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A COMPARISON OF THE SOUNDSCAPE OF THREE ANIMAL SHELTERS

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Abstract

Animal Shelters are unique facility types with a range of human and animal user groups. These facilities temporarily house animals until they are typically returned to their owners or adopted. One of the most common species in an animal shelter is the domestic dog, whose bark can be loud and dominates the soundscape.

The animal shelter building form, particularly the dog housing configuration, can have a large impact on both the noise within dog housing spaces as well as throughout the entire facility.

By looking at acoustic metrics such as Reverberation Time, alpha bar, along with kennel occupancy, bark rate at various times of the day, average and maximum bark level and number of dog barks during the day, one can begin to understand how different shelter designs can impact acoustic metrics.

By following the sonic flows, acoustic itineraries, measuring acoustic properties, and understanding the acoustic calendar, we can begin to understand the impact of kennel room configurations on the overall soundscape. Comparisons of three very different facilities can inform interventions in existing facilities across the world in conjunction with animal care best practices. Incorporating knowledge of a range of shelter's soundscapes allows architects and designers to holistically address the components of the soundscape that can be altered by the physical building.

Keywords: *soundscape, animal shelter, kennel, noise*

1. Introduction

Animal shelters temporarily house animals that are lost, relinquished, cruelty investigations, court-case related, receiving veterinary care, and available for adoption services. Dogs and cats are the most common animals housed in these facilities, but other species include rabbits, chickens, livestock, and even wildlife in more specialty facilities.

Noise is a physical stressor on animals that can lead to behavioral, physiological, and anatomical responses- even when shelters are relatively quiet, noise levels are still over 50 dBA [1]. A persistently noisy environment prevents the uninterrupted sleep required for canine neurological and emotional recovery, which alters normal behavior [2].

The noise in shelters impacts the positive outcome potential for animals in several ways. Loud shelters are unpleasant for potential adopters, who may not stay as long in uncomfortable environments. The impact on dog behavior is starker. Poor behavioral presentation significantly reduces adoptability and can ultimately affect survival within shelters struggling with capacity challenges [3].

There are some standards that regulate shelter design such as municipality agricultural regulations and animal care facility licensing requirements, but these documents often focus on the animal's primary enclosure. Industry-specific guidelines provide more information on the quality of spaces. The Association of Shelter Veterinarians (ASV) developed Guidelines for Standards of Care in Animal Shelters which focus on minimizing noise in animal housing areas. These guidelines also highlight the need to design facilities to mitigate the impact of undesirable sound such as mechanical systems and barking. [4]. However, these standards and guidelines allow for a wide range of animal shelter designs.

2. Soundscape Study

To help architects and designers understand how animal care facilities are used and the acoustic issues, a soundscape study was conducted for three facilities to document the acoustic environment. Prior work Siebein 2025 [5] explored the soundscape of one of the facilities, Humane Society of North Central Florida (HSNCF hereafter). By presenting three shelters with vastly different architectural features, we can begin to understand the role architectural interventions can play in the quality of the shelter soundscape.

2.1 Facility Characteristics

The first facility, HSNCF is a not-for-profit organization that takes in animals from municipal shelters and limited admissions from the public. The second facility is Jacksonville Humane Society (JHS) which is a purpose-built animal shelter with a public veterinary clinic. The third

facility, Friends for Life (F4L), is a non-for-profit organization that primarily utilizes foster homes to house animals and has limited dogs and cats onsite.

Table 1. Overview of Animal Shelters Studied

	HSNCF	JHS	F4L
Year Constructed	2009*	2017	2011
Building Size	15,500	45,600	8,000
Dog Capacity	200	110-120	12
Cat Capacity	155	175+/-	150+/-
* HSNCF's building was not purpose-built and the Humane Society took possession in 2009			

2.2 Acoustic Taxonomies

While the acoustic taxonomies are similar across the three facilities, a few members of the acoustic communities vary based on the species of animals accepted and the public services provided.

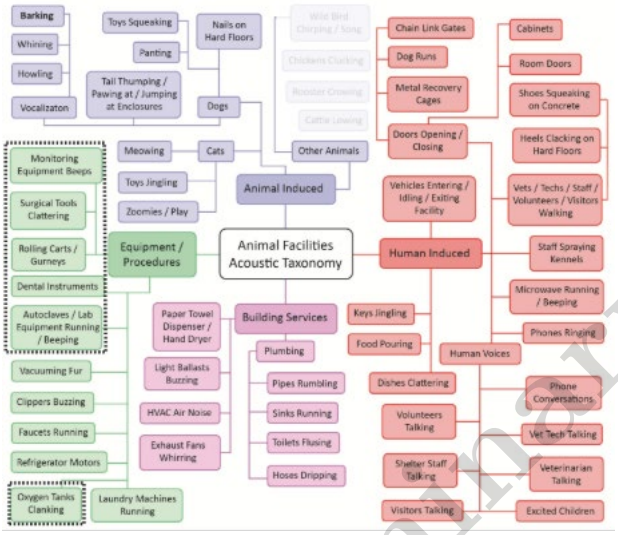

Figure 1. Typical Animal Shelter Acoustic Taxonomies.

JHS has more veterinary functions than HSNCF and F4L; however, F4L has more miscellaneous animals housed on-site than the other two.

2.3 Acoustic Itineraries

An acoustic itinerary is defined as the spatial pathway occupied by a member of the soundscape community as they move through and experience the acoustic environment of a facility. Each itinerary represents both the physical route traversed by an occupant and the corresponding sequence of auditory experiences encountered along that route. Acoustic itinerary mapping varies according to facility type, building age, and architectural design, all of which influence sound propagation and exposure. These variations may affect animal stress responses, particularly in kennel areas of older shelters where large numbers of dogs are housed in shared spaces. Staff and volunteer itineraries often encompass extensive portions of the facility, including back-of-house, administrative, and veterinary care areas, resulting in exposure to a broader range of acoustic environments.

Visitors typically inhabit the lobbies of shelters and may or may not have access to the animal housing spaces. At HSNCF and F4L, the public cannot freely access the dog housing rooms to view animals. On the other hand, potential adopters can walk the dog rooms in JHS.

Animals in shelters are typically brought in through an unloading area, intake zone, or shared lobby; and all of these spaces can be overstimulating if multiple animals or owners are present. Animals are often held temporarily, move to an intake exam room, and then directed to their housing units. There are often multiple housing units in a single room, or acoustical space. Dogs leave their primary enclosures for walks or play in yards while cats tend to remain in their primary enclosure. Staff and animal itineraries overlap since animals do not move unsupervised through a facility.

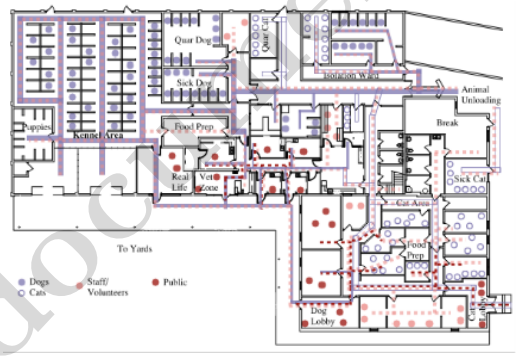

Figure 2. Acoustic Itinerary of HSNCF.

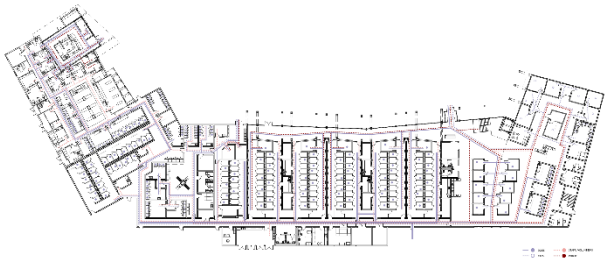

Figure 3. Acoustic Itinerary of JHS.

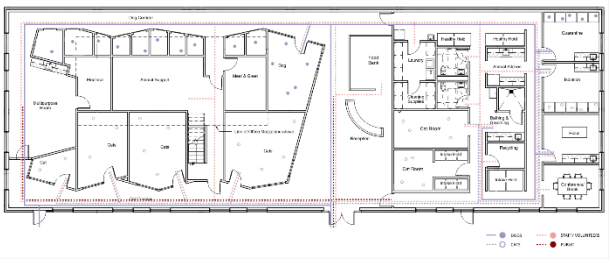

Figure 4. Acoustic Itinerary of F4L.

At both HSNCF and F4L, there is incidental activity in front of a particular dog kennel. Whereas, at JHS, the circulation

occurs around the dog kennel rooms unless staff, visitors, or volunteers need to access the dogs in the room.
Operating hours across the three facilities vary by day of the week. The typical operating hours are shown in the table below.

Table 2. Typical Operating Hours by Animal Shelter

	HSNCF	JHS	F4L
Staff/ Volunteers	6:30-18:00	6:30 – 20:30	6:00-18:00
Public	Adopt by Appointment Clinic 12:30-16:30	12:00 – 19:00 or 10:00 – 17:00	11:00 – 16:00

The public must make appointments for adoptions at HSNCF at time of publishing, but the kennels were open to staff and volunteers at the time of the study. At JHS, visitors can walk in front of the adoptable animals but only using the "public" corridor during hours open to the public. There are volunteer shifts where a large number of dogs are walked as well, however those use the "staff" corridor. This strategy was meant to habituate the dogs to receiving food and walks from the staff side, and to not expect that kind of interaction from the "public" side. This strategy effectively isolates the sonic flows and acoustic itineraries of the staff and volunteers from the public. F4L has more limited public adoption hours, and visitors cannot walk in front of the dog kennels. This helps to isolate the acoustic itineraries of the staff versus the public at F4L.

3. Architectural Characteristics

3.1 Kennel Spatial Characteristics

The architectural features of a space can have a major impact on the soundscape perception of the space. Changes in the finishes, room volume, architectural assemblies are among the soundscape design interventions that architects and acoustic consultants can use to influence the perception of the space. The following table provides a comparison of the spatial/physical characteristics of each room that could impact the barking dog sounds

Table 3. Overview of the Dog Housing Spaces

	HSNCF	JHS	F4L
Dogs Per Room	12 -36	10- 20	1- 2
Wall Construction	CMU to 12 feet 8 inches with stud wall above	CMU to 4 feet with stud wall above	Glazed block to with acoustic material above
Ceiling Material	Exposed structure	Acoustic ceiling tile	Gypsum board
Floor Material	Resinous	Resinous	Resinous
Additional Considerations		Acoustic panels on some walls	Sniff holes in doors, Duct noise transfer
Reverberation Time (500-1,000 Hz)	2.7-3.5 seconds	0.6-0.7 seconds	0.7-0.8 seconds
Alpha bar (500-1,000 Hz)	0.05-0.07	0.22-0.27	0.05-0.06

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.

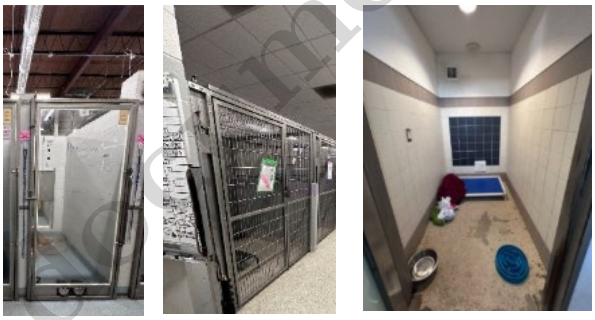

Figure 5. Individual dog housing at each location. From Left to Right: HSNCF, JHS, F4L.

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, and when food is provided.

3.2 Architectural Interventions

The three facilities can be considered as a range of architectural interventions on the animal shelter typology.

HSNCF has minimal interventions and the surfaces within the space (CMU, solid glass doors, etc.) do little to mitigate the dog barking. There is no sound absorbent treatment in the HSNCF kennel space that was observed or measured. This creates excessive loudness and reverberation in the large-volume space and effectively amplifies the sounds heard within it (i.e. barking). Staff are provided hearing protection when in these spaces.
JHS can be considered to have moderate interventions. Architecturally, the building was designed to minimize the number of dogs per room while balancing operational efficiencies for staff. Cost effective design was also a factor since the facility is on the medium-large side, and every room-scale intervention occurs in multiple kennel rooms. Reducing the number of dogs per room, assuming adequate sound separation between rooms, limits the number of

dogs that are triggered by another dog's barking. The volume of the kennels is lower than HSNCF, bringing the absorptive ceiling panels closer to dog height. Partial height CMU walls with stud walls above provide greater isolation than the painted CMU walls at HSNCF. The gate to each enclosure is metal bar instead of the glass like at HCNCF.

F4L has the highest degree of architectural intervention since each dog has its own room for their primary housing unit, whereas the previous shelters consist of multiple kennels in the same room. These rooms have low ceilings and absorptive materials on the upper walls above cleaning height. Limitations to the interventions at F4L include holes in the doors for dogs' olfactory stimulation and treats. While the ducts between adjacent rooms transfer sound, the F4L staff use this as a feature to play stress-reducing music for the dogs through the ducts.

Best practices for new animal shelters include limiting the number of dogs in a room to six to eight canines, providing walls with sufficient STC ratings [7], and ensuring those walls go to the ceiling or roof structure above. Some individual rooms can be provided for the most sensitive dogs. Often shelters must balance operational spending, which funds enrichment for the dogs, and infrastructure spending, which enables low-stress spaces.

4. Acoustic Analysis

4.1 Soundwalks and Soundscape Questionnaire

Soundwalks with shelter staff and volunteers were conducted at each facility. The soundwalks included moving through the lobby, entrance spaces, observing the Meet and Greet rooms, cat rooms, and back of house spaces. Soundwalks culminated in the adoptable dog kennel spaces, as well as dog isolation areas. Soundwalks performed in the kennel spaces indicate that when dogs are housed in conditions where they are isolated, yet directly adjacent to other dogs, and within several feet of a corridor that is heavily used by people throughout the day, they vocalize when humans pass by their kennel. Some dogs are more excitable than others, and some dogs barking excite others to bark as well.

Whereas other soundscapes are potentially less impacted by people performing soundwalks, such as in urban areas, the soundwalks introduce additional humans into the kennel spaces and dogs typically react by vocalizing when the soundwalks occur.

Soundscape questionnaires were provided to staff, volunteers, researchers and designers for each of the three facilities. The results of the PAQ Radar plot show that the HSNCF with minimal acoustic interventions and large numbers of dogs in a single area has more negative perception, with responses tending more towards annoying, chaotic and eventful. The moderate acoustic interventions at JHS of adding sound absorbent material on the ceiling, limiting the room volume, limiting the number of dogs in each space and separating the visitor flow from the staff resulted in a more favorable soundscape perception, with results trending towards vibrant and eventful, yet some still finding the space to be somewhat annoying and chaotic. The F4L facility with the highest level of design interventions also had higher pleasant, calm and uneventful scores compared with the other 2 facilities.

Figure 6. Radar plot of soundscape perception for all 3 facilities overlaid on each other.

Overall, F4L had the most positive soundscape perception, while HSNCF had the most negative.

4.2 24-Hour Sound Level Data

Reviewing the 24-hour sound level data provided interesting comparisons to the intervention levels. Sound levels at HSNCF were the highest for longer periods of time in the acoustically untreated kennel at 95-103 dBA (Shown in gray in Figure 7). Sound levels at JHS ranged from 88-102 dBA with the moderate acoustic treatment including sound absorbent ceiling, lower ceiling height and volume and reduced number of dogs per area. Sound levels of dogs barking in the kennel with the highest degree of interventions at F4L ranged from 66-90 dBA.

Interestingly, the background sound level at HSNCF ranged from 55-60 dBA due to the open air condition and constant exhaust fan operating despite not having central air conditioning. JHS had the lowest background sound levels, ranging from 25-40 dBA. F4L had background sound levels that ranged from 35-42 dBA.

It is clear from the sound level data when the first humans entered and the last human exited the facility. Dogs tend to vocalize when humans pass by their kennel area or perceive human activity.

The sound levels in HSNCF tended to increase when staff and volunteers were in the direct vicinity of the meter, resulting in sound levels ranging from 95-105 dBA. Vocalizing was still consistent but at lower levels as staff moved farther away from the meter, ranging from 80-95 dBA. There were approximately 5 instances when vocalization stopped completely, presumably during the lunch time period.

Sound levels at JHS tended to stay more consistently high, with several instances of sound levels that were slightly higher. Overall sound levels were 0-9 dB quieter than HSNCF, likely resulting from the sound absorbing ceiling and

reduced number of dogs. There was only one period of no vocalizations later in the afternoon.
Sound levels at F4L were lower overall than the two other facilities, and the density of vocalizations were much reduced as well. This is likely due to the isolated dog kennel with solid wall and doors and much smaller number of dogs in the facility.

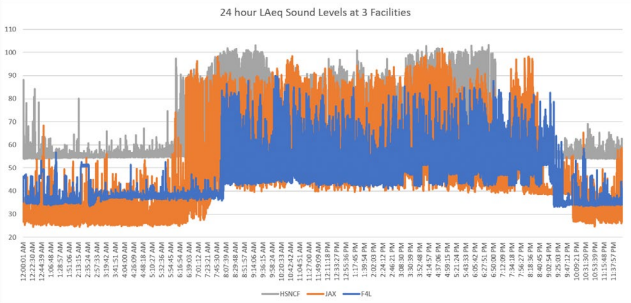

Figure 7. 1 second LAeq sound levels over a 24-hour period for all three facilities overlaid.

The metric proposed by Siebein et al 2026 [8] called "Bark rate" which presents the number of barks per hour was examined across the 3 facilities. The occupied bark rate for F4L was the lowest and 89 during the day time. The bark rate at HSNCF ranged from 88-95, and the bark rate at JHS ranged from 111-113. The bark rate fell to 29 at F4L during the night time hours, to 27-32 at HSNCF and 43-71 at JHS. The occupied bark rate is likely associated with the amount of human interaction during the day.

4.3 Interpretation

Plotting the sound level data in bar graphs by the percent of time above thresholds produced results that agree with the soundscape perception.

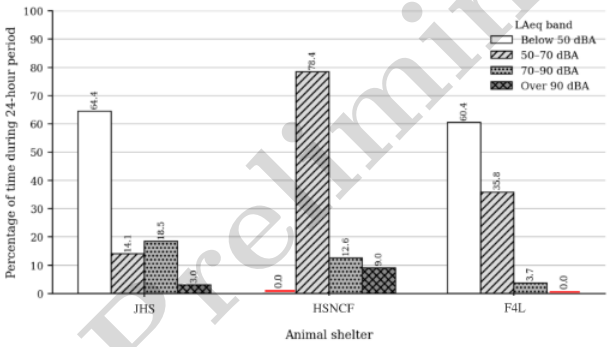

Figure 8. Percentage of time over one 24-hr period in each identified LAeq band for shelters studied

At HSNCF, 9% of the time included sound levels above 90 dBA. There were no times where sound was under 50 dBA for this facility. At JHS, 3% of the time included sound levels over 90 dBA. However, around 65% of the time, sound levels were below 50 dBA. At F4L, there were no sounds above 90 dBA, only 3.7% of the time sounds were between 70-90 dBA and 60.4% of the time the sound levels.
It should be noted that while the percent of time above 80-90 dBA appears to be low, the duration of each dog bark is in milliseconds. The data clearly show that at each facility, the dogs vocalize consistently throughout the day, with very few pauses with no vocalization for extended durations. This means that unless a dog has habituated to other dogs barking constantly, the extremely high levels that happen constantly throughout the day likely make it difficult for the dogs to sleep during the daytime hours. Even with reduced room volume, and acoustic finishes, the dogs are still vocalizing constantly throughout the day. The overall sound level is lower in facilities with interventions, but the vocalizations still occur. The soundscape intervention of an isolated dog kennel for 1 dog measured in the corridor resulted in the lowest overall sound levels, as well as longer periods of time where sounds are reduced.

5. Conclusions

Comparing the soundscape design interventions of three very different kennels has provided insights into potential strategies for future kennel design. The reflective acoustic finishes, high room volume and large number of dogs in HSNCF resulted in the lowest soundscape perception score and the highest sound levels of all 3 facilities.
Providing a reduced number of dogs, lower ceiling height and sound absorbent ceiling resulted in lower overall sound levels from dogs vocalizing. The facility with the highest level of architectural interventions resulted in the most favorable soundscape perception scores and the lowest sound levels. Therefore, architectural interventions that could improve the soundscape perception in kennels include the following:

1. Reduce ceiling height
2. Provide a sound absorbent ceiling
3. Provide smaller kennel rooms for reduced number of dogs
4. Providing completely enclosed kennel units for single dogs who are particularly sensitive to vocalizations.
5. Provide durable, cleanable sound absorbent material on the available upper side walls

An important consideration is that when dogs are housed in kennels, they depend on humans for food, water and enrichment. They also have a basic physiological need for sleep throughout the day but are also social species. If humans are constantly moving past their kennel areas, they are acting as a trigger to the dogs to vocalize. The above interventions focus on architectural approaches, but ultimately operational strategies are the easiest to implement in any facility. Tired, non-stressed dogs are less likely to bark when they are not stimulated. One potential strategy that should be given careful consideration in the future in addition to the architectural interventions previously discussed would be the operational strategy to enact "quiet times". This may be performed in designated kennel rooms after morning feeding, cleaning, and exercise takes place. While there is data supporting reducing public viewing of animals [9] is beneficial for sleep, other studies

show that viewing longer length of stay dogs improves the chances of adoption [10]. Some studies have shown that rewarding quiet behavior also has a positive impact on the kennel soundscape [11]. Ultimately, studying interventions using acoustic data, canine biometric data, canine outcome information, and surveys can help a shelter evaluate the success of each approach.

6. Future Work

Future work may include a larger range of animal care shelter design strategies. Including several cameras, dog biometric data, 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. Pairing this data with interventions from dog behavior experts and operational changes can help optimize the soundscape from a canine perspective. Additional studies could include acoustic measurements before and after architectural interventions such as acoustic panels or wall modifications to determine their impact on canine-generated noise as well as canine perception. It would be beneficial to perform acoustic measurements in a facility that has enacted "quiet hours" to measure sound levels and determine if it can be an effective strategy.

7. Acknowledgments

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