



Synthesis of Studies on the Effects of Noise, 1978–2025



White-crowned sparrow (*Zonotrichia leucophrys*) sings in Denali National Park and Preserve, Alaska.
NPS / KEN CONGER

Synthesis of Studies on the Effects of Noise, 1978–2025

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Abstract

The Natural Sounds and Night Skies Division (NSNSD) works to understand, contribute to, and communicate scientific knowledge that informs management of natural and cultural resources and the visitor experience related to natural sounds and night skies. This project summarizes the results of a systematic annual query of scientific literature to provide park managers with updated knowledge about the effects of noise. This product represents our continued efforts to describe the quantity of literature available, the kinds of noise sources studied, and the breadth of documented effects within an accessible format. Results demonstrate the extent of scientific support for park planning and management related to noise. Distinct subsets of the scientific literature may be of relevance for specific locations or management actions; the authors will assist parks and regions with more detailed and specific analyses of this literature upon request. A CSV of the annual literature results is included with the report products on NPS DataStore.

Acknowledgments

The authors would like to thank the original project developers, Megan McKenna and Sharolyn Anderson, for their vision, expertise, and efforts in developing this workflow. We also thank the peer reviewers for recommendations that improved this report.

Project Summary

This project summarizes the results of a systematic query of scientific literature using a rigorous, transparent process that provides park managers with the current state of knowledge about the impacts of noise. The National Park Service (NPS) is required to use credible scientific information to support natural resource management decisions (EOP 2025; NPS 2001, 2006). The NPS Washington Office provides scientific leadership by distilling complex information to maintain alignment, coherence, and operational effectiveness across the NPS. The Natural Sounds and Night Skies Division (NSNSD), within the Natural Resource Stewardship and Science Directorate (NRSS) of the Washington Office, develops, uses, and distributes the tools of natural and social science to help the NPS fulfill its core mission. Accordingly, NSNSD works to understand and communicate current scientific knowledge that informs park management of resources and the visitor experience.

Noise arising from expansion of human population and infrastructure, transportation networks, and resource extraction alters conditions in public lands and protected areas, including national parks (Buxton et al. 2017; Figure 1). Shannon et al. (2016) developed a comprehensive query to capture relevant literature on noise impacts to wildlife, which produced an authoritative literature synthesis. That published synthesis offered an important peer-reviewed summary of the state of knowledge at the time. This project expands upon the 2015 effort by summarizing annual results from a systematic query of the literature.

It can be challenging, however, to summarize scientific topics experiencing rapid growth in knowledge. This project addresses the challenge by conducting systematic, comprehensive, up-to-date queries and summaries of the scientific literature. Our approach is distinct from the results of ad hoc queries using Google Scholar or a similar tool. We developed, tested, reviewed, and improved our query through an iterative process to ensure that the results are reproducible and encompass relevant literature. No tool can guarantee capture of every publication; however, our process delivers results that are more comprehensive than less systematic internet searches. The product enables managers and scientists to more efficiently synthesize, distribute, and act upon relevant physical, biological, and social science information to support parks in protecting natural and cultural resources and visitor experiences.

This product represents our continued attempt to concisely render knowledge of noise effects on wildlife and people in an accessible format. The project focuses on the quantity of literature, the kinds of noise sources that were studied, and the breadth of effects that have been documented. The value of this brief for NPS managers is increased awareness of the extent of scientific support for park planning and management, and identification of distinct subsets of literature that may be relevant for specific locations or management actions. The authors will assist parks and regions with more detailed and specific analyses of this literature upon request.



Figure 1. Within national parks, aircraft (a) and vehicle noise (b) are most frequently heard, whereas train (c) and watercraft (d) are the loudest noise sources. Analysis is based on acoustic recordings collected and analyzed at 247 sites in 64 national parks across the United States (Buxton et al. 2019).

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Methods

In 2018, we established a method based on key-term searches of peer-reviewed literature published beginning in 1978 using the Web of Science (WoS) citation indexing database (Clarivate 2026). We applied the *pro forma Reporting of Strategies in Systematic Evidence Synthesis* (ROSES) method (Haddaway et al. 2018) as a mechanism to reduce bias through transparent, standardized reporting, and to establish reliable search terms. Although some index bias is associated with WoS, which tends to underreport international publications in languages other than English, the search strategy was developed and reported following the ROSES framework. We tested the results against an established list of relevant papers on the effects of noise (Shannon et al. 2016), capturing 90% of known studies using our search criteria.

Since then, we have conducted annual literature searches using the same search terms (Appendix A), up to and including 2025. A subject matter expert reviewed all papers identified by the search to ensure that only peer-reviewed studies documenting the ecological or health effects of noise were included in the final data set. Irrelevant papers included those that summarized noise levels without documenting a response, studies on noise specific to occupations, and studies that occurred inside hospitals and vehicles (indoor learning spaces were included, due to applicability for park interpretation). For papers deemed relevant, a subject matter expert labeled the publications with a single category of noise source: noise from the built environment (all sources together), recreation, transportation, resource extraction (which included industrial sources), military, or other. The paper was then labeled with an effect category (human, wildlife, plants, multiple, laboratory, review-human, and review-wildlife). Additionally, we used automated searches to identify keywords that appeared in publication titles (sleep, hypertension, annoyance, speech, marine, bird, chronic, industrial, traffic, aircraft, sonar, wind, park, protected area).

Results

Summary of Studies, 1978–2025

From 1978 to 2025, 2,474 relevant studies were identified by the Web of Science search criteria (Appendix A) and subject matter expert labeling (Figure 2). Until the year 2000, most noise impact studies focused on humans. Both wildlife and human studies began to increase steadily in the following decade, with reviews for both categories becoming more common from 2011 onward. 2021 and 2022 each produced a study on the impacts of noise on plants; previously, this literature had been sparse but may require attention in future years with growth in understanding of noise impacts to plants.

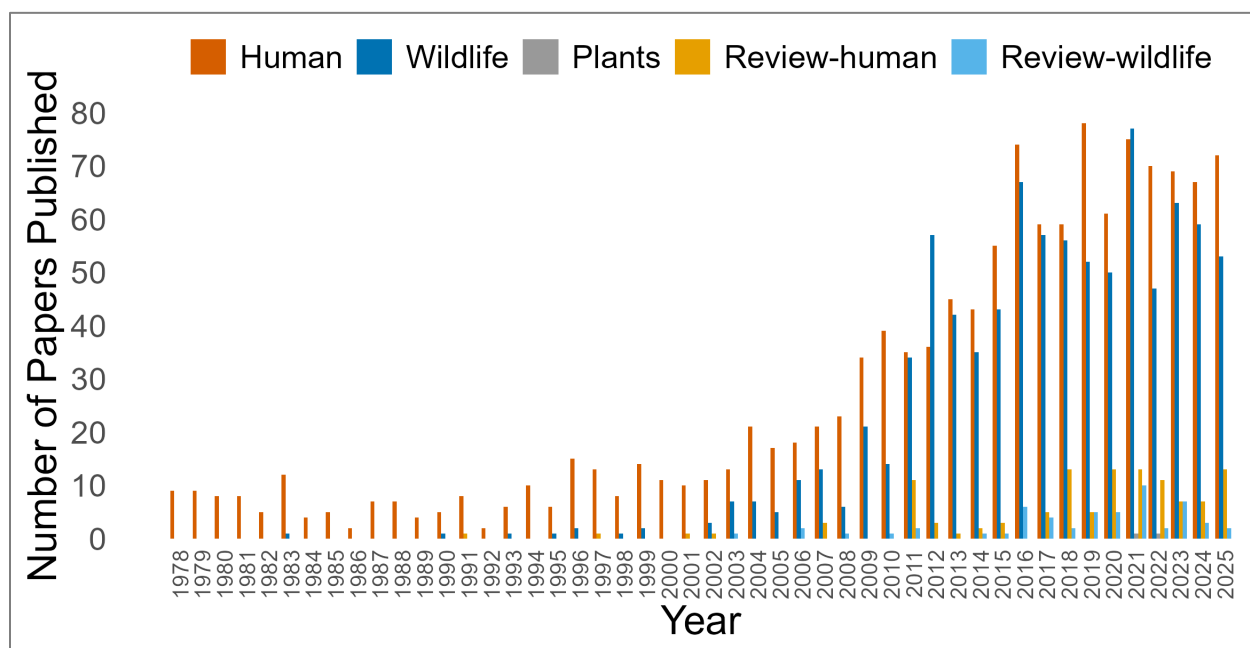


Figure 2. The number of peer-reviewed studies published each year (1978–2025) documenting the effects of noise based on Web of Science search criteria and manual verification. This graphic excludes studies using laboratory animals.

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Sources of Anthropogenic Noise, 1978–2025

Most human studies are focused on transportation noise, while a large proportion of wildlife studies are focused on noise from the built environment (Figure 3). The “other” category reflects several studies on noise impacts from unmanned aerial vehicles (UAV) (i.e., drones), with unspecified origin (i.e., military, recreation). There was one study on UAV noise impacts in 2020 and several more followed in 2021.

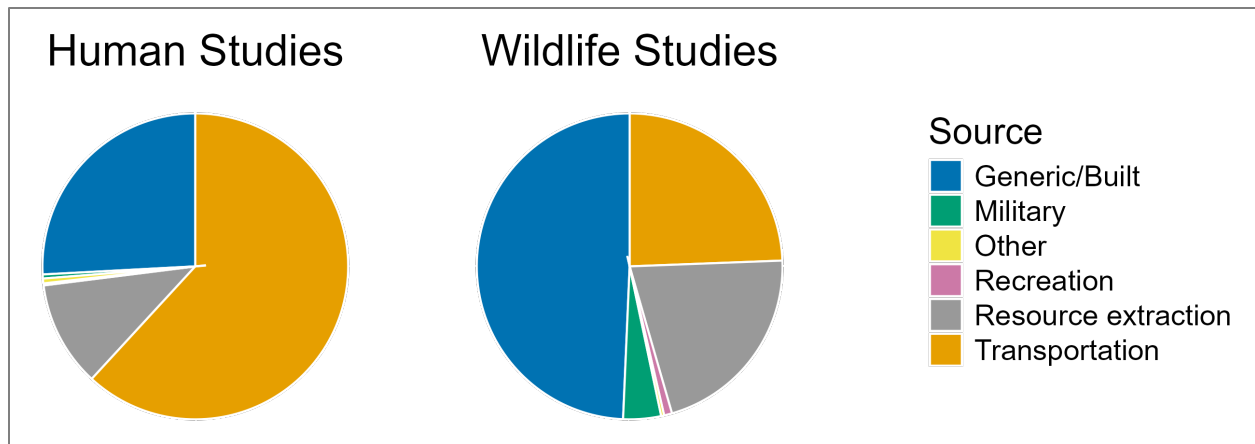


Figure 3. Proportion of studies within different noise source categories. Human studies N = 1,397; Wildlife studies N = 951. These graphics exclude studies using laboratory animals.

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Keyword Trends, 1978–2025

From 1978 to 2025, there were 1,397 studies on humans (114 of which were reviews), and 951 studies on wildlife (55 of which were reviews).

In the 1,397 studies on human response to noise, article titles contained the following keywords:

- Traffic: 499
- Aircraft noise: 223
- Annoyance: 309
- Wind farm noise: 79
- Sleep: 171
- Industrial noise: 51
- Hypertension: 40
- Speech: 20
- Parks or protected areas: 11

In the 951 studies on wildlife response to noise, article titles contained the following keywords:

- Traffic noise: 108
- Underwater sonar: 41
- Chronic noise: 20
- Aircraft noise: 12
- Parks or protected areas: 10

Trends in Topics, 1978–2025

To examine different topics discussed in the literature, we generated word clouds for wildlife and human studies from the titles and abstracts for all publications (1978–2025; Figure 4). Early wildlife publications focused on dolphins and birds, while later studies encompassed a broader range of taxa (including fish) and noise sources (e.g., urban, sonar, road). Early human publications focused on annoyance from aircraft, and later studies included sleep and health effects of multiple noise sources (e.g., wind energy, traffic; Figure 5).

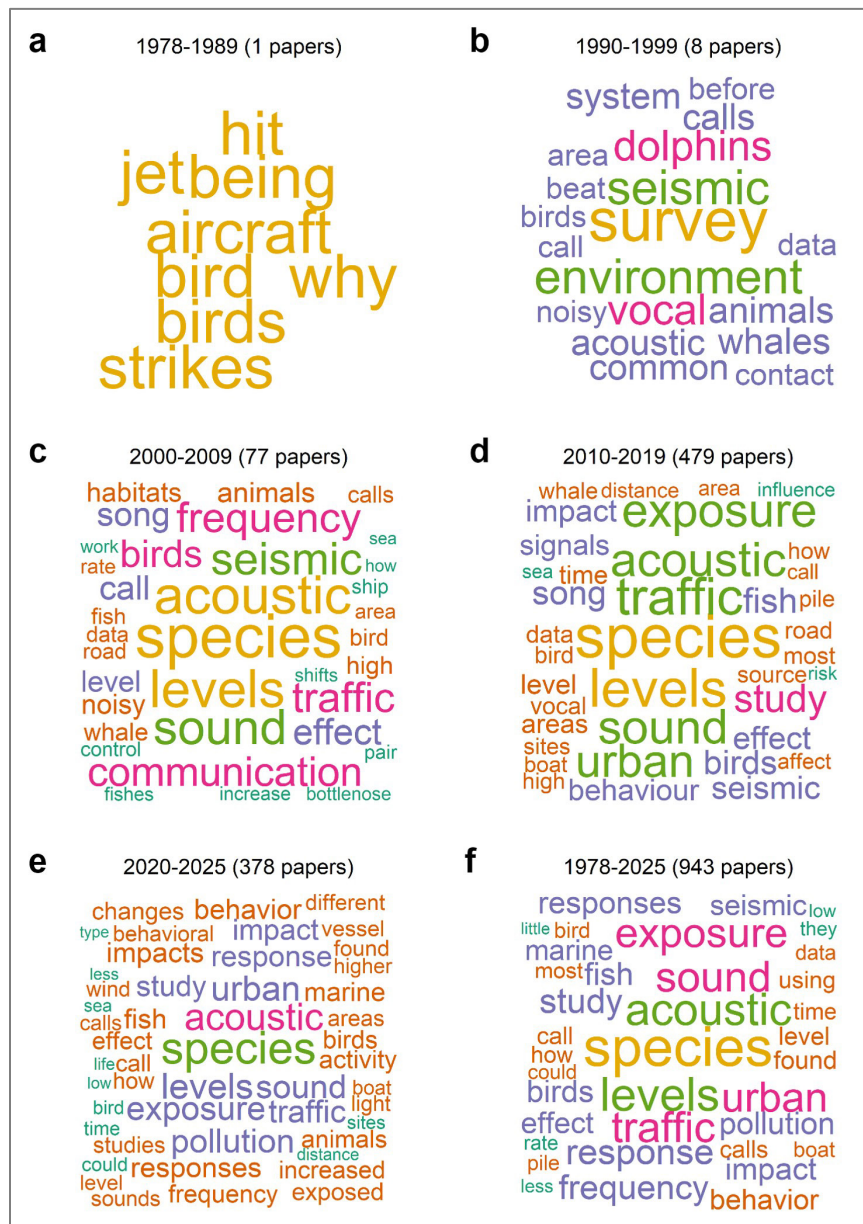


Figure 4. Topic trends for wildlife publications from (a) 1978–1989, (b) 1990–1999, (c) 2000–2009, (d) 2010–2019, (e) 2020–2025, and (f) all years of the study.

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In the 85 studies on human response to noise, article titles contained the following keywords:

- Traffic: 25
- Aircraft noise: 7
- Annoyance: 10
- Wind farm noise: 4
- Sleep: 7
- Industrial noise: 1
- Hypertension: 1
- Speech: 1
- Parks or protected areas: 2

In the 55 studies on wildlife response to noise, article titles contained the following keywords:

- Traffic noise: 4
- Underwater noise: 2
- Chronic noise: 1
- Aircraft noise: 0
- Parks or protected areas: 0

Suggested Readings from 2025

[García-Luna et al. \(2025\)](#) investigated the long-term consequences of chronic noise exposure on the canyon tree frog (*Dryophytes arenicolor*), a species found in rocky arid scrub and canyon areas in Utah, Colorado, Arizona, New Mexico, and Mexico. The authors exposed canyon tree frog tadpoles to urban noise for 6 hours a day until metamorphosis and found that frogs exposed to noise had normal growth but delayed metamorphosis. Noise-exposed frogs that had recently metamorphosed took longer to react to prey but showed no differences in jumping performance compared to frogs that were not exposed to noise. The authors concluded that noise exposure may impact frog energy stores and thus impact their activity, demonstrating that noise impacts may be different throughout the life cycle.

[Ritz-Radlinska et al. \(2025\)](#) investigated the impacts of both artificial light at night and noise pollution on singing behavior in urban European blackbirds (*Turdus merula*). Birds began singing earlier in the morning in areas with both noise and light pollution, although the effects were strongest at the beginning of the nesting season and then decreased throughout the breeding season. Increasing noise pollution also increased the influence of light pollution. Importantly, the authors found that light and noise pollution had greater impacts on urban blackbirds' morning vocal activity than did weather conditions.

Lastly, [Terray et al. \(2025\)](#) performed a systematic review of the impacts of airborne noise on wildlife. The team found that most studies have been conducted in the United States, with birds (64%) and mammals (22%) being the most studied taxonomic groups. The most studied sources of noise were transportation noise (43%) and urban noise (24%), and the most studied effects were on behavior (27%) and vocal communication (25%). This systematic map identified three knowledge clusters and suggested that future studies could examine the impact of anthropogenic noise on (1) mammal behavior, (2) bird reproductive success, and (3) species richness and diversity. Finally, the authors identified continuing knowledge gaps in noise-wildlife research, finding that noise impacts to reptiles and arachnids are particularly understudied, and recreation and military noise sources are also understudied.

Where to Find More Information

A searchable spreadsheet of all relevant studies is available at the “[NSNSD Annual Literature Syntheses on Effects of Noise and Effects of Artificial Light at Night](#)” project in NPS DataStore (Balantic and Olstad 2025). Future annual syntheses and updated content are planned to be published in association with this project reference.

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Appendix A. Web of Science Search Terms

TS = ("wildlife" OR "animal*" OR "endangered species" OR "fauna"
OR "wild animal*" OR "mammal*" OR "reptil*" OR "amphib*" OR
"bird*" OR "songbird*" OR "avian" OR "fish" OR "larva*" OR
"hearing specialist" OR "invertebrate*" OR "whale*" OR "dolphin*" OR
"human*" OR "visitor*" OR "tourist*" OR "sleep" OR "stress" OR
"acoustic trauma" OR "annoyance" OR "health*" OR "migration" OR
"ecosystem*" OR "biodiver*" OR "habitat*" OR "communication")

COMBINE WITH THIS SEARCH

TI = ("noise pollution" OR "anthropogenic noise" OR
"anthropogenic sound" OR "chronic noise" OR (environment* SAME
nois*) OR "ambient noise" OR "acoustic source*" OR (urban SAME
nois*) OR (city SAME nois*) OR (human activit* SAME noise) OR
"acoustic source*" OR "noise event*" OR "noise level*" OR
(construction SAME noise) OR (transportation SAME noise) OR
(traffic SAME noise) OR (vehicle SAME noise) OR "vessel noise" OR
"watercraft noise" OR "ship noise" OR "boat noise" OR "aircraft
noise" OR "helicopter noise" OR (UAS SAME noise) OR (drone SAME
noise) OR (industrial SAME noise) OR (wind farm SAME noise) OR
(wind turbine SAME noise) OR "turbine sound*" OR (compressor SAME
noise) OR "pile-driving noise" OR "pile-driv*" OR "airgun" OR
"air gun" OR "military sonar" OR "naval sonar" OR "sonar signal*" OR
"sonic boom" OR (seismic SAME survey) OR "synthe* noise" OR
"white noise" OR "acoustic alarm" OR (noise SAME disturb*)) NOT
(WC=("Quantum Science & Technology" OR "petroleum" OR "Fluids &
Plasmas" OR "Geochemistry & Geophysics" OR "Surgery" OR
"Telecommunications" OR "Electrochemistry" OR "Mathematics" OR
"Agricultural Engineering" OR "Legal" OR "Geosciences"))

AND LANGUAGE:

(English) All Document Types Indexes = SCI-EXPANDED, SSCI, A&HCI,
BKCI-SSH, ESCI, CCR-EXPANDED, IC
Timespan = 2025-01-01 to 2025-12-31

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