

# Vocalization Variability Among Urban and Rural Coyote (*Canis latrans*) Populations

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## Background

### Problem

"With its uncanny night howls, unrivaled ingenuity, and amazing resilience, the coyote is the stuff of legends." (Flores, D., 2016)

Urban land growth continues to grow at exponential rates encroaching on the territories and habitats of countless species (Seto et al., 2011). These urban environments consist of uniquely fragmented habitats of semi-natural human dominated landscape threatening biodiversity (Larson et al., 2020). Predators are highly susceptible to the matrix of human expansion due to their large habitat requirements and inclination towards competition with humans (i.e., like-predators). Despite this, coyotes persist even in the densest of human presence (Tigas et al., 2002). Anthropogenic disturbances are drastically influential to fragmented and adjacent ecosystems with the breadth of literature on marine and avian species that rely on vocal communication (Shannon et al., 2015). Given coyotes' geographic range, they are found throughout North America, live in both urban and natural habitats, are flexible, opportunistic feeders, and exposed to a variety of pollutants, coyotes are also a bioindicator, serving as a sentinel species for the health of a local ecology (Flores, 2016).

### Purpose

The purpose of this research is to empirically analyze recorded coyote vocalizations with intent to accurately assess coyotes as possible bioindicators of anthropogenic noise disturbances, concurrently producing and reworking existing classifications and indices of coyote vocalizations and behavioral/contextual content.

### Vocalizations

Howls, whining, barks, and growls are all signature communicatory methods of species in the canid genus. These vocal forms of communications are known as vocalizations. Overtime, many perspectives and approaches have aimed at standardization of vocal communication in canids. One of the most intricate operationalized classifications is derived from sound spectrogram analysis (Tembrock, 1976). Tembrock produced ten distinct sound types labelled one through ten based on four fundamental properties:

1. Phonetics: Elements of signal structure (i.e., frequency and intensity)
2. Temporal: Variance in patterns of duration (e.g., irregular repetitions)
3. Semantic: Meaning and content (i.e., message)
4. Pragmatic: Functional purpose (e.g., contextual differentiation)

According to Lehner (1978), coyotes vocalize based on contextual necessity into one of ten different vocalization categories, either individually as a lone coyote or as "sirens" or group calls. These vocalizations convey important information about the signaler (i.e., caller) and/or the receiver.

Vocalization	Context
1. Growl	Aggression
2. Huff	Threat
3. Woof	Alarm
4. Bark	Distress
5. Bark-howl	Threat, Distress
6. Whine	Submission
7. Yelp	Distressed submission
8. Woo-oo-wow	Greeting
9. Lone Howl	Conspecific Solicitation
10. Group Howl	Location signaling



## Proposed Method

### Target Species

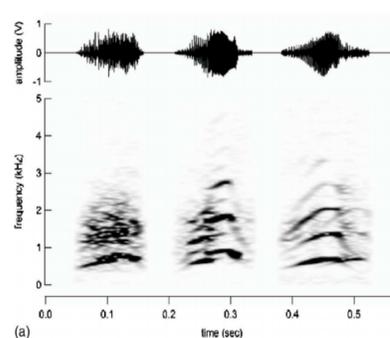
Coyotes range at a medium-size for canids, with a lifespan of up to 14 years. Coyotes have maintained an increased population growth curve in both urban and natural habitats due to being a K-selective species. Coyotes are diurnal and nocturnal, deriving most of their exploratory activity during dawn and dusk; however, foraging behavior is most optimal at night. Being present in every biome on the continent, coyotes have little habitat requirements so long as prey are persistent in the home region. Preferences for plains and grasslands are observed, which is likely due to their evolutionary history in the mid-west and southern united states. Coyotes form dens of interconnecting tunnels, consisting of multiple entrances. Being over several feet, the variance in place can include anything available in the environment including previously abandoned homes of other animals (National Geographic Society, 2021).

The variability between subspecies exists relative to social organization and occurs across the continent (Larson, 2020). However, many are solitary outside of breeding seasons, though sociality is often induced due to prey size in which large animals garner pack hunting. Socially they undergo courtship during a breeding season which can occur two-three months before attempted mating. Mating does not have to be for (life year to year), but it is not uncommon to observe concurrent mates. Litter size is dependent on both population density and food availability. Females give birth during springtime to litters ranging from 3 – 12 pups. By the fall, pups are capable of hunting with the formed packs in the fall spanning through winter to increase efficiency for resource gathering. When communicating, coyotes vocalize using calls that are heard as a chaotic chorus of howls and yips (Fire Effects Information System, 2021)

### Materials

The following materials would be necessary for documenting coyote vocalization and the context

- Six Sennheiser MKH 8020's with UltraVox XT software.
- 10+ wireless cameras for ethogram behavioral analysis post-recording.
- Sound level meter will record the ambient noise pollution.
- SPSS (v.27) software will be used in the regression analysis.



### Design & Procedure

This descriptive study will evaluate coyote vocalizations using sound spectrography, correlating a collection of vocalizations between two environments of two regions, Los Angeles (urban and rural) and Portland (urban and rural). Measurements for vocalization will be recorded on a roughly hexagonal setup of six sound spectrograms approximately 100m apart as to overlap the inputs.

The sonogram measurements will be categorized using ten vocalization classifications (Tembrock, 1976). Along with a camera setup for behavioral observation, wildlife corridors in both cities account for the urban condition and any suitable area with high coyote traffic moderately distant from metropolitan or industrialized areas account for the rural condition. Recordings will take place for a week at each location within a similar time span as to account for seasonal differentiation.

## Proposed Results

### Addressing the hypothesis that ambient anthropogenic noise influences coyote vocalization

A multivariate analysis of variance will be conducted in SPSS software (v.27). Utilizing phonetic characteristics extrapolated from existing literature, primarily Tembrock's classifications, z-scores will be calculated for each phonetic trait of each classification in order to standardize the data. Both urbanization and region will be correlated against recorded calls. These results will be compared to the measured ambient noise pollution in each area. The phonetic properties extracted from the ten classifications are as follows:

- Total Mean Duration (TMD)
- Cyclic Tendency (CT)
- Total Mean Frequency (TMF)
- Horizontal Stratification (Timbre)
- Total Mean Amplitude (TMA)
- Mean Ascension Time (MAT)

Mean range and rate of change will be calculated for each variable (e.g., range, TMFr; rate,  $\Delta$ TMF). Any variance among type specific qualities or notably distinct portions or sections of each call will be noted such as the vertical stratifications of growling or duration of the rising section of a specific type.

\*Note: subscript letters correlate to call type (e.g.,  $TMD_1 = 7.25s$ )

## Anticipated Outcomes

It is estimated that over 400,000 coyotes are killed annually by hunters, trappers, farmers, or by government agencies. In fact, in 2018, the US Department of Agriculture "lethally controlled", 68,000 alone (Edwards, 2019). Not only is this method useless, as seen by their increased population growth, but contributes to wildlife disturbance, specifically ariel gunning. Further research could contribute to ending legislation for wildlife extermination. Just as coyotes have had to adapt to our invasive nature, humans can adapt to the presence of competing species. In creating such an argument, operationalizing coyote vocalizations in relation to behavior will extend understanding of vocal communication and standardize existing literature. A side effect of this establishment is assisting in understanding how to coexist and the status of coyotes in their habitats. Such a prevalent terrestrial species as a bioindicator provides a massive homogenous sample size present in an insurmountable variety of locations to measure environmental effects of anthropogenic noise disturbances.

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