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THE SOUNDSCAPE OF ANIMAL CARE FACILITIES

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ABSTRACT

The soundscape of animal care facilities is an emerging topic that is currently being studied. Animal care facilities include a range of building types, including shelters for displaced animals, veterinary clinics, veterinary hospitals, and must accommodate a range of animal species and sizes.

Each facility has an animal care aspect that informs and helps create the acoustic environment. These facilities are unique in that many of the acoustic communities are not human. In interviewing the various user groups and local experts, the soundscape of animal care facilities is beginning to be understood. By identifying the acoustic taxonomies, acoustic communities, following their acoustic itineraries and understanding the acoustic calendar, planning principles and a conceptual structure can be organized and applied to the design of new animal care facilities, whether horizontally or vertically.

Using basic acoustic metrics such as Reverberation time, alpha bar and STI, large kennel spaces can be analyzed as a starting point since they are especially critical.

Using the soundscape method, analyzing data in existing facilities, and partnering with Architects during the design of these spaces, thoughtful interventions can be incorporated so that the building as a system can holistically address the components of the soundscape that can be altered by the physical building.

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1. INTRODUCTION

The study of soundscapes inherently relies on human perception; the specific study of the soundscape of animal care facilities should incorporate animal perception as well since they are critical members for the acoustic communities. Due to our inability to survey the animal occupants, studies rely on physiological and behavioral stress indicators to determine animal responses to auditory sensations. Savel et al. identified 25 sounds that were interpreted as stressful to dogs, yet these results are inherently subject to human interpretation of dog reactions [1]. A recent study demonstrated that humans may overly rely on context to interpret dog reactions [2] and underestimate the degree of fear experienced by dogs [3]. While we have some understanding of dog hearing, more research is needed to fully understand their auditory perceptions [4].

Dog barking is one of the most prominent elements of the soundscape in the two major types of animal care facilities: animal shelters and veterinary hospitals (or clinics). Nearly 3 million dogs in the United States are temporarily housed in shelters [5], over 12 million worldwide [6]. Typically, visitors to animal shelters immediately perceive dog barking, either from canine occupants of outdoor kennels upon arrival on site, or within the building, due to poor sound control between spaces (especially in older facilities). Dog barking often occurs as a result of human and dog interaction in close proximity and the acoustic features are related to context [7]. While other animals in care vocalize, they are typically not as loud as dogs.

Hospitals, facilities where humans are temporarily housed to recover, are a good corollary to veterinary spaces and animal shelters, which are unfamiliar, temporary housing for companion animals. Unfamiliar sounds that do not promote calm or restfulness may be stressful to the animal occupants.

According to Busch-Vishniac et al. [8] and Busch-Vishniac and Ryherd [9], hospital soundscapes affect staff and patients, potentially increasing stress in the staff and anxiety in the patients. Although animal care facility soundscape studies are not yet widespread, it can be assumed that similar experiences to hospitals may be present in animal care facilities, especially given the potential for the high volume of dog barking that may take place.

According to van den Bosch et al. [10], the evolutionary perspective of audible safety is an important component of auditory environments, warning humans of potential danger. In an acoustic environment lacking a high level of audible safety, people become vigilant and are alerted more easily, which results in stress and appraised unpleasantness. Simply said, people appraise their soundscapes based on the level of safety they attribute to them [11]. While this study is specific to humans, other research has shown that dogs and cats can be stressed by excessive noise [12, 13].

It has been documented that noise affected the length of stay at public places [14]. If the kennel environment is unpleasant due to dog barking, people may not stay long enough to bond with an animal, which can lead to fewer adoptions.

2. SOUNDSCAPE STUDY

To help understand how animal care facilities are used and the acoustic issues, a soundscape study was conducted for a facility to document the acoustic environment. Using principles derived from Murray Schafer's seminal publication, The Soundscape [15], as well as Siebein 2010 [16], the ISO 12913 standard [17], and Siebein 2023 [18], a soundscape exploration of an animal care facility was undertaken to better understand how the spaces are utilized to inform design interventions that can improve the sound quality of shelters. Concepts of describing the notation of soundscapes or "sonography," as described by Schaffer, are described below.

2.1 Acoustic Communities

The acoustic communities include the categories of inhabitants of a soundscape and those vary depending upon the type of animal care facility. The acoustic communities can be divided into three broad categories, with multiple members within each: staff, animals, and visitors. The humans involved typically respond to sounds from 20-20,000 hertz. However, each animal group has different hearing thresholds and sensitivities. Dogs, for example, are sensitive to sound 20 dB at frequencies of 4000–8000 Hz [18] and cats' hearing ranges from 6300 – 7300 Hz [19].

Table 1. Acoustic Community table showing typical users of the space.

Category	Members
Staff (Humans)	• Administrative team (executives, managers, customer service) • Veterinary team (veterinarians, vet techs) • Animal care technicians • Animal control or field officers
Animals	• Typically dogs and cats • Livestock (horses, goats, pigs, etc.) • Birds (chickens, ducks, parrots, etc.) • Reptiles and Amphibians (snakes, turtles, frogs, etc.) • Small Mammals (rabbits, hamsters, etc.)
Visitors (Humans)	• Pet owners • Prospective pet owners • Volunteers

2.2 Acoustic Taxonomies

The acoustic taxonomy is a listing of the sounds typically found in the acoustic environment. The acoustic taxonomy of the animal care facility is unique in that the classification category of "animal-induced" sounds is added. Human-induced sounds include sounds of communication between the acoustic communities and are typical for commercial buildings. Building services sounds are highly dependent on the particular facility and the same is true for equipment. Animal-induced sounds are what make these building types unique. Each animal vocalizes for different reasons, but many are believed to be a stress response from being in an unfamiliar situation with new stressors [20, 12].

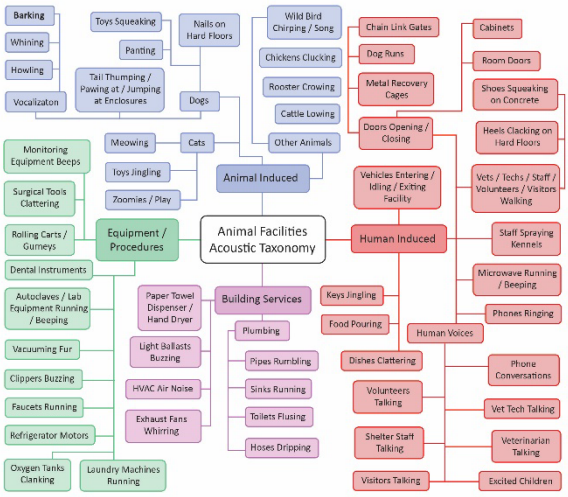

Figure 1. Acoustic Taxonomy of Animal Facilities.

2.3 Acoustical Itineraries as Soundwalk

The acoustic itinerary is conceived of as the path that a soundscape community member might inhabit in their occupying of the space. Each itinerary includes the path along which the participant occupies the space and experiences sound. Acoustic itinerary mapping varies depending on the facility type, age of the facility, and design and can have an impact on the stress responses of animals, especially in the kennel areas of older shelters where large amounts of dogs may be housed in the same area. The itineraries of staff and volunteers may encompass large areas of the building, especially back of house, office, and medical areas.

Visitors typically inhabit the waiting areas/lobbies and exam rooms in a veterinary facility. In a shelter, the visitors may or may not have access to the animal housing.

Animals in shelters are typically brought in through an unloading area or lobby, are held temporarily, and then move to an intake exam room. They are then directed to their individual housing, which is double compartment in a best practices facility. Dogs go outside for walks or play in yards while cats tend to remain in their housing unit or adjacent spaces.

The itinerary shown below shows the overlap of staff and animals, since animals do not move unsupervised through a facility. While the cat and dog adoption housing areas are separate, dog adoption functions do overlap the cat zone.

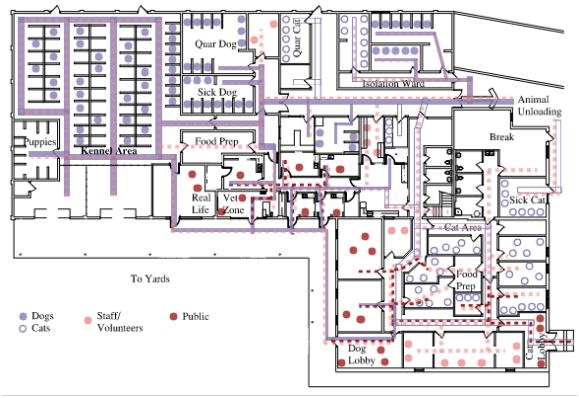

Figure 2. Acoustic itinerary of the Acoustic Community on an animal shelter floor plan.

2.4 Rhythm and Tempi as the Acoustic Calendar

The acoustic calendar shows how sound levels and content vary over time in the animal facility. Animal shelters are typically open a portion of the day to general staff and reduced hours for the public. The acoustic calendar of a veterinary facility can be different. General veterinary practices are only open during business hours and animals are rarely housed overnight. Emergency veterinary hospitals and urgent cares are open up to 24 hours a day with critical care animals housed overnight for observation.

One shelter facility was studied as an example: it is an older, budget-focused facility that lacks sound absorbent finishes and houses up to 36 dogs in the same room. The facility is open six days per week to the public, with Sunday only open to staff. Interviews with staff indicated the following daily schedule that takes place every day in Table 2. This schedule repeats daily, so there is a rhythm and structure to the day.

Table 2. Daily schedule from interview outlines the typical flow of operations.

Time	Activity
8:00	Some public services open
8:30	Dog walks begin; dogs in and out of housing units
11:30	Dog walks end Feeding begins
12:00	Staff lunch breaks, quiet for animals
13:00	Lunch break over, staff return
15:00	Dog walks again

Time	Activity
	Kennel cleaning
17:30	Closed to public
18:00	Staff begin departing

Sound level measurements were made in two locations in the existing kennel to document how sounds levels change over the course of the day. One meter location was inside a dog kennel approximately 2 ft above the finish floor to document sound levels at the approximate ear height of a canine. The other was secured to a fence post at approximately 6 ft in the air towards the front of the kennel, to approximate the location of a human ear.

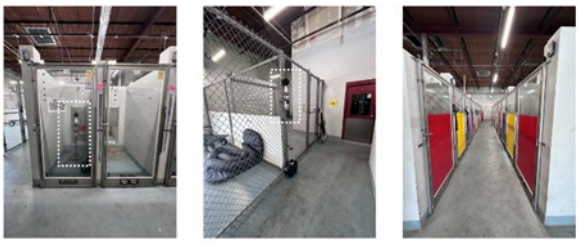

Figure 3. Pictures showing locations of sound level meters in the kennel to document the acoustic calendar. Left - meter in unoccupied kennel unit. Center - meter towards front of the facility. Right - view looking down main corridor at kennel.

It was observed that dogs tend to vocalize when they see a human walking down the kennel corridor. This happens often, when staff and volunteers walk each dog individually during the morning and night, when staff come to spray out the kennel units, or when food is provided.

2.5 Facility's Impact on Soundscape

The layout in this facility includes one large kennel space with 36 dog bays in the same acoustic volume. The dog kennel units face each other with a corridor between them. Each time a corridor is accessed by staff, they are detected by dogs on both sides. It was observed that each time a staff member would walk into the corridor to retrieve a dog for a walk, the walking by the kennel would elicit many of the dogs to vocalize. The other dogs in this large space would then also bark even if they were not visually observing the staff. Staff/volunteers constantly walk by dogs for feeding, walking, enrichment, cleaning, and moving dogs for other reasons. Since it takes staff and volunteers approximately six hours throughout the day to care for the dogs, these dogs are constantly exposed to a very acoustically stimulated environment for a large portion of the day. The lull in dogs barking seen in the data around the lunch period indicates that dogs are not being excited when the staff is not present. This indicates the importance of having acoustically separated kennel spaces with fewer dogs, to reduce the number of dogs being excited at any moment by the caretaking team.

There is no sound absorbent treatment in the kennel space that was observed or measured. This creates excessive loudness and reverberation in the space and effectively amplifies the sounds heard within it (i.e. barking). Staff are provided hearing protection when in these spaces.

In discussions with shelter staff, they identify which dogs vocalize more often. In the area where dogs face each other, staff alter the acoustic itinerary by placing the more vocal dogs in units father away from each other, when there is space and capacity to do so. By placing them farther apart, it reduces the direct sound level of the bark and lessens the impact of the bark on the other higher stressed dogs.

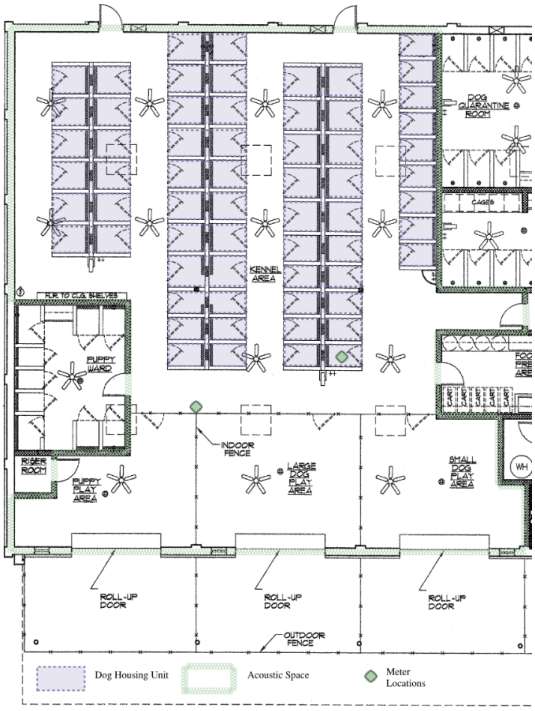

Figure 4. Floorplan of the existing kennel where the acoustic measurements were made.

3. ACOUSTIC ANALYSIS

3.1 24-Hour Sound Level Data

It was found that sounds levels regularly exceeded 100 dBA during the hours of 6:30am to 7pm, when the kennel was occupied by humans. There were an average of 177 instances of sound levels over 100 dBA, 7,417 instances of sound levels over 90 dBA, and 13,622 instances of sound levels over 80 dBA in the location inside the dog kennel unit. During the workday when the shelter is occupied by people, approximately 33% of the time sounds above 80 dBA were measured.

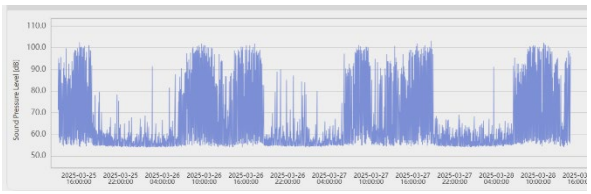

Figure 5. 1 second LAeq sound levels during a 3-day period with meter placed inside a dog kennel unit.

3.2 Interpretation

It was found that during the daytime hours, when humans occupied the facilities, the dogs vocalized consistently at high levels. After humans left for the day, dogs would sporadically vocalize throughout the night; however, those sounds tended to be at least 10 dB lower than the vocalizations during the day. This may mean that different vocalization efforts are made at different times to communicate different scenarios for the animals. This may also mean that the dogs who were barking were located farther away from the microphone, and that may result in the decrease in the sound level. Figure 6 contains a one-day period blown up with 1 second LAeq data shown. The blue brackets show the times the facility is open and closed to the public. Dogs vocalizing in the near vicinity ranged from 90 to over 100 dBA. Dogs barking farther away tended to range from 80-90 dBA.

There are some pauses of relative quiet though the day, including a pause in the middle of the day around the lunch break period.

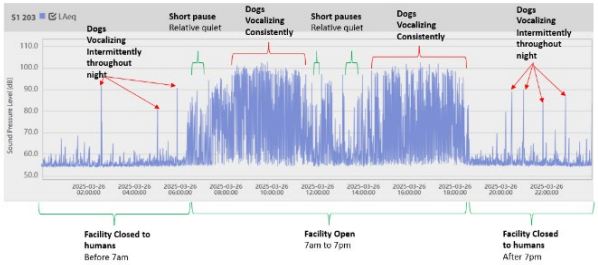

Figure 6. A 24-hr. period showing sound levels measured in the kennel area. Sound levels exceed 80 dBA for much of the day that the kennel is open to staff and the public. Occasional sonic events are seen intermittently during the late night and early morning at lower volume than during the day.

3.3 Reverberation Time

It was not possible to conduct Reverberation Time measurements in the kennel, as it was occupied and there was concern over the noise source disturbing the dogs. It was calculated that the approximate Reverberation Time in the kennel was 2.8 to 3.8 seconds in the 500 and 1,000 Hertz frequencies. This value is typical for acoustically untreated kennels based on Siebein's findings in 2024 [18]. Iterations of acoustic treatment were calculated, and the results are present in Table 3.

Table 3. Calculated Reverberation Time in kennel

1/1 octave band frequency	63	125	250	500	1000	2000	4000	8000
Untreated kennel	2.6	2.1	2.8	3.8	2.8	2.7	2.3	2.2

3.4 Alpha Bar

The alpha bar was calculated to be 0.05 to 0.07 in the 500 and 1,000 Hertz frequencies. This value is typical for acoustically untreated kennels based on Siebein's findings in 2024.

4. POTENTIAL ACOUSTIC INTERVENTIONS

4.1 Existing Kennel Spaces

In existing kennels, there are interventions that can be considered to help improve the soundscape of the animals in the shelter. Operational strategies to improve

dog welfare [21] should be explored first and then approaches to reduce the reverberant sound level in a space should be implemented. Providing designated quiet time during the day allows dogs to decompress [22]. Providing durable, cleanable acoustic materials on the majority of the ceiling surface can improve the sound quality of the kennel room. Siebein [17] found that the reverberation time in kennels with a treated ceiling decreased from approximately 4 to 8 seconds in the 500 and 1,000 Hz octave bands to 0.73 to 1.15 seconds in the same frequencies. Additionally, adding durable, cleanable acoustic material on the available wall surfaces can reduce reverberation. Species-appropriate music to reduce barking and increase restfulness for dogs [23] has also been shown to have a positive impact in veterinary facilities for dogs and cats as well [24, 25].

4.2 Kennel Acoustic Treatment Iteration Results

Iterations of sound absorbent treatment were analyzed to determine how the Reverberation Time and alpha bar might be affected in the kennel that was measured for the study. Those iterations are described in Table 4.

Table 4 Calculated Reverberation Time and alpha bar in kennels with various iterations of amounts for sound absorbent material.

Acoustic Treatment Condition	Reverberation Time (Mid freq)	Alpha Bar (mid Freq)
Untreated Room	2.8-3.8 seconds	0.05 to 0.07
Sound-absorbent material on 80% of ceiling	0.8 to 1.4 seconds	0.15 to 0.24
Sound-absorbent material on 80% of ceiling and 2" thick durable absorbent on 30% of walls	0.6 to 0.8 seconds	0.24 to 0.33
Sound-absorbent material on 80% of ceiling and 2" thick durable absorbent on 50% of walls	0.5 to 0.7 seconds	**4.31o 0.39**

4.3 New Kennel Facility Design

A series of design strategies are presented below that could be considered when designing new kennel spaces to reduce barking and improve the soundscape for dogs and cats. Housing dogs in more rooms with fewer kennels reduces the number of dogs vocalizing in response to stimuli, and with good sound separation, it reduces the impact of their vocalization throughout the facility. Strategic circulation for staff and visitors allows dogs to be taken out of their kennels without overlapping with cleaning, feeding, or get-acquainted activities. Some organizations have experienced reduced barking during adoptions when dogs are fed and exercising from the staff corridor, and introduced to visitors from a public corridor. Providing enrichment areas in close proximity to the kennels (walking paths, yards, real life rooms, etc.) can lessen the need for staff to continuously move in and out of the same area, needlessly exciting the dogs. Figure 6 shows how facility design can reduce the number of dogs in an acoustic space and minimize the overstimulating activity directly in front of dog housing by using a hallway as a buffer.

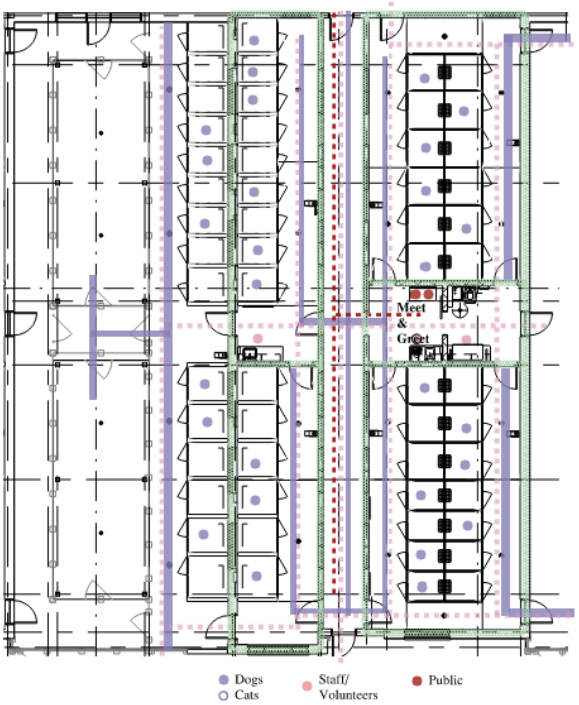

Figure 6. Example Acoustic Itinerary with interventions described above.

5. CONCLUSIONS

Animal care facility soundscapes need further study and research, specifically utilizing acoustic measurements in conjunction with metrics on animal well-being. This soundscape study helped in understanding more layers of the acoustic environment, particularly in the kennel where dogs are housed. In understanding how the acoustic communities use the space, the resulting rhythms and tempi of the space, especially the kennel, and understanding how the sound levels change from day to night as the inhabitants occupy the spaces aid in comprehending the acoustic environment in an animal care facility. By examining acoustic metrics such as Reverberation Time and alpha bar with various iterations of sound absorbent material and comparing it to the previously recommended target values contained in Siebein et al. [17], it allows for the tectonics of soundscape interventions to be developed. In collaborating with animal care facility experts, other proposed interventions have been presented to further improve the soundscape of animal care facilities.

6. FUTURE WORK

Future work may include acoustic measurements in dog and cat holding spaces in animal care facilities (shelters and veterinary clinics) that have used best practices for animal care design. Including several cameras and acoustic cameras that can detect which dogs vocalize, and when, may provide more information on dog behavior, as well as their reactions to sounds. Studying the soundscape in rooms where humans and animals interact can provide information on how acoustic perceptions vary across species. Soundscape explorations should include acoustic measurements and animal behavior evaluations to more fully understand the soundscape from an animal's perspective.

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