ANNOTATED BIBLIOGRAPHY

Editor's Note: The following annotated bibliography, prepared by Kurt Fristrup of the Natural Sounds Program, supplements references listed elsewhere in this issue and may be useful to park managers who are dealing with specific noise issues, as follows:

Overflight effects on birds

The responses of nesting red-tailed hawks (with nestlings) to helicopter overflights (30–45 m [33–49 yd] above ground level, 45–65 km/hr [28–40 mi/hr]) were measured. Nine out of twelve birds flushed at a site with no previous experience with helicopter overflights, versus one out of twelve at a site with a history of exposure. Habituation was inferred, and presumed to reduce the impacts of overflights.

Andersen D. E., O. J. Rongstad, and W. R. Mytton 1993. Response of nesting red-tailed hawks to helicopter overflights. Condor 91(2): 296–299.

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Breeding owls were exposed to helicopter flights and chain saw noise from the ground. The chain saw stimulus evoked more responses than the helicopter flights, despite lower sound levels. The authors suggest this may reflect different sensitivities to these stimuli. Owls showed an alerting response when helicopters were 403 m (441 yd) away (on average), but no response was observed when helicopters were more than 660 m (722 yd) distant. Alerting responses returned to normal levels 10–15 minutes after the trial. Trials that involved close approaches to the nest appeared to decrease food delivery rates. The authors assert that a 105 m (115 yd) protection zone should eliminate flush responses and food delivery rates.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63(1): 60–76.

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For both of the above articles, note that flushing is a relatively coarse measure of response, and it may not be a probable or effective natural response to an aerial threat.

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Four species of ducks exhibited infrequent responses to aircraft overflights in a free-ranging setting. Percentage of time in resting behavior was inversely related to noise exposure, and was the behavioral state that was most susceptible to a response (9 of 14 observations). These findings suggest that aircraft disturbance did not diminish the quality of the study area habitat for waterfowl.

Conomy, J. T., J. A. Collazo, J. A. Dubovsky, and W. J. Fleming. 1998. Dabbling duck behavior and aircraft activity in coastal North Carolina. Journal of Wildlife Management 62(3):1127–1134.

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Captive black and wood ducks were exposed to aircraft overflights and noise from simulated overflights. Black ducks exhibited a rapid reduction in behavioral response upon repeated exposure; wood ducks exhibited a less consistent response, with two groups appearing to become sensitized (increased response with increased experience). Habituation is interpreted has having diminished the impact of overflights.

Conomy, J. T., J. A. Dubovsky, J. A. Collazo, and W. J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management 62(3):1135–1142.

■ ■ ■

Harlequin ducks exhibited decreased courtship behavior for up to 1.5 hours after an overflight, and increased agonistic behavior for up to 2 hours. These were latent responses; the changes in behavior did not appear during or immediately after overflights. The authors note that effects on time-energy budgets may be more severe than might be inferred from short-term behavioral reactions to overflights. They note the probable connection between the latent behavioral responses and a physiological stress response. Peak sound levels for overflights were about 110 dB(A), against ambient backgrounds of 55 and 68 dB(A).

Goudie, R. I., and I. L. Jones. 2004. Dose-response relationships of harlequin duck behavior to noise from low-level military jet over-flights in central Labrador. Environmental Conservation 31(4):289–298.

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These proceedings have several articles of interest. Don Hunsaker's work on gnatcatchers and vireos on military bases in southern California documents decreased reproduction in relation to weekly A-weighted noise exposures. This trend was not statistically significant (measured as a linear regression of eggs laid or fledglings on weekly sound level) due to high levels of variation in the reproductive parameters (and possibly heteroscedasticity).

Effects of noise on wildlife. Conference proceedings, Happy Valley-Goose Bay, Labrador, 22–23 August 2000. Institute for Environmental Monitoring and Research. ISSN 1481-0336.

■ ■ ■

Overflight effects on ungulates

Radio-tagged individuals were found to move significantly farther following a survey helicopter overflight than on control days.

Bleich, V. C., R. T. Bowyer, A. M. Pauli, M. C. Nicholson, and R. W. Anthes. 1994. Mountain sheep (*Ovis canadensis*) and helicopter surveys: Ramifications for the conservation of large mammals. Biological Conservation 70:1–7.

■ ■ ■

The most important factor predicting mountain goat disturbance from helicopter flights was distance. Eighty-five percent of groups that were approached to within 500 m (547 yd) were disturbed, as opposed to 9% of groups that were not approached within 1,500 m (1,641 yd). Seven percent of the flights caused the group to split. One animal was injured while running from the helicopter.

Cote, S. D. 1996. Mountain goat responses to helicopter disturbance. Wildlife Society Bulletin 24:681–685.

■ ■ ■

Probability of fleeing depended on a multiplicative effect of minimum distance to the aircraft trajectory and distance to rocky slopes. Sheep that were closer to rocky slopes were less likely to flee, and moved less distance when they did flee. Distances fled ranged from 15 m to 1.5 km (16 yd to 0.9 mi). Groups were much more likely to interrupt rest than to flee. Resting groups exhibited significant response probabilities at ranges up to 1.5 km (0.9 mi) in some scenarios, and took longer to end vigilance than animals that had been more active prior to the overflight (they did not resume rest within 10 minutes).

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387–399.

■ ■ ■

Disturbance responses were modest for an approach distance of 1 km (0.6 mi), and odds of disturbance increased by 25% for every decrease of 100 m (109 yd) in distance. The length of disturbance response was about 30 seconds, on average.

Goldstein, M. I., A. J. Poe, E. Cooper, D. Yonkey, B. A. Brown, and T. L. McDonald. 2005. Mountain goat response to helicopter overflights in Alaska. Wildlife Society Bulletin 33(2):688–699.

■ ■ ■

This paper includes an anecdotal report of a golden eagle preying on a Dall sheep lamb that was separated from its parent by a helicopter overflight.

Nette, T., D. Burles, and M. Hoefs. 1984. Observations of golden eagle (*Aquila chrysaetos*) predation on Dall sheep lambs. Canadian Field Naturalist 98:252–254.

■ ■ ■

Helicopters caused a notable reduction in foraging efficiency. Disturbance distances were approximately 250–450 m (274–492 yd).

Stockwell, C. A., and G. C. Bateman. 1991. Conflicts in national parks: A case study of helicopters and bighorn sheep time budgets at the Grand Canyon. Biological Conservation 56:317–328.

■ ■ ■

Visitor noise effects

This study documented increased vigilance, decreased foraging rate, and movements away from people. Visitor noise was scored subjectively by the observers. Noise score was more important than the number of visitors in predicting bird response. Noise score was not correlated with the number of visitors. Education and supervision of visitors was suggested as being likely to be an effective mitigation.

Burger, J., and M. Gochfeld. 1998. Effects of ecotourists on bird behaviour at Loxahatchee National Wildlife Refuge, Florida. Environmental Conservation 25:13–21.

■ ■ ■

Community noise

Community noise studies have relied heavily on A-weighted power spectra that are averaged over long intervals (an hour, a day, even a year). The authors note that these measurements typically explain less than half of the variation in responses to noise as measured in surveys. This laboratory study demonstrates that sounds with an identical power spectrum can evoke very different assessments of annoyance. Thus, the relative phases of different frequency components matter in these judgments, not just the amplitudes of these components. The authors also emphasize the importance of experience and the context in which the sound is presented. This finding supports the current NPS practice of obtaining continuous recordings as well as sound level measurements to characterize acoustical conditions in parks.

Fidell S., M. Sneddon, K. Pearsons, and R. Howe. 2002. Insufficiency of an environmental sound's power spectrum as a predictor of its annoyance. Noise Control Engineering Journal 50:12–18.

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Wind energy

This study documents substantial reduction in densities of grassland birds within 80 m of wind turbines (58.2–128.0 males/100 ha [23.6–51.9 males/100 ac]) relative to sites without wind turbines or sites more than 180 m from wind turbines (261.0–312.5 males/100 ha [105.6–126.5 males/100 ac]) in southwestern Minnesota.

Leddy, K. L., K. F. Higgins, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in conservation reserve program grasslands. The Willson Bulletin 111:100–104.

■ ■ ■

Urban noise impacts

This review identifies the variety of changes in bird song that are plausibly related to urban noise, and discusses proximate and

long-term processes of changes in animal communication that may result.

Particelli G. L., and J. L. Blickley. 2006. Avian communication in urban noise: Causes and consequences of vocal adjustment. The Auk 123(3):639–649.

■ ■ ■

This article emphasizes the temporal and spatial variations in noise exposure (in addition to level), as well as the effects of numerous vertical reflecting surfaces (reverberation).

Warren P. S., M. Katti, M. Ermann, and A. Brazel. 2006. Urban bioacoustics: It's not just noise. Animal Behaviour 71:491–502.

■ ■ ■

Park visitor responses to noise

These studies documented responses of visitors to a park near an international airport. Visitors were more annoyed on day 2 than day 1 of the survey: equivalent annoyance required LAeq to be 10 dB(A) higher on day 1 for an equivalent response. The 50% "not acceptable" threshold was crossed at about 50 dB(A) on day 2 and 60 dB(A) on day 1. These tests were repeated with field recordings from day 1 in a subsequent laboratory test. Using LAE (or SEL, which does not divide integrated noise energy by the duration of exposure), the 50% "not acceptable" threshold was crossed at about 80 dB(A). Subsequent correspondence with the authors confirms that the 2004 result is equivalent to the 60 dB(A) finding of 50% "not acceptable" ratings for LAeq on day 1 of the 1999 field study (duration of exposure was approximately 100 seconds).

Aasvang, G. M., and B. Engdahl. 1999. Aircraft noise in recreational areas: A quasi-experimental field study on individual annoyance responses and dose-response relationships. Noise Control Engineering Journal 47(4):158–162.

Aasvang, G. M., and B. Engdahl 2004. Subjective responses to aircraft noise in an outdoor recreational setting: A combined field and laboratory study. Journal of Sound and Vibration 276(3–5):981–996.

■ ■ ■

Evaluations of visual settings and sounds were obtained in field and laboratory experiments. Wooded settings were strongly preferred over downtown street settings. There were strong interactions between scene and sound evaluations. Sounds in wooded settings exhibited a wider range, in terms of enhancing or detracting from the setting. Sounds and the interaction of sounds with site explained 41% of the variation in assessments of site quality. Natural sounds were most preferred. Sounds play a lesser role in determining site quality in urban settings than in wooded settings.

Anderson, L. M., B. E. Mulligan, L. S. Goodman, and H. Z. Regen. 1983. Effects of sounds on preferences for outdoor settings. Environment and Behavior 15(5):539–566.

■ ■ ■

The primary effect of aircraft overflights on visitors is noise. Direct questioning regarding noise is the most effective approach to measuring effects of overflights.

Booth, K. L. 1999. Monitoring the effects of aircraft overflights on recreationists in natural settings. Noise Control Engineering Journal 47(3):91–96.

■ ■ ■

This paper established a high correlation across sites between awareness of noise and annoyance. Very high levels of annoyance were measured from aircraft noise at the Milford Track, which greatly exceeded noise levels then measured at Yosemite and Grand Canyon national parks. This paper notes visitor safety concerns associated with not being able to hear an approaching hazard.

Cessford, G. R. 1999. Recreational noise issues and examples for protected areas in New Zealand. Noise Control Engineering Journal 47(3):97–103.

■ ■ ■

The prevalence of any level of noise-induced annoyance among visitors to several wilderness areas varied between 5% and 32%. Annoyance was more strongly related to noise exposure than the visibility of aircraft or their condensation trails.

Fidell, S., L. Silvati, R. Howe, K. S. Pearsons, B. Tabachnick, R. C. Knopf, J. Gramann, and T. Buchanan. 1996. Effects of aircraft overflights on wilderness recreationists. Journal of the Acoustical Society of America 100(5):2909–2918.

■ ■ ■

Graham, O. J. 1999. Measuring the effects of commercial jet boats on the Dart River on the experiences of recreationists in natural settings. Noise Control Engineering Journal 47(3):104.

Twenty-two percent of visitors reported being annoyed by jet boats, having noticed between four and seven boats. Visitors judged that double this number of boats would ruin their visit.

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There is no apparent relationship between the loudness of sounds and their ranking on an annoyance-pleasantness scale. The three most common annoying noise sources were rowdy people, music, and motorcycles. Mountaineers exhibited a broader range of annoyance-pleasantness ratings than campers, with much higher annoyance ratings for some sounds.

Kariel, H. G. 1990. Factors affecting responses to noise in outdoor recreational environments. The Canadian Geographer 34(2):142–149.

■ ■ ■

Visitor surveys at Grand Canyon, Hawai'i Volcanoes, and Haleakala National Parks were conducted in concert with measurements of noise doses. Annoyance and interference with appreciation of natural quiet and the sounds of nature were the visitor response

measures. The dose-response relationship varied substantially across sites, with visitors at "short hike" sites being more sensitive than visitors at overlooks. Visitors expressed higher levels of interference with appreciation of natural quiet than annoyance, for a given noise dose. Audibility and aircraft noise Leq (average noise energy) were largely uncorrelated for all visitors, suggesting that these may represent independent dimensions of exposure.

Miller, N. P. 1999. The effects of aircraft overflights on visitors to U.S. National Parks. Noise Control Engineering Journal 47(3):112–117.

■ ■ ■

A concise review article whose findings could be applied to the effects of transportation noise adjacent to and within parks on park visitor experience.

Ouis, D. 2001. Annoyance from road traffic noise: A review. Journal of Environmental Psychology 21:101–120.

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A visitor survey at Padre Island National Seashore revealed which factors had the strongest potential to interfere with quality of experience. Seven of the top ten factors were related to noise, many of them directly ("loudness," "loud radios"). Fifty-seven percent of respondents indicated that the most appropriate volume level for radios could "be heard only by people within 10 feet."

Ruddell, E. J., and J. Gramann. 1994. Goal orientation, norms, and noise-induced conflict among recreation area users. Leisure Sciences 16(2):93–104.

■ ■ ■

Skiers were negatively affected by snowmobile encounters. Skiers who encountered snowmobiles rated noise impacts more severely than skiers who did not.

Vitterso, J., R. Chipeniuk, M. Skar, and O. I. Vistad. 2004. Recreational conflict is affective: The case of cross-country skiers and snowmobiles. Leisure Sciences 26(3):227–243.

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Park noise exposure and management

A broad review of the issues as perceived by an eminent acoustical expert who has been engaged on this issue for more than 20 years.

Miller, N. P. 2008. U.S. National parks and management of park soundscapes: A review. Applied Acoustics 69:77–92.

■ ■ ■

Another review of the issues, which offers an interesting perspective at an earlier historical period.

Sutherland, L. C. 1999. Natural quiet: An endangered environment: How to measure, evaluate, and preserve it. Noise Control Engineering Journal 47(3):82–86.

■ ■ ■

This survey revealed that 44% of the park units indicated that the 1999 level of overflight activity was either a moderate or a major concern. Thirty-six percent of park units indicated they had received formal or informal complaints about overflight activity from visitors.

Voorhees, P. H., and L. Krey. 1999. Prevalence and severity of overflights on U.S. national parks: Results of the 1998 survey of national park superintendents. Noise Control Engineering Journal 47(3):107–111.

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Wind turbines and off-road vehicles

Wind turbine noise is shown to evoke annoyance at much lower sound exposure levels (measured as an Leq in dB[A]) than aircraft, road traffic, or railways.

Pederson, E., and K. P. Waye. 2004. Perception and annoyance due to wind turbine noise—a dose-response relationship. Journal of the Acoustical Society of America 116:3460–3470.

■ ■ ■

Stokowski, P. A., and C. B. LaPointe. 2000. Environmental and social effects of ATVs and ORVs: An annotated bibliography and research assessment. School of Natural Resources, University of Vermont, Burlington, USA. Available from http://www.cccofvt.org/wp-content/uploads/2009/02/uvm-atv_nov20_final1.pdf.

Ouren, D. S., C. Haas, C. P. Melcher, S. C. Stewart, P. D. Ponds, N. R. Sexton, L. Burris, T. Fancher, and Z. H. Bowen. 2007. Environmental effects of off-highway vehicles on Bureau of Land Management lands: A literature synthesis, annotated bibliographies, extensive bibliographies, and Internet resources. USGS Open-File Report 2007-1353. Available from http://www.mesc.usgs.gov/products/publications/22021/22021.pdf.

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Recreation ecology

This annotated bibliography refers to several studies addressing noise impacts to visitors.

Leung, Y.-F. 2005. Recreation ecology and visitor impact research—An annotated bibliography. Final Report. USDA Forest Service, Rocky Mountain Research Station. Available from http://logan-park.org/Dissertation/Articles/yu%20fai%20annotated%20bibliography.pdf.

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