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SOUND IN VERTEBRATE PEST CONTROL

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The best known vertebrate pests, as the papers presented at this meeting show, are birds and mammals. Other vertebrates, however, may become pests also: sharks, lampreys, toads (they fall into swimming pools), geckos, tortoises and snakes, for example. Without considering them, however, the depredations by birds and mammals alone are so varied that no single method of pest control can ever be all-embracing. Certainly, no one would suggest that acoustical methods would be, but, with further study, acoustical pest control should be much more widely used. I hope to point out here the possibilities and a few realities in bio-acoustics as related to control of vertebrate pests.

First, let us consider an aspect of acoustical pest control that seems to attract attention: the possible use of ultrasonics. Ultrasonic sounds, defined with man as reference, have frequencies above those heard by man; otherwise they are the same as other sounds. Since biologists who study the effects of liquid-borne ultrasounds on living things usually use very high intensities, causing injury by their high energies, many people believe that ultrasonic sounds have an aura of mystery. This is not so. Ultra-sounds have few special properties. Obviously, if ultrasonic sounds could be used for pest control, human beings would not hear them, and this would be advantageous. However, the pests usually must hear the sounds, and this means that they must have higher ultrasonic limits than that of man.

Rats, mice, and other small mammals can hear sounds that are ultrasonic for man, so acoustical stimuli for them could be inaudible to man. Birds, however, generally have ultrasonic limits lower than that of man, and for them audible sounds must be in man's sonic range. Periodically, stories appear in newspapers about the chasing of birds, usually pigeons, with ultrasonic sound. When any reasonable information is given, one usually finds that this was done with a sound source that produced ultrasonic sound well enough, but produced high intensity sonic sound as well. Invariably no effort was made to distinguish between the effects of different frequencies. In short, ultrasonic sounds may have advantages in pest control, but they are not likely to be somehow "mysteriously" effective.

Ordinary loud noises have been used since antiquity to repel birds and mammals. These can be produced variously, from clapping hands to firing cannons. Many people believe, when they shoot at animals, that the animals flee because they fear death. It seems highly doubtful, from what we know of the conceptual abilities of birds and most mammals, that they can fear an abstraction such as death. The animals are undoubtedly frightened by the noise. Since this is the case, one is inclined to wonder why it has taken so long for firecrackers and guns to be discarded in favor of safer and cheaper mechanical noise generators or recorded shots. The latter, particularly, should be the item of choice for chasing birds, where high intensity noises can be used. Why should anyone use blanks, firecrackers, or exploders, which are expensive at best, when they can simply clap their hands in front of a microphone and produce a recorded "shot" which is infinitely reproducible?

The major drawback to the use of mere noises for chasing birds or mammals is that the animals stop responding after a time. We are all familiar with apparently casual nesting or feeding of birds and mammals in very noisy places. If noises are to be continuously effective, they must be used discontinuously. Thus, where birds attack a crop plant for only a few days, noise-makers may remain effective long enough to protect the crop. However, if protection is needed for a long time, they generally do not.

We have recently been studying the Albatrosses, or Gooney Birds, of Midway Island which fly in front of airplanes and thus create a hazard. In this case, we have been driven, because nothing else seems useful, to try recorded noises, broadcast at high intensities, for keeping the birds away from the airplanes. We hope that adaptation will not set in, because the sound is used only during the short time that a plane is taking off or landing. It is, therefore, broadcast to different groups of Albatrosses at scattered times throughout the day. If operations at the airport were to become continuous, it is almost certain that the birds would no longer respond regularly to the noises.

Animals can be killed by sound if the intensity is great enough. At an intensity of 1 watt/sq. cm., sound kills insects almost immediately and destroys mice in about 30 seconds. This may look promising, but it is really not, for to kill the mouse it must be restrained in a small sound field. Obviously, if one can hold a mouse in a sound field for 30 seconds, he could destroy it by a number of much cheaper methods. In short, high intensity sounds, even though they can kill or injure animals, probably have little promise in practical pest control.

Rats and mice have special acoustical reactions which might be exploited for control. These are the so-called audiogenic seizures, or epileptiform convulsions. The sounds that induce seizures are of high frequencies, mostly ultrasonic for man. There have been many studies on the physiology, genetics, and other theoretical aspects of audiogenic seizures in rodents. Only a few attempts have been made, however, to use these reactions as bases for control. One company has reported informally success in ridding warehouses of rats. Unfortunately, since commercial organizations want to protect their economic rights, it is difficult to get information on the sounds that they use. In general, the field is wide open, and it is to be hoped that research on reactions of rodents to high frequency sounds directed toward practical control will be intensified.

The most recent and successful application of sounds for pest control is the use of animal communication signals. Essentially, one records the acoustical signals of an animal, determines the meanings of the signals to it, studies its behavior and ecology, and, from these data, develops an effective campaign.

The advantages of communication signals over noises are obvious. Loud noises or other sounds are disturbing to man or domesticated animals and are expensive to produce. Communication signals, on the other hand, being a language, are meaningful to animals at relatively low intensities. With birds, for instance, clear-cut reactions to broadcast signals may occur at a mere 3 db above the ambient noise level. Furthermore, communication signals are often quite specific in action, thus allowing one to affect one species without disturbing another.

The communication signals of birds have been most studied, and among birds the most studied has been the Starling. It would take too long to review, even briefly, the work that has been done on the Starling since our report in 1954 on the distress call for Starling control. The repellent action of this distress call was discovered rather accidently. The correct use in practical control of roosting and feeding birds has taken much study on behavior and ecology.

We originally worked with roosting birds, and found that broadcasts of the recorded distress call to birds trying to enter a roost, after three or four consecutive nights, clears the roost. The duration of clearance is variable, depending on a number of factors. The use of the distress call in feeding situations has been exploited mostly in France and Germany, where laboratories have been set up to study communication signals of animals, with the idea of using them for pest control. In the United States, for some time, systematic experiments with the Starling distress call were almost restricted to our laboratory, with only scattered, often perfunctory, tests elsewhere. Recently, Gordon Boudreau of Phoenix, Arizona, has entered the field, working chiefly on agricultural pests, and has done excellent work. He has developed acoustical bird control to the point that it is almost self-supporting economically. In Arizona and California he has Starling control operations in grape vineyards and similar situations.

The success with the Starling distress call led us to study the Herring Gull. Here we could not get a distress call, so we were led to study the language of the bird more carefully to find a call with clear-cut effects. The alarm call, which is produced when a gull sights a captive or dead gull, is very repellent, if broadcast correctly; in this case, correctly means for a short time, followed by a silent period. Some calls, such as the call given when the birds sight food, are very attractive. These reactions can be used for practical control, and this has been done in Europe, particularly Holland, where gulls are thus chased from airports. It seems unfortunate to us that many workers with gulls try to use the distress call of the gull. Our experience with a number of species of birds is that an alarm call is usually more effective than a distress call. Certainly, much work remains to be done on gulls, but in this case, as with Starlings, sufficiently practical results have been achieved to justify the work.

Another pest bird which we have studied is the Eastern Crow. As one would expect, the crow has a goodly repertory of calls. By exchanging recordings with European colleagues, who were similarly studying other species of corvids, we found that crows probably have dialects -- birds from different parts of a continent may have different communication signals. This was also noted with the Herring Gull -- in Europe, this species has one set of signals, in America, a different set. This means that recordings may not be generally valid for a species; instead one may have to record calls for local use only. Other birds for which acoustical controls have been studied, mostly by Boudreau, are linnets, English sparrows, prairie horned larks, robins, and some species of doves.

We might briefly state a few generalizations about acoustical bird control, and note some problems. First, it may be difficult to decide on which call to use as a basis for control. For instance, the relative effectiveness

of alarm calls and distress calls probably differs with the species. Thus, the distress call may be effective with Starlings, because the birds form compact aggregations. Putting it in more or less human terms, an attack upon one Starling which causes it to scream, is a present danger to other Starlings. The distress of one gull, however, may be of little concern to other gulls, which are usually not too close.

With many birds, the fidelity of sound reproduction is unimportant. The Starling in the United States apparently has a poor ear, responding to sounds generally resembling the distress call. However, in Germany, attempts to use the distress call to scare Starlings were unsuccessful until relatively high fidelity equipment was developed. What the cause of this difference is, we do not know. Suffice it to say, that for most of the birds that we have worked with, high fidelity is not necessary. Birds' hearing organs seem to be poorer than those of man.

The timing and spacing of applications of sound are very important, and these can only be determined by studies on behavior. Speaker placement, to deliver the correct intensity, is an important matter also. Obviously, it is necessary, in using a communication signal, to have the sound at the bird approximately what it would be if it were being produced by another bird. If a sound is too loud, the birds respond only as if it were a noise. If the sound is not loud enough, the birds may not react at all.

An important characteristic of the reactions of birds to communication signals is that the reactions may not be immediately obvious. For instance, when one first broadcasts the Starling distress call, he can see that the Starlings fly away precipitously. However, it soon looks as if the repellency is lost. Thus, on the first night of a Starling roost clearance, the birds continue to return after being chased, and ultimately, as it gets darker, they stay. It looks as if they have merely been chased around, and nothing further. But this is not so, for if one continues the broadcasts for a second and a third night, the group deserts the roost. With many feeding birds, Boudreau has found the same. For the first few days there seems to be little or no lasting effect -- the birds fly away, but quickly return. Gradually, however, they stay away longer and longer, and after three or four days almost stop returning to the feeding area. This is an important fact to note, for many persons give up on attempted acoustical controls far too soon.

A criticism directed at acoustical methods of bird control is that they only shift the problems, not solve them. Some people have even worried about the legal aspects. Could one farmer successfully sue another, if birds moved to his farm from the other? The answer seems to be: No. The situation is the same as in the use of mosquito repellents. If you are lying on a beach with a mosquito repellent on you, you are presumably unavailable for mosquito feeding. Obviously, if I am nearby without protection, the mosquitoes that might have fed on you, must feed on me or go hungry. I certainly cannot sue you for protecting yourself, for the repellent is also available to me.

This, however, is a merely legalistic viewpoint. More important to us is the question: Do we merely shift birds to a new place, but still have them as pests? In Millheim, Pennsylvania, Starlings, which roosted in trees in town, moved to a woodlot outside of town, where they were no trouble. There are many situations in which birds can be moved to places where they

might remain harmlessly. In France, Giban and Busnel have shown that sound can be used for population control. Crows were driven from nests by broadcasting distress calls at night. The eggs were thus exposed to cold air and failed to hatch. By the use of sound for only one or two nights, a whole generation of crows from that breeding colony was destroyed. Birds might also be driven with sound into specific areas where they can be easily destroyed. So, sounds need not merely shift pests from place to place.

One of the biggest questions about acoustical pest control to many people is: Why is this not developing more rapidly? Why have so few biologists tried to use this method for vertebrate pest control?

It was, almost to the day, ten years ago that we described the use of the distress call for the control of Starlings. Yet there has been amazingly little serious work done in the United States to test the usefulness of communication signals for pest control. France and Germany have set up laboratories to study this, but, in the United States, the work has been very desultory. Why? I believe that there are good reasons, and I would like to review them.

First, one might expect that commercial enterprises would take an interest in the development of acoustical pest controls. Actually, a number of companies have consulted with us on possible development programs. What probably deters most of them is that we cannot tell them how to make a device that is ready for field tests. We must say that time, money, and research will be needed before a prototype will emerge. Obviously, commercial interests are looking for economic return, and there can be no promise of this. They may be willing to risk capital in investigations of acoustical pest control, but they would like to know how many years and how many people would be involved. Unfortunately, in almost all cases, no one can even guess intelligently.

The second problem in the development of commercial interest involves the protection of a company's rights to its discoveries. The action of the Starling distress call was discovered at Penn State University. The university, under contract with the Air Force, applied for a patent. The application was turned down by the Patent Office on a ridiculous technicality, which does not concern us here. As far as I can discover, the application would probably have been denied for some reason, if not the one cited. So a company could probably only patent a piece of equipment; if no special piece of equipment were used, there would be no protection of rights. For instance, if some company were to find that sounds of certain frequencies and patterns would chase rats and mice, there is nothing to stop another company from analyzing the sounds and using the same sounds in exactly the same way.

Another deterrent to commercial interests has been concern for their public image. In dealing with bird control by recorded communication signals, the press has often been unwittingly most unkind. This field seems to arouse an almost irresistible urge to poke fun and make serious research appear ridiculous. I shall return to this in a moment.

The second group that might do research on acoustical pest control is the university scientists. Probably the greatest deterrent here has been lack

of interest. Universities are usually committed to fundamental research, and this is a special applied sort of work. It does not even fit easily into programs of training in technical sciences, such as wildlife management, so it has been rather ignored.

I think, however, that here too the major deterrent has been bad publicity. Speaking personally, I must say that I have been shocked many times by newspaper stories about this work. Most amazing is the dedication of some editors to the dogma that nothing can control Starlings or other birds. In cleaving to this, the editors do not hesitate to stoop to downright untruth. Starlings as urban pests often create a political problem, and local newspapers, in attempts to smear park commissioners or mayors, may not hesitate to trample on a university professor who is trying to do scientific work. I could name at least two cities in which the distress call of the Starling gave effective control, but local newspapers, to embarrass the administration, reported exactly the opposite. This is not the sort of thing to which university scientists are accustomed.

The third group of workers that should be interested in acoustical pest control are in governmental agencies: state and federal fish and wildlife services, for instance. The slowness of interest here can also be explained. First, these men have their own problems and interests, and pest control is only one, often unwanted, aspect of their work. Typically, too, these agencies are called on for immediate solutions, not long-range research and development. Next, most biologists are not trained in acoustics or electronics, and so equipment used in these studies may be rather foreign to them. I would like to say, parenthetically, that there is no reason why this should deter a biologist, for the necessary electronic and acoustical knowledge can be gained with relative ease. It is not necessary to be an electronic engineer to study acoustical pest control.

Probably the greatest difficulty in the attitude of governmental agencies has been a lack of appreciation of the difference between research and development. Research demands a questioning, doubting attitude. Development takes faith -- the belief that what one is setting out to do can be done, if only he can find how. Thus, in inventing the airplane, the Wright brothers did not stop with the first failure of their airplane. They believed that they could make it fly, and went back to their research to get the information they needed to make it do so. It is this sort of faith that we need in this much less important field now.

We know too little about animal behavior, we know too little about bioacoustics, to plan rigidly controlled tests in advance. We must begin with the idea that, somehow, the acoustical answer to a pest problem can be found. When it is found, it may be economically impractical, but we cannot merely set up one rigid trial, and quit if a selected result is not obtained immediately.

Too many people have been willing to surrender before giving acoustical pest control a reasonable try. It is amazing to observe testing methods being rigidly continued -- because rigidity is believed to be necessary for research -- against an obvious crying need for change. One must usually change his approach as he goes, as he learns about the pest. Boudreau, for instance, worked for three years on prairie horned larks before, still con-

vinced that there must be some call to which these birds would respond, he found the right call and the correct method of application. It is perhaps unfortunate that one has to change his methods in the middle of his experiments, but it is usually necessary. If he is unwilling thus to use his experience, he might just as well not start. It certainly does not make for neat tables or easy descriptions in the final article, but it is unavoidable. I can well remember, in every Starling control operation in which we have been involved, sitting down after each night's work to go over what we had done right and what we had done wrong, so that we could incorporate corrections and new ideas into the next night's work. This is absolutely necessary, if one is to evaluate properly, and it is this that many have been unwilling to do.

My attitude toward acoustical pest control is best expressed by the statement: any pest bird can be controlled by sound. This is obviously an affirmation of faith. My observations during the past ten years make the belief stronger today than ever before. Whether the ultimate control that could be developed would be economically practical or not, would have to be decided in each case. But I do believe that, if one is willing to give the time and brains to it, he can find, for any bird, a method of acoustical control. With mammals, I would not be so sure, but it looks hopeful.

This will not be done, however, by starting with a feeling that it is not going to work, and "loading the dice" against success by supposedly scientific, rigid protocols. One must be willing to reset his sights, to change his direction, so that he can ultimately achieve his goal. Acoustical pest control is new, and certainly not destined to be a panacea, but it has great promise. Achievements, however, will require faith and a certain element of luck, until animal behavior and bio-acoustics have progressed much farther than they have.