13 ribs, and all seals have the full complement of five fingers or toes in each limb.

The vertebral column, which main tasks are to protect the spinal cord and assist locomotion, also reflects the different way of swimming between species. Otariids, that use the front end of their body, have strong and well-developed bone processes on the cervical and thoracical parts of the vertebrae. Phocids, which use their back part, have strong transverse bone process in the lumbar region of the vertebrae.

The skull of pinnipeds is characterised by a short snout and large orbits (the hole in the skull where the eyes are placed). During hunting, seals are usually either shot or culled in the head, with the brain being the main target. Consequently, for hunters this area is the most important. As in all other animals, the location of the brain in the skull is behind the eyes. The brain is enclosed and protected by the parts of the skull bones that are called *the cranium*, which in pinnipeds is large and rounded. The thickness of the cranium varies in different part of the skull and this may inflict on both bullet ballistic and the effect of for instance the hakapik. It is generally thickest over the frontal and basal parts of the brain, where it may be several centimetres thick. It becomes thinner at the upper hind part and on the lateral sides. The thickness also varies to some extent among different species, but most importantly it varies between animal of different size. Generally large adults, especially males, have the thickest skull and deep-diving seals tend to have somewhat thicker skull bones than shallow-diving ones. The skull of young pups has a softer structure and is more fragile than in adults.

Body wall

The integument of seals is compromised of the skin and blubber. The skin bears the hear follicles and is well supplied with blood vessels. The skin can be of considerable thickness, especially in adult males. Moulting, which is annual in adult seals, have significant influence on the animals behaviour. During this process, the blood supply to the skin has to be greatly increased and this inevitably means that heat losses are increased as well. Consequently, the animals spend more time out of the water at the moult.

The fur of seals plays little role in insulation. This is provided by the blubber. Its thickness depends on the age, size and nutritional status of the seal. Seals commonly may have in excess of 7-10cm of blubber of their bodies when well fed. It is not continuous over the whole body surface as it is lacking over the head and flippers. Consequently, blubber thickness is of lesser significance than skull bone thickness, when it comes to shooting or clubbing of seals. However, during the hunt the blubber thickness has significance with respect to how the animal will behave after it is dead. Well-fed animals will usually float when they are dead, while thinner animals most often will sink, in many cases within the course of a few seconds.

The nervous system

The nerve system of pinnipeds is built and functions in the same manner as in other mammalians and it consists of a central part, which is the brain and spinal cord, and a periphery part which are the nerves and nerve cells in the rest of the body. In seals, like in other animals, the nervous system is in principle built like a telecommunication network. The brain is the central; the spinal cord is the main cable; the nerves out to the body acts like the distributing cables, and the periphery nerve cells acts like the telephone with incoming and outgoing information.

The spinal cord is enclosed by the spinal vertebra. The spinal cord of phocids is relatively shorter than that of otariids. The brain, which is enclosed in the cranium, is gross anatomically built similar as in other mammalians. It has two large hemispheres (termed cerebrum), a cerebellum and the brain stem. The brain can be regarded as the true centre of the body responsible for survival, consciousness and the maintenance of physiological conditions. By consciousness we mean awareness of the world around and of the own body. Thus, someone who is unconscious will not perceive pain. Generally it can be said that during seal hunting the same applies as for other mammals: in order to render the animal instantaneously unconscious some specific brain areas have to be put out of function, which includes the cerebral cortex, deep central parts of the cerebrum and/or the brain stem, which contain the centres for consciousness and control units for respiration and heart activity.

It is the brain and spinal cord that are responsible for the reflexes and involuntary reactions in dead animals which I described earlier. Such movements are very common to register when animals are killed or slaughter using physical methods. A reflex can be defined as a stereotyped response mediated by the nervous system. Most of such reflexes do not require cerebral co-ordination and thus it can be elicited in the insensible animal. The basis for this process is very complex and it would take too long to go into detail. Roughly it can be said, though, that reflex activity in an unconscious animal is a result of that the spinal cord looses its chief commander, namely the brain. The brain acts both inhibitory and facilitating on the spinal cord. When the higher control centres have been put out of function, the spinal cord starts to “work on its one” resulting in uncontrolled movements of for instance the limbs.

The circulatory system

The major tasks of the heart and blood vessels are to transport oxygen rich blood from the lungs to all organs and tissues in the body - a job carried out by the arteries - and to remove carbon dioxide from these tissues and transport it through the veins to the lungs where it is breathed out. It is the heart, which really is only a muscle that is the motor in this system. It pumps blood through arterial blood vessels to the periphery parts of the body. The blood is then returned to the right side of the heart via the veins and pumped by the right side of the heart into the lungs. The arterial part is a high-pressure system, while the venous system is a low-pressure system. The term “blood pressure” applies to the arterial blood pressure. It fluctuates with each heart beet (or pulse) between a maximum value when the heart contracts and a minimum value when the heart relaxes. Optimal regulation of the blood pressure is essential. Too low blood pressure results in shock and eventually death. Shock is a state of acute inadequacy of the blood supply to the vital organs, i.e. the brain and heart. During hunting irreversible shock may occur if the heart or major blood vessels are injured or massive bleeding occurs for instance in the lungs. After severe injury the blood pressure will drop almost immediately and the animal will be unconscious, not immediately, but very rapidly. This may, however, be time enough for an animal that for instance is lying near the ice edge to haul itself into the water and sink.

Physiologically, it is the circulatory system of seals that are most different compared to terrestrial animals. These adaptations are of course related to diving. One of the diving champions among pinnipeds, the Antarctic Weddell seal, can stay submerged for more than one hour and reach debts beyond 600m. The basic problem facing air-breathing animals during submersion is the ever-decreasing arterial oxygen tension and an ever-increasing arterial carbon dioxide tension. The solution in pinnipeds to overcome this is to bring in as much oxygen as they can before diving, economise with from the very moment of submersion. Seals have impressive oxygen stores. In addition to the earlier mentioned adaptation of the musculature, also the oxygen carrying capacity of the blood is increased and they also have larger blood volume than their non-diving equivalents. However, the true prerequisite for prolonged submersion is another circulatory adjustment. During dives the heart beats considerably slower and the oxygen rich blood is portioned out to only a few high-priority tissues, i.e. the heart and brain, at the expense of others that are closed off to subsist on local oxygen stores.

The heart of pinnipeds is of normal mammalian construction, though it tends to be broader and flatter than the hearts of terrestrial mammals. It consists of four separate chambers (left/right fore-chamber and left/right ventricles). The left side is responsible of pumping oxygen rich blood out to the body and is therefore larger than the right side of the heart. Like in other mammals the heart is placed behind and below the shoulder blade, and takes up much of the space in the lower part of the thoracical cavity from about the third to the 5-6th rib. Also the heart musculature has higher oxygen storage capacity than in terrestrial mammals. This is important to be aware of for hunters, as the heart can carry on beating a long time after the animal is in fact dead. In the early 1970s experiments were carried out on seals in which the brain was first destroyed by a blow hook and the animals were thereafter bled. Heart activity was recorded for up to 45 minutes after. For comparison, the same procedure was applied on a domestic calf, in which heart activity was only recorded for 10 minutes after the animal was bled.

As most organs in marine mammals are similar to those of terrestrial mammals, their central blood supplies are also similar. The arterial system of pinnipeds is very much as in dogs. The aorta is the parent of all other arteries in the body except for the pulmonary ones. Just as the aorta leaves the heart it sends of branches that supplies the heart itself with blood, the *coronary arteries*. Soon after it makes a U-turn, the so-called *aortic arch*, where one branch travels forward against the head and one travel backward in the thoracical cavity. Most pinnipeds have a distinct dilatation or enlargement of the aortic arch compared to terrestrial animals. The large branch that runs from the arch and up along the neck is paired into two branches. These run on both side of the trachea and higher up they are divided into several arteries that supply the head and brain with blood. In the aortic arch, a large branch is also given off that supply the forelimbs as well as the cervical vertebra with blood. It is these arteries to the forelimbs that are cut when seals are bled by making incisions in their armpit. It is important also to notice that the cervical vertebral arteries supply the spinal cord and also the brain with blood.

The part of aorta that travels backwards from the aortic arch travels in the roof of the thoracical cavity along the vertebral column. It continues into the abdomen, where it gives off several paired and unpaired branches that supply the abdominal organs with oxygen rich blood. The caudal part of the aorta splits into arteries that supply the hind-flippers with blood.

Most of the anatomical modifications of the circulatory system that have taken place in pinnipeds as part of the aquatic adaptation are found in the venous part of the circulation. These are present to ensure that the brain function normally during dives, and they are more developed in phocids. Compared to a dog, they have an extra vein that lies along the frontal part of the spinal cord which ensures that oxygen poor blood is transported away from the brain. Otherwise the venous system is quite similar to dogs. Veins from the head and forelimbs join into a large vessel, called the *vena cava cranialis*. The venous blood from the back part of the spinal cord travels to the heart via a separate vein. The veins from the rest of the body join into the large *vena cava caudalis*. All these veins enter the right part of the heart, which then pumps this blood to the lungs through the pulmonary arteries. In the lungs the carbon dioxide is diluted out from the blood and breathed out and oxygen is breathed in.

The oxygen rich blood is then transported to the left part of the heart which pumps it into the aorta.

The respiratory system

The respiratory system of seals is similar to other mammalian, all though the lungs tend to by relatively larger as in terrestrial mammals. The nostrils are closed when relaxed and the trachea divides into smaller branches, the bronchi, around the level of the first rib in otariids and much lower - immediately outside the lung - in phocids. The airways in pinnipeds, like in other diving animals, are reinforced to withstand the pressure when diving. The lungs fill up a major part of the thoracical cavity dorsally and laterally to the heart. The lungs receive and send off large blood vessels to the heart and the lung tissue contains many blood vessels. Therefore, lung injuries tend to be rapidly, all though not instantaneously, fatal in seals shot with high velocity projectiles in this area.

Contrary to what one might think, the lungs are not a major oxygen reserve during dives. The pinnipeds, an especially the expert divers, expire before submersion to avoid diver’s disease (gas bubbles in the blood vessels). The deep divers therefore seldom utilise the lungs as a source of oxygen.

Abdominal organs

The thorax and abdomen are separated by the diaphragm, a thin muscular wall that is essential for respiration. It is traversed by the aorta, the vena cava caudalis and the oesophagus. Easy-to-find landmarks caudal to the diaphragm include a massive liver and the various component of the gastrointestinal tract. Marine mammal livers are generally not too different from those of other mammals. It has a rich blood supply and is located immediately caudal to the diaphragm. The kidney typically lies against the musculature of the back.

Finally, I will give you a short overview on the seals species that are most topical for this workshop with special emphasis on important anatomical and behavioural differences. A hunter has to be able to differentiate between different species of seals. In many countries there are restrictions and regulations as to which species that are allowed to be hunted. Several countries also have defined hunting seasons or areas for different species. Additionally, various seal species behave differently and there are also some anatomical variations, especially with respect to size, that are important to take into considerations when choosing hunting method and equipment. I would like to emphasise the importance of teaching species knowledge to new and inexperienced hunters that are about to start to hunt for seals, either from experienced hunters to youngsters or as part of official training programs that are offered for new seal hunters in some countries.

Some facts about topical seal species. *(Most of this section is quoted from Bonner, 1994)*

- Bearded seal. Large seals. The two genders almost the same size: ♂/♀: 2,5m, 300kg. Adults are greyish-brown, usually darker on the back. They spend the winter mostly in heavy offshore ice. Breeding takes place on the pack ice. Outside the breeding season the bearded seals are normally solitary.
- Hooded seal. Large seals, the male noticeable larger than females: ♂: 2,5m, 400kg; ♀: 2m, 300kg. Adult hooded seals are pelagic, deep-diving predators. In the spring the hooded seal gather in loose aggregations on old, heavy ice floes to breed. The pups are born from mid-March to early April. Adults are silvery grey with black spots especially on the back and flanks. The adult male has a characteristic inflatable appendage on the nose, the hood, which is formed from an enlargement of the nasal cavity. When inflated (especially when the animal is excited near another male) the nostrils are closed and the hood forms a vast sac about twice the size of a football. Besides the hood, males can extrude an extraordinary membranous balloon from one nostril (usually the left). When the balloon is inflated, the seal can make a loud

"pinging" noise by shaking it violently from side to side. This aggressive play is performed by the bulls to establish dominance and impress the females.

- Grey seal. Relatively large seal. ♂: 2m, 300-400kg, ♀: 1,8m, 200kg. Besides the difference in size between the two genders, there are differences in shape too. The shoulders of the adult bulls are very massive and the skin in this region and over the chest is thrown into heavily scarred folds and wrinkles. The female has the usual streamlined profile. The snout of the adult male is elongated with a convex outline giving it an appearance like a horse head. The body colour of the adults may vary from entirely black to almost creamy-white. Pups are born in a silky white fur which is moulted by the end of the lactation period, which lasts about 15-20 days. Pupping sites are usually on isolated skerries or uninhabited islands. In Canada, and also in the Baltic, spring-breeding seals may give birth on sea ice as well.
- Harbour seals. Medium sized. ♂: 1,5m, 100kg; ♀:1,2m, 70kg. The colour pattern of is very variable, but usually they are darker on the back and lighter below, with a mottle of dark spots on the silvery or creamy-grey belly and flanks. On the back the dark spots coalesce to produce a dark reticulation. Pups are usually born in the adult-pattern coat, but occasionally they can have a natal white coat (but this is usually shed in the uterus before birth). Harbour seals give birth on rocks or sandbanks.
- Spotted seal. Relatively small seal. ♂: 1,7m, 100kg; ♀: 1,5m, 80kg. A seal of the pack-ice. The coat has a background of silvery grey, which weathers to a brownish-yellow, peppered wit black spots which may coalesce on the back to produce a black mantle. The pups are born in a greyish-white natal coat which is moulted to reveal the adult pelage. Pups are born on the ice floes in late March and April. Spotted seal usually remain over the continental shelf and they are not deep divers, feeding in relatively shallow waters. During summer and autumn, the seals move to the coast and concentrate near rivers where salmon are assembling before spawning.
- Harp seal (Medium sized. ♂/♀: 1,7m, 130kg). The harp seals have a very distinct body colour pattern. The adult males are light silvery grey over most of their bodies, but there is a black mask to the face and a black patch over the shoulders, which extends down and backwards over the flanks (harp-shaped or horse-shoe like). In the female, the dark markings are paler and tend to be more broken up. Juveniles are grey with black spots and mottlings. Pups are born in a dense white natal coat. Although there are some variations in timing, the Harp seals generally move southwards before the freezing pack ice. After winter feeding, the females assemble on the ice in the traditional whelping areas. The whelping time varies between mid-February to April. After weaning and mating, the adult seals assemble on ice to the north of the whelping patches to moult. After moulting, the seals follow the melting ice edge northwards to their summer feeding grounds. The pups follow the adults after they are finished moulting. By September, the seals begin a new cycle and move southwards again.
- Ribbon seal. Medium sized seal. ♂/♀: 1,6m, 95kg. The adult male is a dark chocolate brown with broad white bands around the neck, the hindquarters and the insertion of each fore flipper. As in the Harp seal the females are paler and the markings are less distinct. Pups are born on relatively heavy ice floes from April to early May in a white natal coat and after moulting they become blue-grey on their backs and silvery beneath.
- Ringed seal. Small seal. ♂: 1,5m, 80kg; ♀: 1,3m, 60kg. The coat has a light grey background spotted with black. The spots are often surrounded with lighter ring markings. The belly may be free of spots. Most Ringed seal pups are born in a silky white natal coat. The Ringed seal is an ice-breeding seal and most pregnant females make a snow lair in the fast ice. Having excavated a lair, an access hole is kept open through the ice to the water beneath. The pups are usually born in early April.
- Northern fur seal. Males are much larger, as in most other otariids. ♂: 2m from nose to tail, 250 kg; females: 1,2m and 40 kg. Brown in colour. Often called "the bear-like animal". Breed on land.

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Walrus Biology and Behavior

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Species Description and Distribution

Although there were once many walrus-like creatures that roamed our prehistoric oceans, today the walrus family *Odobenidae* is represented by a single modern species *Odobenus rosmarus*. Two sub-species of walrus are generally recognized: the Atlantic walrus (*O. r. rosmarus*) and the Pacific walrus (*O. r. divergens*). These two sub-species occur in geographically isolated populations and have evolved into slightly different forms. Pacific walrus are somewhat larger in body size and skull dimensions than Atlantic walrus and have proportionally larger tusks.

Walruses have a discontinuous, although nearly circumpolar distribution around the perimeter of the Arctic Ocean and the contiguous sub-arctic seas. Their distribution appears to be constrained by water depth and by severe ice conditions. Although they are capable of diving to deeper depths, walruses for the most part are found in waters of 100 meters or less, probably because of the higher productivity of their benthic foods in shallower waters.

Atlantic walrus ranges from the central Canadian Arctic, eastward to the Kara Sea. Several more or less discrete stocks of Atlantic walruses are recognised in Canada, Greenland, Norway and Russia. The Pacific subspecies is represented by a single stock of animals that inhabits the continental shelf waters of the Bering and Chukchi seas.

Habitat

Walruses generally haul out on ice in preference to land. Floating pack ice serves as a substrate for resting and giving birth. Walruses generally require ice thickness of 60 cm or more to support their body weight. Although walruses can break through ice up to 20 cm thick, they usually occupy areas with natural openings such as leads and polynas and are not found in areas of extensive, unbroken ice. Thus, their concentrations in winter are in areas of divergent ice flow or along the margins of persistent polynas.

When suitable pack ice is not available, walruses will haul out on land. Isolated sites such as islands, points and headlands are most frequently occupied. Walruses tend to choose traditional haulout locations and exhibit some degree of fidelity to these sites. Isolation and protection from strong winds and surf seem to be common features of traditional haulout locations. Social factors, learned behaviour, and proximity to their prey base probably also influence the location of preferred haulout sites.

Growth and Body Size

Walrus are large, sexually dimorphic pinnipeds. Adult males are approximately 20 % longer and 50% heavier than females. Males also tend to have more massive skulls and tusks.
At birth, calves of both sexes weigh approximately 50-60 kg. Walrus calves are capable of entering the water shortly after birth, but tend to haulout frequently, until their swimming ability and blubber layer are well developed.

After the first few years of life, the growth rate of female walruses declines rapidly, and they reach a maximum body size by approximately 10 years of age. Adult females can reach lengths of up to 3 meters and weigh up to 1,100 kg. Male walrus tend to grow faster and for a longer period of time than females. They usually do not reach a full adult body size until they are 15-16 years of age. Adult males can reach lengths of 3.5 meters and can weigh more than 2,000 kg.

Reproduction

Walruses are long-lived animals with very low rates of reproduction. Although some females reach sexual maturity at 4-5 years of age, they usually do not reach their full reproductive potential until they are nine or ten years old. Male walruses tend to become fertile at 5-7 years of age; however it is unlikely that they are able to successfully compete for mates until they reach full physical maturity.

The walrus has the lowest reproductive rate of any seal species. Pregnancy lasts through the next breeding season, lowering the minimum interval between successful births to 2 years. In compensation for their low reproductive rate, walrus enjoy relatively low rates of natural mortality. Walrus calves accompany their mother from birth and are usually not weaned for 2 years or more. The prolonged period of care allows walrus calves to achieve an advanced developmental state prior to weaning, which ultimately leaves them well equipped to forage and escape predators.

Food

Walruses are highly specialised benthic feeders. Bivalve mollusks (clams) are their most common food, however other invertebrates such sea cucumbers, crabs, and segmented worms are also frequently found in their stomachs. Although captive walrus appear to do quite well on a diet of oily fish, in the wild, walruses rarely eat fish. Native hunters frequently report incidences of walruses preying on seals and seabirds. The significance of seals and birds in the diet of walruses is poorly understood, but may vary with location and population status.

Anatomical Characteristics

Walrus have evolved many specialised adaptations for exploiting benthic foods in an ice covered habitat.

The shape and size of the skull is quite different from other seals. The skull is large and blocky, nearly rectangular in shape. The front of the skull is greatly enlarged to accommodate the massive tusks. Males, which have relatively larger tusks than females also tend to have much broader skulls. The walrus skull has a large mastoid process for the attachment of powerful neck muscles necessary for hauling a massive body out of the water. There are no super-orbital processes which leave the dorsally situated eyes vulnerable to injury – hunters frequently report walrus with missing or damaged eyes. The lower jaw is also massive. It houses a large and powerful tongue capable of generating enormous suction. The size and weight of the skull and tusks are undoubtedly helpful in maintaining an inverted position while foraging on the ocean bottom. Their mass also contributes to a general lack of buoyancy; most walrus killed in the water sink to the bottom. In comparison with the well-armoured features of its face and jaw, the walls of the cranium are relatively thin. The cranium is the usual target of hunters seeking to kill a walrus instantly.

Walrus skin is extremely thick and tough. Many hunting communities in Alaska and Chukotka still use walrus skin to cover their wood framed boats. Skin thickness increases with age, reaching up to 3 cm in adults. On the neck and shoulders of adult males, the skin is much thicker and is frequently raised up into bosses up to 8 cm.

Walruses have a dense vascularized layer of blubber directly below the skin. Blubber serves as an efficient insulation layer in the cold marine environment, and plays an important role in energy storage. Blubber is a dynamic tissue and its thickness can vary greatly depending upon the nutritional state and life history stage of the animal. Hunters report that males tend to be fattest during the early winter months prior to the breeding season, while females tend to maximise their blubber reserves while pregnant as they approach full term.

Walrus have many of the typical circulatory adaptations characteristic of diving mammals. They have an enormous blood volume; up to 2-3 times larger than a terrestrial animal of comparable size. The walrus heart is large, broad and flat. The heart of an adult male walrus can weigh more than 4 kg. The ascending aorta is greatly enlarged forming an elastic aortic-bulb that helps maintain blood flow between heartbeats while diving. There is a large extra-dural vein within the vertebral canal above the spinal cord which receives blood from the brain, back and pelvis. Walruses also have a large venous sinus in the liver that can hold up to 1/5th the total blood volume during a dive.

Sensory Systems

Walrus sensory systems are adapted for foraging on the ocean floor.

In comparison with other seals, the visual acuity of walruses is not particularly well developed. Their eyes are located towards the top of the head, at a dorso-lateral angle, resulting in poor peripheral vision. Because of their broad skull and snout, walruses also have a blind spot directly in front of their face. Their vision appears to be better suited to benthic foraging: they lack a dorsal arch over their orbital cavity, allowing them to look upward and forward as they forage along the ocean bottom. Their retinal anatomy suggests colour vision, and aboriginal hunters report that walruses are often wary of bold bright colours.

Walrus frequently feed at night and in turbid murky water, suggesting that the tactile sensitivity of their whiskers may be more important than vision in locating food items. Walruses have approximately 450 whiskers served by well-developed sensory and motor nerves. While most seals use their whiskers to detect vibrations in the water, walrus whiskers are more adapted to locate and manipulate prey items in front of their face. Research on captive animals has shown that walruses are capable of distinguishing between different shaped items less than .5 cm in size. The long lateral whiskers are apparently used to locate prey items while the shorter ones in the middle of the snout are used to assess finer details.

Walruses appear to have a fairly well developed sense of smell. They are often observed sniffing each other, suggesting that scent may be important in identifying individuals. Hunters also report that walrus frequently react to the smell of fire or exhaust.

Walrus lack external ear flaps, and have a limited capacity to locate sources of airborne sounds. When diving, walrus close their auditory canals and sound is conducted via the vascular lining of the ear tube. The upper frequency of limit for underwater hearing is approximately 16 kHz.

Behavioural Characteristics

During migrations, walrus can travel several hundred kilometres in a matter of days. When travelling, walrus usually make a series of shallow short dives, usually 1-2 minutes in duration.

Telemetry studies have shown that while foraging, walrus dive to the bottom nearly continuously. Foraging bouts can last for several days. Most foraging dives to the bottom last between 5-10 minutes, with a relatively short (1-2 minute) surface interval.

Walruses are highly specialised predators of clams and other benthic invertebrates. They use their sensitive whiskers to locate prey items in the sediments of the sea floor. With head down and whiskers in contact with the bottom, the walrus proceeds forward, propelling itself by sculling with the hind flippers. They use their fore-flippers, nose, jets of water and suction to dislodge their prey from the sediments. Prey are manipulated by the lips and grasped with the aid of roughly textured gums. The soft parts of molluscs are removed from the shells by suction and the shells are then ejected. Invertebrates without shells are usually swallowed whole without chewing.

Direct observations of walrus foraging indicate that walrus can locate and consume up to 60 clams during each dive to the bottom. The aerobic dive limit for walruses has been estimated at approximately 10 minutes, although they have been known to dive for more than 25 minutes. That maximum depth recorded for a diving walrus was 113m.

Walrus swim in a manner comparable to phocid seals. They use their hind flippers to propel themselves while the fore-flippers are used primarily as rudders to change direction. Their normal cruising speed is approximately 7-10 km/hr, but they can exhibit short bursts of speed up to 35 km/hr.

Social Behaviour

Walrus are extremely social and gregarious animals. They tend to travel in groups and haulout onto ice or land in groups. On land or ice, in any season walrus tend to lie in close physical contact with each other. Youngsters often lie on top of the adults. The size of the hauled out groups can range from a few animals, up to several thousand individuals. When disturbed, stampedes of walrus off a haulout may cause injuries and mortalities. The risk of stampede related injuries increases with the number of animals hauled out. Calves and young animals at the perimeter of these herds are particularly vulnerable to trampling injuries.

The mother-calf bond is extremely strong. A mother walrus is very solicitous and protective of her newborn calf, and watches over it and protects it with vigor. The calf normally remains in her charge for at least 2 yrs, sometimes longer if not supplanted by a new calf.

After separation from their mother, young females tend to remain with groups of adult females, while young males gradually separate from the females and begin to associate with groups of other young males and older bulls. Individual social status appears to be based on a combination of body size, tusk size, and aggressiveness. Individual animals do not necessarily associate with the same group of animals and must continually reaffirm their social status in each new aggregation.

Breeding occurs primarily during the winter, in polynas or other areas of broken ice. Potent males follow herds of females and take up positions when they haul out on ice. Adult males compete for choice areas near the females, and perform elaborate visual and acoustical displays in the water. Sub-dominant males remain on the periphery of these aggregations and apparently do not display. Individual females leave the resting herd to join a courting male in the water where copulation occurs.

There are many anecdotal accounts of walruses attacking hunting boats, or marauding polar bear and killer whales with their tusks. In most cases these relate to wounded animals or females protecting their young. When threatened, walrus frequently form groups in the water and attempt to intimidate the perceived threat by huffing; barking and displaying their tusks.

Hunting Methods

Before the introduction of whaleboats and rifles, walrus were hunted by harpoon and lance. Walrus were stalked at land haulouts or along the flow edge; or by approaching them in kayaks while they hauled out onto ice pans. The large size of the walrus and the logistics associated with butchering and transporting the meat made it necessary for several hunters to work co-operatively. Variations of these traditional hunting practices are still utilised by aboriginal hunters around the arctic.

The introduction of motorised boats and firearms revolutionised walrus hunting making it far less dangerous and far more productive. Modern hunters usually prefer to target walruses hauled out onto large flat ice pans since they can be easily approached, killed and butchered. Typically walrus herds are approached slowly from down-wind to avoid detection by sound or smell. Resting walrus can often be approached to a very close range if care is taken. When multiple animals within a herd are targeted, hunters normally begin shooting at the same time.

The central nervous system (brain) is normally targeted with the objective of killing the animal outright, on the ice, in place for butchering. Animals are usually killed using high-powered rifles. Some hunters prefer full metal-jacketed bullets for maximum penetration of defensive bones.

There is considerably more work and risk involved in taking animals in the water. A walrus in the water must first be wounded, usually by several shots to the body when it surfaces for air. The lungs and spinal cord are frequently targeted. Injured animals must then be harpooned before a killing shot is made because they generally sink upon death. Care must be taken approaching a wounded walrus in the water; they can be dangerous and have been known to attack and damage boats.

Harvest Trends and Conservation Issues

There have been tremendous advancements in walrus hunting technology in recent years.
Powerful long-range boats and global positioning technology have opened up much of the sea-ice habitat occupied by walruses to hunting. Although evolutions in hunting practices have greatly enhanced the ability of hunters to catch walruses, they also raise the potential danger of over-exploitation.

Because walrus have such low rates of recruitment, walrus populations have only a limited capacity to absorb hunting pressure, or to recover from depletions. In addition to hunting practices and means, hunters and resource managers also need to be concerned that hunting practices and patterns remain sustainable.

The use of firearms in walrus hunting has made it easier to kill walruses quickly and humanely from greater distances, but has also lead to a large increase in the proportion of animals killed but not retrieved. Accounts of struck and loss rates for modern walrus hunting practices range from less than 10 percent to more than 50%. Reducing the proportion of animals struck and lost is probably the easiest way to reduce the overall hunting mortality affecting walrus populations.

Because walrus usually sink upon death, some level of hunting loss is unavoidable; however, loss rates can be minimised through appropriate target selection and by utilising suitable hunting practices and gear.

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Ballistics

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Ballistics

Ballistics is the science of the motion; the propulsion and the impact of a projectile. Although closely interrelated, ballistics is commonly divided in three branches:

a) *Internal ballistics* ("interior ballistics"): events taking place within the gun
b) *External ballistics* ("exterior ballistics"): the flight of the projectile
c) *Terminal ballistics* ("target ballistics"): the projectile behaviour at target.

Calibre

When speaking about ballistics, you cannot avoid speaking about the calibre, which has great impact on all the three categories of ballistics. The term calibre is used to designate the diameter of the slug or weapon bore. It is measured in millimetres or thousands of an inch.

There is no single designation or international standard to express the calibre concept. It is rather a "jungle" of concepts to walk into. Europeans manufacturers use the metric terminology like for 7,62 mm, while US manufactured ammunition of the same size is commonly measured in fractions of an inch like .30 inch. But some US manufacturers also use the metric terminology, but they are not using the decimal comma like in Europe (7,62), but a decimal point (7.62) to qualify calibre numbers.

For cartridges (shells) corresponding to the 7,62 or .30 calibre rifles the cartridges designations are commonly shown to comprise of two figures: the first refers to the calibre and the second to the year of the introduction of the original powder charge. For example, a cartridge designated .30-06 means a .30 calibre bullet introduced in the year of 1906. But that calibre is exactly the same as the European calibre designation with the metric system where the figures are 7,62 x 63, where the first figure refers to the calibre in millimetre and the second to cartridge length in millimetre. The US calibre designation of .308 Win is corresponding to the European 7,62 x 51 (mm) or 7,62 NATO. Another common and popular European ammunition is the 6,5 x 55 (mm) (Swedish Mauser), which is practically the same as the calibre designation .257.

In the US system the second number can also designate the propellant load, the number of grains gunpowder, in the cartridge like in the calibre designations .30-30 and .30-40. Occasionally, the second number will indicate the muzzle velocity of the projectile. Some of the calibres designations can also include the name of the manufacturer or person who developed the cartridge like .30 Remington, .30-30 Winchester, .30-40 Krag, .30-06 Springfield, .300 H&H Magnum, .300 Savage, .300 Weatherby Magnum, .308 Norma Magnum, .308 Winchester, .270 Win.

The weight of a bullet is designated in grams (g) or grains (gr) (0,0648 grams). Hunting bullets may range in weight from about 3,2– 32,5 g (50 to 500 gr).

Internal ballistics

Internal ballistics ("interior ballistics") covers the events that take place within the gun from the moment the primer ignites to the moment the bullet leaves the barrel. This is a complex system that involves the case and the primer characteristics; the propellant characteristics, its quantity and burning rate; bullet characteristics like size, shape, weight, and its seating in the case, etc.; barrel characteristics like bore friction, barrel twist and length, etc.

A *cartridge* (shell) is composed of four basic components: *primer*, *case*, *powder* and *bullet*. When struck, the primer at the cartridge base provides the “spark” that ignites the powder charge (propellant). When powder ignites it releases heat and gases resulting in the propulsion of the bullet that leaves the cartridge and will be pushed down the barrel of the firearm at high speed. The barrel grooves (rifles) impart rotation or spin along the bullet’s longitudinal axis to stabilise it in its flight.

Modern *propellants* (powders) are solid chemical compounds that, when confined in a cartridge case, burn at a rapid but predictable rate, producing heat and gases that builds up an internal pressure in the cartridge and barrel of several thousands atmospheres. There are over 100 different component powders available. They are highly specialised and often classified after their morphology, or shape, which can be flakes, sheets, cylindrical sticks and balls.

Modern powders (smokeless powders) are *nitro-cellulose-based* propellants. They are classified as flammable solids. These propellants burn at a very rapid rate, although the shooter hears a single loud explosion. The release of energy through burning is called *deflagration*. The rate of energy release is the *burning rate* of the propellant. They can be classified as *fast-burning* and *slow-burning* powders. When nitro-cellulose is used alone, the propellant is referred to as “single-base”. When mixed with *nitro-glycerine*, the energy increases and those with a mixing of nitro-cellulose and nitro-glycerine is called “double-base”.

Burning rate and energy caused by the powder deflagration are influenced by temperature and consequently it also influences the velocity, range and performance of the projectile, Propellant loads that is made for safe and effective use at 0°C (32°F) may prove excessive if fired at 30°C (100°F). Likewise a load developed at 30°C will likely show a velocity loss of 5-10% when fired at 0°C.

Black powder is now rarely used for hunting purposes except in some types of whaling activities. Black powder was for centuries the only available ballistic propellant and with few, but important modifications it has remained almost unchanged since it was developed. It has its disadvantages. It is a slow burning powder where less than half of the powder converts to gas and the remaining solid residues the thick white smoke along with heavy barrel fouling that will produce rust if not eliminated by hot water washing. The only way to increase velocity when using black powder is to increase the charge weight, which limits its use in firearms using cartridges. Black powder is also very sensitive to friction and electricity. Several accidents have occurred during production and the use of black powder and it is now classified as explosive and storage and sale is entirely banned in some communities. The black powder is therefore replaced with the much safer substitute – Pyrodex - where possible.

The projectile, *bullet,* is intended to efficiently deliver ballistic performance to the target. The choice of bullet depends on the rifle, the cartridge, the target and presumptive shooting range. A small game hunter requires different ballistic performance than a walrus and moose hunter. Shooting at long ranges of several hundred meters (yards) requires different ballistic performance than the shooting at short ranges. With such wide variety of bullet types and forms for the different hunts, the hunters might wonder which bullets to choose for the particular hunt. However, without going into details, for the hunting of terrestrial games and seals, some type of expanding bullets will be preferred. But, for hunting and euthanasia of some species of whales and some African games, solids or full-jacketed bullets are preferred.

External ballistics

External ballistics (“exterior ballistics”) is the science of the flight of a bullet or a missile of any kind between the barrel muzzle and the target. External ballistic studies and predicts the projectile’s *trajectory* or *path* relative to some frame of reference. It is used to set up firing tables, which information includes the bullet path (the vertical distance that the projectile rises or falls relative to the line of sight), its remaining velocity at any distance, and the time of flight at different ranges. By knowing the full trajectory of the bullet, the shooter can predict where the bullet will strike and decide how to "zero" the firearm for best results. By knowing the remaining velocity (and energy) of a known projectile at any point along its path, the shooter can estimate its energy and thus its effectiveness at any distance.

Velocity is the speed of the bullet. Distance measured in meters and time in seconds, results in velocity in meters per second (m/s) or using feet; feet per second (ft/sec). The formula for calculating velocity is:

Velocity (v) = distance (s)/time (t), $v=s/t$.

The velocity affect the bullet's flight (external ballistics) and degree of penetration, expansion and deformation in the target (terminal ballistics). Many factors may influence on the bullet's velocity. Type of propellant, weight, barrel's length, air temperature, but also the composition and design of bullets influence the velocity at which they are propelled. Low-velocity projectiles travel slower than 300 m/s (1000 ft/sec), medium –velocity bullets between 300 m/s and 600 m/s (1000 – 2000 ft/sec) and high velocity projectiles faster than 600 m/s. However, the figure of 750 m/s (2500 ft/sec) and above is generally selected as the designated speed of high-velocity projectiles. Most hunting rifles fire bullets in the medium to high-velocity range. At low velocities, a bullet may expand very little while at higher velocities, the same bullet may expand normally or break it up completely. Bullets that are designed for low-velocities should therefore not be utilised for high-velocities and *vice versa*.

Most bullets are composed of 90% lead, with 10% antimony used as a hardener. Some are composed of zinc, magnesium, plastic and other materials. Some bullets, such as the common .22 calibre cartridge, are not jacketed, but have an outer metallic coat. Medium and high-velocity bullets are manufactured in two basic designs: bullets with an outer full metal jacket, which passes unchanged through the target and expanding bullets where the jacket is open in the front and exposes the core. The outer metal jacket may be composed of different hard metals like steel, copper, brass and alloys of copper and zinc (gilding metal) with a higher melting point than the lead alloy core (copper, cupronickel, brass, soft steel). The jacket restricts the bullet from deformation during passage through the barrel as a result of heat, friction, and pressures generated with high velocities and subsequent deformation on impact.

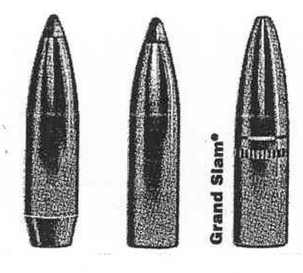

Fig. 1. From left: a) Soft point, boat tail b) Soft point, flat tail c) Full jacket. Illustration from Speer Reloading Manual No. 13.

The bullet trajectory is a product of the forces acting on it during flight. Forces include those pertaining to the Earth and its rotational motion (gravity, centrifugal forces, etc), and aerodynamic forces (drag) produced by the resistance of the air to projectile motion.

Published firing tables have bee evaluated for long-angle fire with no wind and standard atmospheric conditions (altitude: sea level, temp: 15ºC (59º F), pressure: 750 mm Hg (29.53 inches Hg), relative humidity: 78%, air density at sea level) and with gravitational forces constant along the bullet trajectory. If the environment changes (pressure, temp, etc) it will influence the trajectory. The atmospheric pressure and air density changes with the altitude and very dry air generates higher drag on the bullet than humid air. Very low temperatures of the cartridge can influence dramatically on the muzzle velocity of the projectile.

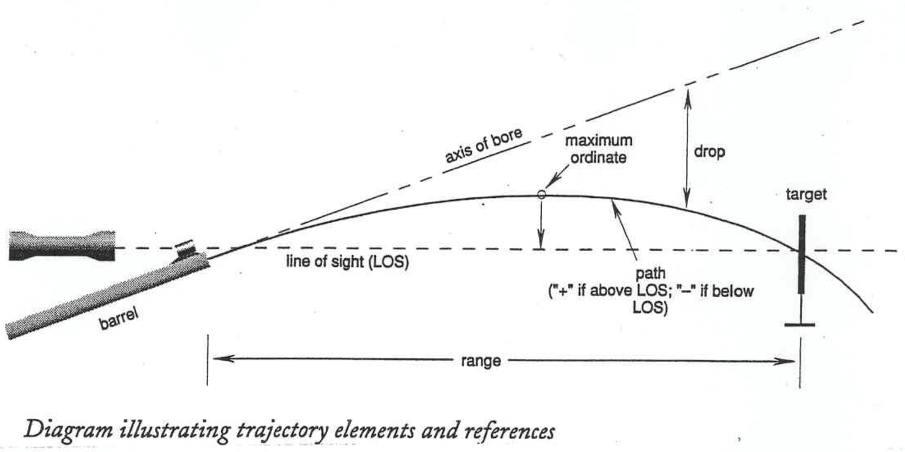

Fig 2. Illustrations from Speer Reloading Manual No. 13.

Because firing tables results from horizontal firing tests, their values cannot be directed used when estimating shooting that includes an elevation angle. Since the muzzle is inclined at some angle, the initial velocity of the bullet now has a component in the vertical direction. In flat firings the bullet drop is always perpendicular to the firing direction, which is not the case for angle shooting. Therefore, for both uphill and downhill shooting, the bullet impact will be higher than expected for level shooting at the same distance. Thus the shooter will have to aim lower in such conditions.

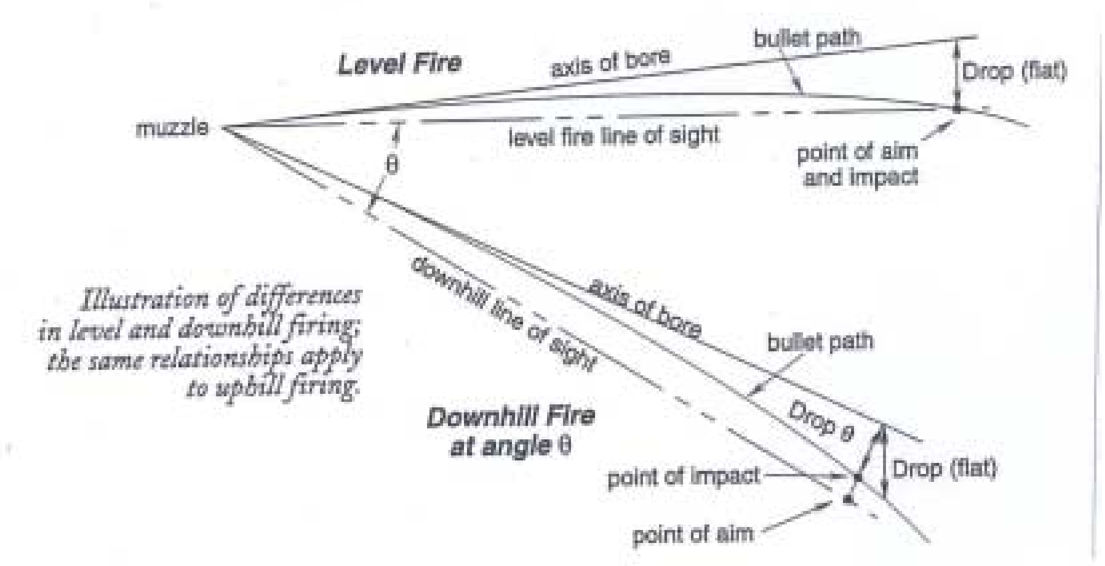

Fig. 3. Illustration from Speer Reloading Manual No. 13.

Air resistance depends on several factors like the projectile's shape and diameter, its muzzle velocity and air density. Higher bullet velocity relative to that of the air, produce greater drag. This is expressed by the concept of *ballistic coefficient*, BC, which simply expresses the bullet's ability to cut through the air. The higher the BC, the more easily the bullet slips through the air. BC is defined as the weight (w) of bullet divided by the square of its calibre (d) and by a factor related to the shape of the bullet (i): $BC = w/id^2$. For example is the BC for a boat tail bullet higher than the BC for a flat tail bullet with the same point shape and weight.

Wind affects bullets flight. Head wind gives an increased drag, while tail wind gives less drag on the bullet. Side wind results in drifting of the bullet from the line of the bore.

Terminal ballistics

Terminal ballistics ("target ballistics") is the science of the stopping process of the projectile at the target. Penetration, wounding effect, energy dissipation, projectile formation and stability are important processes covered by this branch. This effect is of particular interests for hunters and will be detailed in separate lectures in this workshop. In this presentation some basic and general principles of terminal effects will be mentioned.

The seriousness of bullet wounds is often considered to be limited to the tissues in the direct path of the projectile. However, the wounding potential of projectiles is a very complex subject and it is important to remember that deaths in humans and in animals have indeed occurred from hits in a vital structure, even with comparatively "benign" air gun pellets.

Energy is the ability to do work. The energy of an object in motion is called *kinetic energy* (E or KE). It is commonly expressed in kilogram-meters (kgm), foot-pounds or in Joule. The basic formula for calculating the energy of a moving object like a bullet is: $E = mv^2/2$ or $E = pv^2/2g$ where m is bullet mass, v bullet velocity, p bullet weight in grams or grains and g gravitation. It can be read from this formula that changes in velocity, v, has great impact on the energy as it changes with the square of the velocity. A drop or increase in velocity will, therefore considerably influence on the bullet's performance. In some countries therefore a minimum amount of muzzle velocity and energy is specified for big game hunting.

The performance of penetration of the bullet is important because the bullet usually must get well inside the animal to disrupt the function of its vital organs. A bullet that fails to penetrate the fur, skin, muscle, and bone necessary to reach vital organs is unlikely to bring an animal down. The bullets *sectional density* (SD) is very important for its penetration abilities. It is defined as ratio of weight to the square of the bullet diameter: $SD = w/d^2$. When comparing different hunting bullets, it is important to remember that SD stays the same for all bullets of the same weight in the same calibre and that shape does not affect the SD.

Jacketed bullets generally promote greater penetration into the target than bullets that expand and/or flatten or mushroom on impact, thus increasing the resistance during penetration and passage. For expanding bullets the expansion is affected by the type of tissues penetrated, thickness and strength of the jacket, hardness of the core, and the amount of core exposed. A hollow-point, soft-tip bullet can expand two to threefold. Too rapid deceleration and instability of the expanding bullet as it passes through the target may promote bullet fragmentation and enhance tissue destruction. A partial jacket is therefore sometimes included to protect the soft lead from deformation and fouling during its passage through the barrel and provide controlled expansion and penetration in the target.

SHOTGUNS

Shotgun calibres are measured according to their gauge and are capable of firing pellets of variable diameters. Shotguns differ from handguns and rifles both by design and function.

Shotguns are smooth-bore, long-barrelled guns deigned primarily for killing fast moving game birds and small animals. The shot charge consists of a large number of small spheres or pellets that forms a pattern that depends on the distance and "choke" of the barrel. Their use should be limited to close range because of the small mass and low velocity of the projectiles and in game field 25-35 meter (30-40 yards) is the effective range for most shotguns. From a ballistic standpoint, shotguns are decidedly inferior to a single projectile, high velocity rifle.

MISFIRES

(Most of this section is quoted from Speer Reloading Manual Rifle & Pistol Number 13)

Handloading problems

The most common cause of misfires in reloaded ammunition is the failure of the re-loader to fully seat the primer in the case. When a primer is not fully seated, some of the force of the firing pin must be used to drive the primer deeper into the pocket.

Misfires for re-loaders can also be caused by other reasons such as:

- excessive headspace where the cartridge is too far forward in chamber and the firing pin cannot make solid contact
- incorrect cartridge
- lack of propellant
- contamination of primer or ammunition with oil or water

Gun problems

- Broken or damaged firing pin
- Inadequate firing pin spring
- Grease or dirt in the firing pin mechanism that slow down the pin fall
- Build up of powder residue or grease in the chamber
- Excessive headspace

When bolt hard to open

Hard bolt lift is a signal of DANGER. It can be due to several factors. However, for safety's sake it should always be considered to be a sign of excessive pressure and dangerous and firing should be ceased until the cause is diagnosed and corrected.

Unusual sounds and/or recoil

- A soft report or lack of recoil can indicate a squib load and the danger of a bullet being lodged in the barrel. Check for obstruction!
- A faint hissing sound following a shot, or hear a sound like the opening of a beverage can when you open the bolt, you almost certainly have a bullet stuck in the bore. Check for obstruction!
- Double sounds or a detectable delay between pulling the trigger and the cartridge firing are signs of poor ignition.

Poor accuracy

- Improper ammunition
- Inconsistent positioning of gun in the rest
- Poor attachment of sights
- Guard screws in the stock are not secure
- Bore unclean and fouled with powder residuals, lead or jacket material
- Wood stock warping due to moisture absorption
- Excessive lubricant
- Wind and/or cold

Slam-fires

A slam-fire is the discharging of a cartridge in the firearm by the closing of the bolt without the pull of the trigger. In most cases this is a phenomenon associated with military style semi-automatic rifles. It can be caused by a high primer or by a heavy un-sprung firing pin.

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Terminal ballistic

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Some definitions

Terminal ballistic describes the effect a projectile cause while striking the body as well as the counter-effects produced upon the projectile. This lecture will focus on the interaction between the projectile and the tissue.

When a projectile strikes a medium, a so called "bullet-body interaction" occurs. This interaction leads to transfer of energy from the projectile to the medium which lead to a degree of destruction of the involved medium. *Wound ballistic* is the study of the terminal ballistic of both bullets (and its fragments) in living tissue. *Ballistic wounds* are penetrating injuries caused by projectiles.

Energy transfer

The energy that a projectile transfers as it penetrates tissue is associated with several direct and indirect phenomena:

- The tissue that comes in direct contact with the projectile is *cut*. During the several hundred microseconds that it takes for a typical rifle bullet to penetrate tissue, a region of very high pressure develops at the bullet's leading edge in which the tissue is disrupted.
- Transfer of energy from the projectile to the tissue causes low frequency, high-displacement transverse waves (*shear waves*), which cause the tissue surrounding the bullet's trajectory to be stretched aside so that a temporary void are created. This is called the *temporary cavity*. In living tissue, the temporary cavity is often irregular and asymmetrical. The dimension of the temporary cavity will vary between different bullet types and also with the structure of different body tissue. After the temporary cavity has reached its maximum size, it starts to collapse and finally the *permanent cavity* is formed, which is identical with the observed final wound canal. The permanent cavity often contains foreign material, like bone parts, hair and for expanding bullets also bullet fragments.

With respect to shooting of pinnipeds with rifles, it is these to first mechanisms of energy transfer and injury creation that are the most important. However, the projectile also transfers energy to the tissue through two other mechanisms:

- Transferring energy from the projectile also causes high frequency, low-displacement longitudinal waves (*shock waves*).
- Some energy is also transferred from the projectile to the target in from of *heat*.

Ballistic wound of the skull and brain

Generally, shots fired at the brain will in many cases be grossly destructive and cause very severe bleedings and tissue damage. The brain is in particular vulnerable to ballistic injury, as it is enclosed in the heavy bones of the skull and the tissue therefore has little room for expansion. When a rifle bullet hits the skull, the pressure inside will increase dramatically. High pressure within the skull are amongst other often associated with bleedings in the brain tissue and meninges, which may be extensive if the pressure delivered is high. The brain stem is the area that is most sensitive to increased intracranial pressure. Additionally, the brain tissue possesses little elasticity and ballistic wounds to the brain are therefore often of an "explosive" character. If the pressure at impact is high, the brain can be blown away and pressed through natural openings like the sinuses or foramen magnum. The cranium itself can also crack and fractures and bone splints can cause secondary damage to the brain. A projectile, if powerful enough, does not have to hit the brain directly to cause devastating injury. Shock waves created from an impact site close to the brain, for instance the upper cervical spine, may be sufficient to cause bleedings and tissue disruption in higher and vital areas in the central nervous system.

A series of pictures were shown from experimental trials conducted by a group of researchers (Thali et al. 2002, 2003) to characterise the progressive formation of trauma caused by different bullet types in different areas of the skull, including head through-and-through gunshot and glancing/tangential gunshot using expanding and full-metal jacketed ammunition.

Ballistic wound to the chest

The major organs in the chest (lungs, heart and major vessels) tolerate ballistic injury differently. The lung tissue has very low density compared to other organs in the body and it is relatively elastic and therefore tolerates more stretch compared to for instance the brain. This does not mean, however, that the temporary cavitation cannot be a destructive process in the lungs. Projectiles with high-energy transfer are more than capable of causing severe damage to this tissue.

Wounds to the heart are frequently as destructive as wounds to the skull. The catastrophic injuries often encountered after wounding of the heart, in particular with high-velocity weapons, is mainly due to temporary cavitation occurring in a fluid-filled and little elastic organ. The large vessels, like the aorta and main pulmonary vessels, are susceptible to the same damages as the heart.

Abdomen and soft tissue

Generally, hits in organs in the abdominal cavity are very seldom rapidly fatal. The internal organs of the abdomen can be divided into dense organs (liver, kidney, spleen) and hollow organs (gastrointestinal tract, bladder). The dense organs are highly vascular (rich in blood) and friable (lacks elasticity and tear easily upon stretching) and the formation of the temporary cavitation will result in severe tissue disruption in these organs. The permanent cavity in these organs will often be of almost the same size as the temporary cavity. The gas or fluid filled organs in the abdomen is totally different as these tissues are relatively tolerant to stretching.

Hits in the musculature are never fatal. If a marine mammal is hit in the musculature and then dives, bleeding will stop quite rapidly due to diving adaptations in the circulatory system.

Practical hunting situations

At the end of the lectures a serious of pictures of harp seals on the ice were shown to indicate where and how to shoot the animals in order to render the animal instantaneously unconscious with one rifle shoot. Points were also made on how to prevent the wounding of animals during such circumstances.

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Animal welfare and the Canadian harp seal hunt

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The annual harp seal (*Pagophilus groenlandicus*) hunt on the Atlantic coast of Canada is the largest seal hunt in the world. Most of this hunt occurs in the Gulf of St. Lawrence (hereafter referred to as the Gulf, with a current quota of –98,000 animals) and at the Front (northeast of Newfoundland, with a current quota of –247,000 animals). The Northwest Atlantic population of harp seals is currently estimated at 5.2 million animals, based on an estimated total annual production of 997,000 pups. This herd is the object of regular counts by scientists of the Canadian Department of Fisheries and Oceans (DFO) (Stenson et al., 2003). Its current replacement yield (number of animals that can be taken in a given year without reducing the total population in the next year) is –255,000 animals (Hammill and Stenson, 2003). DFO=s 2003-05 Management plan allows for a harvest of 975,000 seals over three years, with an anticipated reduction of the population to –4.7 million animals by 2006 (Anonymous, 2003).

This is a competitive form of hunt and, in recent years, quotas have been reached within less than a week in the Gulf and also at the Front. Despite the very large number of seals taken, animal welfare issues surrounding the hunt have always been the topic dominating the attention of the news media and the public. It was on the basis of these issues that, in the early 1980s, the European Economic Community decided to ban the importation of harp seal products from Canada, thus leading to the collapse of the hunt. Therefore, if only for pragmatic reasons, animal welfare issues cannot be ignored anymore by people exploiting wild animal resources. Moreover, humane practices are perfectly compatible with, and actually optimise, the harvest of pelts of good quality.

The harvest of whitecoats (newborn harp seals), which fuelled the opposition to the harp seal hunt by animal welfare groups and the general public in the 1970s, has been prohibited in Canada since the mid 1980s. Beaters now represent –90% of the commercial harp seal harvest in Canadian waters. These animals are 3-4 weeks old or older and weigh on average 30 kg; they have been weaned at about 12 days of age and have lost their white coat, but continue to spend the majority of their time resting on ice floes. Slightly older animals are targeted at the Front than in the Gulf and are thought to provide pelts of better quality.

Hunting methods used at the hunt are greatly influenced by ice conditions. Cold winters in the Gulf promote the formation of large ice floes on which it is easy to move on foot or even by snowmobile or all-terrain vehicle. Under these conditions, the hakapik (a wooden club, 105-153 cm long, with a metal ferrule with a slightly bent spike on one side and a blunt projection on the opposite side used to strike the seal=s skull) is preferred to the rifle. Its proper use can be easily mastered; it can quickly kill the target animals and does not damage their pelt; and the cost of ammunition is avoided. Conversely, mild winters in the Gulf result in small ice floes on which beaters are less easily accessible and from which they can more readily escape into the water when approached; small ice floes also predominate at the Front, which is in more open sea. Under these conditions, rifles are the more efficient weapon.

Animal welfare issues at the hunt revolve primarily around the proportion of animals that are supposedly not killed instantaneously and thus may subsequently be hooked, bled or even skinned when still conscious. Understanding how pain can be prevented and how irreversible loss of consciousness or death can be achieved requires a few basic principles of anatomy and physiology. Pain is perceived as a result of nerve impulses from the periphery reaching the cerebral cortex (Lemke, 2004). Therefore, the integrity of the cerebral cortex, involving both cerebral hemispheres, is required for pain sensation. The base of the brain (brain stem) contains vital centres (control of respiration and blood circulation), and its destruction ensures that the animal is dead. It is therefore conceivable that a seal with both cerebral hemispheres destroyed but with an intact brain stem would still be alive but unconscious and unable to perceive stimuli, including pain. It is also possible for a seal to lose consciousness only temporarily as a result of concussion from a blow to its head, without there being significant damage to its brain. In this context, the Marine Mammal Regulations of the Fisheries Act of Canada (Marine Mammal Regulations, 1993) ask that the sealer verify that the animal is dead by confirming that it has lost its blinking reflex at the touch of its cornea. Loss of this blinking reflex may indicate death or, perhaps, only a deep level of unconsciousness which is not necessarily irreversible. For this reason, immediate and rapid bleeding of the animal is important in order to ensure that it will never regain consciousness. This practise is also important for the preservation of the quality of the pelt.

Scenes that are typically used in the media to illustrate the alleged cruelty of the hunt are those showing a sealer clubbing a seal with a hakapik. Yet, this author believes that proper use of the hakapik is an efficient and quick method of killing beaters. The top of the skull of young harp seals (up to at least 1 year of age) is very thin and can be easily crushed by one or a few blows from this weapon. A single blow may crush only one side of the skull and, according to some, can potentially leave the other side of the brain intact and available to perceive pain. However, the resulting concussion should be sufficient to cause at least temporary loss of consciousness. If so, immediate and rapid bleeding of the animal is again important to ensure that it will never regain consciousness. It also appears that, in many instances in which the top of the skull is only partially fractured, portions of the base of the brain case are fractured as well, thus presumably causing major damage to the brain stem, a vital component of the brain (Daoust et al., 2002). Nonetheless, a minimum of three blows to the top of the skull is recommended, in order to ensure its complete destruction and, thus, that of both cerebral hemispheres. This can then be easily and rapidly verified by palpation of the top of the skull (through skin and blubber). Although this author endorses the use of the hakapik for killing beaters, the same does not necessarily apply to adult harp seals or to young seals of other species, because of the normal increase in thickness of the brain case of animals with age and of wide variations in the configuration of the skull among different species of seals.

The Marine Mammal Regulations (1993) specify the minimum muzzle velocity (1,800 feet per second) and energy (1,100 foot-pounds) of the ammunition that can be used at the harp seal hunt. However, some hunters/sealers argue that these rifle regulations may have been designed to hunt adult harp seals, that these types of ammunition are unnecessarily powerful to kill beaters, and that less powerful ammunition such as a .22-caliber Rimfire Magnum cartridge: 1) has sufficient power to kill beaters when the shot is aimed at their brain case, 2) causes less damage to the pelt, 3) is safer for use on the ice because of its shorter range, and 3) is less expensive. A recently completed study of .22 Magnum ammunition, using intact heads of beaters under controlled conditions, suggested that, based on the damage caused to the skull of these heads, this type of ammunition is 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, unpublished data). However, as compared to ammunition of higher power, it may be more likely to injure a beater than to kill it instantaneously when hit elsewhere than in its brain case. Other factors, such as human safety and the hunter=s marksmanship, also need to be considered in the decision to allow or not the use of .22 Magnum ammunition. However, from an animal welfare perspective, a precautionary approach would suggest that this type of ammunition be not allowed during the harp seal hunt. Field observations are needed to complement this study.

The swimming reflex is a stereotypic movement of a recently killed harp seal which is the counterpart of the paddling movements of livestock animals killed at the slaughter house with a stun gun. It is characterised by vigorous lateral movements of the caudal part of the body, with no movement (such as lifting) of the head and little or no movement of the front flippers. The presence of this reflex has often been used by animal welfare groups as an indication that the seals are still alive after having been struck with a hakapik or shot. Its physiological basis is not clearly understood, and its occurrence and severity in any animal are difficult to predict (Daoust et al., 2002). More specifically, it is not clear to what extent, if any, this swimming reflex (or the paddling reflex in livestock) correlates with the degree of damage to the brain. This stereotypic movement may last considerably longer in seals than in terrestrial animals because of the unique adaptation of their musculature to diving, particularly a much larger store of oxygen in muscle tissue associated with the higher concentration of myoglobin. Complete immobility of the seal immediately following a blow to its head with a hakapik should actually alert the sealer to the possibility that the animal is still conscious, especially if this immobility is accompanied by contraction of the body. This fear-induced paralysis is a typical behaviour of harp seals (Lydersen and Kovacs, 1995), and such immobile seals might be interpreted as dead by inexperienced sealers and, therefore, might still be conscious when hooked, bled or skinned.

In conclusion, this author believes that the killing methods used at the harp seal hunt are appropriate for the species and age group harvested, when properly applied. The hakapik may actually be the better weapon, as it is less likely than the rifle to result in loss of struck animals that will subsequently die from their wounds. Based on his field observations and those of colleagues, it is estimated that –2% of the beaters are not killed properly and suffer for an inordinate amount of time. This value compares to a figure of –40% claimed by some animal welfare groups (IFAW, 2004). Nonetheless, a value of 2% applied to such a large hunt amounts to at least a few thousand animals. In order to improve further the quality of the hunt from an animal welfare perspective, this author proposes the following recommendations: 1) with the hakapik, the top of the seal's skull should be struck with a minimum of three strong blows; 2) with the rifle, ammunition of lower power than is currently indicated in the Marine Mammal Regulations (1993) should not be allowed (although this recommendation needs to be supported by field observations); 3) in every instance, the seal's skull should be palpated to ensure that it is completely crushed or the absence of a blinking reflex should be verified before the animal is hooked, bled or skinned; 4) mandatory training sessions for the sealers should be provided to ensure that newcomers to the hunt have appropriate skills, but also, and as importantly, to try to instil in the sealing community at large the importance of respect for, and humane treatment of, the animals hunted, because, ultimately, the quality of any hunt depends at least as much on the ethics and ability of the hunter as on the killing potential of the weapon used; 5) there should be continuous monitoring of the hunt by independent observers, in order to encourage compliance with proper hunting practices; and 6) the quota should revert to that of the replacement yield soon after 2005; this should ensure a sustainable harvest in the long term, and a less hurried hunt may also be a more careful hunt.

Acknowledgements
I thank Fisheries and Oceans Canada and the Canadian Veterinary Medical Association for their logistical and professional support. I also thank the many sealers in whose company I worked and with whom I talked for their trust.

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