

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

Sound, noise and vibration

Sound, noise and vibration methodology, assumptions and
assessment (SV-001-000)

Annex F - Effects of noise on animals

Contents

1	Introduction	1
2	Review of the effects of anthropogenic sound on UK fauna	1
3	Review of the effects of sound on livestock	4
4	Potential effects arising from the Proposed Scheme	4

1 Introduction

1.1.1 The assessment of the likely impacts, effects and significant effects of airborne noise on animals are reported as necessary in the relevant Volume 5 appendices:

- Agriculture, forestry and soils (Volume 5: Appendix AG-001-001 to Appendix AG-001-005); and
- Ecology (Volume 2 Community area reports¹).

1.1.2 This Annex provides a discussion of the available information regarding the effects of noise, and more specifically noise arising from high speed railways, on fauna. The manner in which this information has been applied to the identification of potentially significant effects associated with the Proposed Scheme is also discussed.

2 Review of the effects of anthropogenic sound on UK fauna

2.1.1 Studies on the effects of sound from transportation infrastructure on fauna are predominantly for highways rather than rail infrastructure, whilst much research from the United States (US) is based upon studies considering overflights of military aircraft. Of the published research, studies are dominated by birds and on behavioural impacts rather than on physiological effects or assessment of physical fitness or community level effects (such as conservation status). Conclusions are often limited because:

- there are confounding disturbance factors – the visual effect of low-flying aircraft in the wild may outweigh the auditory effect;
- noise levels seldom are quantified – most studies adequately described the source of noise and the animal response, but the actual noise levels on the ground were unknown or roughly estimated; and
- observers are not trained in acoustics – levels, frequency content, duration often not reported.

2.1.2 A recent Defra study² concluded that a strong evidence base does not exist regarding the potential impact of anthropogenic noise on (non-marine) UK Priority Species and Species of Principal Importance. The report states that:

'Definite conclusions could be made only about the reed bunting (*Emberiza schoeniclus*), which exhibits shifts in song frequency in response to road traffic noise. It is also likely that foraging in brown long-eared bats (*Plecotus auritus*), singing in European robins (*Erithacus rubecula*), house sparrows (*Passer domesticus*), starlings (*Sturnus vulgaris*) and bullfinches (*Pyrrhula pyrrhula*), and the behaviour of common toads (*Bufo bufo*) are affected by road traffic noise to some degree'.

¹ See Environmental Statement Volume 2, Community area reports

² Radford, A.N., Morley, E.L. & Jones, G. (2012) The effects of noise on biodiversity. Defra Report NO0235

- 2.1.3 Most studies on birds have addressed the impact of road traffic, with song frequency shifts a common finding at high traffic volumes and sound levels, song frequency shift serving as a potential proxy for fitness. Even so, it is not known that this affects long term population viability. There is much less information on terrestrial mammals, which are underrepresented in published literature. For UK Priority Species and Species of Principal Importance, there are direct studies on badger (*Meles meles*), a water vole (*Arvicola* sp.)³ and Daubenton's bat (*Myotis daubentonii*)⁴. In relation to bats, the Defra report goes on to state:
- 2.1.4 'Assessments of the impact of road traffic noise on a species of gleaning bat (the greater mouse-eared bat (*Myotis myotis*)) represent some of the best work on the influence of anthropogenic noise in mammals^{5, 6}. Rather than using echolocation for the detection and localisation of prey (echolocation is still used for orientation), this species listens for prey-generated sounds and gleans food items from the ground or other substrate. These bats avoid foraging when exposed to playback of road traffic noise, but when noise is unavoidable they show reduced foraging efficiency. Greater mouse-eared bats use the same foraging strategy as the brown long-eared bat^{7, 8}. It can be inferred therefore that foraging efficiency in this species is likely to be influenced by the presence of road traffic noise. In contrast to gleaning bats, echolocating bats appear to be at relatively low risk of direct impacts of anthropogenic noise⁹. Audiograms indicate that the best frequencies of these bats are high above the dominant frequencies of the main sources of anthropogenic noise (road traffic, aircraft).'
- 2.1.5 Published studies for reptiles, amphibians, fish and invertebrates are very limited. For reptiles, studies on the sand lizard indicate no behavioural responses observed above 8 kHz; the low frequency susceptibility of reptiles may mean this group is vulnerable to road traffic and other similar sources for which low frequencies are dominant. Studies on amphibians show variable responses with some species showing plastic responses in calling behaviours and others which either do not do so, or are unable to do so. For the common toad, best frequencies are below 2kHz, within the dominant range of most studied anthropogenic noise sources; in response to white noise, the common toad has been shown to demonstrate increased locomotion and escape behaviours¹⁰.
- 2.1.6 There is very little knowledge on the impact of anthropogenic sound on terrestrial invertebrates, and the Defra 2012 report identified no direct studies within the UK and only one paper found worldwide. The hearing sensitivity and capability of the vast majority of invertebrate species remain unknown. Crickets and grasshoppers

³ Iglesias, C., Mata, C. & Malo, J. E. (2011). The influence of traffic noise on vertebrate road crossing through underpasses. *AMBIO* 41, 193-201

⁴ Shirley, MDF et al (2001). Assessing the impact of a music festival on the emergence behaviour of a breeding colony of Daubenton's bats (*Myotis daubentonii*). *Journal of Zoology (London)* 254, 367-373

⁵ Schaub, A., Ostwald, J. & Siemers, B. M. (2008). Foraging bats avoid noise. *Journal of Experimental Biology* 211, 3174-3180

⁶ Siemers, B. & Schaub, A. (2011). Hunting at the highway: traffic noise reduces foraging efficiency in acoustic predators. *Proceedings of the Royal Society B*. 278, 1646-1652

⁷ Swift, S.M. & Racey, P.A. (2002). Gleaning as a foraging strategy in Natterer's bat *Myotis nattereri*. *Behavioural Ecology and Sociobiology* 52, 408-416

⁸ Siemers, B. M. & Swift, S. M. (2006). Differences in sensory ecology contribute to resource partitioning in the bats *Myotis bechsteinii* and *Myotis nattereri* (Chiroptera: Vespertilionidae). *Behavioural Ecology and Sociobiology* 59, 373-380

⁹ Tressler, J. & Smotherman, M. S. (2009). Context-dependent effects of noise on echolocation pulse characteristics in free-tailed bats. *Journal of Comparative Physiology A* 195, 923-934

¹⁰ Llusia, D., Márquez, R. & Beltrán, J. F. (2010). Non-selective and time-dependent behavioural responses of common toads (*Bufo bufo*) to predator acoustic cues. *Ethology* 116, 1146-1154

(Orthoptera) are considered potentially sensitive to anthropogenic sound though their best frequencies (4-20kHz) may be above that of the dominant frequencies for transportation noise.

- 2.1.7 A review of existing research¹¹ by Hanson identifies reported effects of noise upon different animals, including interference with communication, masking predation, startle and fright, along with other physiological effects. Hearing acuity differs significantly between species and consequently no uniform frequency weighting has been established to best evaluate response. In this absence, the A-weighted sound pressure continues to be used and a number of studies are cited using various noise sources which suggest that levels of around 100 dB are associated with an observable effect for disturbance in domestic and wild birds (effects such as accelerated hatching, nest abandonment and panic responses), domestic animals (reduction in cattle milk production, changes hormonal composition in swine) and startle/panic effects in terrestrial mammals.
- 2.1.8 Studies specifically investigating the effects of sound from high speed rail and other rail transport are few but it is important to note that high speed train pass-by have a different signature to sound from heavily used highways where the sound levels are more continuous and more likely to result in masking and communication interference effects than startle or panic effects. There are however some similarities between the characteristics of noise arising from high speed rail and sub-sonic low flying aircraft, including rapid onset rates, high maximum sound pressure levels and spectra dominated by low frequencies. It is however acknowledged that high speed train pass-by are more regular, fixed in terms of route and more consistent in terms of signature, so that habituation may be more likely to occur than for irregular and less predictable over-flights by aircraft.
- 2.1.9 Hanson suggests that the SEL, which accounts for both sound pressure level and duration of the event, is the most useful predictor of responses in both wildlife and domestic animals. SEL can be described as the sum of the sound energy over the duration of a noise event normalised to a 1 second reference period.
- 2.1.10 Some of the research studies indicate that some animals habituate to noise after several repetitions of exposure. Previous exposure to noise levels below 100 dB served to eliminate panic among turkeys, and swine showed initial alarm followed by indifference to aircraft noise greater than 100 dB(A).
- 2.1.11 With regard to the effects of noise on horses, the International League for Protection of Horses issued advice in relation to the Airdrie-Bathgate Railway Improvements Bill¹² which indicated that horses usually became habituated to repeated noise including that from passing trains, although it was acknowledged by the Promoter of the scheme that there may be a short period of adjustment.
- 2.1.12 Based on the preliminary indications identified in these studies regarding the most appropriate descriptor, threshold levels for disturbance and habituation characteristics of a small number of species, the US Department of Transportation,

¹¹ Hanson, CE (2007) High speed train noise effects on wildlife and domestic livestock. Proc IWRN 9, 2007

¹² <http://www.parliament.scot/parliamentarybusiness/PreviousCommittees/15387.aspx> Committee Report reporting the findings of the Scottish Parliament Committee hearings into Airdrie-Bathgate Railway Improvements Bill, and the Environmental Statement submitted with the Chiltern Railways (Bicester to Oxford) Improvements Order application (December 2009)

Federal Railroad Administration (FRA) has identified interim criteria for identifying the potential impact of high speed rail noise on animals in wilderness and farming areas.

2.1.13 The FRA interim criteria¹³ have been defined as follows:

- noise metric – A-weighted sound pressure level (dB(A));
- noise descriptor –SEL;
- threshold for impact – 100 dB(A); and
- habituation – no general criterion (insufficient information on species specific responses).

2.1.14 It should be noted that these criteria are based on responses observed in birds and mammals only. Criteria are not yet fully developed to the point where dose-response relationships can be fully described for different animal species.

3 Review of the effects of sound on livestock

3.1.1 In their second Special Report of Session 2015-16, the House of Commons Select Committee on the High Speed Rail (London – West Midlands) Bill requested that HS2 Ltd undertake a study to understand how livestock might be affected by the operation of HS2 Phase One. HS2 Limited agreed to undertake the requested study and the findings are presented in report Noise effects on Livestock¹⁴. The report identifies an additional screening criteria for HS2 train sound levels at an animal’s ear:

- Daytime 70 dB $L_{pAeq, 16hour}$;
- Night-time 60 dB $L_{pAeq, 8hour}$ and
- During a train pass-by 90 dB L_{pAFmax} ¹⁵

4 Potential effects arising from the Proposed Scheme

Ecological receptors

4.1.1 Having considered the foregoing literature, the approach to assessment of noise effects on fauna arising from operation of the Proposed Scheme has been developed on the basis of the FRA interim criterion¹⁶. A screening distance equivalent to SEL 100 dB(A) has therefore been used to identify relevant ecological species along the route which may potentially be subject to significant adverse effects.

¹³ Federal Railroad Administration (2012), High-speed ground transportation - Noise and Vibration Impact Assessment. U.S. Department of Transportation

¹⁴ HS2 Ltd (2017) *Noise effects on Livestock* (Issue 2), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/590162/Noise_Effects_on_Livestock.pdf

¹⁵ Where the animal is habituated to the source then this screening criterion is not applicable

¹⁶ Federal Railroad Administration (2012), High-speed ground transportation - Noise and Vibration Impact Assessment. U.S. Department of Transportation

- 4.1.2 For a 400m high speed train (source sound level as defined in Annex D of this appendix) travelling at a speed of 360kph and in the absence of natural or man-made wayside barriers, the SEL 100 dB(A) contour lies at a distance of approximately 25m from the track. For lower speed sections of the route, or where wayside features reduce the level of sound, this distance is reduced. Consideration of the FRA guidance would suggest that adverse effects on relevant wildlife species are less likely to occur beyond this distance.
- 4.1.3 Relevant ecology receptors along the route were identified within the screening distance from the Proposed Scheme. Consideration was then given to the line speed and the presence of wayside barriers at that location in order to confirm whether the SEL 100 dB(A) criterion would be exceeded.
- 4.1.4 The assessment of effects is detailed within the relevant Volume 2: CA report, or Volume 5: appendix, taking in to consideration relevant factors for each specific receptor, such as sensitivity and value of species.
- 4.1.5 No specific, separate approach has been defined for the assessment of construction sound. Effects arising from construction noise are likely to be temporary and reversible and more detailed assessment is likely to be necessary only for particularly sensitive receptors such as sites of special scientific interest (SSSI) designated for waterbirds where large numbers of sensitive species could be affected during the construction period.

Livestock

- 4.1.6 In conjunction with the Agriculture and land use assessment, livestock receptors have been identified and predicted operational airborne noise levels presented for these locations and assessment
- 4.1.7 Relevant agricultural livestock receptors along the route were identified in conjunction with the Agriculture and land use assessors and predicted operational airborne noise levels are provided in the relevant Volume 5 appendix (SV-002-001 to SV-002-005) and where the additional screening criteria is exceeded then an assessment is provided in the Agriculture and land use section of the relevant Volume 2 Community area reports.
- 4.1.8 No specific, separate approach has been defined for the assessment of construction sound. Effects arising from construction noise are likely to be temporary and habituation is shown to occur reasonably quickly.