

Sound lures for stoats

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ABSTRACT

Stoats are significant predators of New Zealand wildlife. The main method of stoat control at present is trapping, using fresh hen eggs as a lure. Eggs and other food-based lures often become putrefied or dehydrated, and have to be replaced frequently. An electronically produced sound lure, if capable of attracting stoats, could remain active for several months without the problem of decay or dehydration that food-based lures present. The objective of this project was to determine whether recordings of bird and mammal calls would attract captive wild-caught stoats. Analogue recordings of starling, silvereye, and house sparrow distress calls did not attract the stoats, but digital recordings of chick, mouse, and stoat calls did attract the stoats in the first 5 min after playback. Whether the stoats responded to the quality of sound (digital versus analogue recordings) or to the different types of calls (e.g. chick, mouse, and stoat versus starling, silvereye, and house sparrow calls) is unclear because the digital and analogue recordings were not of the same sounds. Further research is required to establish the importance of the quality, type, duration, and frequency of sound to stoats.

© December 1999, Department of Conservation. This paper may be cited as:

Spurr, E.B.; O'Connor, C.E. 1999: Sound lures for stoats. *Science for Conservation 127B*: 25–38.

or in full as:

Spurr, E.B.; O'Connor, C.E. 1999: Sound lures for stoats. Pp. 25–38 in: Department of Conservation 1999: Progress in mammal pest control on New Zealand conservation lands. *Science for Conservation 127*, x + 74 p.

1. Introduction

Stoats (*Mustela e. erminea*) are significant predators of New Zealand wildlife. They contributed to the final extinction of the South Island subspecies of the bush wren (*Xenicus l. longipes*), New Zealand thrush (*Turnagra c. capensis*), and kokako (*Callaeas c. cinerea*), and possibly hastened the decline of the kakapo (*Strigops habroptilus*), takahe (*Notornis mantelli*), and little spotted kiwi (*Apteryx owenii*) (King 1990). Stoat predation is an important factor in the continuing decline of several bird species, including the yellowhead or mohua (*Moboua ochrocephala*), kaka (*Nestor meridionalis*), kakariki (*Cyanoramphus* spp.), and kiwi (*Apteryx* spp.) (McLennan et al. 1996, O'Donnell 1996, Wilson et al. 1998).

The main method of stoat control at present is trapping, using fresh hen eggs as a lure (King 1994). Poison-baiting has also been trialled, using fresh hen eggs injected with either sodium monofluoroacetate (compound 1080) or diphacinone (Spurr 1996, 1998). Other food-based lures and baits (e.g. canned cat-food and dead mice) are also attractive to stoats but rapidly become putrefied, flyblown, or dehydrated, and have to be replaced frequently (Dilks et al. 1996).

Stoats can detect prey by sound as well as smell and sight (King 1990). For example, stoats prey on broods of chicks more frequently, and sooner, than on clutches of eggs, probably due to the greater conspicuousness of chicks compared with eggs (Moors 1983). There are also many anecdotal accounts of stoats attracted to the sounds of prey.

In addition, a subspecies of the stoat, the dwarf 'weasel' (*Mustela erminea muricus*), has been reported to use sound for detecting prey (Willey 1970).

An electronically produced sound lure, if capable of luring stoats into traps or bait stations, could remain active for several months without the problem of decay or dehydration that food-based lures present. Sounds may also attract stoats from greater distances than food-based lures.

A project to investigate sound lures for stoats was started in 1995/96 by I. Flux (Department of Conservation), and continued by Landcare Research in May 1997. Some results from 1995/96 are included in this report.

The objectives of the present report were to:

- Determine whether captive stoats are attracted to recordings of natural prey calls, simulated prey calls, and other sounds from electronic devices.
- Compare trap-catch effectiveness of sound lures versus standard hen egg lures in the field (with assistance from DOC).

2. Methods

2.1 ATTRACTIVENESS OF SOUNDS TO CAPTIVE STOATS

2.1.1 Sounds tested

In the preliminary trial in 1995/96, the distress call of a starling (*Sturnus vulgaris*) from an analogue recording was loaded onto an EPROM (erasable programmable read-only memory) chip. The chip was connected to a small headphone speaker, and could be activated by attachment to a battery to emit sound for about 15 seconds at 2-min intervals.

In 1996/97, EPROM chips were loaded with the distress calls of either a starling, silveryeye (*Zosterops lateralis*), or house sparrow (*Passer domesticus*) from analogue recordings. Again, the chips could be activated to emit sound for about 15 seconds at 2-min intervals.

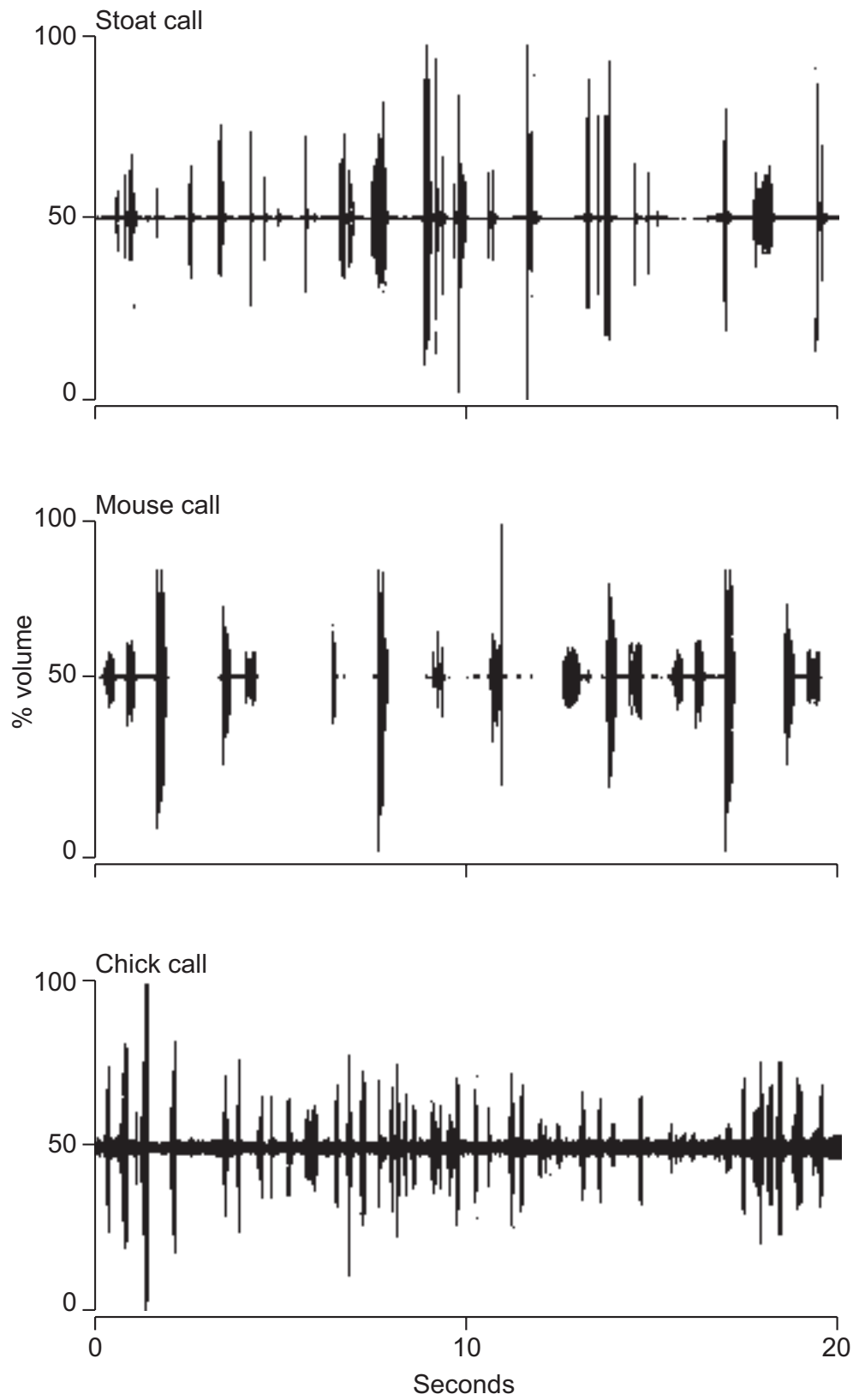
In 1997/98, vocalisations from day-old domestic hen chicks (from a hatchery), a captive mouse (*Mus musculus*), and a captive stoat (both held at Landcare Research animal facility) were recorded onto a high-quality digital minidisc recorder (Sony MZ R30). The chick and mouse calls could be described as contact calls, while the stoat call was a threatening bark (shriek or chirp of Erlinge 1977). The calls were edited on Cool Edit 96 to get the most realistic sound possible and to eliminate background noise. They were then stored as 16-bit, mono, 44 kHz WAV files (Fig. 1). The sounds were amplified and played through a small Sony 'sports' portable speaker for 20 seconds at 30-min intervals.

2.1.2 Evaluation of attractiveness of the sounds

The attractiveness of the sounds to stoats was evaluated using captive wild-caught stoats housed individually in cages (0.7 m × 0.5 m × 1 m) at the Landcare Research Animal Facility. The cages had a thick layer of straw on the floor and a nest box with Dacron bedding. The stoats were fed beef or horse mince, or a dead day-old chick and an occasional hen egg, and had free access to water. For testing, they were individually transferred to a large observation pen (approx. 10 m × 5 m × 2 m) and allowed to acclimatise for a minimum of 3 days. The observation pen had overhead 300-watt halogen lights for observations at night.

In the preliminary trial in 1995/96, the analogue recording of a starling distress call was presented separately to two stoats (a male and a female) for 1 night. An EPROM chip containing the starling call and a small headphone speaker were placed in each of two identical single-entrance wooden tunnels, raised on legs 10 mm above ground, and spaced 3 m apart at one end of the observation pen. The chip in one tunnel (selected at random) was activated with a battery to emit the starling call through the speaker for about 15 seconds at 2-min intervals overnight. The responses of the stoats to playback of the starling call were monitored using a 24-hour time-lapse video recorder. Data extracted from the videotapes were the number and duration of visits by stoats that made contact with each tunnel (usually either by going underneath or over the top), and the number and duration of entries by stoats into each tunnel. The data were insufficient for statistical analysis.

FIGURE 1 WAVE FORMS OF SOUNDS PLAYED TO CAPTIVE STOATS.



In 1996/97, analogue recordings of the distress calls of a starling, silvereye, and house sparrow were presented separately to 10 stoats (all males) for 1 night, usually with at least 1 night between tests. Not all stoats were presented with all calls ($n = 9$ with the starling, 7 with the silvereye, and 5 with the house sparrow call). Also, the order of presentation of the calls was not randomised, although it was not the same for each stoat. For this series of tests, an EPROM chip containing a bird call and a small headphone speaker were placed in each of two identical perforated opaque plastic containers that were tied 1 m apart and 1 m above ground to the end wall of the observation pen. One chip (selected at random) was activated to emit the bird call for about 15 seconds at 2-min intervals overnight. The responses of the stoats were monitored using a 24-hour time-lapse video recorder. Data extracted from the videotapes were the number and duration of visits to the perforated opaque plastic containers. It was not necessary to transform the data for statistical analysis. The effects of sound playback (i.e. sound 'on'), sound type (i.e. starling, silvereye, or house sparrow call), and sound playback \times sound type interaction on stoat responses were determined by a split-plot analysis of variance. The latter two effects were determined within the effects of sound playback. Possible residual and carry-over effects of one sound type to the next were also examined for within the effects of sound playback. Where the residual effects were not significant, the tests of sound type and sound playback \times sound type were made without allowing for such effects. In a separate trial with four stoats, a dead house sparrow was placed inside each of two perforated opaque plastic containers together with a house sparrow EPROM chip and a small speaker. Again, the chip in one container (selected at random) was activated to emit a house sparrow call for about 15 seconds at 2-min intervals overnight, the responses of the stoats were monitored using a 24-hour time-lapse video recorder, and the number and duration of visits to the perforated opaque plastic containers were extracted from the videotapes. The data were transformed with \log_e to ensure normality and equal variance of residuals, and analysed by analysis of variance.

In 1997/98, the calls of a day-old domestic hen chick, mouse, and stoat were presented separately to each of nine stoats (five males and four females) for 1 night, usually with at least 1 night between tests. The order of presentation of the sounds to the stoats was randomised in an attempt to quantify possible residual and carry-over effects of one sound type to the next. A small Sony 'sports' portable speaker was placed at the far end of one of two identical single-entrance wooden tunnels (selected at random) that were located 1 m apart in the middle of each observation pen. The sounds were played through the speaker for about 20 seconds at 30-min intervals overnight. The responses of the stoats to the sound playbacks were monitored using a 24-hour time-lapse video recorder. Data extracted from the videotapes were the timing, number, and duration of visits by stoats onto the top of each tunnel, and the timing, number, and duration of entries by stoats into each tunnel. The data were transformed with the square root transformation to ensure normality and constant variance of residuals. The effects of sound playback, sound type, and sound playback \times sound type interaction on stoat responses were determined by a split-plot analysis of variance. As above, the latter two effects were determined within the effects of sound playback, and possible residual and carry-over effects of one sound type to the next were also examined within the effects of sound playback. Where the residual effects were not significant, the tests of sound type and sound playback \times sound type were made without allowing for such effects.

2.2 EFFECTIVENESS IN THE FIELD

Because we did not find the distress calls of starlings, silvereyes, and house sparrows attractive to captive stoats in 1996/97, we did not proceed with the field trials in 1997/98, but instead, with agreement from the Department of Conservation, tested the attractiveness of digital rather than analogue sounds to captive stoats (see 2.1 above).

3. Results

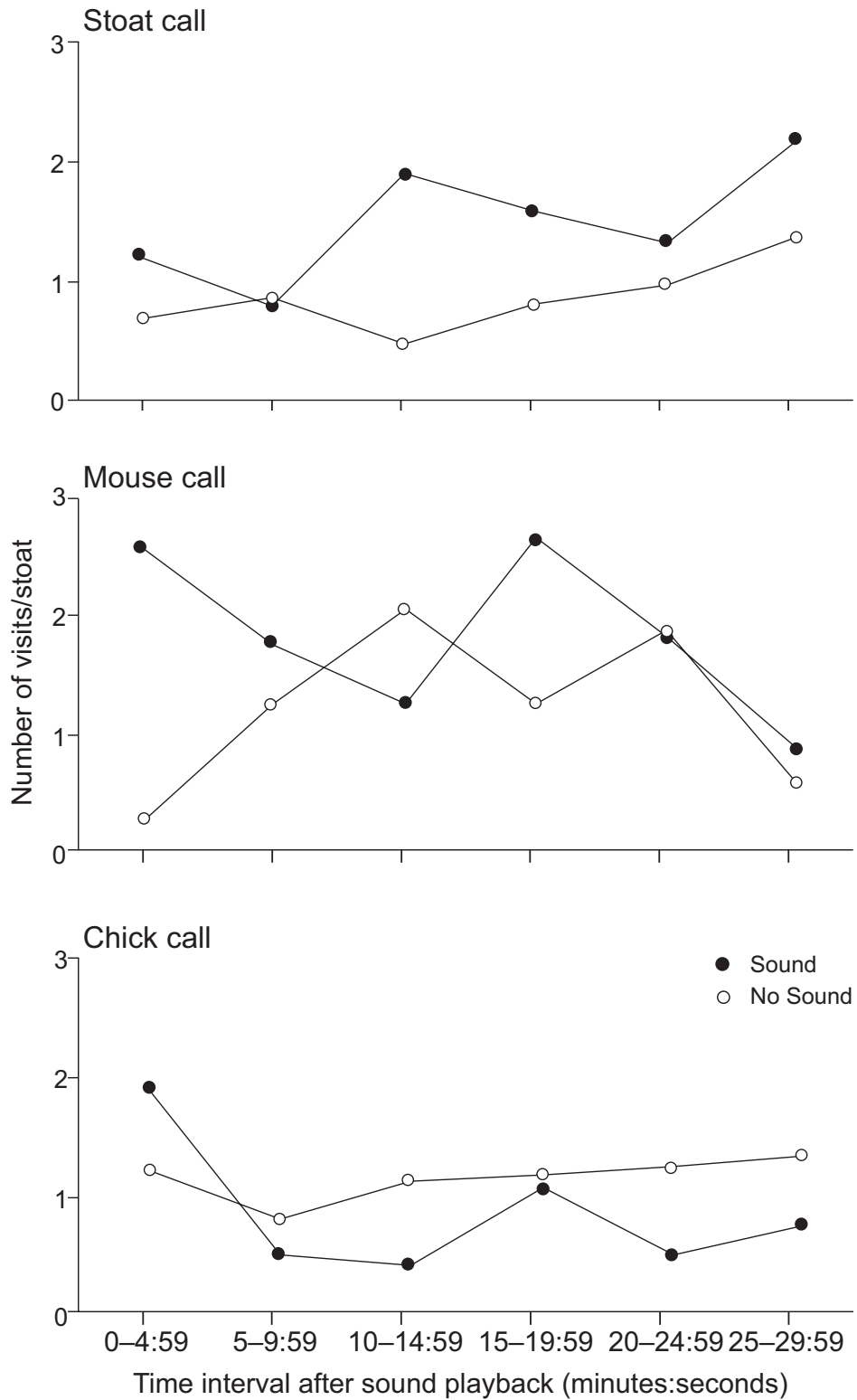
In the preliminary trial in 1995/96, with the analogue recording of a starling distress call presented to two stoats for 15 seconds at 2-min intervals for 1 night, one stoat visited the tunnel with sound playing more often and for a longer duration than the tunnel without sound playing, whereas the second stoat showed the opposite response. With only two stoats tested, there were insufficient data to enable a statistical analysis, but overall there appeared to be no difference in the number and duration of visits and entries to the tunnels with and without sound.

In 1996/97, with the analogue recording of starling, silvereye, and house sparrow distress calls presented to a larger sample of stoats, there was no statistically significant difference between the total number or duration of visits by stoats to the tunnels with sound playback than to the tunnels without sound playback ($F_{1,9} = 1.770$, $P = 0.216$ for number of visits, and $F_{1,9} = 0.070$, $P = 0.803$ for duration of visits) (Table 1). There was no significant difference between the sound types ($F_{2,16} = 0.150$, $P = 0.861$ and $F_{2,16} = 0.080$, $P = 0.924$, respectively, for number and duration of visits), no interaction between sound playback and sound type ($F_{2,16} = 0.460$, $P = 0.637$, and $F_{2,16} = 1.290$, $P = 0.302$), and no residual effects, indicating no carry-over of the effects of one sound type to the next ($F_{2,14} = 2.570$, $P = 0.112$ and $F_{2,14} = 2.050$, $P = 0.166$).

TABLE 1 NUMBER AND DURATION OF VISITS PER STOAT PER NIGHT TO CONTAINERS WITH AND WITHOUT PLAYBACK OF THE DISTRESS CALLS OF BIRDS IN 1996/97 (n = NUMBER OF STOATS TESTED).

SOUND TYPE	NUMBER OF VISITS TO CONTAINERS		DURATION OF VISITS TO CONTAINERS (SECONDS)	
	WITH SOUND	WITHOUT SOUND	WITH SOUND	WITHOUT SOUND
Starling call (n = 9)	2.1	1.9	13.2	9.6
Silvereye call (n = 7)	1.6	3.2	1.1	16.7
House sparrow call (n = 5)	1.8	1.6	17.2	6.7
Average of all bird calls (n = 21)	1.8	2.3	10.1	11.3
House sparrow call plus dead house sparrow (n = 4)	10.2	10.8	109.1	85.6

FIGURE 2 NUMBER OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT SOUND PLAYBACK, AT 5-MIN INTERVALS IN THE 30 MIN AFTER SOUND PLAYBACK (DATA BACK-TRANSFORMED FROM SQUARE ROOT).



When a dead house sparrow was placed in each of the two perforated opaque plastic containers together with an EPROM chip of a house sparrow distress call, there was a marked increase in the number and duration of visits by stoats to both containers (Table 1). However, there was no significant difference between the number or duration of visits by stoats to the containers with and without the calls being emitted ($F_{1,3} = 0.047, P = 0.843$ and $F_{1,3} = 0.148, P = 0.727$).

TABLE 2 NUMBER OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT PLAYBACK OF CHICK, MOUSE, AND STOAT CALLS, AT 5-MIN INTERVALS DURING THE 30 MIN AFTER SOUND PLAYBACK IN 1997/98.

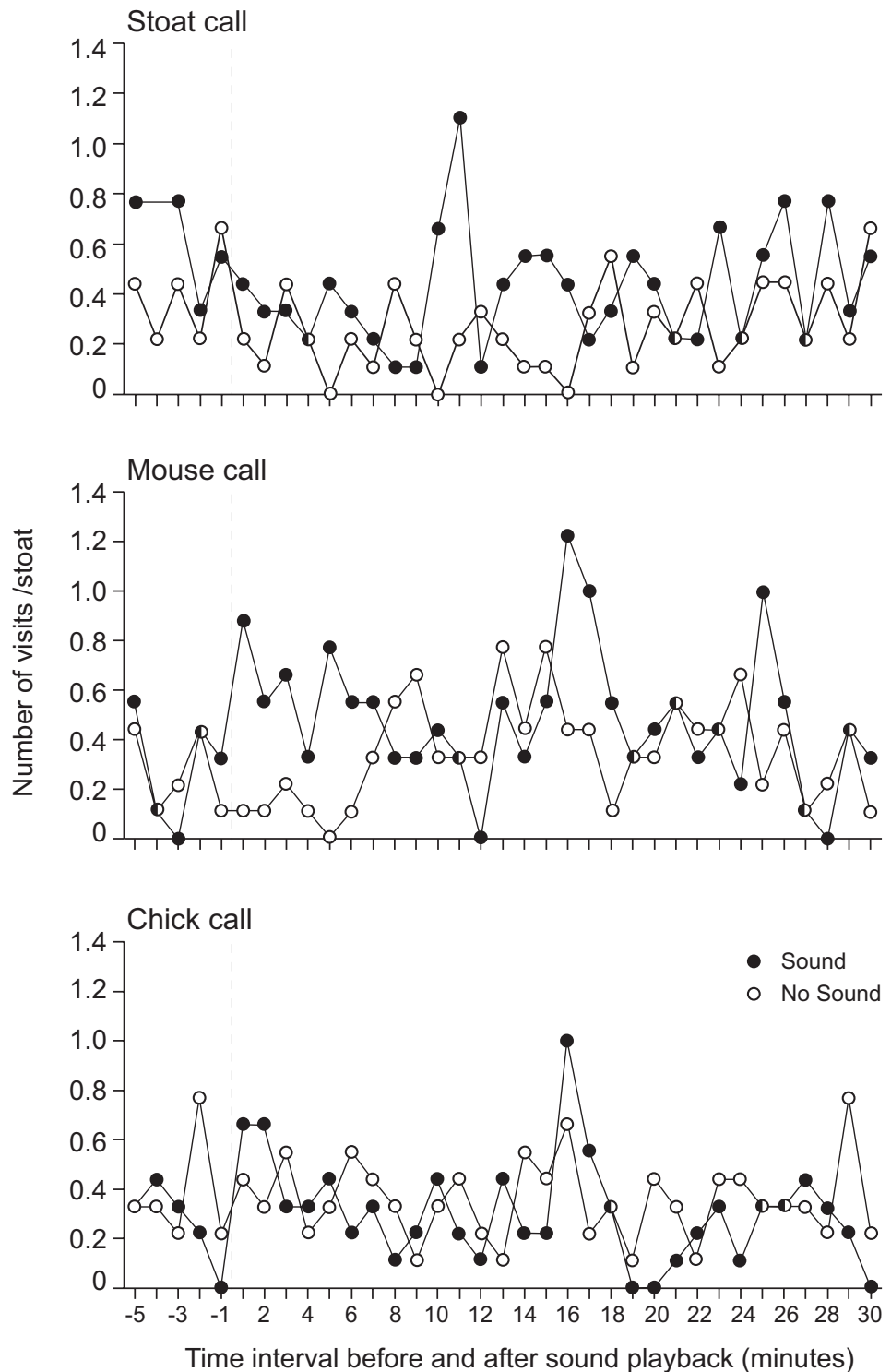
TIME AFTER SOUND PLAYBACK (MINUTES:SECONDS)	NUMBER OF VISITS PER STOAT TO TUNNELS		F _{1,8}	P
	WITH SOUND PLAYBACK	WITHOUT SOUND PLAYBACK		
0-4:59	1.8	0.7	23.87	0.001
5-9:59	1.0	1.0	0.00	0.962
10-14:59	1.1	1.1	0.00	0.966
15-19:59	1.7	1.1	1.49	0.257
20-24:59	1.2	1.3	0.08	0.786
25-29:59	1.2	1.1	0.30	0.601
0-29:59	10.2	9.0	0.53	0.488

In 1997/98, with 20 seconds of digital sound playing at 30-min intervals throughout the night, stoats visited the tunnel with sound playback significantly more often than the tunnel without sound playback in the first 5 min after sound playback (Table 2, Fig. 2). There was no significant difference between sound types ($F_{2,30} = 0.900$, $P = 0.418$), no interaction between sound playback and sound type ($F_{2,30} = 1.510$, $P = 0.238$), and no residual effects, indicating no carry-over of the effects of one sound type to the next ($F_{2,28} = 2.470$, $P = 0.103$). At other time intervals after sound playback, there were no significant differences between the number of visits by stoats

TABLE 3 DURATION OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT PLAYBACK OF CHICK, MOUSE, AND STOAT CALLS, AT 5-MIN INTERVALS DURING THE 30 MIN AFTER SOUND PLAYBACK IN 1997/98.

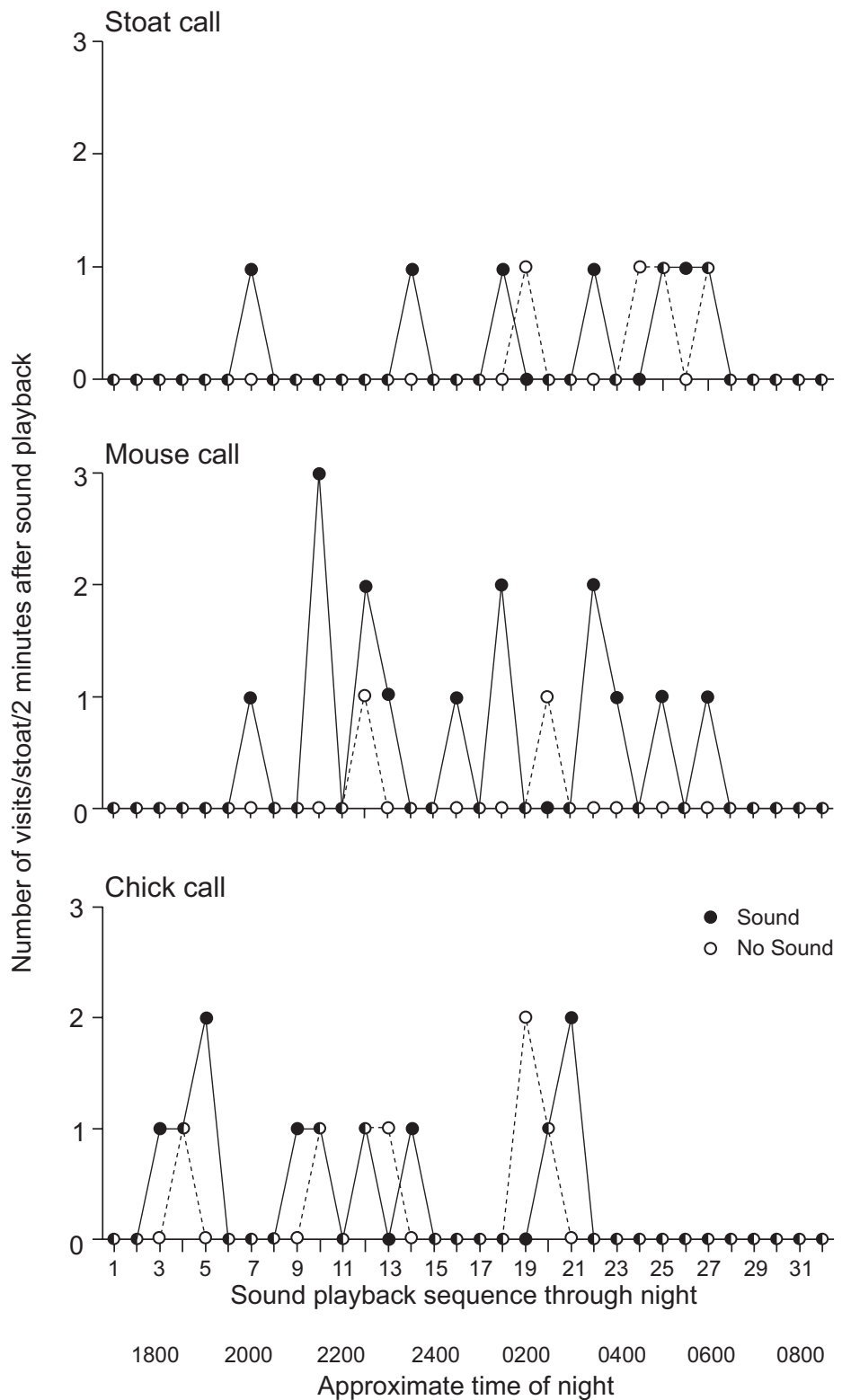
TIME AFTER SOUND PLAYBACK (MINUTES:SECONDS)	DURATION OF VISITS (SECONDS) PER STOAT TO TUNNELS		F _{1,8}	P
	WITH SOUND PLAYBACK	WITHOUT SOUND PLAYBACK		
0-4:59	35.9	6.7	19.30	0.002
5-9:59	10.9	9.4	0.06	0.813
10-14:59	12.7	12.8	0.00	0.998
15-19:59	16.8	11.4	0.93	0.362
20-24:59	12.3	13.5	0.04	0.857
25-29:59	12.3	7.8	1.38	0.274
0-29:59	131.1	101.2	0.90	0.370

FIGURE 3 NUMBER OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT SOUND PLAYBACK, AT 1-MIN INTERVALS IN THE 5 MIN BEFORE AND 30 MIN AFTER SOUND PLAYBACK (RAW DATA). THE 5 MIN BEFORE SOUND PLAYBACK ARE THE SAME AS THE LAST 5 MIN AFTER SOUND PLAYBACK.



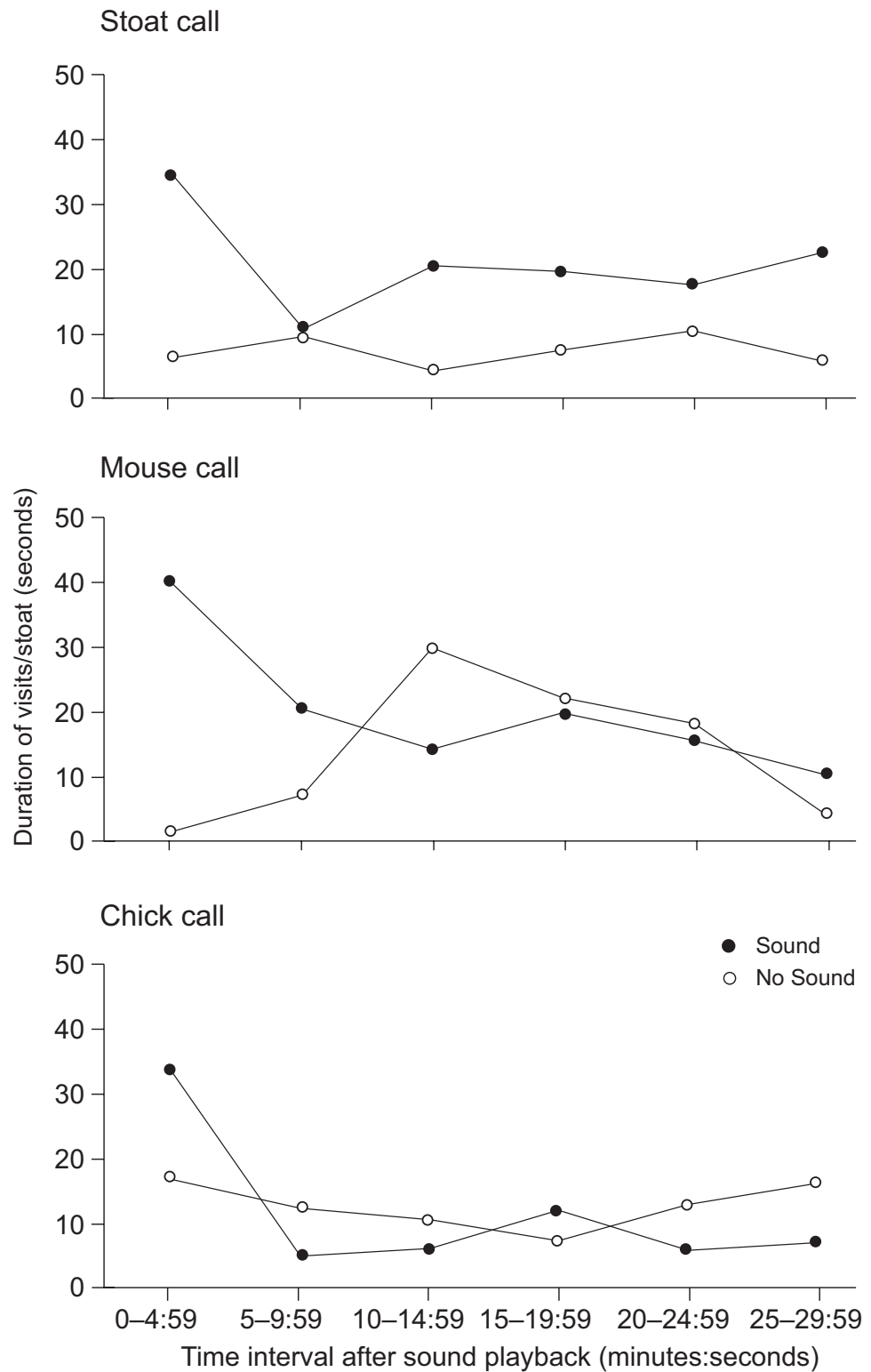
to the tunnel with sound playback than to the tunnel without sound playback (Table 2, Fig. 2). Again, there were no significant differences between sound types ($P > 0.2$ for all tests), no interactions between sound playback and sound types ($P > 0.1$ for all tests), and no residual effects ($P > 0.5$ for all tests). Overall, in the full 30 min after sound playback, there was no significant difference between the total number of visits by stoats to the tunnel with sound playback than to the tunnel without sound playback (Table 2, Fig. 2). Again, there was no significant difference between sound types ($F_{2,30} = 1.060, P = 0.359$), no interaction between sound playback and sound type ($F_{2,30} = 1.060, P = 0.360$), and no residual effects ($F_{2,28} = 0.830, P = 0.448$).

FIGURE 4 NUMBER OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT SOUND PLAYBACK, IN THE 2 MIN AFTER EACH SOUND PLAYBACK (RAW DATA). PLAYBACKS WERE AT 30-MIN INTERVALS THROUGHOUT THE NIGHT.



When the data are viewed at 1-min intervals instead of 5-min intervals after sound playback, the initial responses of stoats can be seen to vary from 2 min for the chick call to 6 min for the mouse call (Fig. 3). Although stoats visited the tunnel with sound playback more often than the tunnel without sound playback in at least the first 2 min after sound playback, there were many times after sound playback that the stoats did not visit the tunnel with sound playback within 2 min, even when the stoats were active (Fig. 4).

FIGURE 5 DURATION OF VISITS PER STOAT PER NIGHT TO TUNNELS WITH AND WITHOUT SOUND PLAYBACK, AT 5-MIN INTERVALS IN THE 30 MIN AFTER SOUND PLAYBACK (DATA BACK-TRANSFORMED FROM SQUARE ROOT).



Stoats not only visited the tunnel with sound playback more often, but also spent a significantly longer duration of time at the tunnel with sound playback than at the tunnel without sound playback in the first 5 min after sound playback (Table 3, Fig. 5). There was no significant difference between sound types, no interaction between sound playback and sound type, and no residual effects ($P > 0.3$ for all tests). At other time intervals after sound playback, there were no significant differences between the duration of visits to the tunnels with and without sound playback (Table 3, Fig. 5).

TABLE 4 ENTRIES PER STOAT PER NIGHT INTO TUNNELS WITH AND WITHOUT SOUND PLAYBACK IN 1997/98.

TIME AFTER SOUND PLAYBACK (MINUTES:SECONDS)	STOAT CALL		MOUSE CALL		CHICK CALL	
	SOUND	NO SOUND	SOUND	NO SOUND	SOUND	NO SOUND
0-4:59	0.22	0.33	0.44	0	0.33	0.11
5-9:59	0.11	0.11	0.11	0.11	0.33	0.33
10-14:59	0.89	0.11	0.33	0.22	0.33	0.33
15-19:59	0	0.22	0.78	0	0.22	0.11
20-24:59	0.11	0.22	0.22	0.11	0.56	0.11
25-29:59	0.11	0	0.11	0.22	0.11	0.33
0-29:59	1.44	1.00	2.00	0.67	1.89	1.33

Again, there were no significant differences between sound types, no interactions between sound playback and sound type, and no residual effects ($P > 0.1$ for all tests). Overall, in the full 30 min after sound playback, there was no significant difference between the total duration of visits to the tunnels with and without sound playback (Table 3, Fig. 5). There were no significant differences between sound types, no interactions between sound playback and sound type, and no residual effects ($P > 0.4$ for all tests).

Stoats entered the tunnels only once or twice per night (i.e. on 10–15% of the visits to the tunnels). They entered the sound playback tunnels about twice as often as the tunnels without sound playback (Table 4). However, only about 20% of the entries were in the first 5 min after sound playback. Only two stoats entered the tunnels every night (i.e. with all three sounds) and one stoat never entered the tunnels.

4. Discussion

The stoats tested were not attracted to the analogue recordings of distress calls of a starling, silveryeye, or house sparrow. However, they were attracted to the digital recordings of the chick, mouse, and stoat calls in the first 5 min after sound playback. It is unclear whether the failure of the analogue sounds to attract stoats was because the sounds were not of sufficient quality or reality, or because the species of bird (starling, silveryeye, and house sparrow) or the type of sound (distress calls) were not attractive to stoats.

The quality of sound at particular frequencies may be critical for animal hearing. If stoats are like weasels (*M. nivalis*), they are unusual for small mammals in having good hearing at both high and low frequencies (Heffner and Heffner 1985). The

digital sound recordings we used had both higher and lower frequencies than the analogue sound recordings we used (G. Hickling pers. comm.). The digital recordings were also more realistic than the analogue recordings. Thus, digital sound recordings should be used for future tests.

The first 5 min after sound playback is when we would expect stoats to respond if they were going to respond. The lack of response by stoats to any of the sounds tested 30 min after sound playback may indicate a waning of attraction to sound over time. We do not know if more frequent playing of a sound would increase its attraction to stoats or cause habituation. In practice, if a stoat was caught in a trap the first time it entered a tunnel after sound playback then waning of attraction and habituation to sound over time would not be a problem. However, it is of concern that most stoats seldom entered the tunnels, even in the first 5 min after sound playback, and one stoat never entered the tunnels after sound playback. Thus, the sounds tested did not appear to be strongly attractive to stoats.

The stoats were much more strongly attracted to the smell of a dead house sparrow than to an analogue recording of a house sparrow distress call. We did not test stoat response to a digital recording of a house sparrow distress call. Consequently, we cannot say whether stoats are more attracted to smells than to sounds. It is likely that stoats use all three senses, sound, smell, and sight, when hunting.

This study investigated the responses of stoats to sound only at night. However, stoats are diurnal as well as nocturnal (King 1990, 1994). A study by Alterio and Moller (1997) found that stoats were equally active during the day and night in autumn, but were more active during the day than at night in spring. They could be more attracted to nocturnal prey at night and diurnal prey during the day. Thus, it would be worth determining whether stoats are attracted to the sounds of diurnal prey during the day.

This study did not investigate the effects of sound volume, duration of sound playback, or interval between sound playbacks on stoat responses. If the sound volume is too strong it may repel stoats, but if it is too weak it may not attract them from a long distance. If the duration is too short and / or the interval between playbacks is too long, then stoats may not have time to locate its source. These factors need investigating before sound lures can be used for stoat control.

5. Recommendations

Further trials should be done with captive stoats to determine:

- Which types of sounds (e.g. calls of different species of birds, contact versus distress calls, different types of mouse calls, calls of diurnal versus nocturnal prey, etc.) are the most attractive to stoats.
- Aspects of sound delivery, e.g. frequency, volume, duration, and periodicity of sound playback. These may play a vital part in the reality and therefore attractiveness of the sounds.

Field trials should be done only after the sound most attractive to captive stoats has been determined.

6. Acknowledgements

This research was undertaken for the Department of Conservation, Wellington, from May 1997 to February 1999 (Investigation No. 1920, Landcare Research Contract LC9899/65). We thank L. Milne, A. Rhodes, N. Watkinson, and P. Willcock for maintaining the stoats in captivity; C. Duston, I. Flux, R. Porter, and M. Thomas for technical assistance; I. Flux for supplying the EPROM chips; G. Hickling for editing the digital sound playbacks; W. Ruscoe and R. Webster for statistical assistance; C. Eason and E. Murphy for comments on the draft manuscript; C. Bezar for editorial advice; and W. Weller for word-processing.

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