

# Depredation Investigation: Using Canine Spread to Identify the Predator Species

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**ABSTRACT:** When livestock are killed by predators, circumstantial evidence is often the only information available to determine which predator species made the kill. Evidence can consist of rake marks, scat, hair, attack points, tracks, sightings, and canine punctures. Canine punctures in particular can be informative because they offer the most direct evidence of attack, particularly if they are linked to tissue hemorrhaging. When investigating canine punctures, a common technique to identify the predator species is to measure the canine cusp spread for maxillary and mandibular tips as measured from the maxillary to maxillary tip or mandibular to mandibular tip. The assumption is that different predator species will have different and distinct canine spread. Surprisingly, little has been published on canine spread and comparing different carnivore species, leaving wildlife managers unable to reliably use this technique for predator identification. During 2008, we started a project to assess the width of canine spread in carnivores. The majority of information gathered to date shows a narrow range of measurements for coyotes and broad variation in feral/free ranging dogs that can overlap coyote measurements. The information provided on scientifically measured canine spread will assist the wildlife damage manager in determining the actual predatory species, especially when used with additional evidence gathered on site.

**KEY WORDS:** canine measurements, *Canis latrans*, coyote, damage identification, dog, forensics, livestock loss, predation

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## INTRODUCTION

Coyotes (*Canis latrans*) are considered to be the most common and serious predator of livestock in the western United States (Wade and Bowns 1982). Notwithstanding the amount of damage caused by coyotes, feral dogs (*Canis familiaris*) are fast approaching the amount of losses caused by coyotes, often surpassing coyotes in localized areas (Bergman et al. 2009). Overall, coyotes and feral dogs account for  $\frac{3}{4}$  of all livestock predation caused by wildlife (NCAT Staff 2002).

When livestock are killed by predators, circumstantial evidence is often the only information available to determine which predatory species made the kill. Evidence can consist of rake marks, scat, hair, attack points, tracks, sightings, and canine punctures. The presence of predator sign and predators in the area of the depredation, even with the livestock disappearance, do not always provide sufficient evidence to implicate specific predators (Wade and Bowns 1982). Canine cusp punctures in particular can be informative because they offer the most direct evidence of attack, particularly if they are linked to tissue hemorrhaging. When investigating canine cusp punctures, a common technique to identify the predator species is to measure the canine spread for maxillary tips and mandibular tips of canine cusps, as measured from the tip of the canine cusps to tip of the companion canine cusp between maxillary tips or mandibular tips. The assumption is that different predator species will inflict different and distinct puncture marks. Surprisingly, little

has been published on canine cusp spread or comparing canine cusp spread among carnivore species, leaving wildlife managers unable to reliably use this technique for predator identification. We provide empirical data for the depredation investigator to distinguish between coyote and feral dog depredations.

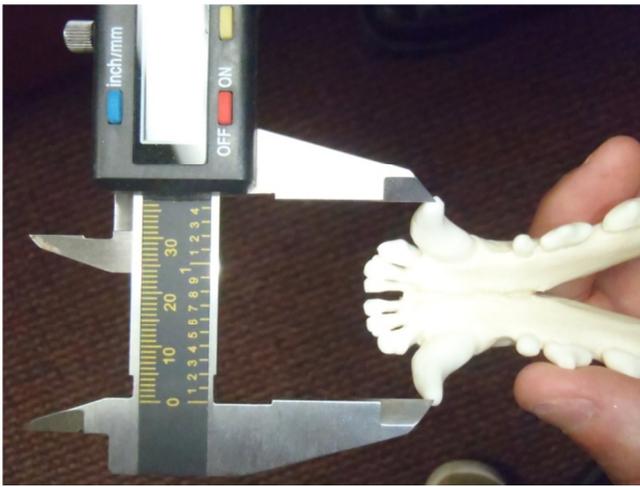
## METHODS

### Study Area

The study took place opportunistically across the state of Arizona. The state can be divided into 6 biogeographic regions (Brown 1994): to the northeast is the Great Basin; the southwest is composed of the Sonoran desert; the northwest is Mohavian; the southeast are Chihuahuan and Madrean; central Arizona is the Interior (Arizonan). Collections took place in all 6 biogeographic regions.

### Canine Tooth Spread Measurement

Canine cusp spread was measured using “point to point” measurements with a digital calipers (Figure 1). Individual jaws of the calipers were placed on the center of each maxillary or mandibular tip (Murman et al. 2006). Measurements were taken from maxillary tip to maxillary tip or mandibular tip to mandibular tip. Distance was measured in millimeters to one decimal place (e.g., 27.2 mm). In individuals with worn teeth, the individual taking the measurement estimated the approximate center point on the canine cusp and placed a single jaw of the calipers at that location.



**Figure 1. Photographic picture demonstrating the measurement of canine tooth spread using a digital calipers.**

## RESULTS

Tooth spread was measured opportunistically by the U.S. Department of Agriculture, Animal and Health Inspection Service, Wildlife Services employees within Arizona. Additionally, feral dogs were measured with the cooperation of the Navajo Nation. Measurements were taken opportunistically and no animals were taken specifically for this project. Measurement of coyote canine cusp spread was conducted after individual animals were taken for wildlife damage management purposes. Measurements of feral dog canine cusp spread were conducted after dog round-ups by the Navajo Nation Animal Control Program or in conjunction with wildlife damage management activities. Measurements began in 2008 and ended February 8, 2010. For this study, pairs of canine cusps with missing or broken teeth were not measured.

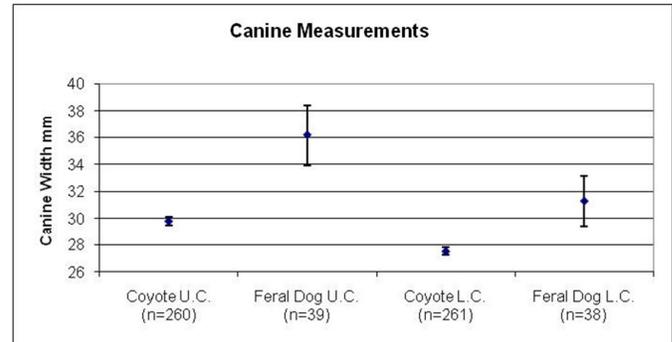
Wildlife Services employees measured 39 feral dog maxillary tip spreads and 38 feral dog mandibular tip spreads of the canine cusps (Figure 2). Feral dogs ranged from 14.8 to 48.4 mm for maxillary tip spread and ranged from 17.2 to 41.3 mm for mandibular tip spread. The mean maxillary tip spread was 36.2 mm (95% C.I.: 33.9 - 38.5 mm); the mean mandibular tip spread was 31.3 mm (95% C.I. 29.4 - 33.2 mm).

Wildlife Services employees measured 260 coyote maxillary tip spreads and 261 coyote mandibular tip spreads of the canine cusps (Figure 2). Coyotes ranged from 18.0 to 37.0 mm for maxillary tip spread and ranged from 15.5 to 32.8 mm for mandibular tip spread. The mean maxillary tip spread was 29.8 mm (95% C.I. 29.5 - 30.1 mm); the mean mandibular tip spread was 27.5 mm (95% C.I. 27.2 - 27.8 mm).

## DISCUSSION

Several authors have suggested using cranial and dentition measurements to distinguish between feral dogs and wild canids (e.g., Howard 1949, Lawrence and Bossert 1967, Newsome et al. 1980, Walker and Frison 1982, Callaway 2001). When conducting depredation investigations, the field investigator does not normally

have access to skulls of predators associated with the depredation event. In most cases, the only evidence associated with skulls are rake marks on the hides and puncture marks in the hide, bones, and meat of the carcasses.



**Figure 2. Maxillary (U.C.) and mandibular (L.C.) tip spreads for coyotes and feral dogs in Arizona.**

Several depredation procedure guides have provided limited data for the distance between canine cusps on feral dogs and coyotes (Table 1). The authors were able to find only two studies (Elbroch 2006, Murman et al. 2006, Foust 2010) that provided a range of measurements and an average spread for coyotes based on geographic location.

Coyotes from Arizona were within the ranges provided by Elbroch (2006) for the northeastern U.S. and western U.S. The spreads of maxillary tips and mandibular tips for Arizona were smaller than the mean for the specimens from the Chicago Museum of Natural History (Murman et al. 2006, Foust 2010). Our measurements also fit the suggested spreads provided by depredation manuals (Wade and Bowns 1982, AgriLIFE Extension 2004, Halbritter et al. 2008).

Feral dogs from Arizona had a larger mean for both maxillary and mandibular tip spreads as compared to specimens from the Chicago Museum of Natural History (Murman et al. 2006, Foust 2010). No other author reported maxillary and mandibular tip spread for canine cusps of feral dogs.

Variability was seen in both species with the greatest variability seen among feral dogs. The greater variability among feral dogs can be attributed to selective breeding by humans as well as age and sex differences of individuals. More than 400 different breeds of dogs, from the diminutive chihuahua to the large Scottish wolfhound, have been developed through human history (Clark and Brace 1995). Slight variability was seen among coyotes, which could be attributed to age or sex.

## MANAGEMENT IMPLICATIONS

Determining the loss of livestock depredation is similar to resolving a forensic case. In most cases, the depredation specialist must rely upon circumstantial evidence to determine the species that caused the depredations. The evidence with the greatest implication for species is rake marks and puncture marks associated with hemorrhaging. By measuring the distance between

**Table 1. Canine spread data provided by depredation procedure manuals and studies.**

Species	Location	Upper Canine Spread (mm) [Maxillary Tip]	Lower Canine Spread (mm) [Mandibular Tip]	Study or Manual
Coyote	Arizona	29.8, SE 0.16 N = 260	27.5, SE 0.14 N = 261	current study
Feral dog	Arizona	36.2, SE 1.11 N = 39	31.3, SE 0.92 N = 38	current study
Coyote	Chicago Field Museum of Natural History	30.62, SD 2.419 N = 47	28.64, SD 2.945 N = 47	Foust 2010, Murman et al. 2006
Domestic dog	Chicago Field Museum of Natural History	33.00, SD 7.232 N = 27	29.85, SD 7.887 N = 27	Foust 2010, Murman et al. 2006
Coyote (F)	Northeastern U.S.	27.10 - 32.22 Avg 30.42 N = 4	25.52 - 29.54 Avg 28.22 N = 5	Elbroch 2006
Coyote (M)	Northeastern U.S.	30.95 - 35.90 Avg 33.20 N = 6	27.00 - 35.10 Avg 30.28 N = 6	Elbroch 2006
Coyote (F)	Western U.S.	25.68 - 30.24 Avg 27.47 N = 10	23.40 - 28.05 Avg 25.55 N = 10	Elbroch 2006
Coyote (M)	Western U.S.	25.90 - 32.97 Avg 29.48 N = 9	25.21 - 28.79 Avg 27.06 N = 10	Elbroch 2006
Coyote	Not listed	1 1/8 - 1 3/8 in (28.6 - 34.9 mm)		Halbritter et al. 2008
Domestic dog	Not listed	Variable		Halbritter et al. 2008
Coyote	Not listed	More than 1 inch (>25.4 mm)		AgriLIFE Extension 2004
Coyote	Not listed	1 1/8 - 1 3/8 in (28.6 - 34.9 mm)	1 - 1¼ in (25.4 - 31.75 mm)	Wade and Bowns 1982
Dogs	Not listed	Variable		Wade and Bowns 1982

rake marks and puncture marks, the depredation specialist can begin to determine what caused the depredation. The data provided herein and supported by similar studies provides a set of tools for the depredation biologist to make a determination of predatory species that is based on science and not generalities. By applying the information acquired during a bite mark investigation, the depredation specialist can use the acquired measurements in conjunction with additional circumstantial evidence (e.g., scat, tracks, DNA, sightings), personal experience, this publication, and guidance from depredation manuals (Wade and Bowns 1982, AgriLIFE Extension 2004, Clucas 2005, Halbritter et al. 2008) to make a positive determination of the predatory species that caused the depredation. Future research should continue the data collection of canine spread from additional geographic regions and for other predatory species. The information collected will help the depredation investigator to further refine the accuracy of a determination as to what caused the depredation.

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