Environmental Research Consultancy Department

UK Civil Aviation Authority

# The Effects of Aircraft Noise on Biodiversity: an update

**CAP 3166**

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Chapter 1
# Introduction

1.1 CAP2517, published in 2023, was commissioned by the Department for Transport and was intended to be a concise overview of the current knowledge on the impacts of aircraft noise on biodiversity. This report is an update to CAP2517 and includes findings in this area since 2023.

1.2 The definition of biodiversity is: “the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable”. It includes all terrestrial (land-dwelling), marine (aquatic) and other different ecosystems and ecological complexes. Biodiversity is essential for all processes in nature and supports all life, including humans.

1.3 The main points from CAP2517 were:

- Aviation affects biodiversity through habitat loss (airport expansion), wildlife management, and pollution (light and noise).
- Communication Disruption: Aircraft noise masks acoustic signals essential for mating, territory defence, and predator warnings.
- Behavioural Changes: Animals may alter call frequency or amplitude, expending extra energy and reducing fitness.
- Breeding and Survival: Reduced reproductive success, nest abandonment, and increased predation risk are documented in birds, amphibians, and insects.
- Sensitive Groups: Fish, mammals, reptiles, amphibians, and invertebrates are highly susceptible to noise and light pollution. Impacts include navigation disruption (e.g., cetaceans), feeding interference, and habitat displacement.
- Cumulative Effects: Persistent noise can lead to population declines and ecosystem imbalance.

1.4 Evidence from other transport noise sources suggests similar patterns, reinforcing the need for integrated noise management for biodiversity effects. The following chapters include findings between 2023 and 2025 and are grouped by species. This report has been published to provide the public and the aviation industry with a concise and accessible update on the impacts of aircraft noise on biodiversity. It should be noted that the CAA has not validated any of the analysis reported, nor takes any view on their applicability to UK policy making.

Chapter 2

# Aircraft Noise and Birds

2.1 Much of the research around aircraft noise and the impact on wildlife focuses on the effects on birds around airports. **Alquezar et al** investigated the amount of corticosterone present in the feathers of birds around three Brazilian airports.

2.2 It is explained that one way to evaluate how wildlife is responding to noisy environments created by urbanisation is by measuring the levels of glucocorticoid hormones linked to the stress response. Long-term changes in these hormones may indicate whether a given population, or an individual is chronically stressed. The stress response can be defined as a set of behavioural and physiological changes that help an individual restore internal physiologic balance when exposed to external stimuli, for example as predator exposure, shortage of food resources, competition and unfavourable climatic conditions.

2.3 In birds, corticosterone (CORT) is the glucocorticoid hormone similar to cortisol in mammals. When exposure to threats is occasional, CORT release induced by the hypothalamic-pituitary-adrenal (HPA) axis helps individuals to deal with risky situations. However, when exposure to unwanted stimuli is continuous, the stress response becomes chronic and can lead to detrimental consequences to the bird's breeding activities, survival, and cognitive ability.

2.4 In studies that have focused on the specific impacts of noise pollution on birds, evidence suggests that individuals from species that are common in cities (i.e., urban adapters or exploiters) are more likely to present no differences in baseline CORT levels and/or in body condition when compared to individuals of the same species in quiet areas. This lack of baseline CORT level differences can be either because the species is insensitive to these disturbances or because the species have adapted to the stressful condition.

2.5 In this study the authors attempted to test whether Neotropical[1] birds living in the vicinity of airport environments are under higher physiological stress than those living in quiet environments, using a measurement of CORT in the feathers (CORTf). In addition, they investigated whether an individual's CORTf concentration is related to its Body Condition Index (BCI), given that body condition has been suggested as the best measure of chronic stress. Differences in CORTf concentrations at a species level were tested at the two study areas (airport-affected and quiet control sites) to examine whether the follow the same

[1] Birds of the Western Hemisphere that migrate long distances from wintering grounds in the New World Tropics (or “Neotropics”) to breeding grounds in North America.

general trend, or alternatively, are species-specific. At the population level, the authors tested whether song frequency and preference for urban environments could explain the direction and strength of the response.

2.6 Six study sites around three Brazilian airports were chosen (3 exposed to aircraft noise and 3 quiet sites) and the birds were temporarily captured, and three feathers taken from their tails. They were also assessed for body condition. 1187 birds were captured and had their feathers collected in the six sampled sites, totalling 15 species.

2.7 The results indicated that across species, individuals with a better body condition had lower CORTf concentration. At the species level, it was observed that CORTf concentration was not consistently affected by airport noise. When comparing individuals living in quiet sites with those living near airports, the authors found that 2 species had higher and 2 had lower CORTf concentrations near airports, while 11 species presented no significant differences between sites. At the population level, model selection indicated that the direction and strength of these differences are weakly related to species song frequency (peak frequency), as lower-frequency singers tended to present higher CORTf levels at airport-affected sites.

2.8 There was a lack of consistent findings, but the authors suggest that CORTf concentration and BCI are related, providing support to the idea that this measurement can be used as a proxy to assess chronic stress in birds. They also show that birds living in the proximity of airports do not exhibit consistent elevations of CORTf in their feathers, but that species with low frequency songs seems be more affected than those with higher song frequency. They argue that although extreme noise seems to be the factor driving such responses, it is important to notice other probable aspects of airport environments that could be affecting CORTf concentration, such as air pollution, nearby urbanisation, resource availability, etc.

2.9 **Nightingale et al** published findings on conservation beyond boundaries, and the use of animal movement networks in protected area assessments. Protected areas (PAs) are a core component of conservation policy and practice. However, many species for which they are designated are highly mobile and may move among sites within and beyond PA boundaries. Environmental impacts on sites beyond those boundaries could thus impact the PA's protected populations, with the risk of adversely affecting its conservation objectives. Conservationists therefore urgently need tools to assess impacts on PAs and their populations of developments beyond their boundaries.

2.10 The authors present a framework for using network analysis of observations of marked individuals to assess the protection footprint of PAs in the wider landscape and the impact footprint of developments within or neighbouring PAs. Network analysis can describe an interconnected ecological system as a whole and quantify the contributions of individual components to overall connectivity. This is illustrated with the use of this framework by assessing the impact of a current airport development proposal on a partially protected wetland, the Tagus estuary in Portugal, specifically by evaluating the extent of noise disturbance on the PA's population of Black-tailed Godwits, a protected migratory wader species.

2.11 It is explained that the designation of PAs is frequently based on the presence of particular species, often highly mobile animal species for which connectivity within and between PAs is likely to be particularly important. For example, the European Union (EU) Birds Directive (2009/147/EC) compels member states to classify PAs according to the presence of particular bird species, especially migratory species. Member states are required to ensure that birds in PAs are not significantly impacted by disturbance, pollution, or habitat degradation.

2.12 The site in this study is the Tagus estuary (Portugal's largest wetland and an important site for waterbirds). Part of the estuary is designated under the EU Birds Directive as a Special Protection Area (SPA). Plans have recently been approved to construct an international airport in the heart of this estuary, on a site overlapping part of the PA. The Environmental Impact Assessment (EIA) conducted for the development considers the main threat of this development to bird conservation to be noise disturbance from aeroplanes, with one take-off or landing every 2.5 min, flying at low altitude (<200 m) over the SPA and the consequent changes in behaviour, from alarm-calling to taking flight and leaving the disturbed area.

2.13 The predicted impact of the Tagus airport development varies depending on the threshold of noise sensitivity assumed, with louder noise occurring over a smaller area. Although the EIA's reference for waterbird noise responses reported altered behaviours above 50 dBA, the EIA itself only considers relevant areas impacted over 65 dBA and limited to areas within the PA. Individual movements within or to/ from the PA were not considered and the authors argue that this risks adversely affecting the integrity of the PA.

2.14 To demonstrate the applicability of this proposed framework, the authors use network analysis of individual movements of a conservation-priority species, the Black-tailed Godwit to assess the protection footprint of the Tagus estuary SPA and the impact footprint of the proposed airport. They aimed to quantify:

(a) the proportion of the local godwit population protected by the PA during the year, and its overlap with the area to be impacted by development, and

(b) the wider areas used by birds from the PA, and birds from the impacted area.

2.15 Using network analysis, they then assess which sites contribute most to connectivity, and how the predicted development impact might diminish connectivity. The authors collated data from individually marked godwits marked in three locations: breeding in Iceland, stopover in the Wash, UK, or wintering in the Tagus estuary. They used network analysis of locations of marked individuals to assess the protection footprint of the Tagus estuary SPA as it relates to godwits, and the impact footprint of a proposed airport development adjacent to, and slightly overlapping, the SPA.

2.16 They found that, while protection from the Tagus estuary SPA covers 82.8% of the godwit population for at least some portion of the year, frequent trans-boundary movements mean that 61.0% of those individuals use unprotected sites as well. 14 of 16 unprotected sites were found to support birds that also use the SPA. The authors also found that the majority of the most important sites for connectivity were outside the protected area. Taken together, these results show that the surrounding, unprotected landscape plays an integral role in supporting the SPA's godwits, especially during October-December.

2.17 The Tagus godwits' frequent trans-boundary movements mean that 44.6% of the SPA's godwit population would be exposed to noise disturbance from the proposed airport, and 68.3% of individuals overall. This compares with estimates of 0.46-5.5% in the airport's EIA. Furthermore, the proposed frequency of disturbance events (on average one per 2.5 min during operating hours) suggests that disturbance in the Tagus would be chronic, potentially leading to causing permanent abandonment of disturbed areas.

2.18 The authors found that many of the sites most important to connectivity in the estuary, which include both feeding and roosting areas, would receive at least 55 dB of aircraft noise, and that threatened sites are connected to five more sites on average than unthreatened sites. Simulating avoidance of those sites by godwits revealed significantly reduced connectivity across the estuary-wide movement network, as well as increasing the relative importance of the remaining sites, many of which currently lack statutory protection.

2.19 The authors concluded that it seems likely that the proposed development would lead to a decrease in the size of the godwit population in the Tagus estuary SPA, through death and/or relocation of individuals that depend on the impacted area (especially during early winter), as well as increasing disturbance and physiological stress, and reducing habitat availability, of those that remain.

2.20 **Bahía et al** reported on how anthropogenic city noise affects the vocalisations of forest birds. The study investigated how anthropogenic noise, specifically from aircraft, helicopters, and vehicles affects the vocalisations of four ecologically important bird species in the Andean-Patagonian Forest (Argentina). These species play key roles in pollination, seed dispersal, and arthropod control, making their communication vital for ecosystem functioning.

2.21 Aircraft and vehicular noise occupied the 0-4.5 kHz frequency range, overlapping with the vocalisations of some bird species. It is explained that this overlap creates acoustic masking, reducing the detectability of bird calls. The species-specific observations were found to be:

- White-crested Elaenia: Increased minimum, maximum, and dominant frequencies during and even after noise events, suggesting persistent changes. Also shortened pauses between syllables, increasing repetition rate.
- Green-backed Firecrown: Raised frequencies slightly and reduced duration of vocal elements during noise.
- Thorn-tailed Rayadito: Noise did not alter frequency but significantly shortened pauses and call duration, increasing repetition, which is an energetically costly strategy.
- Austral Parakeet: Low-frequency calls overlapped heavily with aircraft noise, causing severe masking. Potential loss of critical signal elements.

2.22 The authors explain that some of these changes persisted even after the noise stopped, indicating lasting disruption. The implications for biodiversity included communication disruption, whereby altered vocal patterns can affect mate attraction, territory defence, and predator avoidance. Increased repetition and higher frequencies raise metabolic costs and stress levels, impacting energy costs and stress. Since these birds are key pollinators and seed dispersers, noise-induced communication breakdown may impair plant reproduction and forest regeneration. Persistent changes suggest potential evolutionary impacts and cascading effects on species interactions.

2.23 Conservation recommendations were suggested, included the incorporation of noise management protocols in protected areas, especially near tourist zones and flight paths. The use of sound mapping and propagation modelling to guide infrastructure planning was also proposed, along with promotion of electric transport and regulation of air traffic over sensitive habitats. The authors suggest further research on the potential impact of anthropogenic noise on wildlife in different types of environments (at local and regional levels), and how it translates into impacts on ecosystem functioning.

2.24 **Engel et al** investigated the mechanistic pathways for anthropogenic noise impact (including aircraft noise) on avian species. Due to the vulnerability of birds to man-made noise and the importance of acoustic communication for mate attraction, territory defence, predator detection and parental care, this review collated information on the pathways of noise impacts on anatomy and physiology of birds and their resulting habitat selection.

2.25 The review includes various transportation and construction noise sources, amongst others. Aircraft noise was found to span 50–5000 Hz, overlapping with the vocal ranges of many bird species, especially those communicating at low to mid frequencies (200–2000 Hz). High amplitude levels (often exceeding 93–110 dBA) were found to sometimes cause temporary or permanent hearing damage in birds, particularly during repeated or prolonged exposure. The propagation effects of aircraft noise travelling long distances and penetrating habitats reduces signal-to-noise ratios, causing acoustic masking, which interferes with birds' ability to detect and interpret calls.

2.26 The mechanistic pathways of various noise impacts are discussed in the review. For aircraft noise the pathway would include emission, propagation and outcome stages.

- Emission: Aircraft engines produce broadband noise with dominant mid-frequency components.
- Propagation: Noise spreads through air, attenuated by vegetation and terrain, but still reaches forest interiors.
- Reception: Birds' hearing thresholds vary by body size. Small birds hear higher frequencies, large birds hear lower ones. Aircraft noise overlaps with many species' communication ranges.
- Outcome: Masking of vocal signals, stress responses, and behavioural changes.

2.27 There are physiological, behavioural and ecosystem impacts of noise with regard to birds. The physiological impacts include hearing damage at high intensities (>110 dBA). Chronic stress elevates the heart rate and stress hormones, reducing fitness and reproductive success. Behavioural changes include the avoidance of noisy areas (e.g., nesting further away from flight paths), altered foraging efficiency and predator detection. The authors also describe the impact on vocal plasticity. Birds increase amplitude, shift frequencies, or change timing of songs to compensate for noise. Ecosystem consequences include disrupted pollination and seed dispersal due to impaired communication in key species. There are also potential population decreases and altered community structures, leading to ecosystem function loss.

2.28 The authors conclude by recommending that buffer zones are implemented, and flight altitudes should be regulated over sensitive habitats. Sound mapping and propagation modelling should be used in conservation planning. The promotion of quieter technologies and flight scheduling to minimise disturbance is also suggested.

2.29 **Chen et al** investigated divergent bird diversity patterns among four airports in the same bioregion. The study, which was a count survey between 2018 and 2019, examined bird diversity patterns at four airports in the Lower Yangtze River Plain, a region along the East Asian-Australasian Flyway, which is critical for migratory bird conservation. Airports create unique ecological conditions where aircraft operations and noise intersect with wildlife habitats, influencing biodiversity and potentially increasing bird strike risks.

2.30 147 bird species were recorded in the study: 50 permanent residents and 96 migratory species. Nanjing Lukou International Airport (NJ) had the highest richness (125 species), while Huai'an Lianshui (HA) had the lowest (67 species). Diversity varied significantly among airports due to differences in surrounding habitat composition (farmland, wetlands, woodlands, residential areas). The findings suggested that woodlands and wetlands near airports supported the greatest bird diversity. Farmlands attracted large flocks of granivorous species (species which feed on seeds, droplets and fruits of plants), potentially increasing collision risk. Residential areas generally had lower diversity, except NJ, where mixed habitats boosted richness.

2.31 The authors concluded that aircraft noise and operations create disturbance zones that alter bird behaviour and habitat use. Birds may avoid high-noise zones, therefore reducing habitat availability. Aircraft noise can mask bird communication signals, affecting mating and foraging success. Airports with heterogeneous habitats (NJ and CZ) maintain higher biodiversity, but this also increases strike risk when combined with noise and flight activity. Homogeneous landscapes (HA, YT) showed lower levels of diversity but still pose risks due to concentrated populations of certain species.

2.32 The authors offered some conservation and management recommendations. Firstly, the integration of ecological planning into airport safety protocols, which would maintain buffer zones and manage land use to reduce attraction of high-risk species. The prioritisation of habitat management near wetlands and farmlands would help to minimize strike risk. Seasonal monitoring during migration peaks is essential, and future strategies should balance aviation safety and biodiversity conservation, considering noise mitigation and habitat configuration.

2.33 **Wang et al** investigated how aircraft flight noise and activity affect bird communities at an airport in eastern Hebei Province, China. Surveys were conducted during flight days versus non-flight days (June-August 2019) using sampling across 10 airport zones.

2.34 36 species were recorded, with the dominant species being Eurasian tree sparrow and barn swallow. 45% were insectivorous birds, 19% omnivorous, 22% carnivorous, and 14% grain-eating.

2.35 Species richness and individual density dropped significantly on flight days, from 18.8 on non-flight days to 12.7 on flight days. Individual density also dropped from 366.2 birds per unit area on non-flight days to 73.4 on flight days. Species diversity showed localised declines, especially in areas near runways, and uniformity was slightly higher on flight days, suggesting fewer species but more even distribution.

2.36 For species-specific responses, the results indicated that some species avoided noise (e.g., swallows, sparrows), but raptors increased on flight days (upland buzzard, eastern buzzard, common kestrel), who were likely exploiting prey disturbed by noise. Certain species appeared only on flight days (e.g., upland buzzard, black-crowned night heron), while others were exclusive to non-flight days.

2.37 The authors described the behavioural and ecological implications. Noise levels of greater than 100 dB during take-off/landing likely drives avoidance in small birds and creates hunting opportunities for predators. Disturbance effects vary by airport zone, with those areas near runways being most impacted.

2.38 It is suggested that there should be measures to implement targeted bird strike prevention in high-risk zones, raptor activity could be monitored on flight days, and further research is required on breeding success and vocal behaviour under noise conditions.

2.39 **Ciot et al** assessed how human disturbance, including proximity to airports and associated aircraft noise, affects the physiological stress of Golden Eagle nestlings in Spain and Portugal, using feather corticosterone (CORTi) as a stress indicator.

2.40 The study was conducted in Spain (Madrid, Castilla-La Mancha, Asturias, Castilla y León) and Portugal (Bragança district). Nestlings of Mediterranean Golden Eagles were sampled during late May to mid-June in two consecutive years (2018 and 2019). Active nests were located on cliffs or occasionally on trees.

2.41 Down feathers were collected from nestlings for corticosterone (CORTi) analysis, which reflects stress during feather growth, and age, weight, and body condition were recorded. Nestlings were banded for identification. To examine the human pressure indicators population size was calculated (Number of inhabitants in the municipality where the nest was located).

2.42 Proximity to airports was measured by straight-line distance (km) from each nest to the nearest international airport (Madrid-Barajas, Francisco S. Carneiro, Zaragoza, Bilbao, Santander).

2.43 The airports included in the study typically generate noise levels up to 140 dB during aircraft take-off, which the authors based on published acoustic data for commercial aviation. This level was used as a reference for potential exposure intensity in nests closer to airports. Although direct noise measurements at nest sites were not performed, distance to airports served as a proxy for noise exposure risk.

2.44 Sites were monitored from February for breeding activity. Sampling occurred 40-45 days post-hatching. Nestlings were lowered from nests using safety protocols, sampled, and returned immediately. Feathers were processed and corticosterone extracted and measured.

2.45 Year, population size, distance to airport (proxy for noise), brood size, and body condition were analysed using linear mixed models (LMMs) with nest as a random effect. Distance to the airport was tested for correlation with CORTi levels. A marginally significant negative effect was found, indicating that nests closer to airports (and therefore exposed to higher noise levels) had higher corticosterone concentrations, suggesting that noise pollution from aircraft is a significant stressor during development. Elevated CORTi may initially help survival in stressful conditions but can lead to long-term negative effects (immune suppression, growth delays).

2.46 The authors concluded that aircraft noise is a critical factor in Golden Eagle welfare. Recommended future measures include buffer zones around nesting sites to reduce noise exposure, and temporal restrictions on human and aviation activities during breeding season. Further research on chronic noise effects on breeding success and behaviour is recommended.

2.47 **Sordello et al** published a review of the impact of anthropogenic light and noise on owls. The review included 39 studies (1945-2024) on how anthropogenic sensory pollutants such as artificial light and noise affect owls. Among noise sources, aircraft operations were highlighted as significant contributors to acoustic pollution alongside road traffic, industry, and recreational activities.

2.48 Aircraft noise is part of the broader category of anthropogenic noise that disrupts natural soundscapes in this review. In general, noise was found to reduce owl vocalisations, impairing communication essential for mating, territorial defence, and parent-offspring interactions. Helicopter noise can cause flushing behaviour (owls leaving nests) and stress-related movements. Thresholds for flushing were lower during nesting season, indicating heightened sensitivity.

2.49 Noise interferes with prey detection by masking natural sounds and distracting owls. Even low noise levels (e.g., 40 dBA from traffic) reduced prey detection by around 17%. Exposure to loud noise (including aircraft) increases stress markers such as glucocorticoid metabolites (GCMs) and alters immune responses. Chronic noise can lead to long-term health impacts, reduced fitness, and compromised immunity. At a population level, noise contributes to reduced occurrence and reproduction in some owl species. The authors explain that habitats near airports or military zones may become unsuitable due to persistent noise disturbance.

2.50 **Engel et al** produced a systematic review of anthropogenic noise impacts on avian species. The review analysed 50 peer-reviewed studies on anthropogenic noise impacts on birds. The review identified aircraft/jet noise as a source in three studies within the dataset of 50 papers. Impacts were categorised into:

- Physiological responses:

In the Common Murre (Uria aalge), aircraft disturbance during the breeding season caused reduced survival success and nesting failures.

Chronic exposure to aircraft noise has been found to elevate stress hormones (glucocorticoids), impair immune function, and reduce reproductive success.

- Behavioural changes:

In the Wood Duck (Anseriformes) behavioural alterations were found (e.g., vigilance, movement changes) when exposed to aircraft/jet noise during low flyovers.

Increased avoidance behaviour was observed, and disruption of normal activities in birds near airports.

- Communication and auditory perception

Aircraft noise masks bird calls, reducing effective communication for mate attraction and territorial defence.

Evidence of song frequency shifts in species living near airports (e.g., Chiffchaffs), possibly as an adaptation to noise masking.

- Fitness outcomes (survival and reproduction)

In the Black-crowned Night Heron (Nycticorax nycticorax), aircraft noise was linked to decreased population density near airports.

Birds tend to abandon nesting or feeding sites in high-noise zones, reducing habitat connectivity.

2.51 The review concluded aircraft noise can be a significant ecological stressor for birds, especially during breeding and nesting seasons. Recommended actions include buffer zones around airports and flight paths, flight restrictions during critical breeding periods and integration of noise impact assessments into aviation and urban planning.

2.52 **Van der Kolk** et al investigated how aircraft disturbance frequency influences bird responses and how this affects large-scale impact predictions. Animals may habituate to frequent disturbances or redistribute spatially (avoidance), resulting in higher tolerance in areas with frequent disturbance. Conversely, rare disturbances often provoke strong reactions. Despite this, no previous studies have quantified how tolerance to aircraft disturbance depends on overflight frequency, nor assessed how ignoring this factor misrepresents large-scale predictions.

2.53 The aim was to quantify how strongly bird responses to aircraft disturbance depend on overflight frequency and demonstrate how incorporating frequency dependent tolerance (FDT) changes predictions of energetic costs and disturbance maps for shorebirds. The study was conducted in the western Wadden Sea, a UNESCO World Heritage site and key habitat for millions of migratory shorebirds. Combined and standardised data from previously collected observations from six locations with varying air traffic intensities were used.

2.54 Study sites included military training areas (frequent jets and helicopters), civil airports (frequent small airplanes), and one remote site (rare aircraft). Aircraft types were grouped into five categories:

- Helicopters (civil and military)
- Jet fighters
- Small airplanes
- Medium-sized airplanes
- Large transport airplanes

2.55 Aircraft generally flew at ≤ 450m altitude, and this was lower near airports and training areas. Over 2000 hours across sites were observed for data collection. The sample of bird species was focused on non-breeding shorebirds (e.g., bar-tailed godwit, curlew, oystercatcher, gulls). A disturbance event was recorded when ≥1% of the observed flock took flight during an aircraft overflight. This threshold excluded isolated reactions likely unrelated to aircraft.

2.56 Statistical analysis with logistic mixed-effects regression models were used to examine:

- Fixed effects: Aircraft frequency, aircraft type, bird species.
- Interaction: Aircraft frequency x aircraft type.
- Random intercept: Site (to account for methodological and site-specific differences).

2.57 The findings indicated that for Frequency-Dependent Tolerance (FDT), birds almost always fled (around 80%) when aircraft were rare (<0.01 overflights/hour). Birds rarely responded (around 7%) when aircraft were common (>3 overflights/hour). The authors explain that this suggests a strong habituation effect, meaning tolerance increases with disturbance frequency.

2.58 Initial data suggested large differences (e.g., jets appeared least disturbing, medium-sized planes most disturbing). After accounting for FDT, differences among aircraft types were much smaller. Disturbance probability ranged from

20% (small planes) to 47% (large transport aircraft). Helicopters and transport aircraft remained more disturbing than small civil planes.

2.59 Impact assessments often extrapolate disturbance responses measured at one location to other areas or future scenarios. However, this assumes that animal responses are constant across contexts. If tolerance to disturbance varies with exposure frequency, such extrapolations can be highly inaccurate, either underestimating or overestimating impacts. It is explained that the risk of ignoring FDT can lead to unreliable extrapolations of the data, with over-estimation of impacts in low-traffic areas, and under-estimation in high-traffic areas. When FDT was included, disturbance maps became more homogeneous, reducing extreme “hotspots.” The maximum predicted cost dropped from 2.3% DEE (energy expenditure) to 0.14% DEE. Sites exceeding critical thresholds (>0.5% DEE) fell from 14% to 0%.

2.60 The authors explain that these findings indicated likely habituation rather than avoidance. Birds in high-traffic zones did not abandon sites, suggesting they learned to tolerate aircraft. Rare aircraft types may still cause longer flight times, increasing energy costs per event.

2.61 It is concluded that the policy and conservation impacts of this study are that impact assessments must account for FDT, the current practice of using fixed disturbance probabilities is misleading. Future infrastructure projects (e.g., airports) risk overestimating or underestimating impacts if FDT is ignored.

2.62 Recommendations for the future include the collection of disturbance data across a range of frequencies, the standardisation of metrics (e.g., flight initiation distance, disturbance probability), and consideration of the cumulative effects of multiple disturbance sources.

Chapter 3

# Aircraft Noise and Other Animals

3.1 There have been several studies that focused on the impacts of aircraft noise on other species, which are highlighted in this chapter.

3.2 **Serrano and Ochoa-Ochoa** investigated how aircraft noise modifies acoustic signals and social interactions of a micro-endemic frog from Mexico City. Urban noise pollution is a growing conservation concern, but the effects of aircraft noise on amphibian communication are poorly understood. The study focused on the Pedregal frog (Eleutherodactylus grandis), a threatened, micro-endemic species in Mexico City. Micro-endemic refers those species that are established in a limited area.

3.3 In 2021, a new airport route introduced frequent aircraft overflights (8-12 per hour) over the frog's habitat in the Pedregal de San Ángel Ecological Reserve. The study had two main objectives:

- Assess how transient aircraft noise affects the acoustic properties of individual frog calls.
- Determine whether chorus-level vocal interactions are altered during aircraft overflights.

3.4 Frog calls and ambient noise were recorded during the night sampling period (June-August 2021). Call duration, dominant frequency, amplitude, and repetition rates were measured before, during, and after aircraft overflights. Aircraft noise overflights were approximately 87 seconds, 64-83 dB SPL (average 74 dB) with a centre frequency of around 269 Hz.

3.5 The findings indicated that the individual call of the frog changes during aircraft overflights, with a slight increase in call duration after overflights, and the dominant frequency decreasing by 8-14 Hz. Call amplitude increased by 0.6-0.9 dB Standardised Sound Pressure Level (SSPL). No significant change was observed in the rate of call repetition.

3.6 The number of calls in the chorus dropped significantly during aircraft overflights (mean reduced from 64 to 50 calls per minute). Aircraft noise raised ambient sound levels by around 10 dB, potentially masking frog calls.

3.7 The authors explained that the aircraft noise induces plastic changes in frog acoustic signals and reduces social interactions during choruses. These changes may affect mate attraction and reproductive success, as vocal effort is critical for frog breeding. Although the observed effect is transient, it adds to existing stressors like traffic noise and habitat fragmentation.

3.8 The study concludes that aircraft noise is a new disturbance for this species, which already faces urban pressures. Long-term monitoring is needed to determine whether frogs adapt or suffer fitness declines. Noise mitigation measures should be considered in conservation planning for micro-endemic species under flight paths.

3.9 **Zhao et al** also investigated the effects of aircraft noise on frog populations. Noise pollution can disrupt animal communication, mating, foraging, vigilance, and territorial behaviours, and is linked to biodiversity loss. Most previous studies focus on individual species or single traits, leaving a gap in understanding community-level responses, which this study aimed to address.

3.10 The aims of the study were to investigate how aircraft noise during take-off affects the acoustic traits of multiple frog species, community-level calling behaviour and social network structure. A second aim was to assess whether noise alters patterns of acoustic similarity among individuals and species.

3.11 The study site was a swamp near Haikou Meilan International Airport, Hainan, China, and the species studies included spot-legged tree frog, Guenther's frog, pointed-tongued floating frog and ornamented pygmy frog.

3.12 The peak intensity of the aircraft noise was approximately 83 dB SPL during take-off. The authors recorded calls before, during, and after aircraft take-off, and analysed six acoustic parameters (frequency, call duration, rate, effort). Social Network Analysis (SNA) was then applied to the data to quantify changes in acoustic similarity and clustering at community and species level.

3.13 The results indicated that at a community-level, aircraft noise increased the aggregation of conspecific (members of the same species) calls, and frogs produced calls that were more similar to each other during noise events. The SNA indicated that networks showed higher degrees of clustering in spectral-temporal traits during aircraft take-off.

3.14 The implications for biodiversity are that noise pollution alters acoustic network structure, potentially affecting mate attraction and reproductive success (since call traits influence female choice). Persistent noise could lead to reduced species richness and changes in the community structure and ecological dynamics. The authors stress that these results highlight the need for integrated approaches (beyond single-species studies) to understand and mitigate noise impacts on biodiversity. The results suggest frogs may synchronise or standardise calls in order to maintain communication under masking noise.

3.15 Conservation recommendations include the monitoring of noise impacts at a community level, not just individual species, and the consideration of noise mitigation near critical habitats (e.g., wetlands near airports). Long-term studies are needed to assess fitness consequences and adaptive potential.

3.16 **Bhagarathi et al** authored a review article on the impact of anthropogenic sound on marine mammals. Anthropogenic noise in oceans has increased significantly due to human activities such as commercial shipping, seismic surveys, sonar, offshore drilling, and aircraft overflights. Publications between 1959 and 2022 were considered, with a focus on recent research (last 10–20 years), but older studies were included if relevant. A subjective approach was used to select topics directly related to anthropogenic sound and marine mammals. Articles were screened for relevance to impacts on marine mammals, legislation, management measures, and related stressors. 77 papers were included in the review.

3.17 Marine mammals are highly dependent on sound for navigation, communication, foraging, and reproduction. Noise pollution disrupts these functions, threatening biodiversity and ecosystem health. Aircraft overflights (including military and civilian planes) produce intense, short-duration noise bursts that propagate over large distances in marine environments. Impacts include:

- Behavioural changes: Walruses and Steller sea lions may stampede or abandon calves during aircraft overflights, causing injury or death.
- Stress responses: Increased heart rate and stress hormones in species like beluga whales.
- Habitat avoidance: Some species temporarily vacate haul-out sites or feeding grounds when exposed to repeated overflights.
- Sensitivity by age and sex: Young, pregnant females and cow-calf pairs are more vulnerable than adult males.

3.18 Aircraft noise adds to cumulative stress from other anthropogenic sources, amplifying biodiversity risks. The review highlights broader biodiversity impacts, such as:

- Hearing Loss: High-intensity sounds (including impulsive noise from explosions and sonar) cause temporary or permanent threshold shifts, reducing communication range and increasing predation risk.
- Masking: Background noise interferes with detection of biologically important signals, forcing animals to alter call frequency or amplitude.
- Physiological Effects: Noise can induce stress, disrupt immune and reproductive systems, and cause tissue damage or gas embolisms in deep-diving species.
- Behavioural Disruption: Changes in surfacing, diving, and vocalisation patterns; avoidance of noisy areas; reduced feeding and mating success.

- Mass Strandings: Linked to high-intensity sonar and seismic air guns, especially in beaked whales.
- Population-Level Effects: Displacement from critical habitats, altered migration routes, and reduced reproductive success threaten species survival and ecosystem balance.

3.19 The authors explain that marine mammals act as sentinel species, indicating ecosystem health. Their decline affects nutrient cycling, carbon sequestration, and marine productivity. Noise mitigation strategies are important for regulating flight paths and altitudes over sensitive marine habitats. Seasonal restrictions could be implemented for noisy activities during breeding or migration seasons. It is also concluded that more research is needed in biodiversity-rich regions like the neotropics, where data gaps persist.

Chapter 4

# Aircraft Noise and Other Findings

4.1 **Botteldooren et al** presented findings on sound communication interference weighting for terrestrial animals, at the 11th Convention of the European Acoustics Association (2025). The background to the study is that anthropogenic noise, including traffic, industrial activity, and aircraft overflights, is a major threat to terrestrial biodiversity. Noise disrupts communication, mating, territorial signalling, and predator detection, leading to altered species interactions and community structure. Birds and mammals rely heavily on acoustic signals for survival; interference from human-made sounds can cause masking and behavioural changes, as previously described in this report.

4.2 The aims of the study were:

- To address limitations of A-weighting for wildlife noise assessment: A-weighted sound levels are widely used in noise studies but are based on human loudness perception, making them unsuitable for evaluating impacts on terrestrial animals such as birds and mammals. The study aimed to explore alternative weighting methods that better reflect how noise interferes with animal communication.
- Develop and test communication interference weighting (CI-weighting): Investigate whether weighting curves derived from animal vocalisation spectra can provide a more accurate measure of noise impact on biodiversity. Use bird song recordings to create species-specific weighting curves and compare them with traditional A-weighting.
- Evaluate the practical implications for biodiversity monitoring: Apply these weighting curves to real-world noise data collected from suburban and urban environments. Assess whether CI-weighting significantly changes conclusions compared to A-weighting, especially for large-scale biodiversity surveys versus species-specific studies.
- Support conservation and ecological research: Provide tools for more targeted impact assessments of anthropogenic noise (including traffic and aircraft) on wildlife communication. Inform strategies for noise mapping and management in biodiversity-sensitive areas.

4.3 The study area (Ghent, Belgium) lies under multiple air corridors, and although the nearest airport is 60 km away, aircraft noise was found to be clearly audible in quieter suburban zones. Aircraft noise adds to cumulative anthropogenic sound pressure, especially in areas already affected by road traffic.

4.4 Some of the findings included that aircraft overflights contribute to high disturbance levels, even when overall noise is dominated by traffic. At times and locations with significant noise (including aircraft), high interference levels occur regardless of weighting method (A-weighting or communication interference weighting). The authors suggest that for large-scale biodiversity assessments, existing A-weighted noise maps may suffice, but for species-specific studies (e.g., endangered birds), communication interference weighting (CI-weighting) is more accurate.

4.5 Birds adapt to noisy environments by shifting song frequencies upward (possibly as a side effect of singing louder), timing vocalisations during quieter periods (e.g., early morning chorus). However, adaptation has limits; chronic noise, including aircraft can reduce mate attraction success, increase energy costs for communication, and alter community composition, favouring species tolerant of noise.

4.6 A strong correlation (Spearman's $\rho > 0.89$) was found between A-weighted and CI-weighted levels across 40 urban/suburban sites. The authors concluded that for continental-scale biodiversity mapping, A-weighting may be acceptable, but for local studies near flight paths, CI-weighting better reflects species-specific communication interference.

4.7 **Waddington et al** reported on developments in managing the ecological impacts of noise on wildlife habitats for sustainable development. The authors are from the University of Salford, UK, and the paper summarises the content and outcomes of a workshop at the University of Salford in December 2022 and focused on the development of a UK network on anthropogenic noise impact assessment in wildlife. This study aims to identify key knowledge gaps and enable initiatives to advance assessment of the ecological impacts of anthropogenic noise on wildlife.

4.8 Most studies on the effects of noise on wildlife are short-term and do not fully consider how noise affects different seasons or life stages. New methods and tools are needed to study the soundscapes of wildlife habitats and assess the impacts of anthropogenic noise to better understand how noise affects wildlife populations and communities. The authors explain that the long-term effects of chronic noise exposure on wildlife populations and communities are not well understood. This is a significant knowledge gap, as chronic noise exposure can have a variety of negative impacts on wildlife, such as reduced population sizes and diversity. Most studies on the ecological impacts of environmental noise have focused on traffic noise. However, other noise sources, such as industry, construction, and aircraft, also have the potential to impact wildlife. The authors stress the need for more research is needed on the effects of these different noise sources on wildlife.

4.9 Following the focus group (N = 23) held at the first "Habitats workshop" at the University of Salford in December 2022, a feedback form was sent to participants to collate expert opinion from industry, academia and government on knowledge gaps and prioritise research questions to be addressed. The identified knowledge gaps in anthropogenic noise impact assessment for wildlife were summarised:

1. Assessment methods: More robust and reliable assessment methods are needed.
2. Classifiers and indicators: better classifiers and indicators for acoustic biodiversity and sound quality are needed.
3. Applied AI: AI algorithms need to be developed and applied to improve the classification and grouping of species, organisms, and types of noise.
4. Equipment and sensors: new equipment, sensors, and tools need to be developed that will minimise the need for human presence within investigated habitats.
5. Experiments with animals: More research is needed on the hearing capacities of different species and the differentiation between chronic, acute, direct, and indirect impacts of noise.
6. Species hearing: More research is needed on how different species hear and the noise thresholds for the animals' health and well-being.
7. Impacts: More research is needed to investigate the potential impacts on a wider range of species, their reaction, hearing thresholds, and behaviour, and to verify the effects of long-term exposure.

4.10 Based on the results of this study, recommendations for future research on managing the impacts of anthropogenic noise on wildlife were given:

- Assessment methods: develop and validate more robust and reliable assessment methods.
- Classifiers and indicators: develop and validate better classifiers and indicators for acoustic biodiversity, sound quality, and a wide range of species and organisms.
- Applied AI: Develop and apply AI to improve classification and grouping of species, organisms and types of noise.
- Equipment and sensors: Develop new equipment, sensors and tools that will not influence the investigated habitat.

- Experiments with animals: Conduct more experiments with animals to investigate their hearing capacities, and the differentiation between chronic, acute, direct, and indirect impacts of noise.
- Species hearing: Conduct more research on how species hearing varies across taxa and what the appropriate noise thresholds would be from the perspective of the animal's health and wellbeing.
- Impacts: Conduct more research to investigate the potential impacts on a wider range of species, their reaction, hearing thresholds and behaviour, and to verify the effects of long-term exposure.
- Impact assessment: Investigate different approaches adopted on impact assessment, such as direct and indirect impact, as well as dose-response in the context of both acute and chronic noise exposure.

4.11 The authors concluded that this work is an important contribution to the field of knowledge of the effects of anthropogenic noise on wildlife. They stress the need to develop a better understanding of the impacts both in the short-term and long-term. This includes differentiating between chronic, acute, direct, and indirect impacts. They suggest that findings from this workshop will help to inform future research and policy on the assessment and mitigation of the ecological impacts of anthropogenic noise.

4.12 **Nelson-Olivieri** et al published a paper on the consequences of inequitable noise for urban wildlife. This study consisted of two parts; the first was a spatial analysis of how urban noise correlates with the distribution of urban zoning in the US, and the second part which was a literature review of the effects of noise on wildlife in urban landscapes. Most studies of noise impacts on urban wildlife occurred in North America, followed by Europe.

4.13 In the literature review, the authors found vocal behaviour to be the most studied biological response to noise, followed by population-level responses and physiological responses. Birds were the most frequently studied taxa (comprising 84% of papers in the review), but they observed an increase in the number of studies on other taxa in recent years. Environmental and transportation noise were the most studied noise categories, and the effects of these two chronic noise categories on vocal behaviour comprised the majority of studies that were reviewed. Only four aquatic studies were included in the review.

4.14 The authors found that urban noise ranging from 23-113 dB was associated with changes at the ecosystem, population, and species level, including changes to animal physiology, fitness, and multiple behaviours (i.e., vocalisation, vigilance, movement, mating, and foraging), with physiological responses being exhibited over the widest range of noise levels. Noise levels below 50 dB still elicited changes in vocalisation, population metrics, physiology, fitness, and whole ecosystem metrics. Multiple bird studies found evidence that noise levels ranging from 23 to 93 dB were associated with changes to abundance and richness, community composition physiology, reproduction, mating behaviours, vocalisation characteristics, vigilance, and foraging behaviours. Studies of terrestrial mammals found changes in abundance and vocal, vigilance, and foraging behaviours at noise levels between 38 and 80 dB.

4.15 It is explained that many responses to noise involved reduced biodiversity and altered acoustic diversity. Seventy-two percent of population-level studies reported reduced abundance or occurrence of wildlife with elevated noise exposure, and 93% of vocalisation studies reported altered vocal behaviour. The authors conclude that this study provides evidence that noise is inequitably distributed in cities across the US, and that inequitable noise may drive complex biological responses across a diversity of urban wildlife.

4.16 **CAP 2527** Habitats Regulations Screening Report was published in 2023 on behalf of the Civil Aviation Authority (CAA) and included a Habitats Regulation Assessment (HRA) Screening Report for the Airspace Change Masterplan for the (UK). The masterplan is a single co-ordinated implementation plan for airspace changes in the UK up to 2040 to upgrade the UK's airspace and deliver the objectives of airspace modernisation at a system level. Changes in where aircraft fly over the UK may have consequential environmental impacts, including noise levels on the ground, greenhouse-gas emissions, and local air quality. As part of this report a literature review was conducted on disturbance to birds, sea mammals and bats due to aircraft overflight.

4.17 For breeding birds, responses may be altered due to aircraft noise for behaviours displayed when trying to attract a mate (e.g., altering the timing of main singing periods), showing elevated levels of stress hormones, and in overall falls in productivity (including through nest abandonment). The review explains that changes in song activity could lead to increased energy expenditure and therefore reduced fitness of individuals and reduced rate of reproduction.

4.18 They cite differences between birds depending on the situation, suggesting that the effect of aircraft noise will differ between species, distance from the runway, habitat structure and flight schedule. The authors cite different sound levels associated with behavioural responses of breeding birds, for example with Brown (1990) reporting behavioural responses in crested terns between 65 dBA and 95 dBA, but with strong responses (preparedness to fly or flying off) restricted to exposures over 85 dBA). Harlequin ducks began to show behavioural changes when noise levels exceeded 80 dBA from military jets flying between 30 to 100m (around 100 to 330ft) above ground level (Goudie & Jones, 2004). The birds disturbed by overflight typically looked up or changed position on the nest but did not leave the nest in response to aircraft. There was no difference in nesting success attributable to differential levels of aircraft overflight. Research on the altitude of overflights and behaviour of breeding birds revealed mixed findings.

4.19 Wintering and migratory birds may be disturbed by aircraft overflight causing a reduction in foraging time and increased energy expenditure. The literature tends to report findings of disturbance with regards to sound levels or aircraft altitude, or both. A study by Conomy et al concluded that across all species observed, 1.4% of their time was spent reacting to aircraft, and that only 2% of the birds surveyed were disturbed at all by low-flying military aircraft.

4.20 Flights below 500m and up to 1.5km away (lateral measurement) often elicited flight responses from brent geese, with low, slow flying aircraft and helicopters being reacted to most frequently. The review includes data that suggests that small, slow and low flying aircraft are responsible for greater levels of disturbance than other types of over-flight. This has also been supported in the literature.

4.21 The authors include specific monitoring results at Heathrow Airport. "At Heathrow, the Southwest London Waterbodies Special Protected Area is located approximately 1km from the airport boundary and is directly overflown hundreds of times per day (dependent on wind direction). Over the course of two winters 9,240 overflights of waterbodies located between 1 and 5km from the airfield were monitored. Of these only 82 elicited disturbance responses from wildfowl despite noise levels reaching 88 dB and aircraft (including large models such as Boeing 747-800 and Airbus A-380) at altitudes of between 300 and 900m. These disturbances were caused mainly by unusual low-level manoeuvring by large aircraft. It is also notable that most of the bird disturbance in the area around Heathrow was due to other types of human activity (e.g., dog walking, jogging etc.)."

4.22 The report discusses the potential for aircraft noise impacting sea mammals; with those spending time on land at most risk (e.g., common and grey seals). Seal populations are regularly monitored and counted using small fixed-wing aircraft and helicopters. It is suggested that due to the lack of observed effects during this process, sea mammals are not likely to be impacted by overflights.

4.23 Research on the effect of overflights on bats is mixed, with some studies suggesting no effects of aircraft noise, and some showing reduced foraging behaviour.

4.24 **Terray et al** published a systematic map update on the evidence for the impacts of airborne anthropogenic noise on wildlife. In 2020, Sordello et al mapped the literature on the impacts of anthropogenic noise on wildlife up to 2018. Since then, research on this topic has grown significantly, and to reflect this, the authors presented an updated systematic map to include studies on airborne noise published to 2023. 863 studies (1972-2023) on the impacts of airborne anthropogenic noise (ANN) on wildlife were included.

4.25 The review focused on terrestrial and semi-aquatic species, excluding underwater noise, and included transportation (road, rail, aircraft), urban, recreational, military, recreational, and industrial noise sources. The main outcomes assessed were behaviour, communication, reproduction, physiology, and community-level effects.

4.26 Aircraft noise is part of the transportation category, which is the most studied source of ANN (43% of studies), followed by urban noise (24%). Most studies were conducted in the USA (226 studies), followed by Canada (52 studies), Australia (40 studies) and Brazil (38 studies). Birds are the most studied taxonomic group (64%), followed by mammals (22%), with behaviour (27%) and vocal communication (25%) being the most studied outcomes. The main impacts of ANN on wildlife were found to be:

- Auditory masking: Aircraft noise can mask biological signals, reducing detection of predators or mates.
- Behavioural changes: Increased vigilance, avoidance of noisy areas, and altered time budgets (less foraging, more stress).
- Communication interference: Birds and mammals may shift vocal frequencies or increase amplitude to overcome masking.
- Reproductive effects: Disruption of mating calls and nesting success, especially in birds.
- Community-level impacts: Potential reduction in species richness and changes in habitat occupancy near airports or flight paths.

4.27 The authors discussed the knowledge gaps currently present in this area, such as the need for more studies in Africa and Central Asia. Limited research exists on the long-term effects on species diversity and functional traits. There is also limited research on the impacts on reptiles, insects, and arachnids. Military and recreational aircraft noise in remote ecosystems are also understudied.

4.28 The authors conclude by proposing three areas of research for future systematic reviews:

(1) What is the impact of anthropogenic noise on mammals’ behaviour?

(2) What is the impact of anthropogenic noise on birds’ reproductive success?
(3) What is the impact of anthropogenic noise on species richness and diversity?

4.29 The **European Environment Agency** (EEA) published a summary of the impacts of environmental noise on biodiversity, which included a diagram of the mechanistic pathways involved in the impact of anthropogenic noise on wildlife. This is reproduced in Figure 1:

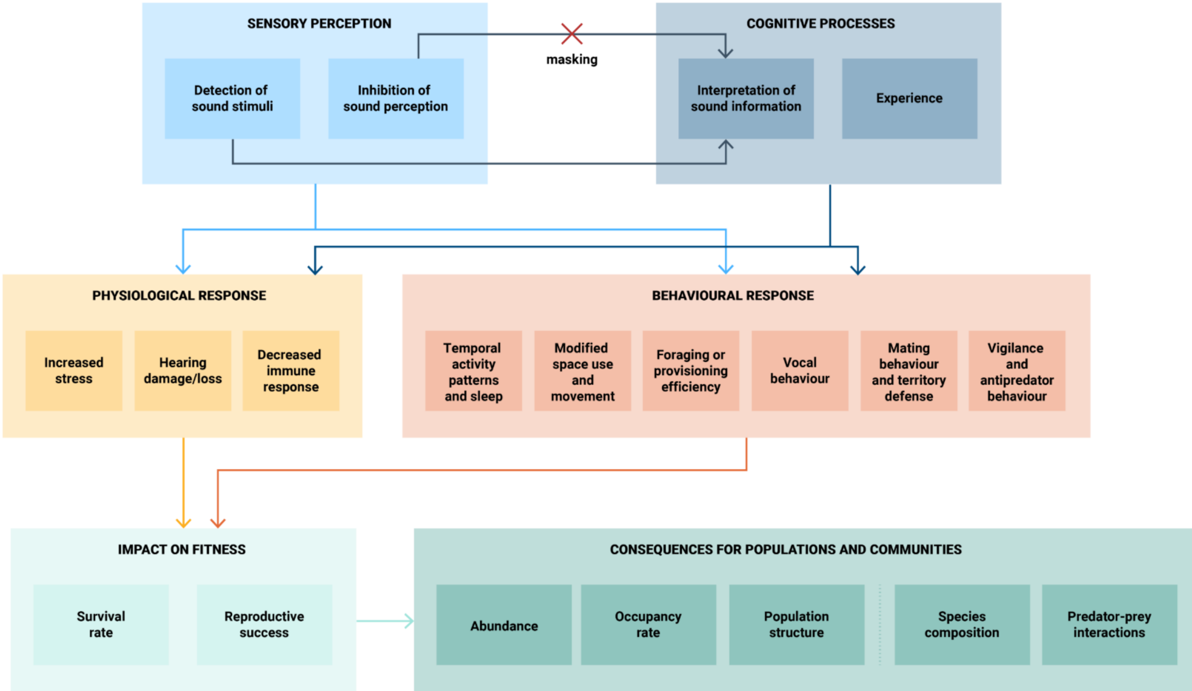


**Figure 1:** mechanistic pathways involved in the impact of anthropogenic noise on wildlife (reproduced from the European Environment Agency website).

4.30 The summary highlights that noise pollution impacts biodiversity, disrupting species' behaviour, physiology, habitat use, and ecosystem functioning, and that transportation noise (roads, railways, aircraft) is a major contributor.

4.31 EU legislation (Environmental Noise Directive) focuses mainly on human health, but other policies (e.g., Marine Strategy Framework Directive, Birds and Habitats Directives) address biodiversity impacts. For marine environments, underwater noise from human activities causes stress and behavioural changes in marine species, especially whales and dolphins. The EU sets threshold values for underwater noise under the Zero Pollution Action Plan.

4.32 In terrestrial environments, nearly 20% of EU Natura 2000 protected areas experience transportation noise above 55 dB, which is deemed harmful to wildlife, and the Environmental Noise Directive (END) focuses on human health, rather than wildlife. Other relevant policies for impacts of noise on biodiversity include: the Birds Directive, Habitats Directive, Biodiversity Strategy for 2030, Nature Restoration Law, Green City Accord, and Green Infrastructure.

4.33 Research projects such as AquaPLAN (aquatic biodiversity) and PLAN-B (terrestrial biodiversity) aim to reduce noise and light pollution impacts. The AquaPLAN project, headed by the University of Pisa, is a four-year (2024-2027) EU-funded research initiative under the Horizon Europe programme, focused on understanding and managing the combined impacts of light pollution (Artificial

Light at Night - ALAN) and anthropogenic noise on aquatic biodiversity across European waters.

4.34 The aim of AquaPLAN is to quantify how light and noise pollution affect aquatic ecosystems (marine, freshwater, and estuarine), and to develop empirically sound strategies to monitor, prevent, and mitigate these impacts. Critical knowledge gaps will also be addressed by creating richer datasets and management tools for biodiversity protection.

4.35 PLAN-B: Tackling noise and light pollution for a sustainable tomorrow, is a sister project to AquaPLAN, co-ordinated by the University of Ghent, and also runs between 2024 and 2027. The aim is to understand and reduce the impact of ALAN and noise pollution on terrestrial biodiversity and ecosystems. It is intended this work will enable a pathway to be formed towards meeting the EU and international biodiversity targets.

Chapter 5
# Summary

5.1 This report is an update to CAP 2517 (2023) and reviews recent findings (2023-2025) on how aircraft noise affects biodiversity, including birds, mammals, amphibians, and ecosystems. It has highlighted physiological, behavioural, and ecological impacts of noise, as well as conservation implications.

5.2 In birds, aircraft noise can cause physiological stress as measured by corticosterone (CORT) in feathers. Some species near airports exhibited elevated stress hormones, especially low-frequency singers, suggesting chronic stress can impair breeding and survival. Golden Eagle nestlings near airports showed higher stress hormone levels, indicating noise as a significant stressor. Chronic exposure may impair growth and immunity.

5.3 Behavioural changes include altering song frequency and amplitude to overcome noise masking, increasing energy expenditure. Persistent changes in vocal patterns affect mate attraction, territory defence, and predator detection. Noise can lead to nest abandonment, reduced productivity, and altered timing of singing periods. Surveys near airports suggested reduced species richness and density on flight days, with avoidance of high-noise zones and altered habitat use.

5.4 Aircraft noise disrupts frog communication during choruses, reducing call rates and altering acoustic traits. This affects mate attraction and reproductive success, with potential long-term impacts on population viability.

5.5 Conservation and policy recommendations in the studies included in this report include implementation of buffer zones and regulation of flight altitudes over sensitive habitats. Utilisation of sound mapping and propagation modelling in planning, with the scheduling of flights to avoid critical breeding periods. The promotion of quieter aircraft technologies and noise abatement procedures. Finally, the integration of biodiversity considerations into Environmental Impact Assessments (EIAs) for airport projects.

5.6 Anthropogenic noise, including aircraft noise, and the impact on biodiversity is an area of research that continues to grow rapidly, with an-ever increasing responsibility to the environment and natural world balanced with the growth of air transport. The increased use of technologies such as drones and UAS, with their unique noise profiles will also require an understanding of noise impacts on wildlife and ecosystems to protect them from adverse effects.

Chapter 6

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