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DOCUMENT 14

DESCRIPTION OF MAKAH GRAY WHALE HUNT

Description of Makah Gray Whale Hunt

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The Makah gray whale hunt will include a mix of traditional hunting methods with modern tools and weapons to ensure a quick and humane death for the hunted whale. The hunt method used will be the same method used during hunts in 1999 and 2000. A video of the Makah's 1999 whale hunt can be seen at https://www.youtube.com/watch?v=cGmc1-fbs5U.

The hunt will include a team of eight crew members in a 10 meter long canoe and a team of at least three in a motorized chase boat of at least 6.5 meters. The crew in the canoe will be the first to approach and harpoon a whale. The crew of eight works together to paddle into position to harpoon the whale. The goal is to approach the whale to harpoon from the right side of the canoe. After the harpoon is deployed the crewmember immediately behind the harpooner ties on floats and additional line. In 1999, the crew in the canoe held the harpoon line. In the future the whalers will either again hold the line or will let go of line and leave the buoys to retard the swimming speed of the whale. After the harpoon is deployed the chase boat will approach and harpoon the whale a second time.

After the whale is securely harpooned the chase boat will approach with a rifleman. The rifleman will shoot a .50 caliber or larger rifle targeting the base of the brain stem and the first couple vertebrae to cause the immediate death of the whale. Research by Dr. Allen Ingling has shown that rifles of .460 caliber and larger are more than capable of firing shots that will sufficiently penetrate and damage the central nervous system to immediately kill a whale (Appendix A). A safety officer will work with the rifleman and keep track of other boats on the water and other potential hazards for a shot. When the rifleman has a clear and safe shot the safety officer will signal through oral and physical communication that the rifleman is safe to shoot.

This approach was used by the Makah Tribe in its successful 1999 gray whale hunt. As shown in the video, the time to death of the whale from when it was first struck with a harpoon until it was dead was around 8 minutes. We hope with appropriate training and certifications that future hunts have similar or quicker time to death.

After the whale is dead a crew member will secure a line to the whale's tail or will dive in and attach a line through the lower jaw and upper lip of the whale. The whale will then be towed to shore by a larger support boat. At shore there will be crews to conduct the spiritual and cultural practices for the whale and a team to butcher the whale.

Appendix A: Document IWC/51/WK14 APPENDIX presented to the IWC in 1999.

Ballistic Testing of Large-Caliber Rifles

For the Makah Tribal Gray Whale Subsistence Hunt

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ABSTRACT

Ballistic trials of high power weapons and cartridges in addition to the previously tested .50BMG were undertaken to further enhance the efficacy and humaneness of the Makah Gray whale hunt. The Winchester .458 Mag., Weatherby .460 Mag., and the A-Square .577 were all shown to be potentially effective as additional weapons to humanely dispatch a gray whale. The .577 and a newly developed .50BMG cartridge were also shown to have the capability of reaching a partially submerged target.

Introduction

The Makah Tribe previously reported to IWC on the testing of a .50BMG rifle to humanely dispatch gray whales during the Makah Tribe's ceremonial and subsistence hunt (Ingling, 1997). The .50BMG was tested on gray whale carcasses and found to be a potentially effective and humane weapon for quickly dispatching a harpooned gray whale. The results of those tests are in the 1997 report to IWC titled "The Development of Techniques Incorporating Traditional Elements to Enable the Makah to Harvest Gray Whales in an Efficacious, Safe, and Humane Manner." This current report provides further information on ballistic testing of large caliber rifles and bullets that may be used to further increase the efficiency and humaneness of the Makah hunt. Additional tests were conducted to improve upon the previously tested .50BMG. There was subjective evidence that the .50BMG rounds lost energy at a very high rate in passing through water, thus putting in question the effectiveness of the round if it became necessary to shoot at a partially submerged target. In addition, concerns about ricochet off the water needed to be addressed. The penetration test previously carried out from a distance of 40 feet (12 meters) is probably beyond the outer limit of the use of a rifle from a small boat. The target distance should be kept within 30 feet (9 meters) to keep the angle of incidence of the path of the projectile to the surface of the water or target greater than 10 degrees to minimize the occurrence of ricochet (Kato, 1981). Ideally a large vertical surface of the target will be exposed, but the worst case of a partially submerged target must be considered. Additional reasons to test other large caliber rifles were to identify weapons that would not have the single shot limitation of the .50BMG and that might be lighter and easier to handle.

The major objective in hunting with a rifle is to deliver a projectile into the prey that creates sufficient damage to either kill the animal immediately or disable it to the point that it can be approached quickly and killed by a bullet to the brain stem (base of the brain and upper spinal cord). In modern firearms, for most game, this is accomplished by high velocity bullets that expand on impact, creating a "wound channel" of much greater diameter than the original bullet. The effective wound channel is greater than the final diameter of the expanded bullet and is proportional to the velocity of the bullet (MacPherson, 1994). In this manner, much greater trauma can be produced by relatively small projectiles. Small, high velocity projectiles rapidly lose energy after penetration into flesh, especially if they are capable of expansion. In the more common game species, this is not of particular concern. Hunted species of up to several hundred pounds body weight can be effectively taken with bullets of .22in (5.6mm) caliber. However, in large game, rapid loss of energy of the bullet will prevent penetration deep enough to reach a vital or disabling site in the animal. One method of reducing the loss of energy and achieving adequate penetration is to use non-expanding bullets, but since the trauma necessary to kill the animal is dependent on the cross-sectional area of the bullet, then larger diameter bullets must be used. Larger bullets are heavier, thereby requiring more power, thus requiring heavier guns. The ideal ammunition for a specific application then becomes a complex balance of bullet diameter, length, weight, and shape, and the propellant charge. The gun to accommodate the bullet must also be matched to the application and the selected round.

There are three different types of movement of a bullet traveling on its way to a target. The first is translation, or linear velocity as the bullet proceeds to the target. The second is rotation, which is the spin imparted to the bullet by the rifling of the barrel, and the third is precession (Alphin, 1996). Precession is not as obvious as the first two, but is very important, especially when shooting at close range. Precession is the "wobble" of the bullet around the axis of its rotation. Precession is caused by any variation at the end of the barrel that might produce different forces on opposite sides of the bullet as it exits the barrel. Examples of what might cause such a difference are muzzle brakes, flash suppressors, bent barrels, damage to the barrel end, and ejecta (burnt powder residues) from the propellant charge. For most common ammunition and firearms, where the range to target is usually beyond 50 yards or meters, the gyroscopic effect of the bullet rotation will eliminate the precession if the round is symmetrical. This is very important, since if precession is severe and the target is close, then the bullet can actually strike the target sideways and penetration will be minimal. Precession can be minimized by a variety of techniques. Faster rotation will increase the gyroscopic effect and more quickly dampen the precession. Rifling as fast as one turn in 10in. (25cm.) or faster can be used. The use of precision machined monolithic bullets (solid bullets, or at least bullets that act that way) that have good symmetry and resist deformation are also less likely to precess. Paradoxically, a slightly reduced propellant charge, although reducing the projectile energy, may also reduce precession and increase penetration. The mechanism here is that there are less ejecta and less residual force impinging on the rear of the bullet as it leaves the barrel. The use of heavier bullets will increase penetration by increasing both the rotational (increased gyroscopic effect) and translational momentum of the bullet. The aspect ratio, the ratio of the bullet diameter (caliber) to the length is also a critical factor. The "Greenhill" formula (Hatcher, 1966), developed to calculate the barrel twist necessary to stabilize a particular bullet, can be used to compare various aspect ratios to determine if a particular bullet will be more or less stable than another. The formula states that for steel jacketed lead bullets the required twist in calibers equals 150 divided by the length of the bullet in calibers. The length of the bullet in calibers is simply the inverse of the aspect ratio, so this demonstrates that the aspect ratio is the critical issue in damping out precession and stabilizing the bullet, given a fixed rifle barrel twist.

Objectives

The objectives of this research were to conduct further ballistics tests on various large caliber rifles and cartridges to improve the efficiency, safety parameters and humaneness of the proposed Makah gray whale hunt. We wished to identify and test the parameters of some commercially available weapons and ammunition that affect the depth of penetration by the projectiles and to modify those parameters where possible to achieve maximum penetration. In addition, factors such as weight, recoil, and loading ease were evaluated as they relate to the subsistence hunting of gray whales by Makah whalers.

Materials and Methods

A tank 2ft x 2ft by 20ft (60cm x 60cm x 6m) was constructed of plywood. A hole 8in. (20cm.) in diameter was cut in the center of one end and the entire tank lined with a heavy plastic sheet. The tank was set up on drums and filled with water. The filled tank contained about 5000lbs (2300kg) of water. It is a generally accepted premise that water is an approximate substitute for ballistic gelatin in determining the penetration of bullets in flesh if a factor of .55 is applied to the result. The weapons under test were then fired from a distance of about 30 ft. (10m.) from the tank, through the hole in the end of the tank and into the water. Since the top of the tank was open, the bullets could be seen on the bottom of the tank and the penetration distance measured from the tank front. This tank proved inadequate for the stresses of testing these very high power weapons and a second tank was constructed of a 20 ft. (6m) section of 3ft (1m) metal culvert. A portion was cut out for the length of the culvert for observation and plywood ends were bolted on with a 10in (25cm) hole cut in one end and covered with cardboard for the testing. This tank held approximately 6000lbs (2700kg) of water.

Weapons tested were: Garand .30-'06, Winchester .458 Magnum, Weatherby .460 Magnum, State Arms .50BMG, LAR .50BMG and A-Square .577. Ammunition tested was military standard Spitzer (pointed) ammunition for the .30-'06 and the .50BMG and blunt-nosed rounds for the .458, .460, .50BMG, and the .577. The specifications for these rounds are listed in table 1, and the rifle specifications are listed in table 2.

Cartridge	Caliber		Length		Weight		Velocity		Energy	
	in.	mm.	in.	mm.	gr.	gm.	ft/sec	m/sec	ft-lbs	joules
.30-'06 *	.30	7.62	1.40	35.5	180	12	2700	823	3000	4000
.458	.458	11.63	1.43	35.5	465	30	2250	685	5200	7000
.460	.458	11.63	1.43	35.5	510	33	2550	777	7400	10000
.50BMG *	.50	12.7	2.31	58.7	650	42	2700	823	10000	13600
.50BMG	.50	12.7	1.87	47.6	750	48	2700	823	12000	16300
.50BMG **	.50	12.7	1.31	33.3	570	37	3200	975	13000	17625
.577	.58	14.7	1.44	3.65	750	48	2460	750	10000	13600

Table 1. Cartridge Specifications.

*Spitzer **Woodleigh

Rifle	Caliber in.	mm.	Barrel Length in.	cm.	Rifling Twist
.30-‘06	.30	7.62	26	66	10
.458	.458	11.63	26	66	14
.460	.458	11.63	26	66	16
.50 LAR	.50	12.7	30	76	15
.50 SA	.50	12.7	30	76	9.5
.577	.58	14.7	26	66	12

Table 2. Rifle Specifications

Results

The penetration of the bullets into the water tank are shown in table 3. Although the recoil was considerable for all of the weapons from the .460 up, the SA .50BMG and the .577 pack a real wallop since they were operated without muzzle brakes. Although the .577 has less energy, as a lighter weapon it produces a felt recoil equal to the SA .50BMG. The Woodleigh cartridge in the SA .50BMG produced the greatest recoil force, since the energy level was the highest of all combinations tested. Although substantial, the felt recoil was not judged unbearable by any of the riflemen who now all have considerable experience with these weapons.

Rifle	Cartridge	Penetration in.	Penetration cm.	Flesh Equiv. in.	Flesh Equiv. cm.
.30-‘06	Spitzer	47	120	26	66
.458	Round Mono	79	200	44	111
.460	Round Mono	93	236	52	131
.50 LAR	Spitzer	70	177	39	98
.50 SA	Round Mono	130	330	72	183
.50 SA	Woodleigh	240	610	133	339
.577	Round Mono	240	610	133	339

Table 3. Bullet Penetration in Water

It was clear from the penetration trials that there were major differences in the characteristics of the different bullets. The .50BMG Spitzer cartridge completely destroyed the first wooden box test system. The front end of the water tank was resting on a steel drum which was crushed down 4 inches (10 cm.). The Spitzer bullets and the rounded monolithic bullets were not tested in the LAR .50BMG rifle during the second set of tests with the metal tank because of the potential destruction of the test system. The Spitzer bullets were not tested in the SA .50BMG for the same reason. Several of the rounded monolithic bullets curved upward through the water and went airborne at a steep enough angle to clear the far end of the tank, approximately two feet above the water surface.

Discussion

The .30-‘06 is not considered in the same category as the other guns and ammunition and was included to establish a baseline that is familiar to most hunters. The penetration values from the guns and ammunition other than the .50BMG show a progression that would be expected from the energy and/or momentum values of the projectiles. The .50BMG pointed Spitzer round fired from the LAR was a surprise in its results. It was clear that the bullet tumbled early in its travel in the water tank. The likely explanation for this is that the bullet was precessing wildly and did not stabilize appreciably in its flight prior to impacting the target. The evidence of this was a tear in the plastic at the point of entry rather than a small hole as with the other rounds and also the tremendous amount of energy that was transferred to the system in the first few feet rather than being gradually lost over an expected longer penetration path. Contributing factors to this were the muzzle brake and the slow rifling twist of the LAR .50BMG. Apparently, the pointed projectile is also more unstable than a blunt projectile, at least in media denser than air. This phenomenon is recognized by both the native hunters of Alaska, who blunt their projectiles and by the Norwegian whalers (Oen, 1995). Unstable projectiles take the path of least resistance in materials more dense than air. (Alphin, 1996; Hatcher, 1962). This was also evident in the curved path of the long .50 BMG monolithic rounded bullets. Although sufficiently stabilized to penetrate to a depth of 10 feet (3 meters) or so, they were unstable enough to move toward the "softer" side of the water trough, the surface. The SA .50BMG rifle, with the muzzle brake removed and with the fast rifling twist provides good close range penetration with the rounded monolithic rounds and excellent penetration with the short Woodleigh bullet. The Spitzer bullet (typical military surplus ammunition, both armor piercing and full metal jacket ball ammunition) in the SA .50BMG rifle has been shown to penetrate 4 feet (1.2 meters) of flesh (Ingling, 1997) but that bullet is the most erratic due to the inherent close range instability.

Conclusions

From the penetration data, we can see that for whales in which the braincase lies less than two feet from the surface of the whale, all of the weapons tested, even the .30-‘06, are capable of delivering a killing shot. However, the .30-‘06 does not have a margin of error in targeting. The progressively larger calibers provide an increasingly larger window of opportunity and should therefore be considered more effective. Any of the .50BMG combinations of gun and cartridge are more than adequate to accomplish a humane kill of the gray whale. The .577 and the SA .50BMG-Woodleigh bullet combination have demonstrated a capability in excess of that needed for the largest gray whale that might be encountered. A fast twist .50BMG with the Woodleigh bullet is the equal in penetration to the .577 and in addition, delivers about 30% more energy to the target. Potentially this combination would be more effective, but the weight of the .50BMG, 20 lbs.(9kg.) versus the weight of the .577, 14 lbs.(6.4kg), and more importantly, the 3-shot magazine of the .577 clearly makes the .577 the more suitable weapon for humanely dispatching gray whales.

References

Alphin, Arthur B., ed., The A-Square Handloading and Rifle Manual, On Target Press, Bedford, KY, 1996.

Hatcher, Julian S., Hatcher’s Notebook, The Stackpole Company, Harrisburg, PA, 1962.

Ingling, Allen L.,”The Development of Techniques Incorporating Traditional Elements to Enable the Makah to Harvest the Gray Whale in an Efficacious, Safe, and Humane Manner.” Paper IWC/49/HK4, Monaco, 1997.

Kato, Hidehiro, “Trial-firing of .410 Marks at a Minke Whale Carcase on the Factory Ship, 1979/80 Antarctic Season.” Paper SC/32/Mi29, Rep. Int. Whal. Commn 31, 1981.

MacPherson, Duncan, Bullet Penetration: Modeling the Dynamics and the Incapacitation Resulting from Wound Trauma, Ballistic Publications, El Segundo, CA, 1994.

Oen, Egil O., “Ballistic Trials Using Harpoons with Sharp-Pointed and Butt Heads and Hunting Trials Using Modified Cold harpoons to Kill Minke Whales.” In Killing Methods for Minke and Bowhead Whales, IWC/47/WK8, Dublin, Ireland, 1995.