FNR-603-W

Community Soundscape Planning Guide

Controlling Noise & Protecting Natural and Cultural Sonic Spaces

Center for Global Soundscapes

PURDUE UNIVERSITY | Forestry and Natural Resources

Learning the Basics

+

Impacts of Noise on People and Wildlife

+

Soundscape Workbook

+

Planning Tools and Resources

SOUNDSCAPES & LAND USE PLANNING

This *Community Soundscape Planning Guide* is to be used by communities in the United States and other places, to focus land use planning within the context of the sonic spaces of built and natural areas locally. The guide has several sections.

- **Learning the Basics** helps planners understand what a soundscape is and what is noise
- **Impacts of Noise on People and Wildlife** summarizes what is known about how sound affects people and wildlife
- **Soundscape Workbook** allows individual planners or community groups to work through major issues related to natural and cultural soundscapes and the occurrence of noise in their community
- **Planning Tools and Resources** describes tools already in existence and new tools such as an app and online mapping system developed at Purdue University

This planning guide is also associated with several Purdue Extension projects that are underway and which can be offered to communities. The first is an online GIS-based tool called TippingPointPlanner (tippingpointplanner.org) which allows communities to walk through, in a 2-day, Purdue Extension facilitated program, the assets, threats and potential solutions to land use based challenges such as managing nutrient loading and runoff using such approaches as green infrastructure. More information about this Extension program can be found at https://www.purdue.edu/fnr/extension/program-impacts/tipping-points/

Much of the work to create this planning guide was supported by a grant from the Indiana Department of Natural Resources Coastal Services Program. Students, staff and students in Purdue's Discovery Park Center for Global Soundscapes as well as those in the Purdue Department of Forestry and Natural Resources, developed this guidebook through input from the community leaders in northwestern Indiana who participated in a February 2017 workshop.

As this planning guide is a first edition and truly one of a kind, we welcome input to improve it to make it more effective. Our goal is to produce a sonic environment that is healthy and enjoyable.

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SECTION 1:
LEARNING THE BASICS

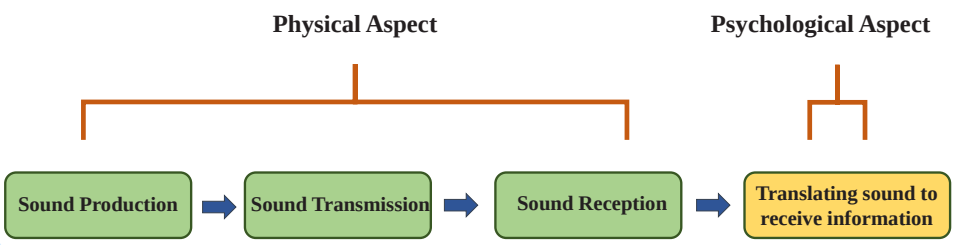
Anything that moves makes a sound. Sound sources can be *biological* (i.e., living organisms), *geophysical* (e.g., thunder, rain, wind through trees, avalanches, ice breaking, and waves breaking on a shore) or those originating from *human activity* (e.g., machine noise, church bells, and music). After sound is produced, it travels as a wave through a medium (air, water, or a solid substance such as the ground) to reach a target or receiver; only organisms can perceive and process information that sound might carry.

Common sounds within a community can also form a sense of place which are often shared by everyone. If you live in the Midwest United States, for example, spring peepers, a small native frog of wetlands, signal the start of spring for many people. As people from your community enjoy city parks and other outdoor areas, are the sounds they hear contributing toward the experience that these spaces are designed for? Are noise levels from the urban environment causing health problems?

WHAT IS SOUND?

Sound is a vibration or pressure wave, a form of energy that causes particles to move through any elastic medium (i.e., bounces back when pushed); the medium can be a solid, liquid, or a gas. For a vibration or pressure wave to exist, an object has to physically generate waves that produce rapid changes in pressure that is passed from molecule to molecule across space creating a chain reaction until the energy dissipates. When these vibrations reach a human ear, they are collected by a membrane (the tympanum) and then passed to the hammer, anvil and stirrup bones that amplify the vibration. This vibration is captured by the cochlea situated in the inner ear, which is lined with tiny hairs (cilia) that move and produce a nerve impulse to the brain. That is how we, mammals, hear. Other animals hear sound in various ways; we know that nearly all mammals, birds, reptiles, amphibians and most insects hear or have ways to detect vibrations or pressure waves around them.

The physics of sound is studied by the science of acoustics that seek to understand how sound waves propagate through different media as well as the interaction between these waves and objects located across space (e.g., hills or a dense forest). However, in physiology and psychology, sound is traditionally perceived as a subject of perception by the brain. From this standpoint, if we ask the question "if a tree falls in the forest with no one to hear it fall, does it make a sound?" the psychological answer would be "no." However, from the perspective of acoustics, the answer to the previous question would be "yes," the tree will make a sound independently if it is heard by someone or not, as the pressure wave indeed existed in that space.



The physical and psychological aspects of acoustic communication.

WHAT ARE SOUNDSCAPES?

A soundscape[1] can be defined as the collection of sounds that occur in an area at a particular time. This term was coined in 1969 by R. Murray Schafer, a Canadian composer and environmentalist. Since then, it has been used by many disciplines to describe the association between landscapes and their sounds.

Soundscape ecology[2] can be described as all sounds, those collectively as biophony (biological sounds), geophony (geophysical sounds), and/or anthrophony (human-produced sounds), emanating from a given landscape to create unique acoustical patterns across a variety of spatial and temporal scales. These sounds reflect the spatial and temporal variability of ecological and social processes[3] occurring at that place at any given time. This Community Soundscape Planning Guide has been developed by the Discovery Park Center for Global Soundscapes at Purdue, a team of soundscape ecologists with training in ecology, community outreach, social science and signal processing. The Center has been at the forefront of developing a new science -- soundscape ecology – which use the concept of soundscapes in an ecological and social context. The Center works on a variety of research, education and outreach projects related to sound, ecology, conservation, and planning.

1 Schafer, R. M. (1993). The soundscape: Our sonic environment and the tuning of the world. Simon and Schuster.

2 Pijanowski, B. C., Villanueva-Rivera, L. J., Dumyahn, S. L., Farina, A., Krause, B. L., Napoletano, B. M., ... & Pieretti, N. (2011). Soundscape ecology: the science of sound in the landscape. BioScience, 61(3), 203-216.

3 Dumyahn, S. L., & Pijanowski, B. C. (2011). Beyond noise mitigation: managing soundscapes as common-pool resources. Landscape ecology, 26(9), 1311.

WHAT IS THE DIFFERENCE BETWEEN SOUND AND NOISE?

Noise is a type of sound perceived by humans that causes an unpleasant experience, therefore it is an unwanted sound. From this standpoint, people can subjectively evaluate the quality of the sonic environment regarding the level of background noise capable of masking important sounds.

Sounds that are considered to be noise can be rather subjective; to one person, the sound of a loud motorcycle might remind them of the pleasant experiences of riding such a vehicle during a sunny afternoon; to others, it might be an unwanted sound that unexpectedly interrupts their current activity. Some sounds are more universally accepted as noise, such as the sounds of a nearby highway or the constant sounds of jets flying overhead.

NOISE AND CULTURAL SOUNDS

There are many sounds produced by humans that may not be considered noise and are rather very important part of a community's identity[1]. These might include the sounds of a church bell, the sounds produced by a foghorn or boat, or public musical performance.

Some human produced sounds can be considered cultural and important in one community, and noise to yet others. For example, the sounds of trains in some communities may define that soundscape for members living there especially if there are historical or economic ties to that transportation system. Other communities may find those sounds to be unwanted and therefore noise.

1 Smith, J. W., & Pijanowski, B. C. (2014). Human and policy dimensions of soundscape ecology. Global environmental change, 28, 63-74.

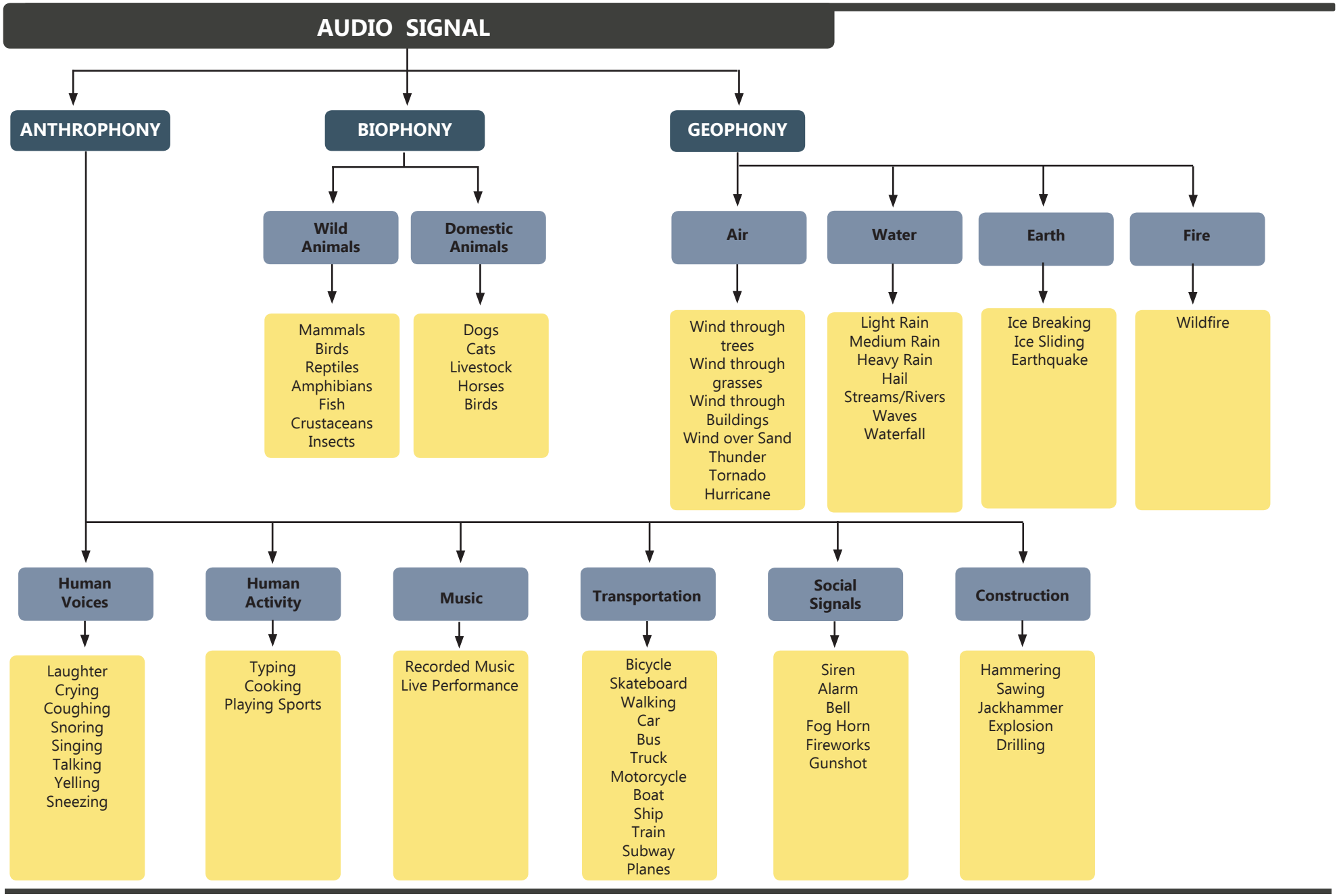


Figure 1. Sound Taxonomy Diagram. As sounds are often related to the source producing it, the above illustration attempts to organize sound sources hierarchically across numerous groupings of sources that are useful for understanding ecosystem dynamics as well as for natural resource and land use planning. This taxonomy does not necessarily have to be strictly followed and could be modified if the natural and cultural soundscapes and noise types significantly differ from those contained here.

SECTION 2:

IMPACTS OF SOUND ON PEOPLE & ANIMALS

NOISE AND HUMAN WELL-BEING

As noise affects health and behavior of humans and other animals, it is considered a type of pollution, although it has historically been treated differently than other types of pollutants like airborne chemicals, air particulate matter, or electromagnetic waves, among others[1].

Noise can be measured with high precision with powerful instruments, however it gains more meaning if we couple this measurement with human perception and a physiological sensitivity to these sounds. Every person has her/his own perception and sensitivity about noise, making thresholds variable among people.

It is well known that people who are more sensitive to noise show an increase in heart rate and blood pressure than people who are more noise tolerant[2]. The effect is more pronounced in some populations that are more highly vulnerable to any kind of stress, such as adults with hypertension, cardiovascular disease, and with diabetes.

Other effects of noise on people result in what some psychologists call "learned helplessness," which is a situation when adults and children continue to fail at a task due to the overt presence of environmental stimuli that result in a repeated lack of responsiveness. For example , when children from schools near noise sources (like trains, highway) were asked to solve a puzzle within four minutes, 15% of them gave up before the time limit, while children from schools with quiet surroundings gave up at a much smaller rate of 2%. This motivational reduction has been increasingly reported by teachers in schools with noisy environments.

1 Dumyahn, S. L., & Pijanowski, B. C. (2011). Beyond noise mitigation: managing soundscapes as common-pool resources. Landscape ecology, 26(9), 1311.

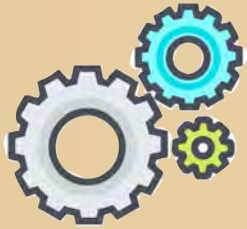
2 Stansfeld, S. A., & Matheson, M. P. (2003). Noise pollution: non-auditory effects on health. British medical bulletin, 68(1), 243-257.

SOUND PRODUCTION AND HEARING IN ANIMALS

There are certain sounds that, because of their origin or loudness, may produce discomfort to people, as well as to animals. Generally, these are human-made sounds like those we can find in a city, especially those produced by traffic, horns, sirens, etc.

In the natural world, many animals, like birds, mammals, reptiles, amphibians, fish and insects, hear best at the frequencies they produce and have varying sensitivities to sounds of other frequencies. All these groups of animals produce a high diversity of sounds that are influenced by several factors; for instance, habitat, body size of the organism, and the medium in which the sounds are produced (e.g., water or air). Animals produce sounds for many reasons, like finding mates, defending a territory, or for warning of predators. Some sounds from the natural environment (e.g., the sounds produced by rivers) are known to be used for orientation.

Animal	Frequency Range	Weight of Animal
Bat	1200-16000 Hz	0.002-2.20lbs (1-1000 g)
Cat	500-1300 Hz	5-10 lbs (2.5-4.5 kg)
Dog	300-800 Hz	20-100 lbs (10-45 kg)
Dolphin	200-11000 Hz	331-442 lbs (130-180 kg)
Elephant	30-70 Hz	15,000 lbs (7,000 kg)
Gorilla	250-600Hz	300-400 lbs (130 to 180 kg)
Horse	550-950 Hz	1,000 lbs (450 kg)
Large Birds	400-600 Hz	50-100 lbs (22-45 kg)
Lion	10-430 Hz	420 lbs (200 kg)
Monkey	800-1300 Hz	79 lbs (36 kg)
Mouse	Up to 4000 Hz	0.09-0.01lbs (40-70 g)
Small birds	2200-2500Hz	0.003-4.4 lbs (1-2000 g)
Tiger	83-246 Hz	5-10lbs (2.5-4.5 kg)
Whale	10-3000 kHz	420,000 lbs (200,000 kg)



HOW ANIMALS PRODUCE SOUND

Some animals produce sounds by moving their bodies; for example, woodpeckers strike trees with their beaks producing a "pecking" sound. Others move any part of their bodies that interacts with a medium; for instance, bees or mosquitoes, which move their wings through the air, producing a "buzz". In some environments, like the desert, this is the predominant sound that soundscape ecologists hear in their recordings. Finally, animals also vocalize to others of their own species; these include birds, mammals, insects, fish and frogs.

Diversity of sounds in nature is also produced simply due to the body size of the animal creating the sound. Typically, larger animals produce sounds with lower frequency (e.g., big cats) while smaller animals tend to produce sounds with higher frequencies (e.g., birds). Some animals can exert tremendous amount of energy into sound production; the roar of a lion across the savannah can be heard as far as 7 miles away.

CULTURAL VALUES & SOUNDSCAPES

Besides natural and human made sounds and noise, there is another aspect of the sonic environment that deserves attention: the cultural value of specific sounds. Cultural sounds consist of those sound sources which have certain social values related to traditions, contemporary culture, or habits. Sounds associated with these social values are cultural sounds.

Sense of Place

We create different types of relationships with the place we belong. For instance, we can connect with a place from an historical or familial perspective, such as where we were born or lived in a place for a period of time. Additionally, we can generate spiritual connections with a place that are emotional or intangible rather than actually generated. We can connect with a place from ideological relationships when moral and ethical bonds are developed, for instance, when we follow or live according to certain philosophical guidelines, which could be religious or secular. We can also generate narrative relationships with a place through stories, myths, family histories, politics, and fiction. Each of these relationships between people and places forms a sense of place that makes a particular place unique.

Sounds are an important component of personal connection to place[1] because they influence emotional and aesthetic values we assign to spaces. Sounds help to generate affective psychological bonds between people, their culture, roots and values. For example, the whistle of a train, the calls of street vendors, or children playing in parks are all sounds that people feel connection with and may define their belonging to a particular place. This point of view also considers that sounds form a "sense of belonging to us," if we consider that values of sounds may be shared by the community, family, or an individual.

While our environment changes with time, cultural soundscapes may change as well. For example, when we build new places or modify the existing ones, we incorporate new sounds into the environment, changing those pre-existent soundscapes that many have depended on psychologically. We might also shutter certain places like churches, train stations, or schools that used to produce particular sounds important for members of a community. In this case, we might be losing cultural soundscapes that are impossible to restore.

NOISE AND WILDLIFE BEHAVIOR

Noise is generally a product of urban development and industrialization. In addition, it modifies the acoustic environment of natural areas (on land or even in aquatic environments). Even pristine natural areas do not escape noise pollution. One study across 22 US National Parks showed that noise was, on average, audible more than 28% of the time.

Bernie Krause, a natural sounds recording expert, proposed that "each creature appears to have its own sonic niche (channel, or space) in the frequency spectrum and/or time slot occupied by no other at that particular moment."[2] This way animals can avoid interference with other animals when they communicate by finding "niches" in which they can hear and be heard. These niches can be found by modifying characteristics of the sounds animals produce, such as the frequency of their calls or by communicating in different times of the day or year (seasonally).

1 Dumyahn, S. L., & Pijanowski, B. C. (2011). Soundscape conservation. Landscape Ecology, 26(9), 1327.

2 Krause, B. L. (1993). The niche hypothesis: a virtual symphony of animal sounds, the origins of musical expression and the health of habitats. The Soundscape Newsletter, 6, 6-10.

Animals will be affected by noise in several ways.[3] Noise that occurs in urban areas generally is composed of low frequency sounds like those from traffic and may prevent animals to communicate with other members of their species. Species that live in these kinds of environments may have to modify their vocalizations to urban noise in several ways. It has been found that some bird species modify the frequency and timing for their songs to be heard over the surrounding noise.[4] For example, a small bird called the Great Tit increases the pitch of their songs to be heard above the city's noise.[5] Other species, like European Robins, adjust the timing of their vocalizations to coincide with those periods when the cities are quieter. Conversely, some species of Hummingbirds and House Finches, select noisy areas[6] in order to avoid nest predation as it is thought that predators cue into nests using sound of nestlings calling to their parents.

Additionally, in noisy environments, the speech (humans) or vocalizations (animals), have to be louder in order to enhance the receptor's capacity to receive the acoustic signal and decode the message. This need to increase the volume of a vocalization is called the Lombard Effect.

3 Kight, C. R., & Swaddle, J. P. (2011). How and why environmental noise impacts animals: an integrative, mechanistic review. Ecology letters, 14(10), 1052-1061.

4 Nemeth, E., & Brumm, H. (2010). Birds and anthropogenic noise: are urban songs adaptive?. The American Naturalist, 176(4), 465-475.

5 Fuller, R. A., Warren, P. H., & Gaston, K. J. (2007). Daytime noise predicts nocturnal singing in urban robins. Biology letters, 3(4), 368-370.

6 Francis, C. D., Ortega, C. P., & Cruz, A. (2009). Noise pollution changes avian communities and species interactions. Current biology, 19(16), 1415-1419.

SECTION 3:

SOUNDSCAPE WORKBOOK

This section helps community planners to think through all of the issues related to planning for natural and cultural soundscapes and to potentially identify areas of concern where noise is present.

Exercises include:

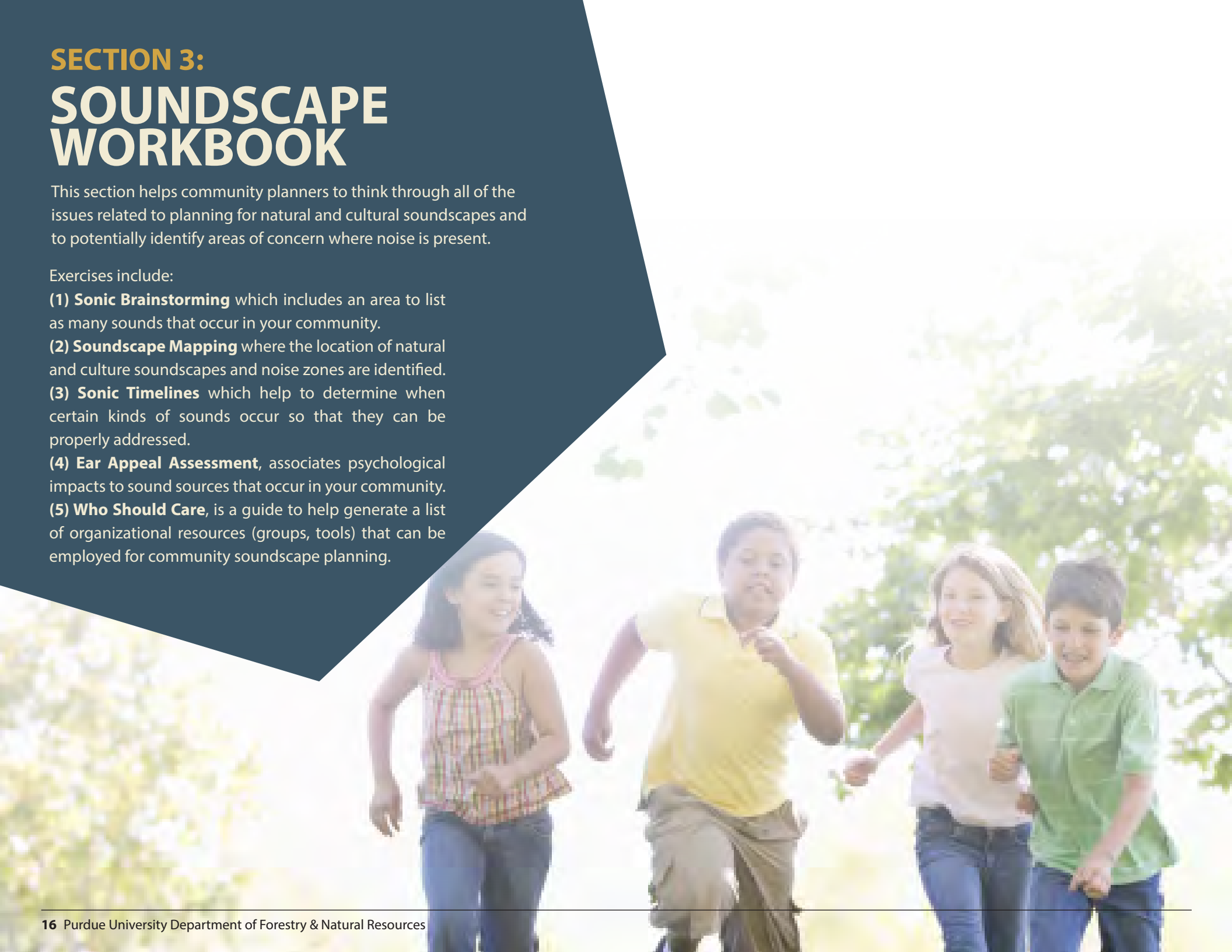
(1) Sonic Brainstorming which includes an area to list as many sounds that occur in your community.

(2) Soundscape Mapping where the location of natural and culture soundscapes and noise zones are identified.

(3) Sonic Timelines which help to determine when certain kinds of sounds occur so that they can be properly addressed.

(4) Ear Appeal Assessment, associates psychological impacts to sound sources that occur in your community.

(5) Who Should Care, is a guide to help generate a list of organizational resources (groups, tools) that can be employed for community soundscape planning.



EXERCISE 1: SONIC BRAINSTORMING

What are the sounds of your community?

Cultural Sounds	Natural Sounds	Noise Sources and Noise Levels from 1 (quiet) to 5 (very loud)

EXERCISE 2: SOUNDSCAPE MAPPING

Where do these sounds occur and are there soundscape and noise zones that our community should consider?

Please include: cultural and natural sounds, as well as noise sources and relative levels.


NO BIKES ON SIDEWALK
WRONG WAY
DEERE

EXERCISE 3: SONIC TIMELINES

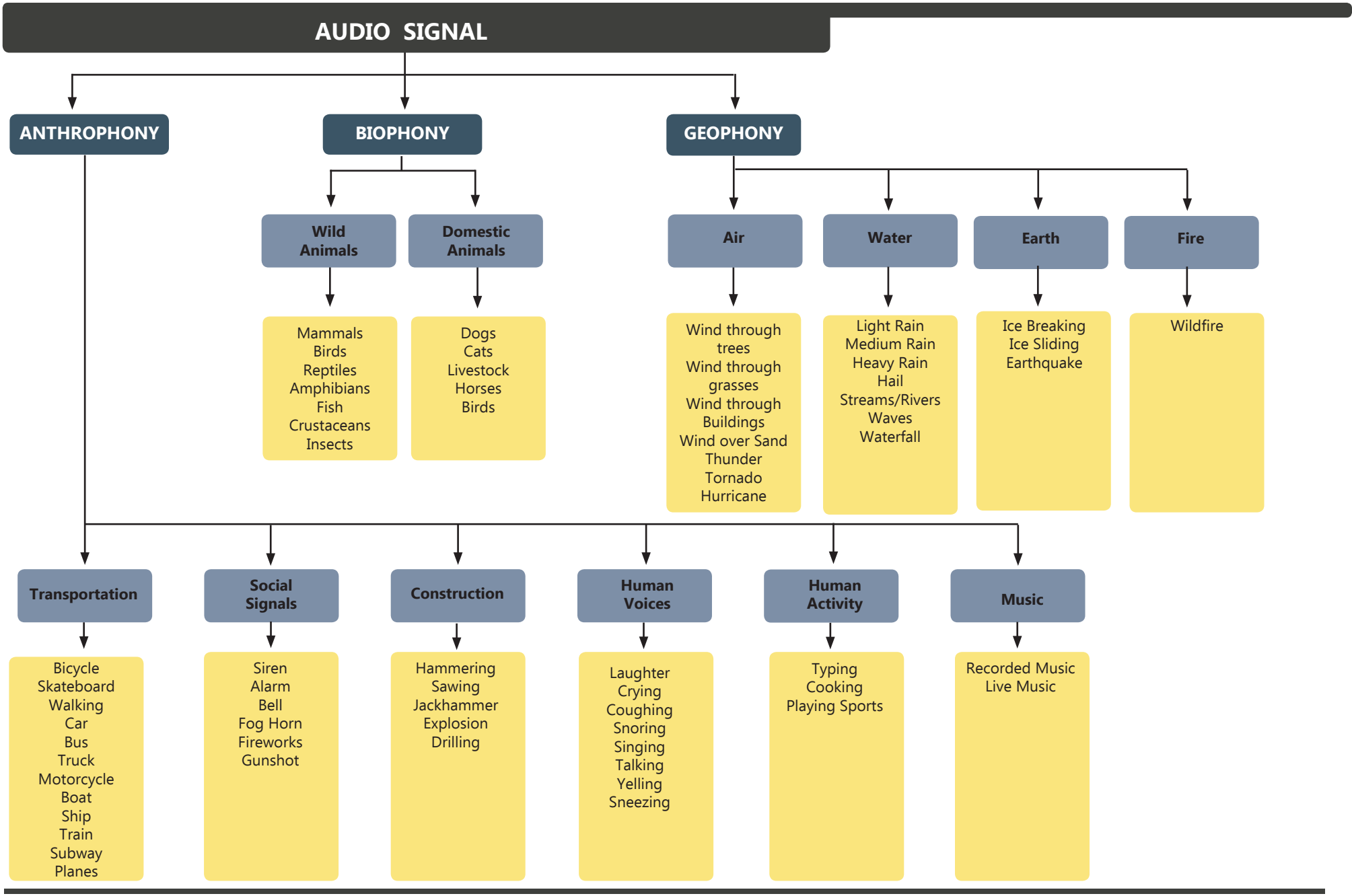
SOUNDSCAPE AND NOISE TIMELINES

List sounds and noise and describe how they change over time. Time horizons should be hourly, day of week, or seasons/events.

When is highway traffic the greatest? When do community members experience natural sounds? Are there times of the year when certain sounds (e.g., gunshot from hunters) are most common?


14
SOUTH SHORE LINE

EXERCISE 4: EAR APPEAL ASSESSMENT



Sound Taxonomy Diagram. As sounds are often related to the source producing it, the above illustration attempts to organize sound sources hierarchically across numerous groupings of sources that are useful for understanding ecosystem dynamics as well as for natural resource and land use planning. This taxonomy does not necessarily have to be strictly followed and could be modified if the natural and cultural soundscapes and noise types significantly differ from those contained here.

How do members of your community feel about sounds that occur in your community and should they stay or be removed?

Please consider each sound, below and indicate your assessment of by circling both an emoji and thumbs up (stay) or down (remove). Refer to the taxonomy on the opposite page.

ANTHROPHONY				BIOPHONY				GEOPHONY			
Transportation	Bicycle			**Wild Animals**	Mammals	👍 👎	😀 🙂 😐 😕 ☹️	**Air**	Wind through trees		
	Skateboard				Birds				Wind through grasses		
	Walking				Reptiles				Wind through buildings		
	Car				Amphibians				Wind over sand		
	Bus				Fish				Thunder		
	Truck				Crustaceans				Tornado		
	Motorcycle				Insects				Hurricane		
	Boat			**Domestic Animals**	Dogs			**Water**	Light rain		
	Ship				Cats				Medium rain		
	Train				Livestock				Heavy rain		
	Subway				Horses				Hail		
	Planes				Birds				Streams/ Rivers		
Social Signals	Siren			**Human Voices**	Laughter				Waves		
	Alarm				Crying				Waterfall		
	Bell				Coughing						
	Fog Horn				Snoring			**Earth**	Ice Breaking		
	Fireworks				Singing				Ice Sliding		
	Gunshot				Talking				Earthquake		
Construction	Hammering				Yelling			**Fire**	Wildfire		
	Sawing				Sneezing						
	Jackhammer			**Human Activity**	Typing						
	Explosion				Cooking						
	Drilling				Playing Sports						
				Music	Recorded Music						
					Live Music						

EXERCISE 5: WHO SHOULD CARE?

Brainstorming exercise. List some possible organizational resources that can be employed for community landscape planning.

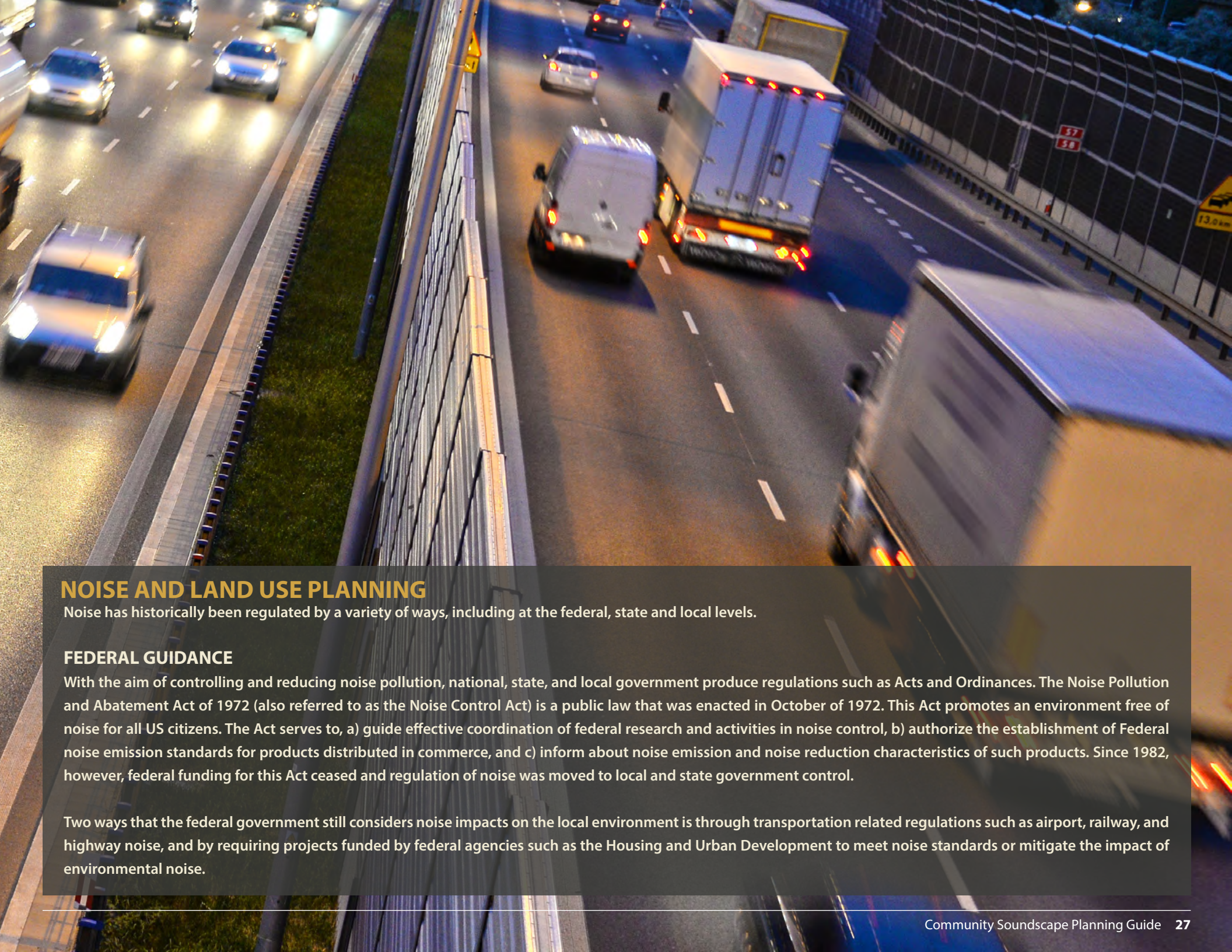
These might include individuals, groups, or tools that would be helpful.

Contact Name	Contact Info	Resource Catagory *(i.e. Company, Person or Tool)*

Contact Name	Contact Info	Resource Catagory *(i.e. Company, Person or Tool)*

SECTION 4:

TOOLS & PLANNING RESOURCES



NOISE AND LAND USE PLANNING

Noise has historically been regulated by a variety of ways, including at the federal, state and local levels.

FEDERAL GUIDANCE

With the aim of controlling and reducing noise pollution, national, state, and local government produce regulations such as Acts and Ordinances. The Noise Pollution and Abatement Act of 1972 (also referred to as the Noise Control Act) is a public law that was enacted in October of 1972. This Act promotes an environment free of noise for all US citizens. The Act serves to, a) guide effective coordination of federal research and activities in noise control, b) authorize the establishment of Federal noise emission standards for products distributed in commerce, and c) inform about noise emission and noise reduction characteristics of such products. Since 1982, however, federal funding for this Act ceased and regulation of noise was moved to local and state government control.

Two ways that the federal government still considers noise impacts on the local environment is through transportation related regulations such as airport, railway, and highway noise, and by requiring projects funded by federal agencies such as the Housing and Urban Development to meet noise standards or mitigate the impact of environmental noise.

Federal Aviation Administration (FAA)

The FAA has been working since 1981 to reduce the number of people impacted by airport noise. It established a program to assist airport operators in reducing the impacts of airports on communities. One way the program works is that airports are granted funds to buy adjacent property and prevent development. Another way is to improve existing structures so that they permit less noise to enter. The third way airports act to reduce the impact of aircraft noise is to map the sound impact on the land, identify land uses that are less vulnerable to noise, and route air traffic and runway approaches over those land uses. All of these activities are carried out under the FAA's "Part 150 Program." [1, 2]

Federal Highway Administration (FHWA)

The FHWA studies the noise impact of future highways as well as mitigation measures such as noise barriers and berms. [3]

Federal Railroad Administration

The FRA has the ability to approve "quiet zones" in communities where adequate rail crossing safety improvements have been made. Locomotive engineers are required to sound their horn in advance of all crossings, except in these special zones. Municipalities typically partner with railroads, the Indiana Department of Transportation, and the FRA to plan, improve, and designate segments of urban rail corridor as quiet zones. Quiet zones do not affect the noise generated by train as it passes along the rails, they only reduce the use of train horns. [4]

Federal Department of Housing and Urban Development

HUD provides guidelines for all funded and insured projects that must meet minimum requirements for a suitable living environment. It has established that noise levels above 75dB (day-night average) are not acceptable. Normally unacceptable noise levels (but potentially acceptable if attenuation improvements are made) are 65-75dB. These noise levels are measured from all sources, and are taken outside the structure. [5]

Local Noise Ordinance Pertaining to "Nuisances"

In Indiana, each township passes its own set of noise regulations. Generally, ordinances have a standard structure. For example, they dedicate a section to definitions of the terminology used along the documents that may vary between ordinances, such as noise, sounds, decibels, sound level, motor vehicles, property boundaries, etc. Regulations also apply to activities that generate noise and are prohibited or regulated (in some cases forbidden during certain times of day), like the use of vehicles without a muffler, the use of a horn or signaling for an unreasonable period of time, operating radio, TVs, instruments, or loudspeakers that produce sound louder than the necessary volume to be heard, street sales, loading operations, construction activities, etc. Exemptions to the prohibition of using noisy devices or equipment are established, such as the use of sirens or emergency-related sounds, gardening machinery, and celebrations. Some or all of these kinds of sounds can be defined as nuisances in local laws. Township noise ordinances could benefit from evaluating spatial and temporal variables that reflect current noise problems within township boundaries.

Some ordinances have special sections dedicated to animals and vehicles that may be very common noise sources. For instance, Michigan City and Chesterton, Indiana, regulate owning animals that cause noise disturbance like barking dogs, birds that sing loudly, or roosters. A few ordinances like Porter and Counties, Indiana, and the city of Indianapolis, make explicitly mention the noise levels allowed. For example, these municipalities regulate the decibel level (dB) of motor vehicles at given speeds and distances. Enforcement and penalties are common to ordinances, and should rely on scientific measures of sound to ensure the ordinance is applied without bias, and measurements are defensible when challenged. Local police are responsible for enforcing noise regulations related to public nuisances. Fines or other penalties can be applied to residents, depending on the jurisdiction and details of the complaint.

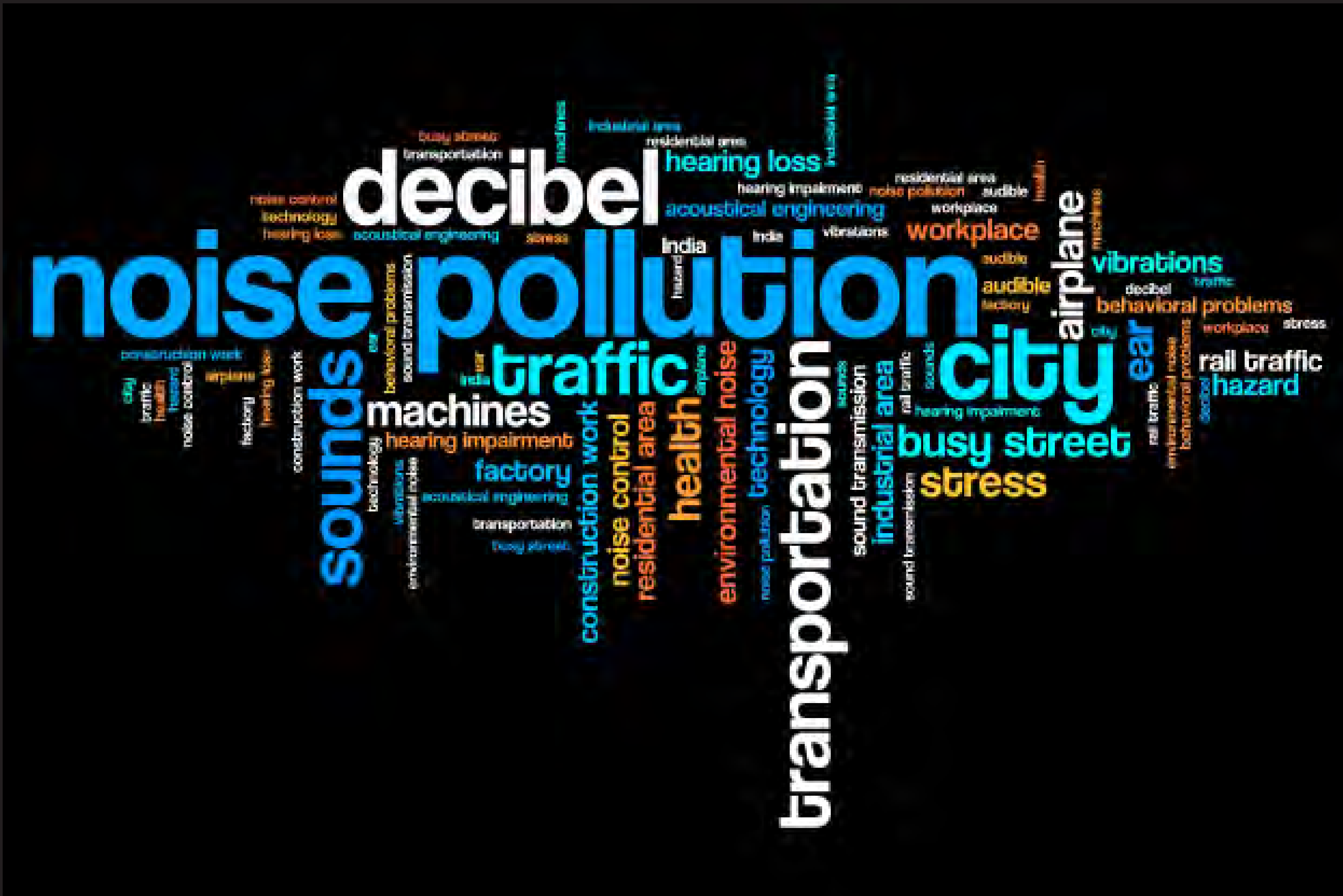
1 Federal Aviation Administration. Fact Sheet – The FAA Airport Noise Program. Retrieved 7/24/2017 from https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=18114.

2 Federal Aviation Administration. FAA Airport Compliance Manual – Order 5190.6B. Retrieved 7/27/2017 from https://www.faa.gov/airports/resources/publications/orders/compliance_5190_6/media/5190_6b_chap20.pdf.

3 Federal Interagency Committee on Noise. (1980). Guidelines from Considering Noise in Land Use Planning and Control. Retrieved 7/24/2017 from https://www.rosemonteis.us/files/references/federal-interagency-committee-1980.pdf.

4 Federal Railroad Administration. (2013). Federal Railroad Administration Locomotive Horn Sounding and Quiet Zone Establishment Fact Sheet. Retrieved 7/24/2017 from https://www.fra.dot.gov/eLib/details/L04309.

5 Federal Interagency Committee on Noise. (1980). Guidelines from Considering Noise in Land Use Planning and Control. Retrieved 7/24/2017 from https://www.rosemonteis.us/files/references/federal-interagency-committee-1980.pdf.


noise pollution
decibel
transportation
city
traffic
sounds
machines
hearing loss
acoustical engineering
workplace
airplane
vibrations
audible
behavioral problems
rail traffic
hazard
busy street
stress
ear
health
residential area
noise control
construction work
environmental noise
technology
industrial area
sound transmission
hearing impairment
factory
India

Local Zoning Ordinances

Local ordinances were designed to manage general noise situations of local residents. However, the current ordinances and laws may lack specifications that manage current noise problems in urban environments. For example, if we look at zoning ordinances in Indiana, they largely follow traditionally established patterns of separating incompatible land uses. Some zoning ordinances are not specific enough with situations that involve between (residential-industrial) districts and within (industrial processes) districts. Residential-industrial districs are present in Indiana and occur when a tractor trailer manufacturer or gravel mine are located within view from residential homes. Industrial processes include noise produced by industry, such as manufacturing equipment, loud air conditioners, etc. Some Indiana ordinances, such as Tippecanoe County's Unified Zoning Ordinance (shown below), specify permitted noise levels within each district, defining the origination and units of the noise measurement. See the following chart that shows performance standards for noise generation in industrial and residential zoning districs.

4-10-6-b-1 TABLE OF NOISE LIMITS:

PERFORMANCE STANDARD CATEGORY	MAXIMUM PERMITTED SOUND LEVEL (*dbA*)	POINT OF MEASUREMENT
A	55/45[1]	On adjacent rural and residential land ***uses***
B	60	On adjacent commercial land ***uses***
C	65	Across I1, I2 or I3 ***zone*** boundary line

FOOTNOTES TO 4-10-6-b-1:

1 In any ***residential zone***, the maximum permitted sound level shall not exceed 55 ***dbA*** between 7:00am and 9:00pm and 45 ***dbA*** between 9:00pm and 7:00am.

The table defines performance standards for categories A (adjacent rural and residential,) B (adjacent commercial,) and C (boundary line zones) and maximum permitted sound level. In order to consider intra-district noise impacts, property line measurements would be used in alaysis that measures the noise impact between two properties within the same zoning assignment.

Landscape regulations are also found in the zoning ordinacne. Trees and other greenery can diffuse sound and provide an aesthetic barrier to sources of noise. In some zoning districts, these barriers may be required as a mitigating feature.

EXERCISE 6: REGULATIONS and LAWS

What are the regulations and laws in your community that help you to plan?

Name	Description

Although some local governments regularly measure noise levels in many areas within their communities, it is necessary to have more detailed information about the spatial (e.g., across neighborhoods) and temporal (e.g., daily, or seasonal) soundscape patterns and the sources that produce these sounds. In this way, we can improve regulations that affect specific geographical regions in target communities. For example, noise regulations do not consider the effects of noise pollution on vulnerable populations, such as the elderly and children. However, there are positive examples such as Indianapolis, Fort Wayne and Michigan City, Indiana, which specify quiet zones like hospitals, educational institutions, and churches, around which noise production is restricted. Another type of zone that can be used is an overlay zone. These apply specific regulations in addition to the existing regulations of the "underlying" zone. Vigo County, Indiana has implemented the "Hulman Regional Airport Noise Overlay District" to "regulate development and land use within noise sensitive areas surrounding Hulman Regional Airport; encourage the types of land uses having maximum compatibility with aircraft operations; protect the airport from the encroachment of incompatible land uses; and, protect and promote the public utility of Hulman Regional Airport."

Communities can improve their sonic characters through mitigation, but also by improving the quality and type of natural sounds and soundscapes. These sonic characteristics reduce noise for residents and community members while providing a habitat for wildlife.

For example, a new technology called auralisation (digital visualization using sounds) enables us to listen to virtual acoustic environments that have only existed in the past, that are about to be built, or that are fabricated. Such tools could be utilized in community planning in an effort to preserve beneficial soundscapes or to assist in examining problematic soundscape.

Architects and environmental engineers use this approach, in remodeling or for the construction of new concert halls and classrooms. Why not use this technology in open spaces to improve our daily lives? Certainly, we can interact more positively with our soundscapes by enhancing those sounds that are positive for us and reduce those that negatively affects us.

"How can we craft noise ordinances to improve human well-being?"

First, we can incorporate a spatial component into noise regulations. For example, if we know that noise affects learning we can specify in an ordinance that requires construction of schools to occur in quiet areas, as well as reduce current noise levels around school zones. Secondly, communities should implement a noise monitoring program.

NATURAL and CULTURAL SOUNDSCAPES

Natural and cultural soundscapes are an important dimension of planning. We might think of an historical example, the Alhambra in Granada, Spain. This is an Islamic palace built in the 13th century by Muslims who colonized Europe between 711-1492 AC. As they used to inhabit the desert back home, water was highly precious to them. The calmness that the sound of running water produces was surely familiar to them and highly precious. Because these colonizers were now living in a "European oasis", they decided to incorporate the sound of running water into the palace. Thus, they constructed a system of fountains and cascades in the courtyards and rooms within the palace with water running and falling through structures, producing extremely relaxing sounds. This could be thought as one example of ancient planning to improve soundscapes of the built environment designed affecting the daily lives of residents.

RECORDING THE SOUNDSCAPES IN YOUR COMMUNITY

Another useful way to keep track of the sounds you hear is by recording them. If you install the Purdue Center for Global Soundscape's mobile recording app "Record the Earth" on your phone, you can record the sounds around you, store them on the cloud, and if you visit https://www.recordtheearth.org/ you can listen to and even visualize them in a map. You will also be prompted to key in some sense of place attachment information too. Community groups could use this app to help document both the sounds occurring at a place and also how people emotionally react to their local soundscapes.

EXERCISE 7: PLANNING FOR HEALTHY SONIC SPACES

Toward an action plan for your community

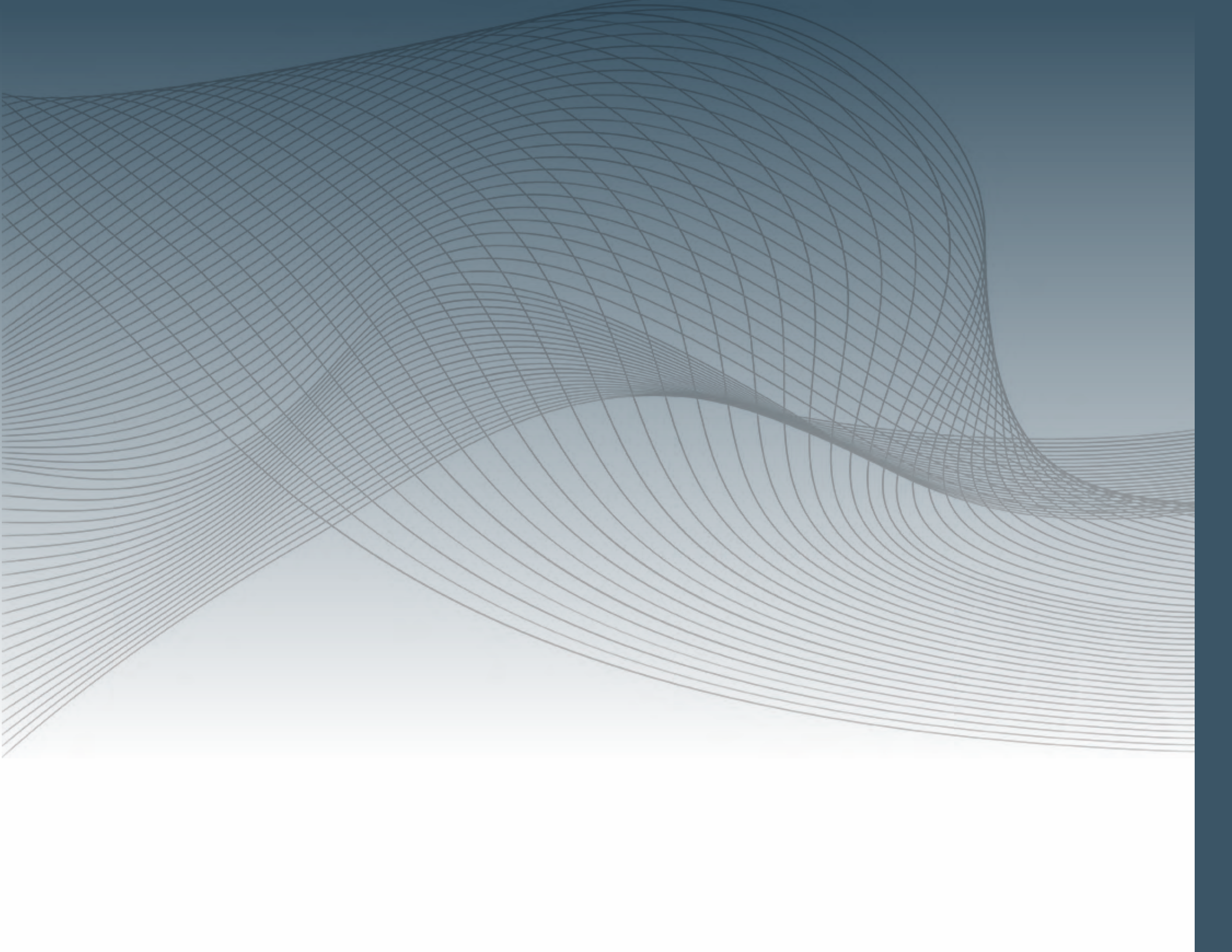
Our TippingPointPlanner.org tool and associated two-day workshop leads communities to an "Action Plan" section that positions planners to move forward with "actionable" planning objectives. This section of the workbook is designed to provide you with some simple space to organize action plans for noise, natural sounds, and cultural sounds. The following sections are part of our Noise and Soundscape Planning Action Plan:

Noise Monitoring and Abatement	
Objectives What would you like to accomplish? Provide a list or narrative of what you would like to accomplish in this broad area of sonic space management.	
Planning Resources What tools, organizations, technologies, etc. are available to you to move toward your objectives?	
Action Plan State how you would move toward your objectives listing short-term (30 days to 1 year) and long-term outcomes (1 to 20 years) with strategies for attaining these within the time frame you describe.	

Natural Sounds Promotion and Protection	
Objectives What would you like to accomplish? Provide a list or narrative of what you would like to accomplish in this broad area of sonic space management.	
Planning Resources What tools, organizations, technologies, etc. are available to you to move toward your objectives?	
Action Plan State how you would move toward your objectives listing short-term (30 days to 1 year) and long-term outcomes (1 to 20 years) with strategies for attaining these within the time frame you describe.	

Cultural Sounds Promotion and Protection

Objectives What would you like to accomplish? Provide a list or narrative of what you would like to accomplish in this broad area of sonic space management.	
Planning Resources What tools, organizations, technologies, etc. are available to you to move toward your objectives?	
Action Plan State how you would move toward your objectives listing short-term (30 days to 1 year) and long-term outcomes (1 to 20 years) with strategies for attaining these within the time frame you describe.	



SECTION 5:

REFERENCES & GLOSSARY OF TERMS

RESOURCES

For a broad and concise source of information about key federal program policy regarding noise, refer to the Federal Interagency Committee on Noise report titled "Guidelines for Considering Noise in Land Use Planning and Control" from 1980. It contains various tables and a rich source of references including studies and reports by agency.
https://www.rosemonteis.us/files/references/federal-interagency-committee-1980.pdf

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KEY TERMS

Sound: A pressure wave generated by vibrating objects that travels through a medium (e.g., air or water).

Amplitude: The magnitude of pressure changes, which can be measured in various ways.

Decibel(dB): A unit expressing the amplitude of a sound.

Noise: Sound that impedes communication or interferes with life functions.

Wavelength: The waves that produce sound can be represented in space as the figure below. The distance between two peaks in the plot is called wavelength.

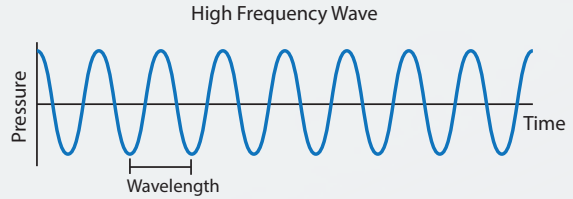
Frequency: Is defined as the number of occurrences of a repeating event per unit time. Technically is the speed of changes in pressure, or the speed of the vibrations. We can measure frequency by counting the number of wave cycles or periods per second (Hertz).

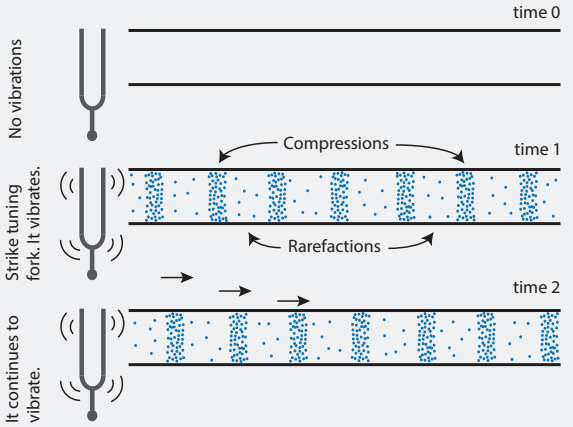
Compression and rarefaction: Compression refer to the areas of increased molecule density because of the high pressure. On the other hand, there are spaces where we can find a low density of molecules, this is called rarefaction.

Sound pressure: Sound pressure is the pressure measured caused by the sound wave relative to the surrounding air pressure. Loud sounds produce sound waves with relatively large sound pressures, while quiet sounds produce sound waves with relatively small sound pressures. Like other kinds of pressure, it is commonly measured in units of Pascals (Pa).

Sound pressure level: Sound pressure level is a measurement of the effective pressure of a sound relative to a reference pressure that is typically the threshold of human hearing (2x10-5 Pa). Because human ears are sensitive to a very wide range of sounds, sound pressure level uses a logarithmic scale (a shorter scale) to represent the sound pressure.

dBa: This measurement is called A-weighted decibels (dBA). This unit has been adopted for measurements of environmental noise for example, to measure roadway noise, construction noise, and railroad noise, as well as to assess potential hearing damage as a result of noise.





ABOUT US

Earth has about a dozen major terrestrial biomes, and we are on a quest to discover how soundscapes vary across time and space within each of these major biomes. We record soundscapes in diverse national and international locations in order to learn about the dynamics of sound in the world's different ecosystems.

OUR MISSION

The world around us is full of amazing sounds that are often ignored by humans. Unfortunately, many of the sources of these sounds are actually in danger of being destroyed by human activities. Our mission is to raise awareness about soundscapes and to encourage the younger generation to open their ears and become soundscapers! More broadly, we aim to interest people in nature and science through the wonder of natural sounds.

AUTHORS and CONTRIBUTORS

Bryan C. Pijanowski

Dr. Pijanowski is Professor and University Faculty Scholar in the Department of Forestry and Natural Resources at Purdue University. He is also the Director of the Discovery Park Center for Global Soundscapes. He and his team have circumnavigated the world recording and studying places through the lens of sound and the paradigm of soundscape ecology. He has also worked closely with communities across the Great Lakes states where his models of land use change are being employed to understand how changes in ecosystems might affect water quality and human well-being.

Kristen Bellisario

Dr. Bellisario received her PhD from the Department of Forestry and Natural Resources, Purdue University. She is a classically-trained flutist specializing in modern music performance and analysis techniques. Her PhD research focused on finding unique patterns in soundscapes and how animal communities respond to noise. Some of her recordings include howling coyotes, bats, and many grassland birds.

Javier Lenzi

Dr. Lenzi received his PhD from the Department of Forestry and Natural Resources and Ecological Sciences and Engineering Graduate Program, Purdue University. His area of specialization is the effect of human activities on coastal bird breeding biology and in particular on the physiological and behavioral impacts of plastics of generalist-feeding gulls. He has worked in the United States and Uruguay.

Dan Walker

Dan is a community planning extension specialist for the Department of Forestry and Natural Resources at Purdue University and for the Illinois-Indiana Sea Grant program. Dan collaborates with Purdue Extension staff, community leaders, stakeholders, and interest groups within the Great Lakes Region through programs that combine research-based tools with community planning processes to help determine and achieve the public interest. Dan is a member of the AICP.

David Savage

David Savage is a PhD Student in the Department of Forestry and Natural Resources and the Ecological Sciences and Engineering Graduate Program, Purdue University. His research focuses on the applications of acoustic tools to monitor biodiversity in agricultural ecosystems, especially in premium crops like coffee. He has worked on studies throughout the South Pacific, the US, and Colombia.

Kara Salazar

Kara is Sustainable Communities Extension Specialist for Purdue University's Department of Forestry and Natural Resources and Illinois-Indiana Sea Grant. Working with multidisciplinary teams, Kara develops programs, products, and resources to support community planning and sustainable development strategies in Indiana communities. Focus areas include placemaking and enhancing public spaces, lawn and landscaping conservation practices, community development, and natural resources management. Kara is a certified planner (AICP) and a Professional Community and Economic Developer (PCED).

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CENTER FOR GLOBAL SOUNDSCAPES

Department of Forestry and Natural Resources
Purdue University, West Lafayette, Indiana 47907
www.centerforglobalsoundscapes.org

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