

**Post-Hearing Statement of Daniel Fink, M.D., to the
Washington, D.C. City Council's Committee of the
Whole Regarding the Leaf Blower Amendment Act of
2017 (Bill No. 22-234), July 2, 2018**

**Gas-powered Leaf Blower Noise is Hazardous to the
Auditory and Non-Auditory Health of Residents of the
District of Columbia**

**Daniel Fink MD
Board Chair
The Quiet Coalition
P.O. Box 533
Lincoln MA 01773**

DJFink@thequietcoalition.org

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EXECUTIVE SUMMARY

As one of the nation's leading experts on noise and health, I am commenting on health issues related to gas-powered leaf blower (GLB) noise. The vast majority of GLBs emit noise at dangerously high levels, loud enough to cause hearing loss and non-auditory health problems. In addition, these loud noise levels pose special risks for vulnerable populations in the District of Columbia (e.g., children, pregnant women, the elderly, and those at home with illnesses), are a disability rights issue for those with auditory disorders, and are loud enough to interfere with concentration and communication for those working from home.

Animals evolved in quiet. Noise is stressful because historically it indicates danger. Only a few marine mammals can close their ears. The ear lacks protective mechanisms against loud noise, which causes hearing loss, tinnitus, and hyperacusis. Involuntary physiological responses to noise include: 1) an autonomic nervous system response, leading to increases in heart rate and blood pressure; 2) a neuroendocrine response, leading to increases in stress hormone levels, in turn leading to abnormalities in blood glucose, blood lipids, blood viscosity, and clotting factors; and 3) an inflammatory response, causing vascular inflammation, also leading to cardiovascular disease and death.

Noise as quiet as 35 decibels (dB) can disrupt sleep and at 45 dB is loud enough to interfere with human activity. At slightly louder noise exposure levels, 55 dB time weighted average, noise exposure causes the stress responses noted above. These in turn lead to anxiety, premature birth, low birth weight, obesity, hypertension, cardiovascular disease, and death. At 70 decibels time-weighted average for 24 hours, noise causes hearing loss. The auditory injury threshold is only 75-78 A-weighted decibels (dBA). The ability to understand speech decreases at 70 dBA ambient noise and approaches zero at 75 dBA. None of this information is new, even if it is not widely known. The vast majority of GLBs in home and commercial use emit noise greater than 70 dB at 50 feet.

To respond to the problem of GLB noise, many cities across the United States have already banned GLB use, without any noticeable problems in landscape maintenance. These bans have withstood legal challenge. There is no reason why this City Council can't take steps to protect District residents from the adverse health effects of GLB noise, Failure to protect citizens from noise may be viewed in the long gaze of history as harshly as the government failure in Flint, MI to protect citizens, especially children, from water contaminated with lead.

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Daniel Fink MD MBA
Board Chair
The Quiet Coalition
P.O. Box 533
Lincoln MA 01773

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INTRODUCTION

Thank you for accepting my post-hearing written statement. I apologize for being unable to attend the July 2, 2018 City Council meeting in person. By way of introduction, I am regarded as one of the nation's leading advocates for noise control and one of the nation's and the world's experts on the effects of noise on the public, i.e., the effects of non-occupational noise exposure on hearing and general health.

I graduated from Yale University cum laude with honors in biology, received the M.D. from the University of Rochester (NY) School of Medicine and Dentistry, and trained in internal medicine at the University of Cincinnati Medical Center. I received an M.B.A. from the Wharton School at the University of Pennsylvania, where I was also a Robert Wood Johnson Foundation Clinical Scholar and a Senior Fellow at the Leonard Davis Institute of Health Economics. I am certified by the American Board of Internal Medicine, and licensed to practice medicine in California. After a brief foray into academic medicine, the bulk of my career was in medical management, broadly dealing with issues of resource management and quality improvement. I finished my full-time career as a faculty physician at Cedars-Sinai Medical Center in Los Angeles, CA, teaching medical students and residents, and remain on the Emeritus Medical Staff there. My noise activities, begun in late 2014, constitute an unpaid second career.

Although my specialty is internal medicine and not otolaryngology, I have learned enough about noise and health since 2014 to have had presentations accepted at national and international meetings, including the Institute for Noise Control Engineering (INCE) in Providence, RI in 2016 ("What is a safe noise level for the public?") and in Grand Rapids, MI in 2017 ("Transportation noise exposure is strongly correlated with morbidity and mortality"), the 12th Congress of the International Commission on the Biological Effects of Noise (ICBEN) in Zurich,

Switzerland in 2017 (“Hearing loss is probably not part of normal aging”, and “Disability rights aspects of ambient noise for people with auditory disabilities”), and at the 174th meeting of the Acoustical Society of America (ASA) in New Orleans in December 2017 (“Disability rights aspects of ambient noise for people with auditory disabilities under the Americans with Disabilities Act”). I have written articles for Tinnitus Today, published by the American Tinnitus Association, for Hearing Health, published by the Hearing Health Foundation, and blog posts for Silencity (www.silencity.com) and for The Quiet Coalition.

The paper presented at INCE 2016 appeared as an editorial in the January 2017 issue of the American Journal of Public Health. [1] The two IC BEN papers are available online. [2,3] The ASA presentation was published in Proceedings of Meetings on Acoustics in December 2017. [4] I have been asked to write an article for the Fall 2019 issue of Acoustics Today, also a publication of the ASA.

I am founding board chair of The Quiet Coalition, a group of professionals from various disciplines concerned about the impacts of noise on health, environment, learning, productivity, and quality of life in America. From 2015 until June 30, 2018, I served on the board of the American Tinnitus Association. I serve as an expert consultant to the World Health Organization on its Make Listening Safe program, and as an informal consultant to the Centers for Disease Control and Prevention (CDC) on noise and health issues. In 2016, I was among members of the medical community- perhaps the very first- who alerted the CDC that noise was a health and public health issue needing its urgent attention, not just an occupational health and safety problem. [5] I am a member of the Acoustics Proposal Review Committee for the Facilities Guidelines Institute, chartered by Congress in the 1946 Hill-Burton legislation to set architectural standards for health care facilities. I am also Medical Advisor for SoundPrint, a smart phone app that records and reports restaurant noise levels, and serve as Interim Chair of the Health Advisory Council for Quiet Communities, Inc. in Lincoln, MA. Again please note that these are all voluntary unpaid positions.

I have no financial conflicts to disclose, specifically holding no stock or other investments in companies manufacturing either gas or battery powered yard maintenance equipment including leaf blowers unless such investments are in mutual fund and similar investments without my direct involvement in investment decisions. My only goal is to make the world a quieter place, and to find quiet restaurants in which to enjoy the meal and the conversation with my wife.

The adverse health effects of noise are summarized in the Figure on the next page. These include both direct effects including hearing loss, sleep disturbance, and stress responses, and indirect effects that also lead to involuntary physiologic changes and adverse health effects.

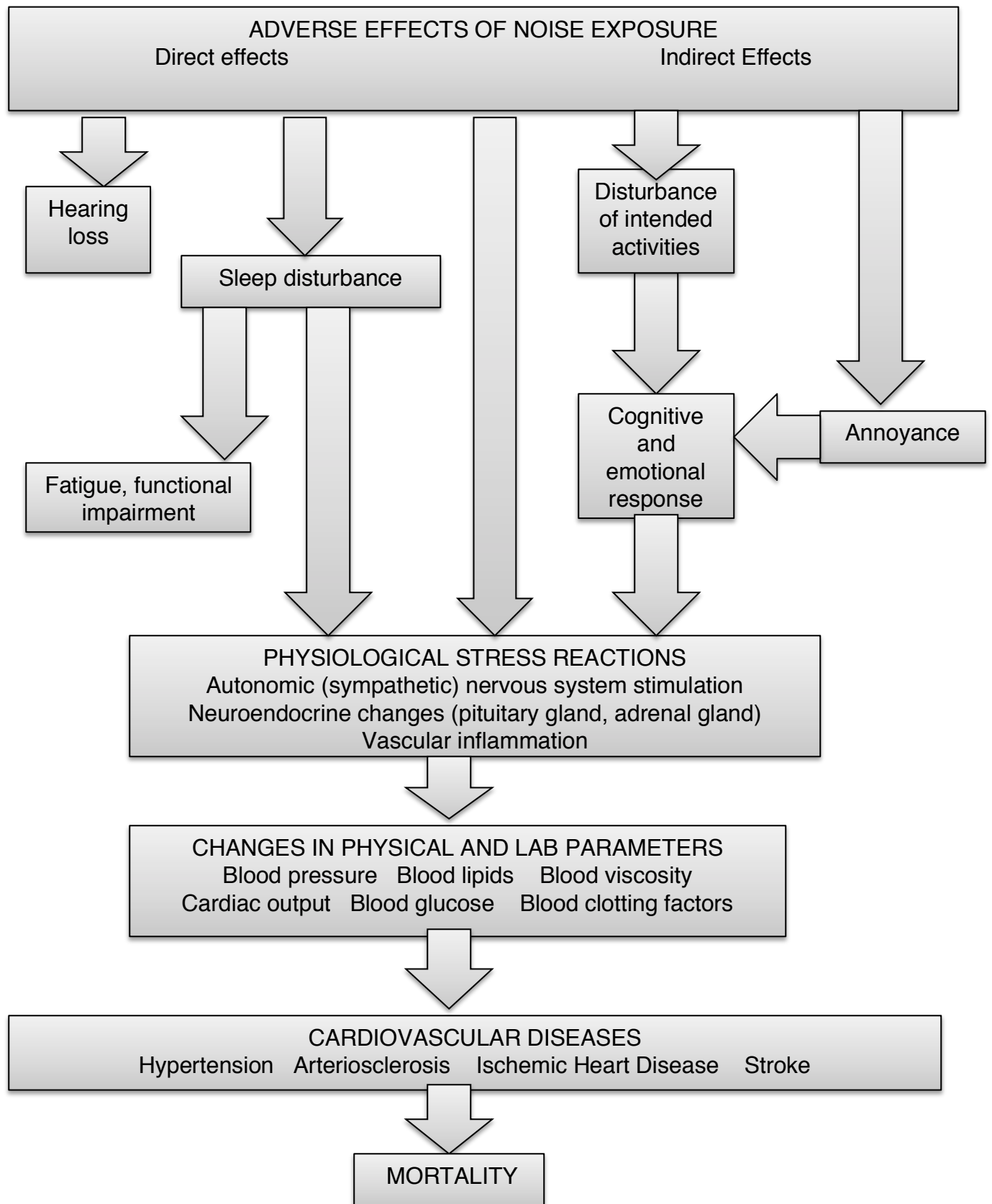


FIGURE Adverse Effects of Noise Exposure Adapted with permission from Babisch W, Updated exposure-response relationship between road traffic noise and coronary heart disease: A meta-analysis. Noise Health 2014;16:1-9.

ADVERSE HEALTH EFFECTS OF NOISE: HEARING LOSS

As shown in the Figure, noise is a pervasive environmental pollutant with both direct and indirect adverse effects on human health. These adverse health effects were summarized in 2014 by Hammer et al. [6] and by Basner et al. [7]. This is not new information and no more research is needed to be absolutely certain that noise exposure causes hearing loss and a multitude of non-auditory human health problems. The scientific evidence is incontrovertible.

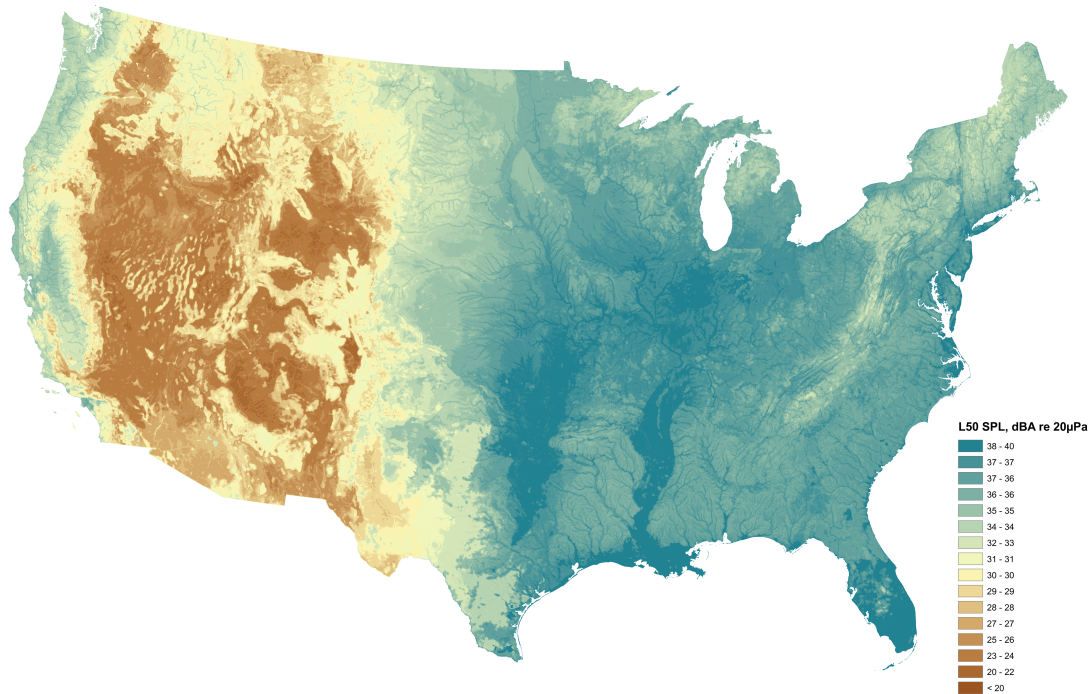
An evolutionary biology perspective helps explain why noise causes health problems. The hearing sense appears to have evolved from a primitive vibration detection sense in one-celled organisms, generally either to help detect food or to help avoid being eaten. As the hearing sense evolved over time, it developed exquisite sensitivity. Predators use hearing to find food. The snowy owl uses hearing to find rodents under a foot of snow. Herbivores, from rabbits to prairie dogs to deer, antelope, and zebras, use hearing to detect danger. Except for a few marine mammals, most animals can't close their ears. Hearing and noisemaking also developed for communication, in insects, reptiles, birds, and especially mammals. One of the evolutionary advances helping mammals become the dominant species in almost all environments was the development of specific cochlear mechanisms to amplify sound, allowing detection of food, avoidance of predators, and communication over long distances. [8]

One thing that hasn't changed, though, is that animals, including humans and our primate ancestors, evolved in quiet. The National Park Service noise map (see next page) shows that without human activity, ambient environmental noise levels are very low, below 40 A-weighted decibels (dBA)* in the entire United States and below 30 dBA in much of the country. [9] In nature, loud noise is rare- a thunderstorm, a landslide, a waterfall, an earthquake- and perhaps a collection of birds in a tree at dusk, a lion's roar, or primates communicating with each other through the forest, so mammals including humans did not develop protective mechanisms against loud noise.

What is a safe noise level for the public? The National Institute for Deafness and Other Communication Disorders states on its website, "Long or repeated exposure to sound at or above 85 decibels can cause hearing loss." [10] This statement is true, but misleading. Eighty-five decibels without time limit is not a safe noise exposure level for the public. Eighty-five A-weighted decibels (dBA) is an occupational noise exposure level that even with strict time limits- 8 hours a day, 250 days a year, for 40 years at work- does not protect all exposed workers from hearing loss. This topic was discussed in detail in the NIOSH Science Blog post on February 16, 2016. [11]

*A glossary of technical terms can be found in Reference 17.

National Park Service Sound Map- Natural Conditions (Green = Sound Pressure Level (SPL) 40 dBA, Brown = SPL 30 dBA)



There appear to be no experimental studies of the health dangers of GLB noise for humans, and it is unlikely that such studies will ever be done. Ethical considerations and federal law protect research subjects from harm. The dangers of noise for hearing and general health are now so well known that it would be difficult if not impossible to get needed institutional approvals for such studies. Researchers studying other noise issues, e.g., whether earplugs protect hearing in those attending an outdoor music festival [12], have had to design their studies to work around these ethical and legal concerns. The earplug study recruited subjects only among those who did not care enough about their hearing to be planning to use hearing protective devices at the music festival, who were then randomized to ear plug use or not.

Research regulatory requirements would not preclude observational or epidemiologic studies of hearing loss or other health issues in those exposed to GLB noise, but based on numerous articles about GLB noise in print and broadcast media, it does not appear that such studies would add much to our knowledge of the health impacts of GLB noise.

I will discuss the safe noise level in great detail because it is imperative to understand precisely why noise is a major health and public health problem. As I wrote in the American Journal of Public Health in 2017 [1], the only evidence-based safe noise level to prevent hearing loss is a time-weighted average of 70 decibels for 24 hours over a lifetime. This is not new information. This noise exposure level was calculated by the Environmental Protection Agency (EPA) in 1974 [13], based on data collected by the National Institute for Occupational Safety and Health (NIOSH) from occupational studies of hearing loss after workplace noise exposure. [14] Those calculations remain valid.

As with potential studies of the health effects of GLB noise on humans, the occupational noise exposure studies on which the EPA and NIOSH monographs are based cannot ethically be repeated, since it is now known that noise exposure causes hearing loss. This is a rare instance where older studies, despite what would now be viewed as obsolete equipment and inadequate measurement protocols, remain both valid and important because the research needed to obtain new information about noise exposure and hearing loss in controlled conditions just cannot be done.

A full discussion of the decibel scale and sound measurement is beyond the scope of these comments, but it is important to understand that the decibel scale is a logarithmic scale and a proportional, not an absolute, measurement of sound intensity or energy. Because of the mathematics of logarithms, a 3 dB increment indicates a doubling of the sound energy or sound pressure level (SPL). An 85 dB sound has 31.6 times more energy than a 70-decibel sound, not 21% more as might commonly be thought. The term loudness also has specific technical meaning in psychoacoustics- “the subjective perception of sound pressure”- and is often misused in discussions about sound measurements to mean either the absolute sound pressure level or the relative sound pressure level measured in decibels. Both uses are wrong. In general, it takes a 10-dB increase for humans to have perceived sound intensity to have doubled, but perception of “loudness” depends on many factors and is an unreliable measure of sound intensity or SPL.

The NIOSH level is A-weighted, for occupational safety and health purposes, to reflect the frequencies heard in human speech. The decision to use A-weighting, rather than C-weighting or unweighted decibels, appears to have been made because hearing loss was the compensable injury workers were presenting to workers compensation authorities after occupational noise exposure. This may not be appropriate for auditory health and certainly not for the non-auditory health effects of noise. A-weighting reduces measured sound levels by approximately 5-7 decibels. The causal factor for sound damage is the total energy of the sound, with some evidence that higher frequency sound damages cochlear hair cells needed for hearing, and lower frequency sound damaging vestibular hair cell

involved in balance. [15,16] C-weighting emphasizes lower frequency sounds, below 200 Hertz.

The EPA adjusted the NIOSH 85 dBA Recommended Exposure Level for the additional time exposure- 24 hours a day instead of 8 hours a day, and 365 days a year instead of 250 days a year, to calculate the 70 decibel safe noise exposure level for the public, to prevent noise-induced hearing loss in 99% of the public. [13] By convention, time-weighted averages are presented as dB, not dBA or dBC. The 70 dB safe noise exposure level to prevent hearing loss has also been reported by the World Health Organization (WHO) [17], in a review article by Passchier-Vermeer and Passchier [18], by a National Institutes of Health (NIH) Consensus Conference [19], and by others. (NIH reported that the safe noise level to prevent hearing loss is 75 dB for 8 hours, but mathematically this is the same as 70 dB for 24 hours.)

The actual safe noise exposure level to prevent hearing loss must be less than 70 dB time weighted average for 24 hours over a lifetime for several reasons. First, the EPA only adjusted the greater exposure time for hourly and daily greater exposure, but not for the greater years of exposure, so the EPA's calculations were only based on 40 years noise exposure. There are no occupational studies of noise exposure and hearing loss over more than 40 years. With life expectancy in the United States approaching 80 years [20], it is clear that further adjustments downward must be made for the greater lifetime noise exposure. The additional years of noise exposure undoubtedly explain most of the high prevalence of hearing loss in older Americans. [21]

Second, the NIOSH noise exposure studies on which the EPA calculations were based assumed that workers had quiet when not at work, something that is no longer true. (*Vide infra*) This is not explicitly stated by NIOSH, but is implied in the numbers in Tables 1-1 and 1-2 in the NIOSH Noise Criteria monograph [14].

Third, the NIOSH noise exposure recommendations that were adjusted by EPA allowed an 8% rate of "excess hearing loss" in workers exposed to occupational noise at the 85 dBA level. This presupposes that hearing loss is part of normal aging, which is almost assuredly not true [2] so the actual rate of hearing loss in people exposed to noise at 85 dBA must be greater than 8%.

Finally, an evolving body of research over the last decade, most notably by Liberman and Kujawa at Harvard University and the Massachusetts Eye and Ear Infirmary, strongly suggests that there is no temporary auditory damage. [22,23] This research shows that if a noise- such as that emitted by a GLB- is loud enough to cause temporary auditory discomfort, it is most likely causing permanent auditory damage.

As reported in the Washington Post [24], GLBs produce noise emissions as loud as 112 dB. GLB manufacturers and landscape maintenance companies may claim that there are quiet GLBs, and indeed there may be such devices, but they are few and far between. A quiet GLB is as rare as a safe cigarette. A review of seven popular commercial GLBs by OPE (Outdoor Power Equipment) Reviews [25] found that all produce noise greater than 100 decibels at the user's ear, with sound levels at 50 feet ranging from 76 to 83 decibels. Studies done by others presented at the July 2, 2018 hearing before your Committee on B22-234 confirm that GLBs are too noisy. Often, if the GLB is used outside the homeowner's or office worker's window, the distance is much closer than 50 feet, and the sound level greater than at 50 feet. Greater sound levels are also produced by use of GLBs on noise-reflective hard surfaces, in partially enclosed spaces, e.g., courtyards, and by gang use of GLBs, with three or more GLBs sometimes being used at the same time as other gas-powered yard maintenance equipment, such as lawn mowers or tree trimmers. [24]

GLB noise exposure by nature is intermittent. The landscape workers come to the property, and "mow, blow, and go." Intermittent noise exposure has not been well studied in the occupational setting, with rough approximations being made to account for the intermittency of the noise exposure. This is discussed in the NIOSH Noise Criteria monograph. [Pages 28-29 in 14]. Basically, the same noise exposure criteria apply for intermittent noise as for continuous noise exposure.

An important concept to consider is the total daily noise dose. How much noise is a person exposed to in a day? GLB noise clearly contributes to the total daily noise dose for those exposed to it. As shown by Flamme et al in Kalamazoo County, MI [26], confirmed by Neitzel in Sweden [27], most adults receive excessive total daily noise doses, exceeding the EPA and WHO safe noise exposure thresholds for preventing noise-induced hearing loss. As also discussed by Flamme, the auditory injury threshold- the threshold at which auditory damage from noise begins- is as low as 75 dBA, and the effective quiet level- the level at which the ear begins to recover from noise damage- is only 55 dBA and may be as low as 48 dBA. There is some evidence that the effective quiet level, 55 dBA, is really the sound level at which auditory damage begins. [28]

The problem of non-occupational noise exposure causing hearing loss is unfortunately not merely a theoretical concern. In 2017 the Centers for Disease Control and Prevention (CDC) reported that approximately 25% of American adults age 20-69 had noise-induced hearing loss (NIHL), known to be caused by noise and not by other causes from the characteristic audiometric notch. Most concerning was the finding that of the people with NIHL, a large percentage had no occupational noise exposure whatsoever. [29]

It is commonly thought that hearing loss isn't a big problem. This may be because hearing loss is an invisible disability, and because hearing loss generally does not become common until the seventh decade of life, when most Americans are out of the workforce. [21] Also, coverage for hearing health care and certainly for hearing aids- generally the only treatment for hearing loss, except for cochlear implants for those with extreme hearing loss- is very limited in most health insurance plans and federal health programs, i.e., Medicare and Medicaid, so the economic impact of treating hearing loss falls upon individuals and not governments or insurance companies.

This is an important misconception. Hearing loss is not benign. For younger Americans, hearing loss causes social isolation and major economic impacts, limiting lifetime income by several hundred thousand dollars compared to those with normal hearing. [30] For older Americans, hearing loss is strongly correlated, in stepwise fashion, with increases in social isolation [31], accidents [32], falls [33], and dementia [34, 35], all of which are in turn strongly correlated with increased mortality in elderly Americans.

An additional consideration is that occupational standards, and standards developed by the EPA for environmental pollutants, are for workers and normal healthy adults. Public health practice, and in the United States the law, [36] require that exposure standards be developed to protect vulnerable populations, among them children, pregnant women, and the elderly. While there is no federal guideline, recommendation, or standard for noise exposure [29], noise exposure standards for these vulnerable populations must be more protective than those for workers. The World Health Organization has published information about the specific dangers of noise for children. [37] Approximately 11% of the District's population is age 0-9, and 12% is over 65 years of age. [38] Presumably many of the very young and very old are largely at home during the day, where they are exposed to GLB noise.

Those who are at home during the day because they are sick, disabled retired, or working from home constitute another segment of the population requiring quiet, as do shift workers who sleep during the day. From the EPA report (Figure D-1 in [13], the ability to understand speech begins to decline at 70 dBA ambient noise levels and is almost zero at only 75 dBA. Approximately 40% of Americans work at least part time from home. [39] GLB noise interferes with both the concentration of those working at home, and their ability if needed to carry on telephone conversations.

Those with auditory disabilities- hearing loss, tinnitus, and hyperacusis- also suffer inordinately from GLB noise. For those with hearing loss, quiet ambient noise is especially important to allow understanding speech. [3,4] Also, a phenomenon known as recruitment, which takes place with or without the use of

hearing aids, can amplify loud noises for the hearer and make them painfully loud. Those with hyperacusis- a sensitivity to noise in which sound levels that don't bother those with normal hearing are perceived as painful- are extremely bothered by GLB noise. Those with tinnitus have their symptoms worsened by GLB noise. All those at home during the day, an increasing segment of the population, are much more bothered by GLB noise than someone who leaves the house before 8 a.m., whether for work or school, and returns after 5 or 6 p.m.

ADVERSE EFFECTS OF NOISE: PHYSIOLOGICAL STRESS RESPONSES

As discussed above, noise is generally perceived as a warning sign. Noise causes stress. [40] Research shows that noise causes activation of three different physiological systems that evolved to respond to stress. The first response, within milliseconds of loud noise being heard, is from the autonomic nervous system, with an increase in blood pressure and pulse rate. [41] The second response, which takes a little longer, is an increase in adrenocorticotrophic hormone (ACTH) via the pituitary, which in turn leads to increases in mineralocorticoid stress hormone levels produced by the adrenal gland. [42] The third response, about which less is known, is an inflammatory response to stress, with activation of the immune system, especially in the blood vessels.

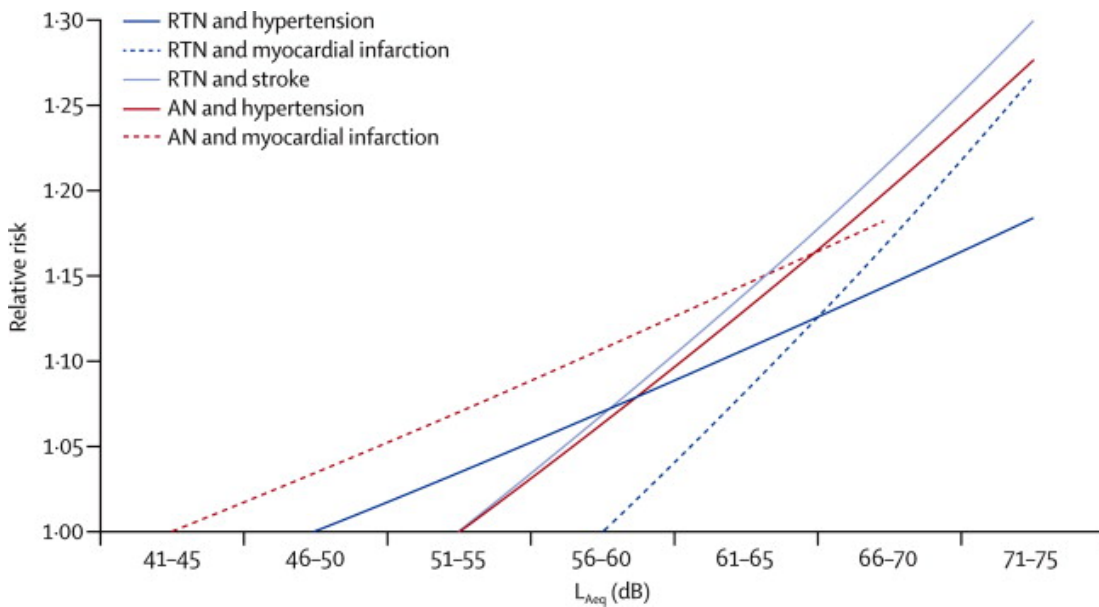


Figure 3 Relative risks of noise exposure and adverse cardiovascular outcomes

RTN: Road Traffic Noise AN: Aircraft noise From Basner et al, Auditory and non-auditory effects of noise on health, Lancet 2014; 383:1325-2332 [7]

The inflammatory response to stress was described by Tawakol et al at the Massachusetts General Hospital. [43] Stress as measured by psychological tests was correlated with vascular inflammation as measured by several research techniques, and long-term follow-up showed an increase in both cardiovascular events and mortality in those with more stress and more inflammation. These data have not been specifically linked to stress caused by noise, but provide a logical explanatory link between noise exposure and increase in cardiac deaths caused by air traffic noise. As shown in Figure 3 in Basner et al.'s review article [7], the increase in myocardial infarction (heart attack) begins at aircraft noise exposure in only the 45-decibel range. [6] GLB noise may be most similar to aircraft noise in both its intermittency and the frequency band range of the sound.

These responses are involuntary. They cannot be controlled. They cannot be habituated, i.e., repeated exposure to the same noise still produces the same involuntary physiological responses. [45] Events that an individual cannot predict and cannot control, such as GLB noise, are more stressful than those that the individual can control. [46] The invasion of quiet moments at home, at work, or at school by GLB noise is stressful for almost everyone.

GLBs were invented in the 1950s but their use didn't become widespread until the 1990s when drought conditions in southern California led to their widespread adoption for clearing lawn cuttings and dust, rather than washing down the lawn and hard surfaces with water from a hose nozzle. Early on, there were complaints about GLB noise, but these complaints have become greater in recent years.

Since, as noted earlier, there appear to be no specific studies of adverse health effects of GLB noise on the public, we must rely more generally on the thousands of studies of the adverse effects of noise on health. Obviously GLB noise contributes to an individual's total daily total noise dose, which causes hearing loss as discussed above, but also non-auditory adverse health outcomes. This body of work is well known in Europe, even if that knowledge has not crossed the Atlantic Ocean, with the early epidemiology studies appearing in the 1980s. In 2002, the European Union issued the Environmental Noise Directive, [47] requiring member states to take steps to measure and reduce environmental noise. In 2011 the WHO issued a monograph about the Global Burden of Disease from Noise [48], summarizing morbidity, mortality, and disability from the adverse effects of noise.

These adverse health effects include cardiovascular disease, including high blood pressure, heart attack, heart failure, cardiac dysrhythmias, and stroke [49,50,51]; reduced cognitive ability, hyperactivity, anxiety, and other mental health problems [52]; poor reproductive outcomes, including low birth weight and prematurity [53]; and obesity [54]. The evidence is strongest for the adverse cardiovascular health effects, with the Central Illustration in Reference 51

graphically summarizing recent research. As Babisch commented, the question isn't whether there is an effect of noise on cardiovascular health, but on the precise nature of the exposure-response relationship. [42] Furthermore, as Basner stated, "The overwhelming majority of noise effect researchers today accept that there is a causal relationship between environmental noise exposure and increased cardiovascular risk." [55] A recent article in the Washington Post also reported on this body of work. [56]

These are population health impacts, which are difficult if not impossible to measure on the individual level. The health impacts of noise are small for each exposed person, but large from a population health perspective because of the millions of people exposed. [6] An increase in the average systolic blood pressure by 1 mm may not be significant for one particular person, but if 100 million people are exposed to noise loud enough to cause this blood pressure increase, a certain number will have heart disease, stroke, or death because of it. Lending credibility to the studies are exposure-response curves, e.g., a 6% increase in the risk of coronary heart disease for each 10 dBA increase in traffic noise, starting at exposure levels as low as 50 dBA. [49, also see Figure 3]

By their very nature, transportation noise exposures are intermittent so the intermittency of GLB noise exposure would appear to be accounted for within the study designs of the effects of transportation noise on cardiovascular health, with one important exception. That is because studies of adverse health effects of transportation noise include total daily noise exposure, with nighttime noise being an important factor because it disrupts sleep. Obviously, GLBs are almost always used during daytime hours. It is impossible to separate daytime noise exposure from nighttime noise exposure in epidemiologic studies, but the residents of the District of Columbia, just like the residents of London [57,] are exposed to continuous noise. Daytime GLB noise adds to this noise exposure.

In many communities, a team of landscape maintenance workers using two or three or more GLBs [24], along with other workers using gas powered lawn mowers, tree trimmers, chain saws, etc. create a disturbing cacophony of sound. Even if the landscape maintenance workers only care for one property on the block, another team will soon arrive to care for another nearby property. This means that anyone at home during the day is exposed to GLB noise, combined with noise from the other landscape maintenance equipment, from early in the morning (as early as 7 a.m. in some communities, certainly by 8 a.m.) until the sun sets, almost every day of the week all year long except in the winter in colder climates, and perhaps when it rains heavily.

Additionally, the frequency band distribution of GLB noise includes a low frequency component that is especially troublesome, since it can travel through windows and walls for long distances. This means that GLB use down the block or even on the next block can be troublesome. From the EPA monograph [13],

we know that noise levels of 45 decibels can disturb human function, e.g., concentration. GLBs are used during the day, so nighttime sleep disruption is not an issue as it is for other urban noise sources, e.g., transportation noise, but many people have to sleep during the day. This population includes shift workers, babies and children taking naps, the elderly, and those who are sick or disabled. Sound levels as low as 33 decibels can disrupt sleep. [5] Good sleep is important both to normal function and to health. It has recently been shown that deep sleep is when the brain removes toxins that accumulate during the day. [59] Bad quality sleep and shorter sleep times are correlated with both mortality [60] and the development of dementia. [61]

LEAF BLOWER REGULATION

In addition to my expertise in noise and health, I also have experience in municipal government and some familiarity with zoning codes and other municipal regulations. I served on the Board of the South Robertson Neighborhoods Council in Los Angeles and on its Land Use Committee from 2007 to 2009. (The neighborhood councils were created by the new Los Angeles city charter in 1999, to provide community input to the city.) It is clear that state and local governments have the authority to regulate noise, such as nuisance noise, noise transmission in buildings, noise from heating, ventilation, and air conditioner systems, and specifically noise from GLBs. More than 100 cities in the United States have already enacted leaf blower bans, ranging from Santa Monica, CA, which bans all leaf blowers, to Sonoma, CA, which bans only GLBs, Maplewood, NJ, which bans GLBs only in the warmer months, to Newton, MA, which has more detailed leaf blower regulations than one sentence can cover. The authority of cities to regulate leaf blower use, including banning their use entirely, has been upheld in courts in multiple jurisdictions. There would appear to be no legal reason why this City Council cannot pass such an ordinance in the District of Columbia.

For those concerned about burdening police authorities with enforcement of a GLB ban, consider the enforcement model used in Santa Monica, CA. Any citizen can report a leaf blower violation with the date, time, and location of the violation to the city's Office of Sustainability and the Environment, which in turn issues a citation. A cell phone picture can be used to supplement the report. Penalties can be assessed against the property owner, property manager, landscape maintenance company, or the person operating the leaf blower. [62] Kevin McKeown, the mayor of Santa Monica at the time this ordinance was passed and who still serves on the city council there, assures me that there has been no problem in

enforcing the law. Mr. McKeown can serve as a resource to this Council on the leaf blower issue.

I also have some expertise in gardens and plants. From 2005-2014, before I became a noise specialist, I served on the Board of the Theodore Payne Foundation for Wild Flowers and Native Plants, Inc. (www.theodorepayne.org). I wrote articles about native plants and gardens, and volunteered as a docent at the Foundation's nursery and on its Garden Tour. For the last fifteen years the Foundation has sponsored an annual tour of home and municipal gardens planted with California native plants. Every year several gardens on the Foundation's Garden Tour are located in Santa Monica. I can assure those concerned about the appearance of the landscape in the absence of GLBs that, from personal observation that the yards and gardens in Santa Monica are just as beautiful and well-groomed as those in other cities in southern California that allow GLB use. Even without GLB use, the Santa Monica gardens-with native plants or without- are pristine.

Furthermore, the concerns of those claiming that a GLB ban will cost jobs and lead to loss of economic viability for landscape maintenance companies are clearly misplaced. A search of the popular consumer referral sites Yelp and Angie's List for landscape maintenance and lawn service companies in Santa Monica, CA and Sonoma, CA finds scores of companies ready to care for the lawns and gardens in those cities without using GLBs. When market forces fail to protect the public and regulatory intervention is needed, the markets always adapt.

There are viable alternatives to GLBs, specifically rechargeable battery-powered leaf blowers. Some cities, e.g., South Pasadena, CA and Southampton, NY, have switched entirely to battery-powered leaf blowers for maintenance of city parks and municipal buildings. For home use, in the last year or two, the "big box" home improvement stores, e.g., Home Depot, Lowe's, and others, have started carrying rechargeable battery-powered leaf blowers and other yard maintenance equipment, including lawn mowers, powered by the same rechargeable batteries. These have become popular enough to be advertised in advertising supplements in the Sunday papers, and in in-store displays. And of course, rakes and brooms still work.

CONCLUSION: ADDITIONAL REGULATORY, LEGAL, AND POLITICAL CONSIDERATIONS

The Noise Control Act of 1972 established federal policy to promote an environment for all Americans free from noise that jeopardizes their health or welfare. [63] The EPA created an Office of Noise Abatement and Control (ONAC) to implement the congressional mandate. ONAC was quite successful until it was defunded during the Reagan administration. [64,65] At that time, EPA officials assured Congress that the benefits of noise control were highly localized and that state and local officials could still engage in noise control activities. (Page 20 in [64]) The proposal to ban GLBs in the District of Columbia falls within that local governmental authority.

The failure of state and local officials to protect the health of their constituents from environmental hazards is perhaps most noticeable today in the sad story of lead contamination of municipal water supplies in Flint, MI, where thousands of residents were sickened and children's brains irreparably damaged from lead in the water, and scores died from legionella infections spread by inadequate water treatment. This tragedy received broad media coverage in 2015, and has recently been summarized in two books. [66,67]

I am certain that the members of this Council, and their citizens, do not want noise pollution from GLBs causing similar adverse health effects in the District. Please take action now to ban GLBs from the District of Columbia. The interval of three and a half years before the bill's provisions would become effective allows plenty of time for an education campaign, for affected stakeholders to adjust their practices, for replacement of GLBs with rakes, brooms, or battery-powered leaf blowers, and for everyone to begin looking forward to a quieter and healthier place to live and work.

The only possible adverse outcome I can foresee from a GLB ban is that members of this Council may be deafened by the applause from their grateful constituents, most of whom favor such a ban, and perhaps even crushed by the press of grateful crowds trying to offer their thanks.

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