



**NORTH ATLANTIC MARINE MAMMAL COMMISSION**

**REPORT OF  
THE NAMMCO EXPERT GROUP MEETING ON  
ASSESSMENT OF WHALE KILLING DATA**

North Atlantic House Copenhagen, Denmark  
17 – 18 February 2010

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## **CONTENT**

<b>Introduction .....</b>	<b>5</b>
Terms of reference	5
Expert Group	5
<b>Background .....</b>	<b>7</b>
Criteria of death	7
<b>Killing methods in use or under development .....</b>	<b>8</b>
Norway	8
Iceland	11
Japan	12
Greenland	16
<b>Assessment and comparison of different hunts .....</b>	<b>19</b>
<b>Education and training of hunters .....</b>	<b>19</b>
<b>Monitoring .....</b>	<b>21</b>
<b>Conclusions and recommendations .....</b>	<b>23</b>
Appendix 1 – Agenda	27
Appendix 2 – List of Participants	28
Appendix 3 -- List of Documents	30



## **INTRODUCTION**

At its 18<sup>th</sup> annual meeting in September 2009 the North Atlantic Marine Mammal Commission – NAMMCO – tasked its Committee on Hunting Methods to organise an Expert Group to assess whale killing data.

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

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

- *The NAMMCO Council requests the Committee on Hunting Methods to organise an expert group in February/March 2010 to undertake a review and evaluate the whale killing data submitted to NAMMCO by Japan in 2009, as well as data and information on recent and ongoing research on improvements and technical innovations in hunting methods and gears used for the hunting of large whales in NAMMCO countries.*

The aim of the Expert Group was to assess the presented whale killing data and give recommendations with respect to possible improvements. In addition to the data from Japan, Greenland, Iceland and Norway were asked to present data and information from their hunts of large whales.

In setting up the Expert Group, the Committee on Hunting Methods identified a small group of qualified persons with extended experience and knowledge in general and/or marine mammal specific biology, physiology, anatomy, pathology and statistics. All members of the Expert Group were invited in a personal capacity as experts in fields related to the issue of killing mammals.

The meeting agenda (Appendix 1) was discussed in detail. At the beginning of the meeting a small drafting committee (Folkow, Suydam, Walløe and Øen) was established with the responsibility to formulate conclusions and recommendations. Based on the discussions and deliberations of the meeting they formulated and presented some draft recommendations on the last day. These recommendations were discussed in plenary point by point and adopted by consensus. The finalising of the full report was done afterwards by correspondence.

The Expert Group met under the chairmanship of Egil Ole Øen on 17 – 18 February 2010 in Copenhagen, Denmark. The present report summarises the discussions of the Expert Group and gives the conclusions and recommendations.

**The Expert Group** (Appendix 2):

Dr. Egil Ole Øen: *Wildlife Management Service, Norway/Sweden, chair of Expert Group\**  
Advisor Eigil Bjørvik: *Department of Fisheries, Hunting and Agriculture, Greenland\**  
Dr. Lars Folkow: *Department of Arctic Biology, University of Tromsø, Norway*  
Whaler Leif Fontain: *Greenland*

*NAMMCO Expert Group Meeting on Assessment of Whale Killing Data  
17 – 18 February 2010, Copenhagen, Denmark*

Dr Hjime Ishikawa: *Institute of Cetacean Research, Japan*

Whaler Erneeraq Jeremiassen: *Greenland*

Whaler Gunnar Johannsson: *Iceland* – submitted information but not present in the meeting

Head of Section Nette Levermann: *Department of Fisheries, Hunting and Agriculture, Greenland\**

Mr Kristján Loftsson: *Hvalur HF, Iceland\**

Dr. Carlos des Neves: *The Norwegian School of Veterinary Science, Norway*

Senior Veterinarian Jústines Olsen: *Veterinary Service, Faroe Islands\**

Professor Robert Suydam: *North Slope Borough, Department of Wildlife Management, USA*

Professor Lars Walløe: *Department of Medicine, University of Oslo, Norway*

Senior Legal Advisor Hild Ynnesdal: *Norwegian Directorate of Fisheries, Norway\**

The NAMMCO Secretariat was represented by General Secretary Dr Christina Lockyer and Deputy Secretary Ms Charlotte Winsnes. Winsnes acted as rapporteur.

\*Member of the NAMMCO Committee on Hunting Methods

## **BACKGROUND**

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

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

Whales are hunted and stunned/killed in the water using the following methods alone or in combination: firearms and harpoon guns with or without explosives.

### **Criteria of death**

Definition of death has changed over the centuries depending on cultural views as well as technological and biomedical advances. In biology, death was traditionally determined by behavioural signs such as termination of movement and respiration, and for a long period of time it was widely accepted that death equalled the absence of pulse and breathing i.e. the classical cardio-respiratory criteria of death (Knudsen 2005).

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

Knudsen in her doctoral thesis "Assessment of insensibility and death in hunted whales – a study of trauma and its consequences caused by the currently used weapons and ammunition in the Norwegian hunt for minke whales, with emphasis on the central nervous system" (Knudsen 2004, p 100) concluded that "...when times to death (TTD) are solely determined on the basis of the IWC criteria which in practice is immobility, a significant portion of animals will be recorded as being sensible or alive when they actually are unconscious or dead." Hence one may conclude that TTD based on the IWC criteria are biased negatively i.e. overestimated.

## **KILLING METHODS IN USE OR UNDER DEVELOPMENT**

### **NORWAY**

Norway (Øen 2010) reported that only minke whales (*Balaenoptera acutorostrata*) are hunted in Norway. The hunt is conducted from small (50 feet) or medium sized (60-120 feet) fishing boats specially rigged for whaling in the spring and summer season. The boats are equipped with 50 mm or 60 mm harpoon guns with corresponding harpoons and rifles with full metal jacket, round nosed bullets of calibres 9.3, .375 and .458 (minimum calibre 9.3 mm) as back-up weapon. The harpoon is carrying a penthrite grenade (Whale grenade-99) loaded with 30 g pressed penthrite as explosive. A charge of 52 g of gunpowder is used to launch the harpoon. The detonation is triggered at a depth of 65 cm inside the whale body by a twin hook connected to the firing pin with an elastic synthetic cord. The harpoon line, the fore-runner, is made of elastic materials like nylon or other synthetic materials and runs through a spring system to a winch to haul the whale in to the boat after it has been shot.

The whale is shot from the side whenever possible and the harpoon is usually aimed at the thorax region. A minke whale that is deadly hit will immediately stop swimming and roll onto its back or pull out some of the harpoon line before stopping. A whale that is still alive maintains normal position in the water and dives actively and resurfaces to blow. If the whale does not immediately turn over on its back it is hauled to the boat using the winch immediately after being shot and the gunner will be ready to fire the back-up rifle in the brain if necessary when it is alongside the boat. Many hunters fire a round as a matter of routine.

#### ***Research***

From 1981 to 2004 three major research programmes to improve and assess the hunting and killing methods for minke whales were conducted in Norway. The goal of these programmes was to:

- 1) develop hunting methods and improved gear to improve the animal welfare associated with the hunting and killing of the whales, and also to improve the hunter's safety; and
- 2) verify the results above by a very close monitoring of the hunt and sampling of time to death (TTD) data, *post-mortem* examinations of the carcass and neuropathological studies of brains from hunted (68) whales; and
- 3) develop and implement automated electronic monitoring technology for the Norwegian minke whale hunt.

The results of this research were new inventions of hunting gear, development and implementation of new weapon-technology, improved hunting techniques and routines, establishment of obligatory education and training of hunters and inspectors, plus an electronic monitoring system (Blue Box). In addition, the way the whales died was verified by the *post-mortem* examinations of the carcass and neuropathological studies of brains. Four types of whale grenades with the potent supersonic explosive penthrite were developed: two harpoon grenades used for minke whales, one for fin and sei whale hunt in Iceland, and one grenade for the traditional darting gun used by traditional subsistence hunters of bowhead whales in Alaska.

In addition, improvements to other parts of the hunting gear were made. The harpoons and harpoon lines were modified and reinforced to prevent breakages, the traditional open harpoon gun sightings were gradually replaced by optical sights, promoting the marksmanship, and a minimum calibre of back-up weapons was established. Formalised,



obligatory workshops and training courses for hunters were established and carried out on a regular basis from 1984 to 2005.

Data of results of different killing methods were collected for 5,552 minke whales from 1981 to 2002. The statistics show a considerable increase in instantaneous death rate (IDR). The time to death (TTD) was reduced accordingly and losses of wounded animals became less than one per thousand during 2000 to 2002.

The percentage of animals that died within one minute using harpoons without explosive devices (cold harpoons) in the seasons of 1981 to 1983 was about 17 % with an average TTD of 11min 20s. Seventeen percent of the whales were re-shot with a harpoon.

The first trials with penthrite grenades with 22 g of penthrite fuse as explosive started in 1983, continued through 1984, and were concluded after a comprehensive field study in 1985-1986. This penthrite grenade increased the percentage of whales that was killed instantly (IDR) by 2.7 times to 45 %. The median and average survival times were considerably reduced and the percentage of whales that were re-shot with harpoons was reduced to 4 %. Prior to the hunting season in 1993, the hunting gears were reinforced. The harpoons were standardised in weight, and reinforced. Gunners and licence-holders were required to take part in obligatory workshops and courses covering issues like animal welfare, anatomy of the whales, instructions in maintenance of weapons, weapons ballistics, new hunting techniques, rifle-shooting. Annual obligatory shooting tests were required to get a licence. From 1993 to 1996 the IDR was increased from 54% to 62% with an average survival time of 3 min using the IWC criteria of death.

During 1997 to 1999 a new grenade (Whale grenade-99) with an improved and reversible safety and arming (SAM) was developed and tested. The penthrite charge was increased to 30 g of pressed penthrite and the weight was reduced 40 %, which considerably improved the balance of the gun and the harpoon ballistics.

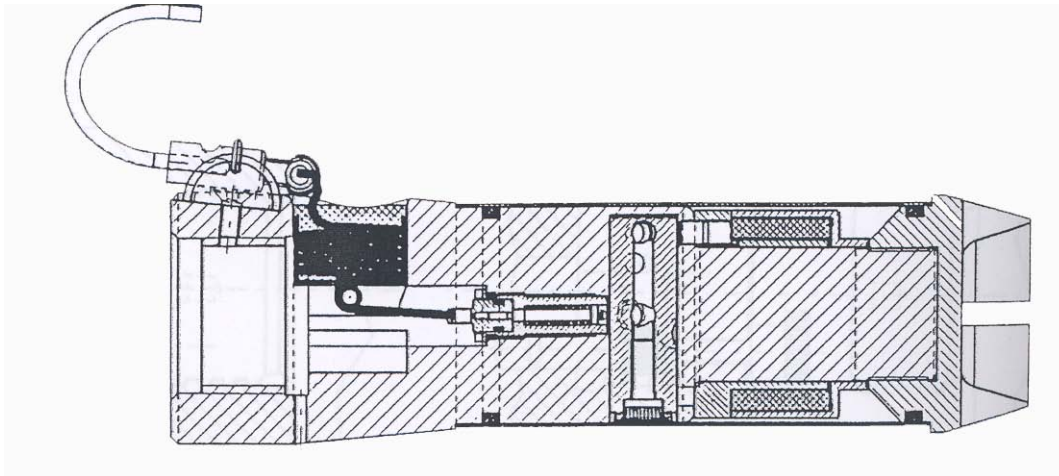


Fig. 1. Whale Grenade-99 (longitudinal section view). The safety and arming mechanism in secured position.

The new grenade was introduced in the hunt on all vessels from the 2000 season on. Trained veterinarians and whale biologists collected TTD from all whales hunted during three seasons. The TTD was recorded as the moment at which cessation of flipper movement, relaxation of the mandible, or sinking without any active movement occurred, which may include periods when the animal may have been unconscious or already dead. The results for the 1,667 minke whales

caught in the three seasons (2000-2002) are shown in Fig. 2. The statistical analysis showed an IDR of about 80 % with no statistically significant difference between the three seasons. The results also showed that the whales died instantaneously or very quickly when the grenade hits and detonates centrally in the thorax or near the central nervous system. Detonation in the cranial part of the abdomen or in musculature dorsal to the thorax also resulted in instantaneous or very rapid death, but the effect of such hits was less reliable.

The angle of the shot relative to the animal's long axis also influenced survival time as shots from directly in front ( $0^{\circ}$ - $10^{\circ}$ ) or behind ( $170^{\circ}$ - $180^{\circ}$ ) gave poorer results than shots directed from the side ( $45^{\circ}$ - $135^{\circ}$ ). However, if a whale was injured in the central nervous system, heart, lungs or major blood vessels (aorta, *vena cava*) it generally lost consciousness and died rapidly regardless of the angle of the shot. Therefore, Øen (Norway) concluded that the methods used in the Norwegian hunt for minke whales are, when applied as recommended, highly effective in causing instantaneous or very rapid deaths.

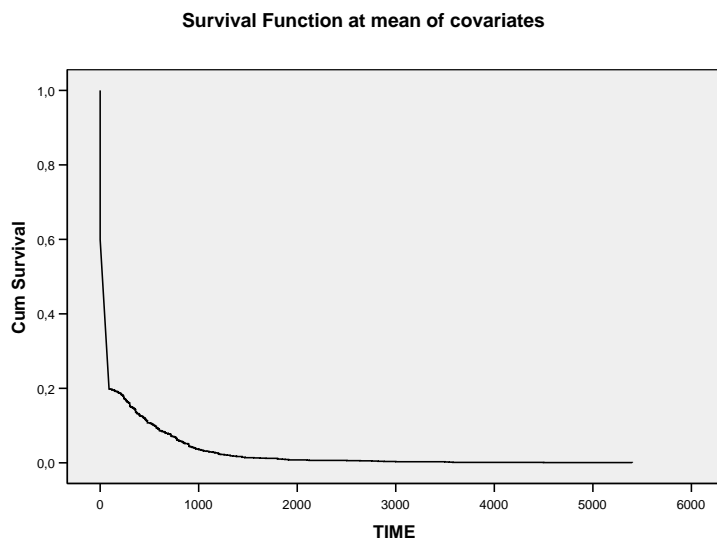


Fig. 2. Survival plot for 1,667 minke whales shot in 2000-02 with the new penthrite grenades developed in 1997-99. Horizontal axis: time in seconds. Vertical axis: proportion of whales still showing signs of life.

## Discussion

The Expert Group (EG) acknowledged the extensive research undertaken and amount of resources invested by Norway over some 20 years in order to improve the efficiency of killing, the animal welfare aspects of the hunt and the safety of the hunters. The introduction of new harpoon guns and the penthrite grenade have decreased TTD and increased the IDR radically, from an IDR of 17% in 1984 -1986 to at least 80 % in 2000 - 2002. Several factors were discussed when explaining the success of the penthrite grenade. The design of the grenade is such that the hunter should preferably aim at the side of the animal as opposed to the cold grenade where they hit from behind. Furthermore the detonation takes place when the grenade has travelled some 65 cm inside the animal.

The EG discussed killing efficiency of the hunting weapons and the following three aspects were noted: shock waves, bleeding and mechanical destruction. However with reference to Siri Knudsen's work (Knudsen 2004) the shock waves was considered the most important factor of these three to cause instantaneous death when the detonation takes place in the regions in front of the cranial part of the abdomen.

The EG strongly emphasised that successful and rapid kills is dependent on both equipment, target area and the angle of the shot i.e. to shoot the animal from the side and in front of the abdominal region. .

The EG welcomed and encouraged plans for sampling new TTD data in the Norwegian hunt recognising that 8 years have passed since the last data were collected. The importance of random sampling was emphasised if data are not sampled for all whales taken.

## **ICELAND**

### **Minke whale**

Iceland resumed commercial whaling in 2006 following a temporary stop in whaling from 1986 due to the IWC moratorium. A research programme on minke whales was carried out from 2003 to 2007 that included the taking of 200 whales.

The hunt is conducted from small boats - both fishing boats and others. The whales are being flensed on board and the boats are not dependent on returning to a land base before they have reached their storage capacity. The crew has mainly consisted of whalers with experience from the pre-moratorium years (before 1986) and the scientific sampling programme 2003-2007.

The hunting equipment is similar to that which is used in the Norwegian hunt i.e. 50 mm harpoon guns with the Norwegian whale grenade charged with 30 g penthrite and .458 calibre rifles as a back-up weapon. The harpoon is connected to an elastic line tied to an underline that is connected to an effort-sensitive hydraulic winch. Traditionally 40 g of gunpowder was used to launch the harpoon, but the charge was increased to 52 g in 2009 in line with what is used in Norway. As a result the whalers reported that not a single incidence of line breakage occurred, while previously it was not uncommon that the harpoon failed to penetrate through the animal, resulting in very loose attachment of the harpoon to the whale.

The traditional 16 – 18 mm nylon line has been substituted with a line made from 10 mm Dynema® on all boats. This line is reported to be much stronger and also lighter compared to the previous line of nylon thus decreasing the needed power of the shot. The “back line” on the winch is made of nylon.

Instead of a spring system the Icelandic hunters are using a winch that can be adjusted to a certain pressure, above which it gives in, similar to the reel on a fishing rod. Minimum allowed power of the winch is 5 tonnes. Hauling of the whale towards the vessel should start immediately after it has been shot. If the whale is alive it is shot in the brain with a rifle bullet as soon as possible. This can often be done before the animal has been pulled all the way to the ship. Systematic TTD data have not been collected from the commercial hunt. In 2009 the IDR was estimated by the hunters of the vessels operated by the minke whalers’ association to be 70 %.

Iceland has so far not collected any data on TTD, but has referred to the results from the Norwegian hunt when dealing with questions of killing efficiency. In the cases where TTD has been noted, it has been based on information from the hunters and not on *post-mortem* examinations.

### **Discussion on the Icelandic minke whale hunt**

The EG emphasised that although the hunting methods and hunting equipment may be similar in Norway and Iceland this does not necessarily make the efficiency of the killing comparable. It is therefore advisable for Iceland to collect data on TTD and IDR to get better and more reliable data from the hunt.

### **Fin whale (*Balaenoptera physalus*)**

Fin whale hunting is conducted from medium-sized boats that are exclusively used for whale hunting. The hunting grounds are within Iceland's 200 miles exclusive economic zone (EEZ), and the whales are towed to a land station for flensing and processing

The boats are equipped with strong winches for hauling the whales alongside the boat. The winch can load up to 30 tonnes.

The hunting weapon used is a 90 mm harpoon gun loaded with a harpoon with 4-claws. Prior to 2009, cast iron grenades filled with black powder (500 g) together with (from 1986 on) a modified penthrite grenade with 100 g of penthrite fuse were used to kill the whales. When Iceland resumed fin whale hunting in 2009, a prototype of a modified penthrite grenade with 100 g of pressed penthrite was developed and tested. This prototype which was made of aluminium was lighter than the previous grenades. However, it showed some weaknesses with the head design and the trigger hooks and will be replaced by a new prototype penthrite grenade made of steel (Proto 2) in 2010. The back-up weapon is reshooting with harpoon grenade.

The new grenade is still in a development stage and no data have been collected on the TTD or IDR.

### **Discussion on the Icelandic fin whale hunt**

The EG noted with satisfaction the work being done on improving the hunting methods, and the continuation and completion of this work was strongly encouraged.

In 2010, the second prototype of a new penthrite grenade designed for the fin whale hunt with 90 mm harpoon guns, will be tested. The EG emphasised that it will be important to document the efficiency and performance of the new grenade. It was recommended that TTD and IDR should be collected and analyzed with covariates such as estimated distance and angle of the shot, hit region and detonation area for the sake of improving hunting methods.

The EG furthermore encouraged the specialist examination of organs and tissues to understand better how the whales die.

In view of a reported accident with a prototype grenade detonating during flensing the EG recommended an examination of the potential use of acoustic monitoring of grenade detonation in order to enhance human safety during flensing.

## **JAPAN**

The Japanese Whaling Research Programmes in the Antarctic Sea (JARPA and JARPA II) and the Western Northern Pacific (JARPN and JARPNI) have been carried out since 1987/88 and 1994 respectively. These programmes are all referred to as offshore operations. From the

2002 season, JARPNII extended its research programme to also cover common minke whales closer to shore – referred to as coastal operations.

**Minke whale**

The coastal research operations are conducted from four small catcher boats. There are no freezers or refrigerating facilities on board so that the whale carcasses must be transported as soon as possible to a land base. The hunting weapons used are 50 mm harpoon guns equipped with a penthrite grenade charged with 27 g of explosives. In the coastal operations cold harpoon and/or steel lance are used as the secondary weapons.

In the offshore research operations they use catcher boats for sightings and hunting with a mother ship for flensing, processing and biological research. In this hunt, a 75 mm harpoon gun charged with 30 g penthrite grenades is used. The boats are equipped with two winches and use whaling sonars to spot the whales. In the offshore operations cold harpoons and/or rifles of calibre .375 are used as the secondary weapons.

**Fin, sei (*Balaenoptera borealis*) sperm (*Physeter macrocephalus*) and Bryde’s (*Bedeni*) whale**

The large whales: fin, sei, sperm and Bryde’s whales are all hunted with 75 mm harpoon guns. With the exception of the smaller Bryde’s whales, where 30 g of penthrite is used, the penthrite charges are larger than for minke whales (see Table 1 below) and the fuse has a longer delay time. The secondary (back-up) weapons used for these whales are a second penthrite grenade or large calibre rifle (.458).

Table 1. Summary of primary and secondary killing devices for target whale species.

	Primary killing method (grenade )	Primary killing method (fuse )	Secondary killing method	Remarks
Fin whale	75 mm harpoon with 60 g penthrite explosive	0.1 sec./0.05 sec. Delayed	Second harpoon with 60g penthrite explosive	Rifle is not effective as the secondary killing method.
Sei whale	75 mm harpoon with 60 g/50 g penthrite explosive	Ditto.	Second explosive harpoon and large calibre rifle (.458)	Penthrite amount and fuse was selected by estimated body length.
Sperm Whale	Ditto.	Ditto.	Second explosive harpoon with 60g/50g penthrite explosive	Rifle is not effective as the secondary killing method.
Bryde’s whale	75 mm harpoon with 50 g/30 g penthrite explosive	0.05 sec. delayed or 0 sec.	Second explosive harpoon and large calibre rifle (.458/.375)	Penthrite amount and fuse was selected by estimated body length.
(Antarctic) Minke Whale	75 mm harpoon with 30 g penthrite explosive	0 sec. fuse	Second cold harpoon or large calibre rifle (.375)	50 mm explosive harpoon is used for coastal operation.

**Research**

Hunting methods have been successfully improved over the years reducing TTD and increasing the IDR. Improvements and modifications have been made both to the fuse (igniting device for the penthrite charge) and the harpoon head. The former Japanese grenades for minke whales often misfired and in addition, the “struck and lost” rate was relatively high in some hunts – in some cases due to large bits of shrapnel from the grenade casing after it

had exploded cutting the line of the harpoon. The current grenade has a refined fuse that explodes earlier after penetration into the whale body. Also the harpoon head (casing) is shorter and made of steel that produces less and smaller sized shrapnel.

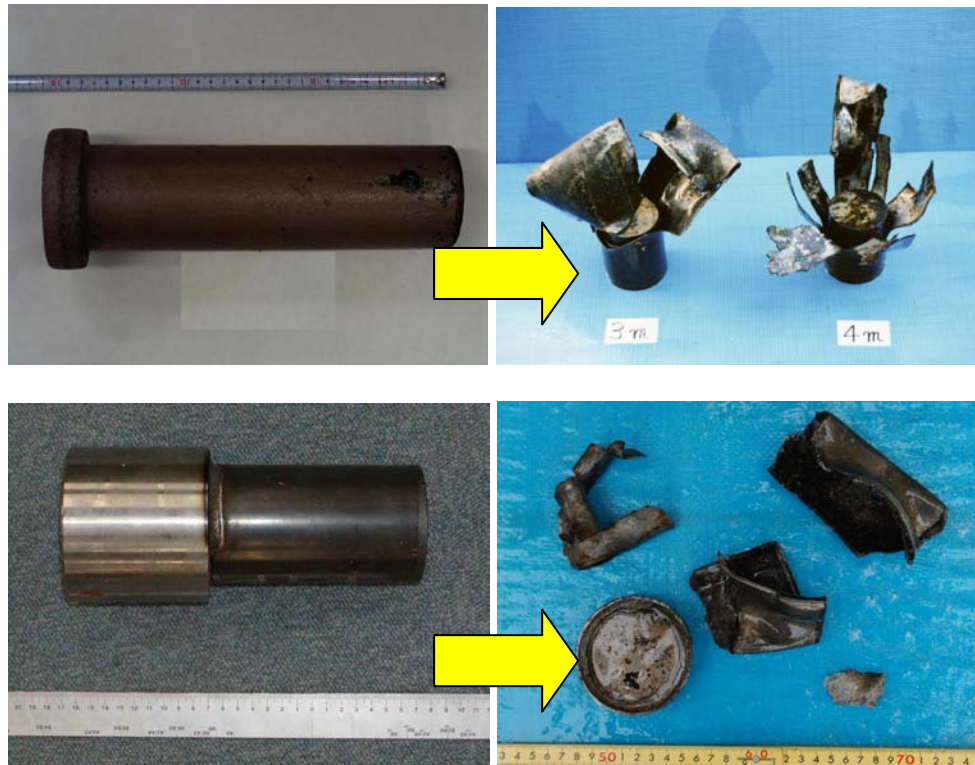


Figure 1. (Upper) The traditional style harpoon head and shrapnel after explosion. A large shrapnel with a heavy weight was left in the whale body frequently. It sometimes cut the harpoon line and caused “struck and lost”. (Lower) Improved harpoon head produces less and small sized shrapnel than the traditional one, which is expected to reduce possible “struck and lost”.

Regression analysis of TTD and IDR from the coastal research operations of common minke whales from 2002 to 2009 (Table 2 and Fig. 2) revealed a significant decrease of the TTD ( $p < 0.0001$ ) and increase of the IDR ( $p = 0.001$ ).

The same improvements of TTD and IDR are found in the offshore operations for the common minke whale during the research years from 2005 to 2009 (Table 4.), the Antarctic minke whales from 2005/06 to 2008/09 (Table 3) and the Bryde’s whale during research years from 20005 to 2009. For the sei whales IDR also increased significantly but TTD did not show significant decrease (Table 4).

Table 2. TTD and IDR for common minke whales taken in the JARPNII coastal operation. Yearly total number from 2004 to 2008 season was combined with two surveys (in Sanriku and Kushiro region).

Season	Species	Total number	Time to death (TTD)			Instant death rate (IDR)
			MED	MEAN	S.D.	
2002	Common minke whale	50	8:50	8:17	6:07	14.0 %
2003		50	7:40	7:51	2:36	14.0 %
2004		60	5:50	6:51	6:50	30.5 %

2005	(coastal)	120	5:20	6:13	7:16	32.5%
2006		95	3:10	6:42	14:23	43.2%
2007		106	1:45	4:42	6:52	47.2%
2008		110	2:15	4:57	7:23	40.9 %
2009*		60	0:00	2:54	4:02	55.0 %

\*Data of 2009 Kusiuro region (59 sample) are not analyzed.

Figure 2. TTD and IDR for common minke whales for each survey of JARPNII coastal operations. TTD is indicated by a medium value (seconds) and IDR is indicated by a percentage.

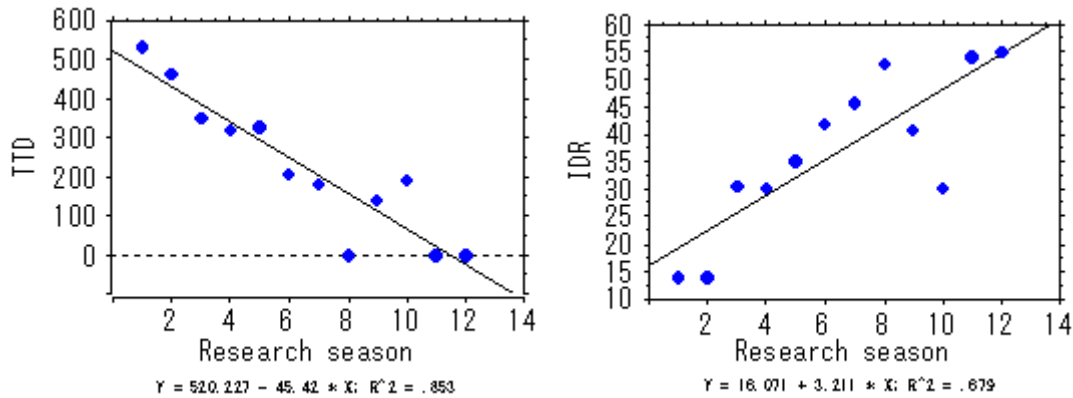


Table 3. TTD and IDR from the 2005/06 to 2008/09 JARPAII. The data for fin whales were excluded because of insufficient numbers of data for analysis.

Season	Species	Total number	Time to death (TTD)			Instant death rate (IDR)
			MED	MEAN	S.D.	
2005/06	Antarctic Minke whale	853	0:00	2:06	3:37	50.3 %
2006/07		505	2:00	2:26	3:57	40.6 %
2007/08		551	0:00	1:57	2:33	51.0 %
2008/09		679	0:00	2:12	3:17	54.2 %

Table 4. TTD and IDR for minke, Bryde's and sei whales from the 2005 to 2009 JARPNII.

Season	Species	Total number	Time to death (TTD)			Instant death rate (IDR)
			MED	MEAN	S.D.	
2005	Minke whale (offshore)	100	2:30	2:32	3:02	40.0 %
2006		100	1:30	2:01	2:36	44.0 %
2007		100	0:55	3:02	6:11	50.0 %
2008		59	0:00	2:37	4:06	52.5 %
2009		43	0:00	1:49	2:09	53.5 %
2005	Bryde's whale	50	2:15	2:25	2:56	42.0 %
2006		50	2:25	2:14	2:13	40.0 %
2007		50	0:00	2:23	3:11	54.0 %
2008		50	0:00	4:49	13:17	60.0 %
2009		50	0:00	1:59	3:35	68.0 %

2005	Sei whale	100	3:20	3:59	4:21	38.0 %
2006		100	2:40	3:43	4:52	42.0 %
2007		100	3:55	4:54	5:24	34.0 %
2008		100	3:30	4:31	7:45	43.0 %
2009		100	3:25	4:29	7:46	47.0%

### **Dolphin**

A paper on improvement of slaughtering methods in dolphin drive fisheries in Taiji, Japan during the years between 2 000 and 2009 was presented to the meeting.

### **Discussion on the Japanese large whale hunts**

The EG focused its discussion on the presented material for minke whales.

The EG acknowledged that there had been a significant improvement in TTD and IDR in recent years in the Japanese hunt, especially in the common minke whale hunt in the coastal operations. Based on the presented material the EG thought it plausible that this could be explained by the increased charges of penthrite in the grenades.

The EG pointed to the fact that although Japan use penthrite like in Norway there are substantial differences in reported IDR. One possible explanation put forward was that the chase of the whales lead to hits from behind instead of hits from the side of the whale which reduced the efficiency of the grenade detonation.

The EG emphasised that it would be important to learn more about the TTD of the animals not killed instantaneously which accounts for approximately 50 % of the caught animals. It was furthermore essential to examine where these animals were hit. Most of the whales not killed instantaneously are killed by rifle shots.

The EG recommended logistic regression analysis on IDR from Japanese minke whale catches, both coastal and offshore, to try to identify the reasons for the differences between Japanese and Norwegian IDR, and to use Cox's regression methods on TTD for whales not killed instantaneously, to study the efficiency both of the harpoon method itself on these whales and the efficiency of the secondary killing methods.

### **Discussion on the Japanese dolphin hunts**

The EG welcomed the information on hunting methods from Japanese dolphin fisheries which clearly shows considerable improvements over the recent years. Because of limited expertise in the present EG and the need for detailed discussions it was recommended to organize a dedicated working group on the taking of small cetaceans with pertinent experts invited.

## **GREENLAND**

In Greenland both minke whales and fin whales are hunted with 50 mm harpoon guns using harpoons equipped with the Norwegian penthrite grenade (Grenade-99) charged with 30 g of pressed penthrite. The trigger rope for the minke whale grenade is 45 cm and it detonates the grenade 65 cm after penetration into the whale body. The grenade used for fin whale is slightly modified with a 110 cm long trigger rope which triggers the detonation at a depth of about 130-140 cm. In Greenland, minke whales are also hunted with rifles from dinghies (collective hunt). The reporting of TTD is based on information from the hunters. The hunters



make their estimations based on the IWC criteria i.e. when the flippers and the whale no longer move, including when the whale has sunk and there is no movement in the harpoon line or floats. When a whale is reported as instantaneously killed it is dead within 1 minute. There is no system for *post-mortem* examinations to confirm TTD.

### **Whaling with harpoon gun**

#### **Minke whale**

The primary weapon is a 50 mm harpoon gun loaded with the penthrite grenade. The harpoon is attached to a forerunner which in turn is attached to a winch onboard the vessel. The gunners aim at the region in front of the pectoral flippers in order to wound the heart and surrounding areas.

The back-up (secondary) weapons used are either a second harpoon or rifles with calibres 7.62 mm (30.06) and full mantled bullets or round-nosed bullets calibres .375. The rifle shots are aimed at the side of the head to hit the brain or the cervical cord. During the years 2001 to 2008 it was reported that 27 – 31% of these whales died instantaneously or within 1 minute, and that 61 – 67 % died within 5 minutes.

#### **Fin whale**

Fin whales are hunted with the same 50 mm harpoon guns loaded with a penthrite grenade as in the minke whale hunt. The difference is the longer trigger cord. The secondary weapon is the same as the primary weapon. The hunt is carried out by two boats of a minimum length of 30 feet working together or by one boat of a minimum length of 36 feet.

The gunners shoot in the heart and lung regions by aiming at the area in front of the pectoral fins.

During the years 2001 to 2008 it was reported that 20 % of the whales died instantaneously or within 1 minute, and that 40 – 50 % died within 5 minutes.

A modified penthrite grenade with 45 g of pressed penthrite will be produced in 2010 and the plan is to implement this modified grenade in the fin whale hunt during the 2010 or 2011 hunting seasons.

#### **Bowhead whale**

In 2009, three bowhead whales were hunted using the same weapons as for the fin whale hunt.

No information was given on TTD or IDR for this hunt.

### **Discussion on the harpoon gun hunt**

The EG noted that in the minke whale hunt there are quite substantial differences between Greenland and Norway with respect to TTD although the equipment and method used are similar to the Norwegian hunt. The percentage of animals killed instantaneously is much lower than in the Norwegian hunt.

The EG pointed to several factors as possible explanations:

- the fact that the TTD is estimated by the hunters themselves without any necropsy reports to confirm it and that the hunters use the IWC criteria for determining when a whale is dead, most probably overestimates the TTD,
- there are more small vessels in Greenland than in Norway,
- although all harpoon guns were overhauled in 1999, hunters are beginning to report worn-out guns,
- the lack of organised and standardised training courses for gunners with respect to shooting.

The EG noted and encouraged the expressed request from the hunters for a debriefing at the end of the season in order to exchange information and experiences.

It was pointed out that there had been improvements in TTD for the fin whale hunt in recent years and that this was probably the result of increased experience by the hunters.

Both with respect to the fin and bowhead hunts the EG encouraged the setting up of shooting trials in order to teach the hunters about the trajectory of the harpoon through the water. Based on these trials it will be possible to better advise on how to approach the whales and where to aim at the whales.

The EG agreed with the opinion voiced by Greenland that an increase in the current penthrite charge in the fin and bowhead hunts would be recommendable and that it would be of interest to also investigate a potential increase in the propellant charge. For the three large species, fin, humpback and bowhead, it was recommended that the same modified penthrite grenade be used. In general it was encouraged that hunters be trained to measure and report on strike and detonation location, and the distance between these two points.

The EG emphasised the need for more statistical data. It would be especially important to know the survival times of those whales that are not killed instantaneously and also to get more information on the actual target area. The EG agreed that the manner in which the data are currently presented may give a more negative picture with respect to TTD and IDR than is actually the case. Greenland was therefore urged to present the statistics in a more appropriate and correct way.

### **Collective minke whale hunt**

It is a prerequisite for the collective hunt that a minimum of 5 skiffs must participate. Typically small dinghies with outboard engines and also small fishing boats are employed in this hunt. Hunters fire the rifle into the water in order to drive the whale towards shallow and inshore waters. To prevent the whale from sinking when it is dead, it is necessary to first attach floats to the whale before killing it. The floats are attached by throwing hand-held harpoons into the animal. In order to be able to attach the floats it is necessary to wound the animal by firing several rounds into the animal so that it is slowed down sufficiently so that the hunters can get close enough to attach the floats. At the first opportunity, hand harpoons with floats are attached. Once the whale has been secured with a sufficient number of floats, it is killed with rounds aimed at the brain. The weapons used in the collective hunt are rifles of calibre 7.62 mm (30.06) or larger with full jacketed bullets for the wounding and round-nosed bullets with higher calibres like .375, to kill the whale.

During the years 2001 to 2008 it was reported that 0 - 2 % of the whales in the collective hunt died instantaneously or within 1 minute, and that 6 – 10 % died within 5 minutes.

### **Discussion on the collective rifle hunt**

The EG recognized that the nature of the collective hunt imposes longer TTD. From a hunter safety point of view and in order not to lose the whale, the whale needs to be wounded first to slow it down to enable getting close enough to secure the whale with floats before killing it.

The hunters themselves stated that there are clear differences in killing efficiency between different geographical regions in Greenland and it was thought that this might be the result of differences in hunters' experiences. It was also noted that the presented material showed a quite substantial decrease in the maximum TTD from 2005 and onwards and that this also possibly reflected more experienced hunters.

The EG emphasized that more data are needed with reference to TTD and also with respect to the hit region. A reference was made to Norwegian anatomical figures of the position of the brain of minke whales for the purpose of hunter's aiming. The EG recommended that experienced hunters should meet with less experienced hunters to exchange information. It would be especially important to focus on where to aim the first shot, and the aiming of the shot that kills the whale after the floats have been attached.

## **ASSESSMENT AND COMPARISON OF DIFFERENT HUNTS**

In assessing the different hunts presented to the meeting, the EG found that it was only with respect to the minke whale that it could possibly make some comparisons between certain aspects of these hunts. However, even for the minke whale hunts it was evident that the collection of more data is necessary before one may analyze the reasons for the observed differences with respect to killing efficiency. The collection of TTD for those whales that do not die instantaneously was emphasized as being especially important.

In general it was the opinion of the EG that information on IDR for all hunts is probably biased low and TTD is biased high. Furthermore it was thought that these biases are probably greatest for the Greenlandic hunt, and for other hunts where the TTD are estimated by the hunters and are not corrected by *post-mortem* examinations.

## **EDUCATION AND TRAINING OF HUNTERS**

### **Norway**

Norwegian whaling is subject to strict and detailed regulations concerning all aspects of the whaling activities. There are rules for hunting season, quotas, equipment and monitoring. The permission to go whaling is given on an annual basis, and there are certain requirements that must be met in order to get a licence.

One of the most important conditions is the unconditional requirement of having passed the obligatory course for licence holders and gunners. The training courses are mandatory and arranged by the Directorate of Fisheries.

During the courses the hunters are equipped with a handbook of relevant laws and regulations together with hunting procedures and weapon regulations. Professional and technical

personnel are giving lectures on laws and regulations, animal welfare, anatomy and physiology relevant for the understanding of the behaviour of the whales.

The hunters are also taught how to use the different tools correctly, maintenance of the tools (rifle, harpoons, harpoon guns) and how to take care of the products from the hunt. Furthermore the licence holders are trained in how to take biological samples of the catch for the DNA-register.

The courses are no longer arranged on a yearly basis, but whenever there are new regulations concerning the hunt or new licence holders. However, on a yearly basis prior to the beginning of each hunting season, the hunters are required to pass obligatory shooting tests, both with rifle and harpoon guns. The shooting tests with the harpoon guns are conducted by inspectors from the Directorate of Fisheries.

### **Iceland**

Traditionally, education and training of minke whalers took place informally by transfer of knowledge from one generation to the next. Formal courses in the use of harpoon guns and grenades were first held in 1983 by Dr. Egil Ole Øen from Norway and the most recent course was held in 2009. In order to get a licence for minke whaling, Icelandic regulations require that the gunner undertake a course in handling of harpoons and grenades as well as holding a general licence for firearms. No training requirements exist on an annual basis.

In the fin whale hunt the gunners have been trained in how to handle grenades.

### **Japan**

In Japan, gunners, crew members and the persons concerned always have a meeting before the start of a research cruise to discuss experiences and results of data analysis from the last season with respect to improving TTD. Also during the season necropsy records obtained by a researcher on the mother ship are sent to the gunners on the sampling vessels as soon as possible so that the gunners may review the results of their shots while their memories are still fresh.

### **Greenland**

In Greenland, only full-time hunters can apply for a licence to hunt large whales. Presently there are no training courses or tests to be passed on how to shoot and where to aim at the animal. Knowledge is passed from generation to generation.

As in Iceland, there are only courses in how to handle the grenades. The use of penthrite grenades became mandatory for boats equipped with harpoon guns in 1991. A special course is obligatory in order to buy, handle and use harpoon grenades. The grenades may only be bought after presenting the certificate from this course together with the licence for whaling.

Licences for whaling with harpoons are only given to boat owners who have taken the course or have at least one crew member who has passed the course. It is KNAPK who organizes the courses in cooperation with the Ministry of Fisheries, Hunting and Agriculture. The courses are held once or more times a year depending on demand. The programme of the course includes the mechanics of the Whale grenade 99, security aspects, mounting of the harpoon, storage and handling of the grenade, as well as operations of the harpoon cannon.

KNAPK and the Ministry also organize courses in mounting and renovating of the harpoon guns. These courses are taken by people who have a technical education on welding and who are working with metal and are employed in a shipyard approved for the mounting and checking of harpoon guns. The harpoon guns are, by regulation, examined and approved every other year by a person certified through the before-mentioned course.

### **Discussion**

The EG recognized that whaling takes place in many different regions/countries and that it therefore may be difficult to make a requirement for standardized training programmes. However the importance of training and education in order to secure efficient killing both from an economical and animal welfare point of view and also with respect to hunter safety was highly emphasized. The EG acknowledged the importance of regular training and exchange of information in order to achieve more efficient hunts and to improve animal welfare. It was regarded as essential to combine theoretical education with physical meetings in order to exchange information and experiences. The processes of sampling and recording of data should also be included in the training programmes.

With reference to a handbook that has been developed and successfully used in the Alaska bowhead hunt, the EG recommended that NAMMCO develop a standard handbook for hunters giving relevant information *inter alia* on weapons, killing techniques and animal welfare.

## **MONITORING**

### **Norway**

Today, at-sea monitoring is carried out by the Electronic Trip Recorder (the Blue Box). The Blue Box system consists of a control and data logger box (Blue Box) designed to independently monitor and log hunting activity data provided by an independent GPS and different sensors placed in certain areas and structures of the boat. The data prove that a whale is shot and taken onboard. The control box and the sensors are configured and calibrated individually for each vessel before each hunting season. The system is automated with programmes designed for the continuous operation and logging of data for at least 4 months and equipped with back-up batteries and automatically restarting functions following system interruption.

When the hunting season is closed, the encrypted data are collected from the Blue Box, decrypted and analyzed by authorized personnel in the Directorate of Fisheries.

In addition, inspectors from the Directorate of Fisheries are conducting periodic and random checks of hunting activities. These inspectors have attended the same training courses as the licence holders and gunners. TTD data was collected until 2002. A supplementary sampling of TTD data is planned to be conducted in the future.

### **Iceland**

All caught animals are reported to the Directorate of Fisheries. For each whale they report on sex, length, where the animal has been taken, etc. No TTD or IDR are reported. National inspectors will accompany the whaling boats at random intervals.

### **Japan**

Whaling of large species in Japan is only conducted by the Japanese Whale Research Programme under the Special Permit (JARPAII, JARPNII). In those programmes, a researcher(s) is/are allocated to all whaling vessels and also a national inspector(s) is present at a mother ship (offshore operation) or a land base (coastal operation). In other types of whaling, such as dolphin fisheries and small type whaling for toothed whales, there are some researchers at the land station for biological data collection. However, this is conducted voluntarily and do not cover all species and seasons.

### **Greenland**

Hunting is regulated and administered by the Ministry of Fisheries, Hunting and Agriculture, and supervised by the Fisheries Licence Control Authority. Locally, a team of wildlife officers control hunting activities making sure that regulations are followed. These wildlife officers work in close cooperation with the municipalities, the police, Island Command Greenland and the Government of Greenland. In the small communities in Greenland it would be very difficult to kill, flense and distribute a large whale without the local authorities noticing it and asking for the relevant licence or permit. In addition, the wildlife officers monitor the hunt by making random checks out in the field and in the open markets where the hunters sell their products. In 2009, 9 wildlife officers and up to 12 assisting wildlife officers were employed nationally, and they operated 8 vessels in West Greenland.

The reporting system in Greenland is a self-reporting system. When a hunter catches an animal he must inform the authorities and obtain a stamp in his licence. Any sale of edible products is forbidden until the licence is stamped. If the catch occurs at the weekend, it must be reported on the following Monday. Hunters with a harpoon gun licence must present the invoice for the purchase of the harpoon grenade together with the used grenade. The harpoon grenades in Greenland are marked with unique serial numbers and distributed under a tightly regulated system.

For every large whale taken, the responsible person (captain of the harpoon boat or the chosen leader in the collective hunt) is required to fill out a special report that is submitted to the Ministry shortly after the hunt. The information given includes information about the hunter, his licence and boat, description of the weapon used to kill the animal, serial number of the grenade, etc. Furthermore it gives information on species, catch area and flensing place, body length, sex, reproductive state of females, stomach contents, weight of meat products, “struck and lost” and estimated time to death (TTD).

### **Discussion**

The EG noted that monitoring serves at least the following three important purposes:

- Ensures that the hunt is carried out according to laws and regulations;
- Provides information relevant for the management of the stocks;
- Provides information on killing efficiency and animal welfare.

The EG recommended standardizing the TTD criteria used across hunts. It was acknowledged that the hunters are doing the monitoring in addition to many other responsibilities – therefore a balance will have to be achieved between hunting activities and monitoring /collecting of information.

The EG recommended that a small group be formed to prioritise the needed monitoring information.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Norway**

Data have not been sampled in the last 8 years.

The Expert Group (EG) recommended a sampling of Time to Death (TTD) in the same way as was done in previous years so that the data are comparable – either on all boats or in a random sample of boats.

### **Iceland**

#### ***Minke whale***

The EG recommended that in the future, Iceland reports for minke whales whether the whales are killed instantaneously and if not, the TTD.

#### ***Fin whale***

The EG recommended that in the coming season, data of killing efficiency - TTD and Instantaneous Death Rate (IDR) should be collected and analyzed with covariates (estimated distance and angle of harpoon cannon shot, hit region and detonation area) for the sake of improving hunting methods.

It was noted that a development programme for the fin whale hunt has started in Iceland. In 2010 the second prototype of a new penthrite grenade designed for the fin whale hunt with 90 mm harpoon guns will be tested. The EG acknowledged the work and encouraged continuation and completion of this work.

The EG furthermore encouraged the specialist examination of organs and tissues to better understand how the whales die.

The EG recommended an examination of the potential use of acoustic monitoring of grenade detonation in order to enhance human safety during flensing.

### **Japan**

#### ***Minke whale research hunts***

The EG acknowledged the improvements taken place in recent years in the Japanese minke whale hunts and in particular in the coastal hunt.

The EG recommended logistic regression analysis on IDR from Japanese minke whale catches, both coastal and offshore, to try to identify the reasons for the differences between Japanese and Norwegian IDR, and to use Cox's regression methods on TTD for whales not killed instantaneously, to study the efficiency both of the harpoon method itself on these whales and the efficiency of the secondary killing methods.

#### ***Other species – Dolphin***

The EG welcomed the information on hunting methods from Japanese dolphin fisheries which clearly shows considerable improvements over the recent years. Because of limited expertise in this EG and the need for detailed discussions it was recommended to organize a dedicated working group on the taking of small cetaceans with pertinent experts invited.

## **Greenland**

### ***Minke whale***

#### *Harpoon hunt*

In Greenland and Iceland, TTD is estimated by the hunters but they have no necropsy reports to confirm TTD. In addition, the current IWC criteria used tend to overestimate TTD.

The EG recommended Greenland to present the data and analyses in a statistically more informative way than is being done now.

It was furthermore recommended the organization of a practical training course for gunners. There should, as stated by the hunters, be a debriefing at the end of the season in order to exchange information and experiences from the season.

#### *Rifle hunt*

There is a risk of a longer TTD and higher “struck and lost” in the rifle hunt than in the grenade harpoon hunt.

The Greenlandic hunters stated that there is a clear difference in efficiency of killing between different geographical regions in Greenland.

The EG recommended that experienced hunters should meet with less experienced hunters to exchange information. It is especially important to focus on where to aim the first shot and the aiming of the shot that kills the whale after the floats have been attached.

More data are needed with reference to the body position where the whale is hit and TTD. Norwegian anatomical figures of the position of the brain of minke whales can be used for training purposes and be handed out to the hunters.

### ***Fin whale***

The EG acknowledged the improvement of TTD in recent years in Greenland. This improvement is probably the result of increased hunter experience.

### ***Bowhead***

The EG recommended that shooting trials are set up to study the trajectory of the harpoon through the water and on this basis give advice on how to approach and where to aim at the whale.

### ***Fin whale and bowhead***

The EG agreed with Greenland’s recommendation to increase the current penthrite charge for the fin and bowhead hunts and also to investigate a potential increase in the propellant charge.

### ***Fin, humpback and bowhead***

The EG recommended that the same modified penthrite grenade be used for the three large species – in fin, humpback and bowhead whale hunts.

It was furthermore recommended that hunters be trained to measure and report on strike location, detonation location and distance between the two.



## **Assessment and comparison of different hunts**

### ***Minke Whale***

Processing of data:

The EG recommended collecting TTD for whales that do not die instantaneously. The purpose is to analyze the reasons for differences among different hunts in order to improve efficiency.

Information on IDR for all hunts is probably biased low and TTD is biased high and these biases are probably greatest for the Greenlandic hunt. This especially concerns hunts where the TTD are estimated by the hunters and are not corrected by *post-mortem* examinations.

### **Education and training**

Regular training and exchanging of information is very important to achieve more efficient hunts and to improve animal welfare.

The EG recommended that NAMMCO develop a handbook for hunters giving relevant information *inter alia* on weapons, killing techniques and animal welfare.

The EG emphasized the importance of combining theoretical education with physical meetings in order to exchange information and experiences, including sampling and recording of data.

### **Monitoring**

Monitoring serves at least three important purposes:

- Ensures that the hunt is carried out according to laws and regulations;
- Provides information relevant for the management of the stocks;
- Provides information on killing efficiency and animal welfare.

The EG recommended standardizing the TTD criteria used across hunts. It was acknowledged that the hunters are doing the monitoring in addition to many other responsibilities – therefore a balance will have to be achieved between hunting activities and monitoring /collecting information.

The EG recommended that a small group be formed to prioritise the needed monitoring information.



## **Appendix 1 - Agenda**

1. INTRODUCTORY ITEMS
  - 1.1 Appointment of Chair
  - 1.2 Appointment of Rapporteur(s)
  - 1.3 Review of Documents
2. TERMS OF REFERENCE AND BACKGROUND TO THE WORKSHOP
3. ADOPTION OF THE AGENDA
4. DESCRIPTION OF KILLING METHODS IN USE AND/OR UNDER DEVELOPMENT  
CRITERIA FOR DEATH AND REVIEW OF TTD DATA
  - 4.1 Norway
    - 4.1.1 Minke whales
  - 4.2 Iceland
    - 4.2.1 Minke whales
    - 4.2.2 Fin whales
  - 4.3 Japan
    - 4.3.1 Minke whales in Antarctic and N. Pacific
    - 4.3.2 Minke whales, coastal
    - 4.3.3 Sei whales
    - 4.3.4 Bryde's whales
    - 4.3.5 Other species
  - 4.4 Greenland
    - 4.4.1 Minke whales
    - 4.4.2 Fin whales
    - 4.4.3 Bowhead whales
5. ASSESSMENT AND COMPARISON OF METHODS AND EFFICACY
  - 5.1 Minke whaling
  - 5.2 Large whales (Fin, Sei and Bryde's whales)
  - 5.3 Bowhead whaling
6. EDUCATION AND TRAINING OF HUNTERS
7. MONITORING SCHEMES
8. CONCLUSIONS AND RECOMMENDATIONS
9. OTHER MATTERS
10. ADOPTION OF REPORT

## **Appendix 2 - List of Participants**

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### Appendix 3 - List of Documents

NAMMCO/EG/Doc 1	Agenda
NAMMCO/EG/Doc 2	List of Documents
NAMMCO/EG/Doc 3	List of Participants
NAMMCO/EG/Doc 4	Terms of Reference
NAMMCO/EG/Doc 5	<i>Ishikawa, Hajime 2010</i> . Progress report on the killing method of whales in the second phase of Japanese whale research program in the Antarctic Sea (JARPAII) and Northwest Pacific Ocean (JARPNII).
NAMMCO/EG/Doc 6	<i>Ishikawa, Hajime 2010</i> . Progress report on the killing method of whales in the JARPNII coastal operation.
NAMMCO/EG/Doc 7	<i>Iwasaki Toshihide 2010</i> . Brief report on improvement of slaughtering method in dolphin drive fisheries in Taiji, Japan during the years between 2000 and 2009.
NAMMCO/EG/Doc 8	<i>Øen, EO 2010</i> . Norwegian minke whaling: research to improve hunting and killing methods for minke whales in Norway 1981 – 2004.
NAMMCO/EG/Doc 9	<i>Ynnesdal, Hild 2010</i> . Electronic monitoring of Norwegian minke whale hunt.
NAMMCO/EG/Doc 10	<i>Jóhansson Gunnar 2010</i> . Minke whaling re-established in Iceland.
NAMMCO/EG/Doc 11	<i>IWC/59/ASW/8 rev</i> . White paper on hunting of large whales in Greenland. Greenland Home Rule Government 2007.
NAMMCO/EG/Doc 12	<i>IWC/M10/2</i> . Report of the small working group on conversion factors (from whales to edible products) for the Greenlandic large whale hunt.
NAMMCO/EG/Doc 13	<i>IWC documents</i> : Summary of Activities Related to the Action Plan on Whale Killing Methods (based on Resolution 1999-1) for the years 2005, 2006, 2007 and 2008. Submitted by the Greenland Home Rule Government to IWC

#### Additional documents:

*Knudsen SK. 2004*. Assessment of insensibility and death in hunted whales. A study of trauma and its consequences caused by the currently used weapons and ammunition in the Norwegian hunt for minke whales, with special emphasis on the central nervous system. Thesis for the degree of *Doctor Medicinae Veterinariae*, The Norwegian School of Veterinary Science, Department of Arctic Veterinary Medicine, Tromsø, Norway.

*Knudsen SK. 2005*. A review of the criteria used to assess insensibility and death in hunted whales compared to other species. *The Veterinary Journal* 169, 42-59.