Canadian Acoustics / Acoustique Canadienne 19(5) 3-10 (1991) *Research article / Article de recherche*

NOISE IN RURAL RECREATIONAL ENVIRONMENTS

Herbert G. Kariel
Department of Geography
University of Calgary, Calgary, Alberta, T2N 1N4

ABSTRACT

This study describes and analyses the relationship between people's evaluation of various sounds commonly heard in rural outdoor recreational environments and their measured dB(A) or sound pressure levels. The findings indicate that sound pressure level alone is not a good predictor of annoyance. Rather several complexly interrelated factors relating to the harmonic content of the sounds themselves and those concerning their socio-psychological aspects influence the way in which people evaluate different sounds. Factors relating to the perception and evaluation of sounds in rural recreational environments are discussed and implications for other rural settings are presented.

SOMMAIRE

La présente étude se propose d'analyser le rapport entre l'impression que se font les gens des bruits qui les entourent dans les aires de loisirs en plein air et leur niveau de pression sonore réelle mesurée en décibels (dB(A)). Les résultats indiquent que le niveau de pression sonore, pris tout seul, ne suffit pas à prédire le désagrément qui en résulte. Au contraire, les gens font une évaluation des bruits perçus selon plusieurs facteurs se reliant entre eux de manière complexe et qui ont trait au contenu harmonique de ces bruits eux-mêmes, aussi bien que selon des facteurs ayant trait aux aspects socio-psychologiques de ces bruits. Cette étude examine également les facteurs relatifs à la manière dont les gens perçoivent ces bruits et ce qu'on peut en conclure pour le milieu rural dans un sens plus large.

1. INTRODUCTION

For the many who visit forests, parks, wilderness areas, and similar types of rural or outdoor recreational environments, escaping noise and crowds is one of the significant benefits obtained (Driver, Nash, and Haas 1987). While in these environments individuals are exposed to a variety of natural sounds such as those of birds and streams, the sounds of people talking or setting up camp, and technological sounds, such as those of chain saws or aircraft overflights. Some of these sounds are considered pleasing and satisfying, while others are deemed annoying and distract from the quality of the recreational experience which people seek.

This paper summarizes research on the relationship between individual's evaluation of sounds commonly heard in rural or outdoor recreational environments and their measured sound pressure level (dB(A)) and discusses factors which relate to the perception and evaluation of these sounds. Planning implications for recreational and other rural areas are also presented.

2. PREVIOUS STUDIES

In contrast to the many studies of noise and its annoyance in urban areas, there are relatively few studies about noise in rural or outdoor recreational environments. Harrison (1974b) summarized investigations carried out by the U.S. Forest Service on the effects of noise from off-road vehicles (snowmobiles, motorcycles, dune buggies, and all-terrain vehicles) on operators, bystanders, and forest recreationists. Kariel (1978, 1980) studied campers' evaluation of natural, person-related, and technological sounds commonly experienced at campgrounds. Harrison, Clark, and Stankey (1980), using the Outdoor Recreation Opportunity Spectrum, discussed the unacceptability of noise in Forest

Service recreation areas in general terms. Dailey and Redman (1975), in suggesting guidelines for campsite spacing, described physical and psychological properties of a number of human-related noises often associated with recreation in roadless areas. Dellora, Martin, and Saunders (1984) synthesized their laboratory studies of conflicts between four-wheel-drive users, bushwalkers, picnickers, and other recreationists in Victoria, Australia.

3. METHOD

Data for the reaction of people to sounds are from two studies by Kariel (1978; 1980) in which evaluations were measured by attitude surveys. In the first study, visitors (n=713) to highway-oriented campgrounds in three of Canada's mountain national parks (Banff, Yoho, and Kootenay) were asked to rate a number of nature-, person-, and technology-related sounds commonly heard in these settings, on a five-point, bipolar, pleasantness-annoyance scale, even if they had not experienced them all. Mean values of these ratings were computed and ranked, from the most pleasing (water, campfires, and wind) to the most annoying (car noise, motor or trail bikes, and chain saws) (Table 1 and Figure 1). Questions about such items as trip purpose, type of sleeping accommodation used, ownership of noise-producing items, and experience with particularly annoying sounds were also asked. Additional information, such as time of day effect, was gained in conversation with interviewees following completion of the questionnaire.

Results showed that sounds which are considered most annoying are technology-related, those as acceptable or neutral were usually person-related, and nature-related ones were deemed most pleasing. If a sound was considered annoying, the degree of annoyance was greater in the evening than during the day and greatest at night. The evaluation of pleasing sounds was constant regardless of time of day. Agreement among respondents was greatest with respects to sounds considered pleasant, next greatest for annoying sounds, and least for acceptable ones.

Additional information was provided by analyzing the relationship between the evaluations of sounds and other questions asked of respondents.

– *Purpose of the trip*: Sounds which represent possible conflicts or which might interfere with enjoyment of the trip purpose were considered annoying. Those persons whose major purpose was hiking were more annoyed by person- and technology-related sounds than those who had other trip purposes. Individuals whose primary purpose was camping were less bothered by persons talking, but found sounds from horses and mules annoying; those picnicking were not as bothered by all sounds. Fishermen disliked sounds of pets, which they felt would interfere with fishing and swimmers found the sound of wind unpleasant.

– *Sleeping accommodation*: People who slept in tents were more pleased with natural sounds and more annoyed by person– and technology–related ones, and generally preferred a quieter environment than those in other accommodations.

Table 1. Mean rating of sound sources, from Pleasing (1) to Annoying (5) for persons staying at highway-oriented campgrounds and mountaineers at a mountaineering camp.

Source	Campers	Mountaineers
Water	1.20	1.30*
Campfire	1.32	1.76
Wind	1.40	1.21*
Birds, insects, or other native animals	1.44	1.42
Horses or mules	2.34	2.42
Chopping wood	2.39	2.65
Persons' activities	2.67	3.09*
Persons talking	2.81	3.11
Radio	3.28	4.56*
Pets	3.31	3.84*
Trains	3.53	4.04*
Motorboats	3.75	4.83*
Aircraft	3.78	4.20*
Road or highway traffic	4.00	4.61*
Snowmobiles	4.27	4.61*
Car noise (door slamming, horn blowing, engine running, etc.)	4.29	4.76*
Motor or trail bikes	4.36	4.98*
Chainsaws	4.37	4.48

*Difference between the two groups is statistically significant at $P<0.05$

– *Previous camping experience*: More experienced campers found sounds from radios, trains, motor boats, and cars more annoying than did those who had taken fewer trips.
– *Trip duration*: Length of trip, whether overnight or of several weeks' duration made no difference.
– *Value attached to camping experience*: Those who placed a greater value on camping experience tended to be more pleased with nature-related sounds as well as those associated with camping than were other individuals. They were also more annoyed with sounds from highways and motor or trail bikes.
– *Ownership of noise-producing items*: Those persons who owned a noise-producing item were less annoyed by its sound than were others: pet owners liked the sound of pets, chain saw owners were less annoyed than non-owners by their sound.

Of those respondents who had experienced particularly annoying sounds (N = 487), the most frequently mentioned sounds were person-related (people being raucous or noisy, playing the radio or tape deck); sound of motorbikes, trail bikes, and similar equipment; that of trains; dogs barking; and automobile and traffic noise. Forty six per cent of all respondents had discussed annoying sounds with fellow campers. As was also found in other studies (TRACOR 1969), only a minority, 13%, had discussed annoyances with officials.

Additional data are from Kariel (1980) in which the same procedure for obtaining sound ratings was used in a backcountry area. Participants (n=46) of the Alpine Club of Canada were interviewed at a general mountaineering camp held near Glacier Lake, in Banff National Park. The sound ratings were treated in the same way as in the first study and the ordering was similar for both groups (r_S =0.91, z =3.74) (Table 1 and Figure 1). While mountaineers differed little from highway-oriented campers in their evaluation of nature-related sounds, they rated person-related ones as somewhat less acceptable, and technology-related sounds considerably more annoying. This difference, although not as strong, also showed up when the small

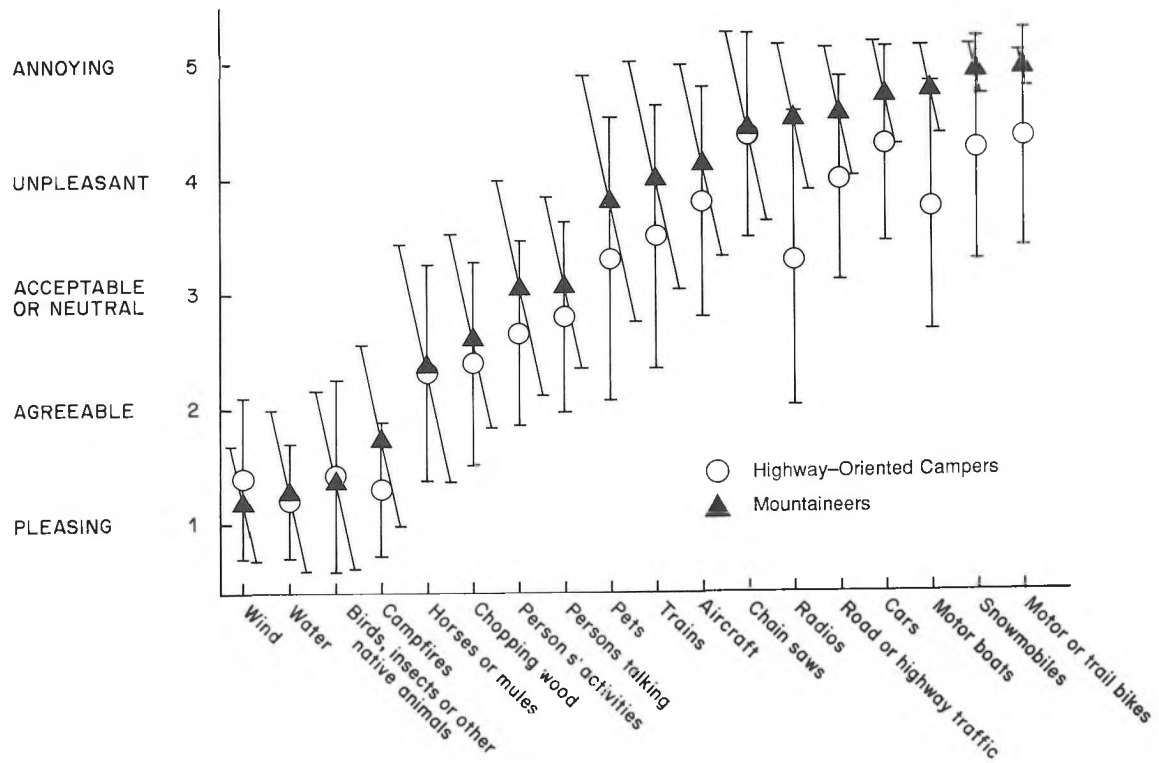

Figure 1. Comparison between highway–oriented campers and mountaineers in their rating of sound sources.

group of highway-oriented campers who had given mountaineering as a trip purpose (n=17) was analyzed. Hence, these differences probably relate to the fact that mountaineers are generally more wilderness purist in their viewpoints and characteristics than highway-oriented campers.

Sound pressure level data were obtained in the field and were supplemented by those reported in other studies (for example: U.S. EPA 1971; Dailey and Redman 1975; Harrison 1974a and Ohlson 1976). Sound pressure level measurements collected specifically for this study were made and recorded using a single channel version with a of 40 dB range for each setting or more than a total range of 140 dB, of the data acquisition system described in Jones and Babott (1977). This system consists of a microphone which picks up the sound, a box containing circuitry which converts the sound into digital form, and a cassette tape recorder for storing the digitized data. The recorded data are then played back via an interface into a computer for analysis and printed out. The printout includes various L_x values, all in dB(A), but only L_{eq} values are reported since L_{eq}, L_{10}, and L_{dn} are all equally good predictors of subjective response and is the accepted current practice (Hall and Taylor 1977; Fidell, Barber and Schultz 1991). A few measurements were made by observing the sound pressure level, as measured by a sound level meter, over a period of time and calculating L_{eq}. Some impact sounds, such as chopping wood were read off a sound level meter, recorded and averaged, a procedure which provides an approximation of L_{50}. The microphone and measuring instrument used was a standard GENRAD 1565-B sound level meter. All readings were taken on the dB(A) scale. Those readers who wish to convert sound pressure level to Sones can apply the appropriate equation.

The microphone or sound level meter was either positioned or, in a few instances, hand-held approximately 1.5m above the ground. The distance from the sound varied with the source, but approximated that of the nearest camper, since it was reasonable to believe that those persons nearest the source and therefore exposed to the higher sound pressure level would evaluate the sound as more annoying.than those at a greater distance. All recordings were taken at campgrounds or in similar settings except for those for a helicopter, which were taken on a mountain slope at an elevation roughly similar to that of the helicopter (2450m, 8,500 ft.) and at a distance of about 3km.

Weather and other environmental conditions were generally good at times of recording. There was no rain, and wind varied from calm to light breeze, except when the sound of wind through trees was specifically recorded. Cloud cover ranged from overcast and scattered clouds to clear. Vegetation varied from grassy areas with shrubbery to open forest, and topography was reasonably level.

4. RESULTS

The sound pressure level of the sources varied considerably, ranging from a low of 22 to 27 dB(A) for those of insects to a high of 83 dB(A) for chainsaws (Table 2). This variation is not only due to the sounds themselves, but also to the distance to the sound source as well as environmental factors. When these sound pressure levels were related to their ranking on the pleasantness-annoyance scale, using the broader categories of the questionnaire, there was no apparent relationship (r=0.20); that is, the level of annoyance appeared to be independent of dB(A) level. Examination of the particularly annoying sounds reported as having been experienced also showed that there was little relationship to sound pressure levels alone.

5. CAUTIONARY COMMENTS

Before discussing findings, some cautionary comments regarding the data on noise levels and the responses given on the questionnaires should be made.

– All sound level values are not directly comparable, since different ones were used in different studies. For example, peak levels were reported in U.S. EPA, Dailey and Redman used L_{50}, and the author used L_{eq} as well as direct readings of peak values.

– Different methods were used to record data, ranging in sophistication from reading a sound level meter directly by eye to a complex system involving analysis of the statistics of the sound levels.

– The duration of the sound samples varied, being quite short for direct sound level meter readings, especially for impact type sounds and longer for continuous ones.

– Distances from sound sources varied among and within studies. Dailey and Redman, for example,used 15.2m (50 ft.), while I tried to use the distance from the sound source to the nearest campsite.

– The sound pressure level of a source may have quite a range, depending upon various factors, such as whether a radio is turned on especially high (full blast), the number of persons in a group and how loudly they sing, whether a helicopter is taking off or flying, a trail bike is being accelerated, or if a wild animal is charging, or merely ambling along.

Table 2. Range of sound pressure level at the observer in dB(A) of various sound sources in rural recreational environments: at different distances, under various environmental conditions, and by different researchers.

83	Chainsaw[a] 15.2m	50-62	Birds, terns and gulls call notes[f]
78	Person yelling[b] 15.2m	50	Crickets[e]
76	Safety whistle[b] 15.2m	49.9	Chopping wood 5m
74	Trail bike[c] 15.2m	48	Wind blowing through trees
73.6	Aircraft, small 100m	48	Conversation[b] 15.2m
73	Snowmobile[d] 15.2m	48	Birds[e]
73	Dogs howling[e]	47.8	Persons talking, taking pictures, etc. 15m
72	Harmonica[b] 15.2m		
>70	Aircraft, small[f] 300-400m	47-48	Creek, small, with rapids 15m
70	Aircraft sight-seeing, Grand Canyon[e]	46.6	Automobile, warming up 30m
68	Helicopter 150m	45.1-55.5	Helicopter, ca. 3km
66-71	Chopping wood 5m	45	Background, lm opposite small rapids of ca.5m wide brook[b]
66	Pounding tent stakes[b] 15.2m		
66	Clattering pans[b] 15.2m	44.9	Birds, crows, call notes 20m
65.1	Motor boat trolling 75m	44.3	Campfire with persons talking 25m
65-68	Persons talking 20m		
64.8	Car door being slammed 10m	44	Radio, playing music 25m
64	Chopping wood[b] 15.2m	43.4	Garbage container being opened and closed 40m
62.0	Wind, fresh breeze blowing through trees		
61.2	Creek, small with rapids 5m	43	Camp stove 5m
60	Singing[b] 15.2m	42.8	Aircraft, small at high altitude
60	Dogs barking[e]	42-52	Road traffic 100m
59.8	Campfire 2m	40-46	Chipmunks 10m
57.5	Diesel generator 50m	39	Squirrel[e]
57	Trail bikes 100m	36.1	Road traffic 100m
55-68	Persons washing dishes, doing camp chores 15m	35.5	Automobile, engine idling 30m
		35	Background, coniferous forest, low wind[b]
54.8	Wind, gusty, with rustling of tree foilage		
53.8	Birds, woodpeckers, call notes 5m	34-41	Birds, chaffinch song notes[f] 30-100m
53.6	Train in distance 1km		
53.0	Persons setting up camp 15m	30.7	Bird flying along lakeshore 15m
52.9	Campfire 5m	30	Background, meadow, low wind conditions[b].
52.9	Birds, woodpeckers, call notes 5m		
52	Radio playing music[e]	30	Wind, rustling of grass and brush
52	Guitar[b] 15.2m	23.4	Background, open mountain slope
51.9	Persons eating and talking 15m	22-27	Insects[f]
50.2	Creek, medium size 15m	16	Background, rim of Grand Canyon[e]

Unless footnoted, sound pressure levels are the author's measurements; L_{eq} in decimals, L_{50} and peak values in whole numbers, and distances are estimates. More than one value for a source indicates measurements were made by different researchers or under different conditions. Distances, where shown, are the author's or as given in the sources.

a) Myles, Hirvonen, Embleton, and Toole (1971) L_{50}.
b) Dailey and Redman (1975) peak values.
c) Harrison (1974a) peak value.
d) Sound rating tag on Bombardier Nordic Safari 503R, at 15.2m (50') and 78dB(A) at wide-open throttle, in accordance with Society of Automotive Engineers regulations J1161 and J192A.
e) U.S.EPA (1971) peak values.
f) Ohlson (1976) L_{50} values.

– There were some differences between the sounds measured and those which were identified on the questionnaire in the attitude survey. Those on the attitude survey included both specific and generalized ones, while the measured sounds were nearly all specific. For purposes of analysis, specific sounds, such as persons talking, were grouped under the generalized sound, persons' activities.
– Questions regarding the duration of sounds were not included in the survey.
– Respondents probably generalized sounds to averages on the basis of past experiences or anticipations of them in the future, and hence did not include consideration of persistence in terms of duration or frequency, or particularly loud ones.

6. DISCUSSION

Despite the limitations and biases which may have been introduced by the items pointed out above, the overall finding that annoyance is independent of dB(A), within the range of sound pressure levels studied, appears to be reasonable in light of the data available and our present understanding of annoyance from noise in outdoor recreational environments.

If sound pressure level alone is not a good predictor of annoyance, how is it related to annoyance and how else can persons' evaluations of noise in rural or outdoor recreational environments be accounted for? It would appear that several complexly interrelated factors relating to the physical characteristics of the sounds themselves and those concerning their socio-psychological aspects influence the way in which people evaluate different sounds.

Regarding the physical characteristics of sounds, transportation and community noise studies have found that sound pressure level is related to annoyance, i.e. higher sound pressure levels are more annoying than lower sound pressure levels (Galloway and Jones, 1974; Kryter, 1985). Although this finding was not born out in this study, I suspect that person- and technology-related sounds would also be deemed more annoying at higher levels.

Sounds of higher-pitch or frequency tend to be more annoying than lower-pitched ones. Also, rhythmic sounds, such as those from engines, as well as those which are irregular or intermittent, are judged to be more annoying than continuous ones, even when other properties are the same (Dailey and Redman, 1975). On the other hand, noises which have a random component, such as those from wind, flowing water, and other nature-related sources, tend to be considered more pleasing.

A number of researchers have pointed to the importance of the socio-psychological or perceived meaning or connotation of a noise (Parry and Parry, 1972; Harrison, 1974b; Dailey and Redman, 1975; Schultz, 1978). When a sound is heard, people interpret, evaluate, and attach meaning and significance to it and also judge its appropriateness for the setting, whether it is potentially harmful or helpful, how it relates to past experience, and the like.

The total experience in the setting is important in judging a sound's appropriateness. If we consider only the source of a sound, a stream for example, we take it out of context. We then ignore the larger scene as well as the activity in which the person evaluating the sound may be engaged.

Sounds which are interpreted as aiding or benefiting an activity are evaluated positively, while those deemed as interfering with or being detrimental to an activity or as being harmful are considered to be displeasing or annoying. Sounds may include noises which interfere with conversation, sleeping, relaxing, or other activity. The thresholds interfering with conversation and sleep seem to be approximately 45 and 35 dB(A) respectively (Kryter, 1985).

As the primary reasons for visiting rural or outdoor recreational environments are to escape the noise of urban areas, enjoy the natural scene, reduce tension, and obtain tranquility or solitude (Driver, Nash, and Haas, 1987), sounds which are felt to interfere with these experiences will be considered as annoying. In this connection it should be mentioned that, since sounds are detectable, and hence identifiable, from great distances and at very low levels, even without registering on a sound level meter, they can be intrusive and provoke reactions.

Expectations and ideas about which sounds are appropriate in a specific environment and at a particular time are also important in determining their annoyance. This helps to explain why people who stay at campgrounds only overnight are more tolerant of noises than those who use them as a destination or for a longer period of time. Although off-road vehicles are not ordinarily heard at campgrounds, it is noteworthy that, where their presence is considered inevitable, as with dune buggies at the Oregon Dunes National Recreation Area, sound pressure levels of 85 dB at 15.2m (50ft.) were considered acceptable (Harrison 1974b). Also, the sound of chain saws, for example, might be considered less annoying in Finland or Sweden where they are seen as a natural part of forested environments.

Instances of preventability or misfeasance, such as when persons have their radio turned on loudly, or are joy-riding a trail bike around a campground, are considered annoying. This reaction is similar to what has been found in transportation noise studies (Galloway and Jones, 1974; Leonard and Borsky, 1974, for example). In transportation studies,instances of misfeasance are considered extra annoying, at the same sound pressure level compared with normally anticipated operation of vehicles, while sounds which have a presumed utility and are infrequent are deemed sub-annoying. In addition, sounds over which persons feel they have no control or which are unpredictable, are considered annoying (Glass and Singer, 1974).

At the same time people will be tolerant of or even pleased with a disturbing sound, at least for a short time period , if they believe that it will aid or benefit an experience or activity, such as the sound of a chain saw used for cutting wood or the sound of a snowmobile or helicopter when it signifies that rescue is on the way.

A number of other items contribute to the annoyance of a sound. Sounds which engender fear, such as those from wild animals, and prior experiences with sounds are also important in determining their degree of annoyance. Persons who have had pleasant experiences with horses find the sound made by them pleasing, while others with less pleasant memories, such as hiking on trails disturbed by them, dislike their sound. The same holds true of sounds made by native mammals, especially bears and by insects, such as mosquitos. Time of day and type of sleeping accommodation also relate to annoyance. For sounds which are considered annoying, the degree of annoyance is greater in the evening than during the day and greatest at night, whereas the evaluation of pleasing sounds is constant regardless of time of day. In addition, I suspect that some sounds will become annoying if they continue for long time periods.

7. IMPLICATIONS

The results of this study as well as others can be used for planning purposes in rural or outdoor recreational environments to enhance the recreational experience of users. It appears to be important to keep the level of human– and technology–related sounds generally low; if possible below the background level of about 15–20 dB(A). In discussing guidelines for planning campsite locations so as to minimize annoyance from noise, Dailey and Redman (1975) suggested that they be located laterally along streams and so as to take advantage of environmental features, such as natural relief and vegetation, but not near lake shores or in meadows. Disturbance from noise may also be minimized by designating different areas for different types of accommodations, such as recreational vehicles, trailers, and tents. Special sections might also be set aside for late arrivals. It would also be desirable to restrict or regulate the use of sound-producing items, such as aircraft overflights, snowmobiles, generators in motor homes, motor boats, and radios, in order to safeguard a recreational milieu. This could be done by legally designating recreational areas as noise-sensitive, limiting noise levels, and making quietness a condition of use. Patrolling campsites and equitable enforcement of regulations is obviously tricky and managers are often hesitant to do so. It would appear, however, that the preponderance of campers would be willing to accept regulations as long as they were reasonable and fairly and impartially administered (Hendee *et al.* 1968). Education concerning the need for low sound levels is probably the most effective way to preserve a quiet atmosphere. Signs such as the ones used in many European cities showing an automobile horn with a red slash through it, might be effective reminders.

If the findings of this study also apply to other rural areas where ambient sound pressure levels are generally low and natural sounds predominate, then nature- and person-related sounds would also be considered pleasing or acceptable. On the other hand, continuous or intermittent technological or mechanical sounds, such as those emitted by compressors and other equipment at gas processing plants, would be deemed annoying even at quite low sound pressure levels or at levels falling within the Alberta ERCB (Energy Resources Conservation Board) directive of between 40 and 56 dB(A) L_{eq}. Such sounds have been considered annoying by persons living near such a plant (Dects, pers. comm.). Annoyance would be aggravated at higher sound pressure levels which occasionally occur. Such exotic sounds are urban-type intrusions into rural settings and interfere with the serenity experienced in them. Since affected individuals would likely express their displeasure and possible frustration more vociferously if little or nothing is done to alleviate annoyance, it would appear wise to restrict such sounds to the immediate vicinity of the source. Other technology-related sounds, such as those of road traffic, farm machinery, or even road construction, would likely be tolerated because they are of relatively short duration or interpreted as benefiting rural residents.

ACKNOWLEDGEMENT

I would like to express my appreciation to the following for their contribution to the research and this paper: F. Babott for designing and constructing the

data acquisition system, writing the computer program and for making suggestions regarding recording and analyzing sounds; the Canada Council and the University of Calgary for research grants; and staff members of the Department of Geography for contributing to the final product.

REFERENCES

Fidell, S., Barber, D.S., and Schultz, T.J. 1991 "Updating a dosage-effect relationship for the prevalence of annoyance due to general transportation noise," *Journal of the Acoustical Society of America,* 89(1):221-233.

Dailey, T. and Redman, D. 1975 *Guidelines for Roadless Area Campsite Spacing to Minimize Impact of Human-Related Noises,* USDA Forest Service General Technical Report PNW-35.

Deets, V., Plant supervisor, Esso Quirk Creek Gas Plant, personal communication.

Dellora, G.B., Martin, B.V., and Saunders, R.E. 1984 *Motorised Recreational Vehicles: Perception and Recreational Conflict,* Environmental Report No. 17, Monash University, Graduate School of Environmental Science.

Driver, B.L., Nash, R. and Haas, G. 1987 "Wilderness Benefits: A State-of-Knowledge Review," in R. C. Lucas, compiler, *Proceedings-National Wilderness Research Conference: Issues, State of Knowledge, Future Directions,* Fort Collins, CO, July 23-26, 1985, USDA Forest Service General Technical Report INT-220, 294-319.

Galloway, W. J. and Jones, G. 1974 "Motor Vehicle Noise: Identification and Analysis of Situations Contributing to Annoyance," in U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *International Congress on Noise as a Public Health Problem,* Dubrovnik, Yugoslavia 1973, Proceedings, 785-803.

Glass, D. C. and Singer, J.E. 1974 "Behavioral Effects and Aftereffects of Noise," in U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *International Congress on Noise as a Public Health Problem,* Dubrovnik, Yugoslavia 1973, Proceedings, 409-416.

Hall, F.L. and Taylor, S.M. 1977 "Predicting community response to road traffic noise," *Journal of Sound and Vibration* , 52:387-399.

Harrison, R.T. 1974a *Motorcycle Noise,* USDA, Forest Service, Equipment Development and Test Report 2428, San Dimas Equipment Development Center, San Dimas, CA.

—1974b *Sound Propagation and Annoyance under Forest Conditions,* USDA, Forest Service, Equipment Development and Test Report 7120-6, San Dimas Equipment Development Center, San Dimas, CA.

Harrison, R. T., Clark, R.N. and Stankey, G.H. 1980 *Predicting Impact of Noise on Recreationists,* USDA, Forest Service, San Dimas Equipment Development Center, San Dimas, CA.

Hendee, J.C., et al. 1968 *Wilderness users in the Pacific Northwest – Their characteristics, values and management preferences,* USDA Forest Service Research Paper PNW-61, Portland: Pacific Northwest Forest and Range Experiment Station.

Jones, H.W., and Babott, F. 1977 *Internoise 77,* "A Multi-Channel Digital Noise Measuring Apparatus for the Measurement of Noise Propagation," Proceedings, B148-154.

Kariel, H. G. 1978 "Evaluation of Campground Sounds in Canadian Rocky Mountain National Parks," revised version of a paper presented at the Annual Meeting, Association of American Geographers, Salt Lake City, UT. April 14-17, 1977.

— 1980 "Mountaineers and the General Public: A Comparison of Their Evaluation of Sounds in a Recreational Environment," *Leisure Sciences,* 3:155-167.

Kryter, K. D. 1985 *The Effects of Noise on Man,* New York: Academic Press.

Leonard, S. and Borsky, P. N. 1974 "A Causal Model for Relating Noise Exposure, Psycho-social Variables and Aircraft Noise Annoyance," in U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *International Congress on Noise as a Public Health Problem,* Dubrovnik, Yugoslavia 1973, Proceedings, 691-705.

Myles, D.V., Hirvonen, R., Embleton, T.F.W. and Toole, F.E. 1971 *An Acoustical Study of Machinery on Logging Operations in Eastern Canada,* Ottawa:Canadian Forestry Service, Department of Fisheries and Forestry.

Ohlson, B. 1976 "Sound fields and sonic landscapes in rural environments," *Fennia,* 148:33-43.

Parry, H.J. and Parry, J.K. 1972 "The Interpretation and Meaning of Laboratory Determinations of the Effects of Duration on the Judged Acceptability of Noise," *Journal of Sound and Vibration,* 20:51-57.

Schultz, T.J. 1978 "Synthesis of social surveys on noise annoyance," *The Journal of the Acoustical Society of America,* 64:377-405.

TRACOR, 1969 *Public Reaction to Sonic Booms,* TRACOR Document T-70-AU-7136-U, Austin: Tracor.

U.S. EPA (ENVIRONMENTAL PROTECTION AGENCY) 1971 *Community Noise,* Washington, D.C.:Office of Noise Abatement and Control, NTID300.3.