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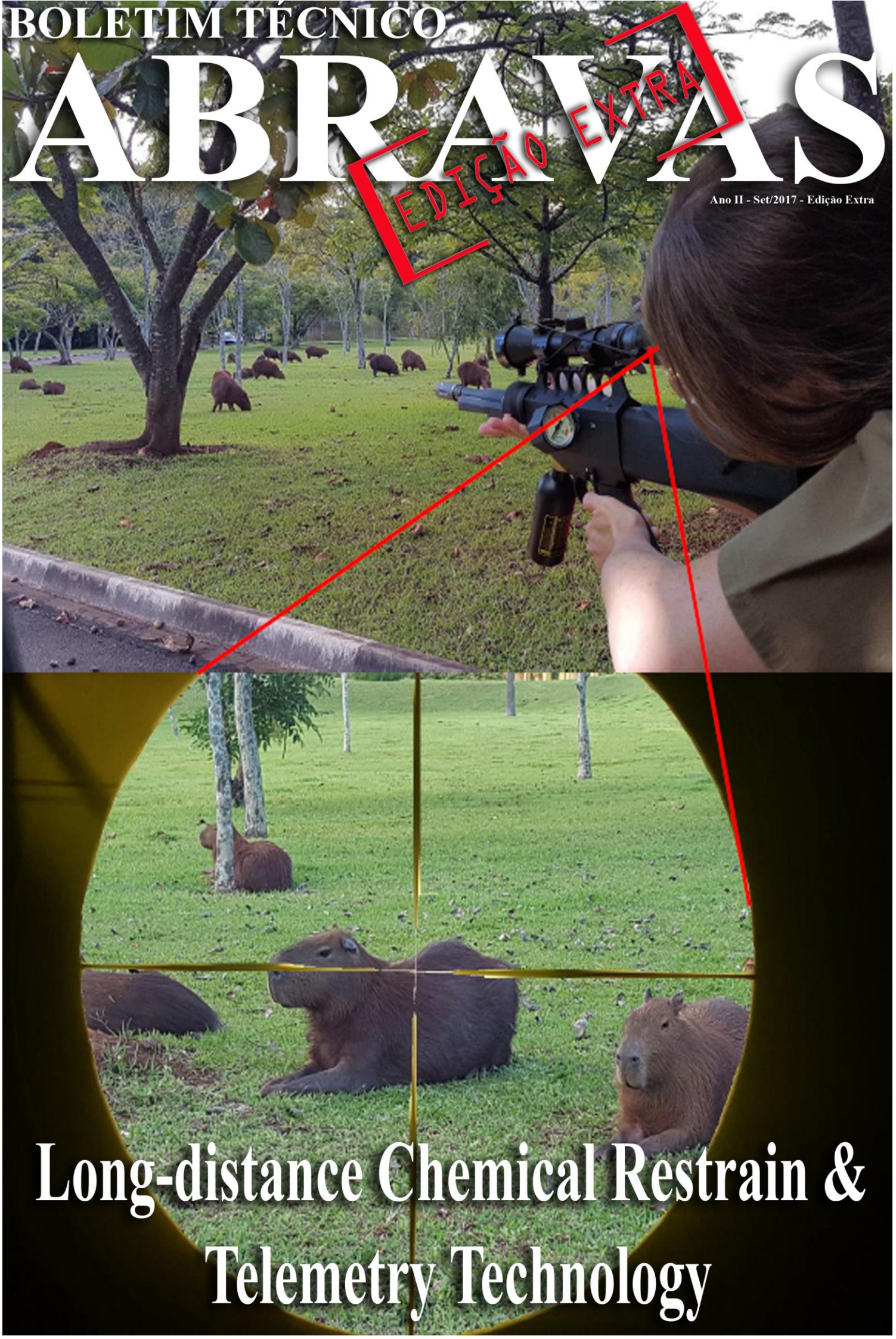
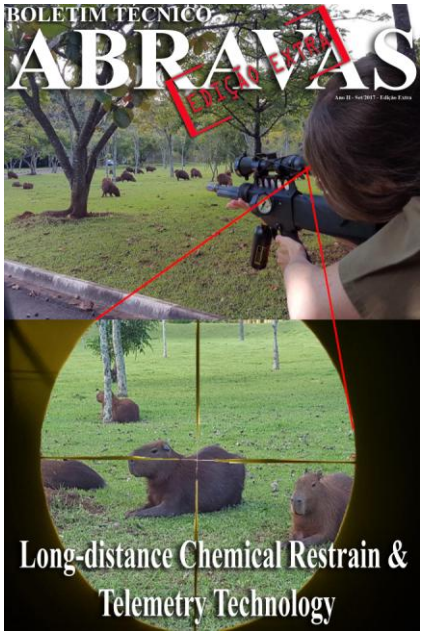


# Long-distance Chemical Restrain & Telemetry Technology

# BOLETIM TÉCNICO ABRAVAS

EDIÇÃO EXTRA

Publicação digital da Associação Brasileira de Veterinários de Animais Selvagens – Ano II - Set/2017 - Edição Extra




## Foto da Capa

Derek Rosenfield

With 4 minutes X Caliber in Action HD Video (PC optimized)

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Mestrado em Reprodução Animal (Animais Silvestres) pela Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo.

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Doutorando em Reprodução Animal (Animais Silvestres) pela FMVZ/USP na linha de pesquisa de controle das populações de animais selvagens, ferais e pragas, através de métodos contraceptivos reversíveis para uso in-situ e em cativeiro, com ênfase em conceitos de imunocontracepção.

**Introduction toTechnical Aspects of Remote Drug Delivery Systems (*RDDS) with Telemetric Support in Free-Ranging Wildlife**
*RDDS = Remote Drug Delivery System

**Introdução a Abordagem Técnica de Sistemas de Administração Remota de Fármacos (*RDDS), com o Apoio Telemétrico em Animais Silvestres de Vida Livre**
*RDDS - (Sistema de Aplicação de Fármacos Remoto)


## Abstract

With this technical bulletin, it is our intent to introduce the latest technology available for long-distance delivery of veterinary medication, such as chemical immobilization, administrations of vaccines, for tracking purpose or to sample biomaterials in free-ranging wildlife. For veterinarians and wildlife management, the need to capture and/or treat free-ranging animals is a frequent occurrence, but doing so with the animal's well-being at interest is a challenging task, trying to minimize the animal's stress and risk of injury, or even death, during capture, while providing safety for personnel at the same time. The overall focus of the bulletin is on reviewing products, how to operate Darting Systems for Remote Drug Delivery, and some practical advice on field use and strategies.



**Keywords:** Radio-Telemetry; Projector; Wildlife Management; Capture-stress


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## Introduction

Remote Drug Delivery (RDD) has become an important tool for wildlife veterinarians and managers, allowing the safe delivery of medication and vaccines, while keeping capture-stress to a minimum. The employment of remote Drug Delivery (RDD) methods represents a unique event, and there is no "one strategy serves all" solution. Furthermore, RDD is a good strategy for an individual capture, rather than for a group of animals. Also, depending on the project purpose, the species to be treated, the individual animal, the habitat, and its ambient influences, all must be accessed and implemented to developan adequate strategy. The following text suggests the employment of Remote Drug Delivery Systems, or RDDS for long-distance wildlife management, supposed to be one of the most adequate and reliable means of animal capture, causing a minimum of capture-related stress and the lowest risk of injury when used accordingly and competently. Nevertheless, these described darting systems are not a simple point-and-shoot endeavor! Before getting into detail about Projectors and Darting, some important information about the acquisition, use, and transport of dart projectors in Brazil are presented.

## Legality

Legislation regarding the use of the projector is rather complicated and cumbersome, overcoming all the involved bureaucracy, is a serious investment of patience, persistence, time and money. In Brazil, a CO2 operated projector is classified as a "controlled product" and one needs to go through an intensive administrative process, in order to import, purchase, transport, and operate a projector, not including the cost of the projector itself. The governmental regulatory body for overseeing all the processes and granting all permissions is the Brazilian Military, specifically the *Diretoria de Fiscalização de Produtos Controlados – DFPC*, together with the local *Serviço de Fiscalização de Produtos Controlados - SFPC*. The Military classified gas operated projectors as "0290-1 Compressed Air/Gas action guns", and calibers higher than 6mm, (.50 = 12,7mm), have its use restricted, and special justification are

needed, for example: “professional use for veterinary services” must be provided. To be able to operate and transport a projector for veterinary use, after going through the obligatory background check, the following are some of the documents necessary for possession and transport: a certificate as a registered user (*CR – via Requerimento da Concessão de Arma de Pressão*) allowing the possession/use of a gas operated projector, and in order to transport from point A to B, a Transport Certificate is needed, however, it is NOT a Carry-on license.


MINISTÉRIO DA DEFESA
EXÉRCITO BRASILEIRO
COMANDO MILITAR DO SUDESTE
2ª REGIÃO MILITAR
REGIÃO DAS BANDEIRAS

Certificado de Registro

MINISTÉRIO DA DEFESA
EXÉRCITO BRASILEIRO
COMANDO LOGÍSTICO
DIRETORIA DE FISCALIZAÇÃO DE PRODUTOS CONTROLADOS
NÃO VALE COMO PORTE DE ARMA
VÁLIDA PARA TRANSPORTE DE ARMA SEPARADA DE SUA MUNIÇÃO

| | | |
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| GUIA DE TRAFEGO Nº: PF20170000015803 | SFPC/02 | Folha : 1 de 1 |
| GUIA DE TRÁFEGO VÁLIDA ATÉ: 17/11/2019 | | |

Official Documents for the operation of a Projector, Dro, 2017

In case the projector is to be imported to Brazil, a prior issued Certificate of Import License from DFPC will be needed, as well as a transport permit from the SFPC, enabling the retrieval of the projector from the airport.

**Common Wildlife Non-Lethal Capture and Drug Delivery Systems**

There are several capture methods available, however, just a few can be considered adequate for the application in wildlife management, especially when the animal’s well-being is apriority and the animal is to be released right after the procedure. Which method to choose depends primarily on the species to be captured, but also on the purpose, number of animals, and what are the surrounding circumstances. Traditional non-lethal capture methods includecorral cage traps, net-guns and immobilization by chemical agents, - employing blow darts, injection-pols, cartridge-fired, compressed air, - or CO2 gas projectors. All of them offer pro & cons, especially regarding the intensity of capture-related stress, and their potential risk factors.

**Corral System**, a method with a lesser degree of capture stress, eventough, personnel tranquilizes the animal with injection pole, blow-dart or handgun projector afterwards.

Corral Capture Fence with baiting, Dro 2106; Sugar cane bait. Dro, 2017

**Pole-Syringe (Jab-stick)**

Pole-syringe, Livestock Health Systems Au, 2017

**Net-Trapping**, associated with extremely intensive stress, as well as increased risk of injury/death.
Effective reach: 30 – 50m

Net-Gun, animal capture, Helicopter Capture, Heliwild, 2017;Net-gun, WCE, 2017; Net-Gun, Netted animal, Animal Care & Equipment Services, 2017

**Blow-Gun**

The oldest form of remote drug delivery, poisoned darts for hunting by indigenous tribes, dating back thousands of years. Mostly used for distances less than 3m. Some optic aids can be used, such as a flashlight, or a laser, especially, during night application.

**Capture-Stress**

There is not much literature available, comparing and analyzing capture methods and their associated stress levels. One study[1], compares specifically drop-net versus immobilization darting techniques and their associated capture-induced stress by monitoring serum cortisol levels in White-tailed Deer (*Odocoileus virginianus*). In his observation, DeNicola describes that:"…with remote immobilization the serum cortisol concentration was in an average of 3.5 – 5.0 times lower than with drop-net physical restraint method", supporting the argument of minimized capture-stress using long-distance DDS.

Our report focuses on technologies that allow for long-distance applications, meaning distances that can't be reached effectively with a blow-dart or handgun-projectors, essentially

starting at distances over 20meters.RDDS, in several studies, including life-application by the author, are believed to minimize capture-stress and risk of injury to the animal, while providing safety for the executing staff, representing an alternative immobilization strategy to be considered. Of course each wildlife capture episode/procedure has its own dynamics and demands specialized strategies and there are many situations that do not allow for the employment of such RDDS [1–3].Another current study is seeking alternative capture methods, by employing animal-conditioning for corral traps and long-distance immobilization in Free-Ranging Capybaras - (D. Rosenfield and C. Schilbach- Pizzutto), with some promising preliminary results (to be published 2017/2018).

**The Remote Drug Delivery Systems**

The reasoning behind the premise of less capture-stress induced when using tranquilizer darts rests on the explanation that a) the animal doesn't know where the dartis coming from;b) can't see, nor smell a predator, and therefore; c) does not detect any immediate threat, until the sedation takes effect; d) injection pain would be comparable to a larger insect sting. A Remote Drug Delivery System that utilizes compressed air, or CO2 gas, is a very powerful technology, that demands knowledge and requires extensive training**,** to avoid that the animal gets severely injured, put in agony, or even in risk of dying. One must practice with different darts, distances and ambient situations, until familiar enough to be capable and competent to handle the projector. To reiterate, this technology is not a simple point and shot application, and the longer the distance, the more knowledgeable and skillful the shooter must be! Someone darting animals without proper instruction and training would simply be irresponsible.

**Long-distance Drug Delivery System Air/$Co_2$ Gas projectors**

The X-Caliber, a CO2 gas high-performance projector with a .50 caliber (12.7mm) bore size.

Photo: $CO_2$ projector X-Caliber; Pneu-Dart, 2017

Effective range: 1cc dart over100 meters. Author's note: "*Based on own experience, the X-Caliber, being certainly, one of the most sophisticated and accurate pieces of equipment in its class, handling these distances with high accuracy".*

**Pyrotechnical (cartridge-fired) projectors**

22.cal bullet, Dro,2017

The.22 caliber cartridge-fired projector, model 380, from Pneu-Dart. Not very common in regular cartridge fired rifles, this model for RDS application offers a 5-position power control, allow to adjust distance and impact. Effective range: 1mldart ± 70 meters.


**CO2 Gas hand-fired projectors**

For avery accurate short-range application, Pneu-Dart's X2.

Photo: $CO_2$ projector X-Caliber; Pneu-Dart, 2017; 12 gram CO2 cartridge, Dro, 2017

**Shooting Compressed Gas vs Gunpowder**

The main difference between cartridge-fired and compressed air/gasprojector is the capability to adjust muzzle velocity, which is the speed of a projectile when it leaves the muzzle of a rifle. With some exceptions, the cartridge-fired rifle does not allow adjustments, one of the big advantages with Air/Gas fired projectors. Being able to adjust pressure (pressure-gauged), permits for a much more accurate delivery of the dart, minimizing potential risks of tissue injury to the animal. Besides, CO2 compared to .22 caliber has a better distance-reach, it is a cleaner shooting, doesn't create smoke as no black powder burning occurs, and is less noisy. Furthermore, in Brazil, CO2 gas is readily available and less bureaucratic to use.

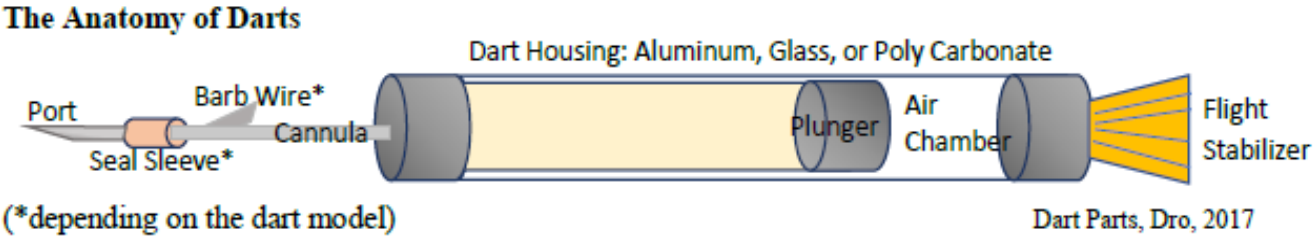

Photo: $CO_2$ projector X-Caliber; Pneu-Dart, 2017, modified Dro, 2017)

The gas pressure is being controlled by the valve (1) and monitored by the pressure gauge (2), allowing for very precise adjustments. Which pressure to choose depends mainly on the size (volume) of the dart, injection depth, the purpose of the application, and the desired distance. However, several other factors must be considered when choosing the right pressure amount, for example: environmental effects, like rain, or wind, shooting downhill, or uphill, and which species (thickness of the skin).

Observation: It is being said that some predator species, for example, jaguars, are able to hear/see the dart closing in, and perhaps dodge them.

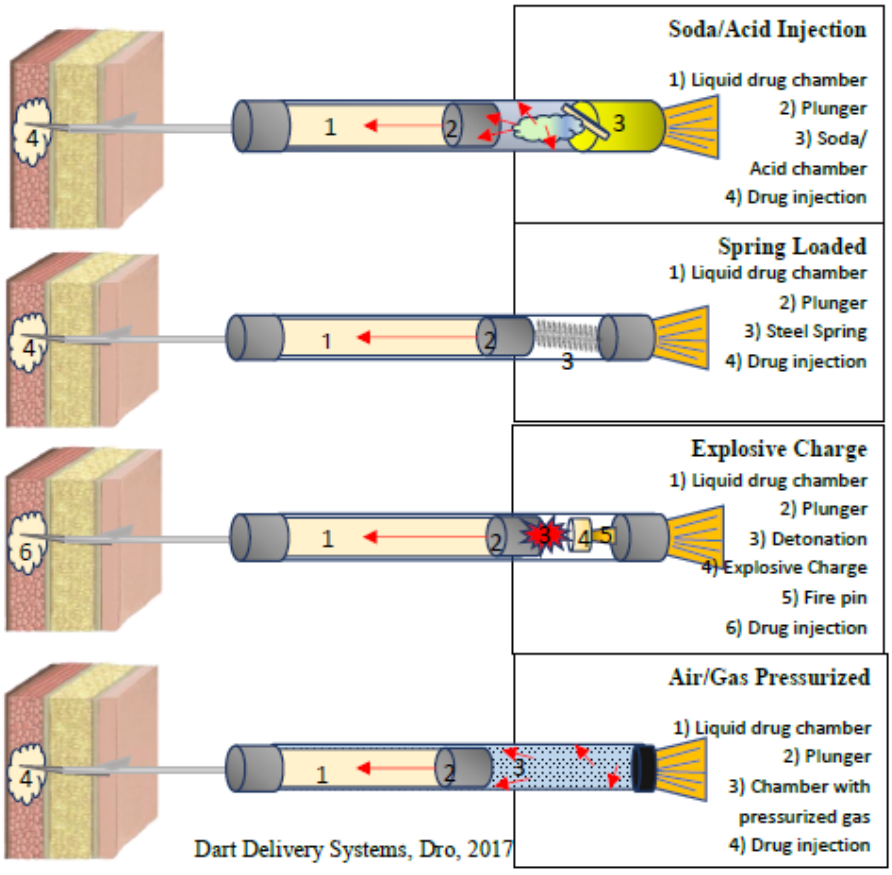
**Dart Technologies**

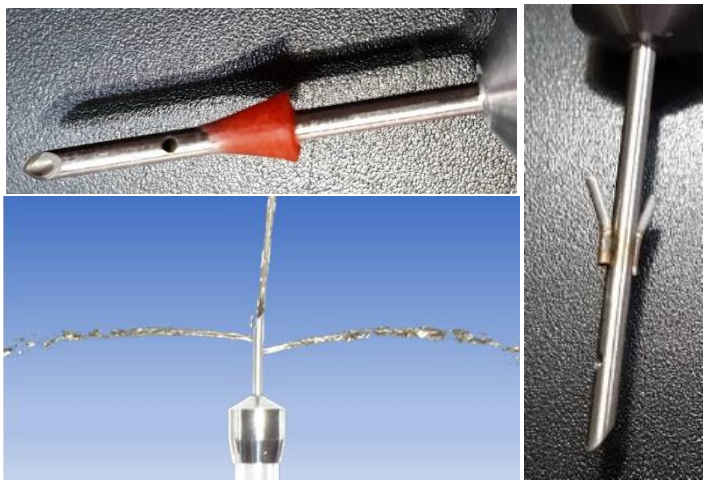
Darts come in all shapes for many purposes and qualities. Some are reusable, others, due to integrated pyro-technologies, are one-time use only, and must be disposed of afterward. And of course, the home-made versions, as these, in many countries, are financially more affordable/available.




**Dart Injection Technologies**

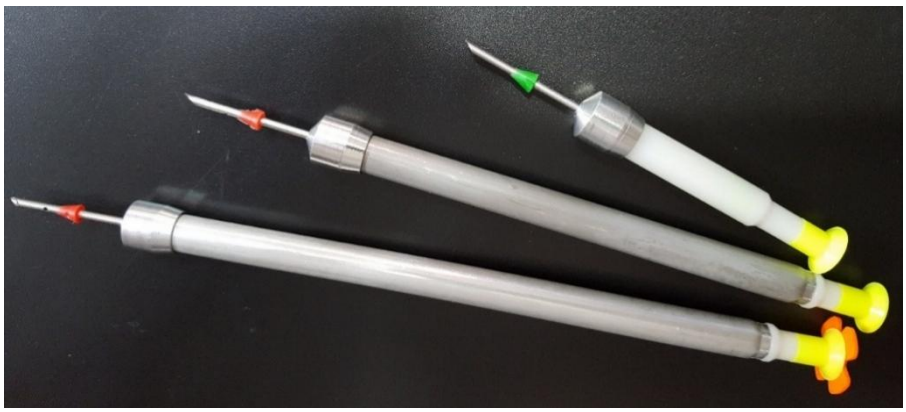
To guarantee a complete drug delivery, tranquilizer darts need a mechanism, forcing the drug load out of the dart liquid drug chamber, this can be achieved either by a:





Pneu-Dart technologies for darts are quite sophisticated in their make-up, offering: Cannulas (needle portion of the dart) with either a color-coded gelatin collar, that under the animal's body temperature starts to soften, and after a few minutes, letting the dart fall off freely from the animal, or a barb-wire, that requires initial capture of the animal, so the dart can be surgically removed. Also, the concept of a cannula with a better drug injection distribution, the Tri-Port (one end, - and two sideports).This style cannula is to prefer over one single endport, as the drug is being administered to a larger surface, quicker and better chances of complete drug delivery, lesser push-back risk, and more importantly, lesser tissue damage.

Photos: Pneu-Dart RDDs with barb-wire and Tri-Port cannula, 2017; modified, Dro, 2017



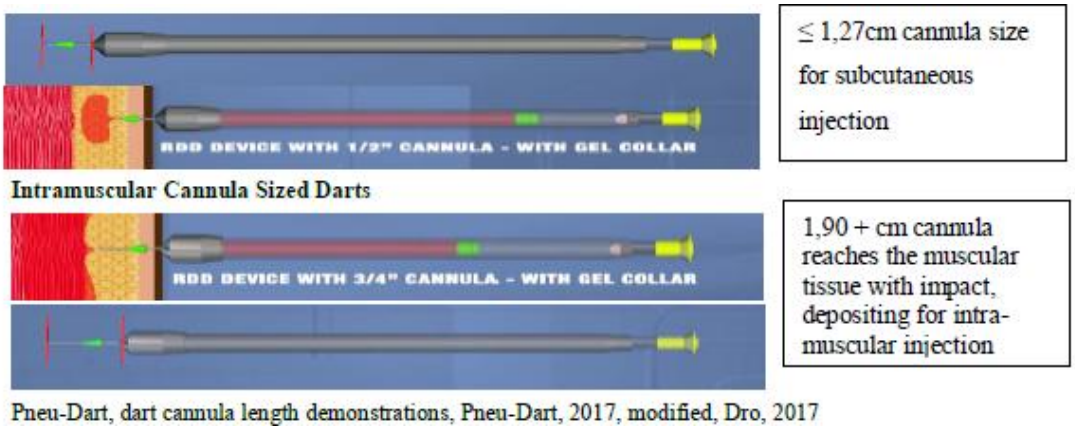
One of Pneu-Dart's latest inventions, although a decade in the makings, is the patented Slo-Inject® technology. In comparison to regular dart drug release, Slo-inject®extends the rate of injection by 33%, providing a highly desired double effect, a) reducing the potential risk of tissue injury, and b) minimizing the "push back", of the dart during the injection. For more in-depth information, watch Pneu-Dart's training video: http://www.pneudart.com/pneu-dart-slo-inject-flow-lab-video/

Photo: Pneu-Dart's RDD devices, Rosenfield, 2017

## Intramuscular vs. Subcutaneous Administration

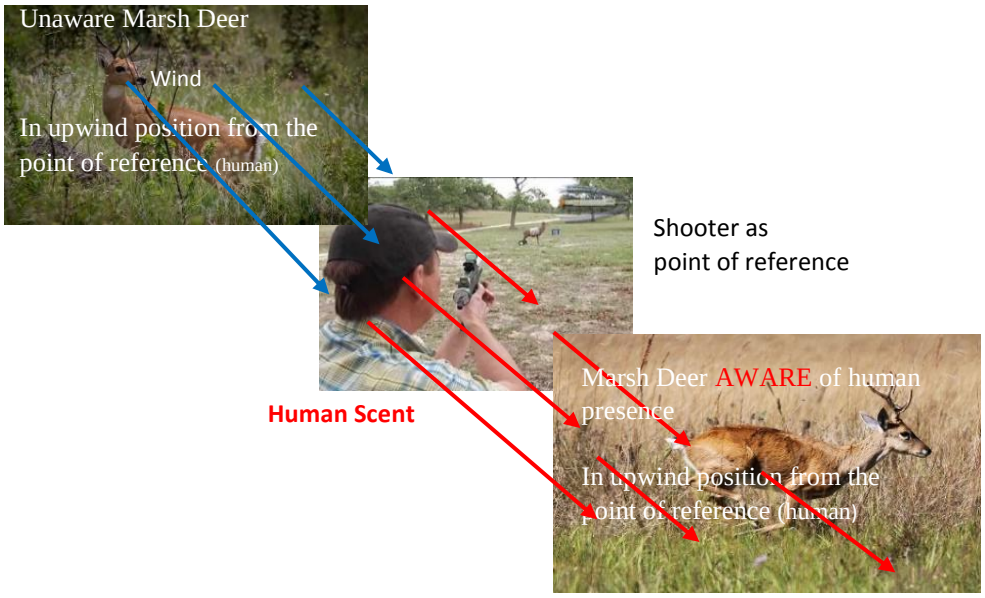
Depending on the length of the dart cannula (needle), and the species tobe treated, the drug can be deposited either intramuscular or subcutaneous, examples:

**SubcutaneousCannula Sized Darts**




Pneu-Dart, dart cannula length demonstrations, Pneu-Dart, 2017, modified, Dro, 2017

**Preliminary Planning - Approach – Avoiding Scent detection by the animal**




Pampas Deer, Bart van Dorp, 2012; Pampas Deer, H. P. de Oliveira, 2012; Graph: Animal approach Upwind (Windward) vs. Downwind (Leeward), Dro, 2017

**Shooting Positions**

A comfortable and stable position is fundamental to be able to drive the dart into its intended target. Especially for long distance shots ( over 20m), it is recommended to have some support to hold the projector stable, as standing and free-holding is the most unstable position, quickly tiring, and under stronger motion influence of the heartbeat and breathing. Rule of thumb, the closer to the ground, the more stable the position, and the more accurate the shot.

The Standing position with support, is quick, although less stable. As a support, any inert object that has the same height as the shooter may serve, a tree, a wall, bamboo, even sugar cane. Important is it provides sufficient steadiness until the shot can be taken. The non-shooting hand grabs the structure, allowing for projector stock to rest on it. This position is not meant to plan an elaborate shot, spending much time on it.

Standing position w/ support, Dro, 2017

The "Sitting-on-foot", or kneeling position is a quick and comfortable shooting positions, allowing the projector holding arm to rest on top of the knee, while the upper body sits on the heal-portion of the kneeling leg. However, somewhat less stable, as the shooting arm is w/o support, enough of a stable position, if the shot doesn't take much preparation and planning.

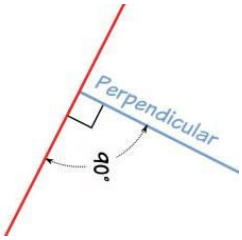
Kneeling Shooting position, Dro, 2017

The "Prone" position, lying flat on the ground, is the slowest of all position to take, yet, the most stable one, allowing to prepare and plan for the most accurate shot. Both arms are supported, and the body is in the most relaxed position, resting entirely on the terrain.

Prone position, Dro, 2017

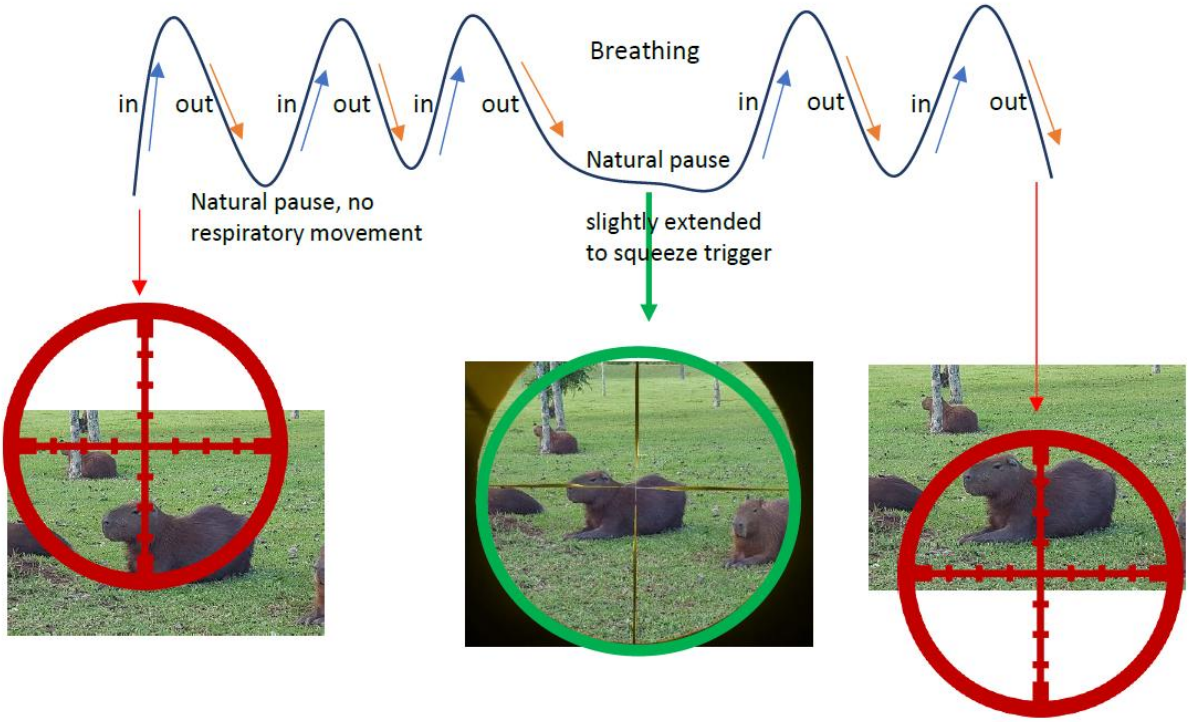
**Targeting**

Whenever possible, try to position yourself to execute a perpendicular shot, the larger away from the 90º angle the higher the chance of a ricochet, or incorrect dart placement, perhaps causing a subcutaneous injection instead ofan intramuscular, or no injection at all.




**Breathing**

When holding your breath for extended periods of time, you will start to shake, you will feel your heart beat stronger and breathing will continue intensively, interfering with a precise shot.




Breathing cycle for shooting, Dro, 2017

Capybara through scope, Dro, 2017

## Sniper-like execution

As dramatic as it sounds, some of the sniper techniques are indeed a necessity to ensure a successful shot. Being familiar with some of these concepts will only improve one's chances to hit the intended target. .

## Preparing for the shot - Pressure Adjustment &The Trajectory Chart

**Pneu-Dart X-CALIBER Suggested Pressure Settings for 1/2cc – 10cc Dart Capacities**

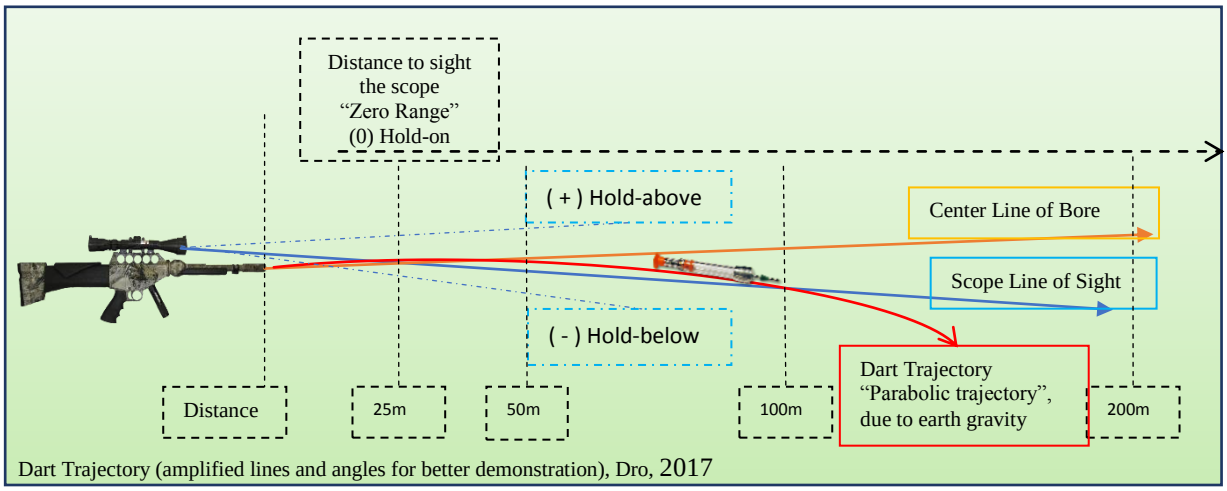
| YARDS | 1/2 cc | Hold | 1 cc | Hold | 1 1/2 cc | Hold | 2 cc | Hold | 3 cc | Hold | 4 cc | Hold | 5 cc | Hold | 6 cc | Hold | 7 cc | Hold | 8cc | Hold | 10 cc | Hold |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 = | 1.5 bar | 0 | 1.5 bar | 0 | 2 bar | 0 | 1.4 bar | 0 | 1.7 bar | 0 | 2.1 bar | 0 | 2.4 bar | +0.5 | 3.5 bar | +1.5 | 4.1 bar | 0 | 4.1 bar | +1.5 | 4.8 bar | 0 |
| 10 = | 2 bar | 0 | 2 bar | +1.5 | 2.5 bar | 0 | 2.4 bar | -1 | 2.4 bar | +1 | 3 bar | +2 | 3.1 bar | +1 | 4.8 bar | 0 | 4.8 bar | 0 | 5.5 bar | 0 | 6.9 bar | 0 |
| 15 = | 2.4 bar | 0 | 3 bar | -0.75 | 3.1 bar | 0 | 3.5 bar | -0.75 | 3.8 bar | -1 | 4.8 bar | -2 | 5.5 bar | -1 | 6.2 bar | 0 | 6.9 bar | 0 | 6.9 bar | +2.5 | 8.3 bar | 0 |
| 20 = | 3.1 bar | 0 | 3.5 bar | +1 | 4.1 bar | -1 | 4.5 bar | -1.5 | 5 bar | -1 | 5.5 bar | -1 | 6.2 bar | -0.75 | 7.6 bar | +2 | 8.3 bar | 0 | 8.3 bar | +3 | 9.7 bar | 0 |
| 25 = | 4 bar | -1 | 4.5 bar | 0 | 5.2 bar | -1 | 5 bar | 0 | 6 bar | -2.5 | 6.5 bar | 0 | 7.6 bar | +1 | 8.9 bar | +3 | 9.7 bar | 0 | 10.3 bar | +2 | 11.0 bar | +2 |
| 30 = | 5 bar | -2.5 | 5.5 bar | 0 | 6.2 bar | -1.5 | 6 bar | 0 | 6.9 bar | 0 | 8 bar | +2.5 | 8.3 bar | +2 | 10.3 bar | +3.5 | 11.0 bar | +4 | 11.7 bar | +1 | 12.4 bar | +5 |
| 35 = | 6 bar | -3.5 | 6.5 bar | +1.5 | 7 bar | +1 | 7.5 bar | -2 | 8.3 bar | 0 | 9 bar | -1 | 9.7 bar | +3.5 | 11.7 bar | +5 | 13.1 bar | +4 | 13.1 bar | +3 | 13.8 bar | +9 |
| 40 = | 6.5 bar | +1.5 | 7 bar | 0 | 8 bar | +2.5 | 8.3 bar | +1.5 | 8.9 bar | +3 | 10 bar | +2 | 10.3 bar | +5 | 13.8 bar | +4 | 15.2 bar | 0 | 15.2 bar | +6 | 16.6 bar | +10 |
| 45 = | 8.5 bar | -2 | 9 bar | -1 | 9.5 bar | -2 | 10.3 bar | +1 | 11 bar | 0 | 12 bar | 0 | 12.4 bar | +4 | 15.2 bar | +8 | 17.2 bar | +2.5 | 17.2 bar | +8 | NR | NR |
| 50 = | 9.5 bar | -1.5 | 10 bar | +2 | 12 bar | -2.5 | 12 bar | +2 | 12 bar | +2.5 | 14 bar | 0 | 14 bar | +5 | 17 bar | +8 | NR | NR | NR | NR | NR | NR |
| 55 = | 11 bar | -1.5 | 12.5 bar | -3 | 13 bar | -1.5 | 14 bar | +1.5 | 14 bar | +3.5 | 16 bar | +2 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| 60 = | 12.5 bar | +3.5 | 14 bar | 0 | 14.5 bar | +1.5 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| 65 = | 14 bar | +3 | 16 bar | +2 | 16 bar | +3 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| 70 = | 17.5 bar | +1.5 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |

**Please note:** This chart is merely a guideline. We encourage all customers to independently construct a trajectory chart with their own projector prior to delivering a dart at an animal.

**(+)** = implies hold above intended point of impact
**(-)** = implies hold below intended point of impact
**NR** = not recommended

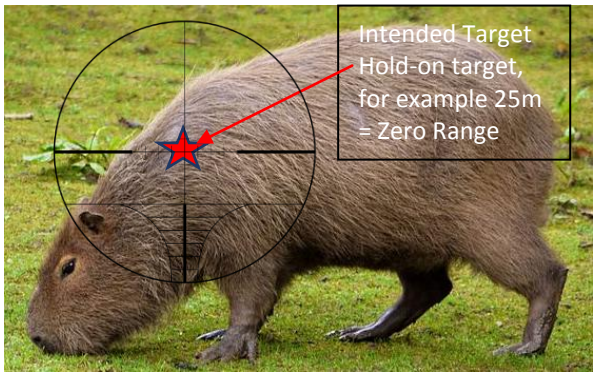
A pressure chart, created by one's own shooting experience, functions as a reference guide to select the adequate pressure value. These lection is based on the type of dart, its drug volume, intended distance and which species. Note from the manufacturer*: "There are still several variables that come into play, so it is strongly recommended to build a chart that is created using their own equipment*". To become familiar with the guidelines of "**hold-on (0),hold above (+)**", or "**hold below (-)**", compensating for impacts to the dart during flight, mainly, the dart drop due to gravity, slopes and wind influences. It is imperative that the projector/scope/target is properly sighted (lined-up) to the shooter, and that they are practicing different dart sizes and distances, gaining a real feel for this powerful projector.
Pressure Chart, Pneu-Dart, 2017

## Example Dart-Trajectory; Hold-on & Hold-above

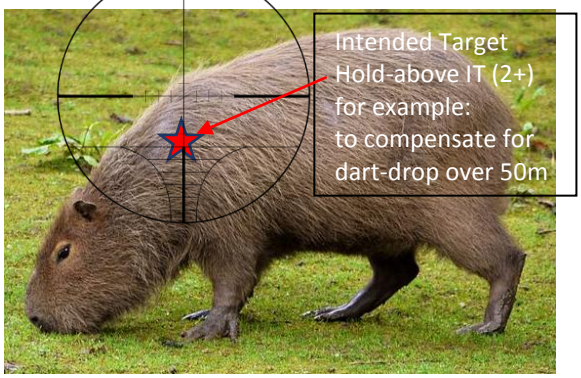


Dart Trajectory (amplified lines and angles for better demonstration), Dro, 2017

**Intended Target (IT); Point of Impact; Hold-on & hold-above**




Hold-on IT, Dro, 2017

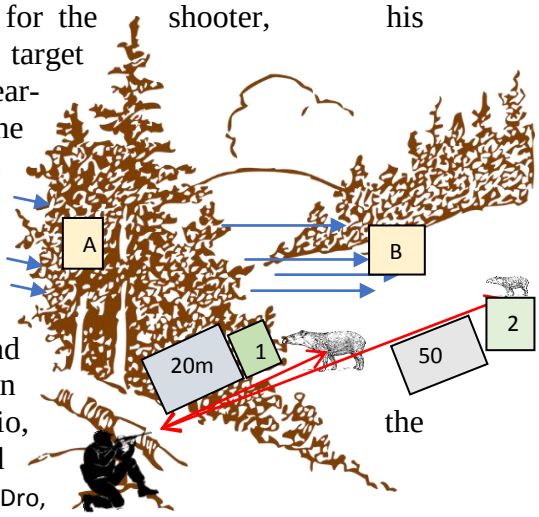



Hold-above IT, Dro, 2017

At first sight, it might be a bit challenging to understand the difference but pay close attention to the cross-hair and red-star position, and you will be able to identify the two-bar (2+ points) difference to the zero-range position.

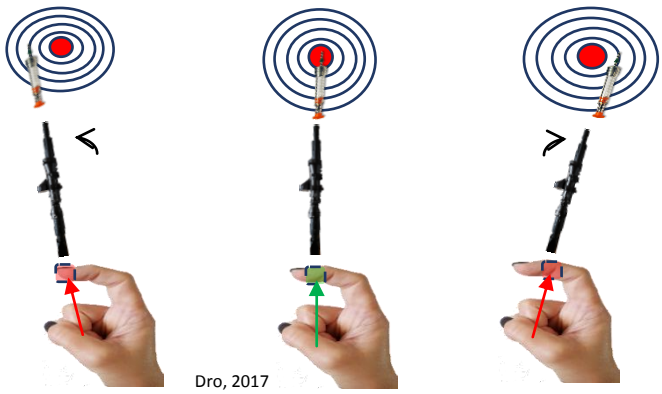
**The Long-Distance Shot, - Wind Impact**

The longer the distance - the higher the demand for the shooter, his knowledge, and skills. Ambient influences, depending on target distance, examples: The combination of 1 and A – a near-distance shot. The shooter is perpendicular to the wind and the animal won't perceive the shooter's scent. The trees and bushes minimize wind impact on the dart between the shooter and the animal, on the other hand, the high grass and bushes might disturb a clear shot. The combination of 2 and B – a long-distance shot. By observing the leaves on the trees and the grass, the shooter observes the wind direction and intensity. Planning this shot with an anemometer (wind meter) is not very practical in this scenario, the best option for the shooter is simply to wait until the wind has dieddown, and then take the shot. (Pixabay,2017; modified, Dro, 2017)




**Pulling the trigger**

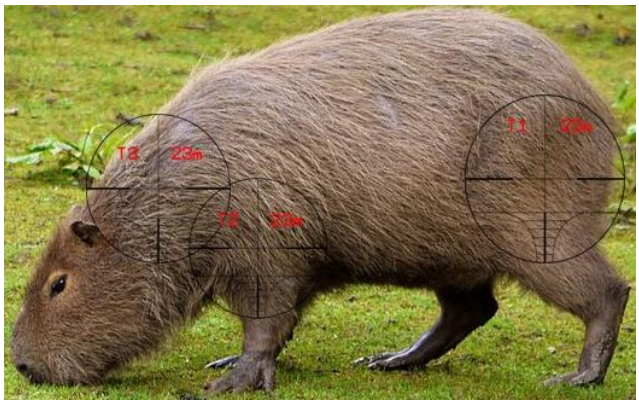
When using CO2 gas projectors, it is important that the trigger is squeezed in **one quick motion**, otherwise gas starts to escape slowly and you won't have the entire pressure for the dart launch, contrary to the trigger-pull of a cartridge-fired projector, where the trigger is squeezed smoothly. Depending on the intensity and direction of the trigger pull by the finger, the dart will hit its target righton, or may just miss it by a couple of centimeters. Remembering, that a movement at the



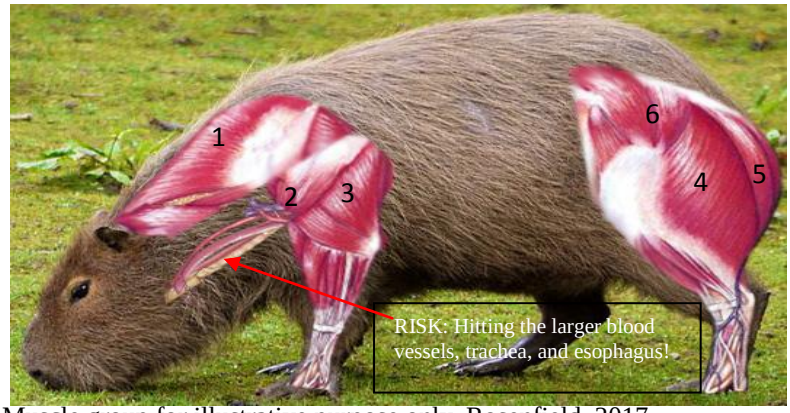
Dro, 2017

muzzle by fractions of a millimeter, translates into centimeters, or meters down the dart-path, corresponding to the distance of the target.

**Preferred Intramuscular Target Region – Anatomy:** For intramuscular darting, the largest muscle groups are being selected. Depending on the species to be treated, muscle groups represent great topographic variations; Location of the muscles and potential risk areas should, therefore, be thoroughly studied prior to application.



Target area for illustrative purpose only,Dro, 2017



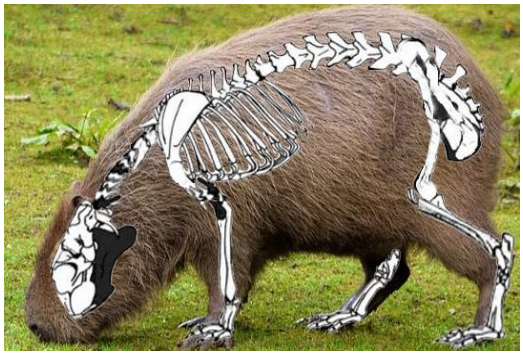

Target Neck Area: (Only if no other choice, high risk of sever injury)
Dorsal/lateral cervical region, - (1) Mm. Trapezius cervical), below the vertebrates

Target Shoulder area. 2nd preferred target, lesser risks for injury
Front-limb musculature:
(2) Mm. Deltoids; (3) Triceps

Target Rump/Thigh. Preferred target, least potential risk for injury. Hind-limb musculature:
(4) Mm. Biceps femoris;
(5) Semitendinosus/Semimembranosus
(6) Mm. Gluteus

Muscle group for illustrative purpose only, Rosenfield, 2017

**Darting - associated risks of injuries:**



Risk: Hitting the hip joint, coxal or ischiatic tuber; femur bone, or stifle joint, may cause the dart to bounce-back, and besides not depositing the drugs completely, the high impact may also cause the bone to fracture. Photo: Skeleton (not proportional), Dro, 2017

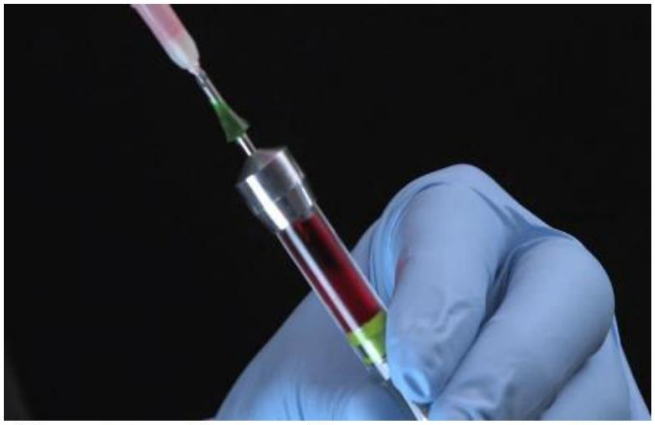
Risk: If the dart hits the animal too high at the neck region, there is a potential risk of injuring the vertebrae, too much caudal, hitting the scapula, and if too low, the risk of hitting either a larger blood vessel (carotid or jugular vein), the esophagus, or the trachea.

**Other Risk Factor to Consider** Do not attempt darting with tranquilizers if the animal's safety cannot be guaranteed! Meaning, the animal can escape into a tree, can flee into the water, or stand on asteep rock formation, etc., as this most certainly will result in severe, if not fatal injuries. Also, depending on the species, some consideration on which target area to choose must be given, for example, fastflexible animals, like a large feline, for instance, might be able to grab

the dart and yank it out, in suchsituations choosing a dart position at the neck muscle area instead the thighs, would make it more difficult to reach the dart, or have someone else do you for you.(pic.)

**Anesthetics**

Nowadays, there is a great number of immobilizing drugs available, and just as variant are the effects that they have, depending on the wildlife species and their sensibility to the agent used. As there is no one-drug-serves-all, each agent has its advantages and risks, therefore, in modern chemical immobilization protocols, agents are combined (associated), to maximize their individual strength, while minimizing their risks. The other big challenge in the field is the administration of the right dosage, based on the best "guesstimate" of the animal's body weight, that's where experience comes into play, a good starting point is an average weight, reported from prior studies. Which drug to use for chemical immobilization should be based on stringed protocols, founded in thoroughly conducted scientific research. Carefully developed for a given species, considering environmental circumstances, and the purpose of capture, or procedures, and their depth of anesthesia required. For example, is the animal captured to conduct a "simple" biometric investigation, or are there intensive surgical procedures involved? Furthermore, desired effects are often dosage dependent.



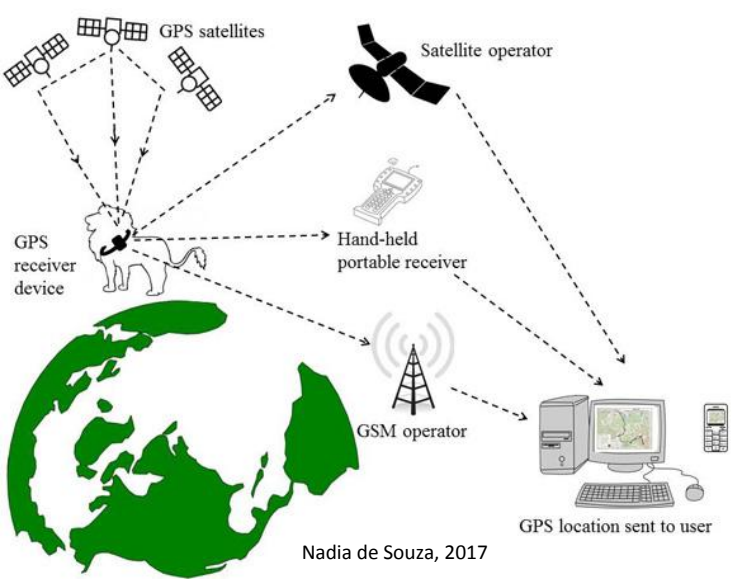
Filling an RDD with a tranquilizer agent, Pneu-Dart, 2017;

Field condition, Dro, 2017

**Examples of commonly used tranquilizer drugs for darting, intramuscular/subcutaneous[4]:**

| Classification | Group | Examples | Principal Targets | Main Effects |
|---|---|---|---|---|
| Major tranquilizer | Phenothiazine | Acepromazine; Levomepromazine; Chlorpromazine | Dopaminergic receptors plus: adrenergic,- histamine,- muscarinic,- acetylcholine, serotonin | Sedation, Neuroleptic; Catalepsy; Antiemetic; Analgesic; Hypnotic |
| | Butyrophenone | Azaperone | Dopamine receptor | Sedation; Neuroleptic; Antiemetic; Hypnotic |
| Minor tranquilizer | Benzodiazepine | Diazepam Midazolam | Gamma-aminobutyric acid (GABA) receptors | Hypnotic; Sedation; Anxiolytic; Muscle Relaxant; Anticonvulsant |
| Adrenergic receptor Alpha (α) 2 agonists | Antagonist: Yohimbine | Xylazine, Detomidine Medetomidine Dexmedetomidine | α 2 adrenergic receptors | Analgesic; Sedation; Muscle Relaxant; Anxiolytic; |
| Hypno-analgesics | Opiates/Synthetics<br>Antagonist: naloxone/naltrexone | Morphine, Fentanil, Carfentanil, Etorphine, Butorphanol (mix) | Opioid-Receptors: μ (mu/MPO), κ (kappa/KOP), δ (delta/DOP) | (Hypno) Analgesic; Sedation Neuroleptanalgesia: combo narcotic analgesic and neuroleptic drug |
| Phencyclidine derivative<br>NMDA receptor Antagonist (N-Methyl-D-aspartate) | Dissociative anesthetics | Ketamine Tiletamine | Primarily N-methyl-D-aspartate (NMDA) receptor (among others) | Analgesic; Sedation; Amnesia |

**Telemetry for Wildlife Immobilization when using Remote Drug Delivery System**




Tracking an animal in the wild can be done either by a GPS (Global Positioning System) Tracking system, attached to the animal by a collar, containing a GPS receiver module, providing geolocation by receiving signals from several satellites; orusing cell phone towers, to triangulate coordinates; or by Satellite-Tracking, picking up signals from the animal's transmitter. Alternatively, the Radio-Telemetry System, essentially a transmitter, attached to the animal, transmitting unique electromagnetic radio signals (frequencies), and a receiver/antenna unit, programmed to the transmitter's frequency, allowing to pick up its signal, in turn, producing a tone that intensifies as the unit gets closer to the animal, or transmitter.

**Part I, Pneu-Dart's Transmitter Dart**


One very useful feature when using RDDS is the capability to track a darted animal with specialized transmitter darts! Vital in many situations where an animal, darted with a tranquilizer, that still hasn't taken effect, would run off into the bushes to hide. Only under difficult efforts could one go after the animal, with slim chances of finding it before recovery occurs. The tracking system would allow going after the animal, pinpointing its position, getting to it timely to start the intended procedures. In fact, it is more a dart-tracking, rather than an animal tracking technology, meaning, the "animal" tracking capability is active only if the dart remains attached to the animal. Once it has fallen out, only the dart can be located. The transmitter/drug delivery dart is made up of 1) a cannula with double barb-wire, to remain securely in the animal until located; 2) the liquid drug chamber; 3) the coupling with the battery, transmitter, and antenna; 4) the transmitter dart housing, and 5) the flight stabilizer.

Transmitter Dart Parts; Dro, 2017

**Part 2, the Receiver**

Pneu-Dart's extremely compact receiver unit doesn't require any assembling, with a click of a bottom, the antenna elements snap into place, just acquire the corresponding setting to the transmitter's frequency, and the unit is ready to go.



Once the animal has been hit with the tranquilizer dart, and consequently took off, the best starting point is the highest available surface, slowly moving the antenna from one side to the other, while rotating the unit 180 degrees, listening to the intensity of the tone. Once identified from which direction the strongest signal comes, start following the signal, continuing to recognize the increasing pulse volume, until the animal is being located.

Pneu-Dart Receiver Antenna; Receiver Unit Display; Transmitter; Tracking I; Tracking II, Dro, 2017

**Other Useful Equipment – The Rangefinder**


Especially, when attempting to deliver darts over long distances, makes the rangefinder a necessity. Having the precise distance allows to make accurate adjustments, mainly choosing the right pressure setting, avoiding potential injuries to the animal, by setting the pressure too high, increasing unnecessarily the dart's velocity and impact force.

Bushnell Unit, Dro, 2017

**Acknowledgment**

We thank Pneu-Dart, Inc. Pa, USA, for all their support in providing equipment and material, as well as technical assistance. We also thank all the members of the Zoological Garden, Guarulhos, SP, for their participation.

**Useful Resources**

- Brazilian Military
  - DFPC: http://www.dfpc.eb.mil.br/
  - SFPC
    http://www.dfpc.eb.mil.br/images/Artigo_AirsoftAgosto2016.pdf

Airsoft Regulation Example:
The 6mm rule does not apply for veterinary darting equipment, as the darts are usually .50 caliber (12.7 mm), essentially a ballistic syringe loaded with an immobilizing drug and hypodermic needle.

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**As opiniões expressas no texto não representam, obrigatoriamente, a posição da ABRAVAS sobre o assunto.*