Norwegian minke whaling
Research to improve hunting and killing methods for minke whales in Norway 1981-2004

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Current whaling practice

In Norway only one whale species is hunted, namely the minke whale. The hunt is conducted with small (50 feet) or medium sized (60-120 feet) fishing boats that are rigged for whaling in the spring and summer season. The hunting weapons consist of 50 mm and 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 equipped with a penthrite grenade mounted on the harpoon tip. The current grenade was developed in 1997-1999 (Whale grenade-99) and is loaded with 30g pressed penthrite as explosive. A triggering device, a twin hook connected to the firing pin in the grenade with an elastic synthetic cord, triggers the detonation when the harpoon has travelled about 70 cm inside the whale body. 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.

During whaling the boats are usually searching for whales in known whaling grounds in a relatively slow speed (4-6 knots/h). If flocks of birds are spotted, the boat often waits there for some time as also whales might come and start feeding on the prey. It is not unusual that whales approaches the boat in such situations and is shot when it blows or the boat might idle up to the area where the whale is expected to blow. If the whale starts swimming from the boat it follow after the whale to get close enough to fire the harpoon. No sonar or similar instruments are used during the hunt as such instruments are regarded to scare the whales.

The whale is shot from the side whenever possible and the gunner will usually aim the harpoon at the thorax region. A minke whale which is hit deadly as it rises to the surface to blow normally stops swimming, rolls on to its back, and floats for a short time before sinking. If it is deadly hit as it dives after blowing, it usually sinks without surfacing or pulls out some of the harpoon line before stopping. If the whale does not loose consciousness or die rapidly, it maintains its normal position in the water and dives actively and resurfaces to blow after some minutes. Therefore, if the whale does not immediately turn over on its back after being hit, or stops pulling out the line, it shall be hauled to the boat using the winch as fast as possible to check whether it is dead. The gunner will be ready to fire the back-up rifle when the whale comes to the boat. The rifle is usually fired at close range and when the whale's head is over water. The shot is directed to the brain. Many hunters fire a bullet in the brain as a matter of routines.

When the whale is lying at the boat side, a wire or rope is put around its tail before it is hauled on to the boat across the deck through an open gate in the gunwale and butchered (flensed). The meat and blubber is put on grates on the deck and cooled before being stored on ice in the hull until it is brought to on land processing plants.

Training of gunners and monitoring of the hunt

From 1984 to 2005 all gunners and licence holders were obliged to attend obligatory courses where they were given a detailed instruction on grenade function, function of the safe and arming

systems of the grenade, maintenance of harpoon gun, the importance of correct harpoon/grenade connector design and animal welfare considerations. Still each gunner is required to pass an annual and obligatory shooting test, both with rifle and harpoon gun. Prior to the hunt the boats and hunting gears are controlled and approved for hunting by governmental inspectors from the Norwegian Directorate of Fisheries and the Norwegian Food Safety Authority. From 2006 on the hunt is monitored at-sea by an electronic trip recorder, "Blue Box", and in random checks at sea and in harbours by authorised personnel from the Norwegian Directorate of Fisheries. TTd data from the Norwegian hunt has not been carried out since 2002. A supplementary sampling of TTD data is planned to be conducted in 2010.

Research programs 1981-2005

From 1981 to 2004 three major research projects to improve and assess the hunting and killing methods for minke whales have been conducted in Norway. The goal of these projects have mainly been

1) to develop hunting methods and improved gears to improve the animal welfare associated with the hunting and killing of the whales and also to improve the hunter's safety (Øen 1983a; b; c; Øen 1984; Øen 1995a; b; c; d; e) and
2) to 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 (Øen and Knudsen 2000; Knudsen and Øen, 2003; Knudsen 2004; Knudsen 2005) and
3) development of automated electronic monitoring technology for the Norwegian minke whale hunt.

The research programs had the most extensive research periods during 1981-86, 1992- 95 and 1997- 2006. It resulted in new inventions of hunting gears, development and implementation of new weapons technology, improved hunting techniques and routines, establishment of obligatory education and training of hunters and inspectors, plus the electronic monitoring system (Blue Box) (Øen 2005). Four types of whale grenades with the potent supersonic explosive penthrite were developed; two harpoon grenades used for minke whales (Øen 1995d; Øen 2003), one for fin and sei whale hunt in Iceland (*Øen* 1987), and one for the traditional darting gun used by traditional subsistence hunters of bowhead whales in Alaska (Øen 1995e).

Improvements have also been made and implemented to other parts of the hunting gears. The harpoons and harpoon lines are modified and reinforced to prevent breakages and a Norwegian whaler developed a new harpoon (Hopmark harpoon), which can be adjusted to fit to the barrel of the individual harpoon guns, which improves its ballistic properties and marksmanship. The traditional open harpoon gun sightings are gradually being replaced by optical sights which promotes marksmanship. Minimum calibre of back-up weapons has been established. Hunting practice has been changed to avoid long time suffering of wounded animals. Formalised, obligatory workshops and training courses for hunters were established and carried out on a regular basis from 1984 to 2005 (Øen 2006).

The inventions, improvements of hunting gears, education and training of hunters resulted in several improvements. 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.

Data of results of different killing methods were collected for 5552 minke whales from 1981 to 2002. The percentage of animals that died within one minute using harpoons without explosive devices (cold harpoons) in seasons of 1981-83 was about 17 % with an average TTD of 11min 20s. Seventeen percent of the whales were re-shot with harpoon (*Øen* 1995a).

The first trials with a new developed penthrite grenade with 22g of penthrite fuse as explosive started in 1983, continued through 1984, and were concluded after a comprehensive field study in 1985-1986 (Øen 1995d). The results showed that the penthrite grenade (1984-86) increased the percentage of animals that were killed instantly (IDR) or very rapidly by 2.7 times from 17% to 45 % (Øen 1995d). The median and average survival times were considerably reduced and the percentage of whales that were re-shot with harpoons was reduced to 4 %. However, some long survival times were still recorded. At that time re-shooting with rifle also often took long time as the rifle usually was kept indoors, unloaded and had to be retrieved and loaded before the shooter was ready. At that moment whales that had survived might already have dived or moved out of shooting range.

Prior to the hunting season in 1993, the hunting gears were reinforced. The required tensile strength of harpoons, forerunners, wires, winches and braking devices was increased from the former 1,500 kg to 5,000 kg. The harpoons were standardised in weight, and the harpoon claws were modified and reinforced. The 60 mm harpoon guns were modified by the introduction of a new and more reliable trigger mechanism. Gunners and licence-holders were required to take part in obligatory workshops and courses covering issues like anatomy of the minke whales with particular emphasis on positions of vital organs like brain, heart and lungs. They were instructed in maintenance of weapons, weapons ballistics, new hunting techniques, rifle-shooting. Each gunner was required to pass shooting tests using harpoon gun and rifle. They were also instructed to shoot the animal from the side whenever possible and to haul it to the boat immediately to determine whether re-shooting with rifle was needed and the rifle was moved from the wheel-house to the harpoon gun platform to be kept beside the gunner at all times.

The results from the 1993 hunt showed a slight increase in the IDR to 54 % (*Øen* 1995b). The obligatory courses for the licence holders and gunners therefore continued. Animal's anatomy, shooting with harpoon gun and rifle and rapid hauling in of the animals were again emphasised. The reports received for the traditional hunt in 1994 showed that all signs of life had ceased instantly in 59 % of the cases. The average survival time was 3 min. In 1995 the reports show that all signs of life ceased instantly in 62 per cent of the whales and the mean survival time was 3 min 24 s.

During the scientific whaling in 1992 and in the traditional hunt in 1993 it was discovered that some 10 % of grenades failed to detonate. A comprehensive work was started to detect and to solve the problem. The problem with misfire was detected and repaired. However, in the next production another problem occurred with the grenade's safe and arming mechanism (SAM). As the manufacturer could not guarantee its function in future productions it was decided to look for alternatives and the planning process to design a new penthrite grenade started in the fall of 1996.

In 1997 a new grenade with an improved SAM was designed by the author and constructed in cooperation with Norwegian Defence Research Establishment (NDRE) (Fig 1). The grenade is equipped with a reversible safety and arming mechanism (SAM) which automatically arms the grenade when it is mounted on the harpoon and re-secure if removed from the harpoon.

The penthrite charge was increased to 30g of pressed penthrite which is safer to handle by personnel and takes less space. The steel body of the grenade was replaced by aluminium which reduced the weight by 40%, and considerably improved the balance of the gun and the harpoon ballistics.

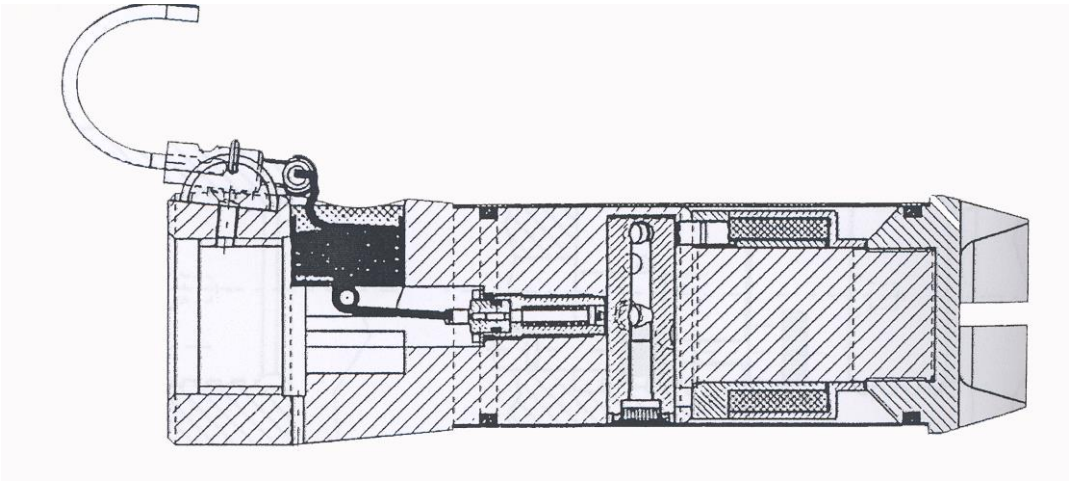

Fig. 1. Whale Grenade-99 (longitudinal section view). Safety and arming mechanism in secured position.

From the 2000 season on all vessels were equipped with the new grenade. The hunters were given detailed instruction in grenade function and use. Governmental inspectors, trained veterinarians and whale biologists, collected data from post mortem examinations, TTD data and the techniqual performance of the grenade. In 2000, 481 minke whales were killed with the new grenade and 78.3 % of the whales were recorded as dead instantly. The average TTD was 2 min. In 2001 the corresponding figures were 552 whales with an instant death rate of 79.7 %. The average TTD was 2min 25s. In 2002, 634 whales had been recorded and 80.7 % of these whales had been recorded instantly dead. The average TTD was 2min 21s using the criteria adopted by the International Whaling Commission in 1980 (*IWC* 1980) where TTD is 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. Only 0.5 % needed a second harpoon grenade (Øen 2003).

The results for the 1667 minke whales caught in the three seasons (2000-2002) are shown in Fig. 2 and 3 together with 2106 minke whales caught during the 1996-99 seasons with the old grenade and prototypes of the new grenade. The statistical analysis showed an IDR of about 80% with no statistical significant difference between the three seasons compared with an IDR of about 60% in 1996-99.

The results also showed that the whales die instantaneously or very quickly if the grenade hits and detonate centrally in the thorax or near the central nervous system (Fig. 4, Table 1). Also detonation in the cranial part of the abdomen or in musculature dorsal to the thorax can result in instantaneous or very rapid death, but the effect of such hits are less reliable.

The angle of the shot relative to the animal's long axis also influences survival time (Table 2). Shots from directly in front (0°-10°) or behind (170°-180°) gave poorer results than shots directed from the side (45°-135°) because the likelihood of hitting the animal so that detonation

would take place in the most vital organs is considerably lower in such cases. 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.

The weapons and ammunitions used in the Norwegian hunt for minke whales are, when applied as recommended, highly effective in causing instantaneous or very rapid deaths. The results (Fig 3, Table 1 and 2) support the recommendation that for welfare reasons the whales should be shot from the side at the thorax or neck, and that all animals should be hauled in fast for control. For precautionary reasons the hunters should re-shoot with rifle any animal that moves or otherwise shows any possible signs of life even though some of these animals are unconscious and dead.

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References

IWC: 1980. International Whaling Commission. Report of The Workshop on Humane Killing Techniques for Whales, Cambridge.

Knudsen SK and EO Øen. 2003. Blast-induced neurotrauma in whales. Neuroscience Research ,*46,* 377-386.

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 syste. Thesis for the degree of *Doctor Medicinae Veterinariae*, The Norwegian School of Veterinary Science, Department of Arctic Veterinary Medicin, Tromsø, Norway.

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

Øen EO: 1983a. Killing Times of Minke Whales in the Norwegian Coastal Whaling in the 1981 and 1982 Seasons. Nord. Vet.-Med., *35*, 314-318.

Øen EO: 1983b. Electrical Whaling - A Review. Nord.Vet.-Med. *35*, 319-323.

Øen EO: 1983c. Progress report on research to develop more humane killing methods in Norwegian whaling. Int. Whal. Commn. *TC/35/HK 1*.

Øen EO: 1984. The use of drugs in whaling. Int. Whal. Commn. *TC/36/HK2*.

Øen EO: 1987. Progress report on penthrite as detonating charge in grenades for 90 mm harpoons. Report to the International Whaling Commission Technical CommitteeReport TC/39/HK 4.

Øen EO: 1995a. Description and analysis of the use of cold harpoons in the Norwegian minke whale hunt in the 1981, 1982 and 1983 hunting seasons. Acta vet. scand. 3*6*, 103-110.

Øen EO: 1995b. Killing methods for minke and bowhead whales. Dissertation presented for the degree of Doctor Medicinae Veterinariae. Norwegian College of Veterinary Medicine, Oslo, Norway. Also: IWC report *IWC/47/WK8*.

Øen EO: 1995c. High velocity projectiles for killing whales. Hunting trials using 20mm high-velocity projectiles for minke whales in 1982. Acta vet. Scand., *36*, 153-156.

Øen EO: 1995d. A Norwegian penthrite grenade for minke whales: Hunting trials with prototypes of penthrite grenades in 1984, 1985 and 1986 and results from the hunt in 1984, 1985 and 1986. Acta vet. scand., *36*, 111-121.

Øen EO 1995e. A New Penthrite Projectile Compared to the Traditional Black Powder Projectile: Effectiveness in the Alaskan Eskimos' Hunt for Bowhead Whales. Arctic. 48(2), 177-185.

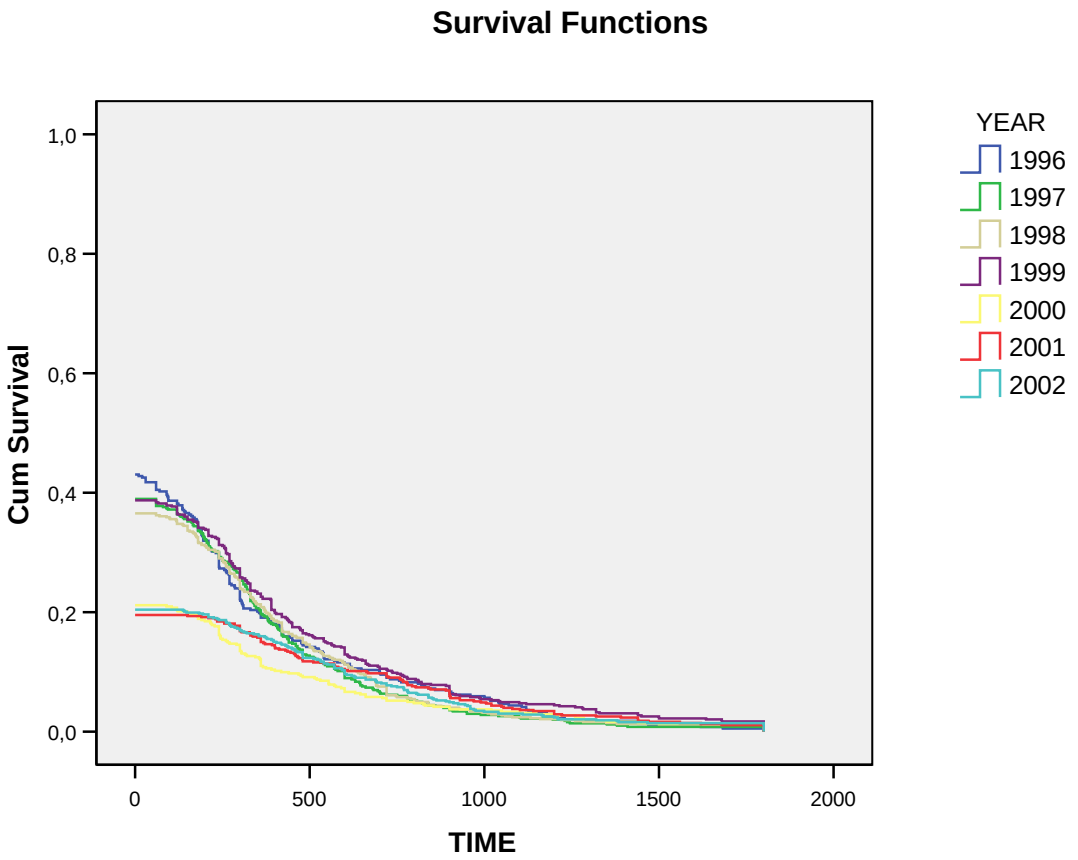
Øen EO: 2000. Norwegian minke whaling. Rep. Int. Whal. Commn., IWC/W*K*.

Øen EO and SK Knudsen. 2000. Euthanasia of whales: Wounding effect of rifle calibre .375 and .458 round nosed full metal jacketed bullets on minke whale central nervous system. Rep. Int. Whal. Commn. IWC/55/WK 15.

Øen EO. 2003. Improvements in hunting and killing methods for minke whales in Norway 1981 – 2003. Rep. Int. Whal. Commn. IWC/55/WK 17.

Øen EO 2005. Electronic Monitoring of Norwegian Minke Whaling. Rep. Int. Whal. Commn., IWC/57/WK17.

Øen EO. 2006. Norwegian minke whaling. Research to improve hunting and killing methods for minke whales in Norway. Rep. Int. Whal. Commn., IWC/58/WKM&AWI 25.



Figur 2. Survival plot for 2106 minke whales shot in 1996-99 with penthrite grenades developed in 1984-85 and prototypes of the new penthrite grenade under devlopment in 1997-99 (plots starting at about 0.4) and 1667 minke whales shot in 2000-02 with the new penthrite grenades developed in 1997-99 (plots starting at about 0.2). Horizontal axis: Time in seconds. Vertical axis: proportion of whales still showing signs of life.

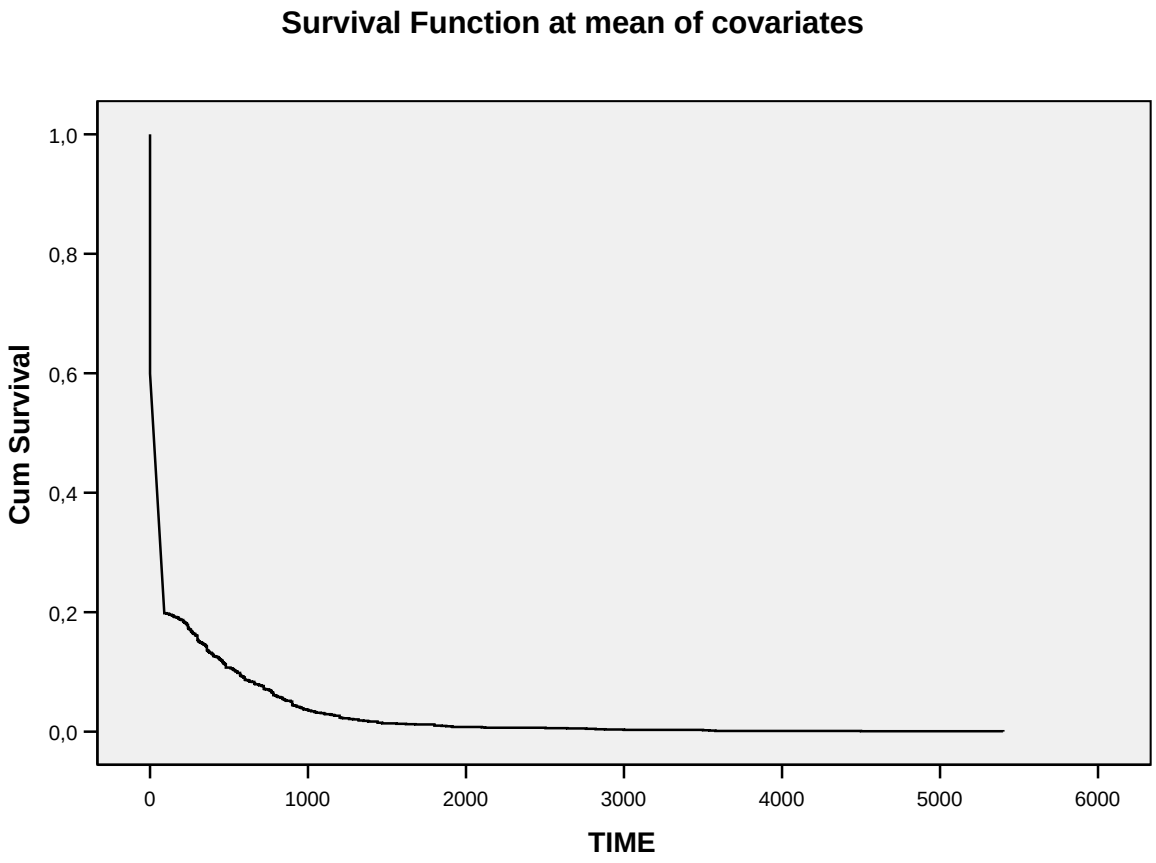
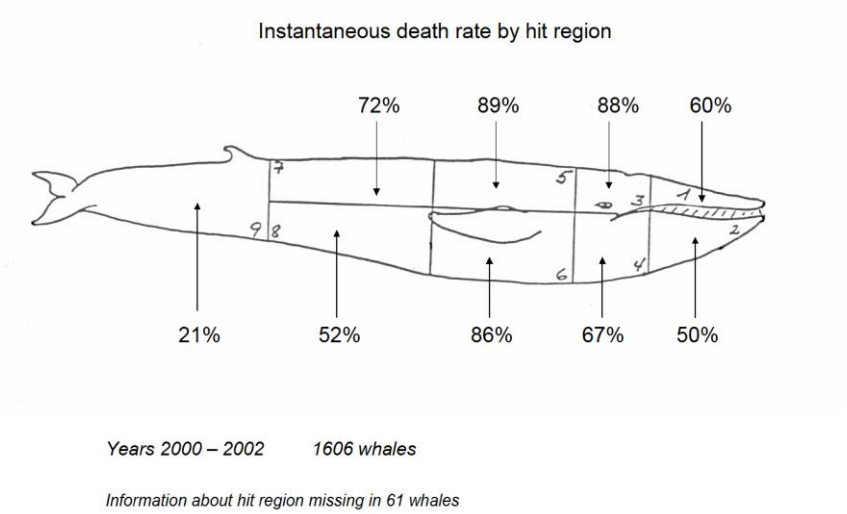


Figure 3. Survival plot for 1667 minke whales shot in 2000-02 with the new penthrite grenades developed in 1997-99. Horizontal axis: Time in seconds. Vertical axis: proportion of whales still showing signs of life.



Figur 4. Figure of minke whales used for comparison of the effect of hits in different regions of the animal.

Table 1. The influence of the Instant death rate of whales (IDR) related to hitting areas in the Norwegian hunt of minke whales 2000-02.

HITREG 1 * INSTANT Crosstabulation

			INSTANT		
			0	1	Total
HITREG 1	1	Count	2	3	5
		% within HITREG 1	40,0%	60,0%	100,0%
	2	Count	3	3	6
		% within HITREG 1	50,0%	50,0%	100,0%
	3	Count	7	49	56
		% within HITREG 1	12,5%	87,5%	100,0%
	4	Count	6	12	18
		% within HITREG 1	33,3%	66,7%	100,0%
	5	Count	81	659	740
		% within HITREG 1	10,9%	89,1%	100,0%
	6	Count	44	260	304
		% within HITREG 1	14,5%	85,5%	100,0%
	7	Count	79	204	283
		% within HITREG 1	27,9%	72,1%	100,0%
	8	Count	69	75	144
		% within HITREG 1	47,9%	52,1%	100,0%
	9	Count	39	11	50
		% within HITREG 1	78,0%	22,0%	100,0%
Total		Count	330	1276	1606
		% within HITREG 1	20,5%	79,5%	100,0%

Tabel 2. The influence on instantaneous death rate (IDR) of the angle of the shot relative to the animal's long axis in the Norwegian hunt of minke whales 2000-02.

ANGEL

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0°-10°	10	,6	,6	,6
	10°-45°	84	5,0	5,1	5,8
	45°-135°	859	51,5	52,6	58,3
	135°-170°	607	36,4	37,1	95,5
	170°-180°	74	4,4	4,5	100,0
	Total	1634	98,0	100,0	
Missing		33	2,0		
Total		1667	100,0		