BIOACOUSTICAL SCARING TRIALS

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This paper and the following one present the results of our work on bioacoustical birdscaring which took place in 1987-88. The first one documents some of the difficulties encountered when assessing the effectiveness of bioacoustical repellents and details the results of our field trials on Starlings and galahs. The second, written by Mr. D.G. Nicholls, presents the preliminary computer analysis of bird calls.

Introduction

There are three types of call which can be exploited for repelling birds (Boudreau, 1968). Alarm calls may be emitted when a predator is nearby or in the event of impending danger. Distress calls are sometimes given off when an animal is captured or subjected to pain. These two types of calls are most often used in bioacoustical trials. Another call, the alert call, may be emitted when danger is detected from a distance. Its function is to lower the response threshold of individuals to subsequent alarm calls and is equivalent to the "Now hear this!" broadcast which often precedes important announcements. Bourdreau (1968) considered the alarm call (with or without alert calls) to be more effective than the distress call in repelling birds.

Biologically meaningful calls may be less prone to habituation because they are either genetically programmed or because they are occasionally reinforced in a natural situation. Natural sounds are also preferable to artificial calls because:

- They do not result in the killing of bird pests.
- They can be broadcast at lower intensities.
- They are species-specific
- They are less annoying to humans

For these reasons alone, bioacoustical methods are well worth investigating.

Examples of bioacoustical studies

Table 1 shows a range of studies directed at measuring the effects of bioacoustical scaring trials. Overall, the technique seems to be successful in repelling birds and it does not always lead to habituation.

Bioacoustics appear to work on a diversity of species. In addition to those species listed in the table, the technique has also been used to successfully disperse blackbirds, herons, lapwings, sparrows, finches, pigeons, larks, goldfinches and a diversity of gulls and corvid species.

Table 1: Some bioacoustical studies carried out on pest bird species.

Species	Situation	Call Used	Effective	Supplementary Scaring	Habituation	Reference
Glaucous-Winged Gull	Airport	5 types	Yes	No	No	Stout *et al* 1974
Carrion Crows Daenzer	Cornfield	Distress	Yes	No	--	Naef-1983
Black-headed Gulls	Loafing site (sand bank)	Distress	Yes	No	Yes	Brown 1962
Herring Gulls	Dumps Cannery Seashore Fish-meal factory	Alarm	Yes	No	No	Frings *et al* 1955
Night Herons	Fish farm	Distress	Yes	No	No	Spanier 1980
Starlings	Roost trees	Distress	Yes	Yes (1/2 trials)	No	Brough 1969
Herring Gulls	Water supply reservoir	Distress	Yes	No	No	Benton *et al* 1983
Starlings	Dairy farm	Distress	Yes	Yes (owl models)	--	Conover & Perito, 1981
Cormorants	Fish farm	Distress	Yes	Yes (cannons)	--	Moerbeek *et al* 1987
Gulls	Dumps	Distress	No-not without supplementary scaring		--	Seubert 1963
		Distress	Yes	No	Yes	Seubert 1963
Black Swans	Grass filtration areas	Alarm Feeding	Yes	Yes (wings)	No	Waters 1986

It has been used in a variety of situations which include feeding, roosting, and loafing sites. One would expect birds to vary in their degree of attachment to different sites. For instance, they are more likely to disperse from a loafing site than they are from a breeding site.

Most of the studies listed have broadcast distress calls which are easier to obtain than alert or alarm calls. The latter calls are more difficult to recognise and their context is not always known. To add to the confusion, Boudreau (1968) claims that starling distress calls are actually modified alarm calls given when the bird is in imminent danger as well as in physical distress!

The use of visual or audio reinforcement has probably influenced the effectiveness of bioacoustics in some of the studies.

An Australian case study

The last entry in Table 1 is the only Australian bioacoustical study of which we are aware. This concerns the use of alarm calls to repel black swans (*Cygnus atratus*) from grass filtration paddocks at the Melbourne and Metropolitan Board of Works Farm at Werribee. Swans cause puddling of the laser-graded paddocks; previous attempts to deter them failed even when cracker cartridges were fired ;) groups.

The study took place in September and October of 1986. The results are reported in detail in Waters (1986) but are summarised briefly here. Alarm calls were broadcast mainly from a stationary vehicle fitted with four 25 watt speakers powered by a 100 watt amplifier. The results are somewhat complicated by the use of two different types of broadcast systems and two types of calls. However, swans were repelled in 16 of 22 trials; unsuccessful attempts included one trial where swans were located on water, one trial in strong wind and four trials using the inferior broadcast system. Trials were, with one exception, either 100% successful or unsuccessful.

There was no habituation noted over the 20-day period; the time taken for birds to disperse after a broadcast decreased as the trials proceeded. In three cases where the return of swans was observed, individuals began arriving back in "waves" after 20 minutes, but this was variable. Feeding aggregations diminished in size ɔidly and markedly over the course of the trials. The long-term results are confounded by the fact that swans normally disperse from the area at this time of the year. Further trials are therefore required.

There are two things worth noting in this study. Firstly, swans were also repelled in two out of four trials where feeding calls were used. Their reaction differed in that they did not leave the area completely. Secondly, visual scarecrows consisting of plastic wings pegged to the ground and displaying the white "flight" pattern of swans, were present throughout the bioacoustical trials. These were capable of deterring swans for 1-1.5 weeks on their own (Montague 1985).

It was because of this early success in bird-scaring trials that our company became involved in further projects of this nature.

Bioacoustical trials using starlings and galahs

The main objective of our study was to assess the effectiveness of bioacoustics basis for the development of an "intelligent" bird-scaring device for agricultura bird pests. Such an automated system would be able to detect the presence of birds in an area, identify them and broadcast a species-specific call. The possibility of enhancing such calls by computer manipulation to produce a "su stimulus" which strengthens or prolongs the effectiveness of the calls was to be investigated also.

The project therefore involved:

- Compiling a library of calls which included alarm and distress calls fo some common Australian bird pest species and for species which associ closely with them, as well as calls from aerial predator and scavenger species.

- Carrying out field broadcast trials for starlings (*Sturnus vulgaris*) and galahs (*Cacatua roseicapilla*).

- Carrying out a digital analysis of some of the bioacoustical calls - this is the first step in identifying, modifying and perhaps enhancing the repellent components of alarm and distress calls.

The emphasis of the study was on practicality. Since the critical period for ma grape and almond growers extends over a 4-6 week period, the success of a bi scaring technique for even 3 weeks would be considered a significant achievement. We recognised that any bioacoustical bird-scaring device would have to be supplemented with some other means of dispersal at some stage, b concentrated on finding what Blokpoel (1976) terms a "useful tool rather than less-than-ideal device".

The study was carried out in conjunction with Data Electronics Pty Ltd and M David Nicholls. The project was funded by the Rural Credits Development Fu of the Reserve Bank of Australia. We understood when we took on the grant it could be renewed for up to 3 years; the results reported here constituted the first phase of a 3-year project. However, the Fund was abolished after one ye funding. The Department of Transport and Communication provided partial funding for the broadcast trial phase of the project.

Equipment used

The recording equipment used consisted of a Sony Walkman Professional tape recorder, a Sony Electret Condenser uni-directional microphone and a JVC M- multi-directional microphone. The former microphone was used to record dis calls from captive individuals, whereas the latter was used to record alarm cal from wild birds. A 35 cm diameter Sony Parabolic Reflector was used for field recording. Calls were transfered onto 3-min continuous loop tapes.

The broadcast equipment used consisted of a Session speaker and a Toa 60W DC amplifier. The broadcast unit was powered by a 12V dry cell battery. In general, the field vehicle was driven to within 100 m of the target area (ie. the area where most bird feeding was occurring at the time). The speaker was placed onto the roof of the vehicle and oriented towards the birds. The volume control knob on the amplifier was turned to the full or near-full position. The tape recorder was turned on for a brief burst of sound each time that birds landed in the target area.

Starling trial 1

Broadcast trials were carried out in late summer 1988 in vineyards located in the Yarra Valley. Trials were carried out during morning and evening activity periods.

Recording calls

The procedure used for recording calls is described in detail elsewhere (Jaremovic and Nicholls 1989); a brief summary is given here for those calls which are relevant to this paper.

Recordings for starlings were obtained at vineyards located in the Yarra Valley near Melbourne. Individuals were captured in mist nets and then hand-held until they emitted distress calls. Calls were recorded for one adult and for 12 immature starlings; they were selected randomly for copying onto continuous loop tapes.

Methodology

A vehicle containing the broadcasting equipment was driven to the centre of the vineyard. The speaker was placed on the roof of the car and oriented towards arget birds. Bursts of distress calls were played each time starlings were observed landing in the vineyard.

Results

Due to the delays experienced in trying to capture and record distress calls, we were not able to broadcast calls for more than two consecutive days before all grapes were harvested.

Results therefore remain inconclusive, but broadcasts were 100% successful each time they were played. Up to 20 broadcasts were played over an 8-hour period on one day and nine bursts were broadcast over a 3-hour period on another day.

Starling trial 2

Broadcast trials were carried out in February 1989 in vineyards in the Yarra Valley; they were carried out through the day.

Recorded calls

In February 1989, a continuous loop tape containing starling distress calls alternating with the calls of brown falcon (*Falco berigora*), brown goshawk (*Accipiter fasciatus*), peregrine falcon (*Falco peregrinus*) and Australian hobby (*Falco longipennis*) (ie raptor known to occur in the local area), was prepared. The starling calls were recorded as described above; the raptor calls were taken from commercial tapes.

Methodology

Calls were broadcast through four speakers located at each corner of the vineyard at a volume approaching a normal level. The tape was first broadcast when grapes started to ripen and was played continuously for 12 hours/day for a six-week period

Results

The broadcasts were successful in keeping starlings away for the first three weeks but soon after, birds showed signs of habituation. Hawks, black-shouldered kites (*Elanus notatus*) Australian kestrels (*Falco cenchroides*) and a peregrine falcon or Australian hobby were observed in the vineyard. Although one of the latter two species was observed to approach a speaker whenever its species-specific call was played, starling distress calls were known to have attracted raptor species on their own; hawks appeared over the vineyard during distress call broadcast trials in late summer 1988. The presence of raptor species probably acted as a positive reinforcement for bioacoustical broadcasts, but regular patrols and shooting were also used to supplement these throughout the six-week period. Gas cannons were used during the last three weeks.

Galah trial

Broadcast trials for galahs took place in February, 1989 at a grain spill located in the Mildura area in northwestern Victoria. Trials were carried out during morning and evening activity periods.

Broadcast calls

When we started the galah trials, we did not have any distress or alarm calls for the species. Recordings of fleeing galahs and cockatoos and of anomalous sounds (eg gunshots) failed to disperse feeding galahs as did the presence of humans as close as 10 m away. However, the presence of soaring eagles and kites caused them to fly to their nearest roost trees. Whistling kite (*Haliastur sphenurus*) calls were found to effectively disperse galahs from the grain site.

A continuous loop tape containing bird calls recorded during the study or taken form commercial tapes was prepared. It contained in the following sequence: three whistling kite calls, galahs vocalising while flying, three shotgun shots followed by the screeches of fleeing galahs and sulphur-crested cockatoos (*Cacatua galerita*), two whistling kite calls, a galah "aggressive" call and galahs vocalising while flying. Attempts were made to record galah alarm calls between trials using the "scare tape".

Methodology

A vehicle containing the broadcast equipment was driven to within 10 m of the grain spill. The speaker was placed outside the vehicle before birds arrived.

Each time that galahs landed at the grain site, one of the first whistling kite calls as played. Typically, galahs arrived at the grain site in small 'waves' of twos or threes and then tens or twenties. Broadcasts began when at least 10-15 individuals had landed at the grain site. If all birds dispersed, the tape recorder was stopped and the trial was considered successful. If any or all of the birds remained, then the next call on the tape was played. If none of the calls was effective in dispersing any or all of the birds, the trial was considered unsuccessful and broadcasts were halted until another group arrived or until the original group was eventually replaced.

Results

In all, 81 trials were used to keep galahs from the grain spill for eight days. Sixty eight (84%) of the trials were successful, that is, they resulted in all the galahs dispersing from the site; thirteen (16%) of the trials were unsuccessful meaning that some or all of the birds did not respond to the broadcasts. Unsuccessful trails were not evenly distributed throughout the 8-day period but were concentrated during the final days when Galahs did not respond to more than half of the broadcasts. Overall, the number of visits by birds to the food source diminished until the eighth day when broadcasts were ignored.

Differences between species

Although the trials described above were carried out on similar group sizes at an established food source (with alternative food present), the response measured differed between species. There are several possible explanations for these results. One of these is related to the way galahs learn to recognise their predators (Conover and Perito 1981). Whereas starlings are repelled by distress call broadcasts, galahs are attracted to them. This behaviour allows individual birds to gather detailed information about their different types of predators. Detailed predator recognition has the benefit of maximising feeding time and minimising energy loss due to unnecessary flights. Species such as galahs may be more difficult to scare away initially and may require complex stimuli from the outset to be effective.

It is difficult to say why the whistling kite call was so effective at deterring galahs during the experimental period. Kites are not known to be predators of adult galahs although they may pose a threat to their young. However, soaring little eagles, whistling kites, and black kites always caused galahs to fly to their roost trees and to perch high up in the branches until the raptor had left the immediate area. Only Australian hobbies were seen actively attacking (but never catching) galahs. None of the other raptor calls had a noticeable effect on the birds.

Black kites and little eagles were observed standing on and feeding on dead galahs it is perhaps this association which makes galahs more wary of these species. The open habitat may have reinforced this effect by increasing their level of 'nervousness'.

Making a better birdscarer

Even though natural calls may delay habituation, they will not stop it (Zucchi 1979, Fitzwater 1970, Boudreau 1968) and supplementary means of deterrence should be used. From the literature, it is evident that various methods can be used to prolong the effects of bioacoustical scaring devices. These are listed below and are supplemented by added information which we have gained from our study on starlings and galahs:

Change speaker locations regularly (Busnel and Giban 1963, Brough 1968)

This can be done physically (although this is most often neglected) or as an illusion by activating only some of the speakers each broadcast or by rotating speakers.

Alternate calls or mix calls with inanimate noise or raptor calls (Martin 1979, Johnston *et al* 1985)

We used "sound cocktails" in our trials and the reasons for their success seemed to be different for each species. In the case of starlings, the mixture of distress calls and raptor calls appeared to scare the birds directly and indirectly by attracting raptors to the site. The alternation of starling and raptor calls meant that each call was played for less time.

In the case of galahs, the sound cocktail allowed us to observe a case where broadcasts which were previously ineffective in deterring birds, were successful when played after an effective call. The whistling kite call lowered the response threshold of galahs and made them more nervous and sensitive to other calls. This is the "pre-conditioning" mentioned by Boudreau (1968). In effect, the whistling kite call delayed habituation because it made the other calls more effective, thereby reducing the number of times it had to be played. On several occasions, the sound of the tape recorder switch was enough to disperse birds. Bird-scaring programmes might be more effective if they started each broadcast session with such a "pre-conditioning" call.

A birdscaring device should be able to play a variety of calls and to interact with other devices present. For instance, the device should be able to broadcast an alarm call, activate a gas gun and then broadcast distress calls. Fitzwater (1970) found that a loud, sharp noise followed by distress calls was more effective in dispersing starlings than distress calls alone. If this sounds far too much trouble to go to for the humble "bird brain", then we only need reflect upon the woeful success we have with simple repetition to admit that a level of complexity is needed!

A further step is to broadcast only those parts of the calls that contain necessary information for dispersal.

Reinforce calls with visual, acoustical or real danger (Brough 1968, Moerbeek *et al* 1987, Busnel and Giban 1965, Inglis 1980, Fitzwater 1970)

This is a point of agreement amongst almost all researchers into bioacoustical scaring. Considerable support is given to this suggestion by the fact that many civilian and military airports in England, France, Germany, Holland, the USSR, Canada, and the U.S. use bioacoustical tapes combined with cracker shells to deter birds (Wright 1969, Blokpoel 1968, Brough 1967).

Visual stimuli may have reinforced the effects of the broadcasts in our study. The presence of the vehicle and speaker seemed to reduce the response threshold of birds to the whistling kite calls. Birds were more alert and even flew away as the vehicle approached the grain site one week after the experimental period had ended. This provides an argument in favour of a mobile scaring system.

Call recordings and broadcasts should be of good quality (Busnel and Giban 1963, Bremond *et al* 1968, Blokpoel 1976, Brough 1968, Slater 1980)

he broadcast equipment purchased and used throughout this study was chosen so as to produce good quality recordings and broadcasts. The speaker in particular was selected over the conventional horn-type models because of its good frequency response. It is recommended that a device have compact disk quality broadcasts.

Broadcast calls should be easily located and appear to be coming from nearby (Slater 1980, McGregor *et al* 1983, Morgan and Howse 1973)

Slater (1980) points out that animals do not necessarily respond to an alarming stimulus by fleeing; their response may depend on their previous activity or on their ability to localise the source of the sound. Resting animals or those which are not able to localise the source of the sound are more likely to freeze than to flee.

The effectiveness of a bioacoustical scaring device might be lowered by emitting broadcasts which appear to be coming from far away. McGregor *et al* (1983) found that great tits (*Parus major*) responded less strongly to degraded than to undegraded songs and hypothesised that the birds use degradation cues to estimate distance. The source of low-quality recording seem to be further away and is therefore less startling to birds (Morgan and Howse 1973). The assessment of direction, on the other hand, is likely to be facilitated by the use of sound which covers a broad frequency range (Slater 1980).

Whereas both of these tasks may be accomplished by using good volume and high quality reproduction, they can also be achieved by altering the frequency distribution and the amplitude of calls, respectively. Simple computing techniques which can accomplish this task will be the subject of the next paper.

Creating a super-stimulus (Boudreau 1968, Bremond 1980)

There are two stages in the production of super-stimuli. The first is to identify critical parameters of the call which make it effective as a deterrent. This can be done by identifying differences between individuals (Brough 1968) or between age classes (Fitzwater 1970), by measuring the response of target species to parts of a call (Morgan and Howse 1974), Aubin 1987), by synthesising calls (Boudreau 1968) or by artificially changing the motivation of the caller (examples in Bremond 1980). The next stage involves enhancing the obtained signal.

Bremond (1980) lists several examples where super-stimuli have been created with bird songs. In the case of simpler calls, several types of manipulations may succeed in increasing the effectiveness of calls:

- increasing frequency (eg fowl, robins, wrens)

- increasing duration (eg fowl, owls)

- increasing intensity (eg fowl)

- increasing harshness (eg parakeets, king-birds)

- alternating distress and alarm calls (eg gulls, finches)

Boudreau (1968) showed that it was possible to create a super-stimulus effect with a non-bioacoustical sound. In broadcasting the synthesised sound of a T-37 jet, he noted an even greater deviation of flying blackbirds than for the real sound.

It is evident that the possibility for creating super-stimuli exists, but it is also obvious that different species are likely to respond in different ways. The next paper reports on the simple manipulations that can be carried out on calls; these have not been tested in the field at this stage.

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