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United States
Department of
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Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins,
Colorado 80526

**General Technical
Report RM-171**

Ninth Great Plains Wildlife Damage Control Workshop Proceedings

April 17-20, 1989
Fort Collins, Colorado

Great Plains Agricultural Council Publication 127

Bjugstad, Ardell J.; Uresk, Daniel W.; Hamre, R.H., technical coordinators. 1989. Ninth Great Plains Wildlife Damage Control Workshop Proceedings. General Technical Report RM-171. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 181 p. [Also listed as Great Plains Agricultural Council Publication 127.]

Abstract

These proceedings consist of 43 presented papers on control of damage caused by many different animals. After an "overview" session, papers were presented in sessions titled: Carnivores, Urban, Big Game, Birds, and Rodents and Lagomorphs.

Keywords: Prairie dogs, coyotes, rodents, bird repellents, predacides, rodenticides.

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USDA Forest Service
General Technical Report RM-171

July 1989

Ninth Great Plains Wildlife Damage Control Workshop Proceedings

April 17-20, 1989
Fort Collins, Colorado

Technical Coordinators:
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Sponsor:
Great Plains Agricultural Council, Wildlife Resources Committee

In cooperation with:
USDA Forest Service
USDA Animal and Plant Health Inspection Service
Colorado State University
Colorado Division of Wildlife
Colorado Department of Agriculture
Wyoming Game and Fish Department

Great Plains Agricultural Council Publication 127

Preface

The professional field of animal damage control has evolved over the years into a complex and diverse activity. It continues to be a very necessary part of the wildlife management scheme. However, it has become increasingly important to include the public and their impressions and attitudes in all phases of planning and implementation. Communication, public involvement and a sensitivity to people and wildlife are now required tools of the trade.

In his keynote address Jack Berryman told us of the necessity to be aware of the attitudes of the public of all phases in vertebrate pest management. We must not be solely defensive. The public must be informed about what is being done, why it is being done, and how all humaneness possible is included in the how it is being done.

The eventual consequences of legislation banning steel leg-hold traps is serious. Such legislation is proliferating and has passed in some states. Such actions require our full professional attention.

This workshop brought together about 200 professionals who shared their experiences, thoughts and projections into the future. Many of the papers presented included a dimension involving the attitudes of various publics plus the influence of those attitudes on the work being done. Only by being keenly aware of the importance of the public in animal damage control programs and by professionally sharing ideas and experiences on how best to conduct good ADC programs will the animal damage control component of wildlife management continue to thrive.

People and wildlife can live together in harmony with proper management and attitudes. Vertebrate pest control methods are evolving well, however both professionals and the public must strive for understanding, balance and harmony.

While many persons contributed to the success of this workshop special thanks are due Gerri Siverts, CSU Extension secretary and the CSU Wildlife students, Chuck Anderson, Rick Gardner, Ron Thomas, Mike Warner, and Jeff Williams, who assisted with audio visual needs.

Although they are listed in these Proceedings, the session moderators, the planning committee, financial contributors and various supporting agencies all deserve special thanks.

The field trip was to Rocky Mountain National Park. Dave Stevens, wildlife biologist, U.S. Park Service, assisted by Rick Spowart, District Wildlife Manager, Colorado Division of Wildlife, made the trip both enjoyable and educational. Thanks to both of them.

We look forward to seeing all of you again in Lincoln, Nebraska in 1991.

Robert S. Cook
Wildlife Committee, GPAC and
Conference Co-chair

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Workshop Summary[1]

William F. Andelt[2]

The Ninth Great Plains Wildlife Damage Control Workshop was attended by 195 registered participants. Participants arrived from at least 20 states and 2 Canadian provinces. A total of 54 papers were presented at the workshop. Seventeen exhibitors provided commercial displays. The workshop concluded with a field trip to Rocky Mountain National Park where wildlife management in the park and elk damage to aspen trees were discussed.

A large diversity of occupations were represented by workshop participants including ranchers, professional pest control operators, extension wildlife specialists, fish and game agency personnel, university and agency researchers, administrators, and others. Participants were very interested in prevention and control of wildlife damage. However, they also were interested in song birds, endangered species, and wildlife enhancement in general.

A great deal of information was exchanged at the workshop. Jack Berryman encouraged us to publish and share our knowledge about wildlife damage control. Bobby Acord stressed that we should measure the success of an animal damage control program by the amount that damage is reduced and not by the number of animals that are removed. Mike Leroux and Ed Hansen, both ranchers, indicated that ranchers like to have wildlife on their lands but ranchers want to be compensated for allowing a large number of wildlife that cause damage to remain on their lands. They also indicated that wildlife agency animal damage control programs are too complex and that additional dialogue is necessary to improve rapport between wildlife agencies and landowners.

The workshop emphasized papers on carnivores, big game, birds, urban wildlife, and rodents and lagomorphs. Agency programs and solutions to wildlife damage problems were discussed. Evaluations of several innovative animal damage control techniques such as the use of monofilament lines for reducing bird activity in citrus trees and around bird feeders as well as the use of anthranilates for repelling birds from cherries and livestock feed were discussed.

Robert Schmidt presented the concerns and views of individuals interested in animal rights and animal welfare. Animal welfare interests are primarily concerned about pain and suffering in animals. He emphasized the use of effective animal damage control techniques that result in the least adverse impacts on problem animals. Dale Shaw (Dr. Martin Windsor), in a thought provoking discussion, emphasized the need for hunters to display appropriate behavior when pursuing their sport.

A diversity of views on the effectiveness of some animal damage control techniques, especially livestock guardian dogs, were presented. Presentations of opposing views are beneficial because they frequently elicit thought, discussion, and additional ideas for better ways to employ animal damage control techniques. Although it is frequently easy to criticize certain animal damage control techniques, the challenge upon us is not to criticize but rather to invent new techniques, determine how to better adapt old techniques, and to determine why other techniques do not work.

In the future, conflicts between man and wildlife will continue. Demand for wildlife damage prevention and control techniques and educational information likely will increase. Wildlife damage control professionals need to continue to evaluate animal damage control techniques and publish their findings. They need to evaluate techniques by conducting true experiments with treatments and controls; descriptive studies are not enough. In the future, wildlife damage control professionals will need to select control methods based upon their effectiveness, minimal amount of pain and suffering caused to target animals, minimal impact upon non-target species, public opinion, and lastly cost. Our roles will remain important for reducing conflicts with wildlife and retaining wildlife on our lands.

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[1]Summary of papers presented at the Ninth Great Plains Wildlife Damage Control Workshop, Apr. 17-20, 1989, Fort Collins, CO.

[2]William F. Andelt is Associate Professor and Extension Wildlife Specialist at Colorado State University, Fort Collins.

Animal Damage Control: The Challenge of the 90's[1]

Jack H. Berryman[2]

Abstract.--The talk identifies the challenges of the 90's as: to fully professionalize the policies and practice of animal damage control; to provide a responsible and acceptable level of control; to gain executive and legislative support; and to improve public acceptance. It points up a number of obstacles and identifies several steps necessary to meet the challenges.

I am really pleased to have this place on the program because I firmly believe that the 90's provide unparalleled but achievable challenges and opportunities in the field of animal damage control. But, there are also unparalleled obstacles to be surmounted.

At the outset let me state the challenges as I see them: to fully professionalize the policies and practice of animal damage control; to provide a responsible and acceptable level of control; to gain executive and legislative support; and to improve public acceptance. In short, to get animal damage control back on its feet. That is a very full plate indeed.

And, there are some very imposing obstacles to be confronted: a long period of benign agency neglect which has sometimes bordered on irresponsibility; increasing public antagonism coupled with declining constituent confidence; declining professional acceptance; and, the mounting influence of the animal rights movement.

Animal damage control is at a very pivotal point in its long and checkered history. The circumstances are right for basic advances -- if we collectively seize the opportunities that now prevail.

I feel I can be candid because of a long involvement in and with animal damage control work.

Let us pause for a moment to review the causes of some of the problems. Animal damage control was one of the early targets -- and victims -- of the so-called "environmental movement" of the late 60's and early 70's. Faced with the increasing emotional attacks of protectionist organizations, the Federal Government and some state governments waffled in their responsibility to implement and defend responsible programs. Rather, they vacillated, which only fueled the fires and added to the divisiveness. They misjudged the movement, thinking it was aimed only at animal damage control, not realizing that it was only the forerunner of a broader anti-hunting and anti-management movement. And, that it would later blossom into the animal rights crusade.

The Federal role was anything but an example of responsible leadership. Aided and abetted by EPA and CEQ, the Department of the Interior tried several tacks. One Secretary wanted Interior "out of the business" which finally resulted in eliminating many of the tools; one studied the problem for his entire tenure -- but successfully avoided decisive, responsible action; and one finally solved the problem, at least for Interior. He got rid of it by acceding to its transfer to the Department of Agriculture. More on that later.

Regrettably many wildlife professionals, especially those in administrative positions, did not cover themselves with responsible, professional glory. They found the activity too controversial. It detracted from their mission; it lacked the appeal of such issues as rare and endangered species; and they did not consider it a part of wildlife management.

With Federal apathy, professional snobbery and mounting public antagonism, some conservation organizations abandoned animal damage control and either moved to neutral or antagonistic ground.

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[1]Keynote address, Ninth Great Plains Wildlife Damage Control Workshop, Fort Collins, Colorado, April 18, 1989.

[2]Counselor Emeritus, International Association of Fish and Wildlife Agencies, Washington, D.C.

And through it all, those who suffered damage lost confidence in the agencies responsible for providing relief -- and some began to take matters into their own hands.

So much for history. It is in the past, and we must look to the future. But, we must understand the reasons for the very low ebb of the late 80's if we are to take constructive positive action to turn the tables in the 90's.

I believe that history will record that the transfer of the animal damage control activities from Interior to Agriculture was the institutional change that set the stage for constructive action. And in saying that, I point out that the International Association of Fish and Wildlife Agencies, which I represented, firmly opposed that transfer as a matter of principle.

One of Agriculture's leaders likened that action to repotting a plant. It is a good analogy. The revitalization is being reflected in improved direction, support and employee morale -- and with actual gains in a professional approach to animal damage control.

The subsequent establishment of the Secretary's Animal Damage Control Advisory Committee provided the means for involving a wide array of interests to assist in implementing a revised and responsible program. I am pleased to be a member of that Committee. With the full cooperation and support of Agriculture leaders, it is moving in a positive way to redirect the Federal role in animal damage control and to define the role of cooperating agencies and organizations. Animal damage control programs rely mainly on the 1931 Act for legislative authority. There remains an urgent need, however, for a legal or legislative clarification on the responsibility for control of waterfowl depredations. I sincerely hope that the leadership, support and direction in Agriculture and APHIS are continued by the new Administration; and, I implore support for its continuation.

Now, with the initial institutional steps taken, what can we, as individuals, do to meet the challenges of the 90's?

First, we need to take a new look at ourselves -- at the profession. Animal damage control is a fundamental part of wildlife management. It is not a separate entity; never an end in itself. The control of animals is never the objective; rather the prevention of various kinds of damage necessary to accomplish a specific management objective. It works in harmony with research, enforcement, protection and acquisition as one means of regulating animal numbers to accomplish a specific management objective. It is also necessary to this Nation's production of food and fiber and as a service to constituents in protecting communications and transportation and human and animal health. In short, it is a vital function and its practitioners are integral contributors to rational resource management -- in no sense second class citizens in the resource community.

Enough of self-examination; we have much to do.

Animal damage control must be fully professionalized. A solid data base, sound policies, improved methodology, protocols and accountability are givens and require no elaboration by me. Additionally, there are specific things that each individual can do.

The long period of harassment of animal damage control workers has caused them to draw inward, to isolate themselves, to adopt a seige or "circle the wagons" mentality. Well, the seige has been lifted and its time to become full and active partners in the professional community. It is extremely important to participate actively in the professional societies; to attend, participate and present papers at the national and regional meetings -- in a word, to come out of our shells and rejoin the professional community.

It is important that those engaged in animal damage control, whether it be in operations, extension, surveys or research, publish more widely in the professional journals and outlets. In addition to publications on the methodology of control, it is necessary to document field observations, results, the ecology of control, and related economic findings. There is need to add to the credible body of knowledge on every aspect of animal damage control. And, this should not be left exclusively to the universities or the researchers. It should also come from those actually engaged in management.

Related to all of this, there has been a welcome change in the views of many wildlife managers. Some of you may recall that following issuance of the Leopold Report in 1964, the popular view was that animal control had no role in wildlife management. Well, it has now been documented that it does have a role under some circumstances -- in the re-establishment or re--introduction of endangered species, in pheasant and waterfowl management and aquaculture. And, there has been increasing recognition of the role of control in protecting communication and transportation systems. So, there is an improved professional climate. This workshop is evidence of that change.

There is need for all of us to influence the universities that animal damage control should be included in wildlife management curricula. It is indefensible that such an important, complicated, controversial and sensitive subject is not covered adequately by formal instruction when students are acquiring the background they will need for a professional approach to resource management issues.

One of the most important first steps in securing public acceptance and increased legislative and executive agency support is to improve cooperation and relationships all across the board. In meeting with the States, the Woolgrowers, APHIS personnel and others, I detect some animosities and frictions -- some overt lack of cooperation. It is a luxury we cannot afford. The agencies of the Federal Government, the state fish and wildlife and agricultural agencies and industry cooperators are all partners in animal damage control work, by practical necessity, by agreement and by legal mandate. This means that cooperation and good working relationships are not just desirable -- they are imperative. To win support, they must stand as one. I urge all concerned to take the initiative -- to take the first step in repairing and building these relationships.

In addition to working in professional and cooperative circles, we must reach the public with accurate information on all aspects of control. We must achieve credibility with the media and utilize all forms of education, including extension, to improve public acceptance.

Obviously a major challenge of the 90's is to provide an acceptable and responsible level of control. That is the mission of the function. I submit, however, that this can only be achieved on a continuing and stable basis by giving priority attention to professionalization, an improvement in relationships and public acceptance.

To achieve this objective, animal damage control must operate from a position of strength within the existing state and federal structures. It must be supported as part of their mission -- not as an appendage, not as a separate entity. It must have credibility, respect, stature and influence as part of the organization -- and also throughout the resource, industry and agricultural communities.

This is one reason why I believe that the new arrangement with the Department of Agriculture and APHIS is so important. The initial support and direction has been provided. And, it is so refreshing and so long in coming. But now it will take individual performance and initiative to secure the gain. It is indeed a case of "pulling yourself up by your own bootstraps." The burden is on each worker, each supervisor and each administrator to demand and reach for the best professional performance and result. This is the surest path to providing acceptable and responsible levels of control.

All that I have discussed runs counter to the animal rights movement for that movement is diametrically opposed to animal use and management. It presents a most serious threat to all management programs. Its proponents are at work on many fronts: medical research, uses of farm animals, hunting, the wearing of fur and other examples, ad nauseum. And, they are working in a very effective and sophisticated manner with an emotionally appealing subject, with well known supporters, a sympathetic media, extensive use of the courts and effective lobbying efforts. They are a force to be reckoned with and a force that must be countered.

But, make no mistake -- there is a vast difference between animal rights and animal welfare. We would not be in the business of wildlife management if we were not interested in the well being of wildlife. Animal rights proponents, however, equate the rights of animals with those of humans. In our opposition to the animal rights movement, we do not want to oppose or even appear to oppose legitimate efforts to correct animal abuses. We don't want to throw the baby out with the bath.

I don't know what the answer is or what a workable broad strategy might be for dealing with the animal rights movement. I am convinced, however, that direct confrontation is not the answer. A successful strategy will need to be intelligent, sophisticated and broad guage. The International Association of Fish and Wildlife Agencies, along with others, is moving in that direction.

That movement will continue to frustrate animal damage control work at every turn. I believe that for now the best strategy and defense, insofar as animal damage control workers are concerned, is to conduct a professional, responsible program. At the same time, it will be important to monitor the movement and stay abreast so that all necessary responses will be professional and rational.

I am convinced that many circumstances come together to provide a real opportunity, a real challenge for the 90's. There is a good block of solid support for responsible control. The International Association of Fish and Wildlife Agencies and its member states and provinces are use oriented. They are wildlife managers. They will be supportive of responsible programs. The Association has, through all the years, been a cooperator and active supporter of responsible control. It will be testifying on an expanded APHIS budget this month. You may be sure this support and cooperation will continue.

We are at a point in resource management where individual performance and action are needed. I am confident it will be forthcoming.

Thank you and good luck!

The Current Program and Future of ADC in the USDA[1]

Bobby R. Acord[2]

The ADC program was transferred to the U.S. Department of Agriculture, Animal and Plant Health Inspection Service in December 1985. The ADC mission continues to be the protection of American agriculture and other resources from wildlife damage. Changes have been implemented to enhance the program, and efforts are continuing toward additional improvements.

As most of you are aware, the Animal Damage Control (ADC) Program was transferred from the U.S. Department of Interior-Fish and Wildlife Service (USDI-FWS) to the U.S. Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS) about 3 years ago. The APHIS-ADC mission continues to be the protection of American agriculture and other resources from wildlife damage. There have been a number of changes in the structure and organization of our program since the transfer to USDA. Today I'd like to discuss some of the changes we've seen since 1985 and outline the direction that ADC is taking to deal with some of the major issues confronting our program at the present time.

One of the measures undertaken by ADC to assure the long-term effectiveness of the program has been the formation of a Strategic Long Range Plan. ADC's Top Management Team (TMT) identified and assessed apparent program strengths and weaknesses, external influences and relationships, and conditions that would ensure continued program vitality. Based on these factors, the TMT identified a set of strategic goals for ADC and developed a plan for their achievement over a 5-year period. We are currently pursuing strategies to achieve many of these goals, and we're optimistic about where the full implementation of this plan is going to take the ADC program.

Another positive step taken to improve our program since the transfer to USDA has been the establishment of a National Animal Damage Control Advisory Committee (NADCAC). NADCAC is composed of 20 members chosen from nominees by the agriculture industry, conservation and environmental groups, land use groups, and wildlife agencies. The purpose of this committee is to make recommendations to the Secretary of Agriculture on policies and program issues regarding wildlife damage control. Issues and problems addressed include wildlife interfering in agricultural production, jeopardizing human health and safety, and creating nuisance problems in urban areas. NADCAC has been very supportive of ADC, and their recommendations have been extremely helpful in guiding the program.

One of the most important issues ADC is currently involved with is the completion of a programmatic environmental impact statement (EIS). APHIS is legally required by the National Environmental Policy Act (NEPA) to conduct an EIS on the ADC program. The EIS under which we now function was completed in 1979 while the program was under the FWS, and covered only the western predator control program. This EIS was formally adopted by APHIS as an interim measure, but was to be replaced as soon as possible. Efforts are well underway toward completion of the new EIS, which will cover the entire program. We have been working closely with the EIS contractor, Dames and Moore, and the draft EIS is due to be released later this year.

One issue that's presented somewhat of a challenge for ADC since the transfer to USDA has been the resolution of migratory bird damage problems. These include waterfowl and blackbird depredations on grain crops, depredations by fish-eating birds at aquaculture facilities, and bird/aircraft strike hazards at airports. While ADC is

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[1] Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop, Fort Collins, Colorado, April 17-20, 1989.

[2] Bobby R. Acord is Associate Deputy Administrator, Animal Damage Control, APHIS, USDA, Washington, D.C.

responsible for addressing these problems, we have encountered some obstacles because we have had no management or regulatory authority. This authority lies with the FWS, and we are currently working closely with FWS people to overcome some of the regulatory obstacles to dealing with migratory bird problems. We're optimistic about these negotiations and are looking forward to being able to solve these problems more effectively in the near future.

Another area of particular concern to our program has been predator control on public lands. This issue is coming under increasing public scrutiny. There are a lot of people out there who are very much against any kind of predator control program being conducted on public lands. On the other hand, the livestock industry at times suffers tremendous losses to predators on these lands, and this industry relys on ADC to help protect their resources. The Forest Service (FS) and Bureau of Land Management (BLM) are becoming very cautious and often more restrictive in allowing predator control on public lands. Increasingly these agencies want to dictate types of control tools used as well as the placement and timing of their use. These decisions are often being made by managers with limited ADC expertise in response to pressure from the public and environmental groups. This has made it more difficult at times for us to carry out our mission. We continue to work closely with FS and BLM policy officials, and are optimistic that we'll be able to address concerns on both sides of the issue and still do our part to protect the agricultural resource.

With the transfer to USDA there has been a change in outlook on the kind of work we ought to be doing, with increased emphasis placed on the protection of agriculture and human health and safety. This change has carried over to ADC's research unit, the Denver Wildlife Research Center (DWRC). The focus of research efforts has now shifted more toward solving specific ADC problems. A strong research effort is vital to the continued success of our program. All of the tools that we have now are our "life blood," and we need to maintain the use of these tools to accomplish our goals, but at the same time we have to start looking at a new generation of control tools--replacements for the tools we're now using in case we eventually lose these. The tools that are going to provide us with effective animal control in the ecological, cultural, and political climate facing us 10-20 years from now will be based on today's investments in long term research. USDA has requested funds to upgrade DWRC facilities and equipment to bring them into compliance with EPA's Good Laboratory Practices and the Animal Welfare Act. These improvements are needed, and they will allow research to better meet the future demands of the ADC program.

In addition to other research, DWRC is responsible for the registration of all the pesticides used in ADC. Pesticide registration is a complicated and expensive process. Costs for registration of a new chemical can range from $5,000 up to $20,000,000 or more, depending on the intended use for the product. Maintaining existing registrations is also expensive. For example, to maintain the registration of strychnine products, additional data requirements have to be completed by ADC and submitted to EPA within the next 2 years. Estimated costs for these data call-ins range from $500,000 to $3 million. Our program has been underinvesting in research to develop data necessary for the maintenance of pesticide registrations, and we're currently trying to catch up. ADC research is dedicated to developing new pesticides and maintaining the registration on those products that are vital to our program. The improvements to DWRC mentioned earlier will help with this endeavor. Increasing costs, increasingly restrictive environmental regulations, and increased opposition to chemical control methods present a challenge to our efforts. ADC will continue to develop and maintain effective control tools that best serve the requirements of the ADC community.

Another issue relative to pesticide registration that is confronting ADC right now is EPA's new Endangered Species Pesticide Labeling Program. The intent of this program is to ensure that the use of pesticides does not threaten the survival of any threatened or endangered species. This is a very complex program being implemented under the authority of the Endangered Species Act, which is administered by FWS, and the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) which is administered by EPA. The program was first announced by EPA in May 1987, and originally was to be fully implemented by February 1988, but is still on hold. It's been quite controversial because if implemented as originally designed, the net effect of the new labeling requirements would have meant severely restricting or eliminating the use of many pesticides registered for use by ADC. Currently EPA, USDA, and the USDI are all working toward revising and improving these labeling requirements to assure the protection of endangered species while still permitting the essential use of pesticides. This program will undoubtedly affect the way ADC operates in some areas, but we can't fully estimate the magnitude of this effect until the scope of the labeling program is completely known.

We all recognize the need to protect endangered species, and ADC is actively involved in efforts toward this goal. In cooperation with other agencies, control programs have recently been initiated to protect endangered species such as the desert tortoise, California least tern, and several species of Hawaiian birds. We are also involved in efforts to control damage caused by one endangered species, the eastern timber wolf in Minnesota. We have responded to this problem by removing those animals that are responsible for the livestock loss. This control program complies fully with the endangered species regulations, and is accomplished through the cooperation of ADC, FWS, and the Minnesota Department of National Resources. ADC involvement with the control of endangered species could increase in the future, either as a result of the natural expansion of endangered species populations, or the reintroduction of endangered species into their former ranges.

Another project we currently have underway is modernization of our Management Information System (MIS). This is a computer based system that records, processes, stores, and reports information that pertains to the operational activities of the program. The MIS was developed in the late 1970's to assist with the informational needs of western State programs, but it only became operational in Arizona, California, New Mexico, Oklahoma, Texas, and Utah. The MIS records and maintains data on resources, damage, control methods used, and animals taken. This system generates a variety of reports derived from these data, including some for internal use and others for submission to State or cooperator entities. Use of the MIS has enhanced the credibility of the ADC program with other Federal, State, and local agencies. However, due to equipment obsolescence, and the need for a uniform system to serve the entire ADC program, the current system has reached its effective limits. A long-range project has been initiated to redesign the system using updated, state of the art hardware and software, and we believe it will provide the database for a decision support system that will improve the overall efficiency of the ADC program. The new system is expected to be operational in all States in 2 years.

Animal damage is being recognized throughout the U.S. as a serious problem, and interest in the ADC program is high. Congress has responded by increasing funding for ADC. We've gone from a budget of 19.4 million at the time of the transfer to a proposed budget of 29.8 million for FY 1990. We're expanding to address a wider range of species and the entire spectrum of wildlife damage problems. We're developing additional cooperatively funded operational programs in the East, and there is widespread support for developing more of these programs. Right now we have cooperative beaver control programs to protect timber in Kentucky, Tennessee, and Mississippi, trout streams in Wisconsin, and endangered freshwater mussel habitat in Louisiana. We also have cooperative damage control programs for Canada geese in Wisconsin and Tennessee, coyote control in New York, gull control at a U.S. Army facility in Michigan, and a nuisance grackle control program in Georgia. Part of the increase proposed for FY 1990 will be used to begin cooperative programs in those States that already have funds set aside for this purpose.

We have strong support within USDA for the ADC program. In the early days of the transfer from FWS there may have been some misdirection of our program, but now we have genuine ADC people leading the program, and we feel we're heading in the right direction. C. Joe Packham, our Deputy Administrator comes from a strong ADC background, and has made great progress in leading our program forward. Employee morale is high, and our people are enthusiastic about their work.

We have embarked on an aggressive staff recruitment and development campaign so we can maintain a qualified and competent workforce. Two years ago, we hired the first ever Supervisory Training Program class for the ADC program. Twenty wildlife biologists were selected from across the Nation and underwent intensive training. These people have become a vital part of our workforce. This class was hired in anticipation of a real drain on our supervisory workforce within the next 3-5 years, due primarily to retirements. Another recruitment avenue we've started using is that of cooperative education students. We are seeing more incorporation of ADC issues and functions in the curriculum at some major universities, and we're working with some of these institutions to develop cooperative education programs. There is getting to be a greater appreciation for ADC as a science in the academic community, but we need to continue working on this.

One of the things that we as leaders in the field of ADC have got to recognize is that there are different perspectives on ADC work, and we've got to attempt to deal with them. As our population grows and becomes more urbanized, the people involved in producing our nations food and fiber are becoming a smaller and smaller minority. This results in an increasingly larger percentage of our population that are not directly affected by the problems that wildlife may create for agriculture or the threats it may pose to public health and safety. The environmental

movement has resulted in increasingly restrictive regulations and opposition to ADC activities. All of these factors highlight the need for an education program, that when presented to the public in an unbiased fashion, will show how important ADC work really is. It's important not only for protecting agricultural products and economic interests of the producers, but for protecting the economic interests of the American consumer as well. We have long-range plans for developing and implementing a public information/education program that hopefully will lead to a greater understanding and appreciation of the need for control of wildlife damage.

We need to emphasize to people that we are not an animal control agency--we are a damage control agency. We emphasize the principles of Integrated Pest Management, and our sole interest is in resolving conflicts as efficiently and in as environmentally acceptable a manner as possible. At the same time there needs to be recognition that American agriculture is not going to provide the habitat and feed the Nation's wildlife free of charge. One of the most detrimental things that could happen to the wildlife resource is to be forced into indemnity for damage caused by its presence. An effective damage control program is a much cheaper alternative. It's up to us to see that it happens!

With the current leadership and support we have from USDA, NADCAC, the agricultural community, our cooperators, and our workforce, we're looking forward to providing the American public with an increasingly valuable service.

Planning for Animal Damage Control Programs within the Animal and Plant Health Inspection Service[1]

Philip S. Gipson and Gary P. Combs[2]

Abstract.--The Animal Damage Control Unit (ADC) and the 10 other units of the Animal and Plant Health Inspection Service (APHIS) have undergone major reorganization. Emphasis is placed on planning and risk analysis. Four levels of planning have been identified: (1) strategic planning for the Agency, (2) strategic planning for each of the 11 units, (3) program design and risk analysis, and (4) operational planning.

INTRODUCTION

APHIS and the ADC Unit have undergone changes that impact American agriculture and the ways wild animals are managed to reduce conflicts with man. In 1987, an APHIS management review group was formed consisting of 11 members from programs and support areas to review the Agency with emphasis on how the Agency could better service American agriculture and the Nation (Helms, 1988). The leadership of APHIS undertook a reorganization of the Agency based on recommendations from the review group. Personnel were assigned to new units and APHIS started to function under the new organization in October 1988. The publication, APHIS, Changing for the Future (Anonymous, 1988), describes the new organization of APHIS.

In December 1985, ADC was transferred from the Fish and Wildlife Service (FWS), Department of the Interior, to APHIS, Department of Agriculture, by Public Law 99-190. ADC became the third major operational unit in APHIS along with Veterinary Services (VS) and Plant Protection and Quarantine (PPQ). The fourth unit of APHIS was Management and Budget (MB). At the time of the transfer, APHIS intended to conduct ADC operations that were biologically sound, environmentally acceptable, and economically feasible.

ADC was placed under the direction of a Deputy Administrator, and the number of ADC regions was reduced from seven that existed under the FWS, to two; one for western States with headquarters at Denver, Colorado, and one for eastern States with headquarters at Brentwood, Tennessee. The Denver Wildlife Research Center (DWRC) and its field stations remained part of ADC and continued to be managed from Denver. At this time, APHIS initiated planning to prepare an Environmental Impact Statement for ADC, to provide guidance, and to assure that animal damage control activities were in compliance with the National Environmental Policy Act (NEPA). Historical reviews of ADC prior to the transfer to APHIS were authored by Wade (1980, 1986).

The purpose of this paper is to explain how planning for new animal damage control programs and revisions of current programs will be conducted in the reorganized APHIS.

THE NEW APHIS

The APHIS reorganization is primarily a headquarters reorganization designed to improve the way decisions are made and to provide better support to operational programs. Emphasis is placed on planning and risk analysis to address concerns about protection of the environment, use of pesticides and other chemicals, animal welfare, and rapidly changing agricultural industries. Multidisciplinary teams of specialists from within APHIS, the academic community, and industry are used to address these complex issues.

Planning and risk analysis are taking place at all levels within APHIS, and they are the focus of this paper. Figure (1) shows the new organization of APHIS. The Agency has gone from 4 major units (PPQ, VS, ADC, and MB) with support from the

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop, Fort Collins, Colorado, April 17-20, 1989.

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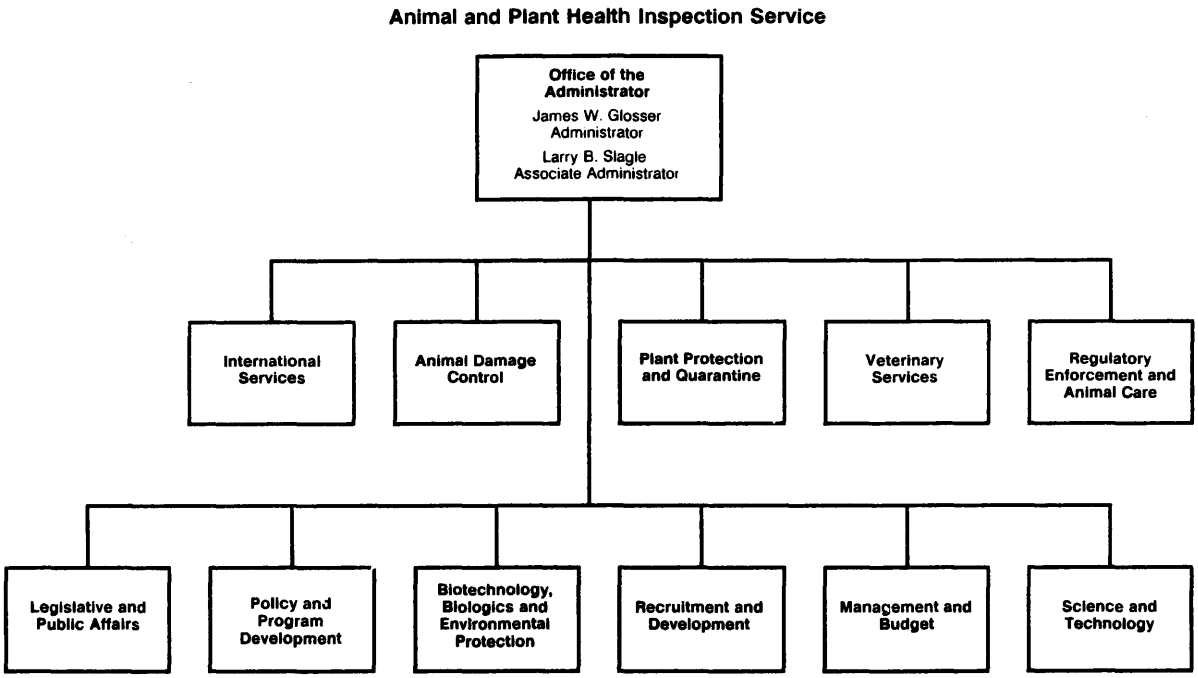

Figure 1. Organizational chart for the Animal and Plant Health Inspection Service (APHIS). Each of the 11 units along the parallel lines has a Deputy Administrator or Director who reports to the Administrator of APHIS.

Legislative and Public Affairs staff and the Biotechnology and Environmental Coordination staff to 11 major units, each with a Deputy Administrator or Director that reports directly to the Administrator of APHIS.

Since the reorganization, ADC includes the office of the Deputy Administrator, Eastern and Western Operational Regions, an Operational Support staff in Hyattsville, Maryland, and a Resource Management staff in Hyattsville.

CHANGES IMPACTING ADC

Two major changes within APHIS have marked impacts upon ADC. First, DWRC and other APHIS laboratories have been assigned to the Science and Technology Unit (ST), and the directors of the laboratories now report to the Director of Science and Technology rather than to the Deputy Administrators of ADC, PPQ and VS, respectively.

DWRC will continue to address needs of ADC, but emphasis must be placed on maintaining communications between researchers at DWRC and ADC operational professionals. DWRC is unique among the APHIS laboratories by having authority to conduct research as well as test and develop tools to serve the ADC Operational Unit. Other APHIS laboratories conduct tests and develop technology to serve the needs of VS and PPQ, but the Agricultural Research Service conducts research for animal and plant pest and disease programs. A formal planning and evaluation process is needed to assure that effective communications occur between the APHIS laboratories and operational programs, and that researchers at DWRC and the Agricultural Research Service are responsive to current and future APHIS operational needs.

The second major change impacting ADC relates to planning and risk analysis. A new unit, Policy and Program Development (PPD), has been formed within APHIS to conduct and facilitate planning, program evaluations, program design, risk assessment, policy analysis, and regulation development. One section of PPD that directly serves ADC is Animal Health and Depredation Management Systems (AHDMS). This section also coordinates program design and risk assessment for VS and other units of APHIS concerned with animal health, animal welfare, environmental issues, and management of wild animals.

PLANNING WITHIN APHIS

Planning within APHIS occurs at four levels (Figure 2). The first level of planning, APHIS strategic planning, is being developed by the APHIS Management Team (AMT) composed of Deputy Administrators and Directors of the 11 units of APHIS. APHIS strategic planning is guided by the Planning and Evaluation section (PE) of PPD.

The second planning level is strategic planning for the 11 units. The Deputy Administrator of ADC and the Deputy Administrator or Director of each of the other 10 units of APHIS are developing strategic plans for their respective units.

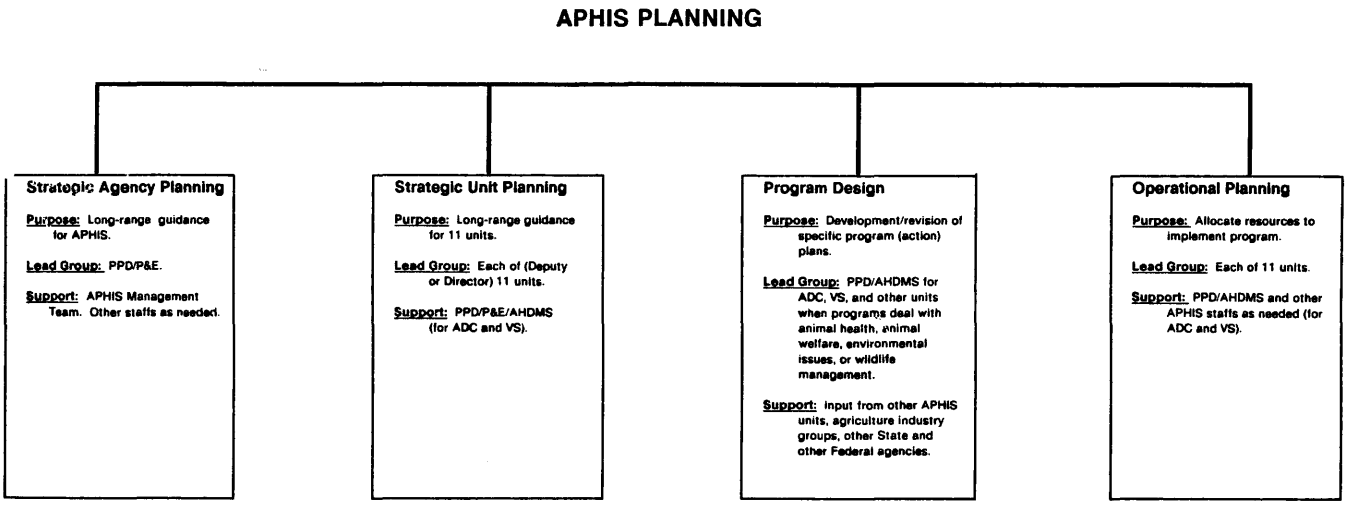

Figure 2. Levels of planning within APHIS.

The third level of planning involves development of long-range goals. Program design is an important part of this process. Design or modification of ADC programs may be needed when new damage threats develop, agricultural production changes, and when technology for controlling damaging animals changes. An example of a new threat to livestock is the recent establishment of wolves in Montana and other States. The rapid expansion of aquaculture, especially in southern States, is an example of a change in agricultural production that calls for ADC planning because of increases in damage from fish-eating birds. An example of a change in animal control technology that should be evaluated for use in ADC programs is refinement of the padded jaw trap.

AHDMS will play a lead role working with ADC and VS to design new programs and to revise ongoing programs. The analysis of risks associated with new or current programs will be an integral part of program design. The process used to design a new ADC program is presented in Figure 3.

The fourth level of planning, operational planning, takes place within each unit to set annual program objectives and allocate and manage resources. For example, once a new ADC program is designed, the ADC Unit will develop short-term operational plans to implement the program.

APHIS is trying to avoid pitfalls that other agencies and industries have sometimes encountered

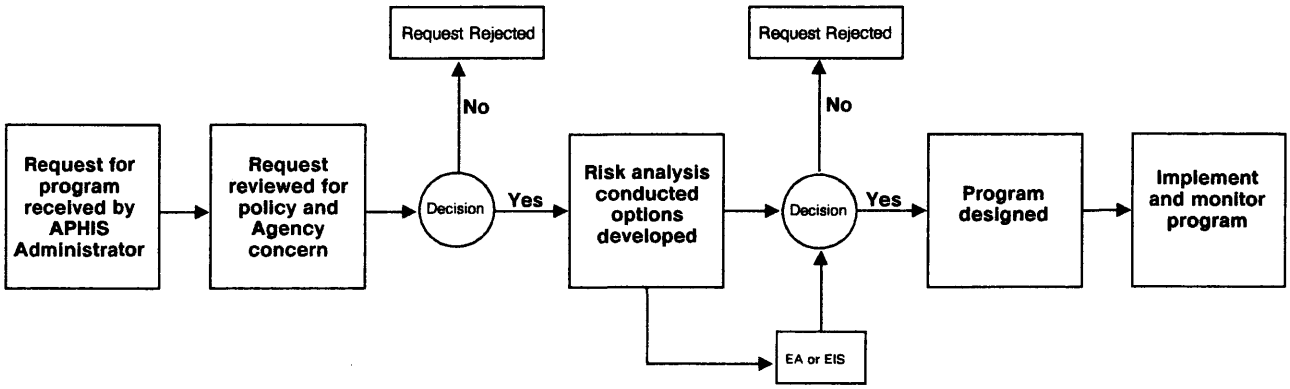

Figure 3. Key steps in review, design, and implementation of ADC programs.

when they hired a consulting firm to do planning or assigned planning to a separate section of the organization. Often this approach resulted in plans not being fully implemented (Below, et al., 1988). APHIS planning involves managers and specialists from all sections of APHIS, as well as specialists from outside the Agency, and interests groups. This involvement should gain acceptance of the processes used in planning and it should gain credibility for the plans produced.

ISSUE MANAGEMENT

An issue management process has been established for APHIS to enable timely identification, assessment, and resolution of emerging threats and opportunities for agricultural protection. When a critical issue is identified, an interdisciplinary analysis team is organized. These teams are composed of specialists from within APHIS and when needed, specialists from the scientific community and interest groups.

Critical issue teams may recommend a variety of actions including a formal program design review as outlined in Figure 3. Such a review could, in turn, lead to a new APHIS program. Other possibilities would be to outline specific steps APHIS should take to solve a crisis, or the committee could conclude that the issue was outside the area of responsibility for APHIS and recommend that APHIS take no action.

An example of a critical issue involving ADC and other units of APHIS is pesticide use. This became a critical issue for ADC when the Environmental Protection Agency announced plans to cancel registrations for products containing compound 1080 and strychnine. A team was established to review pesticide uses in ADC and to recommend actions. However, it was quickly recognized that pesticides, as defined by the Federal Insecticide, Fungicide, and Rodenticide Act (Public Law 100-532, 1988), are also important in animal health and plant protection programs, and a larger committee was established to review the status of pesticide use by all APHIS programs. This committee is composed of specialists from PPD, ST, and a pesticide specialist from private industry. The first action taken by this committee was to prepare an inventory of pesticides used showing the status of each pesticide.

RISK ANALYSIS

Risk analysis is part of the process used to manage critical issues, design new programs, and revise current programs. Risk analysis involves two elements: risk assessment and risk management (Stallones, 1983). Risk assessment is a scientific evaluation of the probability associated with a threat occurring and the magnitude of that threat. Risk management is the design of program strategies to deal with a threat and implementation of the resulting plan.

APHIS units deal with many types of risks. For example, there is a threat of brown tree snakes, Boiga irregularis, becoming established on Hawaiian Islands and other islands, especially in the Pacific Ocean (Fritts, 1988). Experience with brown tree snakes on Guam suggests that the establishment of brown tree snakes on other islands would have negative impacts to poultry and small mammals, wild birds, and public electrical service.

A risk analysis of brown tree snakes establishing on Pacific islands would first assess the threat (risk) of brown tree snakes becoming established on key islands. The likelihood of brown tree snakes being introduced and populations established would be assessed as well as the magnitude of the threat they would represent to animals and electrical utilities. The second step would be risk management for brown tree snakes, which might involve inspection and treatment of arriving cargos and possibly new regulations controlling importation of snakes.

DISCUSSION

The Animal Damage Control Unit (ADC) and the 10 other units of APHIS have undergone changes associated with reorganization of the Agency. The reorganization was designed to improve support to field program delivery through better planning, analysis, and use of resources. It also creates a stronger APHIS identity through interdependence and cooperation among the 11 units of APHIS.

Emphasis is thus placed on planning and risk analysis in the reorganized APHIS. Four levels of planning have been identified (Figure 2): (1) strategic planning for the Agency, (2) strategic planning for each of the 11 units, (3) program design and risk analysis, and (4) operational planning. Animal Health and Depredation Management Systems (AHDMS), a section of PPD, will work closely with ADC to facilitate planning for new ADC programs and revisions to current programs. AHDMS will also facilitate working linkages between ADC and other units of APHIS.

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Status of Strychnine, Compound 1080, and Registered Alternatives[1]

Steve D. Palmateer[2]

Abstract.--This paper reveals the current regulatory status of 1080 and strychnine relevent to data call-in actions, administrative hearings, and litigation outside of FIFRA. All strychnine prairie dog claims are cancelled as well as all label claims requiring a tolerance. The 1080 technical is cancelled and all rodenticide uses have been issued a notice of intent to deny.

The Rebuttable Presumption Against Registration (RPAR) notice (now called Special Review), for 1080 and strychnine was published in the FEDERAL REGISTER of December 1, 1976. The presumption was against all outdoor above-ground uses of strychnine and all uses of Compound 1080. Three other actions by the Federal government should be noted. In March 1972, Executive Order 11643 was issued. This order prohibited the use of all toxicants, including strychnine, for control of predators on Federal lands or in Federal programs. In the same year, the Environmental Protection Agency (the Agency) cancelled the registrations of thallium sulfate, cyanide, strychnine, and Compound 1080 for predator control. Additionally, in February 1978, the Agency restricted products of several active ingredients, including strychnine formulations with concentrations greater than 0.50 percent, for use by certified applicators. The criteria influencing the restriction for strychnine were significant acute oral toxicity, apparent hazards to nontarget species, and the results of use and accident history.

The RPAR criteria that were determined to have been met exceeded for the outdoor above-ground uses of strychnine and all uses of Compound 1080 were: 1) acute toxicity to mammals and birds, and 2) significant reduction in populations of nontarget organisms and fatalities to members of endangered species.

Position Document 2/3 (PD 2/3), which detailed the Agency decision on strychnine, was published for comments in November 1980 for strychnine and in June 1983 for Compound 1080. In these documents, EPA proposed cancellation of many of the uses for both of these vertebrate pesticides or at least modification in terms of use. As you might expect, the Agency received numerous comments on the PD 2/3 documents. The most common criticism was that the Agency had very little definitive data to support its conclusions. The Agency felt that its worldwide literature search had yielded enough data to provide a basis for concern about potential risks to nontarget organisms. Also, as clearly required under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the responsibility for establishing the safety and efficacy of both of these vertebrate pesticides rests with the registrant and not with the Agency. A complete data base for both strychnine and 1080 had not been generated, in large part because of the uncertain registration status of the pesticides.

Therefore, EPA has issued three Data Call-In (DCI) Notices for strychnine and two for Compound 1080. EPA required that all products be supported by data necessary for registration under section 3. These actions were taken under the authority of FIFRA section 3(c)(2)(B) based on the determination that the additional data were needed to support the continued registration of both strychnine and Compound 1080 products.

The Agency required product chemistry, environmental fate chemistry, toxicology, and wildlife and aquatic organism testing. The Agency also requested the development of tolerances for these products if there is foliar contact of the pesticide with a food or feed crop, uptake of the pesticide in a food or feed crop from the soil,

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[1] Presented at the Ninth Great Plains Wildlife Damage Control Workshop in Fort Collins, Colorado on April 18-19, 1989.

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or direct contact of the pesticide with a livestock animal (e.g., dermal contact or ingestion of treated bait), in which case the application is a food use, and food use requirements will apply. Under these circumstances, a petition for tolerance or a petition for exemption from the requirement of a tolerance is required to support registration. All registrants revised their labels to reflect nonfood uses to avoid the tolerance requirement.

EPA reviewed the data requirements very carefully before issuing the DCI documents. EPA feels that the requirements were kept to an absolute minimum to avoid unnecessary data-gathering costs and yet at the same time to provide adequate data in order to make a scientific regulatory judgment about the risks and benefits of Compound 1080 and strychnine. Several registrants requested waivers and/or postponement of data requirements and presented persuasive rationales why the waivers should be granted enabling the Agency to grant these requests.

In October 1985 and again in October 1987, EPA sent a group of its scientists and other staff to public meetings in Denver, Colorado, to explain why the data were needed, how the data should be generated, and describe the standard format for data submitted under FIFRA. The Agency also sent its vertebrate pest biologists to a meeting of the strychnine registrants held in conjunction with the Thirteenth Vertebrate Pest Conference in Monterey, California in March 1988. The most important development at this meeting was the formation of the strychnine data-gathering consortium headed by the U.S. Department of Agriculture Animal and Plant Health Inspection Service, Animal Damage Control (USDA/APHIS/ADC). From the beginning of the strychnine consortium, the Agency has attempted to be helpful to the group (e.g., supplied names and addresses of all strychnine registrants, clarified many of the data requirements, reviewed hundreds of protocols, and made hundreds of determinations of data applicability from one registrant to another). USDA/APHIS/ADC personnel were a particularly fortunate choice by the consortium to be the lead as they have quickly learned the EPA regulatory process and have kept the data-gathering costs to a minimum. In particular, we would like to single out two of the USDA's Denver personnel, Edward Schafer and Kathleen Fagerstone, who have been proficient and professional in their transactions with EPA.

STRYCHNINE

In spite of a efforts by EPA, USDA/APHIS/ADC and others to facilitate the strychnine data-gathering process, it became apparent in October 1988 that the strychnine data requirements were not going to be satisfied in a timely manner. Therefore, on October 6, 1988, the Agency sent Notices of Intent to Suspend to all strychnine registrants for failing to submit product chemistry and/or failing to show significant progress towards satisfying the wildlife safety-efficacy data requirements. Notices of Intent to Suspend were sent to 99 companies with a total of 383 products suspended with the California Department of Food and Agriculture (CDFA) and many California counties holding about 250 of the strychnine registrations.

Fifty-six of the registrants (including CDFA acting as agent for 37 California counties) requested a hearing to avoid suspension. A pre-hearing was held in San Francisco, California, on November 30, 1988 at which the Agency and the affected registrants agreed to attempt an out-of-court settlement. On February 14, 1989, the final settlement document was mailed to all affected strychnine registrants and by March 2, 1989 all parties had signed the agreement. On March 10, 1980, the ALJ approved the settlement.

Several significant label claims have been eliminated as a result of the DCI Notices and/or litigation. Under terms of the settlement, strychnine products may not contain label directions for any food or feed use. Specificially, general broadcast applications of strychnine products are not allowed around food or feed crops. You should be aware that the Agency considers pasture and rangeland a feed use as a pesticide may be ingested by livestock and transported into milk or meat. The significant label target species claims eliminated are house mice, prairie dogs, and porcupines. However, there are still label claims for pocket gophers, microtus, kangaroo rats, marmots, hares, cotton rats, moles, pigeons and several bird species, although some of these species may be required to be dropped in the near future depending on whether registrants decide to produce supporting data.

In a related strychnine action on April 11, 1988, the United States District Court for Minnesota issued an injunction against the above-ground uses of strychnine. The court ordered that EPA temporarily cancel all above-ground uses. Therefore, on May 4, 1988 the Agency sent a letter to all strychnine registrants apprising them of the Minnesota court's April 11, 1988 decision and enclosed with this same letter a copy of the court order. On September 30, 1988, the Agency mailed to all registrants a copy of a notice of temporary cancellation signed by the EPA Administrator. This notice was issued by EPA to avoid a contempt citation. The notice did not rely on the authority of FIFRA but on the enforcement authority of the District Court in Minnesota under its own order. Under this proposal, registrants, distributors, and users of strychnine would be subject to contempt of court proceedings if they did not comply with the order.

1080

In October 1988, the Agency also determined that it was not going to receive the data requested for both the 1080 technical products and the end-use products. Therefore, on October 4, 1988 the Agency mailed a Notice of Intent to Cancel the one Compound 1080 technical product.

This product had a conditional registration which required submission of satisfactory data to satisfy the requirements of the November 22, 1985 DCI Notice.

Several 1080 user groups felt they were adversely affected by the cancellation notice and requested a hearing to contest the cancellation. The Agency requested an accelerated decision based on failure of the Compound 1080 technical manufacturer to submit the data in a timely manner and the failure of the same registrant to comply with the Agency's December 17, 1987 offer to extend the data requirement due dates. The petitioners raised the issue of economic loss to farmers and ranchers and that the cancellation would affect the public health. The Administrative Law Judge (ALJ) ruled in favor of the Agency on the fact that none of the petitioners had challenged the basis of the notice of cancellation. On February 21, 1989, the ALJ issued a preliminary decision and cancelled the product, pursuant to regulation.

In a similar action, the Agency mailed a October 4, 1984 "Intent to Deny Applications for Federal Registration of 1080" to 19 California counties and to the Colorado Department of Agriculture in addition to a Notice of Intent to Suspend to Klamath County, Oregon. At this writing, the Agency has not mailed denial notices to either the California counties or to the Colorado Department of Agriculture.

USDA/APHIS/ADC has submitted an application for registration of a Compound 1080 technical product to be used only in the 1080 livestock protection collar. Since the data base for the 1080 collar use is nearly complete, the Agency is requiring only a small amount of product chemistry data to complete all the data requirements. To date, Montana Department of Livestock, Wyoming Department of Agriculture, South Dakota Department of Agriculture, New Mexico Department of Agriculture, USDA/APHIS/ADC, and Ranchers Supply of Alpine, Texas have registered the 30 mL livestock protection collar.

The Agency has registered several new use patterns for old chemicals. These new use patterns include zinc phosphide and chlorophacinone baits for pocket gopher control, and has greatly expanded the sites and pest claims for 1339 as a gull toxicant.

A new DCI Notice has been issued for warfarin as a followup to the Warfarin Registration Standard issued in September 1981. The warfarin DCI requires very little new data as the registrants will be requested to submit or cite previously submitted data. All registrants will be requested to make label changes. Also, at this point, the data base for zinc phosphide products is not complete and EPA may have to take administrative action to expedite the submission of data on this compound.

The Landowner's View and Recommendations on Wildlife Damage[1]

Michael G. Leroux[2]

Conflict between landowners and state and federal agencies is prevalent in todays society. This report attempts to provide understanding of the landowners views on wildlife damage and offer some solutions to be considered.

INTRODUCTION

The individual landowner's point of view is based upon economic, historic and idealogical values that have led that individual to choose the lifestyle of an agricultural producer. These values vary, depending upon the individual's background, financial situation and goals for the future. These values need not conflict with the overall social patterns of regulation and wildlife management if sufficient flexibility is retained within the regulation and management to permit the landowner to continue to implement his values. When regulation does not acknowledge or find the full effects of a given regulation upon the landowner, or when regulation forces are an unexplained or unsubstanciated burden upon the landowner, conflict will arise between the landowner and the regulating agency and often the species sought to be protected by the regulator.

ECONOMIC CONCERNS

Pest and predator loss is a direct economic burden on the agricultural producer. Losses due to increased numbers of livestock predators, grain eating birds, and loss of productivity due to prairie dogs and ground squirrels can have devastating effects upon an already minimal profit margin for the producer. Additional costs of cleaning up and repairing property damage after the presence of such pests is also an added burden on a fragile economy.

HISTORIC CONCERNS

Historically, the landowner was able to eliminate pests and predators through whatever means he chose. Poisoning, trapping, and unlimited removal by shooting were all economical means to offset damage. With concerns about losses or massive reductions of numbers of several species, due to heavy hunting pressure from all sectors of society or due to externalities of a given pest control problem such as improper use of poisons, society, through state and federal legislation, placed limits upon the means by which a landowner could protect his economic welfare. While regulation attempted to protect the endangered or preferred species, it did not and has not adequately taken responsibility for increased hardship upon the landowner. It has taken an historical right from the landowner without offsetting this loss with adequate remedy for additional losses the landowner must bear. This is in direct conflict with the historic, economic and idealogical views of most landowners.

LANDOWNER IDEOLOGY

The ideology of most landowners is no different from that of any property owner. Generally the owner has reviewed the costs and benefits of owning a given piece of property and if benefits exceeded costs the individual sought title to the property. In a similar way, most individuals weigh the costs and advantages of owning a home or an automobile before purchasing one. In both cases once the property is purchased, the new owner feels that they have the right to protect and control the environment within the acquired property. In the landowners view he has purchased legal rights to the property and to all produce grown on that property.

Often the property may have pests that reside on the property. For instance, a homeowner may have a family of mice that live in the wood pile. As long as the mouse numbers stay within an acceptable range and do not create more than an acceptable amount of damage

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[1] Paper presented at the Ninth Great Plains Wildlife Control Workshop. (Marriot Hotel, Fort Collins, Colorado April 17-20, !989)

[2] Michael Guy Leroux is a fourth generation Colorado Landowner and member of Colorado Farm Bureau, Denver, Colorado.

to the property owner, the mice and the landowner will live in harmony. Once these thresholds have been overridden, such as the mice family expanding into the linen drawer, conflict will arise between the property owner and the wild life (the mouse) destroying the equibrium of the past mutually accepted situation. The property owner generally reduces the number of mice to a point below the originally accepted threshold and thus restores equilibrium. Historically this same procedure was used by private landowners to retain equilibrium on their property in regard to pests such as predators, birds, rodents, big game and weeds. State and federal legislation have limited the landowners rights through agencies such as the Colorado Division of Wildlife and the Environmental Protection Agency.

Imagine the impact on your life if you could no longer defend yourself from competition for property rights in your home from rats, mice, snakes and pigeons, and the regulators were unwilling to provide restitution for the damage that their regulation caused you. You are in a situation similar to what present large landowners face. Not only would you be unhappy with the regulating agency you would most likely have developed a hostile attitude toward the mouse that at one time you were willing to tolerate within certain levels. We have developed a three sided conflict by improperly implementing regulation. This is the same type of conflict as we now have between wildlife, the landowner and state and federal agencies.

BIG GAME ANIMALS

Big game species are protected under state laws limiting the control of animals that cause economic hardship upon the rancher and farmer. Forage and growing crops losses, losses of harvested crops and damage to physical property such as fences and broken scattered wire and twine add additional economic, physical and emotional stress to the situation. Psycological stress due to losses of projected yields, loss of projected future feed supplies and reduced palatability of forage and damaged feeds that lead to poor health of domestic livestock, placed added burdens upon the landowner. Most big game animal numbers have increased since landowners settled and increased the production of our agricultural areas and means of protecting landowners property have been decreased. Minimal restitution is provided to the landowner for direct losses of stored feeds consumed by big game, yet little or no compensation for other losses has been adequately addressed by the state. Landowners face additional expenses through having to repair damage done by big game hunters to fences and roads and through livestock losses due to hunters. Disease can be controlled in domestic herds through removal of infected animals and vacination only if nondomesticated animals do not continue to spread diseases such as brucellosis.

PREDATORS

Proven losses of livestock, to preditors, are partially covered by state law but with strong limitations as to what is proof of loss. As many predator kills are not immediately found, it is often difficult to prove predator involvement in the loss, much less have opportunity to catch the exact participating predator. The landowner must still accept the burden of the loss wether he is compensated or not. Removal of offending animals, when possible, and reduction of species in overcrowded areas could help to alleviate the problem. To control such predators as coyotes, proper use of poisons must be made available for landowners.

PRAIRIE DOGS AND OTHER PESTS

Control of pests such as the prairie dog, Richardson ground squirrel and starlings is another problem which has multiplied since regulation has limited the use of poisons and other means of control. The application time for poisoning these pests is critical and under current standards, available methods of control, availability of control substances and availability of legal application teams to permit timely control is not often possible. Concerns for endangered species such as the black footed ferret, though legitimate, have been over stressed in areas where no ferrets have historically been known to exist. While responsible control is definitely important for permitting continuity of all natural species, adequate pest control is equally important and adequate pest control methods need to be developed to satisfy both goals.

WATERFOWL AND OTHER BIRDS

The protection and purposeful introduction of migratory and other game birds has lead to losses of both harvested and unharvested crops to many landowners. Geese not only consume vast amounts of grains but they tend to ruin and destroy additional quantities through excrement and tramping. Similar to big game situations, the regulating agencies should accept responsibility for protection of and restitution for losses of landowners property.

FARM BUREAU POLICY RECOMMENDATIONS

Farm Bureau and landowners feel that if problems and concerns are presented, solutions for these problems need to also be recommended. The following are Farm Bureau policy recommendations as developed by their landowner membership.

State Responsibility

Farm Bureau supports maintenance of reasonable numbers of big game animals but feels that wildlife agencies should accept more responsibility for damages done by wildlife and

hunters. Wildlife agencies should provide compensation and protection for damages to fences and roads by hunters and provide funding for counties to provide search and rescue efforts for lost hunters. All loss of feed and/or standing crops and pasture and all property damage on deeded land should be considered eligible for loss claims and these claims must be paid in a timely manner by the Colorado Division of Wildlife. No ceiling should be placed upon the amount of damages the DOW may have to pay. Damages should be paid as they occur regardless of historic levels of wildlife. Posting private property and/or restricting, limiting hunting or selling hunting rights should not be cause for disallowing damages to a landowner.

If a mutually acceptable settlement on game damages can not be reached between the land owner and the Division of Wildlife, an arbitration panel should be set up to settle the dispute.

Ownership and resposibility for all predators and game animals should rest with the state and control be assigned to the Division of Wildlife. If it is necessary to kill wildlife to control damages the Division of Wildlife should accept this responsibility and not force the responsibility upon the land owner.

State and Landowner Relations

The Colorado Division of Wildlife should concentrate on using funds for providing adequate water and feed supplies for wildlife through improvement of currently controlled lands and for paying for game damages and damages caused by hunters, before seeking to purchase additional properties. Adjustments in animal numbers and feed and water changes should be done in cooperation with BLM and other federal agencies in such a way as to be compatible with adjoining ranchers. Private land should in no way be designated as wildlife habitat without consent of the land owners or be condemned for wildlife habitat. The wildlife agencies should seek mutually acceptable leases with landowners for use of their properties for wildlife habitat and hunting. The Division of Wildlife should not be in competition with agricultures private landowners.

No species of wildlife should be introduced into a new area, by The Division of Wildlife, without full knowledge of possible effects being provide to the affected landowners and receiving approval from the majority of these landowners. The wildlife agency should also be required to provide an environmental impact statement any time animals are relocated to any area.

Farm Bureau recommends that landowners be given preference for obtaining limited licenses for the season of their choice for big game that exists on their private land. This permit or license should be complementary and presented upon request.

Farm Bureau recommends that trespass laws be strictly enforced and support possible additions to make the laws more of a deterant than present laws. We recommend our schools put emphasis on teaching about trespassing, infringements of private rights and violations of individuals rights to privacy. The private property owner should not have any responsibility for any accident or injury to any party on his private property without permission. All persons who trespass should forfeit all rights for injury or death and the landowner should be absolved of any liability.

Preservation of Control Practices

For predators and pest all present control practices, including steel traps, snares, and denning should be continued. Under problem conditions, use of chemical toxicants should also be used or allowed under supervision of federal, state or county predator control departments. We recommend that registration and certification of M44 be sought and 1080 oat control be retained for control of ground squirrels and prairie dogs. The bounty system and better markets for hides and furs should be promoted. New methods for controlling and repealing predators should be researched. Aircraft control of coyotes should be considered a viable alternative.

The growing problem of eagles and domestic dogs should be recognized and the public educated so protective action can be taken. Domestic dogs should not be permitted to run unsupervised.

CONCLUSION

In conclusion, landowners view landownership as any other property right. When social concerns limit controls on wildlife, as the state claims authority over these animals, the state must also accept responsibility for the damages these animals may incur and in protecting landowners from this damage. When the state purchases private property in competition with other landowners, they must accept the responsibilities as any other neighbor. Through education and understanding, mutual agreements can be reached permitting each landholder to retain control of their own private property. If the DOW and the other agencies seek to find mutual goals with each individual landowner conflict will become much less a part of our lives. Unless property rights are definitely defined, transaction costs are kept at a minimum and wildlife is valued through direct current demand, of those individuals willing to pay for the costs of maintaining the wildlife, conflict will continue.

The Landowner's View of Wildlife Damage Control Techniques and Agency Programs[1]

L. Bard Field[2] and Ed Hansen[2]

Abstract.--This is an opinion or viewpoint paper. Ranchers, as landowners, depend on the land and environmental quality for the productivity and stability of their businesses. Therefore, they evaluate wildlife damage of their property relative to its effect on their businesses. Historically, ranchers have felt that wildlife damage techniques and agency programs have been ineffective, costly, bureaucratic, and incomplete. Compensation programs, which are a last resort to damage control, are also problem-ridden. Wildlife damage is typically a result of poor population control of wildlife. Landowners are in support of damage control programs which are effective, economical, complete and address the issues at hand and wish to be involved in the development of programs that meet these criteria.

INTRODUCTION

Agriculture, and cattle production in particular, has traditionally been a vital contributor to the stability, economic vitality, and culture of the western United States. Ranchers are the original environmentalists of this area, having protected, nurtured and lived off the land for many decades. The ecosystem in which ranchers live and operate has always included wildlife. Nonetheless, it is this very sector of the ecosystem, which ranchers and landowners respect, protect and support, that is the cause of a great deal of damage to personal property and a threat to landowner's businesses and livelihood. The solutions for prevention of wildlife damage of property are difficult, costly and not always popular with everyone involved. The sources and/or means for compensation to this damage are usually slow and do not fully compensate for the loss. In addition, the compensation process itself is problem-ridden. Nonetheless, wildlife damage is a very real and pressing problem, both for the landowner and wildlife agencies, and is one which must be dealt with logic, a willingness to compromise and fairness to all involved.

[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop (Marriott Hotel, Fort Collins, Colorado, April 17-20, 1989).

[2]L. Bard Field is Director, Member Services/Communications, Colorado Cattlemen's Association, Denver, Colorado. Ed Hansen is owner/manager of Circle Ranches, Inc., Livermore, Colorado.

LANDOWNERS AND WILDLIFE - A BALANCE

Landowner's have allowed access and use of their private land and shared the resources of leased land with wildlife for many years. Ranchers, like most citizens, appreciate wildlife and wish to see them live, healthy, and flourishing. Yet ranchers are different from most other individuals in that they derive their livelihood and income from the land and its resources. This position is sometimes in conflict with wildlife needs. Ranching, because it is a goal-orientated, progressive business, typically results in improvement in the environment. This improved environment is also more desirable for wildlife, which can result in more conflict and competition between wildlife needs and landowner's objectives. While landowners may look kindly upon wildlife flourishing on their land, if their land and property are being destroyed by wildlife, they will protect their property against the destroying force.

Damage by wildlife is an external factor affecting the stability, well-being and profitability of businesses that provide a valuable product to our nation and world. Ranchers run viable businesses and depend on the well-being of the land and environmental quality. They enjoy and support a healthy wildlife population and support the historic purpose of wildlife agencies. A balance of man and nature is essential to the well-being of our nation, and this balance must be more clearly defined in order to be obtained. With this balance in mind, people should be allowed to protect their investment and property from outside sources of danger and damage or be fairly and timely

compensated for the damage by responsible parties.

LANDOWNER'S VIEW OF DAMAGE TECHNIQUES AND AGENCY PROGRAMS

Landowners are a very diverse group with very diverse needs and goals. Ranchers are landowners whose businesses depend upon the productivity of the land and will therefore look upon and evaluate damage by wildlife differently than would a homeowner or recreationalist. The opinions expressed in this paper represent some of those of the membership of the Colorado Cattlemen's Association, because it was requested that this paper be written from that approach. Recognize that this is an opinion or viewpoint paper and in no way represents any official position taken by ranchers operating in the United States.

Ranchers and wildlife agencies have been working for many years to find solutions to damage control problems. This long association between agriculture and wildlife agencies has many times been productive and fostered positive working relationships. In other instances, this relationship has been strained. While many agencies and landowners agree on general damage control issues, they have not always agreed on specific control techniques. Input from landowners has been solicited for the development of damage control techniques, but opinions from special interest groups many times has taken precedence over opinions from landowners whose businesses depended upon the land. Therefore, control programs and techniques are sometimes one-sided in their approach and do not always reflect the needs and concerns of ranchers as well as those of the agencies.

Historically, landowners have viewed wildlife damage techniques and programs as ineffective, costly and incomplete, relative to the purpose of controlling damage to personal property and land by wildlife. Rancher's experiences with agency programs have been that they are bureaucratic, restrictive programs that do not meet needs or established goals, but instead treat symptoms in an attempt to solve the problem. Because of restrictions and terms that need to be met with each program, the programs are ineffective in solving the real problem and do not allow for flexibility or creativity in problem solving. In effect, many times the programs are more trouble and hassle than they are worth.

Wildlife agencies are charged with the challenge of meeting a wide range of needs with limited resources and very few useful, effective tools. Many different professionals (ranchers, miners, loggers, etc.) and special interest groups (hunters, environmentalists, recreationalists, etc.) are forced to rely upon wildlife agencies for solutions to their problems. Because agencies are attempting to meet these varied objectives with common programs, the programs escalate in cost, complexity, and implementation time, while decreasing in effectiveness for any specific interest. In essence, agencies are using programs that will pacify everyone's frustrations, while effectively addressing no one's concerns.

While this workshop deals mainly with wildlife damage control, for many ranchers, the best they can hope for is damage compensation. This too, has its drawbacks. Compensation from the responsible party, which in this case is the state or owner of the wildlife, tends to be incomplete, untimely and difficult to obtain. Compensation programs also tend to be one-sided in their approach and implementation.

SPECIFIC PROBLEMS ASSOCIATED WITH DAMAGE TECHNIQUES AND AGENCY PROGRAMS

In dealing with an opinion or viewpoint paper such as this, the only fair approach is to identify specific problems and then offer solutions. From a ranching/business standpoint, the problems with wildlife damage techniques and agency programs are complicated.

"Wildlife damage" can be a very subjective call, for what may be considerable damage from a landowner's perspective may be minor damage or acceptable use to an agency official. Degree of damage is also difficult to quantify and value. The lack of historical information or a basis from which to work makes damage identification and valuation even more difficult and can be a cause of frustration between landowners and wildlife officials. In addition, time lags between damage and discovery may add to the difficulty in quantification or valuation of damage and may make control or compensation all but impossible. Identifying the specific animals or species causing the damage is necessary in controlling the damage and has, in general, also proven to be very difficult and subjective.

Ranchers on the eastern plains report that damage which can be quantified and valued, such as big game getting into haystacks or predator destruction of young livestock etc., is usually controlled or compensated for in a fair and timely manner. On the other hand, they report damage which is difficult to document, such as destruction of wheat fields or grazing land, is not always controlled or compensated for in a fair or timely manner, if at all. Additionally, damage to some forms of property, such as destruction of young trees in a wind break, are not controlled or compensated for in any manner. Nonetheless, many ranchers on the eastern plains report that they do not report damage unless it is extensive or becomes an extreme problem.

Ranchers on the western slope report that wildlife damage control is a much greater problem in their area. They report a great deal of

resistance to claims of damage by agency officials and a great deal of antagonism in receiving legitimate control solutions or fair and timely compensation for wildlife damage, whether it is easily proven or not.

Ranchers operate private businesses that should be treated by the general public as are other businesses - with respect for professional decisions and operations. Nonetheless, because ranchers own and operate on land that is also used by "public" or "state" property (wildlife), their businesses have come under scrutiny by the general public. While ranchers and wildlife agencies may agree that a particular wildlife species is causing damage to personal property or even the environment, public opinion may dictate nothing be done to prevent or control this damage. The issue of wildlife damage has many times become a tradeoff between damage to personal property and control of wildlife, with individual concerns many times losing to public opinion.

Regulations dictate what ranchers as landowners can or cannot do to control wildlife damage. Many ranchers feel that these regulations are so restrictive, and at times illogical, that the purpose is defeated and cost exceeds benefit. Regulations surrounding prairie dog management are a prime example of the control defeating the purpose. Landowner's can only use a limited variety of materials, most of which are highly ineffective in eliminating prairie dogs or the damage they cause and are exorbitant in price. Regulations involved in finding a black-footed ferret, while attempting to control prairie dog destruction of grasslands, have all but eliminated landowner's and agency's ability to control damage by the prairie dog. Again, it appears as if the symptoms are being treated, not the disease.

Wildlife, in-and-of itself, is not the fundamental problem relative to damage; wildlife population is. Obviously, reasonable populations of wildlife keep the ecosystem in balance. Many ranchers welcome the presence of deer, elk, antelope, predators, wildfowl and small game on their land, which add to the quality of their land and lifestyle. Nonetheless, problems do arise when wildlife populations grow beyond numbers that can realistically be supported by the given environment. When this happens, the ecosystem is pushed out of balance and wildlife are forced to rely on additional and/or different forms of nourishment, shelter and water. Existing wildlife damage control techniques and programs do not do an effective job of managing wildlife populations. Instead, they attempt to control specific repercussions of the problem, such as fencing overly large populations of elk out of private hay fields - which has proven to be nearly impossible to do - rather than controlling the elk population in specific.

These problem areas are general in terms and application, but do represent the general feeling of a wide range of ranchers and their diverse operations. It was felt that a specific discussion of individual regulations and techniques would not be productive to this forum.

POSSIBLE SOLUTIONS TO DAMAGE TECHNIQUES AND AGENCY PROGRAM PROBLEMS

In reviewing the problems presented from the rancher's viewpoint, it becomes apparent that a discussion of potential solutions is also necessary. Identification, quantification and proof of wildlife damage needs to be more objective, consistent and obtainable. Establishment of guidelines with the input of landowners would be most beneficial and would assist in building a better working relationship between the two factions. This would also hold true for the valuation of damage and the consistency of the valuation.

Compensation for wildlife damage should be considered a viable option to damage control if that damage cannot be controlled. Because ranching is a business, compensation for damages to that business should be timely, fair and given without unreasonable restrictions or complications.

As discussed, differences exist within the state and most certainly within the region as to the extent, origin, and diversity of wildlife damage to landowner's property. Flexibility of damage control techniques and programs should be incorporated to fit individual or special circumstances.

Regulations for damage control techniques should be simplified so that the real issue of damage control may be addressed and dealt with. Tools and techniques for managing damage by highly destructive but nonetheless protected wildlife species need to be developed or the regulations and restrictions need to be changed so that landowners can protect their property.

The party responsible for damage of private property and the resources on that property needs to be held responsible for that damage. If the state or Division of Wildlife "owns" the wildlife in Colorado that are damaging property and resources, then they should be held accountable for the damage caused by "their" wildlife. The current regulations, techniques and programs do not maintain this position and therefore put the landowner in a poor position to protect their property while protecting the environment and resources vital to the well-being of their families, their businesses and the native wildlife.

Control of wildlife damage needs to be addressed from the perspective of population control. Many programs could be developed that would more effectively control wildlife

populations while meeting the objectives of many groups and individuals. Wildlife "control" or "harvest" hunts could be utilized more effectively in areas where populations have exceeded resources and would satisfy the needs of landowners, hunters, and many hungry families while keeping the ecosystem in balance. Programs could be instigated whereby landowners who work to support and improve wildlife populations would have more input and flexibility with population control. In many cases where specific populations have exceeded resources, such as in the case of prairie dogs, portions of these populations may have to be eliminated. Predator damage is being successfully managed in many areas with the use of guard dogs and these programs should be encouraged and supported by wildlife agencies.

SUMMARY

Ranchers want to be involved in effective wildlife population and environmental management, but do not want to be involved in ineffective, costly programs that do not solve the real problems and are simply a waste of taxpayer's money. It is for this reason that many ranchers do not utilize agency techniques or control programs and do not apply for damage compensation. Nonetheless, they would be very willing to participate in more effective wildlife population and damage control programs. Granted, wildlife population and damage control programs and techniques have been a challenge for many years, but with increased cooperation, and dedication to problem solving and solutions, between landowners, agency personnel, sportsmen, recreationalists and special interest groups, solutions can be found. Wildlife damage comes many times as a result of over-population for a given environment, and it is the responsibility of the aforementioned people to effectively manage these populations so that they can flourish and remain healthy, while in balance with man and his needs.

Effects of Animal Welfare Philosophy on Wildlife Damage Control[1]

Robert H. Schmidt[2]

Abstract.--Wildlife damage prevention and control activities are often criticized when they involve the deaths of wild animals. However, just as the nuclear industry has failed to convince the majority of the public that its industry is safe, education will fail to convince the public that all wildlife damage control techniques are *humane*. Animal welfare-related legislation, university rules on the use of wild animals for research, and litigation are changing the working environment of our profession. This paper reviews aspects of the animal welfare movement as they affect the wildlife damage prevention and control profession and discusses future strategies for living with it.

As wildlife biologists and practitioners of wildlife damage prevention and control, we manipulate wildlife and their habitats. Often, however, what we actually manage are people. Hunting seasons, regulations on trap sizes and shapes, refuge use restrictions, and hunter education requirements are all part of people management.

The people we manage today, along with those whom we do not manage, are not the same as the people managed even ten years ago. Our society is evolving. The general public does not necessarily know *more* than they did a decade ago, but they know *different* things and have been exposed to new ideas. Today, people are familiar with the condition of many elephant (*Elephas maximus* and *Loxodonta africana*) populations throughout the world, and the impact of habitat destruction and poaching on these populations (Booth 1989). People support spending millions of dollars to rescue two California gray whales (*Eschrichtius robustus*) from the arctic ice, even though this species may have recovered to pre-exploitation levels (Aron 1988). Television, radio, newspapers, magazines, and direct mail solicitations expose people to these events (Schmidt 1987*a*). In addition, experiences with wild animals at parks and zoological gardens reinforce the idea that wild animals are harmless, gentle creatures, usually oppressed by humans.

These events and experiences expose people to new ideas. An advertisement for a cage trap for mice is headlined "Must we kill the mouse?" People are taught that farmers and ranchers are affected by a bad case of predator prejudice. Pictures of monkeys strapped in cages reminiscent of Inquisition days question the appropriateness of vivisection. People are told "Let your buying dollar speak for you when you don't buy fur."

In this environment, wildlife damage control and wildlife management are interacting with a skeptical and hostile audience. Wildlife damage control activities in particular elicit strong emotional responses from the public. Few people are neutral. Although people are often sympathetic to losses caused by wild animals, they are not sympathetic to many of the techniques currently used to prevent this damage.

When I attend wildlife damage control meetings and listen to speakers discussing this cultural evolution, I am struck by three things. First, there is usually a very strong "We are right and you are wrong" philosophy expressed, without a logical framework being presented to document this concept. Second, the plan of action to combat these alien philosophies usually involves "educating the public," even though "public" is never defined and specific educational strategies are never proposed. Finally, these presentations are usually the most popular talks at the meeting, judging from the applause and the discussion in the halls during the breaks. From this I can only conclude that the topic is a major concern on people's minds, and that the presentation acts as a "cleansing" to help us face a naive world.

I am being a bit critical, but I want to demonstrate that these presentations are missing the point. Society is changing. The change is inevitable and unstoppable.

[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop (Fort Collins, Colorado, April 17-20, 1989).

[2]Robert H. Schmidt is a Natural Resource Specialist, University of California Cooperative Extension, Hopland Field Station, Hopland, CA.

And these changes are affecting the practice of our profession. Animal welfare legislation is proliferating at the local, state, federal, and international level. Today I received notice that the European Parliament supported a Declaration calling for labelling of furs caught with leghold traps. In California, a state in which agriculture is still the leading industry, at least two counties have banned the use of leghold traps. Regulatory actions related to concerns for the environment have led to bans on certain uses of both strychnine and sodium monofluoroacetate (Compound 1080). Institutional Animal Care and Use Committees (IACUC) are questioning the appropriateness of wildlife damage control research. Toe-clipping of rodents for mark-recapture studies is being questioned (Silverman 1989). A recent survey of 95 university and college IACUC chairpersons indicated that only 52% of these committees had at least one member who could be considered a wildlife expert, yet these committees are responsible for judging, among other things, the scientific merits of the studies under review (Bowman 1989). Finally, the enforcement of existing regulations is becoming more strict. The techniques used for the capture of animals or the inappropriate use of chemicals can cause a backlash which affects the entire profession.

Clearly, societal forces *are* affecting what we do and how we do it. These negative responses to our work focus on the materials and techniques we use, the applied nature of our activities (a private party is getting something out of it at the expense of *our* wildlife), and the perceived costs, especially in relation to non-target individuals being impacted and the suffering of target animals.

I like to use an analogy to describe how I think we should face these issues which, I repeat, are not *future* issues but are *present* issues. Picture yourself walking along a beach. On one side is the ocean, its vast expense unbroken by land for as far as you can see. On the other side the beach ends in a towering cliff, which rises vertically from the beach. As the tide rises, running up and down the beach is no help. The water laps at your ankles, then your knees. You struggle to keep upright as the tide tries to tug you out to sea. Swimming won't help because there is no place to swim to. To survive, you have to learn. You have to learn to accept the power of the tide and you have to learn to climb.

Animal welfare concerns are that rising tide. The majority of people have real concerns about *animal suffering*. "Education" won't diminish these concerns and threaten to undermine our current activities (Jones 1988). We, as practitioners of wildlife damage control, have to learn a new skill to cope with animal welfare concerns. Whether we act reactively, proactively, or interactively, we simply need to be active. And I submit that the most successful strategy will be to accept the reality of the animal welfare tide and revise our operations and attitudes accordingly (Schmidt and Bruner 1981, Schmidt in press *a*, *b*).

Our activities should focus on at least two areas. The first is to clean up our act. We need to develop more acceptable techniques and materials. We need to react to public concerns. We need to be honest when we evaluate techniques and materials, even if it involves admitting that leghold traps can cause injury and suffering to wild animals. In short, we need to espouse an "I care" attitude (Richardson 1988).

The other area, in spite of my earlier statements to the contrary, is education. However, I see the need to focus upon the education of ourselves to the public's demands (a marketing strategy to understand the clientele) and upon an educational program to promote a more realistic view of the world to the public. This does *not* involve the "We are right and you are wrong" philosophy, but should be an honest assessment of alternatives, so that the public has enough information to make an informed choice. We can assist the public in seeing both the negative and the positive results of a particular management strategy.

Unfortunately, we may be fighting a losing battle. A survey of 174 wildlife biologists in California, Nevada, and Hawaii indicated that 47% of them devoted 10 hours or less *per year* to conservation education activities (Schmidt 1987*b*). Compare this to the number of animal welfare organizations and activities that exist because of committed volunteers. All is not lost, however. We may not have the numbers, money, and commitment to reach the masses, but we can continue to provide expertise to administrators, legislators, and other decision-makers. Our strategy should include:

- Promotion of a "We care" philosophy,
- Promotion of strategies and materials that reduce suffering (Schmidt in press *a*),
- Active research and testing programs to develop more acceptable alternatives, and
- Continuing education programs to disseminate this strategy.

We, as a profession, should *not* fall into the denial trap of claiming that since suffering is so hard to measure we should ignore it. Pain management and identification in animals is more developed than many of us either know or admit (Fraser 1984, Wright et al. 1985).

We should be the leaders in dealing with these new societal concerns about animal suffering instead of letting legislative, judicial, or regulatory agencies do it for or to us. As we sit in a legislative hearing room, testifying in regards to a leghold trap ban, we enhance our credibility if we can honestly project our concerns about animal suffering, and how we actively promote humane alternatives. With this credibility, we can then describe the need to maintain current tools until that time comes when technology presents us with efficacious alternatives. A similar scenario exists for

testimony before a judge or jury in fighting injunctions to stop wildlife damage control activities.

Is this the "wimp" approach? Are we giving up on our principles? Maybe. I am trying to promote a philosophy of concern for societal principles, morals, and ethics. I am trying to assist in the formation of a healthy and exemplary profession. I am trying to lay building blocks for future change and not stagnation and loss of credibility. Most of all, I encourage debate about all facets of the animal welfare issue.

It should be obvious that I have avoided reference to the animal rights movement. The animal *rights* philosophy, which promotes the concept that animals have rights analogous to human rights, is not the same as the animal *welfare* philosophy (Schmidt in press *a*, *b*), which promotes the reduction of animal suffering. It is a vocal but minority movement, and will need to be addressed in the future.

We are not inherently "bad" people, torturing animals for the fun of it. We are working to save livestock from predators, corn from blackbirds, people from rat-borne diseases, and jet aircraft from bird strikes. Simultaneously we attempt to avoid negative impacts on non-target organisms, minimize the use of pesticides in the environment, and remain concerned about endangered species, pets, and public health and safety. We now need to add an additional element to our activities, and that is concern for the reduction of animal suffering in wildlife damage control activities. Let us do so before somebody tells us we have to do it. Let us do so because we can live with it. Let us do so because it is the right thing to do.

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Estimating Domestic Sheep Losses to Mountain Lions[1]

Frederick G. Lindzey and Connie Wilbert[2]

Abstract.--Large, native-range pastures were searched for dead domestic sheep in the Southern Bighorn Mountains of Wyoming. The proportion of dead sheep that had been killed by mountain lions was 23%. Search methods, however, resulted in unequal probabilities of finding sheep that were killed by mountain lions and sheep that died of other causes.

INTRODUCTION

Mountain lions (Felis concolor) will kill most species of domestic livestock although sheep and cattle occur most commonly in depredation incidents. Cattle losses are highest in Arizona and New Mexico with the frequency of depredation problems involving cattle generally decreasing northward in the mountain lion's range (Shaw 1979). Shaw felt that this phenomenon largely could be explained by husbandry practices; losses are greatest where calves are born in mountain lion habitat. Sheep, on the other hand, appear to be killed anywhere they graze in areas occupied by mountain lions with lambs being killed more often than adults. It is common to have more than 1 sheep killed in a single incident (Sitton 1978, Bowns 1984); 59 sheep were killed in 1 night in Nevada (Suminski 1982).

Nation-wide, sheep losses to mountain lions appear small enough to be of little economic importance. For example, Suminski (1982) determined that average losses of range sheep to mountain lions in Nevada averaged only 0.29 percent. Not all woolgrowers share these losses, but rather, a few sustain heavy losses which can have a severe impact on their operations.

Historically, the potential for depredation resulted in widespread mountain lion control and eradication programs. When states began to assume management authority for mountain lions in the 1960's (Nowak 1976), management programs included very liberal depredation provisions aimed at allowing livestock owners to protect their animals. Although states currently vary in their approach to the problem of mountain lion predation on domestic livestock, all include some provisions in their management programs that address this problem. Wyoming is one of 2 states that reimburses owners for livestock killed by mountain lions (Bowns 1984). Wyoming Statute 23-1-901 stipulates that the Wyoming Game and Fish Department "investigate and allow payments for damages to livestock caused by trophy game animals."

Problems encountered in Wyoming in reimbursing livestock owners for animals killed by mountain lions are twofold. First, there are, and likely always will be disagreements over cause of death of individual animals. Secondly, woolgrowers wish to be reimbursed not only for sheep that are documented as killed by mountain lions, but sheep that are not accounted for and that may have been killed by mountain lions. There is general agreement that some of the sheep that do not return from summer pastures are likely to have been killed by mountain lions, but significant disagreement on the proportion of lost sheep attributable to mountain lion predation. The literature provides little assistance in resolving this problem. Studies that have quantified loss of sheep to predators have typically not been done in areas where mountain lions were expected to be a major predator (Klebenow and McAdoo 1976, Nass 1977, Tigner and Larsen 1977, Taylor et al. 1979). Shaw's (1977) work in Arizona, although probably the best investigation of mountain lion predation on livestock, dealt with cattle. Bruscino and Norelius (1987) studied cause-of-death of domestic sheep in the southern Big Horn Mountains of Wyoming and provided the first insight into the potential impact of mountain lions on sheep herds in this region. Their results indicated that 27% of the dead sheep found had been killed by mountain lions.

The primary objective of this study was to locate and determine cause of death of dead domestic sheep on pastures on the east slope of the southern Bighorn Mountains. Secondarily, we wished to evaluate whether our sampling approach provided a representative sample of dead sheep.

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Study Area

The study was done on the east slope of the southern Bighorn Mountains in Johnson County, Wyoming. Searches were conducted within large, native-range pastures grazed by domestic sheep. Pastures varied in the amount of cross-fencing present and thus the degree to which sheep movements were controlled. Pastures are largely privately owned although some grazed areas are leased from the Bureau of Land Management.

Elevation ranges from 1980 to 2500 m. At lower elevations mountain mahogany (Cercocarpus ledifolius) and Utah juniper (Juniperus osteosperma) are interspersed with areas of sagebrush (Atremisia spp.) and open grasslands. Numerous small, dry canyons and several large, deeper canyons run east and west through the area (Bruscino and Norelius 1987). Higher elevations are dominated by mixed stands of ponderosa pine (Pinus ponderosa) and younger stands of limber pine (Pinus flexis). Common juniper (Juniperus communis) is abundant in the understory of dense conifer stands. Small quaking aspen (Populus tremuloides) and lodgepole pine (Pinus contorta) stands occur occasionally in the higher elevations that are dominated by grasslands. The area contains vegetation and topography preferred by mountain lions (Logan and Irwin 1986, Laing 1988).

Timing of grazing on the pastures is largely determined by weather. Sheep are typically trailed onto the mountain after shearing and docking in late May and early June. Although not generally herded, they are visited regularly for inspection. Sheep are trailed from the mountain in October or November depending on snowfall.

METHODS

Pastures were selected for inclusion in the study based on several factors. These included: 1) the willingness of owner-operators to cooperate in the study; 2) proximity to other study pastures; 3) historical level of mountain lion depredation problems; 4) vegetation and topography representative of the southern Bighorn Mountains and; 5) access.

Search blocks were about 130 ha in size. Location of blocks in the pastures was based on spatial use of the pasture by the sheep since the previous search as indicated by reconnaissance of the pasture and or discussions with the owner-operator. Each search block was oriented to include a representative sample of the vegetation and topography in the area used by the sheep. Transects were spaced at 91.4 m intervals within the block and generally oriented across the shortest dimension of the block. Transects were followed using an orienteering compass. Search block locations and transect starting points were identified by distance pacing and topographic features. New search blocks were identified each time a pasture was returned to.

Transects were walked or ridden on horseback by either 1 or 2 observers. When walked or ridden by only 1 observer, every fifth transect was walked again in the opposite direction. Only carcasses judged to be from the 1988 grazing season were included in analyses. Presence or absence of wounds or tooth marks, predator sign, stage of decomposition, sex and age and position of the carcass were noted. Slope, aspect, topography and vegetation type were determined for the carcass site and surrounding area. Distance at which the carcass was first seen, its perpendicular distance to the transect line, and the distance it could be seen from the 4 cardinal directions was measured. Each carcass found was marked with red paint and a numbered tag.

Cause of death for each carcass was determined based on a key. The key was developed from information in the literature (Shaw 1987, Bowns 1976) and suggestions from persons experienced in animal damage control, and reviewed by ranchers and Wyoming Game and Fish Department (WGFD) personnel. Our intention was simply to determine if a sheep had been killed by a mountain lion or not.

Transects were generally double sampled by the first observer flagging the route and the second observer following the flagged transect and retrieving the flags. Each carcass found by either observer was investigated as described above. Carcasses were painted only on the underside by the first observer to prevent it being detected by the second observer because of the paint marking.

RESULTS

Four pastures, averaging 1830 ha in size, were included in the study (table 1). Nineteen search blocks were sampled; 32% were double sampled (table 2). The first search block was sampled in mid-June; the last block was sampled in mid-October 1988. Ten percent (n=18) of the transects in the single sampled blocks were walked twice by the same observer. Fifty-two sheep carcasses were found (table 3). Twelve (23%) of these sheep were killed by mountain lions. Sixty percent of all carcasses found (n=31) were lambs; all sheep killed by mountain lions were lambs. Sex of the dead lambs was determined for only 29% of the carcasses (6 males, 3 females).

Sheep killed by mountain lions were found in areas of dense conifer overstory, sage-grass and

grass vegetation types (table 4). Sheep that died of other causes were found in all vegetation types except those dominated by a conifer overstory. Carcasses of sheep killed by mountain lions were visible from the 4 cardinal directions at significantly shorter distances than carcasses of sheep that died of other causes (t=19.3 df=188) (table 5). This difference was most obvious in sage-grass and grass vegetation types (t=-6.14 df=78, t=5.38 df=106). Although dead sheep were found on slopes up to 40 degrees, most (88%) were located in areas ranging from level to 20 degree slope.

Table 1.--Pasture size, stocking level and percent of sheep missing the after grazing season on the Southern Bighorn Mountains, Wyoming.

Pasture	Size(ha)	Sheep[a]		% loss[b]
1	809	Ewes	1345	8
		Lambs	1074	3
2	1619	Ewes	1468	3
		Lambs	1710	4
3	3173	Ewes	1523	2
		Lambs	1003	8
4	1716	Ewes	1217	6
		Lambs	880	13

[a] Number of sheep on pasture
[b] Percent of sheep reported as missing by operator after grazing season.

Table 2.--Number of search blocks and transects sampled for dead domestic sheep in the southern Bighorn Mountains, Wyoming (June-Oct. 1988).

Pasture	Search blocks	Transects
1	6 (2)[a]	63 (79)[b]
2	4 (1)	38 (48)
3	5 (2)	34 (63)
4	4 (1)	36 (45)
Totals	19 (6)	173 (235)

[a]Number double sampled.
[b]Kilometers of transects. Does not include double sampling or back-walking transects.

Table 3.--Dead domestic sheep found and cause of death of these sheep on the east slope of the southern Bighorn Mountains, Wyoming 1988.

Pasture	Mountain lion	Other causes	Totals	% of loss[a]
1	0	14	14	10
2	7	16	23	21
3	0	3	3	3
4	5	7	12	7
Totals	12	40	52	9.4

[a]Percent of the sheep reported as missing by operators found on transects.

Table 4.--Vegetation types in which domestic sheep carcasses were found on the east slope of the southern Bighorn Mountains, Wyoming (1988).

	Mountain lion		Other causes	
	No.	%	No.	%
Conifer	2	17	0	0
Dense sage	0	0	2	5
Sage-grass	3	25	17	42
Mahogany-grass	0	0	1	3
Grass	7[a]	58	20	50

[a]Four of these carcasses were found together on the same bedground.

Only 1 carcass of a lion-killed sheep was intact, while 20 carcasses (50%) of sheep that died of other causes were whole when found. Intact carcasses of sheep that died of causes other than mountain lion predation were visible at significantly greater distances (x=30.6 m s.d.=30.5) than those that were scattered (x=16.3 s.d.=21.3, t=-2.8 df=106). Eighteen of the carcasses of sheep that died of causes other than mountain lion predation, and not found intact, had been fed upon by other animals. Over half (58%) of the carcasses were first detected by seeing the carcass itself, 19% by first detecting wool fragments, 12% by finding bone fragments, 10% by smell and 2% (n=1) by seeing a scavenger at the site.

Only 1 additional sheep carcass was found on the transects that were walked a second time by a single observer. Two of 11 sheep carcasses were found by only 1 of the 2 observers during double sampling efforts. The 2 sheep that were found by only 1 observer died of causes other than mountain lion predation. These carcasses were found in grass and sage-grass habitats, initially sighted at 6.4 and 11 m. and were visible from 26.2 and 21 m respectively.

Table 5.--Mean distance in meters (s.d.) that dead domestic sheep were visible in differing vegetation types on the east slope of the Bighorn Mountains, Wyoming (1988).

Veg. type	Initial sight[a]		Cardinal dir.[b]	
	Mt. lion	Other	Mt. lion	Other
Confer	8.4[c]		7.8(4.8)[c]	
Dense sage		8.5[c]		9.8(10.5)
Sage-grass	2.0(0.9)[c]	53.3(73.8)	3.4(2.2)	42.6(50.9)
Mohogany-grass		3.1[c]		24.8[c]
Grass	22.1(6.8)	39.8(64.6)	33.9(17.4)	41.2(60.9)
Totals	14.1(10.4)	42.5(90.7)	22.2(19.9)	36.8(54.7)

[a]Distance carcass initially sighted from.
[b]Average distance carcass visible from 4 cardinal directions.
[c]Small sample size (n<5).

DISCUSSION

Fewer dead sheep were found this year than found last year by Bruscino and Norelius (1987) in the Southern Bighorns (52 vs. 77) and a slightly smaller percentage was attributed to mountain lion depredation (23% vs 27.3%). Proportionately fewer lambs (60% vs 75%) occurred in the sample in 1988 than in 1987. The smaller number of sheep examined may be due, in part, to the fact that only half the number of ranches was surveyed this year. Reported average loss of sheep on the 4 pastures was 6%, but ranged from 4 to 9% compared to an average loss of 8.3% reported by Bruscino and Norelius (1987).

Our data support Bruscino's and Norelius' findings that few sheep which die of causes other than predation are found in timbered areas. The proportion of all lion-killed sheep found in timber was 17% this year and 19% last year. Most sheep that die of causes other than mountain lion predation, on the other hand, were found in sage or grass habitats.

The reduced visibility of carcasses of sheep killed by mountain lions probably resulted from a number of causes. Proportionately more carcasses of lion-killed sheep were scattered than were carcasses of sheep that died of other causes, and intact carcasses were detected at significantly greater distances. Secondly, carcasses of lion-killed sheep appeared to be found in areas of denser vegetation even within the same vegetation type.

Differential visibility of carcasses in the various vegetation types and the tendency for lion-killed sheep to be detected at shorter distances are 2 identified forms of bias that may influence the degree to which the sample of dead sheep we found is representative of all the sheep that died during the grazing season in these pastures. Although, by design, our transects traversed vegetation types in proportion to their occurrence in the search blocks, because of differential visibility, the area actually searched in each vegetation type was often not proportional to its occurrence in the search block. The potential for bias in the sample occurs because the proportion of lion-killed sheep appears to differ with vegetation type. The difference in detectability of sheep killed by mountain lions and those that died of other causes presents a similar problem. Due to the spacing of transects (91.4 m), we effectively searched less area for lion-killed sheep than we did for sheep that died of other causes.

Paying for sheep that are not documented, but possibly killed by mountain lions presents numerous problems. Differences in opinion on the proportion of missing sheep killed by mountain lions will be common and the proportion of lion-killed sheep will likely differ between years and pastures. Formulas to determine the proportion of missing sheep killed by mountain lions will need to reflect the uniqueness of years and pastures if they are to gain general acceptance. If samples of dead sheep are to be used in formulas to determine numbers of lion-killed sheep, sampling schemes must be designed to avoid biases such as those we identified.

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Evaluating Mountain Lion Depredation of Domestic Sheep[1]

Mark Bruscino[2]

Abstract.--In 1987, 171 domestic sheep (Ovaris aires) killed by mountain lions (Felis concolor) were examined in the Bighorn mountains of north-central Wyoming. Lions typically killed the sheep by attacking the head or neck regions. Feeding usually started with entering through the brisket and consuming the heart, lungs and liver. Feeding continued with the leg bones sheared above the hock and knee. Most of the carcasses that were moved by the lion were found in shrub or timber type vegetative habitat and in relation to rimrock topography.

INTRODUCTION

The Wyoming state legislature reclassified mountain lions from predator to trophy game status in 1973. The change in classification transferred management responsibility from the Wyoming Department of Agriculture to the Wyoming Game and Fish Department. Since 1981 the Wyoming Game and Fish Department has been responsible for reimbursing stockmen for livestock killed by mountain lions. From $6,858.30 to $55,717.70. Although the majority of the claims have been for losses of domestic sheep, depredation claims for cattle and horses have increased as well.

The Wyoming Game and Fish Department personnel are responsible for determining the cause of death of livestock claimed to have been killed by lions. It has become necessary to be able to accurately evaluate livestock losses to equitably reimburse the stockmen and responsibly manage the department's damage fund.

STUDY AREA

Research was conducted in Johnson and Washakie counties in the southern Bighorn Mountains of north-central Wyoming. The area is a mixture of private and public lands used primarily for pasturing livestock in the summer. The southern Bighorn Mountains is the largest sheep producing area of the state.

Due to winter snow conditions, livestock grazing is restricted to June through early November. Most sheep operations consist of large fenced pastures. The sheep are not herded and are selected to scatter throughout the pastures to equally use the range. The sheep are generally found in the open grass areas for shade during the warmest part of the day. Sheep are rarely found in the rougher terrain due to poor habitat conditions and natural barriers.

Elevations in the area range from 4500 ft. to 8200 ft. above sea level. The area is characterized by open gentle slopes traversed with frequent small canyons and rimrocks. Several large, deep canyons highlight the topography.

MATERIALS AND METHODS

Two search plots were chosen on each of eight ranch operations ranging in size from 249 to 6094 sheep at docking. Ranches and plots were chosen based on historical depredation incidences or suspected problem areas. Search plot ranged in size from 160 to 500 acres depending on the difficulty to inspect the area. An attempt was made to search each area as thoroughly as possible for dead animals. North-south and east-west routes were traveled on successive days for each study plot. Searches were conducted on horseback and foot. In addition, all carcasses in the southern Bighorns reported by stockmen or incidentally discovered by department personnel were also included in the sample.

When a carcass was located, the immediate surrounding area was searched for signs of predators in the form of scat, scratch piles or tracks. Indicators that the animal had been moved, scavenger sign and carcass position were noted. Carcass location, distance to cover, and if the animal was covered was recorded. Stage of decomposition, location and type of external injury, and areas fed upon were examined.

A field necropsy was performed to locate and document subcutaneous trauma, internal trauma, and skeletal fractures. Puncture wounds spacing from canine teeth were measured.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. (Fort Collins, Colorado, April 18-19, 1989).

[2]Mark Bruscino, Game Warden, Wyoming Game and Fish Department, Lovell, Wyoming.

RESULTS

During the 1988 field season 329 domestic sheep carcasses were examined by department personnel. Fifty-eight were discovered during structured ground searches, 17 were located incidental to other field duties and 96 were reported by landowners. Of the 329 sheep evaluated, 171 were determined to have been killed by mountain lions. Of the 171 sheep killed by mountain lions, only nine (5.3%) had lion sign in the form of scat or tracks associated with them. Three (1.7%) of the nine had discernible lion tracks nearby. Six (3.5%) had fresh lion scat within 140 ft. of the carcass location. Laboratory analysis found that all six samples had contained domestic sheep wool.

Thirty-one (18.1%) of the sheep carcasses had evidence that the cat had attempted to move the kill. When the lion did move the carcass, 23 (74%) were moved to areas that provided additional vegetative or topographic cover. Of all the sheep killed, 89 (52.1%) were found in shrub type vegetative habitat, 46 (26.9%) were located in grassland habitat. The remaining 36 (21.1%) were located in timber stands. A significant portion (p .001), 138 (80.7%) were located in rimrock or canyon type topography, while the remaining 33 (19.3%) were killed on flat or gentle slopes. More than one-third (36.4%) of the lion-killed sheep were found in areas of topographic or vegetative cover thought to be adequate for lion concealment and movement. 139 (81.4%) were located within 160 ft. of cover suitable for lions. In only 11 (6.5%) instances did the cat attempt to cover the kill. Covering was usually done with pine needle litter scraped from the immediate surrounding area.

Of the 171 lion kills, 152 (88.8%) showed evidence of biting on the dorsal or lateral portions of the neck or skull. When adult sheep were bitten on the skull, canine teeth usually caused puncture wounds to the cranium caused by the canine teeth. A bite to the skull of a lamb often resulted in fracturing at the sutures or a crushed skull. In most instances there was evidence of only a single bite indicating death by strangulation, spinal cord damage or hemorrhage. In 33 (19.3%) of the lion kill, the sheep incurred fractures to the cervical vertebrae. Significantly (p .001) more lambs (25) had fractures to the cervical vertebrae than did ewes (8).

Eighty-nine (52.1%) sheep had some evidence of feeding, although only 12 (7.0%) had been completely consumed excluding the hide and some skeletal components. Lambs comprised 10 (83.3%) of the sheep fully consumed. All consumed carcasses were found in relation to topographic or vegetative cover. Initial feeding was usually through the brisket region with a portion of the ribs eaten away to allow access to the heart, lungs, and liver. The rumen was often removed and covered several feet away from the feeding site. Feeding typically continued with the striated muscle from the ventral portion of the front quarter or hind quarter eaten while the hide was peeled back. Often one up to all four leg bones were sheared cleanly through above the knee and hock.

DISCUSSION

Although evidence associated with mountain lion depredation of domestic sheep seems to vary, this study found that there are indicators that can be compiled that will point to lion depredation. Tracks were often difficult to discern due to firm soils and exposed bedrock in the area. Lions do not seem to mark their kills with scat or scratch piles on a regular basis. Lions tended to move the carcasses if they were killed in an area unsuitable for concealment while feeding. Oftentimes, carcasses were abandoned where they were killed with little or no feeding which indicates that they have very poor use of the prey item, or they do not always kill for food.

The significant portion of sheep found in relation to topographic or vegetative cover suggests that lions will not venture far from cover to pursue sheep. Wade (1929) and Van Pelt (1977) found that lions use cover to stalk and attack prey. Sheep are found in this type of habitat usually only during the middle of the day or occasionally bed in that type of habitat at night. It is then likely that most attacks take place during daylight hours. This study found that there was a relationship between habitat selected by sheep and vulnerability to lion attacks. When the sheep remained in large open pastures, the rate of attack was less than for sheep using areas with more cover.

Covering of the carcass seems to occur when lions intended to return to feed as most abandoned kills had no evidence of being covered. The cat will generally recover the carcass after each feeding until they do not intend to return. The majority of the kills were neither covered, cached nor fully consumed.

Sheep appear to be easy prey for lions as there was rarely sign of a struggle. Most sheep were killed with a single bite to the neck or head. As carcasses decompose, evidence of cause of death is lost. Tooth marks in the forms of punctures, grooves, scrapes or fractures to the cervical vertebrae are often indicators in advanced stages of decomposition, although they do not always occur. This study is supported by finding by Nowak (1976) that lions kill by severing the spinal column, breaking the neck, or crushing the skull. Lambs suffered cervical fractures at a higher rate than did adult ewes, likely due to less muscle tissue protecting the vertebrae. Lambs were killed at a higher incidence, likely due to vulnerability.

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Trophy Game Animal Damage in Wyoming[1]

Ron Iverson[2]

Abstract: Wyoming is perhaps one of the most liberal and unique states of the fifty states on compensation for game and trophy game animal damage. Trophy game animals as defined by statute in Wyoming includes the Cougar (Mt. Lion), Black Bear, and the Grizzly Bear. According to statute Wyoming is responsible for damages incurred by these species to livestock, land, crops, improvements, and extraordinary grasses. Since the statutes were enacted Wyoming has been faced with a variety of complaints and damage claims caused by these species. Damage complaints received by the Department have covered a broad spectrum, ranging from the stockman losing livestock to the everyday housewife with a black bear coming onto her back porch to eat the dog's food.

This paper illustrates methods, budgetary requirements, and manpower that the Wyoming Game and Fish Department uses to alleviate or reduce damage, investigate complaints, and to compensate for damages incurred by trophy game animals in Wyoming.

Let me start with a brief summary of the makeup Wyoming Game and Fish Department and what some of the requirements are to hold a Damage or Game Wardens position. The Wyoming Game and Fish Department is presently controlled by a seven member board appointed by the state's governor. This board is known as the Wyoming Game and Fish Commission. We have five divisions within the Department; Game Division, Fish Division, Information and Education Division, Fiscal Division, and the Habitat and Technical Services Division. The Game Division, which has the responsibility of handling all aspects of terrestrial wildlife, is comprised of seven districts that are located throughout the state. The districts vary in size from about 8,000 square miles to about 24,000 square miles. Each district has one damage control warden, an average of seven game wardens, one enforcement specialist, three biologists, one biologist coordinator, and a supervisor.

The damage control warden, the game wardens, or the supervisor handle the damage calls for the District and can be notified about any wildlife depredation, which includes Trophy Game Animal damage. The responsibility of prevention and investigations falls mainly on the damage control warden or the game warden assigned to that area. Those responsibilities include wildlife damage prevention and investigations of (big game, trophy game, and game birds), wildlife law enforcement, game management, and public relations. The requirements to become a damage warden or a game warden include a four year degree in wildlife management, biology, range management, or other fields that are related; and must successfully take and pass the game wardens exam. Once hired he must complete the basic training course at the Wyoming Law Enforcement Academy.

The district which I am responsible for is one of the smaller districts in the state with a little over 8,000 square miles. There are five wardens and one damage control warden to handle damage complaints and investigations. The district has a wide variety of terrain, ranging from high desert ecosystems to alpine systems in excess of 13,000 feet elevation.

[1]Paper presented at the Western Plains Damage Workshop, April 16 - 20, 1989, held at Colorado State University, Ft. Collins, Colo.

[2]Ron Iverson, Damage Control Officer, Wyoming Game and Fish Department, Lander, Wyo. 82520

All big game species are present with the exception of mountain goats which are only found in the northwest corner of the state. All three trophy game species, mountain lion, black bear, and the grizzly bear are located in the district. In 1973 Wyoming State Statute 23-1-101 was recodified to add the mountain lion with the black bear, and the grizzly bear as trophy game animals, up to this time the lion was designated a predator. This meant that the Wyoming Game and Fish Department was assigned the responsibility to manage the lions as well as both species of bears. It also meant that the department was responsible for damage incurred by these species to land, crops (cultivated, standing, or stored) improvements, and extraordinary damage to grasses. In 1980 the statute was changed again to include damage incurred by trophy game animals to livestock. The department became liable for payment when a trophy game animal damaged or killed livestock.

Indications are that bear and lion populations throughout the state have been increasing since use of 1080 was banned and grizzly bears achieved threatened status in 1975. Although the grizzly bear is protected under the Endangered Species Act the department is still responsible for the damages caused by grizzlies. With increasing populations our department has realized a corresponding increase in the number of complaints and the number of claims received regarding trophy game animal damage. With these increases, the cost of maintaining these species dramatically increased.

TABLE A-1

MOUNTAIN LION

YEAR	*MAN DAYS SPENT	**LIONS HARVESTED	***MANAGEMENT COST	COST/LION HARVESTED
1981	101.5	18	$180,328	$10,018.22
1982	103.5	21	$363,948	$17,331.86
1983	142.0	37	$232,238	$ 6,276.70
1984	67.0	39	$ 77,695	$ 1,992.00
1985	136.5	56	$189,861	$ 3,390.00
1986	117.0	63	$166,518	$ 2,643.00
1987	138.0	50	$276,806	$ 5,777.00
1988	164.0	102	$264,450	$ 2,593.00

*Man-days spent are days attributed to lions damage prevention, investigation and nuisance wildlife control.

**Lion harvest reflects all kills including removal of problem lions by the Department.

***Management costs are all costs attributed to lions except damage claim payments.

The Department annual reports from 1981 to 1988 illustrates maintenance cost to the department by species, (Tables A1-A3).

TABLE A-2

BLACK BEAR

YEAR	*MAN DAYS SPENT	***BEARS HARVESTED	**MANAGEMENT COST	****COST/BEAR HARVESTED
1981	44	408	$215,137	UNKNOWN
1982	91.5	236	$229,477	UNKNOWN
1983	95	348	$541.919	UNKNOWN
1984	11	300	$556,131	$1,854.00
1985	31	267	$ 53,280	$ 199.55
1986	45	232	$ 68,176	$ 293.86
1987	68	331	$ 78,462	$ 237.00
1988	101.5	289	$ 80,998	$ 280.00

*Man-days spent are man days attributed to nuisance control, damage investigations, and damage prevention.

**Management costs are those costs attributed to black bear management. These costs don't include damage claim payments, (Table A-4).

***Bears harvested are only those bears taken legally by hunters and doesn't include illegal harvest or nuisance bears.

****Unknown costs/bear harvested from 1981-83 can't be figured because management costs for grizzly was combined with the black bear.

TABLE A-3

GRIZZLY BEAR

YEAR	*MAN DAYS SPENT	**GRIZZLY HARVESTED	***MGMT. COST	COST/GRIZZLY HARVESTED
1981	0	PROTECTED	$ 215,137	NONE
1982	0	PROTECTED	$ 229,477	NONE
1983	0	PROTECTED	$ 541,919	NONE
1984	11	PROTECTED	$ 498,440	NONE
1985	59	PROTECTED	$1,386,570	NONE
1986	6.5	PROTECTED	$ 542,640	NONE
1987	12.5	PROTECTED	$ 490,259	NONE
1988	4.0	PROTECTED	$ 677,608	NONE

*Man-days are days attributed to days spent on nuisance control, damage prevention and investigations. From 1981-1983 man days were combined with black bear man days.

**Grizzly harvest indicates bears harvested legally, it doesn't reflect illegal harvest or problem bear harvest.

***Management costs from 1981-83 were combined with black bear management cost. Management costs only reflect cost by the department to manage the grizzly, they don't reflect the cost of damage claim payments.

TABLE A-4

DAMAGE 1981-1989

SPECIES	DAMAGE CLAIMED	DAMAGE PAID	*NUMBER OF CLAIMS
Mountain Lion	$455,770.01	$312,786.43	235
Black Bear	$ 34,428.59	$ 26,042.46	53
Grizzly Bear	$ 2,121.33	$ 2,121.33	2

*Reflects only damage claims submitted for payment, damage complaints aren't included.

As you can tell from these charts maintenance costs rose to the highest levels in the mid 1980's and then dropped but now again have started to raise. Not included in these costs are costs of damage claim payments, (Table A-4). Funding to pay Trophy Game Animal damage as well as Big Game and Game Bird damage comes from a five dollar application fee collected on all nonresident big game license applications. This fund has a $500,000 ceiling on it at which time the moneys are deposited into the general Game and Fish Fund and used for other projects. The dollar amounts paid for damage compensation have risen over the last few years to where in the foreseeable future payments will exceed the limit, at which time other funding will have to be provided.

There are several methods, (from repel collars on livestock to ole shep staked out on the back porch), to reduce or to prevent damage by trophy game animals. The ones I've found to be most manpower and cost effective include: 1.) manipulation of hunting seasons, 2.) manipulation of grazing practices, 3.) trapping and transplanting, 4.) and as a last resort, removal from the population. An example using hunting seasons to reduce trophy game animal damage can be demonstrated using two lion areas in the state. These two areas are in the central part of the state, they have real good populations of wildlife (mainly deer), and have terrain and habitat ideal for lions. Domestic sheep are the primary animals raised by the livestock producers in the area. The lion damage was out of control, mainly to sheep on summer range. Several types of seasons and kill quotas were tried, but what seemed to work best was a year around season with all the kill quotas lifted. This seemed to reduce the damage to where it satisfied the livestock producers. The population of lions in those two area are believed to have decreased.

The Wyoming Game and Fish Department has effectively worked with landowners, National Forest Service, Bureau of Land Management, the University of Wyoming, the Fish and Wildlife Service and the Park Service to change or trade allotments or alter grazing practices to reduce conflicts with wildlife. Some examples are changing the allotments from sheep to cattle or trading vacated allotments to reduce conflicts. These allotments aren't always changed or traded solely for a damage reason, but often times damage conflicts are taken into consideration. In the case of the grizzly some areas have been set aside where the priority is for the bear. These areas are classed as Situation I Grizzly Bear Management Areas and are part of the Yellowstone Ecosystem that is adjacent to Yellowstone National Park. In these areas if conflicts occur the lessee may be asked to move his livestock either to another allotment where conflicts won't arise and a vacated one is available or completely out of the area ... I think that trapping and transplanting is probably the method most used in my District. Most cases involve bears, although some lions have been relocated, from unwanted places like campgrounds, urban areas, livestock allotments and hunting and fishing camps in the back country. It's just a matter of live trapping or tranquilizing the animal and moving it to a location where conflicts won't be as likely. Some of the draw backs of this method are: 1.) it isn't a fail safe method as you might be creating problems somewhere else and the Department has relatively no information of the displacement of the resident animals of the area. 2.) also the problem might occur in an area that is inaccessible with a trap and helicopter, transportation might not be cost effective, I'm sure all departments are watching their budgets. 3.) reaction time might be hampered by involvement of too many agencies as in the case of the grizzly. This brings us to the last resort method which is to destroy the animal. Once the animal has been destroyed it can be used for research, education, exhibits and displays, or hides and skulls can be sold at auction to generate revenue. As in the case of relocation there are exceptions with the grizzly bear. Before any grizzly is destroyed certain things are taken into consideration by the U.S.F.W.S.. If the nuisance grizzly meets the criteria to be destroyed it becomes the property of the Federal Government.

Wyoming's State Statute 23-1-901, says that a person that has damage has 15 days from the time the damage is discovered to report it to a damage control warden, game warden, or a supervisor. By commission policy the Department has three days to initiate an investigation. Investigations of damage caused by trophy game animals can vary from looking at dead sheep - to looking at a bunch of bee hives that are scattered about with mad bees everywhere - to confronting a lady that a bear had just wondered into her house to get ole shep's dog food - to confronting that back country woodsmen with his shredded tent.

Whatever the case may be the most important thing to determine is what actually caused the damage.

Often times bears and lions are blamed for damage that is really caused by other animals such as racoons, coyotes, feral dogs, bobcats, or foxes. Poisons, lighting, and natural causes may also be responsible. A bear or lion on a kill or in the immediate area is not sufficient proof the animal was the cause of the damage. Tracks, geographical locations and scat (unanalyzed) are good indicators of the cause but are not absolute. Bite marks, scat (analyzed), and necropsies are better indicators.

After determining what has caused the problem the next step is to determine how much damage has occurred. In the case of livestock losses actual counts are used. However Wyoming does have certain areas of the state designated as special compensation areas for lion damage to livestock. In these areas the Department will offer for settlement of lion damage claims, a formula based on a study conducted by the department. It states that lion damage settlement will equal confirmed kills plus .27 x total numbers of missing ewes plus .28 x the total numbers of lambs. Total numbers will be determined by shearing counts, docking counts, shipping counts, lamb counts, landowner or lessee counts, lending institution counts, brand inspectors counts, trailing permit numbers, counts based on wool incentive programs, tax records, or combinations of any of the above. This technique recognizes the Department's inability to find all sheep killed by lions and recognizes that all sheep not found were killed by a lion. This plan is in effect on a one year trial basis. In both cases payment is based on current market value. Another type of damage encountered usually with bears is property damage i.e. improvements. According to 23-1-901, the Game and Fish Department is also responsible for damage to improvements. Improvements according to the dictionary are "a change that improves or adds value to something". What it doesn't explain is in whose eyes. So we've looked at everything from camping equipment to furniture to bee hives to show dogs. I guess the hardest part is trying to figure out what things are worth and then reaching agreement with the claimant. As strange as it may seem we have also investigated crop damage by trophy game animals as our law prescribes cultivated, standing and stored crops. Some examples that I'm familiar with are bears in apple orchards, bears in camps eating grain and horse cake, bears in gardens eating vegetables, bears in bee hives eating honey, and bears in barns and granaries eating cake and grain.

After the investigation has concluded and all attempts have been made to prevent ongoing damage and the damage quits or has reached a level that the claimant can live with, a Damage Claim Affidavit (Figure A-1) can be filed within 60 days to the office of the Chief Game Warden.

Figure A-1

G-29A 1988

BIG GAME ANIMAL AND/OR GAME BIRD
DAMAGE CLAIM AFFIDAVIT

STATE OF WYOMING)
)
COUNTY OF _____)

I, _____ of _____
(insert mailing address)

_____, being of lawful age and being first duly sworn upon oath depose and say:

That I am the landowner, lessee or agent (circle one) of the following described property in the county of _____, State of Wyoming, which was damaged by big game animals and/or game birds (circle one or more applicable) of the State of Wyoming, to-wit: (insert here legal description of said property and specify whether owned in fee or leased. If leased, specify whether Federal, State or private): _____

_____

_____

_____

That the damage was caused by big game animals and/or game birds (circle one or more applicable) commonly known and referred to as (here indicate type and approximate number):

_____

_____

That the damage for which this Affidavit of Claim is made was discovered on the following date and ended on stated date: (Here insert the date of damage for each specific item of damage claimed. If part of damage involves a series of depredations, specify date begun and date ended. A verified claim for damages must be presented at the office of the Commission not later than sixty (60) days after the damage or last item of damage):

_____

_____

_____

That said damage amounts to the total sum of $_____, which includes the following items of damage and is computed as follows: (Here specify each item of damage claimed: description of the damaged land, growing cultivated crops, stored crops, seed crops, improvements and/or extraordinary damage to grass):

_____

_____

_____

_____

_____

_____

_____

_____

_____

The property is___, is not___, partially___protected. If so how?_____

_____

The landowner allows hunting___, prohibits hunting___, charges access fees_____ guides hunters___, denies access___, other_____

_____

It is recommended this claim be paid in the full amount of_____, be partially paid in the amount of_____, be totally disallowed_____.

Reasons for the above recommendations and method of calculation of recommended payment are_____

_____

_____

_____

_____

_____

_____

_____

Additional comments or information:_____

_____

Show the amount by species of) Species _____ Amount_____
the total recommended claim) Species _____ Amount_____
payment:) Species_____ Amount_____

Signed:_____ Date:_____
District Supervisor

Signed:_____ Date:_____
Damage Control Warden

Signed:_____ Date:_____
Game Warden

He then notifies the investigating officer who submits all details of what has taken place along with a recommendation for payment in full, partial payment, or no payment along with reasons for that decision. (Figure A-2).

DAMAGE CLAIM INVESTIGATION REPORT - WYOMING GAME AND FISH DEPT.

Name of Claimant_____Claim Amount_____

Species_____Hunt Area #_____Management Unit #_____

Species_____Hunt Area #_____Management Unit #_____

First notified of game damage by_____on_____19____.

Notification was made by letter____, phone____, personal contact____, by_____,

to Wyoming Game and Fish Department representative_____.

First information stated that damage was being done to _____

_____

by_____and commenced_____19_____.

Notification was____was not____, within 15 days after damage discovery as required by W.S. 23-1-901.

The verified affidavit was received on_____19_____. This is____, is not____within sixty (60) days after the damage or last item of damage as required by W.S. 23-1-901.

First investigation of alleged damage occurred on_____19_____

by_____and the following condition of damage was observed.

_____

_____

_____

Action taken:_____

_____

List by date each subsequent investigation, giving findings, action taken and name of investigator:_____

_____

_____

(use reverse side for further comment)

That said damage was reported to the following Game Warden, Damage Control Warden, Supervisor or member of the Wyoming Game and Fish Commission, on the following date or dates, to-wit: (Here specify date and person said damage was reported to):

_____

_____

That hunting of the species for which the claim is filed was/was not (circle one) permitted on the above described property during the authorized hunting season.

That an access fee was/was not (circle one) charged for hunting during seasons on the above described property for the privilege of hunting the species for which the damage claim is filed.

That the total amount of access fee charged per hunter was $_____.

(If varied access fees are charged, explain below:)

_____

_____

_____

That I allowed the following number of persons to hunt on the above described property during the last hunting season for the species for which the claim is filed.

_____.

That the matters stated herein are true.

CLAIMANT: _____

STATE OF _____)
) ss
COUNTY OF _____)

The foregoing instrument was acknowledged before me by _____

this _____ day of _____, 19_____

Witness my hand and official seal.

_____
Notary Public

My Commission expires _____

Date Received:

_____

By _____
State of Wyoming
Game and Fish Department

The Chief Game Warden then makes a decision on how to proceed and notifies the claimant as to that decision. If the Claimant doesn't like that decision he can appeal it before the Game and Fish Commission. If he still isn't satisfied he can take the matter before a arbitration board then on to District Court and all the way up to the Supreme Court.

As you can tell from this brief report, Wyoming has some unanswered questions regarding our Trophy Game Animal species. We need to know what the makeups are for the populations and their sizes. Some work has been done by the Inter-agency Grizzly Bear Management Team, University of Wyoming Co-op Unit and the Department to determine territories and ranges, migration routes, food sources, behavioral activities, habitat uses, and etc., but there are still a lot of unanswered questions. Also the language in the damage statute (Wyo. State Statute 23-1-901) needs to be improved to better define types of damage and allow for interpretation of statutory criteria. Without doing these things the Game and Fish Department can't really effectively regulate or manage Trophy Game Animals and can't really be effective in designing methods to control the damage keeping the resource in mind.

FIGURE A-3

WYOMING GAME AND FISH COMMISSION
CHAPTER XXVIII
REGULATION GOVERNING BIG OR TROPHY GAME ANIMALS OR GAME BIRD DAMAGE CLAIMS

Section 1. Authority. This regulation is promulgate by authority of W.S. 23-1-302.

Section 2. Regulations and Effective Date. The Wyoming Game and Fish Commission hereby adopts the following regulation governing damage claims, filed in accordance with W.S. 23-1-901.

Section 3. Definitions. For the purpose of this regulation, definitions will be as set forth in Title 23, Wyoming Statutes, and the Commission also adopts the following definitions:

(a) "Office of the Department" means Wyoming Game and Fish Department, 5400 Bishop Blvd., Cheyenne, Wyoming 82002.
(b) "Office of the Commission" means Wyoming Game and Fish Commission, 5400 Bishop Blvd., Cheyenne, Wyoming 82002.
(c) "Damage" as used in W.S. 23-1-901 means actual damage as proved to have occurred by the claimant, to livestock, land, crops, improvements and extraordinary grass damage, and shall not include any amount for punitive damages under any circumstances.

(d) "Extraordinary Damage to Grass" as used in W.S. 23-1-901(c) means the consumption or use of noncultivated grass plants in excess of the consumption or use which normally occurred during the two years immediately preceding the time period covered by the damage claim.

(e) "Permitted Hunting" as used in W.S. 23-1-901(c) means the claimant operated in such a manner as to allow or provide for hunting on his land and access to adjoining land to allow for a harvest sufficient to meet the objectives for the area and herd.

(f) "Disinterested Arbitrator" shall mean any person, otherwise qualified, who is capable of making a reasoned and unbiased decision on evidence presented by both parties to the Arbitration Board.

(g) "Hearing" as used in W.S. 23-1-901(e) shall mean a procedually correct arbitration hearing which shall be conducted in such a manner as to afford both parties to present, examine and cross examine all witnesses and other forms of evidence received by the arbitrators. The decision of the arbitrators shall become a part of the agency file and shall be considered coevidence in the event of an appeal of the arbitrators' decision and Department file shall constitute the agency record of decision and any appeal therefrom to district court shall be conducted in conformity with the Wyoming Administrative Procedure Act.

(h) "Investigated by the Department" as used in W.S. 23-1-901(c) means a reasonable inspection of the damaged premises, crops or livestock as deemed adequate by the Department to evaluate and to report to the Commission the extent of damage incurred. Failure of the claimant to allow such reasonable inspection, upon request, shall constitute a bar to making claim as specified under W.S. 23-1-901(c).

(i) "Reasonable Service Charges" as used in W.S. 23-1-901(f) means fifty dollars ($50.00 per day while performing duties as an arbitrator.

(j) "Reasonable Expense Charges" as used in W.S. 23-1-901(f) means actual expenses incurred by the arbitrators for telephone calls, paper supplies, mail service, meeting rooms, plus per diem allowance and transportation expenses as allowed state employees by Wyoming Statutes.

Section 4. Verified Claim Requirements. The verified claim required by W.S. 23-1-901(b) shall be submitted on the form prescribed by the Department designated as "Damage Claim Affidavit". The claim shall set forth a legal description of damaged land, a description of the property damaged, the dates during which damage occurred, the type and number of big or trophy game animals or game birds which caused the damage, when the damage was delivered, to whom the damage was reported and the manner and date reported, whether or not the claimant permitted hunting during the most recent authorized hunting season for the species causing damages. Additional supporting information may be submitted and will be considered as part of the verified claim. Amended damage claims may be filed with the office of the Department in the event that all information is not immediately known by the claimant. In any event, the entire claim must be submitted in writing to the office of the Department within 60 days of the last item of damage.

Section 5. Arbitration Notification Procedure. During the process of establishing an arbitration board to act upon a damage claim, written notification will be made from the claimant to the office of the Department and from the Department to the claimant regarding the names and mailing addresses of arbitrators selected by them. The two arbitrators selected shall notify in writing both the claimant and the office of the Department of the name and address of the third arbitrator selected.

Section 6. Savings Clause. If any provision of this rule or its application to any person or circumstance is held invalid or in conflict with any other provisions of this rule, the invalidity shall not affect other provisions or application of this rule which can be given effect without the invalid provision or applications and to this end the provisions of this rule are severable.

Wyoming Game and Fish Commission

by

Dennis Daly, President

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Coyote Control in Alberta[1]

John B. Bourne[2]

Abstract.--A historical review of coyote damage to livestock, early control measures and the development of Alberta's coyote damage control program is provided, including provincial and federal legislation, provincial policy, research and field testing initiatives, extension and control methodology.

INTRODUCTION

I would like to outline Alberta's coyote damage control program by chronicling its development from early times to the present.

HISTORY OF COYOTE CONTROL

Predator damage control in Alberta and specifically coyote control, had its earliest beginnings when European immigrants settled this province less than 100 years ago. Prior to that, Hudson Bay Company's records document profitable and sizeable catches of "prairie wolf" until the time of settlement on the Canadian prairies (Newman 1985).

Bounty System

Prairie homesteaders describe protecting poultry and young livestock from coyotes by leghold traps, coyote poison, horse and hound chasing. Prior to and during World War I, homesteaders and local governments unified their resources and funds to support a bounty on coyotes. Local municipal records in 1921, for instance, show 6500 pairs of coyote ears turned in for the $2.00 bounty paid in south central Alberta. The bounty system (fig. 1) for coyotes flourished almost continuously until withdrawal in 1948 (Todd and Geisbrecht 1979).

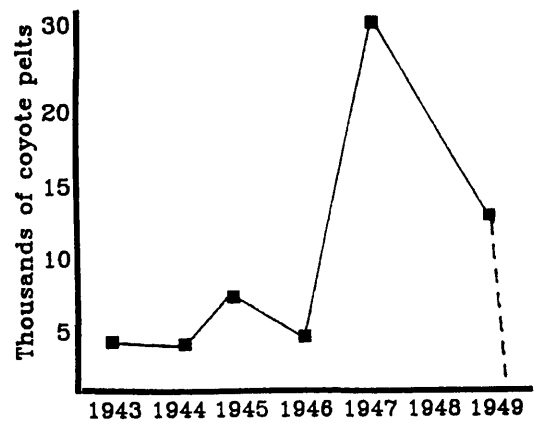

Figure 1. COYOTE BOUNTY 1943-1948

Division of Responsibility

In 1941 game law enforcement and regulatory services of Alberta Agriculture were transferred to the Department of Lands and Forests. Thereafter, fish and wildlife management and game enforcement were the mandate of the Lands and Forest for all species, except those recognized as agricultural pests such as the black-billed magpie, Norway rat, coyote and field rodents. Alberta Agriculture continued to control the coyote in agricultural areas. Control of sport hunting and trapping coyotes, province wide, was and is, the responsibility of Fish and Wildlife (Annual Report 1946).

Early Legislation

In 1948, the unregulated and indiscriminate use of snares, traps and poisons on private land ended with the introduction of legislation that regulated the use and distribution of poisons for coyote control. The Agricultural Pests Act identified persons who could use or issue poisons. In the same year, coyote getters and 1080 poison were acquired by Alberta Agriculture from the USBSFW and used for coyote control. Prior to 1948, strychnine was the primary poison for coyote control.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. (Colorado State University, Ft. Collins, April 19-20, 1989).

[2]John B. Bourne is Regional Supervisor Problem Wildlife, Government of Alberta, Vermilion, AB.

RABIES EPIZOOTIC

In the early 1950's, positive diagnoses of rabies was confirmed in red foxes in northern Alberta when fox populations were at their apex. In 1952, rabies was enzootic in red fox in northern Alberta and the disease was very quickly transmitted to other carnivora including coyotes, wolves, bears and lynx. An intensive vector control program was soon underway; the major control agents and animal removal methodology was fashioned after the coyote damage control program. Over 2 million strychnine baits were used for rabies control during 1952-1956. When the campaign terminated nearly four years later, records indicate 150-170 thousand coyotes and 10-15 thousand wolves were destroyed (Ballantyne 1958).

COUNTY COYOTE CONTROL PROGRAM

At this time, Alberta Agriculture and rural counties were entering a new age of post war agricultural production, advanced agronomy, harvest-mechanization production and changes in land use practices. To deal with the agriculture issues, rural counties hired and trained agricultural fieldmen to conduct cooperative programs and enforce legislation and policy. All county agriculture programs were cost shared 60:40 with Alberta Agriculture. Included in the government and county agreement, was the county responsibility of coyote control (Annual Report 1953).

Alberta Agriculture established procedures and standards of conduct for coyote control, trained county fieldmen and supplied poisons and materials for coyote control. In 1953, Alberta Agriculture began purchasing from the USBSFW its third toxicant, 140 mg strychnine tablets.

Partly as a result in changes in agricultural management practices and new developments in the livestock industry, cattle numbers increased rapidly while sheep and lamb numbers declined. In 1940, there were 1.36 million cattle and .88 million sheep. By 1960 these numbers changed to 2.7 million cattle and .55 million sheep and by 1980 3.73 million cattle and .2 million sheep.

LIVESTOCK PRODUCTION

In the 1970's, livestock production and particularly cattle production, in Alberta increased steadily and continuously. This was due in part to government incentives, low cost breeding animals and availability of low cost marginal land. Also, production of other livestock and poultry increased substantially but for slightly different reasons. As expected, predator complaints and reported losses paralleled industry growth (Annual Report 1970). Also, wolf predation on livestock was reported in the 1970's, something almost unheard of since wolf populations were believed to be still recovering from the rabies depopulation campaign twenty years earlier.

NEW PROGRAM

To reduce off producer complaints, Alberta Agriculture hired ten predator specialists in 1972. Fish and Wildlife also hired or transferred staff to deal with carnivore predation in the forested areas. (Alberta Energy & Natural Resources 1976). Alberta Agriculture predator specialists provided additional assistance to county fieldmen to aid in resolving coyote predation. Until 1972, most coyote control was conducted by county personnel.

Compensation

In 1974 Alberta Agriculture implemented a compensation program to indemnify producers for livestock and poultry losses attributed to predation. Owners of confirmed predator killed animals were recompensed at 80% market value at time of damage. Annually some 500-1000 complainants receive about two $250,000 for coyote losses. Confirmed poultry losses account for about 10% of the total monies paid out (Annual Report 1987).

Federal-Provincial Legislation

Authority to use predacides is under both federal and provincial laws. The Agricultural Pests Act establishes who may issue and set out poisons, while the federal Pest Control Products Act specifies toxicant storage, disposition, toxicological data, worker safety, first aid and specific uses. Prior to 1984 provincial governments could use predacides without federal registration.

Coyote Control Techniques

Lethal neck snares were permitted as a control device was completed in 1984. Lethal neck snares are not classified as restrictive, therefore, do not require federal registration. Also in 1984 140 mg strychnine, 760 mg sodium cyanide, 5 mg 1080 tablet, 5 mg liquid 1080 and 600 mg liquid 1080 were registered with the federal government. Other techniques used in coyote control include leghold traps, guard dogs, electric fences, den hunting and shooting. Aerial shooting is not allowed in Alberta.

PROGRAM OPERATIONS

During the last five years the focus of Alberta's coyote damage control program has shifted from direct assistance to producer training and extension. Part of this change was due to fiscal restraint. Other factors include increased government demand for safer use, care and welfare for the user of restricted devices. This has resulted in a reduction in provincial predator specialists, more work done by counties, greater restriction on use of poisons and fewer toxicants used. To counter this, greater extension efforts have resulted in promotion of preventive techniques and general producer education.

Long term program objectives include promotion of preventative and non lethal control measures. Attaining these goals is made easier by the new era livestock producer, particularly the sheep farmer who is younger, better educated, more experienced and a little more affluent than the previous generation. This results in many innovative and creative producers willing to risk new off-farm ideas.

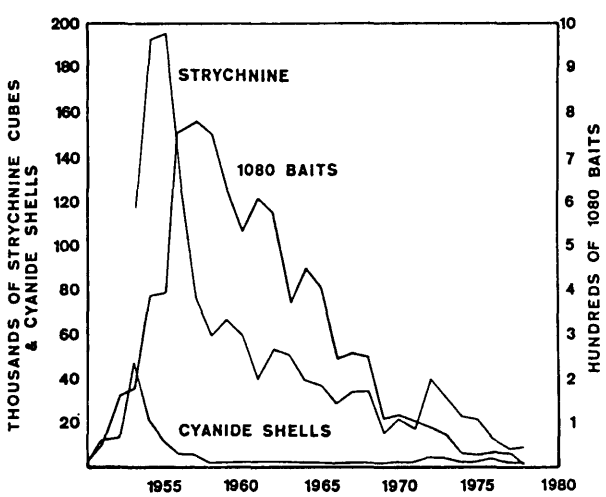
In training producers, the primary consideration in establishing a predation free operation is appropriate and adequate animal husbandry. Many coyote-sheep conflicts occur as a result of poor or unsuitable livestock management practices. Predation would decline if producers constructed sound barrier fences, properly disposed of livestock remains and followed closer herding regimes of their flocks.

Since our initial field test ten years ago, electric fences (Dorrance and Bourne 1980) are now the primary control agent on nearly 25% of all major sheep operations. The rapid growth of electrical technology in fence energizers and other equipment and materials, along with new designs and configurations, have made electric fences very attractive to sheep producers.

Other proven preventative measures are guard animals (including dogs), special herding regimes, routine den removal and a continuum of home variations and remedies of the above.

This has resulted in a significant decrease in and more efficacious use of toxicants (fig. 2). Since 1984 overall toxicant use has decreased and toxicant choice has shifted from strychnine to 1080 (table 1).

Single dose 1080 tablets and liquid 1080 has all but replaced strychnine and the large winter 1080 meat baits.



TOXICANTS FOR COYOTE CONTROL

Figure 2.--(illustrates total toxicant use in Alberta since regulatory authorization began in 1953)

Table 1. TOXICANTS DISTRIBUTED FOR COYOTE CONTROL

Year	Cyanide Shells	Strychnine Cubes	Single Dose 1080	Large 1080 Baits
1978	1549	6670	-	0
1979	1453	6100	-	14
1980	1041	3840	-	14
1981	1672	3700	-	13
1982	1642	3700	-	13
1983	1278	3593	-	16
1984	1175	4184	147	15
1985	873	2609	346	16
1986	482	2166	558	8
1987	565	1567	1769	8

Today, predator specialists spend four and one-half man years investigating about 500 coyote complaints in 65 counties (table 2). Generally predator specialists, working with producers and in many cases with county fieldmen, spend about 20 hours resolving each coyote predation complaint. This is about double the time spent 15 years ago, however, the number of return visits is less than 50%. Predator specialists and county fieldman provide direct control assistance to about 75% of the reported coyote predator claims for compensation (Rodtka, 1989). About 25% of coyote complaints are handled independently by the producer.

Alberta Agriculture produces a number of multimedia articles, slide tape productions and hands-on training workshops for producers to enhance awareness of and need for sound principles of coyote predation control.

Table 2. NUMBER OF CASES AND TOXICANTS SET

Year	Number of Cases	Number of Toxicants Issued	Number of Toxicants Per Case
1984	520	4125	7.9
1985	528	2933	5.6
1986	398	1945	4.9
1987	513	2530	4.9

CONCLUSION

Given the support, cooperation and assistance shown by producers, municipalities, the general public and other agencies such as Fish and Wildlife, Alberta's coyote damage control program appears secure and in tact. I regret that I can not provide an inspired personal vision for the future. Like others, I can only gaze into that

munificent crystal ball. Unfortunately this will not help, for as our former minister once lamented, one can not look into a crystal ball unless one is able to eat ground glass.

No doubt there will be further challenges of budget expenditures and fiscal policy, but with strong leadership, political will and continued support, coyote damage control will prevail in Alberta. There will probably be:

1. Reduced use of poisons and more restrictions on their use.

2. Greater emphasis on non-lethal preventative techniques, particularly electric fences which work very effectively on most operations in Alberta.

3. Greater concern for humane methods of control.

4. More pressure from environmental groups and other organizations concerned with animal rights and humane treatment of wild and domesticated animals.

Alberta Agriculture attempts to make changes in coyote control policy and programs before there is public pressure to do so. It attempts to strike a balance between the real and perceived needs of the farmer and the concerns of environmental and animal welfare groups.

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Texas Department of Agriculture Predator Management Program[1]

Murray T. Walton[2]

Abstract.--In 1988, the Texas Department of Agriculture initiated predator management training and certification for sodium monofluoroacetate (Compound 1080) Livestock Protection Collar applicators and recertification of M-44 sodium cyanide applicators. Training included alternative methods and promoting livestock guard animals. Fifty-four training sessions had an attendance of 879 persons. M-44 applicators were reduced from approximately 5000 to fewer than 700. One hundred twenty-eight individuals obtained Livestock Protection Collar licenses and 43 purchased collars. Results of collar use and measures to increase effectiveness of training and application are discussed.

INTRODUCTION

Texas ranks first in the nation in production of cattle, sheep, and goats and in the top 10 in poultry production (Texas Agricultural Statistics Service 1986). Unfortunately, predators take about 1% of the annual calf crop (Stalcup 1988) and approximately 190,000 sheep and goats each year (Mulder 1988).

Lesser but significant numbers of poultry and adult sheep and goats are also lost to predators. Annual losses are valued at approximately $30 million. Coyotes account for a majority of the damage (Clay 1987). Other predators of primary concern are eagles, bobcats, gray and red foxes, dogs, and feral hogs.

As the state agency with regulatory responsibility for pesticides, the Texas Department of Agriculture (TDA) administers a certification and training program for use of the 2 poisons, M-44 sodium cyanide and sodium fluoroacetate (Compound 1080) Livestock Protection Collars (LPC), registered for predator control in Texas.

TDA seeks to achieve a balance between the valid concerns over livestock losses and the equally valid need to protect wildlife and the environment. Due to the hazards of pesticide use and the limited applicability of M-44s and Livestock Protection Collars, TDA encourages the use of non-lethal methods of predation management where possible. In particular, TDA promotes the use of "Texas bred" livestock guard animals.

The M-44 is a patented spring-operated device used with a toxicant (Shult 1976). Its use in Texas with sodium cyanide capsules is registered as a state-limited-use pesticide for use in controlling coyotes, foxes, and feral dogs preying on livestock and poultry. The method of operation and bait used the with M-44 make the device highly selective for canids.

The Livestock Protection Collar is a rubber bladder containing a toxicant with straps for attachment to the neck of sheep or goats (Rancher's Supply Inc. N.D.). LPCs containing Compound 1080 are registered as a state-limited-use pesticide for taking coyotes attacking sheep and goats by bites to the throat. Only the small collar for use on animals from 15 to 50 pounds is registered for use in Texas. The LPC is the most specific device developed for taking offending animals.

TRAINING AND CERTIFICATION

TDA has conducted a program since 1977 for training and certification of M-44 sodium cyanide applicators. The turmoil over

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. [Fort Collins, Colorado, April 17-20, 1989].

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registration of the LPC caused TDA to re-evaluate its program and work with the Texas Agricultural Extension Service, Texas Animal Damage Control Service, National Audubon Society, Lone Star Chapter of the Sierra Club, Animal Rights Kinship, Inc., the Humane Society of the United States, the Texas Farm Bureau, and the Texas Sheep and Goat Raisers Association to develop a comprehensive predator management approach. Especially helpful to the effort were State Senator Bill Sims, Executive Secretary of the Texas Sheep and Goat Raisers Association, and State Representative Dudley Harrison, Chairman of the Texas House Agriculture and Livestock Committee. This comprehensive approach was key to collar registration for use in Texas and has avoided public controversy.

TDA's training program leading to certification of M-44 and LPC applicators includes instructions on identification of predation, legal alternative methods of predator control both non-lethal and lethal, as well as proper use, safe handling, emergency first aid, recordkeeping, and reporting requirements for M-44 and LPC applicators as required by pesticide label use restrictions. Lecture, slide/tape, and demonstration are used as teaching methods. All participants are provided a manual developed by TDA for M-44 only training or M-44 and LPC training. Manuals contain an outline of all materials covered during training sessions including pesticide label(s), reporting forms, and first aid treatment. The training program relies heavily on material developed by the Texas Agricultural Extension Service for identification of predation and use of collars.[3,4] Seven TDA staff members are trained and equipped to conduct the sessions.

Requirements for M-44 certification include attendance at a training session (2 1/2 - 3 hours) and possession of a private applicator license or certified applicator license for purchase and use of state-limited-use or restricted-use pesticides. Training, M-44 certification, and private applicator license were available with no fee.

In order to obtain a non-commercial certified applicator license to use the Compound 1080 Livestock Protection Collar, a person must complete the training (approximately 6 hours), score 70 or above on the prescribed test and obtain a license. A $20 testing fee must be collected before a person may take the test (2 opportunities to pass the test are allowed without retraining). The annual license fee is $50 for a non-commercial LPC applicator's license. State and federal agency personnel acquiring a non-commercial license to perform official duties are exempt from fees. For a commercial LPC applicator license, a person must complete the training, pass the test, provide proof of financial responsibility and pay an annual license fee of $150.

During 1988, the Texas Agricultural Extension Service assisted TDA in holding 54 predator management training sessions, and TDA conducted an additional 5 sessions for small groups. Twenty-eight of the sessions included LPC training. The first 11 LPC training sessions in the Spring of 1988 were scheduled within weeks of approval of the TDA certification program by the U. S. Environmental Protection Agency in April 1988. Training was made available within a 2-hour driving distance of 90% of the sheep and goats in Texas to provide an opportunity for producers to use collars in 1988.

During the summer of 1988, all certified M-44 applicators were mailed a notice of recertification requirements and provided a reply card for requesting a schedule of training sessions. A more extensive state-wide schedule of training was then held in the Fall of 1988 to recertify M-44 applicators as required by Texas pesticide regulations.

Total attendance at the 59 predator management training sessions was 879 persons with 829 receiving credit for M-44 training and 280 receiving credit for LPC training. Fewer than 700 subsequently satisfied all requirements for M-44 certification. Of those completing LPC training, 194 took the LPC examination with only 4 failures. One person failing the examination subsequently retested and passed. One hundred twenty-eight of those passing the exam acquired licenses.

Due to the start of LPC training well after Spring lambing and kidding, the attendance and resulting number of licensed LPC applicators was considered excellent. The 700 M-44 applicators represents a considerable reduction from the nearly 5,000 certified applicators on record prior to the November 1, 1988 date required for recertification to continue use. However, this drop in applicator numbers is not surprising. Only 100 to 150 applicators purchased M-44 Sodium Cyanide capsules in 1986, 1987, or 1988. Furthermore, a survey of Texas sheep and goat producers conducted in 1978 found that only 14% used the M-44 and rated it the least effective of all control methods reported (Texas Crop and Livestock Reporting Service 1979).

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[3]Wade, Dale A. and James E. Bowns, 1985. Procedures for evaluating predation on livestock and wildlife. Texas Agricultural Extension Service, B-1429, 42p.

[4]Wade, Dale A., 1985. Applicator manual for Compound 1080 in Livestock Protection Collars. Texas Agricultural Experiment Station, B-1509, 50p.

All participants at training sessions are provided an evaluation form to rate the program and offer suggestions. A vast majority have rated it good to excellent.

LIVESTOCK GUARDING ANIMALS

Many Texas sheep and goat raisers are successfully using livestock guarding animals, particularly donkeys and guarding breeds of dogs. A number of Texans are now raising livestock guarding animals. TDA promotes the marketing of livestock guarding animals as a cost effective and socially acceptable alternative to poisons and other lethal control methods. The Department maintains a list of Texas Livestock Guarding Animal Breeders. Prospective purchasers of livestock guarding animals may obtain a copy of the list by contacting the Department. This list is also included in the Department's predator management training manuals for M-44 and LPC applicators.

Promotional activities in 1988 included a press conference on the State Capitol grounds featuring Texas Agriculture Commissioner Jim Hightower along with 3 guarding dog breeds, a donkey, a llama, and their owners present for testimonials. This event in January 1988 received statewide and national press coverage. Further media coverage was afforded through three television appearances, and production of a short television news story featuring a goat raiser/great pyrenees producer, and several radio interviews.

The reply card sent to 4,700 M-44 applicators about recertification also had boxes to check for those wanting to attend LPC training, to attend a livestock guard animal field day, or to receive a guard animal producer list. Eighty-seven wanted LPC training, 121 responded that they wanted to attend a guard animal field day, and 79 requested the guard animal producer list. Other program requirements have resulted in the field day remaining in the planning stages.

1988 LIVESTOCK PROTECTION COLLAR-USE

During 1988, 43 licensed Livestock Protection Collar applicators purchased a total of 827 collars. Counties with applicators possessing collars are shown on Figure 1. Nine applicators with 20 collars each (180 total collars) kept collars in storage in 1988 and reported no use. The remaining 34 applicators used 524 of the 647 collars in their possession.

Of the 524 collars actually used by applicators, 30 were reported as punctured by coyotes, 39 were reported as missing/lost as of December 31, 1988, 15 were pierced or torn by vegetation, 4 were ruptured from unknown causes and 1 was torn during removal. The only reported instance of suspected non-target Compound 1080 induced mortality involved a lamb with a collar ruptured from an unknown cause. Other verified mortality (excluding kills with collar punctures and collared animals lost) involving collared animals included 4 livestock deaths from unknown causes, 1 collared animal killed by a predator without the collar being punctured, 1 collared animal broke a leg while caught in a leg-held trap and was destroyed, and 1 animal was destroyed after being contaminated by Compound 1080 from a collar ruptured during removal.

Minimum, maximum and average Livestock Protection Collar use-days were calculated from "Livestock Protection Collar Quarterly Applicator Data Report" forms submitted by applicators. Minimum collar use-days were determined by adding the number of days from attachment to the last collar inspection on which collars were found to be in good condition. Maximum use-days were determined by adding the intervening period between the last date on which collars were in good condition until the date on which collars were detected to be lost, punctured, torn, or rendered unsuable. An average estimate of 25,694 collar use-days for 1988 was calculated from the maximum and minimum use-days.

Eighteen licensed collar applicators suspected taking from 1 to 5 coyotes with a total estimate of 37 coyotes taken with collars. This estimate was based on collar punctures which resembled coyote tooth marks, finding dead coyotes with dye stained teeth, missing collared livestock, cessation of predation, and other factors. At a minimum, 7 dead coyotes suspected to have been killed by collars were found. Two of the coyotes found dead were suspected to have been killed from puncture of a single collar.

Considerable variation was recorded among applicators in collar use-days required to take coyotes. Results were achieved in 1 night to several months with 4 to 48 collars in use. The lowest average number of use-days per puncture suspected of taking a coyote recorded by an applicator for 1988 was 35 use-days. This applicator placed only 8 collars on goats, recorded 5 punctures and found 2 dead coyotes in less than one month's time. Overall use-days per suspected coyote kill averaged 697 use-days.

These results compare very favorably with tests performed by the Texas Agricultural Experiment Station (1983) from August 1980 through April 1983. Data was collected for 55,735 collar days on an "intensive" site and 35,552 collar days on a "rancher-use" site with 67 and 26 collars, respectively, known to be punctured by predator attacks. This translates to 832 use days and 1,367 use-days per suspected coyote kill. The Texas Agricultural Experiment Station study recorded a number of attacks (63) where collars were not punctured. TDA only had 1 non-puncture attack on a collared animal reported, however, 39 animals were reported as missing or lost. In 1 instance of a missing

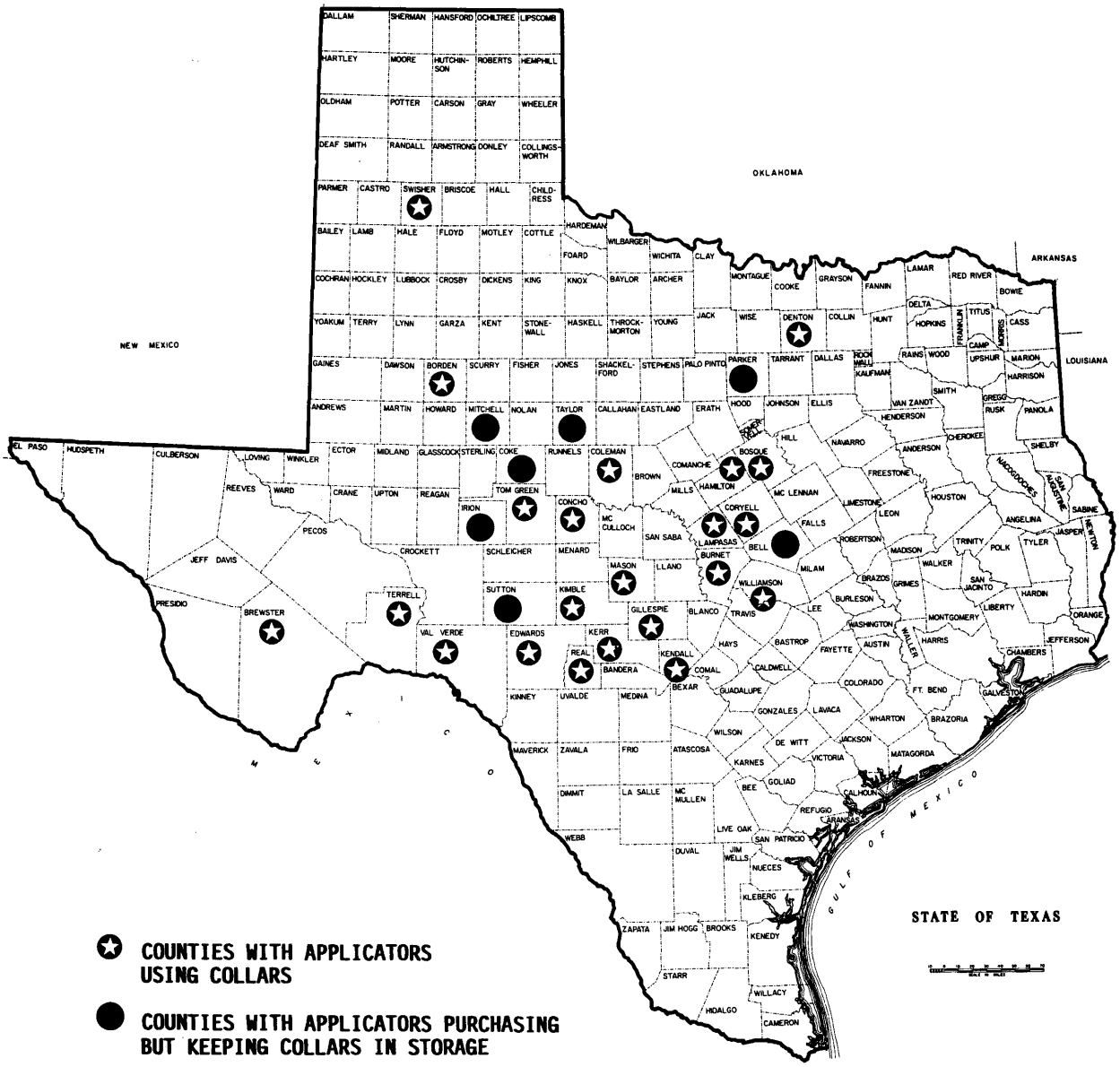

FIGURE 1.--Distribution of applicators purchasing Livestock Protection Collars in 1988

collared animal, a LPC applicator reported to TDA that a dead coyote was located.

Also, the reports of 7 dead coyotes found by Texas LPC applicators in 1988 compares extremely well with recoveries of 3 dead coyotes from 30 collar punctures reported by Connolly (1980).

Inspections of 30 applicators were performed in Calendar Year 1988. Only 1 significant infraction of Livestock Protection Collar use restrictions and TDA regulations has been detected to date. This incident involved use by a non-certified applicator who was provided collars by a licensed applicator. The primary problem encountered was slow reporting of collar use.

LIVESTOCK PROTECTION COLLAR PURCHASERS

Licensed LPC applicators purchasing collars in 1988 represent a good cross section of the Texas sheep and goat industry. They included producers that had entered the business for the first time in 1988 and representatives of families with generations of experience. More than half of the collar users raised both sheep and angora goats. Herd size varied from

slightly less than 200 animals to about 3,300 head, and acreage used for sheep and/or goat production ranged from about 200 acres to 18,000 acres. Predation losses reported to TDA ranged from a couple of animals per year to 450 head. One producer reported loss of 273 lambs out of a 1988 crop of 280 lambs. Collectively, applicators purchasing collars reported losses of approximately 3,000 sheep and 1,800 goats in the previous two years. They had slightly in excess of 29,000 sheep and 22,000 goats on hand at the time collars were acquired.

Thirty-four returns of a questionnaire sent in December 1988 to 42 applicators with collars showed 27 LPC applicators claiming increased predation in 1988, 4 with predation stable, 2 with a decrease in predation, and 1 new producer without prior experience. All indicated predation on sheep and/or goats by coyotes. Second in frequency was predation by dogs. Other predators of major concern were fox, bobcat and eagle. All respondents to the questionnaire used a variety of predator management methods other than collars. Twenty of the replies indicated that assistance was received from the Texas Animal Damage Control; 13 reported using donkeys as guard animals; and 8 reported using livestock guard dogs.

In response to a question on the adequacy of TDA's training program, 33 of 34 responses indicated it was adequate for effective use of collars. The 1 negative response cited inadequate training in "bookkeeping". In a follow up question on what areas of training should receive more attention, 8 indicated targeting/livestock management, 5 checked completing forms, and 2 marked safety. The latter is surprising as safety is stressed throughout training.

The training program is admittedly light in regard to targeting. Collar users were directed to contact Mr. Roy McBride of Rancher's Supply, the collar manufacturer and registrant for Texas, for additional advice on targeting. Recommendations on targeting are also provided on an individual basis by TDA Predator Management Specialists during annual inspections. However, it appears difficult to convince some applicators to use enough collars.

Though instructions for completing forms appear to be a simple matter, it is an area of major difficulty for producers not accustomed to paperwork. To remedy the problems with reporting forms, more attention is being given during training and inspections, completed sample forms are being added to manuals and sent to collar users, and changes have been made in the quarterly report form.

SUMMARY/CONCLUSIONS

A comprehensive approach to predator management training that includes non-lethal as well as lethal means engenders less public controversy and better meets the needs of livestock producers because no one method of predator management suites all situations. TDA's predator management program for training and certification of M-44 sodium cyanide applicators and sodium monofluoroacetate (Compound 1080) Livestock Protection Collar applicators along with the promotion of livestock guarding animals attempts to strike a balance between producers concerns over livestock losses and equally valid needs to protect the environment. Reception of the training program by livestock producers has been excellent with more than 800 attending training sessions in 1988. The training program needs improvement in the areas of targeting collar use and completion of reporting forms.

There is a growing interest in the use of livestock guarding animals and training in their use is needed. Use of M-44 sodium cyanide by individual livestock producers remains limited. Few Texas sheep and goat producers (34) availed themselves of the opportunity to use Livestock Protection Collars in 1988. Several producers were highly successful in taking coyotes responsible for thousands of dollars of damage to livestock. Use of collars supplemented other means of predator control and proved effective in some instances where all other efforts failed and continued use is warranted. Efficiency could be improved by using collars only where and when incidence of attack to the throat of sheep and/or goats is high, rather than in a prophylactic manner as practiced by several applicators. Failure of several collar applicators to take coyotes during prolonged periods of predation can probably be attributed to an inadequate number of collared target animals in pastures with greater numbers of uncollared animals of the same size and species. However, targeting was successful even with the use of a small number of collared animals (4 to 8) when small lambs or kids were placed with a larger number of adult animals.

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The Texas Department of Agriculture gratefully acknowledges the assistance of the Texas Agricultural Extension Service in conducting predator management training sessions in 1988.

APHIS Animal Damage Control Livestock Guarding Dog Program[1]

Jeffery S. Green[2]

Abstract.--One hundred traditional breed livestock guarding dog pups were placed with sheep producers in Wyoming, Idaho, Oregon, and Washington during 1987-88 as part of the APHIS Animal Damage Control program. Producers reared the dogs and integrated them into their operations. Ninety-three dogs were rated as follows: 68% good, 17% fair, and 15% poor. Success was breed-related. Sixty-one percent of the dogs were used on pasture operations and 39% on range operations. Nineteen percent of the dogs died prior to reaching 18 months-of-age.

INTRODUCTION

Included in the transfer of the Animal Damage Control (ADC) program from the U.S. Department of the Interior, Fish and Wildlife Service to the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service in December 1985, was the responsibility for funding and oversight of a guarding dog pilot program in Oregon and Minnesota. Briefly, the objective of the Oregon program was to promote the use of livestock guarding dogs as a method of reducing coyote depredation on sheep. The focus in Minnesota was wolf depredation.

A Congressional Directive in fiscal year 1987 (FY-87) expanded the pilot program in the west to include Washington, Idaho, and Wyoming. An unspecified amount of funds were to be used to purchase guard dogs for placement with livestock producers.

To fulfill the directive, ADC established cooperative agreements with Oregon State University Extension Service (OSES) and USDA's Agricultural Research Service (ARS) to use their guarding dog specialists to conduct the programs in the 4 western states.

In FY-88 Congress renewed their directive to ADC to administer the dog program and continue the purchase and placement of dogs. To more adequately fulfill the directive, ADC discontinued the cooperative agreements with OSES and ARS and employed a guarding dog specialist in February 1988 to conduct the western program. The program in Minnesota was conducted by other ADC Specialists.

For FY-89, the directive was reissued to ADC with several modifications. Montana was to be included in the western program, and Federal funds were not to be used in the direct purchase of dogs. Efforts were to focus on information dissemination and education. ADC employed a second dog specialist in November 1988 to assist conducting the western program.

This paper focuses on the dogs that were purchased with Federal funds and placed with livestock producers in Wyoming, Idaho, Oregon, and Washington during 1987 and 1988.

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[1]Paper presented at the Ninth Great Plains Wildlife Animal Damage Control Workshop [Colorado State University, Fort Collins, April 17-20, 1989].

[2]Jeffrey S. Green is Wildlife Biologist, Livestock Guarding Dog Specialist, USDA-APHIS, Animal Damage Control program, U.S. Sheep Experiment Station, Dubois, ID 83423.

METHODS

Dogs were purchased from commercial breeders who could supply registered pups of recognized livestock guarding breeds with parental stock free from hip dysplasia. In general, pups could be no older than 8 weeks-of-age if not reared with sheep or goats or 12 weeks-of-age if they were reared with sheep or goats.

Most pups were brought to the U.S. Sheep Experiment Station near Dubois, Idaho for early socialization to sheep until they were placed with producers. Some pups were delivered directly from the dog breeder to the sheep producer.

Sheep producers were selected for participation in the program based on several criteria: the magnitude of their predator problem or potential for predation, whether they were a commercial producer with a minimum of 25 ewes and/or nannies in either pasture or rangeland operations, and their enthusiasm and willingness to participate in the program. Priority was given to producers with no guarding dogs and with an ongoing predator problem. Finally, dogs were distributed between the 4 states in consideration of the number of sheep producers and the extent to which guarding dogs were already being used in the state. The objective was to promote the use of dogs in areas and types of situations where they had not been tried previously.

Producers selected for the program were provided literature on the concepts of raising and training a guarding dog. They were counseled by a guarding dog specialist either personnally or by telephone on how to rear the pup and integrate it into their operation. Some producers viewed a slide series on the use of guarding dogs, and some operations were visited by the specialists when the pup was delivered. All producers were encouraged to contact the dog specialist if they had questions or problems working with the dog.

Dogs were rated using the following criteria: 1) the frequency of occurrence of significant problems (e.g. dog wandering excessively; dog harassing, injuring, or killing livestock; dog posing a serious threat to people; dog seriously disrupting sheep management), 2) evidence of the dog displaying guarding behaviors (e.g. barking at disturbances, moving around the sheep, remaining near the sheep), 3) the dog's apparent effect on the incidence of predation, and 4) the producer's satisfaction with the dog.

Data on the dog's performance was gathered from producers through personal visits, telephone conversations, and a written questionnaire. I assigned one of the following ratings to each dog: good - dog generally remained near sheep, incidents of predation markedly reduced or kept to a minimum, minor problems, producer pleased with results; fair - dog had potential, predation somewhat reduced or unchanged, benefits outweighed problems; or poor - dog had no influence on predation and major problems outweighing benefits. Chi-square procedures were used to analyze the data.

RESULTS AND DISCUSSION

One hundred livestock guarding dogs were purchased from summer 1987 through summer 1988. Most of the dogs were Great Pyrenees and Anatolian Shepherds (Table 1). With 1 exception, the dogs were pups, and the majority were between 7 and 8 weeks-of-age. Mean purchase price ($\pm$ Standard Error) including shipping (applicable for 63 dogs) was \$443 $\pm$ 7, range \$250-550. Mean prices for individual breeds and other data are in Table 1.

Eighty-two sheep producers received guarding dog pups. Forty-five pups were placed in FY-87, 55 in FY-88. The number of dogs and producers, respectively, for each state are as follows: Idaho, 36 and 26; Wyoming, 35 and 29; Oregon, 16 and 14; and Washington, 13 and 13. Most producers (n = 67) received 1 dog each. Thirteen range producers received 2 pups, and 1 received 4. Three producers received a second dog following the early accidental death of their first pup.

Ninety dogs remained with the producer they were initially placed with. The remaining dogs (n = 10) were moved to other operations primarily due to the dogs' poor performance. Two producers left the sheep business necessitating moving the dog. The number of dogs in the program is not static due to deaths, and the number of producers varies for the reasons mentioned previously. The remainder of this report will primarily discuss the results of the program as they existed as of 1 January 1989. If the discussion varies from this qualification, it will be noted.

Ninety-three dogs survived long enough to be rated on their performance. Sixty-eight percent were rated good, 17% fair, and 15% poor (Table 2). Great Pyrenees were rated higher than Anatolian Shepherds ($P < 0.01$). Sample size was insufficient to allow meaningful

statistical comparisons with the other 2 breeds.

A recent survey of almost 400 livestock producers who used dogs (n = 763) revealed no breed differences (Green and Woodruff 1988). One possible reason for the differential rating for Anatolians in the survey and this study may be age of the dogs. Dogs in the survey were generally older than those in this study, and it is likely that some of the Anatolian Shepherds in this program will ultimately become good guardians. However, particularly as young dogs, Anatolian Shepherds are clearly more problematic than Great Pyrenees.

Ratings did not differ between the 36 dogs used on rangeland and the 57 used on pastures nor between males and females ($P > 0.05$). With few exceptions, all of the dogs were neutered, females at approximately 6 months-of-age and males at approximately 9 months-of-age.

Forty percent of the dogs injured livestock, and 15% killed livestock (Table 3). More Anatolian Shepherds were involved in both activities than Great Pyrenees ($P < 0.01$). Most of these incidents occurred as the dogs were pups and did not persist as the dogs matured. Two dogs (1 Kuvasz, 1 Great Pyrenees) were culled because they were judged incorrigible in this behavior. One Anatolian was culled also, due in part to this behavior. One young Akbash Dog was with sheep in a corral that was visited by an intruding dog during the night. The sheep piled up, and 70 ewes died. Details of the incident are unknown.

Nineteen of the 100 dogs are no longer in the program (data as of March 1989). Three were culled, and 16 died or disappeared. (Hereafter, all 19 will be termed deaths). Vehicle mishaps and accidents were responsible for the majority of deaths (7), followed by disappearance (4), unknown illness and culling (3 each), and poisoning (2). Nine died between 4 and 9 months-of-age, and 10 died between 10 and 18 months-of-age.

Table 1.--Purchase data for dogs in the ADC dog program.

Breed	n	Number of breeders	Number of different breedings	Mean price ($)
Great Pyrenees	65	19	21	418
Anatolian Shepherd	27	6	8	504
Akbash Dog	5	2	2	478
Kuvasz	3	1	1	400
Total	100	28	32	443

Table 2. Ratings of performance of ADC livestock guarding dogs. (Percentages in parentheses)

Breed	Good	Fair	Poor
Great Pyrenees	49 (83)	7 (8)	3 (9)
Anatolian Shepherd	10 (38)	7 (27)	9 (35)
Akbash Dog	4 (80)	1 (20)	0
Kuvasz	0	1 (33)	2 (67)
Total	63 (68)	16 (17)	14 (15)

Table 3. Dogs that injured or killed sheep. (Percentages in parentheses)

Breed	Injured sheep	Killed sheep
Great Pyrenees	14 (24)	4 (7)
Anatolian Shepherd	19 (73)	8 (31)
Akbash Dog	1 (20)	1 (20)
Kuvasz	3 (100)	1 (33)
Total	37 (40)	14 (15)

Lorenz et al. (1986) reported a higher mortality for dogs on rangeland than pastures. No difference between range and pasture deaths was noted for dogs in this study (17% of range dogs, 23% of pasture dogs, $P > 0.05$), however, the dogs are yet comparatively young.

Of the 81 dogs currently alive, 25 (31%) are < 12 months old, 55 (68%) are between 1 and 2 years old, and 1 (1%) is > 2 years old.

At least 25 producers reported a decrease in predation which they attributed to the presence of their guarding dog. Some termed the decrease "significant" or "remarkable," and others said the dog has "helped." Data from several of these producers for annual totals of sheep lost to predators before using a dog and while using a dog, respectively, are as follows: 70 and 19, 15 and 0, 300 and 30, 490 and 66, 30 and 0, 40 and 0, 70 and 4, 25 and 0, 65 and 5, 700 and 500, 175 and 115.

There are several caveats to be considered with this type of data. Some producers are unable to keep accurate data on predation loss or may not be

inclined to do so in light of other more pressing duties involved with livestock production. Producers continued to use other methods of reducing predation including good livestock management and traditional removal techniques provided by ADC Specialists (trappers) or other professional trappers. The level of depredation is not static between years. It is therefore difficult to definitively attribute a specific level of reduced predation to one control activity. Perhaps the most important evaluative criterion is the producer's general assessment of the value of a control tool.

Several producers noted a reduction in predation and attributed it to the dog, but behavior problems with the dog precluded using the dog further. At least 10 producers are hopeful that the dog will be effective but have not yet seen a reduction in predation.

Several dogs were caught in coyote traps, but none have died as a result of legal predator control activities. At least 2 dogs were poisoned, but the source of the poisoning was not reported. One dog was observed to kill a coyote.

On some operations, while performing their control activities, ADC Specialists made observations on the dogs' performance. In general, these observations confirmed the reports provided by the producers. At least in some instances, there were too many coyotes for a young guarding dog to keep predation minimized. A combination of trapping and other effective removal techniques along with a dog appeared to be essential in keeping losses to predators low. This further illustrates what knowledgeable people have continually advocated, that to achieve success in reducing predation, a variety of control techniques is necessary.

Because the dogs are relatively young, another year's data on predation losses will be important to adequately evaluate the dogs' effectiveness.

Despite various problems with some of the dogs, most producers are pleased with the results to date and in many instances attribute at least some of the reduction in predation to the dog. No fewer than 1 dozen producers have or intend to purchase additional guarding dogs to use in their operations. One range producer in Wyoming commented that if his guarding dog ever learned to write checks and pull camps, he'd have his (the producer's) job.

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Management Problems Encountered with Livestock Guarding Dogs on the University of California, Hopland Field Station[1]

Robert M. Timm and Robert H. Schmidt[2]

Abstract.--Guard dogs are being promoted and utilized as effective predator damage control tools under a variety of livestock management conditions. We report our experience over 1 1/2 years with 5 dogs, primarily Anatolian shepherd and Akbash dog breeds. We discuss a number of behavioral and management problems we have encountered, some of which have not previously been reported in the literature. These include chasing vehicles and wildlife, predation on deer (Odocoileus hemionus columbianus), and incompatibility of dogs with other predator damage control methods.

INTRODUCTION

Since the early 1970s, guard dogs to prevent or reduce predation on sheep have received increasing attention in North America (Coppinger et al. 1983; Green et al. 1984; Linhart et al. 1979). Most early reports dealt with use of guard dogs in fenced pastures, but later investigations showed potenial for guard dogs on open rangeland as well (Green and Woodruff 1983a). This report describes our attempts to use 5 guard dogs at the University of California's Hopland Field Station from November 1987 through March 1989.

The Hopland Field Station, in the North Coast region of California, is comprised of 2,168 ha containing grassland, oak woodland, and chaparral. Elevation ranges from approximately 150 to 915 m. The station is divided into 32 fenced pastures ranging from 6 to 263 ha in size. Most of the pastures are grazed by sheep annually. The location typically has mild, rainy winters and hot dry summers. Annual rainfall averages 90 cm/yr and occurs primarily between October and April. A detailed description of the site was provided by Murphy and Heady (1983).

Most of the sheep maintained by the station are Targhee. The flock usually contains approximately 1200 breeding ewes and 100 rams that are used primarily for research purposes. Studies completed or in progress at this location include such topics as sheep genetics, reproductive behavior, food habits, and response to various management strategies. Shed lambing in the main barn at the station headquarters begins in October and ends in January in most years. Lambs are held with ewes in the barn for a minimum of 48 hours before being turned out onto native annual range. Each animal is individually numbered at birth. Ewes and their lambs are also paint-branded to facilitiate documentation of loss. The station employs two full-time shepherds, who inspect all pastures containing young lambs daily.

Shearing is done in April, and surplus lambs usually are marketed in late spring. Because most sheep are used in one or more research projects, their actual value is substantially greater than market value for commercial Targhee sheep.

PREDATION LOSS

From 1973 through 1983, an average of 10.4% of the station's lambs and 3.8% of the ewes were killed annually by predators. A significant increase in the number of coyote (Canis latrans) kills occurred during this study period (Scrivner et al. 1985). Since 1983, coyote predation has become even more serious, and mountain lions (Felis concolor) have been responsible for additional losses. Domestic dogs (Canis familiaris) kill sheep periodically, and occasional kills by bear (Ursus americanus), bobcat (Lynx rufus), gray fox (Urocyon cinereoargenteus), and golden eagle (Aquila chrysaetos) occur as well.

Some probable reasons for the increasing predation are changes in management by surrounding landowners and an apparent increase in predator numbers. Adjacent ranches on three sides of the field station previously grazed sheep and conducted predator damage control, but no longer do so. Coyotes and, more recently, mountain lions appear to be more numerous in the area, based on visual sightings by field station staff and ranchers.

This level of predation loss has been experienced despite predator damage control efforts by federal or county Animal Damage Control personnel and field station staff. For controlling coyote

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depredation, trapping and snaring are the tools primarily used, but denning, calling and shooting, and sodium cyanide ejector devices (M-44s) have also been employed. Improvement of fences has reduced predation by domestic dogs in pastures closest to human habitations. Sound- and light-emitting devices have been employed for short periods of time to deter predation, but without substantial success.

GUARD DOG ATTEMPTS

We began acquiring guard dogs in November 1987 in an attempt to determine their potential effectiveness at the field station. A brief history of our experience with each of 5 adult guard dogs is as follows.

Dog 1 - "Rex"

A reproductively intact, 2-year-old male Akbash dog was purchased from a breeder in November 1987. The dog was a proven, working dog that had previously protected herded sheep on rangelands in Colorado, under the supervision of shepherds who remained with the flock. Following an initial orientation period of several weeks during which the dog was penned in the headquarters area, the dog was placed in an 85-ha pasture (Watershed II) containing sheep. Despite several attempts to train the dog to stay within this pasture (including periodic chaining of the dog to a sheep shelter and provision of a source of dog food and water at the site), the dog preferred to roam throughout the entire lower-elevation portion of the field station (approximately 700 ha). He was capable of jumping the typical livestock fences dividing station pastures and was consistently found with or near sheep, or traveling between pastures containing sheep. He was frequently seen at or near recent predator kill sites and would remain at such locations for several days before moving on. We speculate that this behavior may have prevented predation from recurring occurring at these locations, but this dog did not signficantly reduce total losses. Of 220 ewes and lambs grazed (November 19, 1987 through February 11, 1988) in the pasture where the dog's feeder had been placed, 10 lambs were known to have been killed by coyotes and 40 more were missing when sheep were removed from that pasture. This represents a total loss of 22.7 percent, most of which we attributed to predation. It became apparent that we either needed dogs that would remain within fenced pastures or with particular groups of sheep, or else we needed many more dogs to protect the area being grazed.

An additional concern developed almost immediately with Dog #1. He chased vehicles and wildlife. He routinely chased cars and trucks traveling along the county road that bisects the lower third of the field station (and provides the only access route to a neighboring ranch). Bicyclists have reported being chased. While our main concern was that the dog might be hit by a vehicle coming in the opposite direction during such a chase, the neighboring rancher and visitors expressed concern about the dog's aggressiveness, particularly when a vehicle contained a pet dog. The guard dog was also observed chasing Columbian black-tailed deer (Odocoileus hemionus columbianus) and jackrabbits (Lepus californicus), and was seen feeding on their remains. It became apparent that he was capable of catching and killing fawns, at least, after running them into a fence. Further, sightings of wild turkeys (Meleagris gallopavo) on the station, which had formerly been common, became rare. We suspect that the dog's activities influenced turkey distribution.

In early summer 1988, Dog #1 became incapacitated as a result of tick-bite paralysis. Following veterinary treatment, his conditions soon improved to normal. He was found to be infested with a large number of ticks, and after this episode more intensive efforts were taken to control ectoparasites on all of the guard dogs.

Dog #2 - "Whistler"

This 23-month-old intact female Anatolian shepherd was obtained in June 1988. Although she had apparently worked satisfactorily with livestock previous to our obtaining her, she was too young to be regarded as a proven guard dog. Upon receipt, we found her to be lethargic and suffering from an infection. Following veterinary treatment, her health improved steadily but she was extremely shy of people to the point that when released into a small pasture, she could not be approached or caught. She did not attempt to cross fence, but she showed little or no inclination to stay with sheep. Her behavior did not improve for several months, except for slight progress in allowing humans to approach.

Upon coming into estrus, she was bred by Dog #1 and had a litter of nine pups in late November 1988. During the last stages of pregnancy and during 6 weeks of nursing pups, she was caged in the headquarters area. During this time, the station was experiencing sheep loss because of coyote attack, but this dog was not available for guarding use because she was nursing pups.

After her pups were weaned, Dog #2 was placed in a 25-ha pasture (Watershed I) with 115 ewes and 225 young lambs, where she remained from December 1988 through March 1989. It appeared that her behavior had changed following whelping, inasmuch as she was more often observed with or near sheep than she had been before. During her time in this pasture, regular (usually daily) checks of this pasture revealed 14 confirmed lamb kills by predators (10 by coyotes, 4 by eagles). Several coyote-killed lambs were not fed upon, perhaps indicating that the dog disturbed the predator before feeding was initiated. One ewe died from causes not related to predation. When the flock was removed from this pasture in mid-March, 21 additional lambs were missing. This represents a total loss of 15.5% of the lambs, most of which we attributed to predation.

Dog #2 was subsequently moved into a series of smaller pastures where a rotational grazing exper-

iment was in progress. Here, the dog began to harass and chase sheep. On one night, she stampeded the sheep, causing them to tear down a fence and gain access to an experimental pasture. The next day, one ewe was killed apparently by being run to the point of exhaustion, and approximately 20 more sheep had wool pulled from their bodies. Dog #2 was immediately removed from the pasture and isolated in a pen at the headquarters area.

Dog #3 - "Misty"

This 2-year-old female Akbash dog was obtained as a proven, working range dog in mid-September 1988 from the same breeder as Dog #1. She had recently borne her first litter of pups. Upon release, she began traveling with Dog #1 throughout the field station, jumping fence without difficulty. The pair began ranging more widely than did Dog #1 alone. On several instances, they were observed on properties adjoining the field station. Once they were apprehended approximately 1.5 kilometers outside the station's boundary, where they were captured by a landowner and returned to the station headquarters.

Dogs #1 and #3 occasionally appeared to patrol alone, but both often were observed at the site of a recent predation event, and both would stay at the location for several days. As with Dog #1 alone, the presence of this pair seemed to prevent subsequent predation at that location.

During the fall of 1988, Dogs #1 and #3 were observed together chasing, killing, and consuming deer fawns. During November and December, they were seen to kill at least one fawn per week. Their behavior and demeanor following verbal reprimands and scolding indicated that the dogs knew they should not chase deer, yet this behavior persisted when the dogs were not closely supervised. After mid-winter, fewer fawns were killed. We think this was due to the fawns having attained sufficient size that they could jump fences more easily and in general avoid the dogs more effectively.

Dog #3 came into heat in early winter and was penned at headquarters to avoid pregnancy. During this time, Dog #1 stayed near the pen for the duration of her estrus cycle and thus became less effective in preventing predation during this time.

Dog #4 - "Brutus"

This neutered 2-year-old male Anatolian shepherd was donated to the field station by a private party. He had regularly killed poultry, geese, skunks, domestic cats, etc. on the small acreage where he was penned with goats. In addition, his persistent barking during the night had generated complaints.

Dog #4 was released into a fenced, irrigated 10-ha pasture containing yearling rams. On occasion, he was observed to display rough play behavior toward the sheep. In three known incidents, he prevented dog attacks on this group of sheep. He has shown excellent attentiveness to sheep, and has been aggressive to strangers. We attribute his success not only to his individual behavior, but also to his placement in this relatively small, flat pasture that is topographically atypical of the station's rangelands.

Dog #5 - "Snow"

This female 2-year-old Great Pyrenees was purchased from a Nevada sheep ranch that uses approximately 30 guard dogs with herded bands. She was pregnant when received, and was housed at headquarters until her pups were weaned. Upon release into the field, she was intimidated by Dog #3 and therefore proved somewhat ineffectual. She would not remain with sheep, but returned repeatedly to headquarters where she spent considerable time. Her long coat may be inappropriate for California annual grasslands because it invites chronic problems with weed seeds including foxtails and other stickers.

SUMMARY OF PROBLEMS ENCOUNTERED

Jumping Fences/Straying Off Property

Green and Woodruff (1983a) report that it may be desirable for dogs to jump fences in order to protect sheep in contiguous pastures. In our situation we believe this behavior is disadvantageous. We think our dogs should stay with one band of sheep, or at least within one large pasture, as their effectiveness seems to be diluted when they travel considerable distances between dispersed groups of sheep. In such situations, coyotes or other predators readily adapt to attacking at times and places when the dogs are absent. Further, excessive amounts of time and energy can be expended in attempts to locate and check on the dogs when their whereabouts are now known. We equipped several of our dogs with radio transmitter collars, but we still expended considerable effort to find individual dogs and check on their well-being. Roaming is undesirable from an additional standpoint: dogs that stray beyond property boundaries are much more likely to be shot or hit by cars. Previous authors have noted the high mortality rate of guard dogs. Three of our five adult dogs roam at will throughout the field station. Currently, we have two of them caged because we believe they are in imminent danger of being shot if they cross onto a neighbor's ranch.

Chasing Cars and Cyclists

Green and Woodruff (1983b) report that 22 percent of guard dog deaths have been caused by collision with vehicles. Undoubtedly, some dogs have the inclination to chase vehicles, and we have not yet found a way to extinguish this behavior. Because two of our dogs (#1 and #3) have chased a neighboring rancher's grandchildren while on their motorscooters, they have been perceived as a safety threat and several complaints have been received about their behavior. As mentioned above, we caged them to prevent their being shot, should they again stray onto the neighbor's property. Although it is

theoretically possible to re-condition adult dogs (by means of shock collars and continuous human observation) to not chase vehicles or deer, in reality we have neither the time nor other resources to expend on such a training effort. Others who have worked with guard dogs have suggested that we would have fewer serious behavioral problems if we had begun by raising guard dog pups rather than attemting to adapt adult dogs to our situation. This also would involve a considerable commitment of time and energy, as well as a lag time of perhaps 18 months or more before the desired level of protection could be achieved. The only long-term solution apparent to us is to sell the adult dogs that display undesirable behaviors to a willing buyer.

Chasing and Killing Wildlife

While there are several reports that guard dogs may chase wildlife such as deer, antelope, hares, etc. (Black 1981, Black and Green 1985, Green et al. 1984), we have found no reports of typical guard dog breeds having killed wildlife. Our observations of Dogs #1 and #3 regularly killing fawns, as well as our suspicions about their harassment of wild turkeys, lead us to suggest that the impact of guard dogs on wildlife needs further study.

Some inviduals have suggested that our dogs' tendency to roam and to chase vehicles and wildlife is in part due to our providing them excess food. Apparently in some instances, guard dogs kept less well-fed have less energy and thus exhibit fewer such behavioral problems. We do not believe this is a solution, for several reasons. First, we monitor the nutritional condition of our dogs closely and, particularly in the warm months of the year, have had a concern that they were not eating enough to maintain their physical condition. Also, we believe that several of our dogs would, if fed less dog food, simply kill and eat more wildlife.

Behavioral Changes During Reproductive Cycles

Male guard dogs are sometimes castrated to reduce their tendency to wander and to follow estrous females (Black and Green 1985, Green et al. 1984). However, it is not generally appreciated that intact guard dogs will periodically be ineffectual because of reproductive activities, as we have observed. Further, because of behavioral and physiological similarities between coyotes and dogs, we speculate that an estrous guard dog might attract coyotes, or that conversely an estrous coyote might interfere with the desired guarding behavior of a male guard dog.

Changes in Sheep Behavior Toward Dogs

Green and Woodruff (1983a) indicate that sheep learn to respond to individual dogs, and thus the use of guard dogs appears not to create behavioral problems among sheep. Yet, our station's shepherds observed that sheep became more complacent in the presence of herding dogs following their adaptation to the guard dogs's presence. Although this problem appears not to be widespread or serious, it can result in increased time and effort being needed to gather and move sheep that no longer responded as easily to herding dogs.

Incompatibility with Other ADC Tools

Surprisingly little has been written about the incompatability of guard dogs and other common predator damage control measures such as traps, snares, and M44 cyanide ejectors. While in theory it might be possible to train guard dogs to avoid scented M44s, not many ranchers would be willing to risk losing a guard dog as a result of using these devices in the vicinity. While it might also be possible to train guard dogs to avoid traps or snares, the potential for catching the dogs remains wherever these tools are placed. Unless the rancher knows the location of all traps and snares, and also has the time to check these whenever a guard dog is unaccounted for, a potential risk remains. This problem is further compounded when guard dogs cross fences and do not remain in predictable areas, but roam widely. Thus, the choice to employ guard dogs might also be a choice not to employ traps, snares, or toxicants, at least not in the immediate vicinity of the dog.

SUMMARY

Green and Woodruff (1983b) noted that some limitations on effective guard dog use include arid climates, widely-scattered livestock, rough terrain and heavy vegetative cover, and abundant predators providing severe pressure. While this description is appropros to the Hopland Field Station, it also is quite descriptive of most of the rangelands in the North Coast of California, traditionally one of the country's most important sheep-producing regions.

It is our experience, after working with a total of 5 guard dogs during these past 1 1/2 years, that they have limited effectiveness. Only one of our dogs is doing the type of job with which we are uniformly pleased; this, despite the fact that most of the dogs were proven working adults at the time we obtained them. From November 1987 through March 1989, we have expended approximately 500 person-hours of station labor (valued at $10.07/hr), in addition to expenditures totalling some $2500 for purchase and shipping of dogs. This does not include expenses for veterinary care, licenses, food, and other items necessary to the maintenance of the dogs. Unfortunately, the extent of problems we have encountered, especially considering our use of more and better-skilled labor than the average ranch, indicates to us that guard dogs are not a viable solution (either practically or economically) except in limited instances in our geographic area. We wonder whether our predator losses would have been more effectively reduced had we spent our time and funds on conventional control tools and methods.

We would like to see further evaluation of the problems outlined above, and we intend to continue research on guard dogs in order to find means to solve some of these difficulties. A better understanding of the situations in which guard dogs will work effectively, and a fuller appreciation of some of the problems they create, will allow ranchers to make better decisions when planning a predator control strategy.

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Black-Footed Ferret Recovery[1]

Dean E. Biggins[2] and Ronald A. Crete[3]

Abstract.--The captive population of black-footed ferrets (Mustela nigripes) increased from 24 to 58 animals in 1988, and was split to provide the species added protection against extinction. Experimental reintroductions may begin in 1991. In some areas, "experimental population" designations as authorized under Section 10(j) of the Endangered Species Act may be used to provide wider management latitude. The Black-footed Ferret Interstate Coordinating Committee oversees much of the work related to reintroduction. Expanded effort to locate wild ferrets now includes a $10,000 reward offer. Research focuses on captive breeding, reintroduction techniques, disease, and habitat. A new Recovery Plan was approved in 1988.

INTRODUCTION

The black-footed ferret (Mustela nigripes), a weasel-like animal closely related to two species of Eurasian polecats, was listed in 1967 as an endangered species in the United States (Federal Register 32:4001, 11 March 1967). Biggins and Schroeder (1988) reemphasized the black-footed ferrets's dependence on prairie dogs (Cynomys spp.), and reviewed landmark events in recent ferret history, culminating with a brief description of status in 1987. Captive propagation of ferrets caught in Wyoming was just beginning, and its success improved in the years following.

The Black-footed Ferret Recovery Plan was completely revised in 1988 (U.S. Fish and Wildlife Service 1988), reflecting emphasis on captive propagation and reintroduction and incorporating the Wyoming Game and Fish Department's Strategic Plan (Wyoming Game and Fish Department, 1987). The current strategy for this recovery effort involves captive propagation of ferrets followed by reintroduction into secured habitats across the species' range in the next 10-20 years. New goals set target levels of 200 breeding adults in captivity by 1991 and 1500 free-ranging breeding adults by the year 2010. Further, there should be at least 10 wild populations with at least 30 adults each, and wild populations should be distributed over the widest possible geographic area (consistent with the historic range of the species). The species will be eligible for downlisting from endangered to threatened status if these criteria are met and the rate of subpopulation establishment is at least as high as the rate of subpopulation disappearance for a period of 5 years. The amount of habitat needed (prairie dog colonies) for 1500 breeding adult ferrets is estimated at 75,000 ha (185,000 ac). About 0.4-0.8 million hectares (1-2 million acres) of prairie dog habitat remain in the United States but much may be unsuitable for ferret reintroduction (Minutes of the Black-Footed Ferret Interstate Coordinating Committee, 8-9 March 1988). Requirements for delisting have not been established.

The remainder of this paper is devoted to describing the present status of black-footed ferret recovery efforts and reviewing the tasks that are faced in the near future. The revised Black-footed Ferret Recovery Plan (U.S. Fish and Wildlife Service 1988) places tasks into the following five groups: 1) captive propagation, 2) location and

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evaluation of habitat, 3) location of additional ferrets, 4) reintroduction, and 5) management of free-ranging populations. Of 190 tasks and subtasks identified, 67 were assigned to the "research" category. All five groups of tasks have investigative and operational elements, and it is imperative that researchers work closely with groups involved in implementing the recovery strategy. The U.S. Fish and Wildlife Service (Service) Division of Fish and Wildlife Enhancement, under the Director of the Denver Regional Office (Region 6), has been delegated lead responsibility to organize and implement a national strategy for recovery of the black-footed ferret. The National Ecology Research Center, within the Service's Research and Development arm (Region 8), conducts or coordinates most Service-sponsored research on the ferret. A 6th group of tasks in the Plan focuses on organizational arrangements that will facilitate work specified in groups 1-5.

CAPTIVE PROPAGATION

Captive propagation of ferrets is a cooperative venture of the Wyoming Game and Fish Department, the U.S. Fish and Wildlife Service, the Henry Doorly Zoo, and the National Zoological Park. The core breeding population is managed by the Wyoming Game and Fish Department in a specially constructed building at their Sybille, Wyoming research facility. Primary funding is provided by the Service from authorizations under Section 6 of the Endangered Species Act of 1973. The six ferrets in captivity in 1986 produced no offspring. Twelve more wild-caught ferrets were added to the captive population in 1986 and early 1987, and 2 of the 11 captive females produced 7 young in 1987. In 1988, 34 kits were weaned from 13 litters produced by 14 females, but an adult female died that year. The total population thus has grown from 18 to 25 to 58 in two breeding seasons, and the program is on schedule. All known black-footed ferrets are in captivity.

By 1991 up to five captive breeding populations in three or more facilities may be established. The parent genetic stock will be maintained at the Wyoming facility while the satellite facilities will be established with young from subsequent generations. The satellite facilities are to be financially self supporting, therefore not requiring additional funds for captive breeding (Wyoming Game and Fish Department 1987). To provide protection against extinction from a single catastrophic event, the population was split following the successful breeding season of 1988. Genetically representative young-of-the-year were sent to two additional facilities; the National Zoological Park's research facility in Virginia received seven ferrets and the Henry Doorly Zoo in Omaha, Nebraska received eight ferrets. The captive breeding phase can be deemphasized after about 10 years, although a small facility may be needed to augment wild populations destroyed by canine distemper or other events.

Much of the research in captive breeding has focused on developing techniques to maximize reproductive output and retain as much genetic diversity as possible. Topics under investigation include collection and cryopreservation of gametes, artificial stimulation of the reproductive cycle, artificial insemination, in vitro fertilization and embryo transfer, methods of detecting estrus, and genetic variability. Cooperating institutions are the University of Wyoming, University of Idaho, National Zoological Park, National Cancer Institute, and the Wyoming Game and Fish Department. In addition, a study of the nutrition of captive ferrets is being conducted by the Bronx Zoo. The National Ecology Research Center coordinates and funds most captive propagation research.

LOCATION AND EVALUATION OF FERRET HABITAT

Remaining potential habitat (prairie dog colonies) for black-footed ferrets has not been accurately estimated. Because of the success with captive breeding, there is increased emphasis on locating ferret habitat. This large effort presently encompasses 12 states, 2 Canadian provinces, and Chihuahua, Mexico. In 1987, the Service (Region 6), invited representatives from state conservation agencies, Service field offices, and several land management agencies throughout the ferret's historic range to attend a meeting to discuss the search for habitat and other aspects of ferret recovery. The resulting group, now known as the Black-footed Ferret Interstate Coordinating Committee (ICC), promotes formation of state working groups and is a mechanism through which the Service receives information to debate, design, and document national-level recovery strategy. In addition, the ICC committee serves as a valuable sounding board for conflicts and barriers to ferret recovery. Representatives of the ICC are members of state-level

committees and communicate directly with state working groups on direction and guidelines devised and concurred upon at ICC meetings. Managers of the captive breeding program attend ICC meetings to advise on the probable timing of reintroductions and to obtain information on the status of habitat evaluations and preparations.

Researchers are working closely with ICC members to develop a system to evaluate the quality of potential reintroduction sites. Ranking sites with the evaluation criteria will help determine the order of reintroductions. The first national-level ranking of reintroduction sites is scheduled for December 1989. States and the Service will then work cooperatively with private and public land managers to develop management agreements and special rules for selected habitats and reintroduction of ferrets. At this time, no sites are managed for ferret reintroduction. Management will involve long-term commitments from state and federal agencies and negotiated agreements with numerous private land managers. Long-term easements may be necessary to compensate affected cooperating landowners.

During the next several years, the Service, states, and other federal agencies will be locating and mapping prairie dog complexes of sufficient quality to be considered for ferret reintroductions. Subsequently, states are proposed to be partitioned into three zone categories: 1) potential reintroduction habitat (black zones), 2) areas that support prairie dog populations, but lack sufficient data to evaluate them as potential reintroduction habitat (gray zones), and 3) areas where quality of prairie dog colonies is too low to warrant a ferret reintroduction effort (white zones). The white zones, encompassing much of the area in the western states with potential ferret habitat, could eventually be block cleared, indicating they would not require further ferret survey clearances for land use proposals needing Federal agency permits or funding. This zone concept does not mean that the Service, states, or other agencies support the eradication of prairie dogs in block-cleared white zones. Prairie dog colonies are an ecological community supporting an abundance of wildlife and plant species, and states are encouraged to develop management plans for prairie dogs in all three zones.

Black-footed ferret survey guidelines promulgated by the Service in March 1989 open the opportunity to begin block clearing complexes of prairie dog colonies under 400 ha (1000 ac) that have no potential for ferret reintroduction. In addition, these guidelines provide a mechanism to exempt surveys where complexes of white-tailed prairie dog (*Cynomys leucurus*) and Gunnison's prairie dog (*C. gunnisoni*) colonies are less than 81 ha (200 ac) or complexes of black-tailed prairie dogs (*C. ludovicianus*) are less than 32 ha (80 ac). These changes were brought about by research findings on ferret habitat requirements. Guidelines are available from Service field and state offices across the historical range of the ferret; Service personnel at these offices should be consulted for more information on the need for surveys.

LOCATING ADDITIONAL BLACK-FOOTED FERRETS

Genetic variability is low in the captive population of black-footed ferrets (O'Brien et al., in press), and finding any remaining wild ferrets would enhance the program. Search effort increased after the demise of the Meeteetse, Wyoming population in 1985-86. A $5,000 reward in Montana (sponsored by the New York Zoological Society) expanded to most other states in the ferret's range by 1988, and the offer was increased to $10,000 in 1989. The ICC recommended development of state contingency plans dictating the course of action if ferrets are located; most states have approved plans in place. Ferret reports are investigated by state conservation agencies and Service field offices. The National Ecology Research Center has maintained a response team to conduct follow-up work on good quality reports and to monitor and capture ferrets if necessary. No new ferret populations have been located despite the increased effort. Research effort focuses on improving methods to locate ferrets, including current studies on feasibility of aerial surveys for detecting sign in winter and studies of prairie dog burrow plugging/ferret digging relationships.

REINTRODUCTION

By the early 1990's, reintroduction will require much of the resources now devoted to other aspects of ferret recovery if captive propagation remains on schedule. Experimental reintroductions are being planned first for the Meeteetse, Wyoming area to test reintroduction protocol and to

reestablish reproduction in the wild as soon as possible. Additional sites selected by the Service and state conservation agencies will receive ferrets that are in excess of the needs of the captive breeding program as soon as they are available. The Service plans to use the flexibility provided under Section 10(j) of the Endangered Species Act to designate reintroduced captive-raised black-footed ferrets as "experimental populations" wherever practicable and prudent. When reintroduced populations of ferrets begin to produce excess offspring, these offspring can be translocated to other reintroduction sites, helping reduce costs of and dependency on captive breeding programs.

Presently, most reintroduction activities are research-oriented. Two laboratory studies are beginning that will address the benefits of submitting ferrets to pre-reintroduction experience (training) in hunting, killing, and predator avoidance. A second phase of experiments will use results of the training phase in actual field trials. A closely related animal, the Siberian polecat (Mustela eversmanni), will be used in these first two phases; the final phase will be experimental reintroduction of black-footed ferrets. The experimental release of Siberian polecats closely parallels a study of California condor (Gymnogyps californicus) release and monitoring techniques using Andean condors (Vultur gryphus) as the investigational surrogate. Close monitoring of the first black-footed ferret reintroductions will be essential, and improved radio-telemetry techniques for monitoring will be tested on Siberian polecats. Canine distemper is a hazard to wild and captive ferrets (Carpenter et al. 1976, Forrest et al. 1988, Williams et al. 1988), and research is underway to develop an effective vaccine and practical means to administer it. Another study will attempt to assess the prevalence of canine distemper in other species of wild carnivores to gain insight into the probability of exposure of reintroduced ferrets. Reintroduction-related research is being conducted by biologists at the National Zoological Park, Wyoming Game and Fish Department, the University of Wyoming, the Wyoming Cooperative Fish and Wildlife Research Unit, and the National Ecology Research Center, primarily with funds administered by the Service.

MANAGEMENT OF FERRET POPULATIONS

Presently, there is almost no activity (operational or research) in this category. Future needs include development of monitoring strategies for ferrets, prairie dogs, and diseases, and refined plans for restocking and translocation to maintain genetic diversity and solve demographic problems.

ORGANIZATIONAL ARRANGEMENTS

This portion of the Plan suggests formation of technical and policy advisory groups to assist in developing effective solutions to the diverse challenges of ferret recovery. Working groups, public relations, education, communication, and funding are also addressed in this category. Examples of advisory groups include the Black-footed Ferret Advisory Team, which counseled the Wyoming Game and Fish Department on management and research of the Meeteetse population, and the Captive Breeding Specialist Group of the International Union for the Conservation of Nature and Natural Resources, which provided valuable assistance during the early stages of captive propagation. The ICC and state working groups were effective organizational arrangements discussed previously.

CONCLUDING REMARKS

The captive breeding program for ferrets has been highly successful, suggesting an optimistic prognosis for ferret recovery. Although it is essential, excellent captive production of ferrets does not assure recovery of the species; the greatest challenges may lie ahead. We speculate that a combination of factors led the black-footed ferret nearly to extinction--perhaps due to the synergism of severe habitat reductions (caused by prairie dog poisoning campaigns and sylvatic plague) coupled with canine distemper in the ferrets (Biggins and Schroeder 1988). We wonder, nevertheless, how much importance to ascribe to each problem, and even whether we have correctly identified all of the problems. If we understand the problems, can they be solved or mitigated? The opportunity to learn directly through hands on research of wild black-footed ferrets vanished with the animals, but the search for explanations continues. A careful evaluation of the behavior, ecology, and genetics of the highly successful Siberian polecat, the black-footed

ferret's closest living relative, should provide a different perspective from which to interpret the black-footed ferret's decline. It is also imperative that the first reintroductions of ferrets be carefully designed studies, because understanding the reasons for any failures may be crucial to ultimately achieving success.

ACKNOWLEDGEMENTS

We thank everyone who has contributed to the black-footed ferret conservation effort. Unfortunately, space is too limited to mention everyone by name, and to single out individuals does disservice to those not named. We appreciate the foundation laid by those who studied ferrets in South Dakota and first attempted captive propagation. A diverse group of researchers at Meeteetse was able to build on that foundation. We are deeply indebted to the managers of the present captive propagation project in Wyoming for rebuilding ferret numbers (and our hopes for the species), to the zoos now contributing to that endeavor, and to the project's advisors. Participants in the evolving cooperative venture leading toward ferret reintroduction include state and federal agencies, private conservation organizations, private landowners, industrial developers, and universities. The team approach is indispensable; perhaps the cooperation exemplified here provides a new connotation for the term recovery team.

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An Assessment of the Urban Wildlife Problem[1]

William D. Fitzwater[2]

Abstract.--Basic urban wildlife problems include: proper identification of species, shift from agrarian to urban society, different interpretations of humaneness, compassion for individual rather than a population as a whole, and public ignorance of urban pest management. Positive values are esthetics and environmental education opportunities. Negative values are disease transmission, life/injury-threatening situations, damage to buildings/other property, water structures/quality, petty annoyances, and indirect economics.

Modern civilization has created artificial habitats. Most other life forms have been walled out of cities except for animals dominated by humans, such as, cats, dogs, caged birds, and exotic fish or those who have adapted to humans so well they have become pests, such as, commensal rats/mice, pigeons, starlings, and house sparrows. As urbanization continues to gobble up more and more living space, evicting other forms of life, we can expect urbanite-wildlife interactions to increase.

SOME CONCEPTS ABOUT NUISANCE ANIMALS IN URBAN ENVIRONMENTS

Identification of nuisance species

There are some 1,100 species of birds and 467 species of mammals present in North America. While less than 2% of these are urban pest species, the ignorance of the urban populace concerning the identification of their "pests" is appalling (Dagg 1974). One woman caught and released in a nearby park some "...eight naked-tail squirrels." (known in the trade as "roof rats") (Whitten 1979). Muskrats are frequently described as very big sewer rats; while effective controls for moles are quite different from pocket gophers, few householders know which they have; some ADC specialists called in to trap gophers ended up with a large, angry armadillo; "starlings" poisoned with treated rice on a Texas courthouse turned out to be cowbirds. Some animal groups, like bats and reptiles, are generally greeted with repulsion, but most wild animals are "cute" until their paths cross those of the urbanite.

Shift from Rural to Urban Society

Since World War II this country has seen a shift from an agrarian society to one predominately urban in its thinking. Surveys have shown a rural society is more tolerant of other animals and willing to share some of their living space with them (O'Donnell & VanDruff 1983). The urbanite, never having had to wrestle basic life needs from the earth, panics when encountering a "wild" animal he can't control. The thought of sharing the house with a mouse is repulsive. On the other hand, the coyote is a friendly dog that lives in a Disney movie or paces the concrete pads in the local zoo. He cannot understand why so much money and effort is being spent to limit coyote numbers in the "out-of-doors".

Different Interpretations of Humaness

While people may advocate humaneness to other animals, this attitude changes when they are directly challenged. One woman called the Extension Service for help in ridding her fireplace of a colony

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of swifts (Anon. 1988). Their flapping wings were spreading ashes all over her living room. She became so desperate she lit a fire in the fireplace but found, "You could smell burning feathers, but they still wouldn't leave." Now this woman would not dream of hurting an animal but she set fire to a bird because it was causing a mess in her living room.

This variable sensitivity to "humaneness" is also shown in the matter of who is the victim. There is little interest in the agonizing death of a lamb in the jaws of a coyote, but if that same coyote is seen trotting down a city street with a freshly-killed house cat in its mouth that is "inhumane" (Howell 1982). Despite public approval of the animal rights' philosophy - - "all animals have rights" - - the urbanite doesn't actually believe all animals have equal rights. Thus he sees no parallel between his desire to eliminate the mouse and the rancher's desire to eliminate the coyote.

The urbanite is horrified at the continued use of the leghold steel trap. The occasional raccoon or squirrel that gets into the attic can often be taken in a live trap so he cannot understand why leghold traps have to be used in the wild. The gap between the technology of going to the moon and developing a painless, BUT effective and practical, trap for field use is not understood.

Poisoning is another dreadful happening. Poisons are associated with a theatrical thrashing about of a victim in terrible pain. This rarely occurs as modern pesticides affect body chemistry and nervous systems in more subtle ways than the metallic toxicants of several decades ago. Poisoning, compared with natural causes, is generally the most humane way for the majority of nuisance animals to go.

Compassion for the Individual

Conditioned to a great extent by Disney make-believe, there is great empathy for the individual. For example, the rescue of two out of three California gray whales trapped in the Arctic icepack has no practical significance on the whale population in the Pacific. The $million plus spent in their rescue could have been better utilized in research on improving status of world whale populations.

While expensive capture and translocation of individual animals from a habitat where they are not wanted or are so numerous they endanger the welfare of that habitat is acceptable (Hadidian, et al 1988), the fact is most transplants are disasters ending in the early death of the transplanted individuals and/or disruption of the new environment in which they were placed. Of 300 eartagged raccoons released in North Carolina at a cost of $15,000, only 16% survived (Boyer & Brown 1988).

Urban Pest Management

More research needs be directed to the problem of urban pest management. The methods in place today are those developed from agriculture. Urban animals due to the largess of urbanites are generally well-fed and more difficult to trap. The use of toxicants in urban vertebrate pest management needs closer scrutiny. Habitat modification is the most effective method of control, but is not popular as it involves the urbanite doing something physical and expensive. Wild animals do not honor human boundaries so while an individual might encourage their presence, neighbors may be very hostile.

Further research needs be done on the life histories of urban animals. Heavier densities are found in species, like squirrels (Flyger, et al 1983) and raccoons (Schinner & Cauley 1974), in urban habitats versus free-ranging animals in open habitats. There is also the need to adapt control measures to conform with city ordinances and wildlife agency codes. The inability to recognize the species of animal involved could lead to a conflict with State wildlife codes as the average homeowner recognizes no restrictions on methods used in solving personal problems. While these attitudes can be changed (Timm & Schemnitz, 1988), we are not doing a good job in this area.

POSITIVE VALUES OF URBAN WILDLIFE

Esthetics

The urbanite is thrilled by fleeting contacts with wild animals in the asphalt/concrete habitat - - unless it is a rat or skunk. Sparrows hustling in the streets and pigeons gliding between tall buildings revive the deeply buried tie between man and lower animals that our forefathers understood.

Environmental Education

Psychologists believe contact with lower animals encourages the development of intellectual and social competence as

well as physical development. Children flock to a petting zoo to have contact with living "toys".

When we discuss "urban wildlife" we are actually dealing with two separate habitats - the "inner city" and the suburbs. While inner city inhabitants could undoubtedly benefit from more contact with wild species, this paved over area offers little refuge for them. Until more natural areas are developed in inner cities, there is little hope much good can come from wildlife contacts in those areas. Suburban habitats are entirely different and will continue to be the site of most urban-wildlife conflicts.

NEGATIVE ASPECTS OF URBAN WILDLIFE

Health

The ubiquitous commensal rodents, i.e., the house mouse, Norway rat, and the roof rat, are the biggest threat to human health as they serve as vectors and reservoirs for many harmful pathogens including:

Amebiasis, Chargas disease, Dwarf tapeworm, Echinococcosis, Endemic relapsing fevers, Histoplasmosis, Leptospirosis, Lymphocytic choriomeningitis, Murine typhus, Plague, Rabies, Rat-bite fever (Haverhill), Rat-bite fever (Sodoku), Rat mite dermatitis, Rat tapeworm, Rickettsialpox, Rocky Mountain spotted fever, Salmonellosis, Schistosomiasis, Sporotrichosis, Toxoplasmosis, Trichinosis, Trichophytosis, and Tularemia.

Pathogenic organisms associated with other avian and mammalian species of wildlife in the urban habitat include:

Aspergillosis (Thrush), Canine distemper, Cryptococcus, Ectoparasites, Encephalitides, Giardiaosis, Histoplasmosis, Leptospirosis, Listerosis, Lyme disease, Newcastle disease, Ornithosis, Plague, Rabies, Raccoon roundworm, Salmonellosis, Toxoplasmosis, and Tularemia.

Life/Injury-Threatening Situations

Besides disease transmission, wild animals can aggressively threaten humans by biting and scratching. Humans have also been killed by alligators, bears, commensal rats, coyotes, dogs, mountain lions, and poisonous snakes in suburban situations. Coyotes, in particular, adapt to human-caused environmental changes to the point this species has become a threat to children in certain areas (Howell 1982). Humans have been killed as a result of collisions between automobiles and deer or dogs and in aircraft with birds, coyotes, and deer. Still another cause are fires started by rodents gnawing on wires or pigeons carrying burning materials into flammable nests (Fall & Schneider 1969).

Property Damage to Buildings

Physical damage through the gnawing activities of rodents, such as, rats and mice (both commensal and native species like pack rats and deer mice), and tree squirrels can result in expensive damage. Squirrels and raccoons join these animals in ripping up insulation for nesting material, chewing holes in siding or walls to gain entry, splintering window frames in a frantic attempt to escape, and cause water damage from holes gnawed in lead or plastic water pipes.

Damage can also be done to the outside of buildings where the acidic accumulations of pigeon feces erode metal drains and limestone building blocks. Nesting, signalling, or territorial activities by woodpeckers result in damage averaging $300 per home (Craven 1984). The mud nests made by industrious swallows under the eaves are unattractive to the neat householder. Loose feathers and nesting material from pigeons and sparrows plug the vents of airconditioners and drains. This action resulted in over a $100,000 loss with the collapse of a flooded department store roof in Santa Barbara, Calif. (Gilman 1978).

Other Property Damage

The branch of the Federal government assigned the task of reducing wildlife damage is currently in the U.S. Dept. of Agriculture, Animal & Plant Health Inspection Service, Animal Damage Control (APHIS-ADC). They have a computerized program providing monetary data on the damage caused by wild animals. Data from two States, California (Thompson 1987) and New Mexico (Nunley 1987) for Fiscal Year 1987 indicates the extent of these losses:

STATE	BUILDINGS	GROUNDS	OTHER PROPERTY
Calif.	$43,727	$71,642	$91,682
N.M.	$ 7,310	$21,653	$ 4,970
Total	$51,037	$93,259	$96,652

This total of $240,948 annually represents only part of the cost of wildlife damage to property in these two states. It does not include the costs of

control measures taken to reduce these losses or those losses not brought to the attention of APHIS-ADC. Whitten (1979) reports an earlier APHIS-ADC compilation for Texas in FY 1978 gave a total of $154,196 for rural losses compared to $197,838 losses in 11 of the largest cities in the State.

Probably one of the greatest losses is in landscape damage. One must consider not only the replacement cost, but the time lost. Trees and ornamental shrubs are barked by squirrels, deer, rabbits, meadow mice, beaver, wood rats, and porcupines. White tail deer alone in Westchester County (N.Y.) cost homeowners from $6.4 - $9.5 million PLUS an additional $1.2 to $1.6 million in attempted control measures (Connelly, et al 1988). Such species as, raccoons, tree and ground squirrels, mice, muskrats, coyotes, chipmunks, armadillos, deer, rabbits, woodchucks, and moles that keep truck gardeners awake nights can also wreck havoc on a city garden or flower bed.

Other target areas are lawns and golf greens. Raccoons, skunks, ground squirrels, and woodchucks dig into them; moles and pocket gophers burrow under them; coots and Canada geese graze them closely. The geese and coots also deposit a high-powered fertilizer creating a golf hazard not covered in the rule book. The extent of this problem was investigated by Conover (1985) who found at least 26% of golf course managers in the Northeast had such a serious problem they would gladly pay an average of $444 to reduce it. Animal waste products can cause unsightly burn spots in the vegetation under heavily populated blackbird-starling roosts.

The food and environs in city zoos is equally attractive to wild animals who eat and contaminate food, destroy ornamental plantings and buildings, and carry diseases. In a survey of zoological gardens 59% admittedly had problems. Control efforts cost an average of $6,500 annually per zoo (Fitzwater 1988).

DeGrazio (1978) reported utility pole damage by woodpeckers cost the Bell Telephone Co. $441,000 annually. Squirrels and roof rats gnaw on overhead cable lines causing power outages. Transformers and crossarms on cable systems are attractive nest sites for squirrels and raptores also resulting in power outages. A study (Hamilton, et al 1980) estimated squirrel-caused outages annually cost power companies in Lincoln (Neb.) $23,764 and in Omaha (Neb.) $47,954. When squirrel guards were placed in Lincoln at a cost of $260,000, annual losses were reduced 78%. Pocket gophers work underground on these cables too.

Water Structures and Quality

Burrowing by muskrats and nutria weaken water-retaining structures, causing cave-ins, washouts, and loss of stored water (DeAlmeida 1987). Dams built by beaver plugging culverts and drainage ditches result in flooding of roads, levees, pasture land, agricultural crops, and forests. Timber loss alone has been estimated at $17 million annually in Mississippi and $23 million in Arkansas (Wigley & Garner 1987).

The quality of drinking water has been lowered for city-dwellers where gulls, geese, and other waterfowl concentrate in water reservoirs. A protozoan parasite, Giardia lamblia, from the bladders of beaver is becoming an increasing problem. Minor disturbances include frogs, snakes, and mammals falling into swimming pools and depredations on ornamental fish in backyard pools by raccoons.

Petty Annoyances

The unesthetic effects of animal feces is undeniable. The mess created by pigeon, sparrow, starling, blackbird, and bat roosts can accumulate on/in buildings causing odor, slipperyness, and health problems. The aroma of a disturbed skunk remains an unpleasant memory long after the incident has passed. The removal of dead animals from the streets after an accident is not a high priority of city governments.

One form of loss that really riles urbanites is a pet cat or dog becoming a meal for a hungry coyote. Neither are they happy about pets fighting possibly rabid raccoons or the consumption of pet food by wild animals. Where poultry are raised within city limits, they must be tightly caged to protect them from raccoons, skunks, opossums, weasels, fox, and coyotes.

Nothing human is sacred to these non-human species. Burrowing animals like woodchucks, pocket gophers, and moles puttering around in cemeteries have brought up remnants of dead humans. The writer once had to scare a Chihuahua raven congregation away from a cemetery as the mourners confused them with vultures having sinister intent.

From the disruption of individual garbage cans to city dumps, urban garbage is another source of annoyance. Raccoons, crows/ravens, dogs, and rats are the chief offenders at the householder's garbage cans. At dumps, rats have long-standing proprietory rights, but bears, gulls, pigeons, and starlings have become frequent and more visible visitors.

Mississippi kites harass humans in certain sections of the country (Parker 1988). While this is only protection of the kite's "nesting territory", humans tend to resent any non-human claims to the same space. Mocking birds are sometimes similarly protective, but, outside of making the family cat miserable, are rarely as menacing as the kites.

There is no wakeup alarm more aggravating than the plaintive cry of a mourning dove under your bedroom window at an ungodly hour. Woodpeckers, too, sometimes choose the early morning to start up their signal drumming on the siding wall next to your bed. The chatty conversation of starlings/blackbirds roosting in trees around the house is doubly annoying - first when they arrive at night and when they leave early the next morning. One New York resident who refused to let authorities remove a communal nest of new South American immigrants, monk parakeets, called two weeks later begging them to take them, please, and give his eardrums a rest. Among the annoying night noises is the ghostly parade of rats, mice, bats, raccoons, and flying squirrels around the attic.

To the individual who sets a feast for song birds in his back yard, it is frustrating to find it disappearing in the mouths of what he considers undesirable aliens, such as, rats, squirrels, jays, house sparrows, and starlings

Indirect Economic Losses

Wildlife damage to farm and forest production cost city-dwellers indirectly in the price of food and fiber (Nunley 1987 & Thompson 1987):

DOLLAR LOSSES TO AGRICULTURE FOR 1987

STATE	LIVESTOCK	AGRIC.CROPS	FORESTRY
Calif.	$404,152	$357,659	$25,595
N. M.	$255,884	$233,291	$12,115
Total	$660,036	$590,950	$37,710

This adds up to $1,288,696 annually for just two states plus the cost of animal damage control measures taken to reduce these losses. Bird damage to grain, sorghum, blueberries, and grapes amounts to $5.8, $1.6, $2.1, and $4.4 millions respectively in crop-growing areas annually (DeGrazio 1978).

We can't put a dollar value on the joy of seeing wild animals, but neither can we ignore the cost/benefit ratio of their presence.

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Urban Wildlife Damage: A Complex Problem[1]

Mark E. Mapston[2]

Abstract. Wildlife can create problems when they conflict with man's health or economic interests, or when their presence is a nuisance. Animals have had to adapt to a variety of environmental alterations thrust upon them by land development and urbanization. This has caused a closer association of some wildlife species with man. What were once mainly rural occurences can now be found taking place more and more in urban and suburban environments. An increasing amount of native and introduced wildlife species are coming into conflict with man --- not just limited to the typically thought of "urbanized" animals such as commensal rodents, squirrels, raccoons, opossums, and skunks. We now also have problems with larger predators, larger rodents, and others.

In order to effectively deal with these newer and increased number of wildlife damage concerns, it will take the combined efforts of civic, private, and state entities as well as the local wildlife damage control agency. Control efforts are largely dependent upon the particular animals involved and the complaint situation and locale.

INTRODUCTION

In recent years the urban and suburban wildlife damage problem has become much more complex. There is a continual expansion of urban and suburban areas into the rural community of our country. With this expansion, more and more native and introduced wildlife species are coming into conflict with man's health or economic interests, or their presence is creating a nuisance.

Animals have had to adapt to a variety of environmental alterations thrust upon them by land development and urbanization. This has caused a closer association of some wildlife species with man. These same animals have more than adequately overcome any difficulties they have faced in the urban and suburban environments and many wild animal populations are thriving in these communities. What were once mainly rural occurences of wildlife damage can now be found taking place more and more in our urban and suburban communities.

URBAN WILDLIFE DAMAGE

Animals can regularly be found raiding garden and trash containers, and eating and drinking from pet dishes from within the confines of a populated neighborhood. Other animals can be found rooting for food in yards and flower beds, while some are taking up residences in attics, barns, sheds, and underneath houses. An increasing amount of wildlife species are coming into conflict with man --- not just limited to the typical "urbanized" animals such as commensal rodents (*Mus musculus*, *Rattus rattus*, *Rattus norvegicus*), tree squirrels (*Sciurus* spp.), raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), and skunks (*Mephitis mephitis*, *Spilogale pretorius*).

We now also have problems with larger predators, exotic birds, bats, larger rodents, and reptiles in these areas as well. Complaints come into the state's animal damage control offices on a regular basis regarding problems associated with these different species.

PREDATOR DAMAGE

Larger predators have imposed themselves upon the urban and suburban scene in redent years. The most common complaints received are for the predation of demestic pets such as dogs, cats, chickens, ducks, geese, and the predation of urban or suburban livestock, or for the harassment of these animals, or the feeding on of pet food or garbage.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. Marriott Hotel, Fort Collins, Colo., April 17-20, 1989.

[2]Mark E. Mapston, Wildlife Damage Control Specialist, Texas Animal Damage Control Service, Waco, Texas.

I have personally been involved with several cases of suburban predation problems. Some of the first direct control work that I did was for coyote (Canis latrans) predation of calves and sheep. In one case, coyotes had killed 8 calves on a small ranch located on the city limits of Wichita Falls, Texas during the winter of 1981-1982. Traditional coyote control methods were employed and 5 coyotes were taken off of the ranch and the predation was stopped.

In another situation, predators were responsible for the loss of 50 head of lambs, 1 ewe, and 1 calf on the city limit boundary of Olney, Texas. This represented an economic loss of $3583.00 to the rancher who was dependent on this ranching operation for his livelihood.

Other Texas Animal Damage Control personnel have related similar complaints and have had to deal with larger predators in the urban/suburban locale. In several instances predators (mainly coyotes) were responsible for killing cattle. In one case, 6 cows and 6 calves were lost to coyotes on a suburban ranch of Fort Worth, Texas. This was an economic loss of $5148.00 to the rancher. Twenty-six coyotes were taken off of this ranch which was surrounded on two sides by urban communities.[3]

On an adjoining ranch, a similar situation occured with the loss of calves to predation by coyotes. At this site, 42 coyotes were taken off of the ranch.[4] Needless to say the ranchers involved in each incident were quite pleased with the results.

I have also worked complaints as have others at urban/suburban Air Force bases, airports, and other such areas. During these occasions, coyotes were traveling on the runways and creating a hazard for the aircraft or they were causing other physical damage to the properties. Control procedures had to be undertaken where possible to try and alleviate the damage. At some facilities this type of complaint occurs yearly.

Requests for assistance with these types of problems are continually being received and are increasing in frequency across the state. I am sure that similar scenarios could be given by other states as well.

OTHER ANIMAL DAMAGE

Beaver (Castor canadensis) have also found their way into the urban and suburban environment as well. Requests for assistance in urban areas are being received continually and once again are on the increase. In some urban areas as many as 2 to 3 calls per week are received regarding urban beaver damage.[5]

Complaints involving urban beaver damage include damage to trees and shrubs, the building of dams on creeks and waterways, the plugging up of drainage culverts, and other types of damage to private property. Beaver burrowing activity in water impoundments both public and private, is another common complaint from many urban areas.

Another increasing problem from within these areas is the incidence of human giardial infection caused by the transmission of the Giardia (Giardia lamblia) parasite by positively infected beaver (Beach 1985). A beaver can shed millions of infectious cysts in a single scat which is generally deposited in the water system in which the beaver inhabits.

The presence of bats in urban areas tends to create much anxiety particularly in the Central and South Texas region. Although bats are the second highest carrier of rabies in the state, most actual bat damage is slight and usually results from bats in a roosting situation.

Birds continually cause problems in most urban/suburban areas because of their roosting, feeding, and/or nesting habits. Bird droppings are also a problem when they accumulate in large proportions. Many different species of birds are involved in these damage or nuisance situations.

Recently, even exotic species of birds have involved themselves with the urban scene. Birds such as Cattle Egrets (Bulbulcus ibis) and Little Blue Herons (Egretta caerulea) have established heronries in urban areas of southern states (Telfair 1983). Complaints are also received regarding such species as Mississippi Kites (Ictinia mississippiensis) (Peterson 1985) and Monk Parakeets (Myiopsitta monachus) due to problems caused from their respective nesting activities.

Other types of animals have begun to inundate our cities as well. Not only do many people keep exotic pets (ie: lions, tigers, wolves, snakes, etc.) that escape periodically, native "exotic" wildlife are beginning to show up in these areas. Reptiles such as the Meditteranean Gecko (Hemidactylus turcicus turcicus) have caused problems. This lizard likes habitat around human habitations as its home and recently has appeared in Dallas which has not been in the animal's normal range of occurence.[5]

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[3]Thomas, Thurman R. 1988. Personal communication. Texas Animal Damage Control Service. Gatesville, Texas.

[4]House, Dayton. 1987. Personal communication. Texas Animal Damage Control Service. Mullin, Texas.

[5]Sramek, Ricky. 1988. Personal communication. Texas Animal Damage Control Service. Dallas, Texas.

I have also received complaints regarding a nuisance situation involving Rough Earth Snakes (Virginia striatula) and Texas Blind Snakes (Leptotyphlops dulcis). Both of these snakes are small (4 to 8 inches) and brown-colored and may occur around human habitations and/or find their way inside buildings.

DISCUSSION

Each of the complaint situations that have been related all required some form of associated control activity to help solve the damage or nuisance problem. This control activity is largely dependent upon the particular species of animal involved and the complaint background and locale. In most cases, technical assistance or control methods instruction is the desired and the primary mode of operation. Many times there are extenuating circumstances which may prohibit specific direct control activities being conducted.

With environmental concerns still in full swing, more and more urban areas are being designated as wildlife and/or bird sanctuaries where little or nothing can be done to alleviate wildlife damage without special and most often hard-to-get authorization. Also, a continually increasing amount of urban and suburban communities are adopting more and more restrictive city legislation which may limit control techniques. This includes the banning of the use of steel-jawed traps from within city limit boundaries, usually including Conibear traps, and the curtailing of the use of certain pesticides and the use of firearms.

Most local city animal control agencies are not set up for handling wildlife damage problems or do not have the personnel with the technical expertise to consult with a complainant on wildlife damage and control. This is particularly true in the smaller urban communities where funds and personnel are limited.

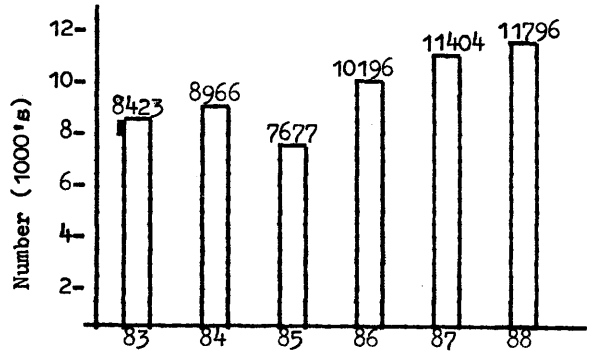
CONCLUSION

The wildlife damage complaints from within urban and suburban communities can be quite varied and may involve numerous wildlife species. There has been a continual increase in damage complaints and the associated technical assistance provided in Texas in the past few years (Table 1). Eighty-five to 90 percent of this technical assistance was provided by an urban wildlife damage control specialist.

By the year 2000, it has been estimated that 90 percent of the human population in this country will live in an urban area.[6] Consequently, there will be an increase in urban and suburban human/wildlife conflicts particularly of the kind described in this paper. Wildlife damage control specialists will be called upon in greater demand for assistance in solving these conflicts. He or she will need to address these problems in the most proficient and professional manner possible.

[6]Hawthorne, Donald W. 1987. Personal communication. Texas Animal Damage Control Service, USDA-APHIS-ADC. San Antonio, Texas.

Table 1. Technical assistance projects of Texas ADC Program, (fiscal years)



In order to effectively deal with these newer and more numerous complaints, it will take the combined efforts of civic, private, and state entities as well as the local wildlife damage control agency. These other entities need to be educated about wildlife damage and wildlife damage control in order that they too can at least provide the proper information to their public and/or provide the proper assistance to the control agent as needed.

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Urban Nuisance Wildlife Problems in Arizona[1]

Rebecca L. Wright[2] and Leonard L. Ordway

Abstract.-- Arizona has experienced an increase in urbanization of wildlife habitat, which has led to an urban nuisance wildlife problem. The Arizona Game and Fish Department is working to lessen the problem through public education, information packets and use of private pest control companies to remove wildlife for a fee.

INTRODUCTION

Wildlife has historically caused depredation and nuisance problems in rural areas nationwide. Typically, man controlled these problems through animal removal or exclusion. Over the last three decades, development of wildlife habitat and rural areas into metropolitan sites has increased, and population distribution has shifted from rural to urban. Nuisance wildlife problems have also shifted from agricultural damage to urban wildlife issues, ranging from a simple misunderstanding by citizens of wildlife habits to actual property damage by wildlife.

Arizona encompasses approximately 114,000 square miles. The state's population (3.5 million) increases each year by 3.5-4.5%, with most settling in urban areas (Arizona Department of Economic Security, 1988). Nuisance wildlife situations have also increased. According to Animal Damage Control's Arizona Annual Report (USDA, FY 1988), javelina (Tayassu tajacu) (fig. 1) caused almost $112,000 damage to crops, turf (golf courses), pets and gardens. Coyotes (Canis latrans) (fig. 2) caused $69,000 damage to livestock and crops. Beavers (Castor canadensis), black bears (Ursus americana), skunks and ground squirrels caused a total of $20,600 damage to private and commercial property.

Rather than being isolated or unrelated incidences, these nuisance wildlife situations are an expanding problem that the Arizona Game and Fish Department (AGFD) is striving to solve or lessen through education of the public, mail-out information packets to affected citizens, and licensing of private pest control companies enabling them to remove wildlife at a cost to the affected citizen.

URBAN NUISANCE WILDLIFE - CAUSES

The factors contributing to urban nuisance wildlife problems in Arizona are similar to factors seen nationwide. These four factors are: habitat transference, habitat destruction, human population expansion and wildlife population expansion/adaption.

Ownership or status of land in Arizona has changed as areas became more urbanized. First, land became private property or State and Federal lands; then the latter was either annexed by cities or developed into unincorporated towns becoming private property. This change in land ownership resulted in a change in habitat management and manipulation. Once annexed into cities or towns, property was developed into residential, commercial or industrial sites.

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[1]Paper presented at the Ninth Great Plains of Wildlife Damage Control Workshop, Fort Collins, Colorado, April 18-19, 1989.

[2]Rebecca L. Wright is Wildlife Manager (Scottsdale), Region VI, Arizona Game and Fish Department, Mesa, Arizona. Leonard L. Ordway is Game Specialist, Region VI, Arizona Game and Fish Department, Mesa, Arizona.

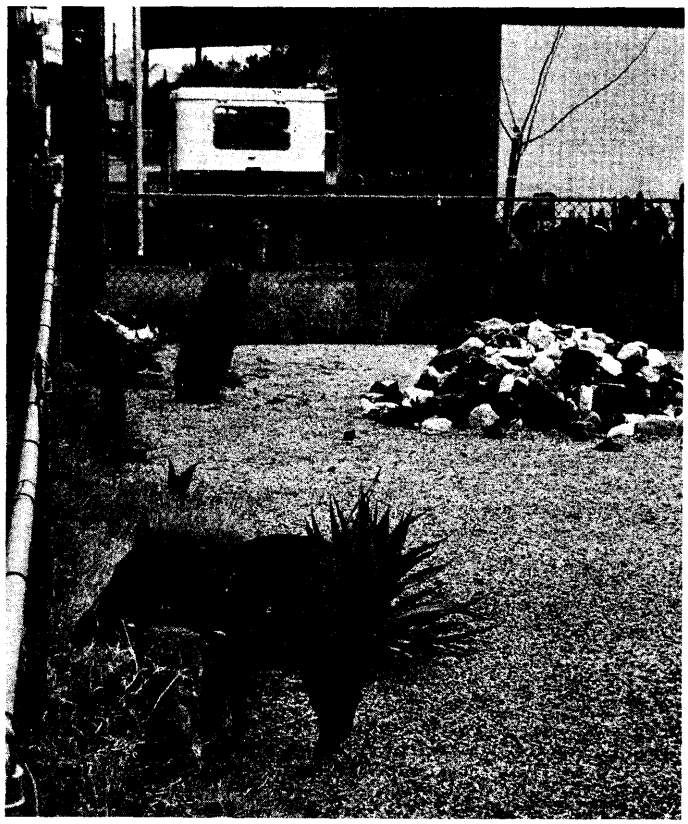

Figure 1.--Javelina (Tayassu tajacu) or collared peccary, frequently cause nuisance problems in metropolitan Phoenix and Tucson. These individuals were removed with tranquilizing dart gun.

Figure 2.--Coyotes (Canis latrans) are occasionally found in towns allowing horse properties or where washes and native vegetation remain.

Two modes of development have been used: 1) removal of native habitat, with evenly spaced residential or commercial communities, and 2) widely-spaced or clustered communities with corridors of native habitat left intact (this mode has become more popular as consumers and developers became more ecologically conscious). These two methods of development have created pockets of untouched or minimally impacted habitat surrounded by developed sites.

Newcomers to Arizona often relocate from more urbanized states. These new Arizonans often have had little experience with wildlife such as javelina, black bears, coyotes, skunks, racoons (Procyon lotor), mountain lions (Felis concolor), raptors, rattlesnakes and Gila Monsters (Heloderma suspectum). Long-time residents in once lightly populated towns who have not seen much wildlife in the past are seeing more wildlife as habitat is destroyed and these animals are forced to seek out other food and cover resources.

Wildlife species have adapted to new food, water, and cover resources in urbanized areas, resulting in an increase of frequency of wildlife sightings. Some species, such as the javelina, have increased in numbers and are also adapting to new habitats, such as ponderosa pine.

PROBLEMS CAUSED BY URBAN WILDLIFE

Despite development of wildlife habitat, often wildlife is not displaced. Instead, wildlife takes advantage of the new food, water, and cover resources presented to them. Landscaped yards, gardens, ornamental cactus, decorative ponds, drip irrigation systems, garbage cans, pet food, food set out for wildlife, and, occasionally, pets, replace traditional food and water resources. Sheds, garages, crawl spaces under house trailers, rafters, and attics are utilized as cover. Wildlife continue traveling on traditional movement corridors, despite development along these pathways.

The public frequently is uninformed about wildlife habits and legal status; many have unrealistic viewpoints on wildlife management. While many Arizonans enjoy seeing wildlife and, at times, encourage them by supplying food and water, many newcomers are surprised or frightened at the presence of javelina, coyotes, woodpeckers, etc. Just observing wildlife does not mean it is creating a nuisance. Yet, someone unfamiliar with a javelina is sure to have some concern.

When evaluating the situation with the affected citizen, Wildlife Managers try to assess what the problem is and how the citizen is contributing to the problem. Contributing factors include failure to remove wildlife attractants and failure to modify habitat (no fences, improper or inadequate fencing, failure to cover crawl spaces, etc.).

SOLUTIONS TO INDIVIDUAL CASES

AGFD has limited manpower and economic resources and cannot physically respond to all wildlife calls. Therefore, these calls are broken down into three categories: 1) injured or captive wildlife; 2) wildlife situations homeowners can alleviate themselves or by hiring a privately owned wildlife pest control company; and 3) live trapping or tranquilizing enclosed or dangerous wildlife. Wildlife Managers respond to any calls involving a threatened or endangered species, a big game mammal, or if the situation is life threatening or politically sensitive.

The first category ("come and get this thing") is cleared by phone instruction. The affected citizen is encouraged to bring the wildlife to the nearest AGFD office. If the citizen can't do this, then a volunteer for AGFD's Adobe Mountain Wildlife Center is sent to pick up the animal.

The second category ("we've got a problem and want you to remove it/solve it") is usually handled by phone instruction and mail-out information packets sent to the affected citizen. These packets contain information on removal of attractants, habitat modification, repelling individual animals, and removal of individual animals. In addition, information on Wildlife Service Permittees (WSP) is included in the packet. WSP are State Pest Control Board licensed pest control companies licensed by AGFD to handle nuisance wildlife (fig. 3). For a fee, a WSP will remove wildlife, develop plans to prevent wildlife damage or offer advice on how to prevent further damage. Currently, few companies work statewide; the majority work only in the Phoenix metropolitan area. As the number of nuisance wildlife calls increases in the metropolitan areas, these companies provide an invaluable service for AGFD.

The third category (removal of enclosed or dangerous wildlife) warrants response by AGFD personnel. Javelina, black bear and mountain lions have posed threats to humans or pets in metropolitan areas in recent years. These wildlife species have been known to become dependent upon food resources presented by humans; the animals then associate food with humans and, subsequently, lose their fear of humans. Occasionally, these animals become trapped on property and can't (or won't) leave. If all other attempts to exclude or deter the nuisance animal fail, then Wildlife Managers will attempt to remove the animal using live traps, tranquilizing dart guns or catch poles (fig. 4). Method utilized is determined by species involved, safety to officers and public, condition of animal, and number of animals involved.

Non-wildlife species such as pigeons and feral pets are handled by WSP or other agencies, such as USDA Animal Damage Control, County Rabies Control or the Humane Society.

LONG-TERM SOLUTIONS

Response to individual cases helps the immediate nuisance problem a property owner is experiencing, yet AGFD is working to prevent or

Figure 3.--Wildlife Service Permittees remove wildlife, devise plans, or offer advice on nuisance problems at a cost to the affected citizen.

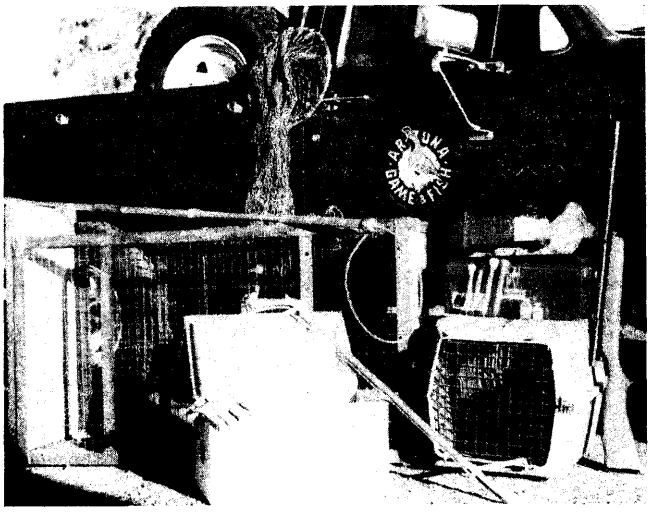

Figure 4.--Wildlife Managers use a variety of equipment for wildlife capture and removal (dart gun, net gun, catch pole, snake tongs, and live traps).

lessen future nuisance problems through education of the public, coordination of efforts of the six AGFD regions, and licensing and training of private companies to assist in wildlife removal. AGFD is designing brochures explaining life histories and habits of javelina, coyotes, small mamamals, birds, and reptiles that detail strategies for preventing problems from these species. These brochures will be available at AGFD offices and will be sent to Chamber of Commerce offices for inclusion in newcomers' information packets. AGFD is also designing slide shows and video tapes detailing nuisance wildlife problems; these will be made available to the public for talks and presentations. In addition, Wildlife Managers are working with community leaders, citizen groups, and city planning branches, outlining methods they can use to help educate their communities about urban wildlife. During the peak nuisance wildlife season, late fall to spring, AGFD collaborates with local newspapers and television stations reference articles and newsbriefs on urban wildlife problems.

AGFD is upgrading and expanding its Wildlife Service Permittee program. Improved yearly training sessions, revised report forms, and stricter reporting requirements allow AGFD to better supervise WSP actions. AGFD also expects to license pest control companies in metropolitan areas other than Phoenix; this will provide an invaluable service to the public and AGFD.

SUMMARY

Urban nuisance wildlife problems will continue to increase as wildlife habitat is developed and wildlife is forced to search out new food, water, and cover resources around metropolitan areas. Response to individual cases by Wildlife Managers will help alleviate immediate nuisance wildlife situations, but long-term solutions such as public education, use of private companies to assist in wildlife removal, and coordination with city planners and developers will help alleviate future urban nuisance wildlife problems.

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Urban Beaver Damage and Control in Dallas-Fort Worth, Texas[1]

Bob Willging[2] and Rick Sramek[3]

Abstract.--Beaver in metropolitan Dallas-Fort Worth, Texas cause considerable damage annually to trees, shrubs, and other property. USDA-APHIS-ADC reported 158 beaver complaints in the Dallas-Fort Worth area, 1984-1988, with damage totalling $60,395. Respondents to a beaver damage survey reported $170,900 in damage. Most incidents occurred at private homes on small creeks or lakes. Respondents used 11 different control methods, and spent $13,775 on control. Effective and consistent approaches to urban beaver damage control are needed.

INTRODUCTION

Beaver (Castor canadensis) populations have increased tremendously in the southeastern United States during the past 30 years, resulting in extensive damage to timber and agricultural resources primarily from flooding but also from direct cutting (Arner 1964, Toole and Krinard 1967, Godbie and Price 1975, Arner and DuBose 1978, Bullock and Arner 1985). Loven (1986) reported $391,153 in beaver damage to dikes and impoundments in Texas during a three year period.

In most southern states, beaver populations were probably at a low between 1890-1930 (Wesley 1978, Woodward 1983), but increased legal protection, low fur prices, and transplant efforts since then has caused beaver populations and distribution to greatly expand. Beaver were nearly extinct in Texas by 1900 (Wade 1986). Between 1939 and 1961 numerous beaver transplants by the Texas Parks and Wildlife Department, facilitated by strict protection and increased man-made water sources, led to the resurgence of the Texas beaver population, and damage complaints were common by the mid-1960's (Wade 1986). Presently there are few restrictions on taking beaver for damage control in Texas, but beaver populations remain high and are expanding.

Beaver damage to timber and agricultural resources has been documented extensively; however, beaver damage to urban and suburban property has received little attention. Beaver populations within the metropolitan area of Dallas-Fort Worth (DFW), Texas cause considerable damage annually to ornamental shrubs and trees, and other property. Beaver control in urban areas is frequently complicated by safety considerations, local regulations regarding the use of certain control methods, and widely varied public attitudes towards beaver control. The purpose of this study was to 1) Assess the extent of urban beaver damage in the DFW area, 2) Determine damage control and prevention methods used by residents experiencing beaver damage, and 3) Assess urban residents' attitudes towards beaver and control methods.

STUDY AREA

This study was conducted in Dallas and Tarrant Counties of northcentral Texas. The cities of Dallas and Fort Worth occupy nearly all of Dallas and Tarrant Counties respectively, and the DFW urban areas are referred to as one metropolitan area. The DFW area ranks 10th in population nationwide with over 3 million people, and covers 4,475 km^2. Both counties are highly urbanized and little land could be considered rural.

Surface water resources are abundant in the area due to its position in the Upper Trinity River Basin. The West Fork of the Trinity begins northwest of Fort Worth and joins the Clear Fork in Fort Worth and the Elm Fork in Dallas. There are 23 major reservoirs located in this basin, with 6 located in the DFW area. Additionally, hundreds of small creeks, ponds, and canals provide extensive riparian habitat for beaver.

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[1] Paper presented at the Ninth Great Plains Animal Damage Control Workshop. (Fort Collins, Col., April 17-20, 1989).

[2] Bob Willging is Assistant District Supervisor, USDA-APHIS-ADC, Fort Worth, Tex.

[3] Rick Sramek is a Wildlife Damage Control Specialist, Texas Animal Damage Control Service, Dallas, Tex.

METHODS

Management Information System

Data summaries for Dallas and Tarrant Counties from the USDA-APHIS-ADC Management Information System (MIS) between 1983-1988 were used to determine annual number of beaver complaints received by ADC, damage estimates, and types of damage. Texas ADC employees routinely complete a computer card reporting each damage complaint received, showing location, species, and type and value of damage. This information is entered in a central databank located at the state office in San Antonio. The MIS system became operational in 1983.

Survey

A 15 question survey with 3 sections was developed to obtain additional information about beaver damage situations. Surveys were sent to DFW residents who had been assisted by USDA-APHIS-ADC with beaver problems between 1984-1988. An attempt was made to send surveys to as many individuals as possible. However, lack of current addresses limited the number of surveys sent to 87. We were primarily interested in obtaining damage estimates, type of damage, control methods used, and attitudes towards beaver control.

RESULTS

Management Information System

Beaver damage from 158 incidents recorded on MIS from 1984-1988 totaled $60,395 (Table 1). Most damage was to ornamental plants and trees, which included typical nursery stock shade and fruit trees and shrubs, and to standing trees, which included wild, native trees. Other types of damage recorded included damage to lake or tank dams, and property damage such as to boat docks and wooden structures. Yearly totals of beaver complaints received by ADC have steadily increased from 12 in 1984 to 64 in 1988.

Survey

Sixty-three percent of the 87 surveys sent were returned. Most responses were from private homes (80%). The remaining 20% were from schools, churches, golf courses, and real estate developments. Damage occurred on small creeks or streams (55%), small ponds or lakes (40%), and reservoirs (2%).

Total beaver damage reported by respondents was $170,900 and ranged from $50 to $50,000 per complaint. Six exceedingly high damage estimates accounted for 67% of the total damage cost. Eliminating these high estimates left an average of $1,807 per incident. The six large damage estimates were reported by a university and private homeowners. Severe damage to pond dams and mature trees accounted for the higher estimates. No attempt was made to verify the accuracy of these estimates.

The most frequent type of damage reported was to ornamental plants and trees (55%). Other property damage reported included garden or fruit tree damage (11%), dike or dam damage (9%), and boat dock damage (1%). Other types of damage reported were flooding, erosion, and damage to wooden gates and fences. One respondent reported damage to a powerline caused by a beaver-felled tree. Some respondents regarded beaver as a nuisance or potential health hazard.

Eleven different damage control methods were used by respondents (Table 2). Most respondents used more than one method. Wrapping trees with hardware cloth or screen was used by 67% of respondents. Other methods frequently used were shooting (33%), conibear traps (18%), and exclusion fencing (18%). Respondents reported spending a total of $13,775 on control efforts. These costs ranged from buying a box of shotgun shells to spending $3,000 on labor to control beavers at a real estate development.

Respondents were asked to categorize each method used as successful (stopped damage), partially successful (some relief from damage), or not successful (no relief from damage). Protecting trees with hardware cloth or screen and shooting were consistently considered to be successful methods (Table 2). Most other methods were perceived as being only partially successful or not successful. Forty-five percent of respondents used some type of lethal control with 84% of them killing at least one beaver. Twenty percent reported killing over 5 beaver. The most used lethal method was shooting.

Sixty-seven percent of respondents were unaware that beavers existed in the DFW area until damage was experienced. Twenty percent had regarded beavers as endangered species before their damage experience. Most respondents (56%) were aware that nutria (*Myocastor coypus*) could be found in the area, and many people initially confused beaver damage with nutria damage. Fifty-five percent of respondents felt that assistance with beaver control was easily obtainable. Only 25% of respondents were opposed to lethal control, and of these, 50% would permit lethal control as a last alternative.

DISCUSSION

Damage

Damage estimates reported by survey respondents were several times higher per incident than that reported by ADC personnel. ADC figures are likely underestimates as they are usually based on one-time telephone consultations or brief inspections of the damage site. Damage reported by survey respondents varied widely and represent individual perceptions of damage severity. It is difficult for individuals to assign accurate and consistent values to urban beaver damage. For example, a mature shade tree has great sentimental and aesthetic value in addition to a high replacement cost. Realistic damage estimates for the DFW area probably lie between ADC estimates and landowner estimates. Both MIS data and survey results rep-

Table 1.—Beaver damage reported to USDA-APHIS-ADC Management Information System, Dallas-Fort Worth, 1984-1988.

		Damage Classification				
Year	n	Ornamental Plants	Standing Trees	Dams	Property	Totals
1988	64	$13,620	$1,575	$ 900	$ 600	$16,695
1987	44	$ 8,645	$4,575	$2,000	0	$15,220
1986	21	$10,960	$6,960	$ 500	0	$18,420
1985	17	$ 510	$5,363	0	$1,300	$ 7,175
1984	12	$ 1,835	$ 300	$ 750	0	$ 2,885
Totals	158	$35,570	$18,775	$4,150	$1,900	$60,395

Table 2.--Number of survey respondents who used control method(s), and degree of success perceived.

	Degree of Success				
Method	Successful	Partial Success	No Success	Totals	%[1]
Wrapped trees	15	20	2	37	67
Shooting	12	6	0	18	33
Conibear traps	4	2	4	10	18
Exclusion fencing	2	4	4	10	18
Repellents	0	4	5	9	16
Lights/Noise	0	3	5	8	15
Live trap	0	1	3	4	7
Do nothing	0	0	4	4	7
Leghold trap	0	0	3	3	5
Electric fence	1	0	1	2	4
Hired trapper	0	0	2	2	4
Snares	1	0	1	2	4

[1] Percent of respondents who used method at least once. Many respondents used more than one method.

resent only those landowners that contacted ADC for assistance. Many landowners experiencing damage attempt to solve the problem on their own or find assistance from other sources. It is evident that beaver damage in the DFW area is a real and significant problem.

Calls to ADC about beaver damage in the DFW area were rare prior to 1975, but have increased steadily since then. This increasing trend is continuing, due in part to an expansion of beaver numbers and range. Beaver, at first occurring in the major reservoirs and rivers, are now being found in small ponds, intermittent creeks, canals, and ditches. One beaver was found living in a drain pipe and was travelling through the storm sewer to feed on neighborhood trees. The increase in calls to ADC may also be due to an increase in suburban growth, and increased awareness of the existence of an ADC agency.

Control

Urban beaver damage control can be extremely frustrating for those affected. Few municipalities possess the expertise or motivation to deal with beaver damage, and local ordinances frequently restrict available control methods. When beaver damage begins it is often very noticeable and generally increases quickly, leaving the landowner feeling helpless. Survey respondents reported using

a variety of control methods, some representing desperate attempts to curb the damage. Surprisingly, 45% of respondents used lethal control methods, often shooting, despite local laws prohibiting the discharge of firearms within city limits. One landscaper felt that careful shooting was the only effective method available to him due to the safety risks of trapping and the infeasibility of wrapping hundreds of trees with wire fencing. We also were surprised that 75% of respondents were not opposed to lethal control methods, probably because the survey sample consisted only of those people familiar with beaver damage and the difficulties of control.

CONCLUSION

Beaver damage in the DFW area is an increasing problem and the adverse economic impact is likely to increase. However, there is no consistent, effective way in which urban residents can solve damage problems in a legal, safe, and biologically sound manner.

Many barriers to effective urban beaver control programs exist. Among these is a prevalent attitude among urban dwellers that urban beavers are somehow "special," which reflects a general lack of understanding about wildlife population dynamics and beaver biology. Experience has shown that a very few misinformed individuals, along with some negative publicity, can put an end to well intentioned and biologically sound beaver control efforts. Safety considerations and local regulations prohibiting trapping and shooting make effective beaver control difficult for the urban dweller.

The difficulties of urban beaver control may lead urban wildlife managers and animal control personnel to adopt a "do nothing" attitude or to suggest to the affected party that beavers should be enjoyed because they are beneficial and interesting. However, these approaches only make matters worse. While beavers may be beneficial in rural areas, there are few urban situations where benefits outweigh damage. Urban residents experiencing beaver damage will go to great lengths, lawful or unlawful, to control it.

It is clear that innovative, comprehensive approaches to urban beaver control, accompanied by a public education program, are greatly needed.

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Managing Urban Deer in Illinois: The Role of State Government[1, 2, 3]

James H. Witham and Jon M. Jones[4]

Abstract.--Decisions by communities to preserve open space within the Chicago Metropolitan Area have resulted in negative deer-human-habitat interactions. These conflicts can be addressed when communities develop consensus on management needs. In November 1988, the Illinois Department of Conservation initiated an urban deer management project to facilitate the needs of residents.

INTRODUCTION

White-tailed deer (Odocoileus virginianus) are abundant and widely distributed in the Chicago Metropolitan Area (CMA). Many urban residents develop an emotional bond with deer; some individuals relate philosophically to deer by passive coexistance or through a perception of mutual interdependence (Heintzelman 1988). Other residents appreciate deer as a natural component of a community, but also demand that coexistance is conditional. Conditional thresholds vary among individuals and are defined by the degree that a person and/or landowner tolerates economic loss (Caslick and Decker 1979, Porter 1983), reduced property aesthetics (Moen 1984, Conover and Kania 1988), increased health risk (Miller 1987, Lastavica et al. 1989), and the ecological impacts (Goldsmith 1982) that are often associated with wild free-ranging deer in urban environments (Decker and Connelly 1989).

Deer management activities in an urban environment are frequently focused on symptoms. In most circumstances, deer-vehicle accidents, browsing damage to native vegetation and ornamental plantings, and the transmittal of pathogens, are the predictable consequences of deer-human coexistance rather than being causal factors in themselves. These symptoms are common in the CMA (Witham and Jones 1987). Treating symptoms through use of site-specific damage abatement techniques (Craven 1984) is generally accepted by the public without significant issue. However, more comprehensive programs that involve population reduction and control require a broader understanding of conflict and a greater acceptance of responsibility among all participants.

In a region such as the CMA, where deer conflicts are abundant and repetitive, a state wildlife agency is well-advised to clearly define its level of involvement in urban deer management. Failure to formulate a definitive position increases opportunities for misunderstandings that can reflect negatively on state government and contribute to the divisiveness of issues.

In 1983, the Illinois Department of Conservation (IDC) contracted the Illinois Natural History Survey (INHS) to study deer-human-habitat relationships in northeastern Illinois. Research by INHS provided baseline biological data, identified and assessed the distribution of conflicts, evaluated alternative management strategies, and implemented experimental pilot studies that explored issues and established management precedence (Witham and Jones 1987). In November 1988, the IDC initiated a permanent Urban Deer Management Project that overlaps the final 14 months of the INHS research program. During this transition period, the IDC will define its role in urban deer management.

In this paper we describe factors that contribute to the recurrence of deer-human-habitat conflicts in the CMA, identify management needs, and suggest opportunities for IDC participation in urban deer management.

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1 Paper presented at the Ninth Great Plaines Wildlife Damage Control Workshop, Marriott Hotel, Fort Collins, Colorado. April 17-20 1989.

2 This study is a contribution of Federal Aid in Wildlife Restoration Project W-87-R, the Illinois Department of Conservation, the U.S. Fish and Wildlife Service, and the Illinois Natural History Survey, cooperating.

3 Use of the word "urban" in the text denotes both urban and suburban environs.

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CAUSES OF DEER-HUMAN CONFLICTS IN CHICAGO

Urban environs are incomplete ecosystems lacking a wide complement of natural mechanisms that regulate deer populations. They are highly perturbed systems altered extensively by humans. In this setting, choices made by individuals, communities, and/or society, are the fundamental cause(s) of urban deer conflicts.

Insular Refuges: a Paradox of Preservation and Development

County forest preserves form the nucleus of primary deer habitat in northeastern Illinois. Since 1915, counties have acquired large sections of non-developed and rural landscape for the "purpose of protecting and preserving the flora, fauna, and scenic beauties...in their natural state and condition, for...the education, pleasure and recreation of the public (Wendling et al. 1981). In concept, forest preserve systems were designed as a network of interconnected refuges (Forest Preserve District of Cook County 1918). Some forest preserves have been developed for educational and recreational uses which include nature centers, zoological facilities, botanical gardens, and an extensive system of maintained picnic and recreation sites. Non-developed properties are a diverse mixture of native hardwood forests, reforestations, riparian systems, old-field succession, and leased agricultural fields.

In 1988, forest preserves totalled 394 km2 or 8.7% of Cook, DuPage, and Lake counties. The human population of 6.3 million in the 3-county CMA is projected to increase during the next decade (1 July 1986 census, U.S. Census Bureau, published in 1987). Private lands near many forest preserves, because of their aesthetic quality and/or higher economic value, have been extensively developed for residential, commercial, and industrial uses. Deer concentrate on preserves but readily cross heavily used highways seeking resources on these adjacent properties. Urban forest preserves will only become more insular over time. This will contribute to the escalation of deer-human conflicts in the CMA.

Demographic Responses of Deer on Preserves

Demographic responses of deer on quasi-insular preserves are similar to those expected of deer that are artificially protected within expansive exclosures. In the CMA, large predators are absent. Winter weather is harsh but within the normal limits of the northern range of the white-tail. Under such conditions, deer survival and productivity fluctuate predominately under the constraint and relaxation of weather variables and interannual variations in available nutrition. In rural settings temporal increases in deer abundance are more likely to be offset by dispersal and by more liberalized harvest through recreational hunting. However, on relatively small, non-hunted, insular urban sanctuaries the negative consequences of increased deer abundance are accutely accentuated. High deer numbers on urban preserves will decline only through catastrophic dieoff triggered by severe weather or disease, or both; or a more gradual reduction through protracted malnutrition, accompanied by degradation of plant resources and a higher frequency of negative deer-human-habitat interactions. The latter best characterizes the conditions that exist on many CMA preserves.

Human Values and Management Efficacy

Moralistic, humanistic, and ecologistic characteristics are typical among urban publics (Kellert 1980). These prevailing values strongly affect the selection of methods used to control deer populations. In general, urban publics favor non-lethal techniques; however, non-lethal methods have demonstrated only limited effectiveness in reducing and controlling deer abundance. In contrast, lethal methods of deer population control are more effective but less acceptable to urban publics.

The inverse relationship between effectiveness and acceptablility of population control methods enhances polarization which is reinforced by different perceptions of the value of wildlife management literature. The wildlife professional is aware of the scope and value of deer management literature (see Wallmo 1981, Halls 1984) and uses this information to improve efficiency without reattempting techniques that have failed previously. Such acceptance is appropriate if it is refined by critical evaluation--a necessity because results presented in literature are at times ambiguous. Failure to provide this distinction perpetuates dogma and reflects poorly on the credibility of the wildlife profession. In contrast, those with opposing viewpoints may have limited knowledge and/or reject the value of wildlife management literature. The latter group frequently demands that all non-lethal alternatives are attempted before lethal control is considered. This syndrome of "reinventing the wheel" at each site is, at times, performed as a compromise to reduce socio-political conflict.

DEER MANAGEMENT NEEDS IN THE CMA

The resolution of urban deer conflicts requires cooperation between the state wildlife agency, the affected individual(s) or landowner(s), and those publics with special interest. None can resolve deer issues independently. A state wildlife agency regulates use of wildlife resources as defined by legislative mandated laws, whereas, land-use activities that are established by property owners are the principal determinants of wildlife abundance and population quality (Smith and Coggin 1984). Interested citizens can profoundly influence management decisions through socio-political processes since deer, and often times deer habitat, are resources held in public trust.

The IDC has no direct control over land-use decisions in the CMA; therefore, landowners must assume a direct participatory role in urban deer management. State wildlife regulations set the boundaries from which options can be selected; however, commissioners and officials of local governments are ultimately responsible for making specific decisions. Inherent in this responsibility is the need to balance human values against the limitations of management options. The role of state government in this process is informational. Landowners must have unbiased information on deer biology, ecology, and deer management alternatives with which to develop the expertise necessary to design, implement, and evaluate site-specific deer management programs.

URBAN DEER MANAGEMENT IN THE CMA

Program Goals

- To acquire state-of-the-art expertise on urban wildlife management and local deer ecology for the purposes of management decisions and public education.
- To facilitate cooperative management programs by providing information and training.
- To increase awareness of urban deer ecology and to promote broader understanding of the consequences of an urban environment shared with wildlife.

Recommendations for State Involvement

The primary responsibilities of the IDC are to regulate wildlife use and to provide technical expertise. In urban deer management, the IDC must clearly distinguish between technical expertise and value judgement; questions of human values cannot be resolved technically and must be reconciled on a local level (Creighton 1984). In this context, the IDC should facilitate the needs of landowners who experience deer-related conflicts, interact responsively with publics that express special interest, but not arbitrate nor advocate values.

The IDC has approached urban deer issues proactively by establishing the deer specialist position in the CMA. A wealth of technical information exists on deer management strategies and methods to abate damage, but there is no universal panacea that will eliminate deer-human conflicts (Matschke et al. 1984). Control methods often produce ambiguous results. The role the IDC must take is to present this information accurately, and to the best extent possible, predict the consequences of specific decision alternatives. It remains the choice of the landowner whether or not to use the expertise provided by the state.

The urban deer specialist must be able to train landowners, or their representatives, in procedures for handling deer, controlling populations, and abating damage. Some landowners will prefer to contract this work to an outside source; there are many "deer experts" in the CMA. Under these circumstances the IDC must define minimum standards that will qualify an individual or organization to perform deer management services. The qualifying criteria should include possession of a specified level of liability insurance, technical expertise, and a demonstrated ability to use this expertise humanely and with maximum consideration for human safety.

Existing IDC policies and regulations on deer management may need to be adapted for application to urban settings. In some cases, new regulations will have to be developed since urban deer management differs substantially from traditional deer management practices in Illinois. For example, during the first six months of the Urban Deer Management Project the IDC established regulations on the translocation and free-release of deer, requirements for handling deer during live-capture, and modified procedures for the charitable donation of venison from animals killed in population reduction programs.

Applications submitted by landowners for deer depredations permits should include a proposal with a problem statement, program objectives, assessment of damage (if assessment is not quantified then the proposal should include quantitative procedures that will be implemented in the future), proposed methods, and an evaluation process that will measure achievement of success. This will encourage landowners to more closely monitor floral and faunal resources that may be negatively affected by deer. Furthermore, these minimal requirements force the landowner to articulate the exact nature of the conflict and how they expect the conflict to be resolved. In doing so, the landowner must address specifics rather than use superfulous terminology such as "overpopulation", "overbrowsing" or "carrying capacity" (Macnab 1985).

We expect the IDC Urban Deer Project to function as the central repository for data collected by local agencies. This will help standardize the collection of data and will promote exchange of information among landowners that are managing deer on their properties.

DISCUSSION

Currently in the United States there is a general movement from representative government to a participatory democracy. Increased public participation in decision processes is viewed more as a right than as a privilege (Creighton 1984). Urban deer issues provide a forum where this shift in attitude is readily apparent and perhaps, accentuated.

If communities choose to preserve open space and yet promote development, to perturb landscapes in ways that impair or eliminate forms of natural regulation of wildlife populations, to request abatement of deer-related damage but place limitations on the acceptability of techniques, then the communities must also accept a more active role in the management process. The IDC initiated the urban deer management project to help communities resolve deer-human conflicts. Success will depend on the ability of the communities to define their site-specific deer management needs and to select management responses that will effectively meet these needs.

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Controlling Raccoon Damage in Urban Areas[1]

David G. Riley[2]

Abstract: Raccoons have become a serious problem in many urban and suburban areas. Damage to homes and buildings as well as the spread of diseases to pets are constant problems when high raccoon populations occur. Various control methods can be implemented with positive results.

INTRODUCTION

In recent years, problems associated with raccoons in urban areas have become serious and very costly. This is due primarily to trends in real estate development and the human expansion into once rural areas. The idea of blending homes and office buildings into the natural surroundings is pleasant to the eye, but it can be an open invitation to the opportunistic raccoon.

Problems caused by raccoons can range from being a simple nuisance in the backyard to extreme structural damage to buildings, including holes in roofs and ceilings and damage to air conditioning systems and electrical wiring. Total monetary value of damage to buildings and other property in Texas for 1987 was $100,901.00. This figure represents only the damage reported to our agency. (Annual Report, 1987)

Another problem linked to raccoons is the spread of diseases to pets. Recently a study was conducted by Texas A&M University and the Austin area Health Department to test for leptospirosis in urban raccoons. Raccoons were collected in Austin, Texas by the Texas Animal Damage Control Service. The findings indicated that 61% of the raccoons tested positive for leptospirosis (Hudson, 1987). Dogs and cats are not vaccinated against this particular strain of the disease; therefore exposure to pets could increase the incidence of leptospirosis in people and pets.

Rabies is another disease that can be spread by raccoons. The national Centers for Disease Control received 1,311 cases of raccoon rabies in 1987. Of these, 1,298 (99%) were reported from the mid-Atlantic and southeaster states; areas of extreme urban development (CDC Summaries, 1988).

PROBLEM CIRCUMSTANCES

In most instances reports of raccoon damage are received from homeowners and businesses that are located within two or three blocks from a stream or green belt area. These natural corridors provide travel lanes by which raccoons are permitted to move throughout a city. Water, food, and shelter are available, depending on the amount of vegetation present. Usually there is not sufficient food or shelter for the local population of raccoons and during dry seasons, water can be in short supply. This lack of food, water, and or shelter, all essential elements, are the reasons why raccoons intrude upon people in urban areas.

DESCRIPTION OF RACCOON COMPLAINTS AND SOLUTIONS

The Texas Animal Damage Control Service provides assistance for various urban wildlife problems. The following are the most common complaints associated with raccoons.

1. Raccoons seen in the neighborhood: Many people do not realize that wildlife is abundant in urban areas, provided there is suitable habitat. In most instances this problem can be solved by providing the individual with information on urban raccoons.

2. Pet food, water, and garbage consumed by raccoons: Pet food left outside after dark and improperly stored garbage will attract raccoons to a home. Water bowls left out over night, uncovered hot tubs, and swimming pools are all easy to reach sources of water for raccoons.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop [Colorado State University, Fort Collins, April 17-20, 1989].

[2]David G. Riley, Wildlife Damage Control Specialist, Texas Animal Damage Control Service, Austin, Texas.

With the exception of swimming pools, all of the above mentioned attractants can be stored properly with a little effort and discipline by the property owner.

3. Raccoons in attics and chimneys: This is the most common complaint received. Serious roof and interior damage can occur when raccoons are living in an attic. Exclusion, if feasible, should be implemented as soon as the problem is discovered. A permanent physical barrier between the ground and roof must be created. Raccoons usually gain access to a structure by way of a tree trunk or limb that is within two or three feet of the roof. To determine if a tree is being used, the trunk should be wrapped with a material that will show claw marks. Plastic trash bags, newspaper, or aluminum foil are all readily available and give good results. If a tree is being used by a raccoon, the trunk can be wrapped with a band of metal sheeting. The band should be 2½ feet wide and the bottom of the metal should be placed at least 2½ feet from the ground. Once in place the raccoons are able to reach the ground, but cannot climb back up the tree. Pruning of limbs used by raccoons may be necessary.

Many times raccoons will climb up the corner of a building. If this is the case, a metal sheet at least 3 feet square should be tacked around the corner. After exclusion of raccoons is complete permanent roof repairs can be made. Chimneys if uncovered, should be secured with heavy wire screening and fastened with masonry screws.

If exclusion is not successful or economical, trapping will need to be implemented.

DIRECT CONTROL

While exclusion or removal of the attractant (food, water, and shelter) is the best approach in dealing with raccoons, many people assume that trapping is the first and best choice. It is my opinion that trapping alone is a short term solution. The probability of raccoons reinfesting a building within a few months is very high. If exclusion and trapping are used very good results can be expected.

Raccoons are not difficult to catch in traps. In urban areas, the cage-type live trap should always be used. Single door traps are more effective for larger animals. If a trap with two doors is to be used, close the rear door. Bait should be placed behind the treadle well to the back of the trap. In selecting a bait, it is not necessary to use high odor fish products. This will attract house cats and possibly raccons other than those causing the damage. Peanut butter on bread or fruit and vanilla extract on bread are effective baits.

Once a raccoon has been trapped, it must be destroyed or relocated. Many people think the animal should be placed "back in the country where it came from". The fact is urban raccoons spend their entire lives in an urban area. Raccoons that are relocated into unfamiliar surroundings are stressed, disoriented, and have never searched for food or shelter in a rural area. The spread of disease to the rural raccoon population is very possible. Many of the relocated raccoons do not live very long after release. In North Carolina, 300 raccoons were tagged and released at a cost of $50.00 per animal; of these relocated raccoons only 16% (48) survived (Boyer & Brown, 1988). Tranquilizing followed by euthanasia is a more humane solution than allowing the raccoon to suffer from stress and starvation.

CONCLUSION

Urban raccoons and the problems they cause can be found in any city whenever food, water, and shelter are available. Wildlife damage control agencies can provide the public with information to increase their awareness of this and other wildlife related conflicts. This will enable people to better understand and deal with these problems as they arise.

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Relocation of City Raccoons[1]

Richard C. Rosatte and Charles D. MacInnes[2]

Abstract.--Twenty-four city raccoons were radio-collared and relocated 25-45 km north of the original capture site in Toronto, Ontario. Following release, extensive exploratory movements were noted with distances of 2-7 km being traversed per night. Home ranges for adult males ($\bar{x}$ = 39 km^2) and females ($\bar{x}$ = 72 km^2) far exceeded juvenile ranges and areas utilized by raccoons in an urban setting. None of the raccoons returned to the original point of capture and mortality of the relocated raccoons approached 50% during the first 3 months following release.

INTRODUCTION

Raccoons (*Procyon lotor*) are considered a pest in many city areas of southern Ontario (Rosatte 1986). Damage to lawns, gardens, residential roofs, chimneys and structures such as sheds and garages are commonly reported. There is also the potential for transmission of infectious diseases from raccoons to humans as well as to other animals (Wright 1977; Jacobson et al. 1982; Isaza and Courtney 1988).

Annually, more than 2000 "problem raccoons" are handled by the local Humane Society and animal control departments in the city of Toronto alone (Rosatte unpubl.). The dilemma is just what to do with those animals. Should they be euthanized, translocated to another locality, or should an investigation be initiated to establish methods to reduce human/raccoon interaction such as the design of predator-proof garbage containers. In many cases, the problem animals in Toronto are live-trapped, transported, and released in other areas. However, no follow-up has ever been carried out to determine the fate of those animals or establish that they did not return to the original capture site.

In 1986, the Ontario Ministry of Natural Resources in cooperation with the Ontario Humane Society initiated a research project to determine the fate of "city raccoons" translocated to either rural areas or a town. The major objectives of the study were:

(a) to determine the humaneness of relocating "problem raccoons" to unfamiliar areas;

(b) to estimate the survival rate of relocated raccoons;

(c) to observe the extent of exploratory movements by relocated animals;

(d) to predict the potential for infectious disease transmission from relocated raccoons to humans, domestic animals and wildlife;

(e) to determine whether translocated raccoons would return to the original capture site.

The following is a summary of the project results.

MATERIALS AND METHODS

Twenty-four raccoons (13 juveniles, 11 adults) were live-trapped (Tomahawk #106 - sardines as bait) in an urban area of Metropolitan Toronto between August 4 and October 1, 1986. The animals were immobilized with a mixture of ketamine hydrochloride and xylazine hydrochloride (10:1 ratio, 30 mg/kg ketamine), ear tagged for identification, weighed, measured and fitted with an adjustable radio-collar (Lotek Engineering, Aurora, Ontario - 151.309-151.467 MHz). They were also vaccinated against rabies with an intramuscular injection of Imrab inactivated rabies vaccine (Mérieux) and administered 0.5-1.0 ml of tetracycline to combat infection. Collared raccoons were then transported between 25 and 45 km north

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[1]Presented at the Great Plains Wildlife Damage Control Conference, Fort Collins, Colorado, April 17-20, 1989

[2]Richard C. Rosatte is a research scientist and C. D. MacInnes is supervisor, Wildlife Research Section, with the Ontario Ministry of Natural Resources, P.O. Box 5000, Maple, ON, Canada L6A 1S9.

of Metro Toronto and released in a rural setting or in close proximity to a town (fig. 1). Groups of 3-5 animals were released at weekly intervals between August 7 and October 1. Attempts were made to locate the collared animals 5 times/week until winter denning began in December. Animals with neck circumferences less than 24 cm were recaptured periodically and collars adjusted to accommodate growth. Collars were removed at the end of the study. Signals from the transmitters were monitored using a Trackfinder TFR-1000 receiver and a truck-mounted 3-element Yagi antenna. Grid locations were tabulated to the nearest 100 metres using triangulation of compass bearings and entered on a PDT-RT11 computer for data analysis. Home range was calculated using the Minimum Area method with a RADTRAC program designed by Queen's University (Voigt and Tinline 1980). Home range or area utilized by the collared raccoons was determined for the initial exploratory movement period and also immediately following that time until winter denning. The exploratory movement period was assumed to be complete when nightly movements were < 1 km. Calculated home range is also a minimum estimate

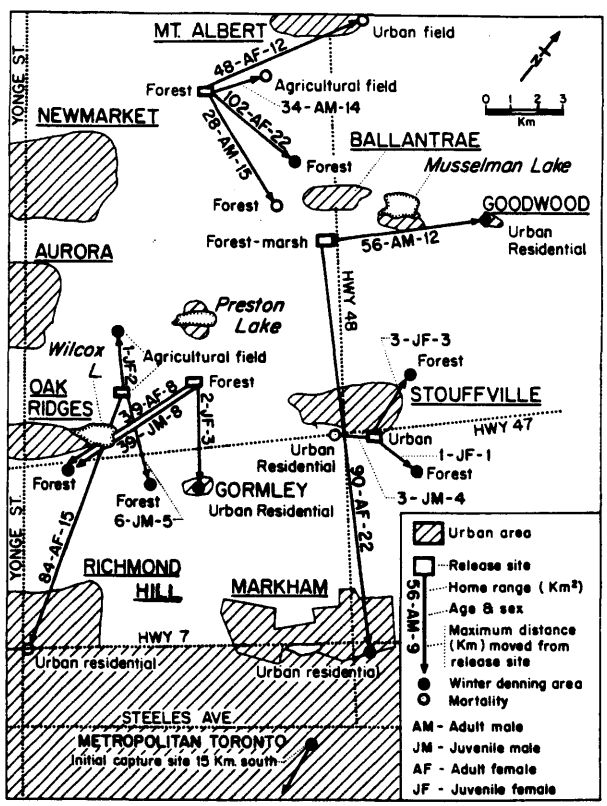

Figure 1. Release site and winter denning area of relocated urban raccoons.

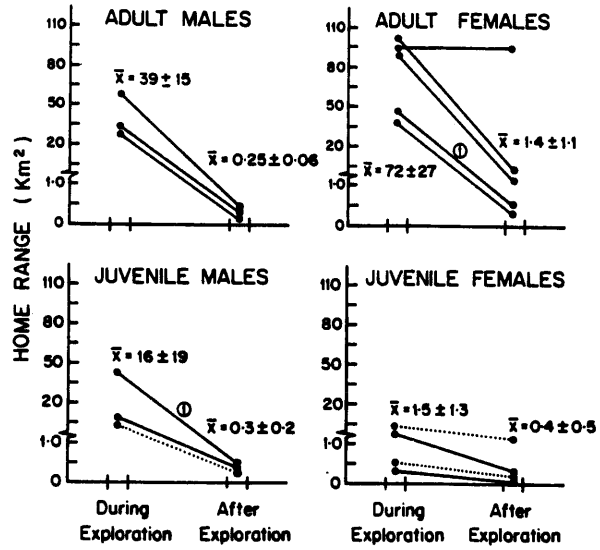

Figure 2. Home range of relocated raccoons during and after the exploratory movement period. ① - adult female and juvenile male travelled and denned together. •.....• town release site raccoon

as locations were taken during the day when the animals were resting. No doubt a greater area would have been covered while they were active during the evening. For lack of a better term in defining the area utilized during the exploratory period, "home range" will be used in the text. Differences in home range and dispersal per age/sex class were tested using a 2-sample *t*-test (Zar 1974). Directional bias during dispersal was tested using critical values of *r* for a circular distribution derived from Rayleigh's Z values (Zar 1974). Significance was set at $p < 0.05$.

RESULTS

Sufficient data were gathered on 15 of the 24 collared raccoons for movement and home range analysis ($\bar{x}$ = 39 different fixes/animal). Those animals were monitored a mean period of 75.2 days (35-71, non consecutive) using 581 locations.

On the average, the collared raccoons explored for 27.7 days (range 9-47) before settling into a well-defined home range. Exploratory movements were generally between 2-7 km/night, while post exploratory movements were less than 1 km/night.

Home range of relocated raccoons

The home range or area utilized while exploring after release was greater for adult raccoons than juveniles ($p < 0.001$). However, after exploratory movements had ceased, we could find no differences in home range between age/sex classes ($p < 0.5$) (fig. 2). Adult home ranges were greater while exploring than after settling down ($p < 0.002$); however, we could find no differences in juvenile home ranges during and after the exploratory period ($p < 0.5$) (fig. 2).

Home ranges of raccoons transplanted to the town were smaller than those released in rural settings during the exploratory period (p <0.05) (figs. 2, 3). However, we could find no difference after the exploratory period had ceased (p <0.5) (figs. 2, 3).

Movements by relocated raccoons

Maximum straight line distance across the perimeter of the home range was greater for adults than juveniles (p <0.001) (fig. 4). As well, the perimeter distance was greater for raccoons released in rural habitats than those released in the town (p <0.05) (fig. 4).

The maximum distance moved from the release site and the distance raccoons settled from the release site was greater for adults than juveniles (p <0.001) and greater for rural releases than the town releases (p <0.05) (fig. 4). However, we could find no differences between age/sex classes, town or rural releases for distances between the original urban capture site and the area where the relocated raccoons settled down (p <0.1) (fig. 4).

Directional movement bias

The mean angle of dispersal for all raccoons from the release site to the winter denning area was 148°, a S.S.E. directional drift. However, the drift was not biased to any specific direction (p >0.05, r = 0.330) (fig. 5). The mean angle of drift following release for age/sex cohorts was: adult males - 99°, adult females - 194°, juvenile males - 229°, and juvenile females - 78° (fig. 5). Directional drift for the different cohorts was not biased to any specific compass direction (p >0.05, r = 0.269-0.834).

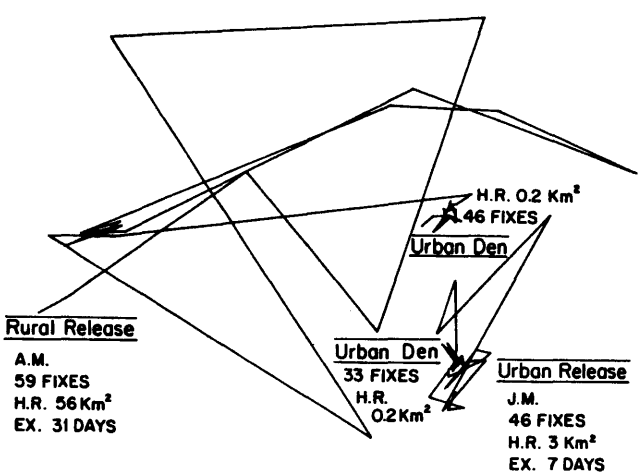

Figure 3. Home range of a rural and a town release site raccoon during and following the exploratory movement period.
H.R. = home range; A.M. = adult male; J.M. = juvenile male; E.X. = exploratory period. Urban Release = town release

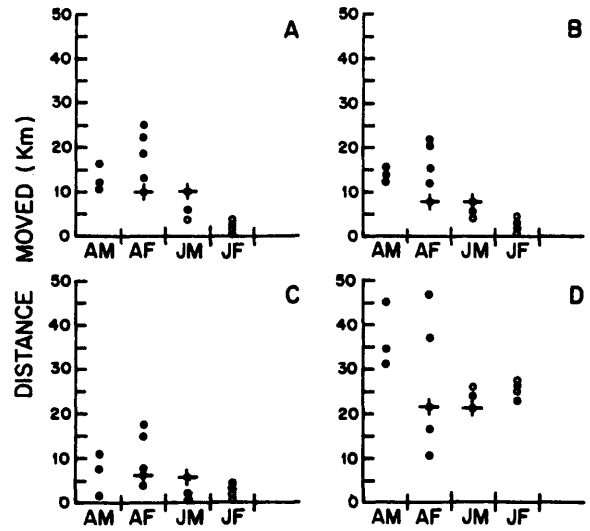

Figure 4. Distances moved by relocated raccoons following release.
A = maximum distance across home range perimeter
B = maximum distance moved from release site
C = distance settled from release site
D = distance settled from original capture site
o = town release site raccoon
• = rural release site raccoon
+ = juvenile male and adult female travelled together
A.M. = adult male A.F. = adult female
J.M. = juvenile male J.F. = juvenile female

Mortalities

Of the 24 relocated raccoons, 50% (12/24) succumbed within 3 months of release. Sources of mortality included shooting (5), road-kills (4), dogs (2) and poison (1). Three additional animals were possible mortalities as they could not be located despite live-trapping efforts, aerial and ground searches covering a 4500 km² area. However, we could find no difference in survival for animals released in the town (3/5) versus rural areas (10/19) (p >0.95).

The physical condition of some individuals was very poor when recaptured in the fall. One adult and two juveniles actually lost weight during the period when they should be storing fat for the winter denning period. In fact, October-November weights of 3 juveniles were 1-3 kg (30-50%) below the mean fall weight of urban juvenile raccoons from the same capture site during a previous study (Rosatte et al. 1987) (fig. 6).

Post exploration locations

Following the exploratory period, 60% (9/15) of the raccoons settled a mean distance of 0.3 km (range 0-1) from a town. The remaining 40% (6/15) settled in forested rural areas an average of 3.0 km (2.1-4.3) from a town. None of those animals were ever located in a town. However, of the animals settling in or in close proximity to towns, 45% of their locations during the tracking period were in towns, mainly residential areas. For the whole tracking period, the 15 raccoons were located in mature deciduous forest 40% of the time, in residential areas 26% and in agricultural fields (mainly standing corn) 34% of the time. They settled into a combination of different habitats including urban residential, forest, agricultural field and urban field (fig. 1). Winter denning sites within those habitats included trees, open chimneys, abandoned barns and sheds.

DISCUSSION

Relocation of raccoons in North America is not a recent wildlife management practice. Since the early 1950's raccoons were trapped and relocated throughout different localities of South Carolina (Frampton and Webb 1974). As well, thousands have been transported from south Florida to Kentucky and Virginia for hunting purposes (Wright 1977; Jenkins and Winkler 1987). In Ontario, as raccoon populations are quite high, most relocations are due to human/animal conflicts and are termed nuisance relocations. During this project, we attempted to examine the fate of city raccoons relocated either to rural areas or a town. The foremost finding was the exceptional exploratory movement period undertaken

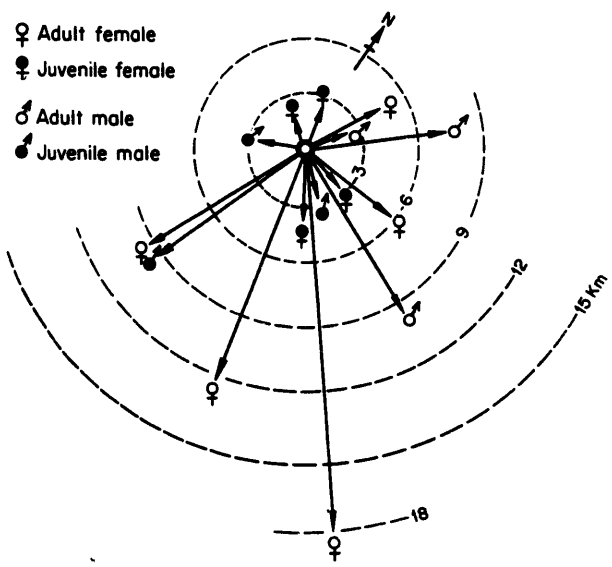

Figure 5. Directional drift by relocated raccoons following release.

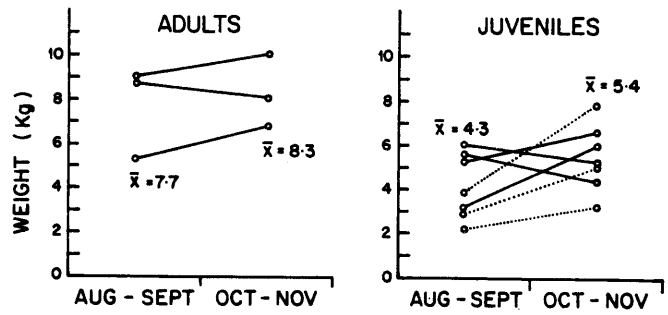

Figure 6. Weight gain/loss of relocated raccoons at the time of release and upon recapture.
o.....o town release site raccoon

by most of the radio-collared animals following release. Nightly forays of 2-7 km straight-line distance was common. Those movements were many times greater than annual movements made by radio-collared raccoons from the same initial capture site in Toronto ($\bar{x}$ = 0.8 km)(Rosatte et al. 1987). As well, home ranges during the exploratory period were exceptional when compared to those of urban raccoons in other cities. Annual ranges of 0.05 - 0.8 km^2 were common for raccoons in Washington, D.C., Cincinnati and New Brunswick, New Jersey (Cauley and Schinner 1973; Hoffmann and Gottschang 1977; Sherfy and Chapman 1980; Slade 1985). Mean annual home ranges for raccoons in the same initial capture site in Toronto were 0.42 km^2 (Rosatte et al. 1987).

The exceptional movements and extensive areas utilized by the relocated raccoons were possibly a result of disorientation through introduction to an unfamiliar environment. That hypothesis is supported by the fact that raccoons released at rural sites moved much greater distances than those released in a town. Once the animals became adjusted to their new habitat, home ranges compared well to raccoons in urban areas.

Disorientation is further supported in that none of the raccoons returned to the original capture site and there was no directional bias in movement following release. That suggests that raccoons do not possess any homing tendencies. Other researchers have also suggested that raccoons have no preference for direction or homing instinct when relocated (Frampton and Webb 1974).

The major concern with large exploratory movements by animals following relocation is the potential for the transmission of infectious diseases. A major epizootic of raccoon rabies in the mid-Atlantic U.S. during the 1980's was attributed to the translocation of raccoons from southern Florida to Virginia (Jenkins and Winkler 1987). As well, in Ontario during the late 1970's, an outbreak of rabies in skunks (*Mephitis mephitis*) was traced to the transplanting of nuisance animals from Mississauga

to Malton, both suburbs of Metropolitan Toronto (D. H. Johnston unpublished). The potential problem with relocation of wildlife is that the animal may be incubating an infectious disease while not exhibiting any clinical symptoms. The authors found a high percentage (55-60) of raccoons in Metro Toronto were serum positive for antibodies against canine distemper and feline panleukopenia. Raccoons have also been diagnosed with rabies, pseudorabies, *Baylisascaris procyonis*, canine parvovirus, canine distemper and canine adenovirus (Jacobson et al. 1982; Cranfield et al. 1984; Thawley and Wright 1982; Rabinowitz and Potgieter 1984; Dubey 1982; Rosatte 1988).

The humaneness of relocating urban raccoons must also be questioned. Mortality within the first 3 months of release was at least 50% and may have been as high as 75% due to the poor condition of some juveniles entering the winter denning period. Annual mortality in a sample (12) of radio-collared raccoons in Metro Toronto was less than 20% (Rosatte et al. 1987). Would it be more humane to euthanize the problem animals at the time of initial capture, or subject them to disorientation, starvation and mortality by dogs, automobiles, poison and shooting?

Another potential problem of relocating urban raccoons is the transfer of the problem from one locality to another. Most farmers in our area of relocation were exceptionally negative with respect to moving raccoons onto their farmland. Their major objections were due to past experiences with crop and building damage due to raccoons, as well as feces in grain storage bins and concern over the potential for disease transmission to their domestic stock. In our case, relocation of problem raccoons only resulted in shifting the human/wildlife interaction from the city to the country.

Solutions

The large number of human/raccoon conflicts in Metropolitan Toronto are due to high population densities of raccoons in some habitat types (Rosatte et al. 1987). Solutions to the conflict could include lowering the population density of raccoons in the problem area. That could be accomplished by:

a. the use of reproductive inhibitors or chemical sterilants in baits to render adult and juvenile female raccoons infertile (Howard 1967; Johnston et al. 1988; Kirkpatrick and Turner Jr. 1985);

b. the surgical sterilization of adult male raccoons following live-capture (Bojrab 1986);

c. euthanize problem raccoons following capture.

Probably the most effective method of alleviating the problem of nuisance raccoons is by exclusion. Many problems could be avoided simply by screening off chimneys and sealing all access to garages, sheds and barns. Predator-proof electric fences can be erected around gardens or an even cheaper method is to employ a watch-dog. If the only solution is to transplant, then if at all possible the animals should be vaccinated with a licensed vaccine to avoid the transmission of infectious diseases.

In conclusion, we do not recommend relocation of urban raccoons to solve nuisance problems as the potential for disease transmission due to large exploratory movements is high. As well, the humaneness of the technique has to be questioned due to high mortality rates and severe weight loss in juveniles.

ACKNOWLEDGEMENTS

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Colorado's Big Game Damage Program: 1979 to Present[1]

Andre C. Duvall[2]

Abstract.--Colorado's big game damage program, enacted in 1979, provides monetary claims for big game damage, prevention materials, and technical advice. Fences, crops, harvested crops, pasture, livestock, and personal property are protected. The average yearly cost for the program has been approximately one million dollars.

HISTORICAL OVERVIEW

The Colorado Division of Wildlife has always paid game damage of some sort. Prior to 1978-79, the Division was liable for damage to hay by deer and elk, and for bear and lion damage to livestock and personal property. Game damage payments totalled $300,000 prior to 1978.

With the extremely severe winter of 1978-79, the deer and elk herds were in serious trouble due to lack of natural forage. Despite a winter-feeding effort, many animals starved and were lost in the heavy snows. That winter the deer and elk caused excessively heavy damage to orchards and stacked hay. The Colorado Cattleman's Association had game damage legislation introduced into the Colorado House of Representatives to alleviate further game damage problems.

LEGISLATION

Colorado House Bill #1235 became law in March 1979 and outlined the legal responsibilities of the Colorado Division of Wildlife for big game damage. These responsibilities included: damage caused by deer, elk, antelope, moose, bear and mountain lion, bighorn sheep, and mountain goat.

Types of damages covered are: fences, crops, harvested crops, pasture and forage, orchards, and real or personal property. In 1981 additional legislation was passed in House Bill #1398. This made the Division also responsible for damage to nurseries. All these statutes were collected into Statute 33, Article 3: Damage by Wildlife (Colorado 1977).

PURPOSE STATEMENT

The Wildlife Commission created regulations to implement the new big game damage law. The Division defined the purpose of its game damage program as follows: "These regulations provide for the handling of big game damage claims, and are intended to provide the basis for compensation to claimants for losses suffered through the movements and feeding habits of big game" (Grieb 1979).

RESPONSIBILITY

The Division is responsible for deer, elk, antelope, moose, bighorn sheep, and mountain goat damage to the following: significant damage to fences on private property in amounts of $100 or more per incident; significant damage to livestock forage which exceeds 10% of the grazing capacity, seasonally deferred grazing land, crops under cultivation, harvested crops, hay meadows, artificially seeded rangelands, pasture meadows, orchards, and nurseries. Damage to ornamentals and home shrubbery is not covered by this law.

Damage to real or personal property by black bear and mountain lion is also the Division's responsibility. Real or personal property is usually taken to mean: livestock, poultry, bee hives, rabbits, buildings, fences, etc. It does not cover campers, automobiles, or camping gear and equipment (Colorado Division of Wildlife 1979).

CLAIM PROCEDURE AND LEGAL RESPONSIBILITY

In order for a claim for big game damage to be approved by the Wildlife Commission, the following procedure must be adhered to:

1. A 10-day notification must be sent to the Division that specifies: dates; numbers and species of big game; type of damage; estimate of damage extent; and location. If damage is recurring, a notification must be sent every 10 days. The Division must investigate the alleged damage within 10 days of the receipt of

[1]Paper presented at the 9th Great Plains Wildlife Damage Control Workshop. (Fort Collins, Colo., April 17-20, 1989).

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notification and provide claim papers if requested by the landowner.

2. An investigative report must be filled out and filed as part of the claim by the investigating officer of the Division at the time of initial notification of the damage.

3. Proof of Loss forms must be returned to the Division by the landowner within 90 days of ending notification of damage. Proof of Loss forms also include forms specific to the damage claimed so it can be correctly documented.

4. Upon receiving the claim, Division of Wildlife representatives must meet with the landowner-claimant within 30 days to try to reach a mutual agreement for the settlement.

5. Claim papers in their entirety must be sent to the appropriate Regional Manager and then to Denver headquarters for payment.

6. Any approved claim for less than $2,500 is paid out of the game damage funds appropriated for that purpose.

7. Any claim over $2,500 must be approved by the Wildlife Commission.

8. If any claim is denied, it must be reviewed by the Wildlife Commission. The claimant has the right of appeal within 30 days to the Wildlife Commission on denials.

9. If the claim is still denied by the Wildlife Commission, the claimant may enter the case before the local district court. The time allowed for this action is within 60 days of official receipt of claim denial (Colorado Division of Wildlife 1980).

10. If claimant cashes the damage payment check, he can no longer appeal the case to the courts.

BIG GAME DAMAGE OPERATIONS AND POLICIES

Predators.--When bear or mountain lion damage complaints are received, the damage is investigated as quickly as possibly so the evidence does not deteriorate to the point where the cause of death is difficult or impossible to ascertain.

Payment on all predator-damaged livestock, other than sheep, is made on the current market value of the animals. Sheep are compensated for on a sliding scale of value due to the unpredictability of the market. The Division has the right to receive the opinion of a licensed veterinarian to determine the cause of death in predator damage cases and often does so, particularly if the value exceeds $1,000.

Bear and mountain lion, killed during the commission of game damage, become the property of the state and must be turned over to the Division of Wildlife within 5 days. When the need arises, the Division has an established list of lion and/or bear hunters who are qualified to hunt the offending animals.

Ungulates.--There are three areas where damage done by ungulates has the severest impact in Colorado: hay stacks; crops under cultivation (usually alfalfa); and orchards.

With hay damage, the payment and investigation center on amounts such as bales, tons, or pounds of hay damaged. Payment is based on replacement value of the hay at the time of damage.

Claims for damage to crops under cultivation are among the most difficult to substantiate. Generally to prove a claim on growing crops, a count of the damage causing animals must be made every 5 days for as long as the damage is continuing. This count is substantiated by Division of Wildlife personnel and is the basis for the average number of big game animals on the claim. One method of evaluating such losses is to compare damaged to undamaged portions of the crop. Another is to clip, air dry, and weigh sample vegetation. A final method is to assign a forage basis, by poundage, to a particular species. This figure is then multiplied by the average number of big game present and the amount of time, in days, they foraged on the crop. The total is then the amount attributed to the game damage claim.

Orchard damage is computed on a percentage basis for each tree unless totally destroyed. Trees are listed by age, species, and production records to determine value.

In areas of severe game damage by ungulates, a damage hunt may be selected as a control measure. An established list of eligible hunters is maintained and may be called at any time of the year for a supervised, controlled damage hunt. A specific number of animals are taken and all are utilized by the hunters or donated to charitable organizations by the Division of Wildlife.

CLAIM DENIALS

There are conditions where game damage claims are denied. If the claim is false and is discovered to be so, claim payments are not made. If the claimant restricts access to private land or denies access to public land under his or her control, for the hunting of the species causing damage, the claim can be denied. Lastly, if the claimant charges over $25 per hunter per season, the claim may be denied under the game damage statute.

BIG GAME HISTORICAL LEVELS

The Division of Wildlife is obligated to determine historical levels of big game ungulates for use in the settlement of game damage claims. These levels are based on the 20-year population averages starting January 1, 1953 and ending January 1, 1973.

FINANCIAL CONSIDERATIONS

The costs of Colorado's big game damage program are paid entirely by big game hunting license revenue (game cash).

In fiscal year 1979-80, one and one-half million dollars were appropriated from game cash monies for the damage program. Approximately $300,000 was paid in claims, $350,000 for manpower and labor, and $850,000 was used to purchase damage prevention materials.

In the intervening decade from 1979 to 1989, the damage program has cost in range of $600,000 to $1,000,000 per year. Claims have averaged approximately $200,000 yearly, with the rest spent for prevention materials, supplemental feed, and labor costs.

DISCUSSION

Colorado's big game damage program has had some interesting consequences.

The Division has spent approximately $10,000,000 over the last decade, which could have been used in other wildlife related endeavors.

Hunting seasons have been influenced and herd objectives (actual numbers of big game animals) have been changed. In some cases, big game herds have been decreased due to damage situations and landowner insistence.

The concept of "wildlife ranching" has in part developed out of the big game damage program and associated concerns.

Large landholdings that previously allowed no access, are now open to reasonable numbers of hunters and recreationalists. This is due to damage claim payment approval being tied to reasonable access to attain harvest.

In some areas of severe damage, the Division has been able to lease or purchase real estate for the state's sportsmen.

Overall, relations have been improved with many ranchers, farmers, and other large landowners. Many now work more closely with the Division on wildlife management activities due to claim payments, damage control efforts, hunting and regulation strategies, and getting to know Division of Wildlife concerns and personnel.

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Colorado's Liability for Big Game Damage to Livestock Forage[1]

Len H. Carpenter[2]

Abstract.--The Colorado Division of Wildlife is liable for damage to livestock forage by big game animals under 2 categories. First is damage to livestock forage in hay meadows, pasture and artificially seeded rangelands. The second is damage to livestock forage on grazing land that is deferred for seasonal use. Calculation of damage is complex and involves consideration of several factors. Damage is based upon the difference between grazing capacity and amount of grazing actually realized by the claimant, provided that amount of damage could have been caused by the big game animals documented to have used the area. Factors such as numbers and kinds of big game animals, current wildlife population, historic wildlife population, animal month equivalents, dietary overlap, forage values, and proportion of time spent on the area by game animals in question must be considered. Approximately $50,000 has been paid to claimants for forage damage since 1978.

INTRODUCTION

The first legislation concerning big game damage in Colorado passed in 1931 when the state became liable for damage to haystacks. In 1969, liability for damage by big game animals was broadened to include loss of livestock, damage to fences, and growing crops. In 1979, orchard damages, losses of livestock forage on artificially seeded rangelands, and losses of forage on seasonally deferred pastures were included in Colorado's big game damage legislation.

The objective of this paper is to describe Colorado's liability for damage done to livestock forage on private lands. Provisions of the legislation and procedures for determining amount of damage and calculation of payment will be discussed. Problems with the process from the viewpoint of both the state and the claimant will also be highlighted.

DEFINITIONS AND PROVISIONS

Colorado Division of Wildlife Regulations Chapter 17, based on Colorado's Revised Statutes Title 33-3, covers damage caused by big game. There are 11 articles in this chapter. Articles IX and X pertain to damage to livestock forage. Article IX deals with damage to livestock forage in hay meadows, pasture and artificially seeded rangelands. Damage to livestock forage on grazing land which is deferred for seasonal use is covered in Article X. Article I presents general provisions which includes definitions important to the legislation. For purposes of this paper it is important to define certain terms.

> "Damage" means any change in the quality or quantity of any property which reduced its value. Damage shall include all costs necessary to restore property to its condition immediately prior to damage, to replace it with property of equal value or to compensate for restoration or replacement.
>
> "Historic levels" means the average number of a species of big game that occurred on the property in question during the 20-year period of January 1, 1953 through December 31, 1972.
>
> "Artificially seeded rangelands" means land on which grasses or legumes have been seeded, and have become established to the extent that 50 percent or more of the useable livestock forage production is from the seeded species and whose primary use is grazing by livestock.
>
> "Grazing land" means land used primarily for production of native forage plants for livestock grazing as differentiated from lands where a crop is harvested.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop, Fort Collins, Colo, April 17-20, 1989.

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"Grazing land which is deferred for seasonal use" means grazing land that is designated for a postponement of grazing by livestock for a specific season(s) with the purpose of reserving forage available for grazing by livestock during a later season.

"AUM equivalents" means the equivalent number of months required for each big game species to equal 1 animal unit month (AUM). The equivalents are: 13.6 antelope months, 8.7 bighorn months, 9.9 deer months, 2.5 elk months, 1.4 moose months, and 10.3 mountain goat months.

Several additional provisions are pertinent to this legislation. No claim for big game damage will be approved where the claimant or other person who controls the land where damage occurred has unreasonably restricted hunting for the species causing damage. A damage claim will be denied when a fee in excess of $25.00 per season has been charged any person for big game hunting access onto or through any lands owned, leased or otherwise controlled by the claimant, or the landowner if the claimant is the lessee.

Any person who submits a claim for damage shall provide a certified statement that damage prevention materials provided by the Division, if any, were used in an effort to prevent or reduce the extent of damage and were not used for any other purpose. In addition, any person who submits a claim for damage shall provide a certified statement on his/her proof-of-loss form that the damages for which he/she is submitting a claim are, or are not, covered under an insurance policy and that he/she does not contemplate receiving insurance compensation for damages claimed.

DAMAGE TO LIVESTOCK FORAGE IN HAY MEADOWS, PASTURE, AND ARTIFICIALLY SEEDED RANGELANDS

Proof of Loss

At the time of the investigation or upon submission of the proof-of-loss form, the claimant shall be responsible to prove by a preponderance of evidence:

1. That the damage occurred and it was more than 10 percent in excess of normal historic wildlife use levels.

2. That damage occurred and that the claimant was unable to graze the damaged area at the rate which would normally be expected by the claimant for this area under similar growing conditions in the absence of big game grazing.

3. That damage was caused by big game and not adverse weather, insects, rodents, or some other cause.

4. That the claimant owns the land or leases it from a private owner.

5. That the meadow, pasture or artificially seeded range land was fenced and that the fence was adequate to exclude any livestock present on adjoining lands.

Documentation of Claim

Documentation by the claimant which is necessary to support a claim includes the following:

1. A statement of the actual beginning and ending dates that the area was grazed.

2. A statement of the numbers of livestock animal units grazed by species.

3. A proof-of-loss form prepared jointly by the claimant and a Division of Wildlife investigator after the livestock grazing period has been completed. Such form shall include an estimate of the amount of grazing which was still available, if any, at the time of investigation.

4. A statement of the number and kind of big game using the designated area including data from all of the claimant's counts made by date and time of day and a list of all known witnesses who participated in those counts which shall be made at least once during every five-day period. Numbers of big game shall be expressed in terms of the average number of animals present and shall include an estimate of the percentage of their daily food intake consumed or damage on the designated area.

5. A statement characterizing the nature of the growing season in one of three categories: favorable, normal, or unfavorable. A growing season shall be considered favorable if, on the average, more favorable conditions occur 1 year in 4 or less frequently. A growing season shall be considered unfavorable if, on the average, less favorable conditions occur 1 year in 4 or less frequently. Such statement shall include data on normal and current year dates of last killing frost and amount of rainfall by week from the nearest weather station, or by other records or evidence where such records are kept.

6. An estimate by a professional range conservationist or other similarly qualified person, acceptable to the Division and claimant, of the normal grazing capacity of the damaged area considering the actual growing conditions, range condition and type of livestock grazed. Such estimate shall include a detailed written description of the basis used to determine grazing capacity.

7. If the damaged area is a hay meadow, a certified statement of the date of last hay cutting.

8. A statement designating the historic average number(s) of big game, by species, present on the property in question.

Evaluation and Settlement

Amount of damage shall be the difference between the grazing capacity of the area and the amount of grazing actually realized by the claimant. Grazing capacity is determined by forage measurement procedures which meet U.S. Soil Conservation Service standards. Liability is limited to that proportion of the damage in excess of the historic big game use levels, and the State shall be liable for such damages only if they are more than 10 percent in excess of normal historic wildlife use levels. This proportion is obtained by subtracting the 1953 to 1973 average population from the current population for the species causing damage and dividing this difference by the current population. The following formula is used for these calculations:

$$\text{GC} - \text{GAR} \quad \text{or} \quad \text{WNC} \times \text{WUM's} \quad \text{X} \quad \frac{\text{WC} - \text{WH}}{\text{WC}}$$

(whichever is less)

where:

GC = grazing capacity of the area in livestock AUM's available

GAR = grazing actually realized in livestock AUM's

WC = current wildlife population

WH = historic wildlife population

WNC = average number of wildlife actually counted

WUM's = wildlife unit months

$$\left(\frac{1}{\text{livestock AUM equivalent}} \right).$$

Value of grazing shall be the current market value at the time and place of the forage loss. Values computed for loss of dry standing forage shall be reduced by the amount which would have been required for purchase of necessary protein, and/or energy supplements if the forage had been used for grazing.

DAMAGE TO LIVESTOCK FORAGE ON GRAZING LAND THAT IS DEFERRED FOR SEASONAL USE

Notice of Intent to Defer Grazing

Any person designating all or part of his/her grazing land as "deferred for seasonal use" shall provide written notice to the Division no later than 30 days prior to the beginning date of intended deferral period. This notice must include a map and legal description of the grazing land which is to be deferred. A statement from a professional range conservationist stating the range site(s) included within the area to be designated and the range condition class(es) of the area is required. In addition, a signed statement by the owner or grazing lessee of the deferred lands is required which certifies that the area to be deferred is surrounded by a fence adequate to exclude livestock from adjacent lands. This statement must also provide the beginning and ending dates of the intended deferral period and the numbers of livestock animal units by species which are intended to be grazed.

Proof of Loss

At the time of the investigation or upon submission of the proof-of-loss form, the claimant, shall be responsible to prove by a preponderance of evidence:

1. That he/she met the requirements concerning notice of intent to defer grazing on the lands where the damage is alleged to have occurred.

2. That damage occurred and it was more than 10 percent in excess of normal historic use levels.

3. That livestock was unable to graze the area at the rate under similar growing conditions in the absence of big game grazing, and that the damage was caused by big game and not adverse weather, insects, rodents or some other cause.

4. That he/she owns the land or leases it from a private owner.

5. That the land was adequately fenced to exclude any livestock present on adjoining lands.

Documentation of Claim

Documentation by the claimant which is necessary to support a claim for damage to deferred grazing land shall include the following:

1. A statement of the actual beginning and ending dates that the area was grazed.

2. A statement of the numbers of livestock animal units grazed by species.

3. A proof-of-loss form prepared jointly by the claimant and the Area Wildlife Manager or his/her designee after the grazing had been completed. Such form shall include an estimate of the amount of grazing which was still available, if any, at the time of investigation.

4. A statement of the number and kind of big game using the designated area including data

from all counts made by date and time of day and a list of all known witnesses who participated in these counts.

5. A statement describing the quality of the growing season as favorable, normal or unfavorable.

6. A statement designating the historic average number(s) of big game, by species, present on the property in question.

Evaluation And Settlement

Amount of damage shall be the difference between grazing capacity of the area and amount of grazing actually realized by the claimant. All definitions, procedures, and calculations presented on meadow and artificially seeded rangelands apply except for the following modification. If the deferred grazing land contains a substantial amount of herbage other than grasses and legumes, the AUM equivalents must be adjusted for the amount of herbage that was consumed by big game that was not livestock forage. This adjustment is made by dividing the appropriate AUM equivalent by the proportion of dietary overlap for the species of wildlife and livestock involved. This proportion (Table 1), shall be used unless some other figure can be shown to reflect more accurately the situation in question. The adjusted AUM value represents the average total amount of forage that could have been eaten by big game.

Table 1.--Dietary overlap values used to adjust AUM equivalents for the amount of herbage consumed by wildlife which is not livestock forage.

Big game species	Cow	Sheep
Elk	0.91	0.96
Deer	0.50	0.80
Antelope	0.80	0.80

PAYMENT HISTORY

During the 10 years that Colorado has been liable for damage to livestock forage by big game there have been 73 claims paid totaling $50,290 (Table 2). The greatest number of payments (21) occurred in 1983-84 which was one of the most severe winters on record. Over the 10 years there have been an average of about 7 claims per year with each claim averaging nearly $689. Over 90 percent of the 73 claims have been in the category of meadows and artificially seeded rangelands.

There have been additional claims filed which for various reasons were not approved. Throughout the evaluation process, an arbitrator may be used if the Division and the claimant cannot agree to the values in question. This is especially true for the determination of the historic levels of a big game species. After the investigation is completed and the Division fails to approve a claim, the claimant has the right to appear before the Wildlife Commission and argue his/her case. The Wildlife Commission then approves or disapproves the disputed claim based on the evidence presented. If approved by the Commission, the claim is paid.

Table 2.--Number of claims and money paid for damage done to livestock forage for years 1978-79 to 1987-88.

Year	Claims	Total Payments ($)
1978-79	1	1,270
1979-80	1	256
1980-81	2	1,184
1981-82	6	1,183
1982-83	5	3,378
1983-84	21	13,423
1984-85	14	8,998
1985-86	9	11,894
1986-87	6	2,354
1987-88	8	6,350
Total	73	50,290

DISCUSSION

Obviously the process of documenting, evaluating, and paying a claim is complex. This has proven to be a major frustration for both the Division and the claimant. In many cases it costs more to document and investigate a claim than the claim is worth. The considerable paper work required is a major hurdle for the private landowner and results in many potential claimants not following through. Even though it could be argued that this is good from the viewpoint of the Division, it is actually a liability because working relations between the Division and the landowner suffer when this happens.

There need to be improvements in the process. One possible solution might be forage leasing arrangements worked out between the landowner and the Division before damage occurred. The money could come from a fund that is limited in amount (i.e. some percentage of big game license fees), ear-marked, and set aside for this purpose. Landowners would sign up in advance on a first-come first-served basis and reach agreement with the Division on the forage value per AUM equivalent. The unknown in this arrangement would be number of big game animals (animal unit month equivalents) on the property in question. This would be determined during winter and spring months when damage was occurring. This agreement could be strengthened by including penalties or forfeiture of payment if hunting was unreasonably restricted by the landowner during regular hunting seasons.

Some people suggest that the State should not be liable for forage. However, if it is agreed that forage is a value either as livestock food or as big game food, and if that forage is removed from private land by public animals, then it can be argued that this is a loss to the private landowner and should be compensated. The question becomes one of what is the damage? Is it weight loss by the livestock grazing the forage which has been reduced by the big game animals? Is it a loss in reproductive capability of the livestock foraging due to reduction in forage? Is it a delayed birthing period as a result of the lowered nutritional level of the livestock? Is it reduced range condition as a result of too many herbivores grazing that range? Or is it some combination of all of the above?

These questions need answers. Unfortunately, finding answers will not be easy. The Colorado Division of Wildlife is currently conducting research in Northwestern Colorado on effects of different densities of elk during winter and early spring, on spring livestock forage. Measurements are being made on cow and calf weight performances, livestock birth dates, and range condition. Additional controlled research efforts like this are needed. It would be much easier to determine liability and design equitable compensation if the true damage were known.

Habitat Manipulations to Prevent Elk Damage to Private Rangelands[1]

William M. Long[2]

Abstract.--Habitat manipulations were initiated on the Wick Brothers big Game Winter range in southern Wyoming to alter traditional movement patterns of Rocky Mountain Elk (Cervus elaphus nelsonii). Manipulations included spraying with 2-4-D and follow-up fertilization of the same plot in successive years with ammonium nitrate at the rate of 40 lbs. (18 kg.) free nitrogen per acre. Burning hay meadows and upland sagebrush sites and salting were used in combination with the other treatments. Elk distribution shifted to the treated plots in response to the increased quality and quantity of the grass production on these areas. Spring distribution of elk shifted to Department lands and away from private lands. This shift in spring elk distribution should augment efforts to enhance calving habitat and develop a migration corridor south of the unit through silvicultural treatments on adjacent National Forest land.

INTRODUCTION

The impact of elk (Cervus elaphus nelsonii) grazing on native rangelands has received increased interest in recent years from members of the Wyoming Agricultural Industry. Historic elk use was tolerated until the depressed economy of the agri-industry brought increased need of efficiency in the livestock operation. By the late 1970's and early 1980's, several landowners and ranch managers questioned the use of private rangelands by elk, in what they felt was direct competition with their domestic cattle operation. As a result, an increased number of damage claims was received by the Department pertaining to wildlife use of private lands. Those claims are legally covered under Title 23 Article 9 of Wyoming Game and Fish Law.

The State of Wyoming Game and Fish Department pays damage as mandated by state statute 23-1-901 which states; "The Department shall consider the claim upon a description of the livestock damaged, the damaged land, growing cultivated crops, stored crops, improvements and extraordinary damage to grass." In several cases ranchers claimed damage to native private rangelands as a result of early season grazing by elk, under "Extraordinary Damage to grass." By definition in the regulation, extraordinary use means, "the consumption or use of noncultivated grass plants in excess of the consumption or use which normally occurred during the two (2) years immediately preceding the time covered by the claim." (Wyoming Game and Fish Law, Revised, 1988).

In response to these damage claims, department personnel work load was shifted to accommodate the need to document elk distribution and numbers on private land. Pre-claim data is a necessary prerequisite for determining baseline or normal use and "Extraordinary use" or use in excess of the baseline use. Documentation became labor intensive and other alternatives were researched to simplify the process. Historical use by elk of private lands was documented and use calculated in the form of Elk Unit Months (EUMS). Conversion to the universal Animal Unit Months (AUMS) was made and the claimant reimbursed for that use.

Efforts to alter this historic use pattern were initiated to reduce the number of elk using private land and reduce the cost of managing the elk that winter on the Wick Unit.

Our research focused on one elk herd that traditionally utilized private native rangelands in the spring where claims of alleged damage had occurred. The problem centered around the spring migration of elk off of winter range owned by the Department and private native

[1]Presented April 19, 1989 at the Ninth Great Plains Damage Control Workshop, Ft. Collins, Colorado.

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rangelands adjacent to the unit. A list of options was formulated to reduce or eliminate conflicts.

A thorough review of the literature on migration provided insight into the behavior of these elk. The literature suggested that elk migrations are traditional (Murie, 1951; Brazda, 1953; Craighead, et al., 1972; Knight, 1970) and are learned behavior (Anderson, 1958; Murie, 1951). Recent research addressed elk spring migration patterns in the terms of habitat; habitat requirements and habitat accessibility during movements from the winter range to spring range (Adams, 1982; Compton, 1975; Skovlin, 1982). Researchers also indicated ungulate use could be altered through salting, fertilizing and spraying. Dalke (1965) reported salting has a limited effect on spring elk distribution, yet research also suggested that movements of elk were related to use of natural salt licks (Knight, 1970). Christensen (1969) reported that elk distribution could be changed by spraying sagebrush (Artemesia sp.) and Skovlin et al. (1983) suggested that elk distribution could be altered with vegetative manipulations including fertilizing.

STUDY AREA AND METHODS

A study was initiated in 1981 to address four objectives; 1) document travel routes of radio collared elk off the Wick Unit onto summer range; 2) determine the response of elk to vegetative manipulations on the Unit and on adjacent National Forest lands; 3) identify important elk use areas on Unit and adjacent National Forest lands as spring transitional range which could be enhanced; 4) inventory the vegetative and physical characteristics of habitats used by elk in the spring.

The Wick Brothers Big Game Winter Range study area is about halfway between Laramie and Rawlins, in south central Wyoming. The unit is located 6 miles (9.65 km) southeast of the town of Elk Mountain, Wyoming, on the northern edge of the Snowy Range. Elevation of the study area ranges from 7,263 feet (2,214 m) to 8,907 feet (2,715 m). The topography is dominated by high rolling hills and benches. Major watersheds include Mule Creek, Wagonhound Creek and Foote Creek, tributaries of the Medicine Bow River. Precipitation averages 15.6 inches (39.73 cm) and moisture occurs generally as snow and early spring rains. During the winter, wind keeps the upland sites snow free and available to elk. Snow deposition is generally in the draws and stream bottoms as a result of snow drifting. The area is mapped to range sites using the Soil Conservation Service Technical Guide (1978) and has been summarized by Pinchak (1983). Range sites include wetland, subirrigated, grazeable woodlands, loamy sites, very shallow, shallow loamy and coarse uplands. The sites on private lands classed as very shallow, shallow loamy, and coarse uplands appear to be the most vulnerable to spring grazing in the areas where cattle and elk use overlap.

Field work was initiated in 1982 in the pretreatment phase of the project. Adult elk fitted with radio collars have been monitored since 1982. Radio collars have been placed on 19 cows and 1 bull during the course of this project. Elk were collared primarily to determine migration routes, the response of these elk to any shift in migration routes, and the use of the vegetation treatment areas on the Unit and on National Forest land.

In an attempt to hold elk on the Unit longer in the spring, series of manipulations were planned. The use of salting was first initiated in 1982, burning and spraying in 1983-1985, and fertilization with ammonium nitrate was applied in the fall of 1985. The use of fertilizer was repeated again in 1986 on plots treated previously by spraying 2-4-D on sagebrush. Spraying was generally directed at Big Sagebrush (Artemisia tridenta), 3-tipped Sagebrush (Artemesia tripartita) and Black Sagebrush (Artemesia nova). Mat forming forbs, as well as the sagebrush, were removed, releasing the grass communities.

RESULTS AND FINDINGS

Transects were established following treatments in 1983. A standard utilization cage and end of the year production transect utilizing a circular hoop of 9.6 sq. ft. (.8918 sq. m.) was read in 1984 (Stroud and Pers. Comm.). The 1984 results of the 2-4-D spray program showed a dramatic increase in grass and forb production (Table 1) when followed up with fertilization of ammonium nitrate. The elk responded to the increased forage quality and quantity and regularly were observed on vegetative treatments.

It appears that both fertilizing and spraying are useful in attracting elk. However, the benefits from fertilization appears to be more short lived. Fertilization acted as an attractant for two successive years. Spraying and the resulting change in the plant community, appears to prolong elk use over time.

Table 1. Results from the plot sprayed with 2-4-D and fertilized with ammonium nitrate. (Stroud, 1985).

Production	Treated 1983	Control 1983
Grasses	676.7	235.0
*Forbs	246.1	285.1
Shrubs	94.3	260.8

*Forb production appears to decline on treated area. However, reduction in mat formers increased production of other forbs.

In addition to the vegetative treatments a program of salting was initiated in 1982 to attract and hold elk. This program showed limited success. However, it appears that elk did use salt heavily through all phases of the project. Shifts in elk distribution were documented to areas near established salt stations.

The use of salt and the use of the treated areas by elk appeared to be greatest in late March and April which coincides with the period of damage on adjacent private lands. In the areas treated by fertilization and herbicide, elk use increased 3 fold over pre-treatment levels, 50.8 EUMS compared to 130.0 EUMS. Shifts in elk home ranges between years was also documented, favoring the treated areas.

Concurrent with habitat improvements on the Wick Unit, the Forest Service and Wyoming Game and Fish personnel designed a timber sale on adjacent National Forest land to improve spring elk habitat. Clear cuts were designed to create a mosaic of openings, aspen patches, and conifer stands to provide better habitat for elk calving and spring forage. A number of the clearcuts were designed to blow free of snow to provide winter forage and access to the upper Wagonhound drainage in early spring. This silvicultural treatment was proposed to augment efforts on the winter range to hold elk on public land in spring and attract elk away from traditional calving areas and spring migration routes determined from monitoring telemetered elk. The timber sale was complete in 1987. The slash should be treated and the clearcuts should be seeded with grasses in 1989. The response of the elk will be determined by monitoring radio collared cow elk over the next two years.

DISCUSSION AND SUMMARY

Both telemetered elk and noncollared elk responded to increases in vegetative production on areas treated by fertilization and herbicide. Shifts in spring use patterns of marked elk towards the treated areas and reduced use of private rangelands were noted. The treatment and post treatment data clearly supports other research which indicates the usefulness of vegetative manipulations to alter ungulate distribution (Christensen, 1969; Dalke, 1965; Skovlin et al., 1983). In the case of the Wick Unit, the manipulations established a use pattern that could enhance efforts to establish a migration corridor on public land.

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Characteristics of Deer Damage to Experimental Orchards in Ohio[1]

Kerry M. Mower,[2] Thomas W. Townsend,[3] and William J. Tyznik[4]

SUMMARY

We measured several variables of newly established apple trees (1) to compare growth differences between trees damaged by browsing deer (Odocoileus hemionus) and trees protected from deer, (2) to determine if seasonal browsing patterns existed, and (3) to determine if deer browsed selectively among Ohio's 3 most commonly planted apple cultivars. All testing was done at the 0.05 alpha level. Experimental trees were measured repeatedly from June 1986 through May 1988.

Trees were planted in experimental orchards planted at research farms representative of areas where apples are grown commercially. Each experimental orchard contained 20 trees each of 3 cultivars, red delicious, golden delicious, and red rome. Trees were planted randomly by cultivar pairs and one tree of each pair was enclosed in a welded wire cylinder 1.5 m high to exclude deer. Eight orchards were planted the first year; 5 additional orchards were planted the second year. At the beginning of the second year half of the tree pairs in the 8 original orchards were randomly selected and the exclosures switched from the control to the treatment tree. Trees were measured monthly the first year, and bimonthly the second year because the trees were much larger. Variables measured included branch length, number of leaves/branch, number of leaves/cm of branch length, and browsing frequency. Radial growth was determined by measuring trunk diameter at time of planting and each autumn thereafter.

Length of branches in all orchards but 3 were significantly reduced by browsing deer and browsed trees in all but 2 orchards had significantly reduced numbers of leaves. Browsed branches were observed in all but 1 orchard. The reduction in branch length ranged from 0% in the single undamaged orchard to 98% in one of the most serely browsed orchards; reduction in number of leaves/branch had a similar range from 0% to 85%.

Significant seasonal effects were found in branch length, number of leaves/branch, and browsing frequency between browsed and control trees. Two seasonal patterns existed among significantly browsed orchards. Browsing was concentrated either in early summer or autumn. Orchards with greatest branch and leaf reductions sustained significantly more browsing in early summer than any other season. Browsing in these orchards began as soon as trees began to grow and decreased only when trees failed to initiate new growth, became dormant, or died. Orchards with lower levels of browsing were damaged in late autumn and winter. Deer began to browse these orchards at the time leaves dropped from trees in adjacent wooded areas. Leaves persisted on apple trees longer than in surrounding forest trees. Sporadic browsing continued into winter in such orchards.

No evidence was found that deer selectively feed on any of the 3 cultivars tested. Browsing was severe enough to cause higher mortality among treated trees in 6 orchards ($p < 0.01$). Four orchards were moderately browsed; mortality rates between browsed and unbrowsed trees were not different but radial growth was reduced significantly among browsed trees. Three orchards were browsed lightly, neither mortality rate nor radial growth was significantly different between browsed and unbrowsed trees.

After 2 growing seasons, most foliage was beyond the reach of deer. Browsing damage is most critical to small and immature trees. Growth rate and tree vigor are affected by edaphic conditions, rootstock, and cultivar. Under conditions of rapid growth, apple trees can outgrow the detrimental effects of deer browsing and protection might only be needed the first 2-3 years.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. Forth Collins, Colorado, April 17-20, 1989.

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Deer Damage to an Austrian Pine Tree Nursery in Wheatland, Wyoming[1]

Dennie A. Hammer[2]

Abstract.--During the winter of 1987-1988 southeastern Wyoming experienced severe weather conditions. The agricultural land south and west of Wheatland, Wyoming became critical to the survival of both mule and white-tailed deer. A 120 acre commercial tree nursery was located in these farmlands at the foothills of the Laramie Mountain range. Approximately 150 deer moved into the nursery seeking both hiding and thermal cover. Shifting snow created large snow drifts throughout the area which inhibited the foraging patterns of the deer. The deer yarded up within the confines of the nursery and were forced to consume pine needles in an attempt to meet their daily energy requirements. This foraging by deer caused various degrees of damage to 4,564 Austrian pine trees. Evaluation techniques used to determine the extent of the damage in monetary terms were those developed by a tree and landscape appraising firm. The completion of the evaluation resulted in the largest single damage claim ever paid by the Wyoming Game and Fish Department for wildlife depredation.

INTRODUCTION

During late December (1987) and throughout January (1988), southeastern Wyoming experienced severe winter weather. Mule deer were driven down from their winter ranges in the foothills of the Laramie Mountain range by heavy snows, cold temperatures and strong winds, and were forced into the agricultural land south and west of Wheatland, Platte County, Wyoming. The extraordinarily high density of deer in this area created many depredation problems, most of which occurred to easily accessible and unprotected piles of field corn and stacked alfalfa hay. Centrally located within this agricultural area is a commercial tree nursery, operated by Wyoming Evergreens of Wheatland, WY. The nursery, at this time, was nine years old, 120 acres in size, and producing approximately 120,000 trees. Deciduous and coniferous trees were being grown, however, the majority of production was in coniferous trees such as Austrian pine (Pinus nigra), Ponderosa pine (Pinus ponderosa), Blue spruce (Picea pungens), Bristlecone pine (Pinus aristata), and Rocky Mountain juniper (Juniperus scopulorum). During the severe weather, the nursery provided excellent hiding and thermal cover for a large number of displaced deer. Although a livestock fence encompassed the nursery, it was not a barrier to deer movements.

DAMAGE INVESTIGATION

In early February, 1988, the Wyoming Game and Fish Department (WGFD) was informed by Wyoming Evergreens nursery manager that wintering deer had caused extreme damage to a large number of trees within the nursery. As winter progressed, shifting snow had created large drifts throughout the agricultural area. The deep snow inhibited foraging patterns and approximately 150 mule and white-tailed deer yarded up within the confines of the nursery. As the deer became stressed by the winter conditions, they browsed heavily on the nursery stock in an attempt to meet their daily energy requirements. Subsequent field investigation of the damage revealed that the majority of damage had occurred to the Austrian pine trees. Although several species of trees had sustained various degrees of damage, the Austrians were apparently the most palatable.

The Austrian pine is a native of central and southern Europe and Asia Minor. It is very adaptable to nearly any growing condition,

[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. [Ft. Collins Marriott, Ft. Collins, Colorado, April 17-20, 1989].

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adaptable to nearly any growing condition, provided there is full sunlight. It's growth form is densely pyramidal, stiffly branched, and wide spreading. The fascicles of two needles are dark shiny green on yellow-brown twigs. Needles are recurved and range between 3 and 6 inches and are both unbendingly stiff and very sharply pointed. Winter buds have a pineapple-like silhouette and are very hairy. The rough bark is dark brown-gray and noticeably grooved (Hudak, 1980).

The most apparent damage to the trees was needle removal through browsing (fig. 1). Closer examination of the damaged trees revealed that many of the lateral branch buds had been selectively removed (fig. 2), and depending upon the height of the tree, terminal branch buds had also been browsed off. The actual amount of deneedling varied from slight to over 50% of an individual trees' needles. On many of the severely damaged trees needles had been eaten to within one-half inch of the branch. The majority of deer had moved out of the nursery due to improving weather when investigated by Department personnel, but 40-60 deer were still utilizing the nursery.

Figure 1. An Austrian Pine tree which sustained heavy deneedling to it's lower branches due to deer browsing.

To prevent further damage to the nursery, short-term scare tactics were employed. Zon guns were set up around the perimeter of the nursery and operated on a 24-hour basis. In addition, nursery personnel patrolled the area

Figure 2. An Austrian Pine tree showing lateral branch bud removal due to deer browsing.

during the night periodically shooting explosive cracker shells and whistle bombs provided by the WGFD.

DAMAGE EVALUATION

Wyoming Evergreens estimated there were 20,000 Austrian pines in the nursery. Of these, 12,000 were considered to be six to twelve feet tall and of harvestable size. The remainder of the Austrians were five feet tall or less in height. Although as previously stated, several species of trees sustained damage, Wyoming Evergreens was interested in recovering damages only to an estimated 4,564 Austrian pines.

Under current Wyoming statue (W.S. 23-1-901) the WGFD is responsible and may be held liable for damage caused by big or trophy game animals or game birds. In 1981, John Demaree and Tim Fagan, Damage Control Wardens (WGFD), organized a handbook of methods used to evaluate various types of wildlife damages. The handbook is used as a reference source for the majority of the damage claims submitted to the WGFD. However, there were no techniques described in the handbook for evaluating damage to nursery trees. Generally, damage to ornamental trees was just a matter of determining replacement costs.

In an attempt to locate previously used evaluation techniques, literature searches were conducted through the U.S. Fish and Wildlife Center in Maryland, and the Science Library at the University of Wyoming in Laramie, WY. Neither search resulted in locating workable evaluation techniques for our situation. Several western and mid-western State agencies

and Universities were contacted with virtually no success in identifying previously tested procedures.

On several occasions, WGFD personnel attempted to formulate workable evaluation techniques. At the same time, the nursery also continued to refine their estimates of the actual damage and unfortunately, agreement over the actual cost figures between Wyoming Evergreens and the WGFD could not be reached. Subsequently, Wyoming Evergreens suggested contacting a tree buyer from Denver, Colorado who had done business with the nursery in the past and who was, therefore, familiar with their operation. After visiting the nursery, the tree buyer felt that he was not qualified to assess the actual damages in monetary terms. The buyer recommended contacting Eyerly and Associates, Denver, Colorado, a consultant firm which provides landscape and tree appraising services. Shortly thereafter, the consultant firm was contacted by the WGFD, and the damage situation explained to them. It was learned through this contact that the firm had extensive nursery business background and served as a principal witness for the U.S. Justice Department in a court case in Arizona. After having reviewed the available information, the firm felt that the damage claim could possibly be assessed utilizing National Standards currently in use for appraising damages due to hail storms. The firm also agreed to evaluate the damages in monetary terms and to support their findings in a court of law if the need arose.

ASSESSING THE ACTUAL DAMAGE

The evaluation procedure began by determining the average size of the damaged trees and placing them into four categories. Category 1 trees ranged from 7 to 9 feet (averaged 8 feet), Category 2 trees ranged from 6 to 7 feet (averaged 6.5 feet), Category 3 trees ranged from 3 to 6 feet (averaged 4.5 feet), and Category 4 trees ranged from 2 to 4 feet (averaged 3 feet).

The next step was to identify the quantity of trees that sustained deer damage. Information on size and quantity was obtained from information submitted to the WGFD by Wyoming Evergreens. The consultants reviewed the information and after an on-site inspection of the nursery, concurred that the numbers provided were reasonable. Then utilizing Wyoming Evergreens' catalog of available nursery stock and 1988 price lists, and examining the current fair market value of Austrian pine sizes not listed by Wyoming Evergreens, a basic value/tree was assigned to each category. By multiplying the basic value/tree by the number of trees in that category, a total cost was determined for each category. Since the prices quoted in the catalog included the costs of digging, market preparation, and freight charges (within 200 miles), it was necessary to deduct this cost from the total cost. Digging costs were considered to be less for trees under six feet in height, therefore, two separate digging cost figures were used. The number of trees/category multiplied by the digging cost/tree gives the digging cost/category. Then by subtracting the total digging cost/category from the total cost/category, you obtain the initial value/category of the damaged trees.

There were two basic assumptions made that should be identified here. The first is that each of the damaged trees is considered a total loss to the nursery, therefore, damages will be assessed only one time. Wyoming Evergreens had proposed that because the damage was variable, some of the trees would take longer (years) to recover than others. Based on this, a restoration plan over a four year period was suggested. The plan would have required annual inspections with a payment applied each year based upon growth and recovery rates. However, the consultants felt that this type of plan would project too many variables, such as environmental conditions, degree of care, current market value, disease and other unknowns. The second assumption is that the initial value of the trees is the value of a tree that was in perfect growing condition prior to the deer damage. This condition is based upon a tree's annual growth rate, percent decadence, structural weakness, the presence of insects and/or disease, mechanical injury, survival conditions, and life expectancy. The condition of a tree is evaluated as a percentage along a scale from 0 to 100%. It was determined by the firm that the condition of the trees prior to the deer damage ranged from 30 to 60% and that a fudge factor of 5% should be added to provide a reasonable average of 65%.

Multiplying the initial value/category by the condition factor gives the total value of the trees in each category. Since the trees are considered a total loss to the nursery, there are removal and cleanup costs that need to be considered. As with the digging costs, the cost to remove and cleanup a damaged tree varies with the size of the tree. Once this cost/size of tree was determined, the removal and cleanup cost/tree was multiplied by the number of trees/category to determine the additional cost of the trees/category. The sum of the total value/category and the removal and cleanup cost/category equals the assessed damages due to deer depredation/category. Finally, the sum of the four category assessments equals the recommended damage claim payment (figure 3).

Figure 3. The calculations used in determining the recommended damage claim payment were:

C_i = a category of trees by average height
N_i = number of trees/category
BV = basic cash value of a tree given it's height
TC_i = total cost/category
dc = digging cost/tree given it's size
DC_i = digging cost/category
IV_i = initial value/category
CF = condition factor
TV_i = total value/category
rc = removal and cleanup cost/tree
RC_i = removal and cleanup cost/category
AD_i = assessed damages/category
RDCP = recommended damage claim payment

so, the calculations for each category are:

$$TC_i = BV_i \times N_i$$
$$DC_i = dc \times N_i$$
$$IV_i = TC_i - DC_i$$
$$TV_i = IV_i \times CF$$
$$RC_i = rc \times N_i$$
$$AD_i = TV_i + RC_i$$

then, the recommended damage claim payment is:

$$RDCP = AD_1 + AD_2 + \ldots$$

SUMMARY

The damages awarded to Wyoming Evergreens is to this date the largest amount of money ever paid by the WGFD for an individual deer depredation claim. We feel that the procedures followed by Eyerly and Associates to assess the damages were fair and reasonable. As part of the damage claim agreement, Wyoming Evergreens was informed that all of the 4,654 damaged trees had to be removed, and documentation of that action had to be provided before future damage claims would be considered. It was also suggested that a deer-proof fence be installed by Wyoming Evergreens to prevent deer movement into the nursery. The nursery has since erected an eight-foot deer-proof fence.

Prevention of damage situations is always the preferred course of action; however, this may not always be possible. It is important that States such as Wyoming which are financially liable for wildlife damage make available through publications and workshops those techniques and procedures for damage evaluation that are workable, tested, and acceptable. In addition, state wildlife agencies should promote and fund scientific research to develop improved evaluation techniques which are specific to unique wildlife damage situations.

LITERATURE CITED

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Experimental Applications of High-Tensile Wire and Other Fencing to Control Big Game Damage in Northwest Colorado[1]

A. Eugene Byrne[2]

Abstract.--Conventional fencing methods - V-mesh wire, square mesh wire and wood panels are compared to experimental methods - 15 wire high-tensile wire fences; electric high-tensile wire fences of three designs; baited electric fences; hog panel fences; plastic mesh fences and visqueen wrapped haystacks. Total cost of materials, cost per ft./yr. and comments concerning estimates of efficacy are discussed. The V-mesh wire, hog panel and plastic mesh fences all have a very high cost per ft. and cost per ft./yr. rating and should probably not be used. High-tensile and square mesh wire fences are effective and cheaper alternatives. Modern high-tensile wire electric fences can be an effective alternatives in some situations. Results from tests using visqueen wrapped haystacks and baited electric fences are encouraging and more experimentation is needed. Wood panels should only be used as an emergency game damage prevention method.

INTRODUCTION

The Colorado Division of Wildlife (CDOW) has statutory responsibility for big game damage to growing crops, orchards, nurseries, fences, harvested crops and livestock forage. Most years the CDOW spends over $1,000,000 per year for game damage prevention materials and claims. From 1979 - 1988, CDOW personnel in Northwest Colorado experimented with various prevention methods to prevent mule deer (Odocoileus heminous) and elk (Cervus elaphus) damage to haystacks; nurseries and orchards; livestock feedlots and ensilage pits. These experiments were conducted as management experiments opposed to scientific controlled experiments. The evaluation of each of the treatments involved the perception of efficacy by the cooperating landowners and the author. The cost per foot of the fencing is discussed for each type of treatment as well as the life expectancy for the fence and the cost per ft./yr.(the cost of the materials divided by the life expectancy). All costs are based on the estimated cost to build 40 rods of the fence (660 ft.). These costs include all materials, including the staples and tie wires etc., but do not include cost of labor. The cost of materials are based on the retail price in Colorado for the spring of 1989. The experimental methods are compared to the conventional method of damage prevention fencing using V-mesh, square-mesh and wood panels. The material list and costs for each method are summarized in table 1.

METHODS & RESULTS

Conventional Methods

The following fencing methods are the primary methods that are currently being used to control most of the deer and elk damage in Northwest Colorado.

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[1] Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. [Marriott Hotel, Fort Collins, Colorado, April 17 -20, 1989].

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Table 1.-- List of items; cost per package unit; number of each item needed; total cost; cost per ft. and cost ft./yr. to build 40 rods (660 ft.) of each type of fence. All costs are retail except for wood panels.

ITEM	PKG. UNIT	PKG. COST	SINGLE UNIT	SINGLE UNIT COST	V-MESH FENCE QTY	V-MESH FENCE TOTAL COST	SQUARE MESH FENCE QTY	SQUARE MESH FENCE TOTAL COST	15 WIRE HI TENSIL QTY	15 WIRE HI TENSIL TOTAL COST	8 WIRE ELEC HI TENSIL QTY	8 WIRE ELEC HI TENSIL TOTAL COST	MOD. ELEC FENCE W/O EXIST. QTY	MOD. ELEC FENCE W/O EXIST. TOTAL COST
Charger, fence, 110 volt (1-25 km.)	ea.	$165.00	ea.	$165.000							1	$165.00	1	$165.00
Clamp, fiberglass T post	50/box	$2.25	ea.	$0.045							72	$3.24	25	$1.13
Clips, dropper	1,000/box	$25.00	ea.	$0.025					2610	$65.25				
Clips, hog ring	100/box	$2.50	ea.	$0.025			165	$4.13						
Droppers, fence stays	ea.	$2.50	ea.	$2.50					174	$435.00				
Fencing, Tensar, plastic mesh, 7 in X 164 ft.	roll	$285.00	1 ft.	$1.738										
Flashing, galvanized steel, 14 in. x 50 ft.	roll	$39.73	5x6 in	$0.142										
Insulating tube	100 ft/roll	$12.00	1 ft.	$0.120							20	$2.40	12	$1.44
Panel, wood, 8 ft. x 8 ft.	ea.	$14.00	ea.	$14.000										
Panels, metal (hog), 6 ft. x 12 ft.	ea.	$25.00	ea.	$25.000										
Post, 10 ft. steel	ea.	$4.59	ea.	$4.590			40	$183.60						
Post, 12 ft., wood, 5 in. top	ea.	$10.87	ea.	$10.870	61	$663.07	21	$228.27	35	$380.45	13	$141.31	10	$108.70
Post, 6 ft. steel	ea.	$2.53	ea.	$2.530									33	$83.49
Post, fiberglass, 10 ft.	ea.	$6.50	ea.	$6.500							9	$58.50	5	$32.50
Post, wood, 7 ft. x 5 in. top	ea.	$2.75	ea.	$2.750										
Rod, grounding, 8 ft. with clamp	ea.	$6.95	ea.	$6.950							1	$6.95	1	$6.95
Rods, steel, 1/2 in. x 7 ft.	ea.	$3.00	ea.	$3.00										
Sleeves, high tensil wire crimping, FW 2-3	100/box	$13.50	ea.	$0.135					94	$12.69	50	$6.75	32	$4.32
Spike, 3/8 in. X 12 in., 50 lbs./box	133/box	$32.20	ea.	$0.244	6	$1.46	6	$1.46	6	$1.46	6	$1.46	6	$1.46
Spring, Tension indicator	ea.	$4.50	ea.	$4.500					1	$4.50	1	$4.50	1	$4.50
Staple, 2 in., insulated	200/box	$38.00	ea.	$0.190							35	$6.65	12	$2.28
Staples, 2 in., galvanized, 50 lbs./box	2,450/box	$23.90	ea.	$0.010	488	$4.88	168	$1.68	465	$4.65	27	$0.27	24	$0.24
Strainer, high tensil wire	ea.	$2.75	ea.	$2.750					15	$41.25	8	$22.00	5	$13.75
Twitch Stick, 1 in. X 1 in. X 48 in., Oak	ea.	$1.50	ea.	$1.500	4	$6.00	4	$6.00	4	$6.00	4	$6.00	4	$6.00
Visqueen, black, 10 ft. x 100 ft., 6 mil	ft.	$47.08	ft.	$0.471										
Wire, 32 in. square mesh X 330 ft.	roll	$66.60	1 ft.	$0.202			660	$133.32						
Wire, 47 in. square mesh X 330 ft.	roll	$85.88	1 ft.	$0.260			660	$171.60					660	$171.60
Wire, barbed, 12 1/2 ga., 1320 ft.	roll	$35.30	1 ft.	$0.027	1980	$53.46	1320	$35.64						
Wire, hi-tensil, 4,000 ft./roll	roll	$72.75	1 ft.	$0.018					9900	$180.18	5280	$96.10	3300	$60.06
Wire, smooth, 12 1/2 ga., 1320 ft./roll	roll	$32.80	1 ft.	$0.025	504	$12.60	504	$12.60	504	$12.60	504	$12.60	504	$12.60
Wire, V-mesh, 72 in. x 165 ft.	roll	$322.00	1 ft.	$1.952	660	$1,288.32								
		COST OF FENCE (660 ft.)				$2,029.79		$770.30		$1,144.03		$533.73		$676.02
		COST PER FOOT				$3.08		$1.18		$1.73		$0.81		$1.02
		LIFE EXPECTANCY (YEARS)				30		30		40		40		35
		COST PER FT/YR				$0.10		$0.04		$0.04		$0.02		$0.03

ITEM	PKG. UNIT	MOD. ELEC FENCE W/ EXIST. QTY	MOD. ELEC FENCE W/ EXIST. TOTAL COST	BAITED ELEC FENCE QTY	BAITED ELEC FENCE TOTAL COST	TENSAR PLASTIC FENCE QTY	TENSAR PLASTIC FENCE TOTAL COST	HOG PANEL FENCE QTY	HOG PANEL FENCE TOTAL COST	VISQUEEN FENCE QTY	VISQUEEN FENCE TOTAL COST	WOOD PANEL FENCE QTY	WOOD PANEL FENCE TOTAL COST
Charger, fence, 110 volt (1-25 km.)	ea.	1	$165.00	1	$165.00								
Clamp, fiberglass T post	50/box	25	$1.13	8	$0.36								
Clips, dropper	1,000/box												
Clips, hog ring	100/box												
Droppers, fence stays	ea.												
Fencing, Tensar, plastic mesh, 7 in X 164 ft.	roll					660	$1,147.08						
Flashing, galvanized steel, 14 in. x 50 ft.	roll			22	$3.12								
Insulating tube	100 ft/roll	12	$1.44	4	$0.48								
Panel, wood, 8 ft. x 8 ft.	ea.											88	$1,232.00
Panels, metal (hog), 6 ft. x 12 ft.	ea.							57	$1,425.00				
Post, 10 ft. steel	ea.												
Post, 12 ft., wood, 5 in. top	ea.	10	$108.70			61	$663.07	58	$630.46				
Post, 6 ft. steel	ea.												
Post, fiberglass, 10 ft.	ea.	5	$32.50	4	$26.00								
Post, wood, 7 ft. x 5 in. top	ea.			2	$5.50								
Rod, grounding, 8 ft. with clamp	ea.	1	$6.95	1	$6.95								
Rods, steel, 1/2 in. x 7 ft.	ea.					3	$9.00						
Sleeves, high tensil wire crimping, FW 2-3	100/box	32	$4.32	4	$0.54								
Spike, 3/8 in. X 12 in., 50 lbs./box	133/box	6	$1.46			6	$1.46						
Spring, Tension indicator	ea.	1	$4.50										
Staple, 2 in., insulated	200/box	12	$2.28										
Staples, 2 in., galvanized, 50 lbs./box	2,450/box	10	$0.10			488	$4.88	580	$5.80				
Strainer, high tensil wire	ea.	5	$13.75	1	$2.75								
Twitch Stick, 1 in. X 1 in. X 48 in., Oak	ea.	4	$6.00			4	$6.00						
Visqueen, black, 10 ft. x 100 ft., 6 mil	ft.									660	$310.86		
Wire, 32 in. square mesh X 330 ft.	roll												
Wire, 47 in. square mesh X 330 ft.	roll												
Wire, barbed, 12 1/2 ga., 1320 ft.	roll					1980	$53.46	1320	$35.64				
Wire, hi-tensil, 4,000 ft./roll	roll	3300	$60.06	660	$12.01								
Wire, smooth, 12 1/2 ga., 1320 ft./roll	roll	504	$12.60			504	$12.60	6600	$165.00				
Wire, V-mesh, 72 in. x 165 ft.	roll												
			$420.79		$222.72		$1,897.55		$2,261.90		$310.86		$1,232.00
			$0.64		$0.34		$2.88		$3.43		$0.47		$1.87
			35		40		10		40		1		5
			$0.02		$0.01		$0.29		$0.09		$0.47		$0.37

V-Mesh Wire Fence

The V-mesh wire fences have been used primarily to control damage to haystacks and ensilage pits. This technique is seldom used on orchards or nurseries because of the high cost of materials and the difficulty of erecting the fencing. The first V-mesh wire haystack fences were installed during the early 1960's.

The V-mesh wire fence is constructed using 12-ft. wood posts set at 12 ft. intervals and double "H-braces" are used for spans that are in excess of approximately 200 ft. (fig. 1). All corner posts are set 4 ft. in the ground and line posts are set a minimum of 3 ft. Sometimes, 10-ft. steel posts will be used in lieu of a wood line posts as a cost saving measure. Using more than one steel post between each set of wood posts is not advisable if elk damage is anticipated. The V-mesh wire comes in heights of 42 in. to 96 in. The 72-in. fencing has been the most commonly used. The completed fence is 8 ft. high. When the 72-in. fencing is used, there is a strand of barbed wire 6 in. off the ground and two strands on top of the V-mesh wire. This fence is extremely strong and will stand up under heavy elk pressure and the effects of snow. However, this fence is difficult to build because of the heavy wire.

Using all 12-ft. treated wood posts and 72-in. V-mesh wire with three strands of barbed wire, the fence costs $3.08 per foot. The fence should last 30 years and would cost $0.10 per ft./yr.

Square-Mesh Wire Fence

The square-mesh or field wire fence has been used primarily to control damage to orchards and nurseries. The fence is considerably lighter then the V-mesh wire fence and is easier to erect. The CDOW first constructed fences of this type in the late 1950's.

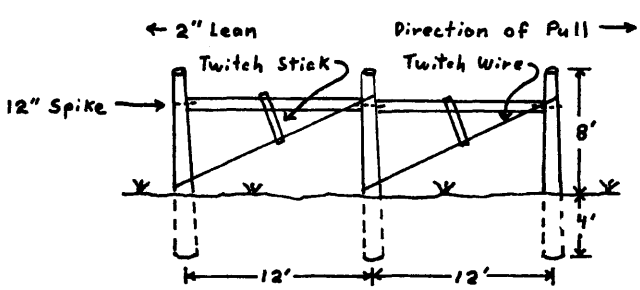

Figure 1.--Construction of a double braced H-brace showing the twitch sticks, twitch wire and brace spike.

The square mesh wire fence is constructed using double braced 12-ft. wood corner posts with line post spaced 12 ft. apart. There are 4 10-ft. steel line posts for every 12-ft. treated wood line post. All corner posts are set 4 ft. in the ground and wood line posts are set a minimum of 3 ft. All steel posts are driven 2 ft. into the ground. Two width of square-mesh wire fencing are used to construct the fence; 47-in. fencing is used on the bottom and 32-in. fencing is overlapped onto the 47-in. fence on the top. The two fences are then joined every 4 ft. with a hog ring. The fence is topped off with 2 strands of barbed wire to make it 8 ft. high. The fence will not stand a lot of pressure from elk. However, by keeping the closest trees or hay at least 10-12 ft. away from the fence, crowding and destruction of the fence by elk should not be a problem. This fence design has proven to be effective in controlling deer damage (Craven 1980, Caslick and Decker 1979).

The fence materials cost $1.18 per ft. The fence should last a minimum of 30 years and would cost $0.04 per ft./yr.

Wood Panels

Wood panels are made from 18 boards (1 in. x 4 in. x 8 ft.) of rough cut lumber. There are 14 vertical boards with 4 horizontal boards nailed to them. Panels were originally intended as emergency haystack damage prevention materials. However, over the years some ranchers and CDOW personnel have viewed the panels as the main method for control of haystack damage problems. Many ranchers are lessees and have refused to erect permanent fencing since they aren't sure how long they would be on the land. Other ranchers like to move their haystacks around each year or don't want a permanent fence in the middle of their hay meadow. One of the big problems with wood panels is their short life expectancy. Some ranches are supplied panels almost every year yet they always seem to need more. Other landowners have used panels for unauthorized purposes such as corrals, roping arenas and stock fences. Some ranchers have thrown panels away or burned them rather than try and replace a few broken boards or loose nails.

Presently, wood panels are being built by the Colorado state prison system at a cost of $14.00 each. This doesn't include transportation costs. The cost per foot is $1.87. Panels rarely last over 5 years, thus the cost per ft./yr. is approximately $0.37.

Experimental Methods

The following are some of the experimental methods of deer and elk damage prevention that have been tried in Northwest Colorado.

Fifteen Wire Non-Electric High-Tensile Wire Fence

High-tensile wire fence systems were first developed in New Zealand over 40 years ago. It has numerous application to game damage control (USS 1980). The CDOW has used this type of fence around haystacks and ensilage pits. The fence is constructed using 12-ft. treated wood line posts that are set every 25 ft. Double braced corner posts are set 4 ft. in the ground and secured with a triple strand of smooth twitch wires and twitch sticks (fig. 1). Corner braces are set to lean 2 in. out of plumb and away from the direction of pull. The proper construction of the "H-brace" corners are critical factors in building high-tensile wire fences since the fifteen wire can exert over almost 2 tons of pull on the posts. If the ground is soft or noncohesive then the corner posts should be set in concrete or triple braced or both. The high-tensile wires are spaced at varying intervals (fig. 2). The completed fence is 8 ft. high and contains 15 wires. Every 5 ft. a fence stay or dropper is installed. These prevent the wire from separating and allowing big game animals to penetrate the fence.

The high-tensile wire is installed in the following manner. Each individual strand of wire is first laid out along the fence. Next, the wire is attached to the corner post by wrapping it around the corner or gate post and crimping the end back upon itself with at least 2 crimping sleeves. The wires are then cut in the middle of each strand and an in-line fence strainer is installed on the wire using crimping sleeves to close the splice. Each wire is then slightly tightened to remove the slack. Then each wire is stapled to the fence posts. It is best to use 2 in. galvanized fence staples. It is important not to drive the staples tight against the wire. The wire should be able to slide freely back and forth between the staple and the post. After all the wires have been stapled, then each wire is tightened to 250 lbs. of tension. A tension indicator spring should be installed to determine the proper tension on at least one of the wires. It acts as a calibration tool to adjust the proper tension for the remaining wires. The final step involves installing the fence stays or droppers every 5 ft. using wire clips (fig. 2). Stays can

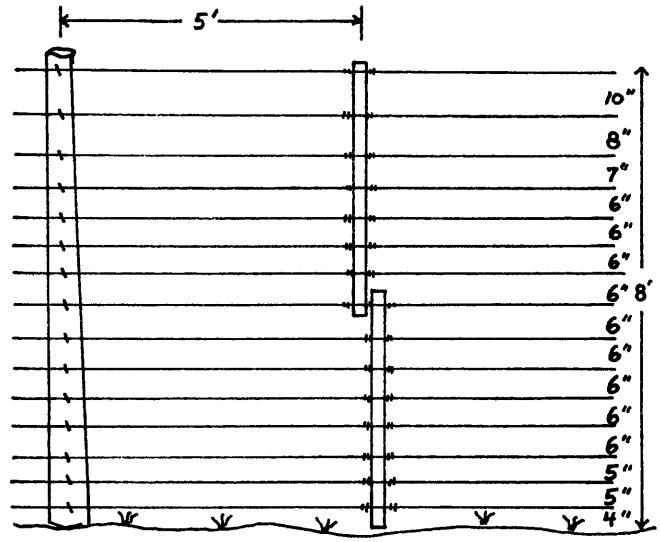

Figure 2--Construction of a portion of a 15 wire high-tensile wire fence showing the wire spacing. The wood posts are spaced 25 ft. apart with 4 sets of stays between each set of wood posts.

be fiberglass or treated wood. The completed fence should be re-adjusted periodically to maintain the tension. The fence can become too tight in the winter or too loose in the summer. Also, the corner post can settle over time. Re-tightening the fence is as simple as adjusting the in-line fence strainers with a wrench.

The completed high-tensile wire fence is extremely strong and resistant to damage by big game and livestock or even the effects of deep snow. If the fence does become loose, it is a very simple task to re-tighten. The breaking strength of USS Max-Ten 200 high-tensile wire is 1815 lbs., almost twice that of conventional barbed-wire (950 lbs.). This brand of high-tensile wire is type III galvanized so it should last in excess of 50 years in dry climates and still retain 50% or more of its original diameter (USS 1980).

The fifteen wire high-tensile fence costs $1.73 per ft. to build. The fence should last a minimum of 40 years and would cost $0.04 per ft./yr. The maintenance cost of this fence should be very low.

Eight Strand Electric High-Tensile Wire Fence

Several of these experimental fences have been built to control game damage to orchards, nurseries and livestock feedlots. This fence has also been used to fence haystacks, but it may not be practical under most situations because of lack of AC

electricity or the cost of amortizing a solar or battery powered fence charger over a small stackyard fence. This fence is designed to exclude most big game after they have been aversion trained by the fence. The fence is fairly inexpensive to build but may not be 100% effective.

The fence is constructed similar to the 15 wire fence above except that the post for this fence can be spaced about 50 - 150 ft. apart. Also, cheaper and easier to install, 10-ft. fiberglass post can be used as line posts. However, it's recommended to set a 12-ft. treated wood post at least every 300 ft. The other main difference is that the fence uses alternating negative and positive wires and no fence stays (fig. 3). All the positive wires must be insulated by using insulated staples, tube insulation or fiberglass line posts. The negative wires need to be well grounded with at least 1 6-ft. galvanized steel grounding rod for every 1,500 ft. of fence in dry soil and 3,000 ft. in wet soil (USS 1980). All the positive and all the negative wires are interconnected into a negative and positive electric grid. The positive wires are connected to an electric fence charger that can be powered by AC or DC current. Direct current models can be powered by a battery or a battery/solar charger. The new type fence chargers that are currently available from New Zealand or United States should be used. These can provide over 5,000 volts of shocking power and have a low impedance. The wires should be maintained at the same tension as the non-electric fence (250 lbs.). In theory, animals will attempt to jump between the wires rather then jump over the fence. By doing so, they are subjected to a very high voltage shock. Hopefully, the experience will

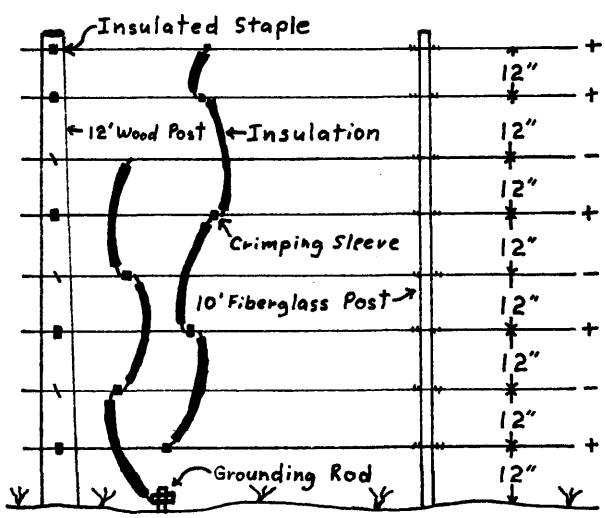

Figure 3--Construction of a portion of an 8 wire high-tensile wire electric fence showing the wire spacing and interconnecting of positive and negative wires.

deter them from entering the fenced area again. The 8-ft. fence should prevent most deer and elk from jumping over the fence. It is important to use the alternating negative and positive wires so that the animal will always be in contact with the ground wire and receive a strong shock even when they are standing on snow covered ground or while they are in mid-air jumping through the fence. These new type electric fences are far superior to the old style and should work much better then the electric fences that Tierson (1969) experimented with to control deer damage.

The cost of the fence using fiberglass line posts spaced at 100 ft. is $0.81 per ft.. This includes the AC fence charger. The fence should last a minimum of 40 years although the fence charger may have to be replaced. The cost per ft./yr. is $0.02. The cost of electricity is additional. U. S. Steel (1980) estimates it would cost $1.00 per month where electricity costs $0.08/kilowatt hour.

Modified Electric High-Tensile Wire Fence

This type of fence is used primarily for orchards and nurseries where an existing square-mesh wire fence is already in place. However, the fence can be constructed from scratch. It provides a very dependable fence against livestock, big game and even small mammals. The electric high-tensile fence is actually constructed on top of the existing fence (fig. 4). The existing corner and gate posts have to be removed and new 12-ft. treated wood posts installed. These posts should be set to the same specification as the double "H-brace" (fig. 1). Next, 10-ft. fiberglass posts are set every 50-150 ft. along the fence. A 12-ft. treated wood posts should be set every 3-400 ft. to make the

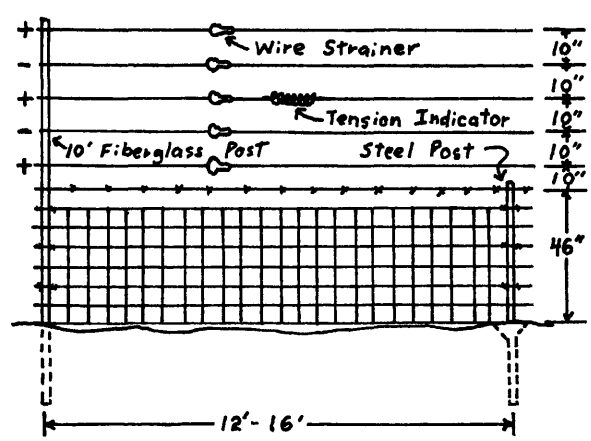

Figure 4--Construction of a portion of a modified high-tensile wire electric fence

fence solid. The bottom portion of the fence consists of the existing square-mesh wire fence, usually 32-47 in. high with 1 or 2 strands of barbed wire on top, set on wood or steel line posts. The upper, or new portion of the fence, consists of alternating positive and negative high-tensile wires. The wires are installed exactly like the electric fence described above (fig. 3). The first high-tensile wire above the old fence should be electric and the top wire should be electric with the remaining wire alternating positive and negative. The wires should be spaced approximately 10-12 inches apart and the top wire should be 8 ft. above the ground. Care should be taken not to allow the first electric wire to sag and contact the existing barbed wire or steel posts. The fence provides a very reliable barrier to prevent livestock and possibly some small game and varmints from penetrating the bottom portion of the fence. The upper portion of the fence can provide a barrier to deer and elk that may try to jump through or over the electric fence wires. This fence can be penetrated by big game, but in theory the experience should be very unpleasant and should deter future penetrations. This fence has the advantage over the all electric high-tensile fence by being at least partially functional at all times and should always deter livestock even when the electricity is turned off. Also, one of the big disadvantages of an all electric fence is vegetation will sometimes ground out the fence. This should not be as big of problem with this fence.

Depending on whether or not there is an existing fence, the cost can vary from $0.64 per ft. with an existing fence to $1.02 per ft. for an all new fence. The entire fence should last a minimum of 35 years. The cost per ft./yr. is $0.02 when there is an existing fence and $0.03 per ft./yr. without an existing fence.

Baited Electric Fence

Kinsey (1976) described using a single strand electric fence, 1 m. above the ground, baited with peanut butter on aluminum foil flags to repel white-tailed deer (Odocoileus virginianus). Porter (1983) found this technique to be very effective in reducing white-tailed deer damage to young apple trees in New York and felt the deer were repelled by behavioral conditioning. He did not test the fence on large areas (>5 ha). A similar baited electric fence was tried on a small apple orchard in Palisade. A single strand of high-tensile wire was installed 1 m. above the ground. Seven-foot wood posts were set at each corner and a 5-ft. fiberglass post was set every 75 ft. to support the wire. Aluminum roofing flashing was used instead of aluminum foil to make the flags or pockets that held the peanut butter onto the fence. The flags were placed approximately 30 ft. apart. The fence was in place for approximately three months (February to April). The landowner was lax in maintaining the battery that powered the fence charger. However, fence did appear to be somewhat effective in reducing deer damage in the fenced area. Deer tracks around the perimeter indicated where some deer evidently came in contact with the wire or flags. These sites contained large amounts of deer hair and torn up ground, indicating a fast retreat. Some deer did cross the fence and continued to browse on the young apple trees. However, the damage did not appear to as severe as prior to the fence.

The cost of the baited fence per foot is $0.34. The main cost is the fence charger. Without the charger the fence would only cost $0.09 per ft. With the exception of the fence charger, the fence should last a minimum of 40 years. The cost per ft./yr. is $0.01. This fence may require a lot of maintenance re-baiting the flags with peanut butter and preventing vegetation from grounding out the fence.

Tensar Plastic Fence

One haystack fence using plastic-mesh fence was installed in Oct. 1986 in the Kremmling area. The fencing is manufactured by The Tensar Corporation, Morrow, Ga. The fencing is 7 ft. high and can be installed similar to V-mesh or square-mesh wire. The CDOW installed the fence on 12-ft. treated wood posts spaced 12 ft. apart. The different fence rolls are spliced together by overlapping the two ends and running a galvanized rod down between the two meshes. The advantage of the fence is that it is very easy to install and easy to work with because of the light weight. However, we are concerned that the fence will break down due to weathering. After 2-1/2 years some strands on the corner posts have already separated.

The cost per foot is $2.88. The the fence should last a minimum of 10 years. The cost per ft./yr. is estimated to be $0.29.

Hog Panel Fence

During the past three years, the CDOW has been using commercial hog panel fencing on an experimental basis. The most commonly used panels are 7 ft. by 12 ft. Although the

panels are made in heights up to 7 ft. and widths up to 16 ft. The panels are secured to 12-ft. wood posts, set about 11-1/2 ft. apart, with fence staples and smooth wire. The fences are relatively easy to construct since no corner "H brace" posts are needed or wire stretching. The panels are very rigid and sturdy. They have been very effective in controlling elk damage.

The cost per foot for the completed fence is $3.43. The fence should last a minimum of 40 years for a cost per ft./yr. of $0.09.

Visqueen (Black Plastic) Wrapped Haystacks

As an alternative to wood panels to control damage to haystacks, CDOW personnel have been experimenting with wrapping the haystacks with visqueen. The visqueen is 10 ft. high and has a thickness of 6 mils. The plastic is attached to the haystacks by placing a pebble, approximately 1 in. in diameter, near the top 1 ft. from the edge and folding the edge over and tying a piece of baling twine around the pebble. The loose end of the twine is then secured to the baling twine on the hay bales. The whole haystack is wrapped in visqueen from the ground up to a height of 7-8 ft. The results have been very encouraging so far for both deer and elk. This technique provides a fairly cheap and easy to install alternative to panels or permanent fencing. It is especially useful when deep snow would limit vehicular access to a haystack making it difficult to use wood panels.

The cost per foot is $0.47. The life expectancy of this material is one season. Thus, the cost per ft./yr. is $0.47.

CONCLUSIONS

1. The effectiveness, initial cost per ft. and the cost per ft./yr., should all be considered in evaluating a fencing system.

2. V-mesh wire fences, hog panel fences and plastic mesh fences (Tensar - brand name) all have a very high initial cost and cost per ft./yr. It would be wise to consider other alternatives before using these materials for permanent fences. Plastic mesh fences have a cost per ft./yr. that is almost 3 times as much as V-mesh and hog panel fences because of their short life expectancy.

3. Square-mesh wire fences are cheaper to build than 15 wire high-tensile fences ($1.18 vs. $1.73 per ft. respectively). Both, offer about the same degree of effectiveness, but the high-tensile wire fence will probably last longer, thus, both have the same cost per ft./yr. ($0.04).

4. High-tensile wire electric fences such as the 8 wire fence and the modified electric fence both offer a low initial cost per ft. and a low cost per ft./yr. rating. The fences are not completely effective in preventing all damage but offer a cheaper alternative and a long term solution.

5. Electric high-tensile wire fences require more maintenance but may provide a good alternative for preventing severe damage that occurs for only a short period of time during a calendar year, such as heavy winter browsing to nursery stock.

6. The baited electric fence has shown some promise and may be a viable alternative to 8 ft. fencing when the fence will only be needed for a few years, such as when a new orchard is being established in close proximity to a much larger mature orchard. More experimentation is needed.

7. Visqueen (black plastic) can be a cheaper and effective alternative to wood panels to control haystack damage. More experimentation is needed.

8. Because of their short life expectancy and high cost per ft./yr., wood panels should only be used as emergency prevention methods. Permanent fencing using square-mesh or high-tensile wire should be used to solve continuing problems because they cost about 80-90% less over their life expectancy.

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The Use of DMA to Reduce Robin Depredation on Cherries[1]

Leonard R. Askham and John K. Fellman[2]

The use of a biorational pesticide, Dimethyl Anthranilate (DMA), was investigated for possible use as a robin repellant in an Eastern Washington Research orchard. Applied in low concentrations (2, 4, and 8% with surfactant), robin depredation was reduced an average of 75%. A double-blind taste test showed no consumer aversion for fresh fruit sprayed with DMA two weeks before harvest. Initial residue analyses show DMA concentrations in sweet cherries to be undetectable (<500ppb) using the sensitive methods of fused-silica open tubular (FSOT) capillary gas chromatography (GC) coupled with flame-ionization detection.

INTRODUCTION

Each year, the state of Washington produces about 58,000 tons of the fresh sweet cherries, or 60% in the United States. Prices for this crop during the last five years have ranged from a low of $689 to a high of $1,030 per ton ($864 five year average). These revenues account for approximately $44.9 million of the states' total agricultural income (Schotzko, 1989; U.S.D.A., N.D.).

As with most soft fruit crops, cherries are prone to bird depredation. In most areas damage is primarily caused by robins (*Turdus migratorius*), common grackles (*Quiscalus quiscula*) and starlings (*Sturnus vulgaris*) (Guarino, 1972) although other species have been known to feed upon the crop at various times. Until recently, the problem was resolved by spraying the ripening crop with methiocarb (a chemical repellent containing 4-[methylthio]-3,5-xylyl N-methylcarbamate) shortly before harvest. In the initial studies, depredation on the cherries, after the material was applied was significantly reduced ($p>0.001$) between treatment and controls. Random samples in sweet cherries showed that the controls received about 5 times as much damage as the treated trees (36% vs. 7%). With sour cherries, over 50% of the fruit was damaged in the control plots while only 20% was damaged in the treated plots.

In 1988, methiocarb (Measurol tm) was withdrawn from the United States market by the manufacturer at the request of the Environmental Protection Agency (EPA) because concentrations of chemical residues found in the ripe fruit exceeded standards established by the federal government. With this material removed from the market, few, if any effective repellent materials and methods remain available to the grower. Unless a viable alternative is found, millions of dollars in lost revenues will be incurred by the producers.

With the depredation of a monoculture by a protected species (such as robins) a non-toxic biodegradable compound with little or no discernable residual taste to the ultimate consumer must be found to replace the banned repellent. One possible alternative is dimethyl anthranilate (N-methyl methyl anthranilate). Dimethyl anthranilate (DMA) is a colorless to pale yellow liquid with a concord grape-like odor that is derived from methylation of methyl anthranilate or esterification of N-methyl anthranilic acid. It has a specific gravity of 1.132 to 1.138, is soluble in 3 or more volumes of 80% alcohol, benzol benzoate, diethyl phthalate, fixed oils, mineral oils and volatile oils (Arctander, 1969). As a naturally-occurring compound, it meets established criteria as a biorational pesticide pursuant to the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (Federal Regisister, 1979).

DMA, long used as a food and drug flavoring additive, has been found to be an effective taste repellant when applied to different food sources in concentrated doses. In a series of tests conducted by Mason and Arzt (N.D.), caged starlings fed progressively less on treated lipophyllic starch treated with DMA as the concentrations were increased from 0.4 to 1.6%. In another series of tests, Mason, *et al* (1985) found that "DMA substantially reduced consumption ($P=0.05$)" during the treatment periods and suggested that the material "might be used as a feed additive to reduce bird depredation without primary or secondary hazards to non-target animals."(p. 636) with concentrations as low as 0.2%. Mason and Bean (1987), however, found that 2% concentrations were necessary to repel Mallard ducks (*Anas platynchos*) and Ring-necked pheasants (*Phasianus colchicus*).

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With this information, a series of trials were established to test differing concentrations of pure (98.7%) DMA on various soft fruit crops. The objectives of the first trials were to: 1) determine if DMA, when applied to soft fruit, would deter birds from consuming a significant quantities of the crop. 2) test whether the consumer could taste the difference between treated and non-treated fruit, and 3) analyze the harvested crop for detectable residues.

MATERIALS & METHODS

Pen Trials

To determine if DMA, when applied in reduced concentrations to soft fruit, would repel birds from the crop, a series of trials using caged birds and ripe grapes was established. In the caged trials, 120 starlings were placed in a 20 X 60 X10 foot wire screened outside aviary for 7 days for pre-trial conditioning. Because fresh cherries were not available when the trials were started, chenin blanc and cabernet grapes and applies were placed in 10 X 14 X 2 inch white enamel pans inside the aviary between 8 and 9 A.M. each day. Cooked french fried potatoes were placed in the same type of trays at noon and left for the remainder of the day. Any residue food sources were removed the following morning and the process repeated. Water was provided, *ad lib*, during the entire period for all trials.

To establish the effective application rate of DMA on small fruit, two groups of twenty starlings were randomly selected from the pool, placed in two identical aviaries, as described above, and preconditioned for an additional two days. The same feeding reqime and conditions as established for the larger population were continued, except that all food was removed at dusk. Each morning between 8 and 9 A.M. pre-weighed samples of grapes dipped in formulations of either 20, 40 or 80 ml of DMA and 3 ml of 95% ETOH and distilled water (2, 4 or 8%, 1 liter solutions) were placed in the white enameled baking pans, paired with non-treated samples, and left for the remainder of the day for 5 consecutive days. Throughout the trails, additional pans of pre-weighed untreated samples were placed in screened enclosures outside of the pens to establish desiccation rates. At noon, 2.5 kg of cooked french fried potatoes were placed in two enameled pans and left in the cages. At 5 P.M. all food was removed from the aviaries, inspected, weighed and recorded.

Field Trials

The following spring, two mature Van cherry trees were treated with 40 ml of DMA and 13 ml of Regulaid (as a surfactant) per 1000 ml fresh water. The amount was doubled for one additional tree. Approximately 1.5 liters of test material was placed on each tree with a Solo (tm) back pack air blast mist sprayer. None was placed on three trees which served as controls for the experiment. The remainder of the orchard was treated with Measurol.

The trees were monitored each day for color change, phytotoxcicity and predation. Immediately prior to and for fourteen days after treatment two, 24 inch branches were cut from the outside of each tree (between the tree rows), 6 feet from the orchard floor. Fruit from each branch was divided into one of three categories, whole and unmarked, partially eaten or marked, or missing. Marking was defined as any blemish that might have been caused by birds feeding on the fruit (excluding cracking). Missing fruit was defined as the presence of a whole green stem, without a desiccated flowering head at the pedestal, where a ripening fruit was borne. Torn remnants of a fruit were often found on these pedestals. The fruit from each category was then counted, recorded, removed from the branch, sealed in double plastic bags, and stored at -40°C until processed.

Taste Trials

Before freezing, 6 oz. sub-samples were selected from each of the treatment groups for taste analysis. Three plates, each containing six fresh cherries from each treatment group, were placed in front of six tasters, three of whom had been informed about the experiment. All were asked to rate each group for sweetness, flavor, and note any abnormal taste.

Residue Analysis

Representative samples of treated cherries were frozen for later extraction and analysis. Cherries were thawed, blended with distilled water, and clarified by centrifugation at 80 g's (500 rpm) for 1 min. Supernatants were filtered, brought to constant volume and stored at -40°C until analyzed.

Initial studies were undertaken with thawed aqueous solutions using purge-and trap cryofocusing injection into a fused-silica open tubular gas chromatograph (FSOT/GC). Despite its apparent volatility, DMA condensed on the glass surfaces of the injection apparatus, forcing the abandonment of this direct procedure. Aqueous samples were then extracted with acidified hexane. The concentrated organic phase was injected into a Hewlett-Packard 5890A Gas chromatograph equipped with a flame-ionization detector and a model 3396A digital integrator. Chromatographic separation was performed on a 30mx0.32mm I.D. DB-1 FSOT column (J&W Scientific, Rancho Cordova CA) held under the following conditions:

- -initial temperature 145°C
- -temperature immediately increased 20°C/min to a final temperature of 280°C and held for 2 min.

Split injection was performed with an inlet split ratio of 60:1 at a helium carrier gas velocity of 37cm/sec. DMA eluted at 256°C with a retention time of approximately 5.6 min. under these conditions. Putative indentification of DMA was by co-elution of standards.

Studies are currently underway to ascertain the difference, if any, between purge-and trap and extraction/direct injection methods.

RESULTS

Pen Trials

Wine grape consumption by the starlings was considerably less when treated with DMA (Fig. 1). The 2% solution reduced feeding approximately 29 to 59%. The 4% solution reduced consumption approximately 46 to 61% while the 8 % solution decreased consumption 94 to 95%. There was no dessication of untreated grapes outside the aviaries.

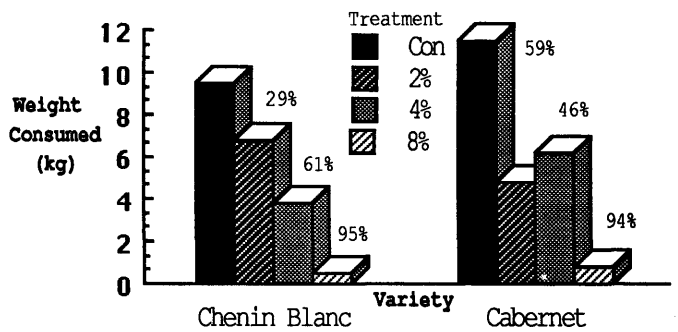

Figure 1. Consumption (kg) of Chenin Blanc and Cabernet Wine Grapes Treated With Three Concentrations of DMA During Choice Feeding Trials with Starlings

Field Trials

Prior to treatment, 9.8% of the fresh fruit on all of the trees in the experiment had either been damaged, eaten or removed by robins (Fig. 2). After treatment, depredation on the fruit on the control trees had increased to 14.9% but had decreased to 6.4 and 3.5% respectively for the 4 and 8% treated samples. None of the trees treated with the 4% solution exhibited any signs of discoloration, cracking or phytotoxcicity (Fig. 2). However, the tree treated with the 8% solution the leaves, stems, branches and fruit were severely burned and discolored where they had been drenched during application. The remainder appeared to be normal.

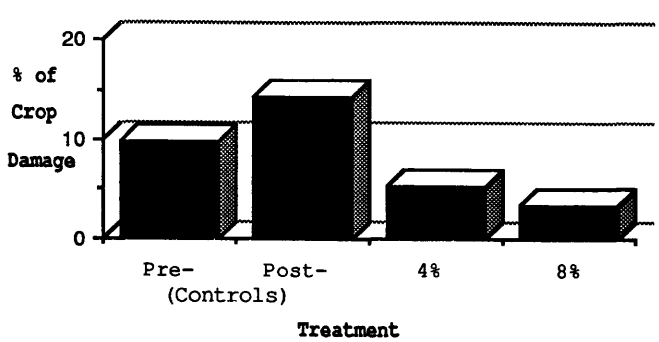

Figure 2. Bird Damage to Sweet Cherries Before and After Treatments with DMA

Taste Trials

No taste differences between treatment groups were noted by the panel. All stated that the first cherry tried was the sweetest, the second less so, and the remainder about the same. None reported any abnormal flavor differences, particularly those that had been informed of what to look for prior to the study.

Residue Analysis

Representative chromatograms of a sweet cherry extract and an extract fortified with a known amount of DMA are depicted in figures 3 and 4.. No DMA was detected in the fruit treated with the 4% and 8% solutions The data for both samples were the same (Fig. 3). Figure 5 depicts the effect of fortification with 1 ppm.

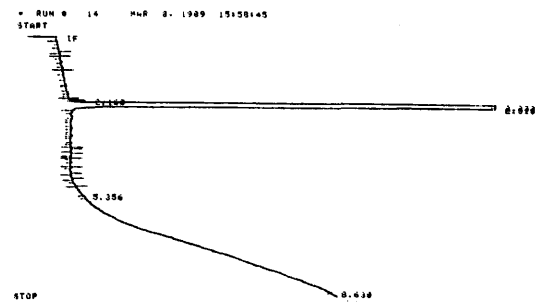

Figure 3. FSOT/GC of extracts from Van Cherries treated with 4 & 8% solutions of DMA. (Arrow indicates position of authentic materials for each sample. Major peak indicates solvent presence)

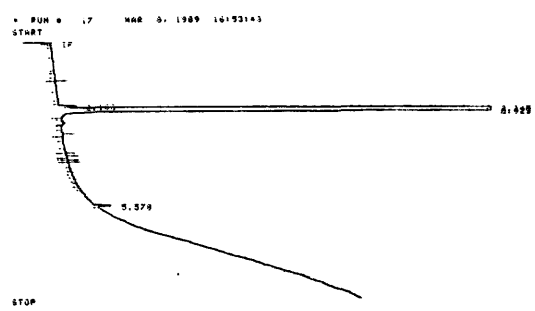

Figure 4. FSOT/GC of Fig 3 fortified with 1 ppm DMA.

DISCUSSION

The use of low concentrations of DMA to reduce bird depredation on cherries appears to be a viable alternative to using methiocarb as a chemical repellant. While the trials were limited, each indicated that the chemical properties of the tested material were well within established tolerances.

During the pen trials, feeding on the grapes treated with 4 & 8% solutions was significantly

reduced over those that had been treated with 1 & 2% or not treated at all. After the pans of fruit had been placed in the aviaries and the researcher had left the area, starlings would immediately fly to each of the treatment sites. When untreated samples had been placed in each pan, the birds would devour as many grapes as possible at one time unless frightened or forced from the site. When samples treated with 4 and 8% solutions were placed, in the pan the birds would pick one grape from a cluster, spit it out, look at the remaining grapes and then fly to another pan where other birds were freely feeding.

None of the concentrations discouraged the starlings from feeding on the apples. Feeding was accomplished by first pecking a hole in the outer layer of the fruit and then removing the pulp and seeds. When finished, each apple had been hollowed out until only the skin, stem and a 1 in. hole remained. These observations indicate that the targeted bird must be able to remove an entire fruit from the stem to receive the full taste of the repellancy compound. Where small amounts of the treated area are removed, when the fruit is pecked, the concentrations tasted or ingested do not appear to be significant enough to cause a taste aversion.

In the field trials, the feeding on non-treated cherries increased a little over 30%. Feeding on treated cherries decreased 62 to 76% respectively for the 4 & 8% treatments.

The taste test showed that there were no discernable taste differences between the treated and the untreated fruit. None of the people (including those who knew that some of the fruit had been treated with DMA) who participated in the trials were able to detect any adverse flavoring from the DMA.

Initial residue studies suggest little retention of DMA inside sweet cherries harvested 2 weeks after orchard treatment. More detailed residue studies are currently underway. One possibility is the sampling methodology precluding analysis of skin residue. It is likely that DMA does not penetrate the surface of sweet cherries. In light of the apparent dissipation of DMA residues coupled with the chemical's long-standing history as a safe flavor additive, further studies of DMA as a Measurol^{tm} replacement may foster the implementation of a lower-input, low impact vertebrate control strategy for sweet cherries.

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Seasonal Effects on Control Methods for the Great-Tailed Grackle[1]

John H. Rappole,[2] Alan R. Tipton,[3] Arlo H. Kane,[4]
Raphael H. Flores,[5] John Hobbs,[6] and Joe Palacios[7]

Efficiency of methods used to control damage to citrus fruit by great-tailed grackles was found to vary considerably from season to season. From April - July, the birds congregated in small breeding colonies where they were susceptible to baiting and poisoning. From August - October, the birds could be baited in to and poisoned at watering sites. Intensive shooting and use of pyrotechnics were also used successfully at this time of year to control damage at groves with high grackle concentrations. From late October - March, birds moved over wide areas each day, and were easily frightened from groves by pyrotechnics and shooting. No single method is available at present to control the entire population or to protect a given grove through all seasons.

INTRODUCTION

The great-tailed grackle (Quiscalus mexicanus) is an abundant permanent resident of the lower Rio Grande Valley of Texas. Though numbers of the birds change from season to season, there is no time when this species is not present. As a result, grackle damage to citrus and other fruit and vegetable crops is a year-round phenomenon.

During the course of our work in the Valley, 8 methods were considered to determine their effectiveness in limiting grackle damage to citrus: 1) monofilament line 2) reflective tape, 3) eyespot balloons 4) pyrotechnics (propane cannons and shotgun scare shells), 5) poisoning of birds, 6) shooting birds, 7) grackle nest destruction, and 8) spraying birds with the wetting agent, PA-14. Details of the methods and results of the research on the effectiveness in reducing grackle damage to fruit of monofilament line, reflective tape, eyespot balloons, pyrotechnics, and poisoning with PA-14 and DRC-1339 are presented elsewhere in this volume (Tipton et al. 1989a, Tipton et al. 1989b).

In this paper, we present the results of control efforts using some additional control techniques, and consider the effectiveness of all of the techniques tested as affected by the seasonal changes in movement and behavior of the great-tailed grackle in the lower Rio Grande Valley of Texas.

STUDY AREA

The lower Rio Grande Valley of Texas (fig. 1) is the fertile delta region of the Rio Grande River (referred to hereafter as the Valley). The rich soils of the delta cover approximately 1,194-km^2 in Texas. We travelled and worked throughout the Valley, but most of our radio-tracking and damage assessments were done in Hidalgo and Cameron counties. Ninety-eight percent of the Valley land is in agriculture of one form or another (George 1985), including 11,760-ha of citrus (Waggerman 1988). Prior to the freeze of December 1983, citrus covered more than 30,000-ha (R. Prewitt, pers. comm.). Natural habitat (thorn forest, savanna, riparian forest) occupies an estimated 4,700-ha in the Valley (Waggerman 1988), and these areas are in various successional stages; none is in pristine condition.

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[1]Paper presented at the ninth Great Plains wildlife damage control workshop [Colorado State University, Fort Collins, April 17-20, 1989].

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METHODS

Shooting was used in conjunction with pyrotechnics as a control device in selected groves where grackles occurred during the day at densities > 10 birds/ha. Control efforts were performed in 1 of the groves (Fox) during the breeding season, 2 groves in the summer post-breeding period (Fox and Moorefield), and 5 groves during the winter period.

Fruit Damage Reduction Using Shooting and Pyrotechnics

Breeding season procedures involved making counts in the grove on 3 non-successive days using a shotgun scare shell ("Shot Tell" scare shells, Reed Joseph International Co., Greenville, Mississippi). These shells are fired from a 12-ga shotgun. They explode about 50-m downrange with a loud (100-db) noise. Damage to fruit in the grove was assessed monthly from July until harvest, which usually occurs in November, though some groves are not harvested completely until February. Fifteen trees were randomly selected in each grove and the total number of fruit damaged by grackles and the undamaged fruit were counted on each tree. Four technicians entered the grove on the first Monday after pre-treatment damage assessment was completed, and shot as many grackles as possible from 0800-1000-h each day, Monday-Friday, for 2 weeks. At 1000-h, they placed 2 propane cannons in the grove. Propane cannons (Margo Supplies Ltd., Calgary, Canada) are metal tubes roughly 1-m in length that stand about 1-m off the ground on a tripod. They are connected to a 10-kg propane tank. A timed, electronic spark ignites a small amount of propane at pre-set intervals producing a loud, "thunderclap" sound of 80-120 db. Two, multi-detonation cannons were placed in the grove, 1 in the center of the north half, the other in the center of the south half. These cannons automatically fired at 2-5-min intervals and were run from 1000-h until dark during the 2 week treatment period. On Monday, Wednesday and Friday of the third week, the grove was entered and a single scare shell was fired over the northern half and the southern half of the grove, and the number of grackles taking flight was counted. On each Monday thereafter, scare shells were fired and grackle counts made. When counts reached 25% of treatment pre-counts, a 1-week treatment of shotgun and propane cannons was repeated.

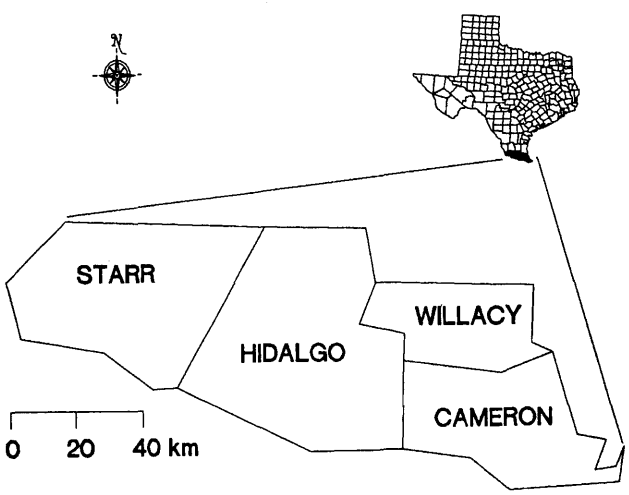

Figure 1.--Map of Texas showing location of the lower Rio Grande Valley.

During the 1988 post-breeding and winter seasons (Aug-Dec), we searched for groves having > 10 birds/ha on which to try our shotgun-scareshell-propane cannon technique. The method was used on 2 groves during the summer post-breeding period (Aug 1988), and on 5 groves during the winter season (Nov 1988). The method was drastically alterred during the winter season due to dramatic changes in the behavior of the birds. During the winter, when a grove was located that contained birds, several scare shells and shotgun shells were fired in a short period (10-20 min), and the number of birds leaving the grove vicinity was counted. The grove was then re-visited at 2-h intervals the rest of the day, and the number of birds in the grove was counted either by using scare shells or by driving up and down the rows and counting numbers of grackles flushed. The grove was then checked once/day for the next 5 days in the same manner.

Fruit Damage Reduction Using Nest Removal

To prevent establishment of breeding colonies in citrus groves, a grackle nest removal procedure was performed in 2 groves with a history of high grackle nesting densities (> 10 nests/ha), and high damage rates as recorded during the 1987 season: Nonmacher (0.8-ha) and Signez (.3-ha). On 23 March 1988 all grackle nests, old and new were removed from both groves. New grackle nests were counted and removed at biweekly intervals thereafter until no new nests were found in either grove (17 June 1988). Fifteen trees were randomly selected in each grove for assessment of damage to fruit. The assessment was performed monthly on the same fifteen trees from July - October 1988. These results were compared with damage assessments performed on the same groves in 1987.

Damage to citrus fruit by grackles was assessed throughout the project, from January, 1987 - January, 1989. Initially (Jan - Oct 1987), a study was done to determine the extent of damage to the citrus industry done annually by the birds, and to identify the major factors correlated with grackle damage to citrus (e.g. proximity to roosting sites, grove isolation) (Johnson et al. 1989). Subsequently, damage assessments were performed on treatment and control groves for each of the different treatment experiments. Damage was assessed monthly in treatment and control groves from July until harvest (Nov - Feb depending on grove).

Grackle Movements

We made daily observations on the movements and behavior of great-tailed grackles throughout 2 complete annual cycles. In addition to these observations, we placed radio transmitters on selected individuals during the different seasons of the year. Birds were captured using a variety of methods including: Australian crow traps, cannon nets, light traps, and mist nets. The most commonly used method involved placing mist nets (12-m x 2.6-m, 61-mm and 121-mm mesh) on 5-m, telescoping poles in areas of high activity, e.g. feed lots (winter), roost sites (winter), nesting sites, and watering sites (summer).

Each captive was banded with a U.S. Fish and Wildlife Service numbered, aluminum band, and given a unique color band and patagial tag sequence for individual identification in the field. A 6-gm radio transmitter (at frequencies between 150.850-151.450 MHz) was attached using a figure 8 harness (Rappole et al., MS). Each transmitter (Custom Telemetry, Athens, Georgia) was 2.5-cm x 1.5-cm x 1-cm with a 23-cm whip antenna, powered by a lithium battery. Average battery life was 6 weeks. Reception distances were highly variable depending on the amount of interference by other radio traffic and power lines. However, normally we were

able to pick up signals at distances of 1.5-2.0-km on the ground, and 3.0-5.0-km from the air using an LA 12, 12-channel receiver, 4-element Yagi antenna with 3-m extension pole, and Dave Clark headphones. Birds were located 2-3 times daily as other duties allowed.

RESULTS

Fruit Damage Reduction Using Shooting and Pyrotechnics

The breeding period for the great-tailed grackle in the lower Rio Grand Valley is early April to mid-July, during which time grackles show considerable site tenacity to breeding colony sites. This fact is illustrated by the results of the shooting and pyrotechnic treatments applied to Fox Grove (table 1). This grove had a density of 16.3 grackle nests/ha in June, 1988 when this control procedure was initiated. Furthermore, there was a history of early season (Jun-Aug) grackle damage to fruit from 1987 (table 2), presumably due to the high grackle populations present in the grove during the summer breeding period. Scare shell counts performed on 3 non-consecutive days prior to the initiation of the intensive shooting and propane cannon work showed mean densities of only 2.9 birds/ha. However, 425 birds were shot in the grove during the 14 day period of morning shooting and cannon work, including 22 on the last control day. Post-treatment counts performed in the grove using scareshells on 3 consecutive days showed mean densities of 0.8 grackles/ha.

Table 1.--Shotgun-pyrotechnic control efforts.

Grove(ha)	Date initiated	Estimated Birds/ha[1]	Control period
Fox (16.0)	6 Jun 1988	27	14 days
Fox (16.0)	1 Aug 1988	9	14 days
Moorefield (40.0)	2 Aug 1988	10	14 days
Valverde (4.0)	9 Nov 1988	80	5 min
Klements (0.4)	17 Nov 1988	280	10 min
Taylor (2.8)	18 Nov 1988	90	20 min
Trenton (8.0)	3 Nov 1988	40	10 min
England (5.6)	3 Nov 1988	40	10 min

[1]Based on number of birds killed for Fox and Moorefield, and number of birds counted in the air for the remaining groves.

Grackles also showed a great deal of tenacity to colony sites during the period immediately following breeding (Aug-Sep) as well, particularly those where drinking water, usually in the form of irrigation ditches, was available. In August, when the treatment had to be repeated in Fox Grove, 146 birds were killed in an 8-day period. Table 3 shows the estimated cost of the shotgun-cannon treatment at Fox Grove during June. Total cost/ha of the treatment was $25.69/ha.

Effectiveness of the shotgun-pyrotechnic treatment increased sharply in the winter months (Nov-Mar) when only a few scare shells were sufficient to cause all of the grackles in a 500-m radius to leave the area within minutes (table 1).

Fruit Damage Reduction Using Nest Removal

The basic conjecture underlying the nest removal treatment was the same as that for the shotgun-pyrotechnic treatment, i.e. that disruption of breeding colonies in citrus groves would cause desertion of the colony and subsequent reduction of early season (Jun-Aug) damage to fruit. However, the birds did not readily abandon colonies in either case. Despite weekly removal of nests from 23 March - 17 June 1988, birds continued to build nests in the colony until the final week of the treatment (fig. 2). Nor did the treatments appear to have a significant positive effect on fruit damage (table 4).

Table 2.--Effects of Shooting, Pyrotechnics, and Cannons in breeding colonies on damage rates to citrus fruit.

		Mean damage % by month			
Treatment	Year	Jul	Aug	Sep	Oct
Moorefield - S[1]	1988		21.7	22.1	21.6
Moorefield - NS[2]	1988	17.3[3]			
Fox - S	1988	3.1	9.3	9.5	3.9
Fox - S	1987[4]	5.3	8.8	18.2	21.4

[1]S = Intensive shooting as described in Methods.
[2]NS = No shooting. We had no damage assessment from Moorefield Grove for 1987. We performed a damage assessment in July before beginning shooting procedure.
[3]Pre-treatment damage levels.
[4]Damage levels from previous year.

Table 3.--Estimated cost of pyrotechnic and nest removal treatments.

Treatment Type	Item	Cost/ units($)	Total Cost($)	Cost/ hectare($)
Pyrotechnic	shells	0.13	173.71	10.85
	labor	3.35	279.74	14.34
	cannons[1]	2.00	4.00	0.25
	propane	2.00	4.00	0.25
	total		461.45	25.69
Nest removal	labor	3.35		

[1]Cost/cannon was $450.00 in 1988 and was amortized over the estimated 20-yr lifespan of the cannon.

Table 4.--Effects of nest removal on damage rates to citrus fruit.

	Mean Damage % by Month			
Treatment	Jul	Aug	Sep	Oct
Nonmacher - T[1]	1.1	2.6	2.2	2.7
Nonmacher - C[2] (physical pair)	1.2	1.4	1.5	2.1
Signez - T	23.0	32.2	37.5	30.1
Signez - C (temporal pair)	15.0	17.3	40.5	37.4

[1]T = Treatment (nest removal).
[2]C = Control (no nest removal).

Annual Cycle of Behavior and Movements of the Great-tailed Grackle

Males begin leaving the large winter roosts in late March and early April, dispersing to breeding sites. These sites are widely dispersed throughout the Valley. In central Hidalgo County alone we located 56 nesting colonies in May, 1987. The colonies vary in size from 2-3 males with 5-10 females and nests in a single hackberry tree at a residence to thousands of nests in extensive thorn forest and citrus groves. Nests are deep, bag-like structures usually placed in the crown of a tree, 4 to 5-m above the ground. Preferred trees for nest placement include ebony (Pithecellobium flexicaule), brazil (Condalia obovata), hackberry (Celtis laevigata), granjeno (Celtis pallida), mature citrus, and giant reed (Arundo donax). Nest building begins in early April and reaches a peak in late April and early May (fig. 2). Females perform all of the brood-rearing duties: nest-building, incubation, brooding, feeding of hatchlings, and feeding of fledglings. Males defend perch sites in the colony and normally take no part in brood-rearing activities, although on one occasion we observed a male grackle defending a nest from an intruding female grackle. The nest had been left vacant by a radio-tagged female who had left to locate food for her newly hatched young. Female grackles readily canibalize the nests of their neighbors.

Radio-tracking data show that adult males during the breeding period (Apr - Jul) seldom move more than 1-km from their perch site, day or night, and spend more than 90% of their time at the site, as illustrated by the movements of male GP 104 (fig. 3). This bird was tracked from 22 April - 7 May and was never found more than 100-m from his perch site, which was located in the top of a mesquite (Prosopis glandulosa) at Garza Brush. Some males, presumably mostly second year birds, tend to show little or no fidelity to a colony or perch site, and spend much of their time at watering or feeding sites. This was the case with GP 109 who was captured at a temporary pond formed by irrigation water across the road from Garza Brush, a chaparral nesting colony. He spent most of his time in a barnyard and pasture 2-km W of his capture point (fig. 3). He was tracked from 22 April - 26 May.

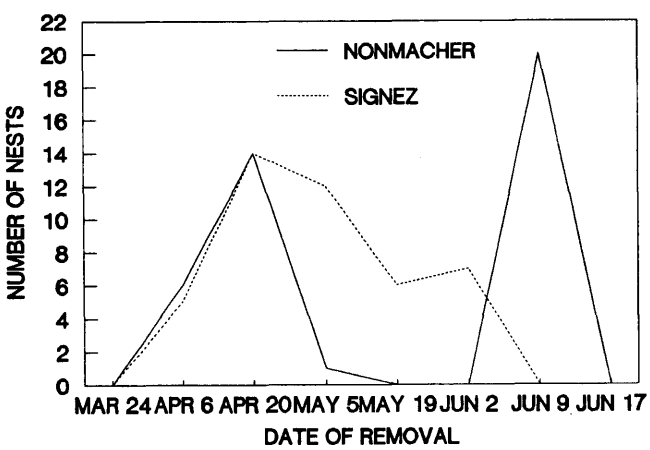

Figure 2.--Graph of bi-weekly counts of nests removed in 2 groves with high grackle nesting densities.

Nearly all females are involved with nesting and rearing of young from April - July, with a few birds continuing to nest into August. During this period, they seldom move more than 1-2-km from the nest site. The movements of female GP 110 are illustrative. She was captured at a pond in Garza Brush on 2 June and followed until 30 July (fig. 3). For most of this time, she made increasingly frequent trips between her nest near the road and the pond 1-km N of her nest, bringing food and water to her nestlings. However, on 28 July, she flew 6-km N to Wallace Marsh to roost and never returned to Garza Brush, presumably because her offspring were independent. Thereafter until her transmitter failed she was found in agricultural fields feeding with other grackles and roosting at night in the marsh with about 10,000 other grackles.

When the young hatch, they are fed primarily Lepidoptera larvae, which the females procure from nearby fallow fields. Seventeen females shot while returning to the nesting colony in the thorn forest of Garza Brush on Monte Cristo Road all had Lepidoptera larvae in their beaks. Females nearly always stop at a watering site on their return with food for their young, and dip the food into the water before flying on with it to the nest. Normal daytime temperatures exceed 37 C in the Valley from June - September, so that water in the vicinity of a nesting colony is a critical factor.

Incubation lasts an average of 14 days, after which the young spend an average of 12 days as nestlings. After fledging, they accompany the mother for several days. They then join flocks of other newly independent young that congregate in hedgerows, brush patches, and cane stands in the immediate vicinity of water. During the post-breeding period from mid-July to September, grackles seldom move far from a watering site during the day. Both the adults and the young perform the pre-Basic molt during this time. In the evening, however, they collect in numerous small roost sites, generally located at marshes, cane fields, residential areas, native thorn forest; anywhere that provides a combination of tall, dense vegetation fairly close (1-2-km) to good feeding and watering sites. The movements of GP 166, a hatching year female followed from 10 August - 29 September, illustrate characteristic movement during this period (fig. 4).

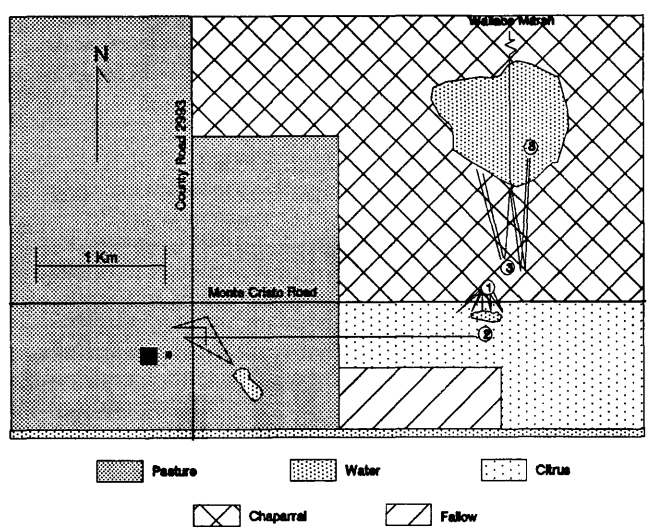

Figure 3. Movements of adult males GP 106 (1) and 109 (2) and adult female GP 110 (3) radio tracked the June–July peak of breeding.

When the weather begins to cool in October, the birds range over much larger distances, and they begin to coallesce into larger roost sites, abandoning many of the smaller roosts.. Instead of restricting their activities to a 1-2-km circle around a dependable water supply, they fly several km in search of food. At this time, and throughout the winter period (Oct-Mar), flying birds readily respond to the presence of other grackles feeding, so that a small flock following a tractor turning up grubs in an agricutural field can become a flock of several hundred individuals in a matter of minutes. Radio-tracking data on female GP 178 illustrate this movement (fig. 5). She was captured on 29 September at a roost in sugar cane. For the next week she moved from the roost to weed fields in the vicinity, but made a 20-km flight to the west on 14 October.

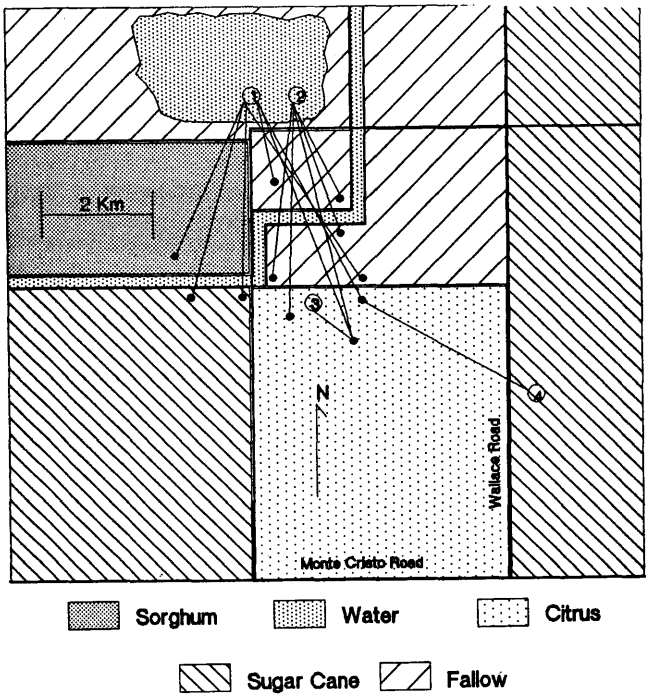

Figure 4. Movements of hatching year female GP 166, tracked from 10 August to 29 September. Circled numbers are roost sites.

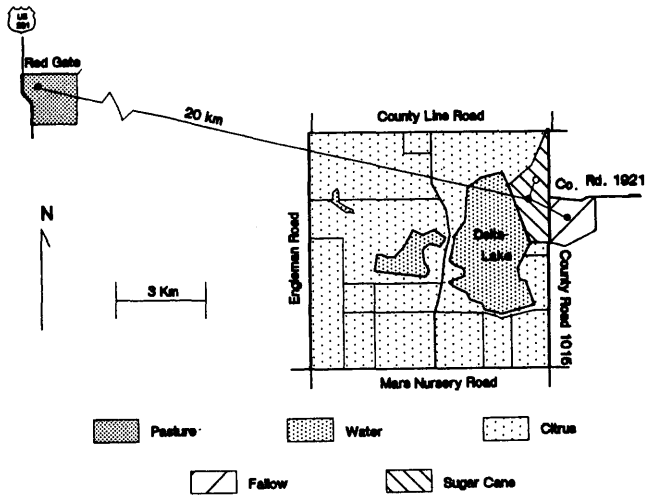

Figure 5.—Movements of hatching year female GP 178 tracked from 29 September to 14 October.

There is an influx of birds from the north in November. Unfortunately, we were unable to document the amount of movement into the area, but migration clearly increases the number of birds wintering in the Valley from November until March when the winter roosts break up.

DISCUSSION

The annual cycle of the great-tailed grackle in the lower Rio Grande Valley of Texas has clear effects on the efficacy of damage reduction efforts in citrus. Nest removal had no measurable effect on reducing fruit damage because it did not cause the birds to abandon the grove. Males continued to display in the groves and were able to attract females right through the nesting season, despite the lack of success in rearing young. Grackle populations remained high in the groves until July so fruit damage continued until that time, at which point a large percentage of the fruit had already been damaged. We conclude that nest removal on is not a suitable method for controlling damage to citrus.

Disruption of the breeding colony by shooting does reduce the rate of damage to fruit. However, this method would be much more effective if instituted early in the season, i.e. late March or early April, before male territories and female nesting sites are established. By June, there were already 16.3 active nests/ha in Fox Grove, indicating that many individuals had their entire reproductive effort for the season committed to the grove. Given this circumstance, it is not surprising that they refused to abandon the grove despite heavy shooting pressure supplemented with scare techniques. Thus each breeding individual had to be shot to remove it from the grove.

Likewise, shooting in groves in the period immediately after breeding (Aug - Sep) required an intensive effort to reduce bird numbers, though damage was held in check by the procedure. We attribute this site tenacity during the post-breeding period to the fact that water is critical during this time, and any site that provides a combination of food, water, and cover in proximity to one another will be readily used by birds despite shooting and cannon pressure. Again, forcing birds out of the groves early in the season provides a good alternative. Failing that, poisoning with DRC-1339 at bait sites near water was successful during this period in some groves (Tipton et al. 1989, this volume).

In contrast to these equivocal results during the breeding and post-breeding periods, it appears that use of pyrotechnics (propane cannons and/or scare shells), offers an excellent deterrant during the winter period. At this time (Oct-Mar), birds forage over several km^2, and readily change their foraging site in response to relatively slight disturbances. A few noisemakers fired in the vicinity of flocks in groves, or even resting in trees near groves is normally sufficient to cause most of the grackles to leave the entire area.

ACKNOWLEDGMENTS

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Fred Guthery, Research Scientist for CKWRI, assisted with the project and the first year data collection and analysis. Nancy Koerth performed statistical analysis. Yolanda de los Santos and Annette Heffelfinger helped with manuscript preparation. David Bergman generated the graphs and tables. And special thanks to Becky Ware Davis, Operations and Public Relations Officer for CKWRI, who kept track of all of us.

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Use of Monofilament Line, Reflective Tape, Beach-Balls, and Pyrotechnics for Controlling Grackle Damage to Citrus[1]

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The effectiveness of monofilament line, reflective tape, beach-balls and pyrotechnics (propane cannons and shotgun scare shells) in reducing damage to citrus by great-tailed grackles was tested in the lower Rio Grande Valley of southern Texas. Results indicate that these treatments can produce reduction in damage. Whether the treatments are economically advisable for a grower depends on the history of grackle damage to the grove and grove size. Only large amounts of damage in large groves justify costs associated with implementation of these methods.

INTRODUCTION

The great-tailed grackle (Quiscalus mexicanus) is a serious pest to the citrus industry of south Texas (Hobbs and Leon 1988). As part of a multi-prong approach to develop techniques to reduce damage to citrus we evaluated a number of non-lethal methods that had been developed for protecting other agricultural crops. Techniques we evaluated were monofilament line, reflective tape (Tobin et al. 1988, Dolbeer et al. 1986), eye spot balloons (Mott 1985, Shirota et al. 1983) and pyrotechnics (Conover 1984). These techniques were evaluated in a series of experiments from 1987 through 1989.

METHODS

In the spring of 1987, 30 groves of 0.4-ha each were selected to test the effects of reflective tape, monofilament tape, and pyrotechnics (propane cannons and shotgun scare shells) on damage by grackles to citrus fruit. Nine groves (3 replications at 3 different intensities) were used to test each technique, and 3 groves served as untreated plots. Groves were placed into groups of 10 based on their proximity to one another and randomly assigned to the 10 possible treatments. Additionally, all reflective tape and monofilament groves (excluding 1 3-m monofilament grove) had individual control groves located adjacent to them.

Fluorescent yellow monofilament fishing line (9-kg test) was strung in a grid pattern at 1 of 3 different spacings (3-m, 7-m, and 11-m) over 9 groves (3 spacings, 3 groves each). Reflective tape was suspended in rows parallel to tree rows at one of 3 spacings (3-m, 5-m, and 7-m) over 3 groves each. Both the monofilament and scare tape were strung approximately 1-m above the canopy, supported by rows of poles with 1 pole every 30-m. The poles were steel electrical conduit (EMT), 3-m long and 1.3-cm in diameter inserted into a 3-m section of Schedule 40 PVC pipe, 1.9-cm in diameter driven 15-cm into the ground. The height of the poles was adjusted for each grove by sliding the EMT section within the PVC section to the desired height, and securing it by drilling a hole through the EMT just above the PVC and inserting a nail. Each pole was supported by guylines running to 3 wooden

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stakes. Poles, stakes, and guylines were all located within the dripline of the trees so as not to interfere with normal grove operations.

In the monofilament groves, Size 24 nylon twine was run from top to top of the poles around the perimeter of the grove, and also across the tops of each row of poles within the grove. In the groves treated with reflective tape, nylon twine was run only across the tops of each row of poles within the grove. The monofilament and reflective tape were then connected to the nylon twine at the desired spacing. Monofilament was attached directly to the twine. Reflective tape was wrapped around wooden dowels, which were then attached to the nylon twine with duct tape.

Propane cannons (Margo Supplies Ltd., Calgary, Canada) were placed in 9 groves of 0.4-ha each in 1987. The cannons are metal tubes roughly 1-m in length that stand about 1-m off the ground on a tripod. They are connected to a 10-kg propane tank. A timed, electronic spark ignites a small amount of propane at pre-set intervals producing a loud, "thunderclap" sound of 80-120 decibels. Three different treatments were applied: 1) 3 groves had single detonation cannons placed in one corner of the grove and pointed toward the diagonally facing corner, 2) 3 groves received 1 multi-detonation cannon on rotomats (cannon placed on 360 degree rotating platform) placed in the center of the grove, and 3) 3 groves had both a multi-detonation and a single detonation cannon placed as described in Treatments 1# and #2 supplemented by firing of "Shot Tell scare shells (Reed Joseph International Co., Greenville, Mississippi) over the treated grove 4 times daily. These scare shells are fired from a 12 gauge shotgun. They explode with a very loud noise at about 50-m down range. Cannons in all treatment groves were turned on in the morning shortly after daylight and off in the evenings before nightfall. These treatments were applied daily from 1 June - 1 September 1987.

In the spring of 1988, two additional series of nonlethal experiments were initiated. Results from the 1987 monofilament-grid experiments indicated that 3-m spacing did reduce damage but was not cost effective because damage levels in the treated groves were not high enough to justify the treatment. Three citrus groves with histories of high damage levels have been selected to revaluate monofilament line placed at 3-m intervals. Control areas were set up adjacent to the treatment plots within the same groves. Two of the groves had been used as control groves in the 1987 monofilament study allowing for temporal comparsion between years. Method for hanging the line was similar to the 1987 study.

Preliminary tests with eyespot balloons (Avery et al. 1988) indicate that this procedure might be effective, especially in urban areas where noisy or lethal techniques might not be accepted. Four groves were chosen for treatment using eyespot balloons. It was determined that commercial eyespot balloons would be cost prohibitive, so beach-balls, 51 cm in diameter, were used. The balls were placed at the end of guyed poles extending 1 m above the canopy in selected groves at densities of 1 beach-ball /10 trees(3 groves) and 1 beach-ball/4 trees (1 grove). For 3 groves, the beach-balls were painted white with 3 large black irises and bright red pupils, and in 1 grove the beach-balls were used as purchased (i.e. multicolored - red, blue, green, yellow). Each 0.4-ha treated area was paired with a 0.4-ha control area adjacent to the treatment area.

Damage was assessed in the 1987 studies by selecting 10 randomly selected trees/grove before initial fruit harvest in the fall of 1987. All fruits on the sample trees were classified as undamaged or damaged by birds. Damaged fruit was further graded using a modified USDA grading scale for grapefruits (Johnson et al. 1989). Grades 1-3 represent fresh (<25% of fruit damaged by birds), juice fruit (>25% of fruit damaged by birds) and unusable fruit, respectively.

For the evaluation of control procedures used in 1988 groves were chosen that had a known history of high damage or were part of our damage assessment program for 1987. Damage was assessed for 1988 experiments by randomly selecting 15 trees/grove and evaluating damage on a monthly basis starting in June. Procedures and time intervals were as followed in 1987 (Johnson et al 1989).

RESULTS AND DISCUSSION

Reflective tape was considered an impractical method for use in reducing grackle damage to citrus in the Rio Grande Valley. As a result of the high daily winds (> 25 km/h) during the test period, the scare tape was consistently breaking at connection points or becoming entangled in the trees and breaking at the point of entanglement. The majority of the tape did not stay suspended for longer than 2 weeks before replacement was necessary.

In an effort to try to develop an attachment technique that would increase the suspension life of the tape, tests were conducted in Kingsville with many attachment methods. All of the tested attachment methods failed to keep the tape suspended for longer than 2.5 weeks. After tests with different methods failed to yield a satisfactory attachment, evaluation of reflective tape was ended.

Results from tests of the effectiveness of pyrotechnics in reducing grackle damage to citrus proved inconclusive. Although there were no significant differences between the various levels of intensity or between treated and untreated groves, it was not possible to determine if differences in damage levels between treatment and control groves and between treatments were due to treatment or location differences.

Monofilament groves in the 1987 treatments had less damage than the mean damage of the 3 test plots. Damage was 0.37, 0.86, and 2.7% lower in the 7, 3, and 11-m groves, respectively, thus indicating that the 11-m spacing afforded the most protection. When treatments are compared to their individual controls ("next-door-neighbor" comparisions), however, the results are very different (table 1). We feel that comparisons with individual controls more accurately measure the effectiveness of the technique because damage tends to be site-specific and differences in damage may be due to location and not treatment. In these

Table 1.—Effects of monofilament on damage rates to citrus fruits in October 1987.

	Mean Damage % in October	
Grove	Treatment	Control
Block 1		
3-m	3.48	7.27
7-m	4.22	7.94
11-m	0.56	0.58
Block 2		
3-m	3.71	15.95
7-m	5.96	13.94
11-m	2.61	8.08
Block 3		
3-m	2.07	
7-m	0.70	3.04
11-m	0.59	0.96

comparisons treatments reduced bird damage an average of 1.95, 4.68, and 8.02% for the 11, 7, and 3-m spacings, respectively.

Monofilament groves for the 1988 treatments had lower damage levels (table 2) for all groves and all months. Since all 3 groves used 3-m spacing, data were combined and a paired t-test was run to compare treated vs untreated groves. The resulting p value was 0.249.

The eye-spot groves in the 1988 treatments also had less damage (table 3). Data for all groves was combined for the analysis. Results from a paired t-test was (p= 0.0535).

Table 2.—Effects of monofilament on damage rates to citrus fruits in 1988.

	Mean Damage % by Month			
Grove	Jul	Aug	Sep	Oct
Val Verde - T[1]	1.7	4.3	3.0	3.5
Val Verde - C[2]	3.0	5.4	4.6	4.4
Anderson - T	0.9	3.0	2.1	2.9
Anderson - C	1.0	4.2	4.1	3.3
Van Meter - T	0.6	2.0	1.6	2.1
Van Meter - C	3.8	5.1	5.3	5.9

[1]T = Treatment (monofilament).
[2]C = Control (no monofilament).

Table 3.—Effects of eyespot balloons on damage rates to citrus fruits.

	Mean damage % by Month			
Grove	Jul	Aug	Sep	Oct
Segrado - T[1]	0.2	1.9	1.2	1.6
Segrado - C[2]	0.9	2.2	3.4	2.6
Dillon - T	2.9	7.4	5.2	7.2
Dillon - C	8.1	12.4	10.1	8.2
Romain Site 1 - T	2.0	4.8	3.0	3.0
Romain Site 1 - C	6.6	9.8	6.6	6.6
Romain Site 2 - T	2.2	6.9	3.7	4.6
Romain Site 2 - C	6.6	9.8	6.6	6.6

[1]T = Treatment (eyespot balloons).
[2]C = Control (no eyespot balloons).

CONCLUSIONS

Grackle damage appears highly variable from 1 site to the next so tests need to be conducted which take this variability into account.

Reflective scare tape is not a viable technique for reducing grackle damage to citrus due to prevailing winds in south Texas. Pyrotechnics are not effective when used a the only method of reducing damage. Propane cannons and scare shells can be used effectively in the fall and early winter when birds are moving from grove to grove on a daily basis. Pyrotechnics are also effective if reinforced with live ammunition. Monofilament line and eyespot balloons all hold some promise in terms of damage reduction. Every grove in which these techniques were used showed lower damage levels than untreated groves. Damage levels in groves in 1988 was in general was lower than in 1987. This reduced damage level and the small sample size could have contributed to the lack of statistical significance.

Cost benefit analysis is presently being conducted to determine if these techniques would be cost effective. Preliminary results indicate damage levels must be very high to justify the use of monofilament line.

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Effects of Grackle Damage Control Techniques in Citrus on Nesting Success of Non-Target Species[1]

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Several techniques were tested to reduce the damage caused by great-tailed grackles to citrus in the lower Rio Grande Valley of southern Texas: monofilament line, eyespot balloons, pyrotechnics, and grackle nest removal. Ten species were found nesting in the treated groves, but only the mourning dove, white-winged dove, and great-tailed grackle in significant numbers. Nesting success was not reduced significantly by any treatment but observations indicate that cannon treatments are likely to have a negative impact on overall nesting success for several species.

INTRODUCTION

Mature citrus groves provide suitable nesting habitat for great-tailed grackles in the lower Rio Grand Valley of southern Texas. Densities > 20 nests/ha were found in 20% of the groves examined during our study. Typically, these groves contain large trees and an ample water supply (irrigation ditches). Also they are usually located near fallow fields that provide a source of Lepidoptera larvae for hatchlings. High nesting densities of grackles are directly correlated with high damage rates to citrus fruit in the groves (Rappole et al. 1989, this volume). Therefore, several control techniques have been tested to reduce the number of grackles nesting in groves with high nesting densities.

In addition to grackles, several other avian species nest in citrus groves including the economically valuable white-winged dove (Zenaida asiatica). This species is estimated to bring 20 million dollars annually to the Rio Grande Valley economy during the 2 weekend/yr hunting season in September (George 1985). In this study, we surveyed citrus to identify what species other than grackles nest in the groves, and we assessed the possible effects of various grackle control techniques on the nesting success of these birds.

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METHODS

Citrus groves were selected at random from a pool of available groves in 1987 to test the effects of reflective tape (scare tape), monofilament line, and pyrotechnics (propane cannons and shotgun scare shells) on damage by grackles to citrus fruit. Nine groves (3 replications at 3 different intensities) 0.4-ha in size were used to test each technique. Groves with monofilament and reflective tape were split into 0.4-ha treatment and control sections.

In 1988, we re-tested techniques that appeared to show some promise in reducing grackle damage to citrus fruit from our 1987 work; and we tested a new technique, eyespot balloons. In testing these techniques, groves known to have had high grackle nesting densities were used, rather than a random sample as in 1987.

Fluorescent yellow monofilament fishing line (20-lb test) was strung in a grid pattern at 1 of 3 spacings (3, 7, and 11-m). The scare tape was used at spacings of 3, 5, and 7-m. Details of these methods are presented in Tipton et al. (1989, this volume). All treatments were put in place during the first 2 weeks of June, 1987 and continued until August 1987.

The pyrotechnics were used in 3 different configurations: 1) 1 single detonation cannon/0.4-ha firing once every 2-5 minutes throughout daylight hours, 2) 1 double detonation cannon/0.4-ha firing every 2-5-min during the day, and 3) 1 double detonation cannon/0.4-ha firing every 2-5-min supplemented with firing of "Shot Tell" scare shells (12-ga shotgun shells that fire an explosive charge roughly 50-m down range) discharged 4 times/day over the grove.

Six additional groves were selected for treatment with cannons alone (2 double detonation propane cannons/0.4-ha) in groves that were known to have high whitewing nesting densities. Treatments were begun during the first 2 weeks of June, 1987 and continued through July 1987. Only whitewing nests were recorded and

tracked in these groves.

Monofilament was tested again during the summer of 1988 when it was installed in early April in 3 groves of 0.4-ha each at a 3-m density using procedures described in Tipton et al. (1989, this volume).

Beach-balls, 51-cm in diameter, were placed in 4 groves during the 1988 season to reduce damage to citrus fruit. These balls were placed at the end of guyed poles extending 1-m above the canopy in selected groves in March, 1988 at a density of 1 beach-ball/10 trees. For 3 groves, the beach-balls were painted white with a large black iris and bright red pupil, and in one grove the beach-balls were used as purchased (i.e. multicolored - red, blue, green, yellow). Each 0.4-ha treated area was paired with a 0.4-ha control area.

In addition to these passive treatments, we instituted a grackle nest removal treatment 1 in 2 groves from March - June 1988. The groves were 0.3 and 0.8-ha in size. In each grove, all grackle nests were removed by pulling them down using a long pole with a hooked end on a bi-weekly basis.

In each of the treated groves, every citrus tree within the grove was given a number (there are roughly 200 trees in a 0.4-ha grove). Each tree within the grove was checked weekly for grackle nests and for the nests of non-target species from 25 June - 15 August, 1987 and from 28 April - 17 June, 1988. For each nest located, the species, date, tree number, and status (number of eggs and/or young, age of young) was recorded, and the tree was marked with a strip of red engineers tape. All nests were re-visited and their status recorded weekly until the young fledged or they were destroyed by predators. The number of eggs laid was compared with the number of young fledged to obtain a percent hatching success for each treatment.

Only the mourning dove (Zenaida macroura) nested in sufficient densities to allow statistical comparison of the effects of treatments on nesting success for most of the treatments. Analyses compared mean percent fledging success (total young fledged/total eggs laid) for each set of treatments (monofilament, reflective tape, eyespot balloons) with paired control groves using a paired t test. The fledging success in nest removal and pyrotechnic groves was compared with that of control groves from the monofilament, reflective tape and eyespot groves for their respective years using a 2 sample t test.

White-winged doves nested in low densities within the randomly selected groves, but were found in good densities in a few non-randomly selected groves, which were used in testing the effects of cannons on whitewing nesting success. The control groves used for comparison with these treated groves were surveyed by Texas Parks and Wildlife Department as reported by Waggerman (1988). A 2 sample t test was used to compare treatment versus control nesting success.

RESULTS AND DISCUSSION

Thiry-six 0.4-ha groves (14.4-ha) were examined for nests in 1987 out of the 48 total groves in the experimental design (excluding the whitewing groves). The remaining groves were missed due to a variety of problems including heavy rainfall, flooding for irrigation, jet-spraying with pesticides, and high winds causing collapse of reflective tape treatments. A total of 14 groves (5.9-ha) was examined for nests in 1988, 12 groves of 0.4-ha each, and 2 odd-size groves of 0.3 and 0.8-ha respectively.

Ten species of birds were found nesting in treatment and control groves during 1987 and 1988 (table 1), 5 in 1987 and 10 in 1988. Mourning doves were the most numerous species in the groves, and were relatively evenly distributed as well, occurring in 30 of 42 groves examined in 1987 and 14 of 14 groves in 1988. Clearly, citrus is a very important component of mourning dove reproduction in the Rio Grande Valley, providing nesting habitat for an estimated 50,000-300,000 pairs. The lower nesting pair density estimates (1987) given in table 1 are probably more accurate as they are based on densities in groves that were randomly selected rather than on groves known to have high grackle nesting densities, as the 1988 samples were.

Table 1.--Total nests and nest densities for species found in citrus groves treated to reduce grackle damage during the 1987 and 1988 breeding seasons.[1]

Species	Total Nests		[2]Nests/ha		[3]Est. pop. (x1,000)	
	1987	1988	1987	1988	1987	1988
White-winged Dove *Zenaida asiatica*	5	4	0.3	0.7	3.5	8.2
Mourning Dove *Zenaida macroura*	77	105	5.3	17.8	62.3	209.0
Inca Dove *Columbina inca*	1	3	0.1	0.5	1.2	5.9
Common Ground-Dove *Columbina passerina*	0	3	0.0	0.5	0.0	5.9
White-tipped Dove *Leptotila verreauxi*	2	3	0.1	0.5	1.2	5.9
Yellow-billed Cuckoo *Coccyzus americanus*	2	3	0.1	0.5	1.2	5.9
Common Pauraque *Nyctidromus albicollis*	0	3	0.0	0.5	0.0	5.9
Northern Mockingbird *Mimus polyglottos*	0	1	0.0	0.2	0.0	2.4
Long-billed Thrasher *Toxostoma longirostre*	0	2	0.0	0.3	0.0	3.5
Great-tailed Grackle *Quiscalus mexicanus*	41	17	2.8	2.9	32.9	34.1

[1]Excludes 1987 whitewing groves.

[2]A total of 16.8-ha (42 groves of 0.4-ha each) was examined in 1987 and 5.9-ha (14 groves of 0.4-ha each) in 1988.

[3]Total pairs of birds nesting in citrus based on estimated citrus acreage of 11,760-ha for the entire lower Rio Grande Valley.

Nesting densities for white-winged doves were far below expected values. Texas Parks and Wildlife Department conducts spring counts based on numbers of calling birds which are then used to estimate breeding population sizes in citrus and chaparral habitats (Rappole and Waggerman 1986). The estimates of nesting densities in citrus were 4.5 pairs/ha for 1987 and 5.1 pairs/ha in

1988 (Waggerman 1988), different by a factor of 10 from our estimates. It should be noted that our groves were located in the east and central portions of the Valley, and that there are groves in the northwest portion where nesting densities are as high as 50 pairs/ha. However, the number and area of these groves is a small percentage of the total 11,760-ha of citrus in the Valley, making us worry that whitewing numbers are currently being over-estimated by a considerable amount. Accurate estimates of whitewing numbers are critical for establishment of proper bag limits for the hunting season.

Reflective tape treatments appeared to have no effect on nesting success for mourning doves (table 2). This result conforms with field observations in which we observed mourning doves and grackles entering groves treated with the tape without any apparent reaction to tape presence. In addition, the tape on these groves was often down because it breaks easily in the strong southeasterly winds (26-32-km/h) that prevail throughout the summer in the Valley.

Table 2.--Mourning dove nesting success (%) for 1988 in groves with monofilament, eyespot balloons, or nest destruction as compared with control groves.

Treatment	Number of groves	Total eggs laid	Mean % nest success	Standard Deviation
Nest destruction	2	43	27.5	23.3
Monofilament	3	33	63.3	32.1
Monofilament control	3	34	53.0	12.7
Eyespot	3	38	47.0	12.1
Eyespot control	3	27	62.0	33.6

Results from the eyespot and monofilament treatments similarly produced no significant reduction in nesting success in mourning doves (tables 2 and 3). Field obseravations were consistent with this result, as we observed no avoidance behavior toward the fishing line or beach balls by birds entering or leaving the groves. However, a great-horned owl (Bubo virginianus) was killed in a collision with one of the monofilament lines.

The lack of any statistically significant reduction in nesting success by the pyrotechnic treatments for whitewings (table 4) and mourning doves (tables 2 and 3) was surprising to us. The effect of the cannons on birds nesting in cannon-treated groves was obvious to the observer, causing the incubating or brooding bird to fly off the nest in many cases, particularly for those located within 50-m of the cannon. The high variance and small size of the samples are the probable explanation for the lack of a statistically significant result. The effects of pyrotechnic techniques on nesting success of non-target species should receive further study if these are to be considered for widespread use.

A similar situation occurred with the statistical evaluation of the effects of grackle nest removal on non-target species. Only 2 groves received this treatment, Nonmacher and Signez, and the statistical analysis showed no significant reduction in nesting success as compared with controls. The Nonmacher grove was 0.8-ha in size. This grove had moderate grackle densities, and mourning dove nesting success was 45.4%. The Signez grove was 0.3-ha and only 2 of 21 eggs laid produced fledged young (9.5%). Grackle density in Signez was very high, despite the removal of their nests, and the effect of the personnel pulling nests down was to frighten incubating or brooding birds of non-target species off from their nests exposing the contents to grackle predation.

Table 3.--Mourning dove nesting success (%) for 1987 in groves with monofilament, reflective scare tape, or pyrotechnics as compared with control groves.

Treatment	Number of groves	Total eggs laid	Mean % nest success	Standard Deviation
Monofilament	8	20	21.4	35.6
Monofilament control	8	16	40.3	41.6
Reflective tape	9	15	31.4	40.9
Reflective tape control	9	3	20.8	35.4
Pyrotechnics	8	53	22.6	34.0

Table 4.--Whitewing nesting success (%) for 1987 in citrus groves containing propane cannons.

Treatment	Number of groves	Total eggs laid	Mean %nest success	Standard Deviation
Cannons	6	100	28.5	19.4
Control	3	109	40.0	15.9

CONCLUSIONS

Citrus provides important nesting habitat for at least 10 species of birds native to the lower Rio Grande Valley of Texas. Refelective scare tape, monofilament, and eyespot balloon treatments placed in the groves do not appear to have negative effects on nesting densities of these species. Propane cannons and bi-weekly destruction of grackle nests may have negative effects, and need to be tested further if their use is expanded for protecting groves from grackles. Populations of white-winged doves nesting in citrus appear to be seriously over-estimated by procedures currently used by Texas Parks and Wildlife Department. Further work should be done to develop accurate techniques for assessing breeding population size of this important game species.

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Use of DRC-1339 and PA-14 to Control Grackle Populations in the Lower Rio Grande Valley[1]

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In an attempt to reduce valley wide populations of grackles in the Rio Grande Valley of South Texas, PA-14 was sprayed over a staging area where as many as 10,000 birds were located. This attempt was unsuccessful and this method of population reduction was deemed not suitable for south Texas. Dog food bait was treated with DRC-1339 and presented to great-tailed grackles in several different situations in an attempt to control depredations to citrus by this bird. Bait presented in feedlots during winter (Nov - Feb) was readily taken by the birds, resulting in a significant reduction of numbers of birds visiting these sites, but with little apparent effect on the valley-wide population or damage to citrus. Baiting at pre- and post-roost staging sites was not effective, even when supplemented with decoys. Baiting at nest colony sites early in the breeding season (Apr - May), and at water sources during the post-breeding period (Jul - Aug) were effective in reducing damage locally.

INTRODUCTION

As part of a multi-prong approach to reducing great-tailed grackle (Quiscalus mexicanus) damage to citrus in the Rio Grande Valley of southern Texas, we attempted to develop methods to eliminate large numbers of birds, thereby reducing the Valley-wide population. Large numbers of grackles (> 500,000 in late winter) were known to roost in sugar cane fields from September to March. During this period grackles also tend to congregate in large numbers (>10,000 individuals) at staging areas prior to entering roost sites. Previous research (Heisterberg et al. 1988) has documented that large numbers of roosting birds can be killed using the avian stressing agent, PA-14 [a-Alkyl (C11-C15)-omega-hydroxypoly (oxyethylene)]. We investigated the dispensing of this material on the grackles by spraying it from an aircraft (Cessna 150 equipped with crop duster chemical tanks). When evaluating this technique we also considered the environmental and sociological hazards posed by the technique against the probability of successfully eliminating a large portion of the grackle population (Otis 1988).

Other studies (Boyd and Hall 1988) have documented success in eliminating large numbers of birds using toxic baits, specifically DRC-1339 (3-Chloro-p-toluidine hydrochloride). These studies were conducted at staging areas and roost sites of crows in Kentucky and Arkansas.

Habitat studies (Rappole et al. 1989 this volume) and previous control efforts indicate that in addition to roost sites and staging areas, large numbers of grackles feed in graineries, cattle feedlots and dairies during the winter months (Oct - March).

Results from feeding trials conducted at Texas A&I in 1987 indicated that grackles preferred dog food over most naturally occurring foods (Beasom and Schulz, in prep.). Preliminary observations have shown that this form of delivery is relatively specific to grackles with minimum acceptance by other species (unpublished data). An Experimental Use Permit was established to use DRC-1339 applied on dog food to be used in staging areas, dairies, and feedlots. In addition, attempts were made to bait birds into other situations, along flight lines, at watering holes, and at breeding colonies to determine if DRC-1339 would be effective in eliminating birds and reducing damage in local areas of high damage.

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METHODS

Grackle Population Reduction Using PA-14

During the winter months (Dec - Feb), great-tailed grackles concentrate in large winter roosts, especially in mature sugar cane fields. The sugar cane is cut through the fall and winter, progressively reducing the amount of cane available for roosting. Those birds roosting in fields that are cut tend to join birds flying to roost sites in uncut fields. As a result, by late January, when few uncut fields remain, a large portion of the grackles in the Valley may roost at a single site. This situation occurred in January and February of 1987 when an estimated 500,000 grackles, roughly 1/2 to 2/3 of the entire Valley grackle population, were roosting in a single 14-ha field of mature sugar cane just south of Donna Reservoir, Donna, Texas. For this situation, we considered using the wetting agent, PA-14, to kill birds in the roost. PA-14 is a surfactant that enhances wetting of birds when sprayed in combination with a rain shower or with water dispersed from sprinklers. The combination of water, the PA-14 wetting agent, and low ambient temperatures (< 7 C) can cause death due to hypothermia in passerines. This plan was rejected because we were informed that it is illegal to use PA-14 on crops grown for human consumption. A further problem involved the proximity of the site to Donna Reservoir. It is illegal to use PA-14 near a human water supply, and the material is toxic to many aquatic life forms.

We next considered using the material on birds that were "staging". This "staging" behavior occurs as the birds approach the roost at night and again when they leave in the morning. Large numbers of birds entering or leaving the roost land at a site, forming an almost solid mass of individuals before entering the roost (evening) or dispersing to feeding sites. Staging areas at the Donna Roost were bare dirt fields where as many as 10,000 birds would alight in an area 100-m in diameter.

Grackle Population Reduction using DRC-1339

DRC-1339 at Dairies

DRC-1339 treated dog food was dispensed at Miller dairy in Hidalgo County, Texas on four seperate occassions between January 1988 and February 1988. The selected dairy was in the flight line of a major roost (>100,000 near Donna, Texas). We applied DRC-1339 to "High-Pro" dog food, identified in earlier research (Schulz and Beasom 1989 in Prep.) as preferred bait. The starlicide label calls for a mixture of 45-g of DRC-1339 to 600-ml of water for 4.5-kg of bait. We doubled the mixture to coat 9-kg of dog food. The bait was coated with DRC-1339 1 day in advance of dispersal, allowed to dry and stored in 5-gallon buckets. A crude volumetric analysis was done to determine how much poison was contained in each pellet. Based on this analysis we estimated 2.75-mg/pellet. This would be 15 times more poison then needed to kill 50% of female grackles and 9 times more then needed for males, based on an LD_{50} of 1.8-mg/kg. Although the formulation of the chemical they used was slightly different, they found the LD_{50} in boat-tailed grackles (Quiscalus major) to be from <1.00 - 1.8-mg/kg. In our analysis we used 100-g for weight of females and 164-g for males. In some simple pen studies we determined that 1 pellet did contain enough poison to give an LD_{100}. We therefore believe it would be possible to reduce the concentration of the posion by at least 50%.

To minimize the possibilities of leaving poisoned bait at the dairy, attempts were made to attract animals by placing bait in large trays (236 x 114 x 13-cm) on the ground. The birds were not attracted to the bait presented in this manner. Nor were the birds attracted to bait placed on large pieces of 0.6-cm mesh screen covered with sifted soil. Finally, we spread the treated dog food on the ground in empty cattle holding pens before daylight. About 20-kg of food was used for each days treatment.

Flight line counts over the dairy were made for at least 3 days prior to and 3 days after baiting. Untreated dog food was spread in the holding pens prior to counts. In February, seperate counts were made of birds flying over the pens and of birds landing in the pens to determine if flight counts and pen counts were correlated.

DRC-1339 Along Flight Lines

Decoys were tested for attracting for baiting with DRC-1339 between 1 March 1988 and 15 March 1988. The area around Donna roost was selected because of a consistent northerly flight line leaving the roost each morning. Three types of decoys were tested on 3 seperate occasions: 1) black poster board silhouettes with horzontal wings, 2) black poster board silhouttes with horizontal wings and tails, and 3) 5 x 8 x 10-cm blocks of black foam. The silhouettes were placed on sticks and inserted in the ground to simulate grackles feeding. The foam blocks were placed directly on the ground. In the first test, we used 27 silhouette decoys with wings. In the second test we used 27 silhouette decoys with wings and tails. In the third experiment we used 12 foam block decoys and a moderate amount of corn scattered around the decoys. Decoys were placed 15 minutes before dawn. Counts of birds landing near the decoys were taken 40-min after the first bird left the roost.

Attempts were again made in the fall of 1988 to attract birds to bait sites. Plastic crow decoys were used in conjunction with milo, cracked and whole corn bait applied in staging areas from 13-26 October. James Glahn, Research Scientist for Denver Wildlife Research Center, helped conduct baiting experiments in December of 1988. On December 7 and 8, 3 staging sites near the Eldora roost were baited with 23-kg of cracked corn and 11-kg of dog food. Eight to 16 live decoys in cages were also used at each site. On December 9-11, 4 bait stations were established near Donna Reservoir roost site. Live and dead decoys were used at each site along with whole corn and dog food.

DRC-1339 at Citrus Groves

Beginning in the spring of 1988 and continuing through July 1988, we used DRC-1339 coated dog food in 5 selected groves. Based on our earlier pen studies we reduced the label-specified concentration of DRC-1339 by 50%.

These groves were selected because they had nesting grackles, histories of high fruit damage and some available source of water. Preliminary trials indicated that baiting near a source of water greatly increased the effectiveness of baiting. The water available to the grackles differed at each site. Three different sources of water were chosen for evaluation: constant source, water pans, and artificial pools.

Although the sources of water varied, the pre-baiting and baiting procedures were the same in each grove. Sites were pre-baited until at least 25% of the birds in the groves were coming to the stations in a 1h period. Decoys were also placed at some bait stations.

Bait stations were observed for 1h each morning and the number of grackles eating the dog food was recorded. Counts were made for at least 3 days post-poisoning.

To evaluate the effect of this technique in reducing damage to citrus, damage assessment to the groves were also conducted. Counts of damaged and undamaged fruits were made on a monthly basis on 15 randomly selected trees. Damage in 1 grove (England's) was compared with results of damage assesment from 1987. Damage for the other groves were compared with pre-treatment levels. Timing and method of evaluation of damage was detailed in (Johnson et al. 1989).

Constant Source of Water

One grove (England's grove) was chosen for its constant source of water in the form of a cattle pond (18.3 x 3.0-m) located in the middle of the grove. The grove consisted of 2.8-ha of grapefruit and 2.8-ha of oranges. Counts were made in this grove from April - November, 1988 with poisoning occurring 3 times (26 May, 18 Jul, and 5 Aug).

Water Pans and Artificial ponds

Four groves with nesting grackles and observed grackle damage were selected for artificial water devices. Water pans (236 x 114 x 13-cm) were placed in each treatment grove. Two of these sites failed to attract birds in the pre-baiting period probably because of nearby competing water sources. These groves were abandoned. Two sites were selected in Rio Farms (A and D) and 2 sites in Santa Rosa (N and S). Water pans were used in the 2 sites in Rio Farms and site S in Santa Rosa grove. For the N site in Santa Rosa an irrigation valve was cracked open and a small pool of water (4 x 2-m) was allowed to form. Dog food was scattered around the pans and at the edge of the pool. When good pre-bait acceptance was observed (75-100% pre-bait taken in 4h period) treated bait was set out. Counts were made by recording the number of birds feeding at the pans for 30 min after the first grackle arrived.

RESULTS AND DISCUSSION

Grackle Population Reduction Using PA-14

We obtained permission to use PA-14 on staging areas during the winter of 1987-88, and attempted to spray birds from an aircraft on the evening of 15 January 1988. This evening was selected because it provided the only suitable meterological conditions for PA-14 during that entire winter. Temperatures were 5 C with a light to moderate rainfall. These conditions are very rare in the Valley, occurring only once or twice a year. The attempt was unsuccessful in any case because the birds scattered as soon as the plane began its low level spraying run. Previous flights over birds roosting in sugar cane indicated that their flight behavior was such that spraying PA-14 could have been effective. This technique might still prove effective if permission could be obtained to spray the birds while roosting in sugar cane. The number of birds in the cane fields might justify the risk and expense of finding the right environmental conditions. With the present restrictions we have to conclude that this method of control is not suitable for south Texas.

Grackle Population Reduction using DRC-1339

DRC-1339 at Dairies

After the initial poisoning at Miller dairy, 43 dead grackles were recovered. Post-counts were not made until 3 days after treatment at which time more birds were flying over than when we poisoned. After the second poisoning, 1,206 dead birds were found. Females outnumbered males 10:1. Post treatment flight line counts dropped dramatically but numbers recovered in about 15 days (fig. 1). After the third poisoning, 31 birds were recovered. Post-count numbers dropped only on the first day after poisoning. Fifty-four birds were recovered after the fourth poisoning. Flight line numbers briefly decreased as in previous trials.

The number of birds landing in the holding pens, as might be expected, was always lower than the number flying over. The response in the pens paralleled the response in the flight lines.

Since dairies attract large numbers of birds in the morning, they represent potential large natural bait stations. However, baiting at dairies was not effective in reducing local populations. The number of birds flying over the dairies differed by only 1,050 birds throughout the study period. The dairy population recovered 2 - 15 days after poisoning.

Only on 1 occasion were we able to recover a large number of birds. The newness of the bait, variable weather conditions or some undetermined factor may have affected our efforts. Because DRC-1339 may take up to 18 hours to kill the birds, the number of dead birds recovered does not reflect the number that may have actually been killed. Most of the dead birds were found along canals and/or in thick grass while large numbers could have died in sugar cane roost sites or other unaccessible areas.

DRC-1339 Along Flight Lines

Attempts to decoy birds into staging areas in spring were not very successful. Using silhouettes with wings, only 28 birds landed near the decoys although hundreds of birds flew over the test site. Using silhouettes with wings and tails , 131 birds landed. The foam block decoys were the least effective with less then 10 birds landing and about 200 birds flying over. The best results were obtained using silhouette decoys with horizontal wings and tails, however the percentage of birds landing was very low regardless of the type decoy used. This method was therefore deemed inadequate for local population reduction.

Results of baiting and decoys in fall of 1988 also left some doubts as to the value of this technique. Only 12 birds were decoyed by the caged birds and bait at the sites near the Eldora

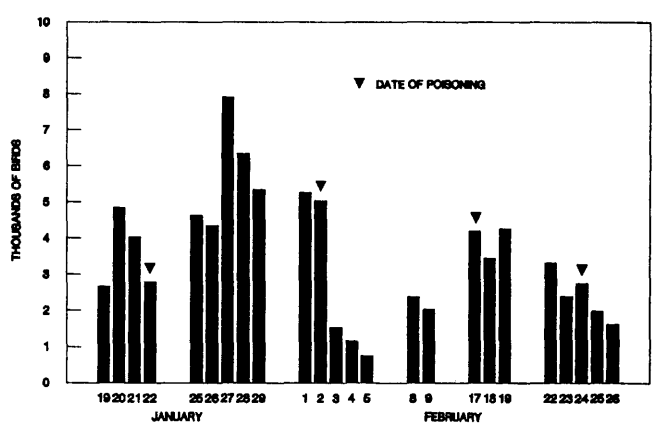

Figure 1.—Grackle use of Miller Dairy.

roost. At one of the sites near Donna Reservoir large numbers of birds fed for about 15 minutes each evening before they entered the roost. The other 3 sites were not used by birds.

DRC-1339 at Citrus Groves

Populations coming to the bait stations in the groves usually dropped immediately after poisoning (fig. 2-5). Populations returned to pre-bait levels within 2 weeks to 1 month after poisoning. Damage to fruit in the groves was reduced in England's grove when compared with damage levels from 1987 (table 1). Damage levels in the other groves remained low except in the Santa Rosa N site.

Table 1.—Effects of DRC-1339 on damage rates to citrus fruit.

		Mean damage % by month			
Grove	Year	Jul	Aug	Sep	Oct
England - T	1988	5.5	5.2	12.6	4.4
England - C (temporal pair)	1987	1.9	6.6	17.8	14.6
Santa Rosa Site N	1988	2.9	2.7	4.1	9.4
Santa Rosa Site S	1988	8.8	8.9	21.4	31.6
Rio Farm Block A	1988	6.0	5.2	3.1	5.8
Rio Farm Block D	1988	0.8	0.6	0.4	1.4

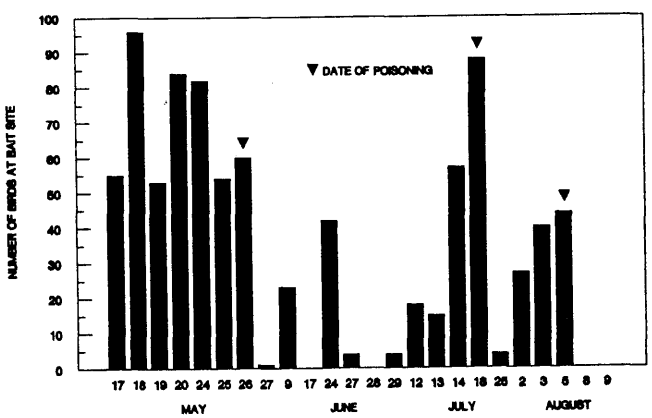

FIGURE 2.—Grackle use of England's Grove.

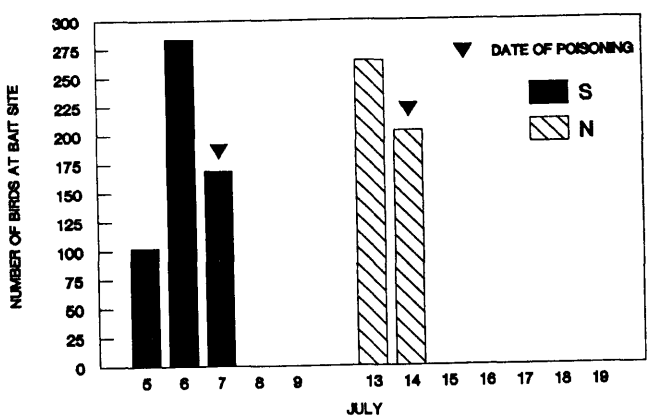

Figure 3.—Grackle use of Santa Rosa N and S.

The individual characteristics of the groves determined the success of the baiting program. Groves with canals and or sorghum fields nearby had poor results in attracting birds. For example, in an 3.2-ha grove with a canal and sorghum field nearby, less than 10 birds from a population of approximately 200 during the peak of the nesting season were enticed to the bait stations in a 3 month period.

However bait stations used in areas with artificial water sources or small pounds were successful in attracting birds and reducing damage.

CONCLUSIONS

Contrary to results obtained in control efforts in other parts of the country, the solution to the grackle problem in south Texas does not seem to lie in techniques aimed at eliminating large number of birds to reduce the Valley-wide population.

Use of the PA-14 wetting agent is not a viable alternative in the Valley for several reasons. A high human population along with extensive agricultural and residential development limits the number of places where the method could be used. Weather in the Valley is normally warmer and dryer than is necessary for the method to work, with the exception of perhaps 1 or 2 nights during the entire year. In addition, the behavior of the birds is such that the only place where they are vulnerable to spraying is when they are on the roost, after dark. Since roosts are normally located in sugar cane or near water, they are not suitable for application of

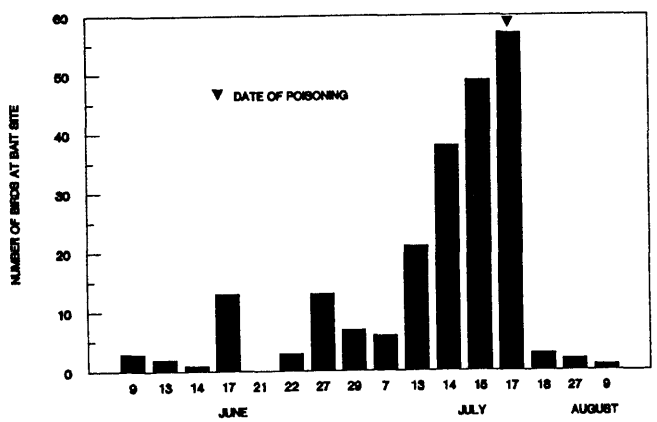

Figure 4.—Grackle use of Rio Farms Block D.

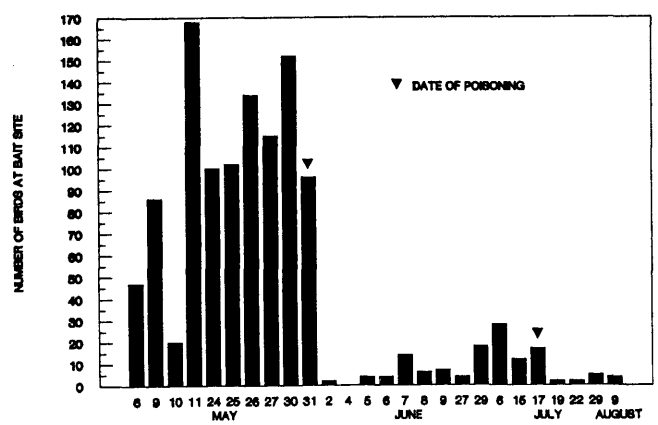

Figure 5.—Grackle use of Rio Farms Block A.

this poison with present restrictions. Even if all of these problems could be solved, it is unlikely that killing grackles with PA-14 or DRC-1339 at central collection points, e.g. roosts or feedlots during the winter, would reduce damage to citrus in summer and fall. Reduction of damage would require a significant reduction in the entire Valley-wide population, since birds at this time forage over several km^2 and fly as far as 10-km to roost. This process would require killing several hundred thousand birds. Such a reduction, even if achievable, is unlikely to be cost-effective. Control at this time is best directed specifically at groves that are experiencing significant damage to fruit by grackles, rather than wasting resources on the Valley-wide population of grackles, most of which are not involved in causing the damage.

The environmental conditions around citrus groves and the seasonal acceptance of bait, dictate the success of using DRC-1339 in groves or nesting colonies. For groves with no source of continuous water near the grove, the use of DRC-1339 coated dog food with a water source offers a viable technique to reduce grackle populations in groves that suffer damage during and immediately following the breeding season (May - Aug) when the birds will remain in the groves. Proposed research for the 1989 growing season will be directed toward establishing bait stations in groves with high levels of nesting grackles or in groves near nesting colonies. Baiting will be started earlier (Apr - May) than in 1988, before the nesting birds become established in the groves. Birds that survive the poisoning will be eliminated with shotguns to try and eliminate nesting in or near these groves. Damage assessment will be conducted in these groves in October of 1989.

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Seasonal Variation in Habitat Use by Great-Tailed Grackles in the Lower Rio Grande Valley[1]

John H. Rappole,[2] Arlo H. Kane,[3] Rafael H. Flores,[4] Alan R. Tipton,[5] and Nancy Koerth[6]

Habitat use by great-tailed grackles was measured by performing weekly censuses of birds in 6 different habitat types: chaparral, citrus groves, feed lots, pastures, residential areas, and agricultural fields. We found that use of chaparral, citrus, and residential sites was low during the winter months, increased sharply with commencement of the nesting season in April, and declined again by October. Use of agricultural fields and pasture was irregular. Feed lot use was low during the summer, but high from October - April with October and March migration peaks. An overall sex ratio of 1.3 females/male was observed with skews from this ratio related to the different life history requirements of the sexes.

INTRODUCTION

The great-tailed grackle (Quiscalus mexicanus) is an abundant permanent resident of the lower Rio Grande Valley of Texas where it is a serious pest on many of the agricultural products of the region. Grackles are not new to the area; they are native, as is testified by accounts from early ornithological investigations in the region (Lawrence 1853:12, Dresser 1865:493). Sennett (1878:28) notes that the species was abundant in towns and in colonies along watercourses. He also mentions that they occurred in chaparral where they showed a marked preference for breeding in stands of ebony (Pithecellobium flexicaule).

The past few decades has seen a marked increase in grackle numbers and a widening of their distribution to the point where they are no longer confined to towns, rivers, and thorn forest. As 98% of the Valley's 1,116 sq km of land surface has been converted to agriculture and residential uses, the grackle has become ubiquitous. The birds are not, however, evenly distributed, and their habitat preferences change through the course of an annual cycle.

Development of a clear understanding of the habitat requirements for grackles is important for the formulation of control strategies. We began investigation of the bird in January 1987, as part of a project designed to provide methods for reducing grackle damage to citrus fruit. Grackles occur in all of the 6 major habitat types in the Valley. In this paper we report on how preferences for these habitats change during the year. We also examine sex ratios by season and habitat type.

METHODS

Habitat use surveys were conducted once/week from the first week of April, 1987 to the last week of April, 1988 for selected sites in Hidalgo and Cameron counties. Twelve census sites were chosen in each county, 2 for each of the 6 major habitat types. The habitat types are: 1) Chaparral, 2) Citrus Groves, 3) Residential Areas, 4) Agricultural Fields, 5) Pastures, 6) Feed Lots. The total number of males and females within a 200-m radius of the census point was recorded using 10x40 binoculars. Information on the movements and behavior of the birds was noted. Censuses were conducted between 0800-1000h and 1400-1600h. The time at which each point was visited was changed weekly.

RESULTS AND DISCUSSION

Chaparral

Only 4,700-ha of chaparral remain in the lower Rio Grande Valley. Dominant tree species in this habitat include: mesquite

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[1]Paper presented at ninth Great Plains wildlife damage control workshop [Colorado State University, Fort Collins, April 17-20, 1989].

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(Prosopis glandulosa), ebony, brazil (Condalia obovata), and spiny hackberry (Celtis pallida). Canopy height is 3 to 4-m away from the river, up to 8 or 9-m along the flood plain. Undergrowth is tangled with extremely dense growths of forestiera (Forestiera spp.), snake eyes (Phaulothamnus spinescens), lime pricklyash (Zanthoxylum fagare), and other shrub species. Canopy cover is 95-100% in ungrazed chaparral, so there is little in the way of ground cover except at openings.

Grackles prefer chaparral as a breeding area above all other habitat types. Adult males begin moving to chaparral and establishing display territories in March (fig. 1). They are joined by adult females in April and nesting is well underway by May. Young are produced in June. Depending on the availability of water, birds may continue to use chaparral into August and September. The habitat is also used for roosting during the post-breeding period into October. However, by the end of October, there is very little grackle activity in chaparral, and numbers remain low until March (fig. 1).

Citrus Groves

There are approximately 11,760-ha of citrus in the Valley (Waggerman 1988), down from nearly 30,000-ha prior to the December freeze of 1983. Citrus includes a number of different fruit varieties for both grapefruit and oranges. The trees are spaced 2 to 3-m apart in rows that are 4 to 5-m apart. Mature trees are 4 to 5-m tall, forming an almost continuous canopy down a given row. Most groves are located near a water source, usually an irrigation ditch, and are irrigated as needed throughout the year. The cycle of citrus production begins with flowering in March. The tiny fruits set in April and reach full development by October. Most of the fruit is harvested in November, but some varieties, e.g. Valencia oranges, are harvested in January or February.

Grackles use the groves primarily as breeding colony habitat, as a substitute for chaparral. The dense crowns of mature citrus and the usual proximity of water to the nest sites in citrus groves serve as the main apparent attractants. The pattern of grove use by grackles is very similar to that seen in chaparral (fig. 2). The birds begin moving into groves in March and remain through the summer breeding and post-breeding periods until October when grove use drops sharply. Grackle use of groves after this time is spotty. Some groves, particularly those with late-maturing fruit, continue to be visited by large numbers of grackles through the winter period. For instance, a small (2-ha) grove on Trenton Road was visited daily in February, 1987 by a flock of over 200 grackles, mostly males. The birds were feeding on mature Valencia orange fruit. When the remaining fruit was finally harvested, the birds no longer visited the grove.

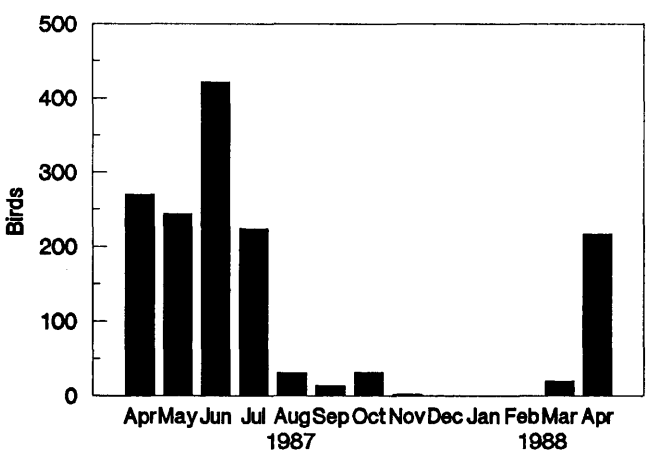

Figure 1.--Grackle use of chaparral.

Residential

The "Residential" category includes a variety of habitat types: lawns, gardens, bird feeders, dumps, and groves of hackberry (Celtis laevigata), palm (Washingtonia spp.), and many other native and exotic species. As a result, use patterns depend on the types of microhabitats chosen to sample. Our 4 sites were mainly park-like with grassy lawns and scattered trees. Therefore, the use pattern is similar to that of citrus and chaparral since the trees were used as breeding colony sites (fig. 3).

Pasture

We use the term "pasture" to refer to areas of actively grazed short grass that are kept clear of shrubs. In the Rio Grand Valley, most such sites are "improved" pasture, i.e. they are cultivated and planted with an exotic grass, e.g. coastal bermuda (Cynodon dactylon). Pasture is used by grackles exclusively as a foraging area for arthropods, and as figure 4 shows, it is used throughout the year with peaks in October and March. These peaks probably reflect movements of transient and winter resident grackles moving into or through the Valley from the north in fall and from the south in spring.

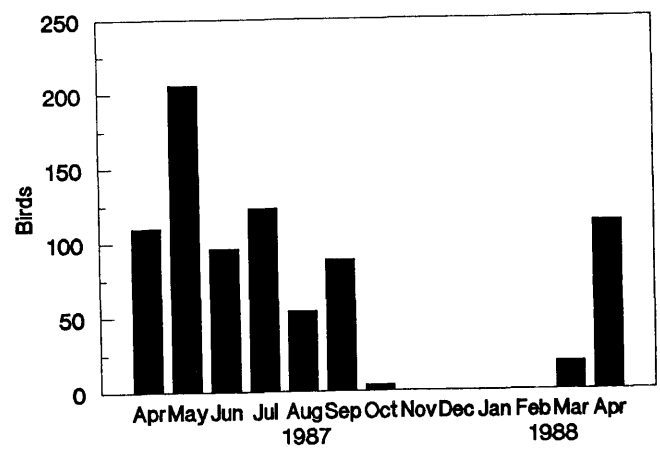

Figure 2.--Grackle use of citrus groves.

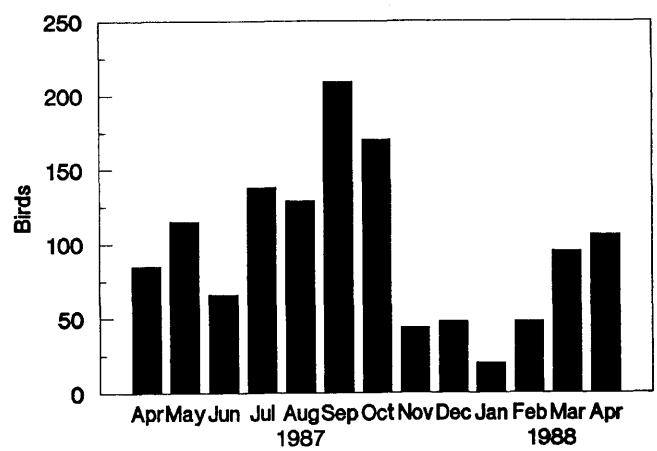

Figure 3.--Grackle use of residential areas.

Agriculture

"Agriculture" includes a wide variety of crops grown in the Valley: sorghum, cotton, sugar cane, melon, tomatoes, beans, aloe, and okra to mention a few. They have in common that they are plowed dirt for a portion of the year, and leafy vegetation the rest of the time. During the periods of plowing and cultivation, grackles are attracted only during and immediately after the cultivation process. Birds flock to machinery working the fields, following behind the vehicles and feeding on the soil organisms exposed. Later, when the crops produce leaves and seeds or fruits, the birds move into the fields to eat either the crop itself (as in the case of young melons) or insects feeding on the crop. They will also eat seeds sown during planting. Peaks in grackle numbers in this habitat reflect responses tuned to the seasonal cropping rhythms of the specific fields included in the sample (fig. 5).

Feed Lots

There are several feed lots, dairies, and graineries in the Valley; places where large amounts of grain are available throughout the year to grackles and other species [primarily pigeons (Columba livia), house sparrows (Passer domesticus), cowbirds (Molothrus spp.), and blackbirds (Aegelius phoeniceus, Euphagus cyanocephalus). The main type of grain available at these sites is sorghum (Sorghum halpense), though corn (Zea mays) silage and other mixed grain feeds are important at feed lots and dairies. These sites are used throughout the year, with greatest use during the winter months, and lows during the summer when most birds are in chaparral, citrus and riparian breeding colonies (fig. 6). As in the pasture habitats, we see peaks during October and March presumably as a result of the migration of transients through the region.

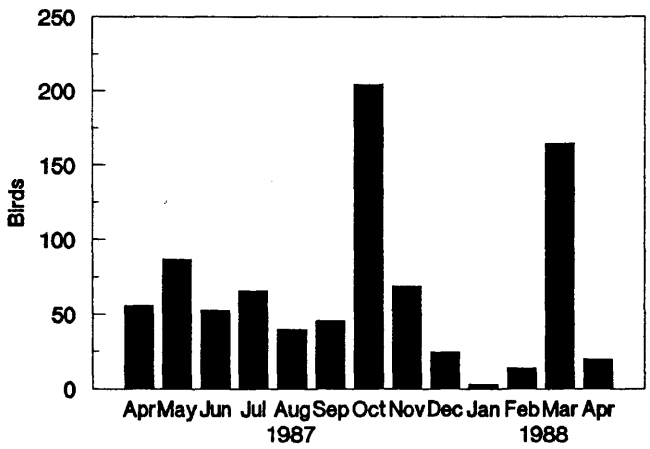

Figure 4.—Grackle use of pasture.

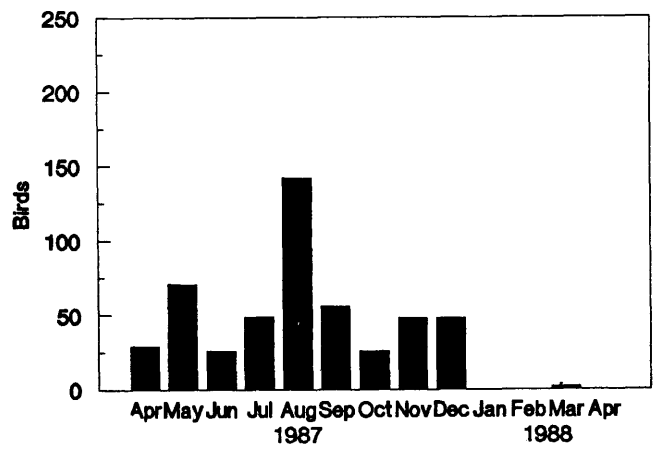

Figure 5.—Grackle use of agricultural fields.

Sex Ratios

During the entire counting period, we observed a total of 12,797 birds at 1,320 counting sites: 5,562 males and 7,235 females for a ratio of 1.30 females/1 male (table 1). Counts at a point were often heavily skewed in favor of 1 sex or the other. As an example, a flock composed of 28 males and 18 females was observed at 0813-h at Carpenter Dairy on 9 December 1988, while at the same locality at 0826-h on 22 December 1988, there was a flock of 38 females and no males. Single-sex flocks are a fairly common occurrence during the winter months.

Table 1.—Great-tailed grackle ratios of males (M) to females (F) by habitat and season.

	Apr–Jun		Jul–Sep		Oct–Dec		Jan–Mar		Total	
	M	F	M	F	M	F	M	F	M	F
Chaparral	505	431	86	183	30	4	20	0	641	618
Citrus	219	193	123	142	4	0	16	3	362	338
Residential	87	179	168	308	88	174	93	70	436	731
Pasture	86	110	99	53	143	156	78	104	406	423
Agriculture	41	85	112	135	101	21	2	0	256	241
Feed Lots	482	777	301	621	1,132	2,088	1,546	1,398	3,461	4,884

Some of the habitat-related sex ratios have rather obvious explanations. For instance, the preponderance of males in citrus and chaparral from July - December is related to the perch defense behavior exhibited by many adult males during the non-breeding season when these habitats are otherwise relatively deserted by grackles. Males are the first to move into the groves in spring (Mar) to defend their perch sites. Females begin to arrive in April, build their nests, and begin laying and incubating eggs. By June, most females are feeding young while the territorial males continue to defend perch sites attempting to attract females whose earlier nesting attempts may have failed. By July, the groves are occupied mainly by females and young; adult males have

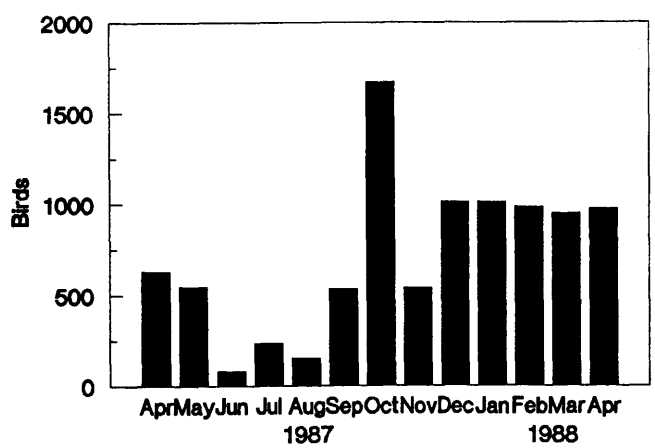

Figure 6.—Grackle use of feed lots.

moved to prime feeding areas, e.g. sorghum fields, pastures, and fallow fields. The higher numbers of females observed in citrus, chaparral, and residential sites from July - September is presumably related to the high movement and activity levels associated with their care of young - at a time when males have begun to desert breeding colonies. However, explanations for sharp sex ratio skews in certain habitats and times of the year will require further investigation. As an example, it is not clear why males predominate in agricultural habitats from October - December.

CONCLUSIONS

Analysis of great-tailed grackle use of habitat in the lower Rio Grande Valley of Texas indicates that birds are dispersed throughout a variety of habitats, particularly during the non-breeding season (Aug-Mar). Concentrations do occur at this time in feed lots on the order of several thousand birds, but numbers even at these locations represent a small portion of the half a million birds estimated to inhabit the Valley. Use of citrus groves during this portion of the annual cycle is irregular and unpredictable with flocks of 200-300 birds occasionally entering groves and damaging mature fruits. However, it is clear that citrus is not a preferred habitat in winter. Grackles concentrate in chaparral, citrus, and residential areas from April - July forming colony sites where trees provide suitable nest placement locations. They often remain in the groves, causing considerable damage, during the immediate post-breeding period (Aug-Sep) if a secure supply of water is available.

Changes in sex ratios during different seasons reflect the different life history requirements of the 2 sexes. Most of the damage to citrus occurs during the late summer months (Aug-Sep), and is done primarily by the females and young that remain in and around the groves attracted to the permanent water supplies in the form of irrigation ditches that are usually available in the vicinity.

ACKNOWLEDGEMENTS

This research was funded through multi-year cooperative agreements with USDA-APHIS and Animal Damage Control. Don Hawthorne, ADC Supervisor for Texas and Martin Mendoza, ADC South Texas Regional Supervisor, were particularly helpful with the project. Animal Damage Technicians John Hobbs, Joe Palacios, Fred Leon, and Judson Dosher assisted with the collection of field data as did Alan Storey, Paul Schulz, John Rappole, Jr., John Norwine, Jody Palacios, David Peterson, David Johnson, and Ralph Bingham of Caesar Kleberg Wildlife Research Institute (CKWRI). Sam Beasom, Director of CKWRI served as overall project leader. Fred Guthery, Research Scientist for CKWRI, assisted with the project and the first year data collection and analysis. Nancy Koerth performed statistical analysis. Yolanda de los Santos and Annette Heffelfinger helped with manuscript preparation. David Bergman generated the graphs and tables. And special thanks to Becky Ware Davis, Operations and Public Relations Officer for CKWRI, who kept track of all of us.

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Fall Food Habits of Double-Crested Cormorants in Arkansas[1]

Albert E. Bivings, Michael D. Hoy, and Jeffery W. Jones[2]

Abstract.--One hundred forty-eight double-crested cormorants (Phalacrocorax auritus) were collected in October-December 1988. Some were collected while actively feeding, but most were collected at loafing or roosting areas. Of the 135 with fish in them, 79% contained gizzard shad (Dorosoma cepedianum) and 16% contained centrarchids (mostly Lepomus sp.). The rest contained a variety of aquaculture (commercially raised) fish. Fish prey weights were estimated from total length of prey items and use of published length-weight tables. Total weights of prey ranged from 39 to 455g with a mean of 185g. This was felt to be a conservative estimate of 1/2 daily consumption. Thus, these birds appear to be eating approximately 370g (0.81 lbs.) of fish per day. Potential impact at aquaculture facilities will depend on the value of the crop.

INTRODUCTION

Double-crested cormorants, formerly year-round residents in Arkansas, are a common migrant throughout the state. The last known nest in the state was observed in 1951 at Grassy Lake (Hempstead county). Recently, birds have been seen during the summer on Lake Millwood, but no nests were observed. Band returns indicate the principal sources of Arkansas cormorants are from Saskatchewan, Manitoba, Wisconsin, and North and South Dakota (James & Neal 1986).

Commercial fisheries in the Great Lakes regions suffered increasing depredation problems from cormorants during the period 1920-1945 (Craven and Lev 1985). Some control measures were initiated in the period between 1946-1950. However, problems subsided as cormorant populations declined approximately 80% in the Great Lakes region from 1950-1978 (Postupalsky 1978). Principal reasons listed for this decline were DDT, DDE, DDD, PCB, other contaminants, and persecution by fishermen (Craven and Lev 1985). These trends have been reversed with a subsequent rise in the populations (Vermeer and Rankin 1984).

The apparent increase in the wintering population of cormorants in the South prompted a study of food habits on Texas reservoirs (Campo, et al. 1988) and this study in Arkansas. The purpose of this study was to attempt to identify and quantify prey items of double-crested cormorants in the fall, when population of both cormorants and aquaculture fish are high. The authors would like to thank Messrs. Neal Anderson, I.F. Anderson, Bob Goetz, Mike Freeze, Danny Nixon, Howard Hammans, Charles Summerhill, David Yocum, Jerry Williamson, and the many others who assisted this project. Thanks are also due to T. Booth and R. Owens for their support and editorial assistance.

STUDY AREA AND METHODS

The study was conducted from 18 October through 05 December 1988 in central and southeast Arkansas at various aquaculture facilities.

Prior to collection, each facility was surveyed to determine the number of birds present and their location. Most cormorants were collected with shotguns, although a few were taken with rifles. Birds were taken either at the feeding site or transiting to or from roosting or loafing sites. Collection of downed birds was simplified by use of trained retrieving dogs.

Cormorant esophagus and stomach contents were removed and prey items taxonomically identified. Fish prey consumed were classified to either genus or species. Prey were counted by species and total length of each was measured to the nearest 6 millimeters (1/4 inch). Numbers and length of each prey species for each bird were recorded and tabulated. Mean total length was computed for each prey species consumed. Total weight of prey consumed was estimated when possible for each sample bird based on published length-weight tables (Carlander 1969).

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. (Colorado State University, Fort Collins, April 18-19, 1989).

[2]United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control, Stuttgart, Arkansas.

RESULTS AND DISCUSSION

During this study, 148 cormorants were collected and examined for esophageal/stomach contents. Of the 135 with food items (91%), 106 (71.6%) contained gizzard shad (Table 1). Mean number of shad per bird was 4.87 and mean total length of shad was 149 mm (5.85 in.) (Table 2).

Total biomass consumed was calculated for 112 of the 135 with prey items based on our ability to determine prey live weights from existing tables. Total biomass ranged from 39g to 455g with a mean of 185g per feeding.

The results of this study were similar to those found in Texas (Campo et al. 1988) and Wisconsin (Craven and Lev 1985) in that rough fish were consumed most of the time and the average size prey was about 150 mm (5.9 in.). Our study did show a greater reliance on commercially important species in our small December sample (N=15) where 33% of the cormorants contained channel catfish. This indicates a potential seasonal shift to catfish that has been suggested by catfish producers. Campo, et al. (1988) noticed a similar decline in shad consumption over time indicated. This may be due to changing shad abundance, vulnerability, or to differential thermal response between shad and aquaculture species.

Since cormorants were full of fish throughout the day, biomass estimates are felt to approximate 1/2 daily consumption. Similar thoughts were compiled by Campo et al. (1988) and Bennett (1970). Our daily consumption of 370g (0.81 lb.) is greater than the hypothetical estimates developed by Schramm, et al. (1987) in Florida, and similar to observed data from other studies (Campo et al. 1988, Bennett 1971). The maximum value of 910g (2 lbs.) per day also agrees with Bennett (1971).

While the occurrence of aquaculture fish is low, it is also important to note that several very high value species were identified. The wholesale value of the single grass carp was about $4; while koi are worth $5-10 each. Thus, a small percentage of the population could produce high dollar damage to an individual producer. Also, if there is a shift to commercially important fish later in the winter, mean consumption of 370g (.81 lb.) of fish by the expanding population of wintering cormorants may result in substantial economic impact to southern fish farmers. Furthermore, cormorant predation on spring brood stock could be disastrous. Additional data needs to be collected on spring food habits when cormorant populations are high and shad populations are reduced.

Table 1.--Occurrence of prey species in esophagus/stomach of double-crested cormorants in October - December 1988 in Arkansas.

Prey Species	Number of Birds	Percent of Total
Shad	106	71.6
Channel Catfish	10	6.8
Bluegill	9	6.1
Green Sunfish	9	6.1
Golden Shiner	7	4.7
Crappie	3	2.0
Goldfish	2	1.4
Koi	1	0.7
Unidentified Sunfish	1	0.7
Grass Carp	1	0.7
Unidentified	13	9.0
		109.8

[1]Total exceeds 100% because birds had more than 1 prey species.

Table 2.--Mean total length of prey species found in double-crested cormorants October - December 1988 in Arkansas.

Species	$\bar{x}$TL (mm)
Shad	149
Channel Catfish	227
Golden Shiner	88
Goldfish/Koi	140
Bluegill	195
Green Sunfish	86
Grass Carp	178
Crappie	167

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Evaluation of Predator Guards for Black-Bellied Whistling Duck Nest-Boxes[1]

Raymond L. Urubek[2]

Abstract. I evaluated the effectiveness, suitability, and expense of 2 styles of predator guards for black-bellied whistling duck (Dendrocygna autumnalis) nest-boxes. Guards evaluated were galvanized bottom-attached shrouds and razor-ribbon wire. Both guards were effective against ground dwelling predators. The group not fitted with guards suffered a 55% overall depredation rate.

INTRODUCTION

Large-scale erection of artificial nesting structures for waterfowl has been a management tool for at least 4 decades (McLaughlin and Grice 1952, Belrose 1976). Most of these artificial nest structures were constructed to benefit wood ducks (McLaughlin and Grice 1952, Strange and Cunningham 1971, Bellrose 1976). Predation by ground dwelling species, primarily raccoons (Procyon lotor), and to a lesser extent avian species has often negated the beneficial effects of nest-boxes (Bellrose et al. 1964, Bolen 1967b).

The black-bellied whistling duck is a Neotropical species whose northern breeding distribution extends into southern Texas and regularly occurs as far north as Refugio County (Belrose 1976). Whistling ducks adapt readily to artificial nest structures (McCamant and Bolen 1979). Efforts to provide artificial nest-boxes for whistling ducks began in the early 1960's (Bolen 1967b) and have become more common in recent years (O'Kelley 1987). O'Kelley (1987) found that proper predator deterrents, reduced competition for nest-boxes, and proper density and location of boxes could increase the efficiency of a box-management program. Bolen (1967b) classified nest box failures into 2 groups, abandonment and predation.

My focus in this paper is an investigation of predation. Unlike the wood duck, whose major nest predator is the raccoon, snakes, particularly the Texas rat snake (Elaphe obsoleta) destroy more nests than any other single predator (Bolen 1967a). Although Bolen (1967a) ranked the raccoon second among nest predators, he felt that they were the most important predator because of the cunning and methodical manner in which they destroyed bird nests.

Information presented here was collected during the Welder Wildlife Foundation's yearly nest box maintenance and refurbishment program. I stress that this information should be approached from a demonstration viewpoint rather than that of a scientific study. There were unequal sample sizes, and many interconnected variables that make statistical analysis of the results questionable.

DEMONSTRATION AREAS

Two oxbow lakes and 5 stock ponds were used in this demonstration. All sites were located within the boundaries of the Welder Wildlife Refuge. The 3,158 ha refuge is located 40 km north of Corpus Christi in San Patricio County, Texas. The Aransas River, a permanent waterway, forms the north and east boundaries. The refuge lies in a transition zone between Gulf Prairies and Marshes and South Texas Plains (Gould 1975). Over 1400 species of flowering plants and ferns occur in this area, mostly of tropical and subtropical origin. Drawe et al. (1978) and Drawe (1988) further describe the soils and vegetation found on the refuge. The 30 year average annual rainfall is 91 cm.

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. [Marriott Hotel, Fort Collins, CO, April 17-20, 1989]. Contribution 337, Rob and Bessie Welder Wildlife Foundation.

[2]Raymond L. Urubek is a Research Biologist, Rob and Bessie Welder Wildlife Foundation, Sinton, TX.

Monthly rainfall means indicate a bi-modal pattern with peaks in spring and early fall (Low 1970, Kie 1985).

METHODS

Data presented here were collected from nest boxes erected before 1982, in 1982, in 1987, and in 1988. Table 1 presents the number and type of boxes available during the 1987 and 1988 breeding seasons.

Table 1.--Nest-boxes and predator guards available during the 1987 and 1988 nesting seasons.

Box and Guard Type	1987	1988
Wooden-Single Box		
Metal Shroud	11	11
Wooden-Double Box		
Metal Shroud	26	26
Wooden-Single Box		
No Guard	16	16
Plastic Box		
No Guard	16	16
Parks & Wildlife		
Razor-Ribbon Wire	0	24
TOTAL	69	93

Boxes erected prior to and including 1982 were of the type described by Bolen (1967a) and included single box units and units that employed 2 nest boxes per pole (fig. 1). Nest structures erected in 1987 included a modified version of Bolen's nest box (1967a, fig. 2) and a modified plastic bucket (Griffith and Fendley 1981) (fig. 3). Boxes obtained from the Texas Parks and Wildlife Department's Wood and Tree Duck Production Project (fig. 4) were erected in April 1988.

Predator guards were of two types; galvanized metal shroud (Bolen 1967b, fig. 1), and razor ribbon wire (fig. 5). Plastic 5-gallon buckets and modified Bolen boxes were not fitted with guards.

Each box was checked in early spring. Old nesting material was removed and a fresh bed of pine bark mulch was installed. Boxes were subsequently examined for usage at 2-3 month intervals through the nesting season. Each box was checked an average of 3 times per year. Nest predators were identified following the criteria of Reardon (1951).

RESULTS AND DISCUSSION

Overall nest box use by black-bellied whistling ducks was 85% and 45% for the years 1987 and 1988, respectively.

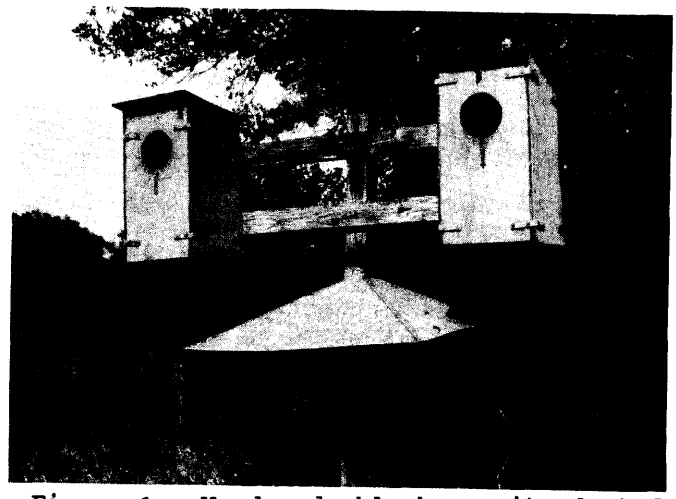

Figure 1.--Wooden-double box unit adapted from Bolen (1967a), with metal shroud.

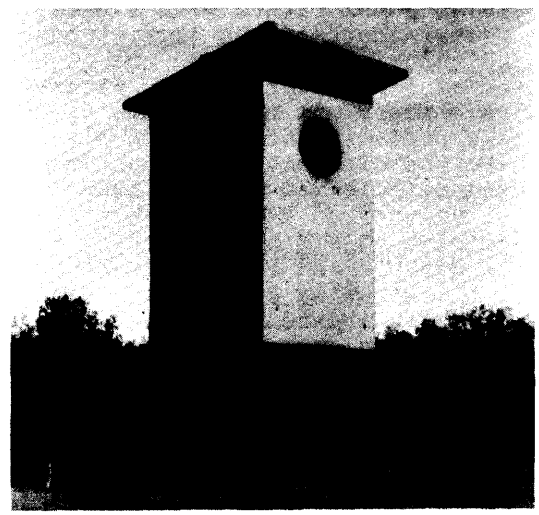

Figure 2.--Wooden-single box modified from Bolen (1967a), shown without predator guard.

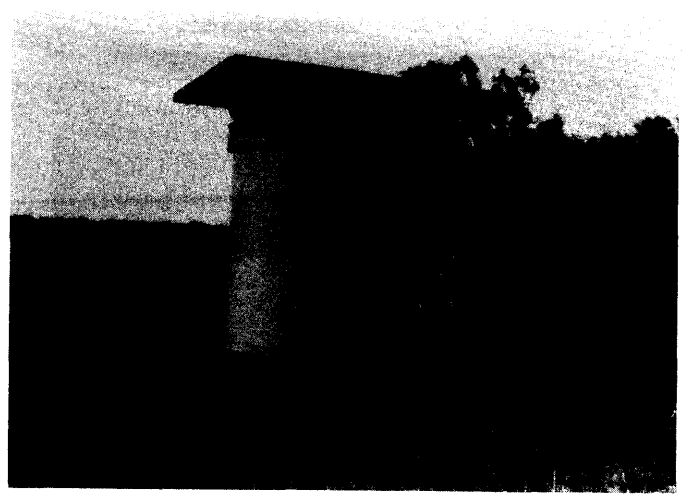

Figure 3.--Modified Griffith and Fendley (1981) plastic 5-gallon bucket nest-box.

McCamant and Bolen (1979) reported an 81% overall whistling duck nest-box use during the 12-year period 1964-75. The low use of boxes in 1988 was caused by drought conditions that left the oxbow lakes dry and water levels of the smaller ponds very low.

Predation was limited to unprotected wooden boxes (55%). Bolen (1967a) found predation rates in unprotected boxes and natural cavities of 23% and 41%, respectively. I suggest that the predation rate observed is higher because of an abnormally large raccoon population and because boxes were placed immediately adjacent to the ponds. McLaughlin and Grice (1952) reported an overall raccoon predation rate of 41% on wood duck nest boxes; however, considering only boxes placed in swamp areas the predation rate rose to 78%. Rat snakes were found in 1 unprotected box and on the ground at the base of a box fitted with a metal shroud. A western cottonmouth (Agkistrodon piscivorus) was found on the ground at the base of a box protected by razor-ribbon wire. There was no evidence of raccoon or snake predation on nests in plastic boxes where the distance from mounting pole to entrance hole was greater than 330 mm.

Galvanized metal shrouds are expensive ($28); however, they are the most durable and can be manufactured to fit the mounting structure. Razor ribbon wire is an inexpensive ($4) alternative if the mounting structure will accept it. Although no accidents have been reported from the use of razor ribbon wire, I suggest its use be restricted to remote areas. If a predation problem arises while using plastic buckets, an inverted 5-gallon bucket (fig. 6) is an inexpensive ($1/unit) solution and can be modified to fit many existing mounting structures. In the south Texas climate I expect the longevity of plastic buckets, razor ribbon wire, and galvanized metal shrouds to be 3, 5, and 8 years, respectively.

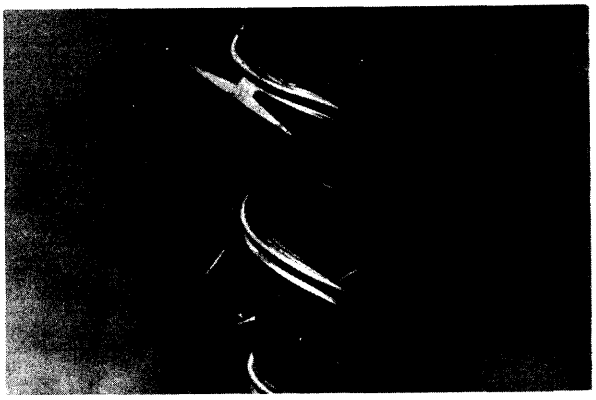

Figure 5.--Razor-ribbon wire guard, shown as mounted on Texas Parks & Wildlife box.

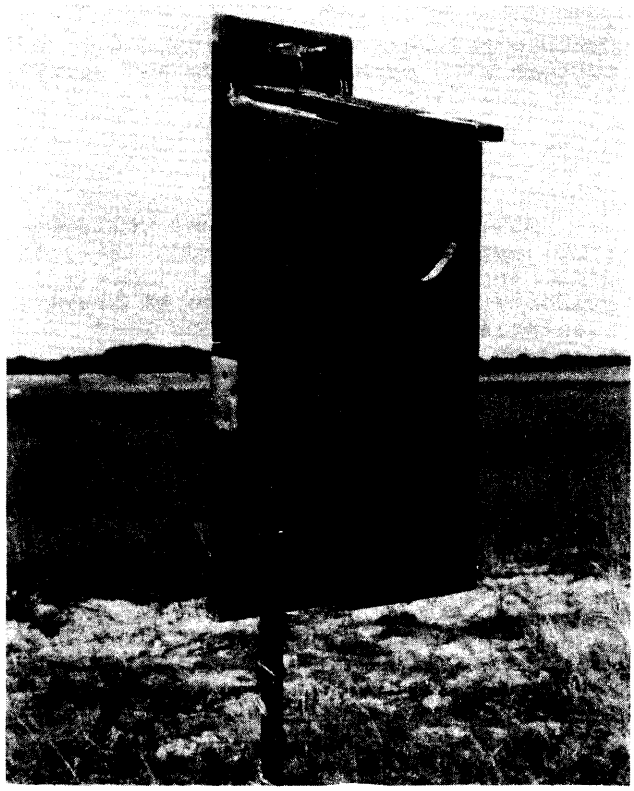

Figure 4.--Nest-box provided by the Texas Parks and Wildlife Dept., shown with razor-ribbon wire guard.

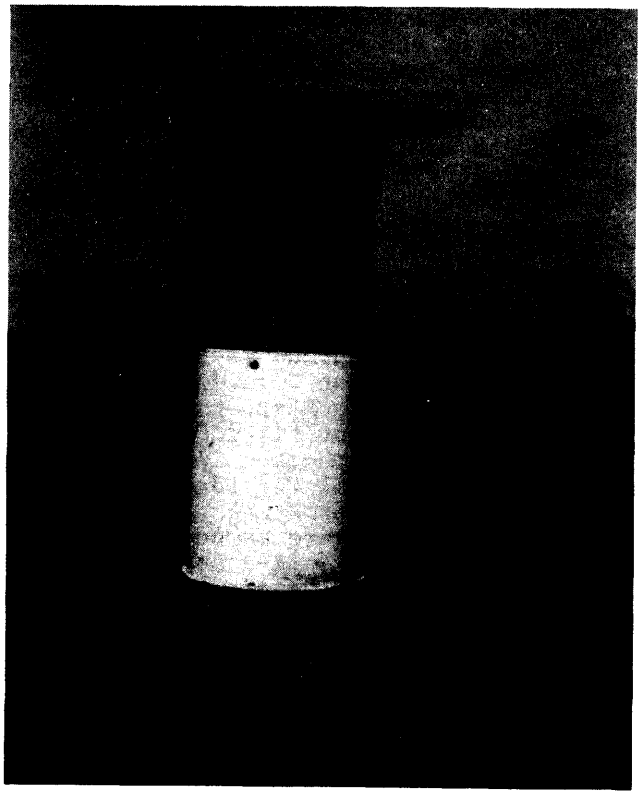

Figure 6.--Modified plastic 5-gallon nest-bucket (Griffith and Fendley 1981), showing additional bucket mounted at base of nest-bucket.

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Field Trials of Alpha-Chloralose and DRC-1339 for Reducing Numbers of Herring Gulls[1]

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Abstract.--We compared the potential of Alpha-chloralose (A-C) and DRC-1339 to reduce a nesting population of herring gulls at an industrial site in Ohio in 1988. Almost all treated baits were consumed by gulls but only about one affected gull was noted for every 10 baits consumed of either chemical. A test indicated our DRC-1339 baits, containing 3.7 - 7.4 times the published LD_{50} value, were not lethal to most captive herring gulls living in fresh water. LD_{50} values of A-C and DRC-1339 need to be more precisely estimated for gull species in fresh and salt water environments.

INTRODUCTION

Gull populations have increased in recent years in North America resulting in urban nuisance problems, agricultural crop damage and reductions in populations of other bird species that compete for nest sites (Ludwig 1966, Drury 1973, Conover 1983, Blokpoel and Tessier 1986). In the western Lake Erie region, ring-billed (Larus delawarensis) and herring (Larus argentatus) gull populations during autumn migration have increased 20- and 6-fold, respectively, in the past 30 years (Dolbeer and Bernhardt 1986).

There are 95 chemical products currently registered by the U.S. Environmental Protection Agency (EPA) to control bird damage and nuisance problems in the United States (Eschen and Schafer 1986). Only four include gulls as target species: Polybutene and Polyisobutylene - both nontoxic tactile repellents; 4-Aminopyridine (Avitrol) - a lethal frightening agent; and 3-chloro-4-methyl-benzenamine HCL (DRC-1339), a toxicant. Currently, DRC-1339 can only be used by U.S. government personnel to control herring, and great black-backed gulls (Larus marinus) in the coastal nesting areas of Delaware, New York, New Jersey, Connecticut, Rhode Island, Massachusetts, New Hampshire and Maine. There are no gull toxicants registered for field use outside the coastal nesting areas of the Northeastern U.S. EPA is currently considering the expansion of the present registration to include ring-billed gulls and other geographical locations.

USDA/APHIS/ADC operational personnel have indicated a need for expansion of present registrations or development of new chemical registrations for gull control (Fagerstone and Schafer 1988). The objective of this pilot field study was to compare the potential of a presently unregistered chemical, alpha-chloralose ($C_8H_{11}Cl_3O_6$) and the registered gull toxicant DRC-1339, to reduce a nesting population of herring gulls in Ohio.

DESCRIPTION OF CHEMICALS

Alpha-chloralose (A-C) is a narcotic which depresses the cortical centers of the brain but has no effect on the medulla (Borg 1955, Crider and McDaniel 1967). A-C has proven to be relatively safe in capturing birds for research (Murton et al. 1963, 1968, Crider and McDaniel 1966, 1967, 1969, Williams 1966, Williams et al. 1966, Crider 1967; Martin 1967, Crider et al. 1968, Austin et al. 1972, Cline and Greenwood 1972, Williams and Phillips 1972, 1973, Pomeroy and Woodford 1976, Holbrook and Vaughn 1985).

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A-C has also been used to reduce populations of several species of birds (without endangering nontarget species) that either were a nuisance, potential hazard to aircraft or harmful to agriculture (Anon. 1960, 1962, Thearle 1960, 1969a, 1969b, Ridpath et al. 1961, Murton 1962, 1963, Murton et al. 1965, Caithness 1968, Thearle et al. 1971, Cyr 1977, Feare et al. 1981, Dolbeer 1987). Several bird and mammal species have had a LD_{50} and a ED_{50} [sometimes referred to as Temporary Immobilization dose (TI_{50}) not to be confused with the therapeutic index (TI)] established[3].

The ED_{50} of A-C for wild birds ranges from 5.6 - 85 mg/kg and the LD_{50} from 32 - 400 mg/kg with a safety factor from 3.2 - 23. The LD_{50} range for rats, cats and dogs is 200-600 mg/kg (Goldenberg 1893, Giban 1950 and 1951, Borg 1955, Ridpath et al. 1961, Schafer and Cunningham 1972, Pesticides Board 1977, Cunningham et al. 1987).

A-C has been registered as an avian control agent in Great Britain, France, New Zealand and Australia. However, limited attention has been given to the use of A-C as an agent for the capture or poisoning of gulls. Borg (1955) had a kill rate of 93% for herring gulls in Sweden with an A-C bait concentration of 100 mg in 80 g fish (0.125% A-C by weight). Caithness (1968) killed at least 85% of a breeding colony of 2,500 southern black-backed gulls (Larus dominicanus) in New Zealand with 5-g bread baits each containing 200 mg of A-C (3.77% A-C by weight). Control activities on lesser black-backed gulls (Larus fuscus) and herring gulls have been conducted at their breeding sites during egg incubation in Great Britain. A-C treated bread squares placed in nests were eaten by the adults (Mitchell 1976). However, neither the ED_{50} nor LD_{50} for A-C have been established for any gull species.

Physical, chemical and toxicological properties of DRC-1339 have been summarized by DeCino et al. (1966) and Schafer (1979). DRC-1339 is a slow-acting toxicant that impairs the circulatory system, causing uremic poisoning and congestion of major organs. Death can occur up to four days after ingestion. DRC-1339 is registered in the U.S. to reduce populations of several species of birds that are a nuisance or harmful to agriculture (Eschen and Schafer 1986) and since 1969 it has been used to reduce gull populations in Maine and Massachusetts (Gramlich 1969, Ladd 1970, Snow and Gramlich 1971[4], and Drennan et al. 1986, 1987). The only LD_{50} information presently available for gulls was obtained by Wetherbee (1968) for herring gulls on the east coast and estimated to be 2.9 mg/kg (Schafer 1979). However, the actual weights of the gulls tested were not considered when dosing or determining the LD_{50}.

STUDY AREA AND METHODS

The study was conducted in 1988 at the Lower Lake Dock Company (LLDC), a 30-ha nesting and loafing site for herring gulls in Sandusky, Ohio adjacent to Sandusky Bay of Lake Erie (fig. 1). Gulls have created various problems at the LLDC, a coal shipping facility, primarily by causing power outages at the transformer station and disrupting workers through aggressive defense of nests and young. The LLDC is 0.4 km west of Turning Point Island, a 2.0-ha man-made island with two adjacent 4 x 450-m breakwalls, that has supported a nesting colony of herring gulls since at least 1977 (Scharf 1978, Dolbeer et al. 1988).

Prebait was made by spreading 12 g of soft margarine on a slice of soft white bread and covering with another slice. The sandwich was then pressed firmly with a flat board and sliced into 18 pieces. Each piece weighed about 3.3 g. Prebaiting was conducted on 12 and 13 April by spreading about 1,000 baits on the ground each day at various sites at the LLDC.

Baiting with A-C was conducted between 0800 and 1000 on 14, 15, 18, 20 and 22 April (table 1). A-C was mixed with the margarine to a level of 4, 8 or 16% by weight, resulting in bread baits containing 26, 53, or 106 mg of A-C. Baits were placed in nests or spread out in lines at 2- to 3-m intervals where concentrations of gulls were located. Bait sites were observed to determine the time of initial bait consumption and initial reaction and immobilization.

DRC-1339 (obtained from Denver Wildlife Research Center) was mixed with margarine to a level of 1.6 or 3.2% by weight. This resulted in each bread bait containing 10.8 or 21.6 mg of DRC-1339, 3.7 to 7.4 times the LD_{50} value of 2.9 mg/kg reported for herring gulls (Schafer 1979). (Note: herring gulls in our study averaged about 1 kg in weight - see table 3). Baiting was conducted on 27 April, 3 May and 13 May in the same manner as with A-C.

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[3]LD_{50} is the median lethal dose that produces death and the ED_{50} is the median effective dose that produces a defined effect (e.g., capture) in half of the population to which the drug is administered and the safety factor (Therapeutic Index) is the ratio of LD_{50} to the ED_{50} ($TI=LD_{50}/ED_{50}$).

[4]Snow, W. O., and F. J. Gramlich. 1971. Gull control, Matinicus Rock and Green Island (Petit Manan), Maine. U.S. Fish Wildl. Serv., Region 5, Memorandum. 3 pp.

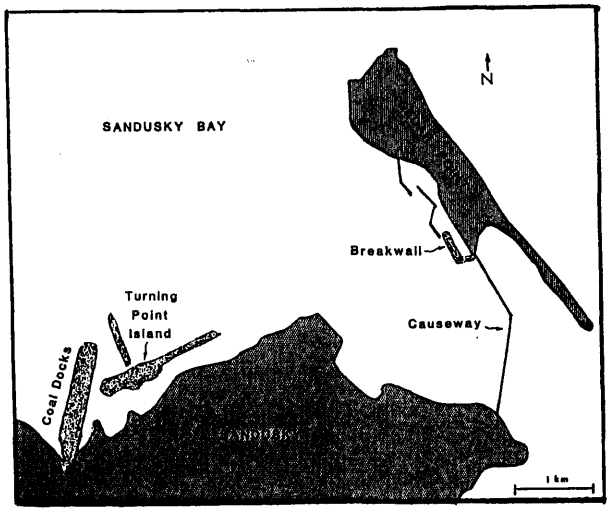

Figure 1.--Map of Sandusky Bay at Sandusky, Ohio showing location of coal docks, Turning Point Island and breakwalls where herring gulls nested, 1988.

A rough estimate of the gull population at the LLDC was made at the time of each baiting by visually scanning the area with binoculars from several observation points. All baits not consumed within two hrs of placement were retrieved. After A-C baitings, the coal docks and surrounding loafing areas up to 2 km away were searched for dead or affected gulls during a 3-4 hr period. After DRC-1339 baiting, similar searches usually were made 24 hrs later and then at 1-2 day intervals for 4 days. Dead birds were retrieved and buried; incapacitated gulls were placed in a 2.5 x 2.5 x 2.0-m holding cage with food (fish offal) and water until they either recovered or died. The Ohio Division of Wildlife and the Sandusky Health Department were notified of our study and requested to report to us any dead or affected gulls brought to their attention.

On 9 May, 12 herring gulls that had been captured at LLDC with A-C baits during the April baitings were each force-fed a DRC-1339 treated bread bait and placed in a 2.5 x 2.5 x 2.0-m holding cage with food and water. Three groups of 4 gulls each received baits with 10.8, 21.6 or 43.2 mg of DRC-1339. Gulls were observed at 24-hr intervals for 4 days.

RESULTS

A-C Baitings.--A total of 1,597 A-C baits were placed at the LLDC during the four baitings of which 1,308 were consumed primarily by gulls and a few starlings (*Sturnus vulgaris*) (table 1). Immobilization occurred as quickly as nine minutes after bait was consumed although most gulls did not show affects for 15 to 20 minutes. Of the 99 affected gulls retrieved, 34 survived. An additional 37 affected gulls were noted floating in the bay, but we were unable to retrieve them because of rough water. Thus, we recorded a total of 136 affected gulls or about 1 gull for every 10 baits consumed. About 1,000 gulls were at the LLDC during these baitings and the subsequent DRC-1339 baitings.

Gulls reacted to affected gulls in various ways. Often gulls would fly, spiraling high above the LLDC. On occasion, a gull would use its bill to tug at an affected mate. Most affected birds were retrieved within 1 km of the LLDC, many becoming incapacitated while in the water of the bay. Two immobilized gulls were found 6 to 7 km from the LLDC by individuals who brought them to us via Ohio Division of Wildlife personnel. Bait shyness from one day to the next did not appear to be a problem. However, on a given day, once gulls started reacting, feeding ceased although gulls did not abandon the LLDC.

DRC-1339 Baitings.--Of 1,570 baits placed out during three baitings, 100% were eaten, almost all by gulls but also by a few starlings (table 1). Initial deaths occurred within 24 hrs but most occurred 48 to 72 hrs after consumption (table 2). A total of 145 birds were retrieved or about one gull for every 11 baits consumed. Bait shyness was not a problem.

Almost all recoveries were within 1 km of the LLDC. Twelve decomposed gulls found dead in a field 4 km southwest of LLDC on 12 May were probably DRC-1339 poisoned gulls but they may have been A-C poisoned birds.

DRC-1339 Bioassay.--Although the lowest dose we evaluated (10.8 mg DRC-1339) was about 3.7 times the published LD_{50} value for herring gulls (Schafer 1979), three of the four gulls survived. One out of 4 gulls dosed at 21.6 and 43.2 mg DRC-1339 survived (table 3).

DISCUSSION

Bait acceptance with both chemicals was excellent, with over 2,800 baits being consumed by gulls. Curiously, however, only about one dead or affected gull was found for every 10 baits consumed of either chemical, and the population of about 1,000 gulls at the LLDC showed little or no decline during the study.

For A-C, ED_{50} and LD_{50} values have not been determined for gull species, but data for other avian species suggest that the doses we provided per bait (26 to 106 mg) should have been sufficient to immobilize a gull consuming a single bait. We know that multiple baits commonly were consumed by individual gulls, especially during the initial two baitings with A-C when we did not spread out the bait as widely as in later baitings. This may explain some of the discrepancy between baits consumed

Table 1.--Alpha-chloralose (A-C) and DRC-1339 baiting of herring gulls at Lower Lake Dock Co., Sandusky, Ohio, 1988.

Date	Chemical	Mg of chemical per bait[1]	No. of baits put out	No. of baits eaten	Time from 1st feeding to first immobilized gull	No. of affected gulls retrieved	Min. no. of affected gulls not retrieved	Min. total affected gulls	No. of retrieved gulls surviving	Min. no. of affected gulls/ bait consumed	Estimated no. of gulls at LLDC	Nontargets retrieved
14 Apr	A-C	26	288	288	15 min	18	4	22	6	1:13	1,200	
15 Apr	A-C	53	372	284	14 min	13	9	22	5	1:13	1,200	1 starling
18 Apr	A-C	53	246	221	16 min	16	0	16	7	1:14	1,000	
20 Apr	A-C	106	270	103	9 min	6	0	6	1	1:27	1,000	1 starling
22 Apr	A-C	53	421	412	17 min	46	24	70	15	1:6	1,000	
Total for A-C			1,597	1,308		99	37	136	34	1:10		
27 Apr	1339	10.8	358	358	24 hr	35	0	35	0	1:10	900	1 starling
3 May	1339	10.8	600	600	24 hr	38	0	38	0	1:16	1,100	
13 May	1339	21.6	612	612	24 hr	72	3	75	0	1:8	1,000	
Total	1339		1,570	1,570		145	3	148	0	1:11		
Total for 1339 and A-C			3,167	2,878		244	40	284[a]	34	1:10		

[1]Bait was made by spreading a mixture of 12 g of A-C or DRC-1339 and soft margarine on a slice of white bread and covering with another slice. The sandwich was then pressed firmly with a flat board and sliced into 18 pieces. Each piece weighed about 3.3 g and contained 10.8 to 106 mg of A-C or DRC-1339, depending on the level of A-C or DRC-1339 in the margarine (1.6 to 16%).

[a]In addition, 6 dead or affected gulls were reported in Sandusky by the Health Department, 6 were picked up around Sandusky Bay within 2 km of coal docks and 12 were located in field 4 km from coal docks. We were unable to determine if these were A-C or DRC-1339 poisoned gulls.

and gulls affected. However, we suspect that some unknown but substantial number of gulls dispersed from the LLDC before becoming immobilized and were never located.

For DRC-1339, the doses provided per bait were 3.7 to 7.4 times the published LD_{50} value for herring gulls and each gull consuming a bait should have died. However, the bioassay we conducted with 12 gulls indicated that either the chemical used was not pure or the herring gulls on Lake Erie have higher LD_{50} values for DRC-1339 than those published. Drennan et al. (1987) noted similar concerns about reduced toxicity of DRC-1339 in a program in Maine for controlling nesting populations of herring gulls and great black-backed gulls.

The fact that the population of gulls at the LLDC did not show a noticeable decline, even considering that substantially more gulls may have died than we recovered, can be explained by the large population of gulls in adjacent areas (fig. 1) such as Turning Point Island (Dolbeer et al. 1988). Gulls at the LLDC probably represented less than 10% of the gulls within a 4 km^2 area and dead gulls could have quickly been replaced. Our findings suggest that problems caused by gulls at the LLDC, such as power outages, can best be solved by erecting wire grid exclusion devices (Blokpoel and Tessier 1984). Poisoning programs at LLDC to reduce populations of gulls will provide only temporary relief at best as long as the gull populations are thriving in adjacent areas.

Although we do not recommend poisoning programs as a means of solving gull problems at LLDC, we recommend further testing of both A-C and DRC-1339 on gulls to develop these toxicants for other situations. Each chemical has unique attributes that would make it preferable in particular situations. A-C is fast acting and, depending on dosage, gulls can either be killed or captured alive. Although bait shyness occurs once gulls start reacting to A-C (usually about 15 min after initial bait consumption), this shyness does not seem to carry over to subsequent days. DRC-1339 is slow acting and thus bait placement and feeding by gulls can occur over an extended period on a given day without bait shyness developing.

For A-C, ED_{50} and LD_{50} values need to be more precisely estimated for gull species. For future DRC-1339 work, chemical assays should be conducted to ensure chemical purity. Also LD_{50} estimates for gulls from the Great Lakes and other regions are needed. DRC-1339 primarily affects the renal system; therefore, there may be a difference in the toxicity of this chemical for gulls living in fresh and salt water environments.

Table 2.--Number of dead herring gulls recovered 1, 2 and 3 or more days after baiting with DRC-1339, Lower Lake Dock Co., Sandusky, Ohio, 1988.

Date of baiting	Mg of DRC-1339/ bait	Number of gulls recovered at 24 hrs	48 hrs	>72 hrs
27 April	10.8	2	18	15
3 May	10.8	3	19	16
13 May	21.6	—[1]	—[1]	72

[1]Searches were not made.

Table 3.--Mortality of captive herring gulls force-fed bread baits with 1 of 3 levels of DRC-1339 on 9 May 1988, Sandusky, Ohio.

Dose (mg of DRC-1339) per bait	No. of gulls	Weight(g) x	SD	Number gulls alive after 24 hr	48 hr	>72 hr
10.8	4	1,053	83	4	3	3
21.6	4	990	179	4	1	1
43.2	4	940	58	3	1	1[1]
Totals	12	994	90	11	5	5

[1]Gull walked with difficulty but flew when released.

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Survey of Animal Damage and Feeding Selectivity of Rabbits in Eastern South Dakota Shelterbelts[1]

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Abstract.--Animal damage to young shelterbelt trees was measured during 1980-82. Rabbits damaged coniferous trees less than deciduous trees or shrubs. Branch clipping by rabbits was the most common form of damage which varied according to species, experiment, and locality. Rabbits did not feed selectivily with regard to 1, 2, or 3 year old saplings.

INTRODUCTION

Establishment of shelterbelts is expensive and therefore requires careful planning to optimize management objectives. Tree species used will determine a shelterbelt's effectiveness in reducing soil erosion, increasing moisture conservation, enhancing crop protection, reducing farmstead energy costs, and wildlife utilization. Shelterbelts are important habitats for wildlife including ring-necked pheasant (Phasianus colchicus) (Warner and David 1982), white-tailed deer (Odocoileus virginianus) (Popowski 1976), cottontail rabbits (Swihart and Yahner 1984), passerine birds (Martin 1980, Cassel and Wiehe 1980, Yahner 1982b, 1983b), raptors (Norelius 1984), and small mammals (Barnes and Linder 1982, Yahner 1982a, 1983a). Most wildlife exhibit positive values; however, rabbits, deer, and small mammals can have a negative value by injuring and damaging young shrubs and trees (Baer 1980).

Winter browsing by wildlife is often ignored in planning shelterbelts, even though wildlife species may cause damage to some tree species such as crab apple (table 1) (Baer 1980, Swihart and Yahner 1983). Knowledge of feeding selectivity and the extent of animal damage facilitates tree selection by potentially identifying woody species prone to animal damage.

Table 1. Scientific name of plants mentioned in text and tables.

Crab apple	*Malus* spp.
Green ash	*Fraxinus pennsylvanicus*
Hackberry	*Celtis occidentalis*
Common lilac	*Syringa vulgaris*
Tatarian honeysuckle	*Lonicera tatarica*
Blue spruce	*Picea pungens*
Eastern red cedar	*Juniperus virginianus*
Rocky mountain juniper	*Juniperus scopulorum*
Elms	*Ulmus* spp.
Siberian elm	*Ulmus pumila*
American elm	*Ulmus americana*
Dogwood	*Cornus stolonifera*
Ponderosa pine	*Pinus ponderosa*
Red pine	*Pinus resinosa*
Loblolly pine	*Pinus taeda*
Northern white cedar	*Thuja occidentalis*
Snowberry	*Symphoricarpos vaccinoides*
Barberry	*Berberis* spp.
Service berry	*Amelanchier alnifolia*
Willow	*Salix* spp.
White willow	*Salix alba*
Cottonwood	*Populus deltoides*
Robusta poplar	*Populus angulata* x *P. nigra*
Northwest poplar	*Populus deltoides* x *P. balsamifera*
Amur maple	*Acer ginnala*
Caragana	*Caragana arborescens*

Quantified data are lacking on animal damage and feeding selectivity of rabbits in shelterbelts on the Great Plains. Previous research focused on (1) local areas where rabbit damage to young trees was extensive (Baer 1980), (2) the establishment and reforestation of conifers (Littlefield et al. 1946, Cayford and Haig 1961, Sartz 1970, Black et al. 1979, Evans et al. 1981), or (3) arboretums or other specialized situations (McCabe 1945, Geis 1954, Swihart and Yahner 1983). We investigated 4 experiments designed to determine the (1) feeding selectivity of cottontails and jackrabbits and their subsequent damage to various tree species and (2) overwinter survival of trees in eastern South Dakota shelterbelts.

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METHODS

Experiments were conducted from 1980 to 1982 to assess animal damage occurring in eastern South Dakota (Brookings County) shelterbelts. A survey of 19 one-year old shelterbelt plantings during fall, winter and spring 1980-81 provided initial data upon which the remaining studies were based. Three experiments were conducted during the winter and spring of 1981-82 to determine effects of sapling age on rabbit damage, amount of damage occurring in 5 to 10 year old shelterbelts, and feeding selectivity of rabbits for 4 baits.

Experiment One

Nineteen shelterbelts, each containing at least 3 rows of trees, planted in the spring 1980 in Brookings County (Barnes 1982) were randomly selected and examined in the fall and following spring for animal damage. Tree species composition was recorded from Soil Conservation Service (SCS) records. Each tree in 4 randomly selected 15.25 m x shelterbelt-width quadrats was examined per shelterbelt.

Individual trees were examined visually. Animal damage was classified and recorded according to animal species causing damage, area of tree injured, and severity of damage (Lawrence et al. 1961). Species causing injury were recorded as rabbit, rodent, deer or domestic livestock. Area of tree injured was recorded as crown, stem, or branch. Severity of damage was recorded as slight, moderate, or lethal, and later grouped as lethal or sublethal. Heterogeneity chi square was used to detect differences ($P \leq 0.05$) in feeding selectivity among tree species.

Experiment Two

A second study was designed to examine differences in feeding selectivity by rabbits due to sapling age of the most common shelterbelt woody species and to determine the efficacy of fencing to control rabbit damage. Twenty shelterbelts were randomly selected from SCS records for study. Shelterbelts contained the following woody species: green ash, hackberry, common lilac, tatarian honeysuckle, blue spruce, and eastern redcedar.

Thirty randomly selected plot pairs (1 fenced and 1 unfenced) of 1, 2, and 3 year-old individuals of each woody species (540 pairs total) were examined in the spring 1982 for signs of animal damage (Lawrence et al. 1961). Fencing was constructed of 2.54 cm mesh x 1 m tall wire held together by wooden laths with sufficent diameter to enclose the complete tree. Hardware cloth, 0.64 cm mesh x 21 cm height, was attached to the bottom of each fence to exclude mice. Fences were placed around the trees during fall 1981 prior to the first snow.

Orthogonal chi square tests were used to detect differences ($P \leq 0.05$) in the amount and severity of damage among 1,2, and 3 year-old trees; among deciduous trees, shrubs, and coniferous trees; and individual tree species within each group. No comparisons between fenced and unfenced trees was made because none of the fenced trees were damaged.

Experiment Three

Seven 5 to 10 year-old shelterbelts were randomly selected from SCS records to assess the amount of rabbit damage occurring to green ash and tatarian honeysuckle, the two most commonly planted trees. Branches of individual trees of each species were examined for signs of rabbit damage in an unreplicated split plot design. Three randomly selected branches on 12 randomly selected trees of green ash and tatarian honeysuckle were examined in the winter 1982 for signs of rabbit injury. Rabbit damage was recorded for each branch and classified as lethal or nonlethal. A split plot analysis of variance (ANOVA) and least significant differences (LSD) were used to test differences ($P \leq 0.0001$) in rabbit damage between shelterbelts and between green ash and tatarian honeysuckle.

Experiment Four

An alternative to controlling problem animals was evaluated by providing 4 alternative forage sources; dried apples, shelled corn, whole oats, and a commercially pelleted rabbit chow (Purina Mills, St. Louis, Missouri). We randomly selected 6 shelterbelts, 2 to 10 years-old, from SCS records for study during the winter 1982. Shelterbelts were divided into 15.25 m quadrats and each of the 4 diets was placed in 4 randomly selected quadrats per shelterbelt. The experiment was replicated during January, February, and March.

Two hundred sixty seven grams of each diet were placed in a plastic gallon milk carton with 1 side cut open to expose bait. Cartons were placed at ground level for easy access and openings were only large enough to allow cottontail rabbits access. Diets were placed adjacent to one another and each diet was randomly assigned a space in each of the 4 quadrats per shelterbelt. Forages were offered during the day and collected the following morning. Orts were returned to the laboratory and weighed to determine daily consumption. Replicated split plot ANOVA and LSD were used to detect differences ($P \leq 0.0001$) in consumption between treatments, replications, and shelterbelts.

RESULTS

Experiment One

We examined 3,541 woody plants (16 species) for signs of animal damage in the 19 one-year old shelterbelts (table 2). Green ash, which was the most common deciduous tree, was found in 90% of the shelterbelts and accounted for 21% of total trees. Common shrubs included tatarian honeysuckle and common lilac. Abundant conifer species included blue spruce and Rocky Mountain juniper.

Of the 3,541 trees planted in spring, 78% were alive the following spring (table 2). Tree survival vaired from 27 to 100% but only 2.3% of total tree mortality could be attributed to animal damage. However, animals caused $\leq$ 20% seedling mortality to Siberian elm, hackberry, and caragana.

Table 2. Occurrence, mortality and animal damage of woody plant species in 19 one year old shelterbelts in Brookings County, South Dakota, 1980.

Species	No. of Trees Examined	% of Total Trees	% Occurrence in shelter-belts	Total Over-Winter Mortality	% Overwinter Survival	% Overwinter Mortality Attributed to Animal Damage	No. of Trees Receiving Sublethal Animal Damage	% of Trees Receiving Animal Damage
Green ash	736	20.7	90.0	63	91.4	4.8	70	10.8C[1]
Honeysuckle	722	20.4	65.0	93	87.1	0.0	31	4.9B
Lilac	420	11.9	35.0	96	77.1	0.0	70	21.6D
Blue spruce	297	8.4	40.0	93	68.7	0.0	3	1.5A
Hackberry	261	7.4	55.0	24	90.8	20.8	71	31.4E
Rky Mtn Juniper	246	6.9	40.0	77	68.7	0.0	0	0.0A
Ponderosa Pine	208	5.9	30.0	131	37.0	0.0	0	0.0A
Amur maple	206	5.8	30.0	16	92.2	6.2	61	32.5E
Dogwood	138	3.9	15.0	100	27.5	3.0	25	68.3I
Cottonwood	59	1.7	20.0	39	33.9	2.6	12	61.9H
Siberian elm	57	1.6	10.0	7	87.7	28.6	5	13.5C
Robusta poplar	53	1.5	20.0	16	69.8	6.2	8	24.3D
Caragana	51	1.4	5.0	10	80.4	20.0	7	20.9D
Eastern red Cedar	31	.9	5.0	3	90.3	0.0	0	0.0A
White willow	31	.9	5.0	4	87.1	0.0	10	37.0F
NW poplar	25	.8	5.0	0	100.0	0.0	12	48.0G
Totals	3,541	100.1		772	78.2	2.3	385	14.5

[1]. Values within columns followed by different letters are significantly different (P < 0.05).

Of trees surviving the first winter, 385 (14%) sustained some form of nonlethal animal damage (table 2). Severity varied by species from 0 to 68%. Of trees receiving nonlethal damage, dogwood and cottonwood received significantly more damage (> 60%) than other deciduous species (table 2). Coniferous species received significantly less clipping injury than deciduous species. Blue spruce was the only coniferous species damaged (1%).

Majority of damage sustained by trees in this study was caused by rabbits and hares. Cottontail rabbits and white-tailed jackrabbits caused 77.8% of the damage to individual trees sampled. Other species responsible for injuring young trees included voles (Microtus spp.) (8.2%), white-tailed deer (6.7%), pocket gophers (Geomys bursarius) (7.0%), and domestic livestock (6.6%). Branch and crown clipping by rabbits was the most common type of injury. Branches were clipped more commonly (170) than either crowns (138) or stems (95).

Experiment Two

Wire fences were successful in preventing rabbits and rodents from clipping or gnawing individual trees. None of the 540 fenced trees were damaged, whereas 21% of the unprotected trees received some type of clipping injury (table 3). The percentage of deciduous trees damaged (43%) was greater than coniferous trees (0%) or deciduous shrubs (21%). Green ash and hackberry received heavy browsing (> 45%) during the first 2 years. Damage between 1, 2, and 3-year old trees did not differ ($P \leq 0.05$), whereas at the 0.10 level of probability, 3-year old trees received less damage (9%) than either 1 or 2-year old trees (26 and 29%, respectively). Two-year old tatarian honeysuckle was damaged more (60%) than common lilac (14%).

Experiment Three

Rabbits clipped green ash branches more than honeysuckle branches in the 5 to 10-year old shelterbelts (table 4). Amount of damage varied by shelterbelt and there was a significant ($P \leq 0.03$) shelterbelt x tree interaction. None of the damage was considered lethal.

Table 3. Rabbit induced clipping injury to 1, 2, and 3-year old shelterbelt trees over winter 1981-82 in Brookings County, South Dakota

Groups	Species within groups	Number of trees: One-year-old examined	One-year-old damaged	One-year-old %	Two-year-old examined	Two-year-old damaged	Two-year-old %	Three-year-old examined	Three-year-old damaged	Three-year-old %	Total examined	Total damaged	Total %
Coniferous tree	eastern red cedar	30	0	0	30	0	0	30	0	0	90	0	0
	blue spruce	30	0	0	30	0	0	30	0	0	90	0	0
	GROUP TOTAL	60	0	0	60	0	0	60	0	0	180	0	0
Deciduous tree	green ash	30	18	60	30	17	57	30	8	27	90	43	48
	hackberry	30	14	47	30	14	47	30	6	20	90	34	38
	GROUP TOTAL	60	32	53	60	31	52	60	14	23	180	77	43*[1]
Deciduous shrub	common lilac	30	5	17	30	4	14	30	2	7	90	11	12
	tatarian honeysuckle	30	9	30	30	18	60*	30	0	0	90	27	30
	GROUP TOTAL	60	14	23	60	22	37	60	2	3	180	38	21
	Age Class Total	180	46	26	180	53	29	180	16	9	540	115	21

1. *Indicates a significant difference (P < 0.05) in number of trees damaged between groups or within a group.

Table 4. Rabbit damage to green ash and honeysuckle in seven 5 to 10 year old shelterbelts in Brookings County, South Dakota

	Mean number of clipping injuries							
	Shelterbelt numbers							TOTAL
Species	1	2	3	4	5	6	7	
Green ash	3.8	4.0	1.0	1.5	4.0	1.9	1.5	2.53A[1]
Honeysuckle	0.7	1.3	0.6	0.4	1.6	1.7	0.8	1.01B
TOTAL	2.2BC	2.6C	0.8A	0.9A	2.8C	1.8B	1.2AB	

[1] Values within totals column or row followed by different letters are significantly different ($P \leq 0.0001$).

Experiment Four

Dried apples were the most selected ration by cottontail rabbits (table 5). Rabbits selected the pelleted ration less than the other diets. Amount of ration consumed varied by shelterbelt and there was a significant ($P \leq 0.02$) treatment x shelterbelt interaction. Significantly less ($P \leq 0.0001$) bait was consumed during the March replicate.

DISCUSSION

Tree species composition of newly-established shelterbelts examined in this study was similar to historic plantings in South Dakota (Walker and Suedkamp 1977, Martin and Vohs 1978) with several exceptions. Green ash and honeysuckle were the dominant woody species planted. However, we observed a reduction in the amount of Siberian elm (> 50% to < 10%) and American elm (> 35% to 0%0) probably because of Dutch elm disease. Elm trees have a value in shelterbelts by providing nesting, roosting, and foraging sites for passerine birds (Martin and Vohs 1978, Yahner 1982 a,b) and do not appear to be a highly selected winter browse species for rabbits (13.5% damaged in this study). However, 28.6% of elm mortality could be attributed to animal damage, the highest of any species examined, indicating this species may need protection from animal damage.

Our data indicated an increased planting of coniferous trees, which is a positive trend because coniferous species are not preferred forage items for rabbits (McCabe 1945, Swihart and Yahner 1983, this study) or rodents (Barnes and Schaid 1981). In addition, conifers provide winter wind protection for wildlife (Hopkins 1984) and nesting and foraging sites for pheasants, mourning doves (Yahner 1982 a,b; 1983a) and selected passerine birds (Geier and Best 1980; Yahner 1982 a, b; 1983a).

Table 5. Feeding selectivity of cottontail rabbits for 4 rations in 6 shelterbelts in Brookings County, South Dakota

	Mean Gram Consumption						
Ration	Shelterbelt number						TOTAL
	1	2	3	4	5	6	
Dried Apples	109.1	167.6	72.7	62.5	116.9	68.9	99.6A[1]
Corn	106.8	55.4	18.7	25.0	42.3	108.2	59.4B
Oats	67.2	50.0	6.7	0.	92.1	72.5	48.1B
Rabbit Pellets	111.1	1.8	14.2	0.	17.6	6.4	25.2C
TOTAL	98.5A	68.7B	28.1C	21.9C	67.2B	64.0B	

[1] Values within totals column or row followed by different letters are significantly different ($P \leq 0.0001$).

Tree survival during this study was excellent except for dogwood (27.5%), cottonwood (33.9%), and ponderosa pine (37.0%). While cottonwood and dogwood were preferred by rabbits (61.9 and 68.3% damaged, respectively), only a small amount of mortality was a result rabbit browsing (2.6 and 3.0%, respectively). Ponderosa pine was not clipped by rabbits. Low overwinter survival of these species probably resulted from poor nursery stock, planting conditions, maintenance procedures, or a combination of these factors.

Animal damage to trees varied depending upon shelterbelt age and feeding preferences of rabbits but accounted for only a small percentage of overwinter mortality. Shelterbelt locality and rabbit density could also impact the amount of damage received by trees. Of the 3,541 one-year-old trees examined, 2.3% were destroyed due to injury from animals. This amount of damage is substantially lower than animal damage estimates for loblolly pine (Hunt 1968), pacific northwestern forest trees (Black et al. 1979), or selected shelterbelt trees (Baer 1980). While approximately 2% of the total number of trees were destroyed, 20% or more seedling mortality of Siberian elm, hackberry, and caragana was attributed to animal damage.

Young trees are more likely to die from browsing than older trees (Timm 1988) and our data indicated that rabbit damage decreased by the time the trees were 3 years old. Moreover, by the time trees reach 5 to 10-years of age, browsing fails to destroy the tree. Caution should be exercised when making generalities however, because woody plant responses to browsing and their abilities to withstand browsing vary. Several coniferous species, including northern white cedar, die after only light clipping (Aldous 1952), whereas others (e.g. red pine) can tolerate light browsing (Marshall et al. 1955) or even severe and repeated browsing (e.g. green ash), although such damage may result in a scrubby growth form (Parker 1941). Several deciduous species (snowberry, willows) may be stimulated or may exhibit increased vigor when browsed (Willard and McKell 1978, Belsky 1986).

Branch clipping by rabbits was the most common type of damage observed in all shelterbelts. This type of damage is usually not lethal but may result in altered tree growth forms. Rabbit populations vary according to available habitat and the amount of damage presumably varies as a function of rabbit density, amount of forage available, and feeding selectivity of individual animals. Differences in amounts of clipping injury between shelterbelts recorded in the 5 to 10-year old plantations were probably a result of varying rabbit densities, associated habitat variables, and availability of alternative forage sources. These data indicate that rabbits are the dominant vertebrate pests in newly-established shelterbelts as suggested by Timm (1988) but the intensity of damage varies geographically and may be related to woody species planted (Geis 1954, Baer 1980, Swihart and Yahner 1983).

Rodent damage was not severe in this study (8.2%). However, vole populations are highly cyclic (Keith 1974) and during peak densities, voles may cause extensive damage (Littlefield et al. 1946, Cayford and Haig 1961, Sartz 1970). Rodent populations were not measured in our study. Rabbit and rodent damage to highly susceptible woody species can be effectively controlled using fences or plastic tree guard tubes (Baer 1980, this study).

Feeding preferences of rabbits in the 1, 2, and 3-year old shelterbelts varied, but generally deciduous trees were selected first, deciduous shrubs were secondarily preferred, and coniferous species were mostly avoided. Even in the older shelterbelts (5 to 10-year age class), rabbits selected a deciduous tree over a deciduous shrub. The amount of damage to specific woody species also varied during each study. In this first study, 10% of the green ash and 5% of the honeysuckle trees were injured, whereas in the second experiment up to 60% of the unfenced trees of both species were injured. The amount of damage incurred by the coniferous species, hackberry, or lilac were similar among studies.

The reason rabbits and rodents select certain tree species and why it varies geographically is not clearly understood. Sweetman (1944, 1946, 1949) reported that in Massachusets rabbits preferred browsing dogwood, cottonwood, and willows similar to our results. However, Swihart and Yahner (1983) and Baer (1980) found that jackrabbits in Minnesota and South Dakota prefer fruit trees; cottontails selected barberry, snowberry, serviceberry, and elms, species occurring in limited abundance in shelterbelts. This feeding selectivity by hares and rabbits may be related to the presence of secondary plant compounds. Most coniferous species planted in shelterbelts contain resins, terpenes, volatile oils, or other secondary plant compounds, which may act as a natural deterrent to browsing (Bryant and Kuropat 1980, Sinclair et al. 1982, Tahvanainen et al. 1985).

Efficacy of providing alternate food for rabbits to alleviate damage to trees will vary due to a variety of factors including rabbit density, proximity to other available habitat, and tree species available for browsing. Our data showed that forage consumption by rabbits varied between shelterbelts which indicated differences in rabbit populations within a given area, availability of alternative forage sources, or feeding selectivity of rabbits. Consequently, this technique may not work under all circumstances. The data indicate if alternative feeding is the preferred control option, January and February are the most appropriate times because low quantities of bait were eaten in March. Low consumption in March could be attributed to natural rabbit mortality by this time or to the reappearance of natural forage. Our data indicated that rabbits preferred dried apples and avoided pelleted ration. Dried apples would be expensive and difficult to obtain; whereas, corn or oats are readily available and are probably more cost effective.

MANAGEMENT RECOMMENDATIONS

Data collected in this study indicate that certain tree species are highly susceptible to rabbit browsing. However, since damage occurred primarily to 1 and 2-year old trees, not all species were heavily browsed, and fencing provided maximum protection from browsing, we recommend that some type of protective device be placed around highly preferred tree species for several years. We also encourage increased planting of coniferous tree species because they do not receive damage from rabbits and they provide benefits to wildlife. We also recommend using woody species that are not highly preferred by rabbits where rabbit populations are high. If providing an alternative forage source is the management option selected, we suggest of the foods tested, using corn or oats during January or February.

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Managing Damage to Alfalfa Caused by Plains Pocket Gophers[1]

Ronald M. Case[2]

Plains pocket gophers (Geomys bursarius) may reduce yields of grasslands and alfalfa fields 21 to 49%. This represents a significant economic liability. Numerous means of reducing pocket gopher densities have been implemented. Some of our current methods to control pocket gophers are being seriously challenged, thus necessitating new ways of managing damages caused by this mammal.

INTRODUCTION

The discipline of wildlife management that deals with problem animals, or damaging animals, is beset with numerous problems. Often the most direct means of lessening problems or damages is through animal removal. Frequently that is accomplished by killing the offending animal or reducing the population of that species. There are numerous alternatives to animal removal including habitat alteration, repellents, fencing, and various cultural practices.

Despite the well-reasoned (to problem-animal managers, at least) pleas to justify animal removal, many segments of society have registered protests to this approach. Their protests run the gamut from being not cost effective to being not humane or in violation of an animal's right to exist to upsetting the natural balance (which now includes chemical contamination of our earth).

One way to deal with these challenges is to direct our efforts to nonlethal methods. This thought is certainly not new. However, much of our thinking in this field has been vertical. We have tried to devise better methods of killing animals. We have strived to make our lethal agent highly species-specific, short-lived in the environment, and incapable of causing secondary poisoning. I suggest that we try more horizontal thinking as we strive to come up with new ways to cope with problem animals, or animal damage problems.

Most recently we have had another factor confound our difficulties. Or, perhaps this has enhanced our opportunities. That is the Agriculture Productivity Act which was passed by Congress in 1985, as a part of P.L. 99-198, The Food Security Act. This act provides the authority to conduct education programs and research in low-input, sustainable agriculture (LISA).

LISA has several objectives including increasing on-farm profits to maintaining the environment. The program will build on Integrated Pest Management (IPM) and crop rotation practices. The outcomes expected of LISA are reduced input costs to the farmer, erosion control, and pollution abatement resulting from decreased fertilizer and pesticide use. This is where we have a problem or an opportunity.

The objectives of my paper are to document that pocket gophers do cause damage to forage crops, that this loss is significant economically, and that there may be new ways to control damages caused by pocket gophers. The new ways are not always new, but they are untested and could incorporate theoretical aspects as well as anecdotal means.

YIELD REDUCTION ATTRIBUTED TO THE PRESENCE OF POCKET GOPHERS

Foster and Stubbendieck (1980) investigated the effects of plains pocket gophers on forage yields on rangelands in western Nebraska. Their findings indicated that pocket gophers reduced yields from 21 to 49% on four different sands and silty range sites. The lowest reduction occurred on the poorest range site. Pocket gophers also reduced range condition (% of climax) on all range sites. And there was a reduction in perennial grasses on all sites where gophers were present with a concomitant increase in annual grasses and both annual and perennial forbs.

Luce et al. (1981) documented that plains pocket gophers reduced yields of dryland alfalfa 43 to 46% in southeastern Nebraska. Alfalfa plant density also decreased, but other plant species increased when gophers were present. This offset the loss of yield somewhat but total forage yields still were 37-38% less when gophers were present.

Hegarty (1984) investigated the effects of plains pocket gophers on irrigated alfalfa and hay meadows in the Nebraska Sandhills. He found that yields were reduced an average of 30% on hay meadows but only 17% on the irrigated alfalfa. Again increaser or invader vegetation was associated with the presence of pocket gophers.

The above studies in Nebraska have been corroborated by other researchers. Fitch and Bentley (1949) reported a 25% reduction in forage on foothill rangelands in California when pocket gophers were present. The pocket gopher was the smaller Thomomys

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[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. [Colorado State University, Fort Collins, April 17-20, 1989].

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bottae. Alsager (1977) noted that rangeland yields increased 16% after T. talpoides were controlled on rangelands in southwestern Alberta, Canada. Finally, Reichman and Smith (1985) found a one-third reduction in plant biomass directly over plains pocket gopher tunnels compared to adjacent areas. It can be safely stated that the presence of pocket gophers will reduce vegetation yields. The economics of controlling pocket gophers have been modeled by Case and Timm (1984). Their model mandates the economics of alternative control techniques compared with no control. However, many improvements still need to be made in our data base.

It is important to know why yields are less when pocket gophers are present. Obvious causes are direct consumption, burial of vegetation, and changes in species composition. In addition plant vigor likely is affected which can influence its competive capabilities. Perhaps this is why yield reductions, in irrigated alfalfa, where pocket gophers were present, were not as severe as on dryland habitats. Finally, pocket gophers also benefit plant production by increasing water infiltration, reducing soil compaction by their tunneling, adding fertility to the soil by their feces and buried vegetation, and by reducing plant density. How can we use this information to minimize adverse effects of pocket gophers?

POCKET GOPHERS AND BELOWGROUND BIOMASS

It is obviously very energy demanding to move through a medium as dense as soil. Thus, if gophers are prudent in their movements, they should dig less in rich habitats and more so in poor habitats, assuming that gophers dig primarily to obtain food. However, Sparks and Anderson (1988) and Anderson (1987) failed to detect any correlation with Geomys bursarius burrowing and belowground resource availability. Cameron et al. (1988) also concluded that burrow systems of G. attwateri were not adaptive to resource availability. Factors that the above authors noted to influence pocket gopher burrowing were the size of the animal and bulk density of the soil.

Why gophers dig so much is yet to be determined. Tunberg et al. (1984) noted that pocket gophers readily invade and utilize tunnels that have been abandoned or are otherwise not used. This may in part be related to locating a mate.

POCKET GOPHERS AND OTHER ALFALFA VARIETIES

Alfalfa with fibrous root systems, such as Spredor II, have great winter hardiness, however, this is accompanied by a yield loss. This probably explains why this variety is not used often where cold tolerance is not critical. By the fourth year the yield is only about 80% of the tap rooted variety, Wrangler.

On the other hand, each time a root of Spredor II is broken or damaged, it will sprout a new shoot. What will be the impact of short term belowground herbivory on yields of Spredor II? Could it be that the presence of pocket gophers will actually increase the above ground yield?

Even without compensatory yield increases, the fibrous rooted variety will survive with some belowground herbivory while the tap-rooted variety will die if the tap root is consumed by pocket gophers. Also, with partial feeding, plant vigor should not be as adversely affected by herbivory and the fibrous variety could maintain its competitiveness.

MANAGEMENT IMPLICATIONS

Public concern about chemicals in the environment and general concern to increase the profitability of the agricultural community have resulted in legislation that will influence damage control operations. We need to expand our data base and expand our thinking to include other control methods. With LISA there will likely be more use of crop rotations and extensive use of alfalfa in those rotations. The frequency of rotation, alfalfa variety, and other benefits from rotation such as reduced insect and disease loss to crops all need to be included in an analysis of damages and methods to control those damages.

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Kansas Attitudes on Prairie Dog Control[1]

Charles D. Lee[2] and F. Robert Henderson[3]

Abstract.--In Kansas prairie dog management is primarily determined by private individuals and local government agencies. We conducted a mail survey of 350 affected landowners as a means to evaluate the effectiveness of current prairie dog control. The same survey was also sent to 350 randomly selected state residents within the general prairie dog range. We evaluated people's perceptions of prairie dogs, the effectiveness of control methods, costs of control, and reasons for poor response to control techniques. Results indicate people that have previously been involved in prairie dog control on lands they manage have different opinions about prairie dogs than general residents.

INTRODUCTION

In Kansas prairie dog management is primarily determined by private individuals and local government agencies. In 1901 and 1903, the Kansas legislature passed laws (K.S.A. 80-1201, 1203) authorizing townships to conduct prairie dog eradication programs and provide funds for Kansas State Agricultural College to hire a field agent to "direct and conduct experiments for the purpose of destroying prairie dogs and gophers" (Lantz 1903). In recent years seven counties have invoked "Home Rule" to take over authority for prairie dog control from the townships and impose mandatory control requirements on landowners. This came about mainly because of increasing prairie dog numbers and disputes over the problems created when prairie dogs dispersed into surrounding pastures.

Some counties have gone to an operational program where the landowner is first given the opportunity to control "his" prairie dogs and if he fails to do so it is done by the county at landowner expense. In several counties the county weed supervisor is given prairie dog control responsibility in the winter. Other counties contract with commercial pest control applicators to conduct the control program. If the landowner refuses to pay the costs, the costs may be extended to the property and extended on the property's tax roll.

Township boards and county commissioners in some cases mandate prairie dog elimination. A few landowners are being forced to eliminate prairie dogs on their acreage even though they may like and protect the prairie dogs.

In Kansas over 97% of the land is in private ownership. In Wallace County, Kansas, a Cooperative Extension Service (CES), estimate indicated over 14,000 acres inhabited with prairie dogs in 1979. CES again surveyed that county in 1988 and determined that there are less than 300 acres inhabited by prairie dogs. This type of reduction in acres has not occurred in other counties that have a county-wide control. However, Wallace county has had some very hardworking,

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persistent and dedicated employees involved in the prairie dog control program for the last 10 years.

Estimates of prairie dog acreage in Kansas are not very precise. Some states, including Kansas, are planning on conducting prairie dog surveys to locate sites for possible black-footed ferret reintroduction. Kansas Cooperative Extension Service surveyed eight counties for prairie dog colonies in Kansas in 1988. The purpose of this survey was, in part, to obtain bench mark data to measure prairie dog expansion 10 to 20 years in future as a result of CRP native grass plantings now taking place. This survey was conducted using Kansas Department of Revenue aerial photographs. These high quality photo's (1:4800) were accurate in locating prairie dog colonies. The photographs were taken in the spring of 1986 and colonies may have changed since then. Some researchers have noted inaccuracies in relying on aerial photos as population indicators (Bishop and Culbertson 1976 and Cheatheam 1973). However, there are not other known methods that involve less expense and offer at least trend data as accurate as this method. Kansas Department of Revenue plans to have photographs available on a 5 year rotation.

METHODS

KSU Extension conducted a mail survey in the fall of 1988 to gather information on Kansan's attitudes on prairie dogs. The survey was sent to 350 landowners who had previously received a permit from Kansas Wildlife and Parks to fumigate prairie dogs. This permit is required by Kansas law (K.S.A. 32-158). About 350 general residents in the prairie dog range were also mailed survey forms. Response rate was good with a 48% return from the landowners with previous permits. Only 22% of the general residents responded to the survey. No follow-up attempts were made to collect information.

RESULTS

The two segments of populations that were surveyed viewed prairie dogs differently. It is interesting to note that 95% of the people who had prairie dogs on their range view them as pests, and 78% of the general residents that responded believed prairie dogs were pests to rangeland. This contrasts with some views that prairie dogs are not as destructive to rangeland as once believed and in some ways may be beneficial to rangeland (O'Meilia et al 1982 and Uresk 1985).

Only 5% of the people with prairie dogs viewed them as being ecologically important but, 18% of the random sample had this belief. Lovaas (1973) reported that prairie dogs are probably the most popular wild animal in the National Park areas of the Great Plains.

The re-introduction of the black-footed ferret is also an issue that concerns those involved with prairie dog management.

About 1/2 of those people who responded to the survey would like to see black-footed ferrets re-established in the wild. There was no significant differences between the two groups of Kansans. Comments about ferrets ranged from "I don't know much about ferrets, but sure haven't seen any good in prairie dogs" to "I'd go for the ferrets if they would wipe out pocket gophers." We believe a great deal of educational effort is needed so that public attitudes can change. Neither side in this problem seem to be embracing knowledge derived from scientific studies. It may be too late to bring about a change in public thinking before environmental factors start having detrimental effects on not only prairie dogs, but man too.

There are many different control methods being utilized in prairie dog control programs. In Kansas more people that responded to the survey used fumigants than any other method reported. Fumigants have the most detrimental effects on any ferrets that may be present, however, we believe the black-footed ferret no longer exists in Kansas.

Zinc phosphide treated oats are now most often recommended as a control method and would have the least detrimental effect upon the black-footed ferret. Yet, only 9% of the respondents indicated they used that product.

Products that were reported to be used occasionally but are not registered for prairie dogs include gasoline, propane, anhydrous ammonia, poison peanuts, larvacide, and chloropicrin.

Sometimes lack of success in control methods by individuals is cited as a reason for county-wide control efforts. This survey indicates 53% of the individual respondents achieved a success rate greater than 90%. Reasons for lack of good success rates varied with the type of

control program used, but 39% of the respondents believe the prairie dogs migrated into their land after they had controlled them.

Some thought could be given to an overall prairie dog management plan within given areas of the Kansas prairie dog range. Public monies could be used to keep prairie dogs within tolerable limits and at the same time demonstrations along with an educational program could be used to bring about better grazing management which would tend to limit prairie dog expansion.

If the general public wants prairie dogs at this particular point in time a cooperative plan with affected landowners needs to be started.

The "boom and bust" control programs are resulting in a reduction in prairie dogs, overgrazing, and no possible hope for restoring black-footed ferrets on private land in Kansas. This would seem to indicate support for control efforts over a large area as opposed to each individual landowner controlling prairie dogs on his property. But the question is, will the objective be "control" or eradication?

ECONOMICS

Costs to control prairie dogs ranged from $3.00/acre to over $100/acre. The average cost estimated by 114 respondents on this question was $32.84/acre. The costs reported by users are higher than previous researchers have reported (Collins et al 1984).

The value of the grass lost due to prairie dogs differed widely among groups. Those people that had permits claimed prairie dogs consumed $30.05 worth of grass per acre and the general resident believed prairie dogs would consume $6.71/acre.

Shooting as a Control Method

Sometimes shooting of prairie dogs is recommended as a control method (Knowles, 1988). In Kansas, we in Extension often get requests for places to hunt.

Of the 87 of the respondents who allowed shooting of prairie dogs only 4 landowners wanted their land on a list as a place that allowed hunting of prairie dogs. Just 8 landowners wished to have their land listed as a place to shoot prairie dogs for a fee. The recommendation of shooting of prairie dogs does not seem to be a viable alternative for Kansas prairie dog managers who must rely on personal contacts to fulfill the need of recreational hunting of prairie dogs.

SUMMARY

People attitudes play a large role in prairie dog management. This survey showed a majority of Kansans consider prairie dogs as pests and not ecologically or recreationally important. If the public does not consider the prairie dog as a valuable part of our natural resources, its future looks bleak. Kansans report excellent success in controlling prairie dogs. Since over 97% of Kansas is held in private lands, governmental agencies concerned with management of prairie dogs may have little to do.

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Effects of Two Prairie Dog Rodenticides on Ground-Dwelling Invertebrates in Western South Dakota[1]

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Abstract.--Immediate and long-term effects of 3 rodenticide treatments on nontarget invertebrates were evaluated on prairie dog colonies. Immediate impacts indicated zinc phosphide reduced ants, strychnine alone reduced wolf spiders, and prebaited strychnine had no impacts. Long-term changes showed increases in wolf spiders and ground beetles and densities were contributed to biotic and abiotic habitat alterations due to lack of prairie dog activities. Among comparisons for efficacy, zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment; long term impacts for insects in general were minimal.

INTRODUCTION

Immediate and long-term effects of rodenticides on nontarget invertebrates has not been fully evaluated. Many rodenticides are nonspecific and a margin of safety to nontarget invertebrates is often overlooked by applicators when selecting toxic baits. Control of black-tailed prairie dogs (Cynomys ludovicianus) in western South Dakota provided an opportunity to study rodenticide impacts on nontarget invertebrates and to compare efficacy of 3 rodenticide treatments.

Prairie dogs create niches for invertebrates in rangeland ecosystems (Wilcomb 1954, Koford 1958, Smith 1967, O'Meilia et al. 1982, Agnew 1983). For example, prairie dogs act as ecosystem regulators by maintaining habitat patches of diverse vegetation (Detling and Whicker 1987) suitable for invertebrates that are associated with bare soils, sparse vegetative cover, and short-grass habitats. Invertebrate habitat provided by burrows is disturbed when prairie dogs are poisoned and prairie dog activity ceases. Burrows are no longer maintained, soil erodes into the hole and vegetation recaptures mounds (Potter 1980). It is unknown how induced changes on short-grass habitat effects invertebrates associated with prairie dog burrows.

This study assessed immediate and long-term responses (1 year after rodenticide application) of invertebrate densities on poisoned prairie dog towns. Secondly, efficacy of zinc phosphide-with prebaiting, prebaited strychnine, and strychnine alone were compared for reduction of nontarget invertebrates. Information will provide further understanding of prairie dog town ecology and management guidelines for minimizing nontarget invertebrate losses due to prairie dog rodenticides.

STUDY AREA

The study was conducted south of Wall and east of Rapid City on Buffalo Gap National Grasslands and in the Badlands National Park of western South Dakota. Vegetated table top buttes and gently rolling mixed grasslands scattered throughout the Badlands formations characterize much of the area and support prairie dog towns (See Deisch 1986 for complete description).

The National Grasslands located in Conata Basin were grazed by cattle at stocking levels set by the Forest Service. American bison (Bison bison) were located in Badlands National Park but cattle were absent.

METHODS

Invertebrates were sampled with pitfall traps (Greenslade 1964, Gist and Crossley 1973). Eighteen permanent sites were established on 15 prairie dog colonies. Metal cans (15 cm x 15 cm) lined

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with plastic buckets were buried flush with soil surface. Pitfall traps were arranged within a grid design with 10 m spacing. Traps were opened (lid removed) for 4 consecutive nights (196 trap nights/session) on each site. Trapping sessions were from May through October of 1983 and May through August of 1984. Mean of each taxa per trap session was estimated for relative density.

Immediate impacts of rodenticides were sampled on each site 1 week before poison application in September 1983. Posttreatment counts were taken the fourth day after rodenticides were applied. Long-term impacts of rodenticides were evaluated from data collected during September 1983 and all 1984 trap sessions. Rodenticides were not applied in 1984.

Rodenticides and Bait Application

Steam-rolled oats used for prebait (4 g) and poisoned bait (4 g) were formulated at U.S. Fish and Wildlife Service Pocatello Supply Depot. A 2.0% by weight active zinc phosphide and 1.5% Alcolec S (American Lecithin Co., Inc.)[5] adhesive were applied to oats. Strychnine alkaloid was applied to oats as 0.5% by weight. Nontreated oats were applied as prebait for zinc phosphide and for 1 strychnine treatment. Active rodenticides on oats were applied 3 days after prebaiting. Both prebait and rodenticides were applied to large areas from bait dispensers affixed to Honda ATV's (Schenbeck 1982). Smaller areas were poisoned on foot and bait was distributed onto mounds with teaspoons.

Statistical Analysis

Each rodenticide was evaluated for effects on nontarget invertebrates by comparing the change of mean relative density on each cluster of treated sites with the change observed on respective control sites. Five comparisons through time included immediate impacts (September 1983) measured between pretreatment and posttreatment poisoning. The remaining 4 comparisons were differences in years from pretreatment (1983) to posttreatment (1984). When a significant correlation existed between pretreatment and posttreatment observations, analysis of covariance was used (Deisch 1986, Uresk et al. 1987) and if non significant, subtraction (Green 1979) was used.

Comparisons among rodenticides for efficacy were produced by forming pairwise contrasts of individual rodenticide treatments. Randomization procedure was used to estimate statistical significance of various contrasts (Edgington 1980, Romesburg 1981, Uresk et al. 1986, Uresk et al. 1987). Rejection of any rodenticide impact (Type II error) to nontarget invertebrates was considered more serious than potential incorrect acceptance of a significant treatment effect (Type I error) (Tacha et al. 1982).

[5]Reference to trade name does not imply endorsement of product.

After significant (P=0.10) treatment differences were detected, Type II error protection was produced by testing each contrast individually. Type I error protection was afforded by testing for a significant (P=0.10) individual contrast of treatment differences with analysis of variance or covariance (Carmer and Swanson 1973).

Individual contrasts were considered biologically significant at P=0.20. Although an alpha of 0.20 is not a standard level of significance, it is becoming more accepted for ecological field studies (Hayne 1976). The number of sites available for this study produced a power of 0.80. This was an acceptable combination of Type I and Type II error protection (Carmer 1976) and allowed for reasonable biological inferences to be drawn from the data.

RESULTS

Five invertebrate classes were collected: Insecta, Arachnida, Chilopoda, Diplopoda, and Crustacea. The 7 most abundant invertebrate families used in statistical analysis were spider mites (Tetranychidae), ants (Formicidae), wolf spiders (Lycosidea), crickets (Gryllidae and Gryllacrididae), ground beetles (Carabidae), dung beetles (Scarabaeidae), and darkling beetles (Tenebrionidae).

Immediate Effects of Rodenticides

Zinc phosphide immediately reduced ant densities on treated sites (fig. 1). Spider mite, cricket, wolf spider, ground beetle, darkling beetle, and dung beetle densities were not immediately affected by zinc phosphide. There were no immediate effects of prebaited strychnine on the 7 invertebrate families (fig. 2). Only wolf spiders were immediately affected by strychnine (fig. 3). Densities decreased 13% on treated sites.

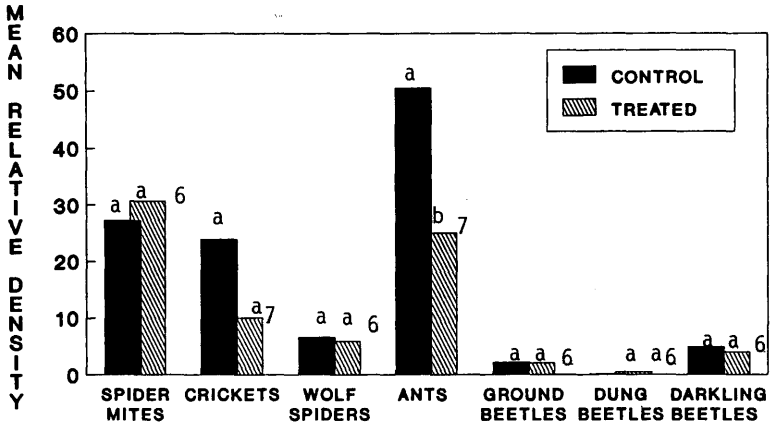
Long-term Effects of Rodenticides

Wolf spiders and ground beetles showed increases after one year on zinc phosphide and strychnine with pre baiting respectively (Deisch 1986). Other insects were variable among rodenticide treatments with no consistant patterns. Generally long-term impacts were minimal for these insects.

Efficacy of Rodenticides

Comparisons of efficacy among 3 rodenticide treatments were made when an immediate or long-term treatment effect was detected. Zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment. Other efficacy comparisons showed no significant differences in reductions of nontarget invertebrates. There were no efficacy differences between strychnine and prebaited strychnine treatments for immediate impacts. Long-term efficacy effects were extremely variable and no consistent pattern in rodenticide effectiveness was detected. Long-term "effects" were not directly related to rodenticides, but more to habitat changes (Deisch 1986).

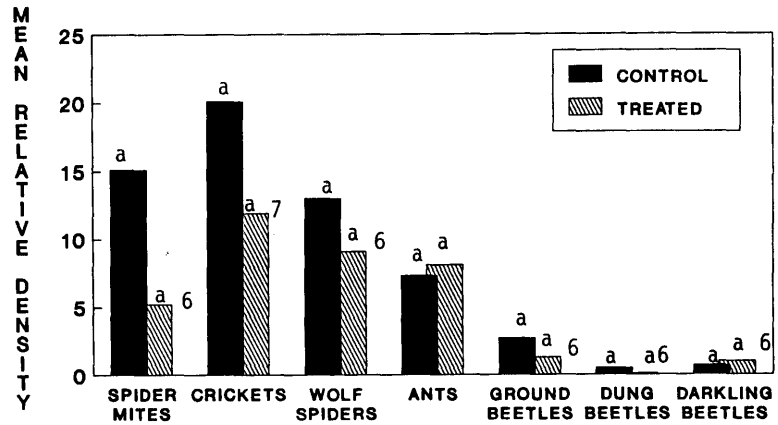
Figure 1.--Comparisons of invertebrate means/196 trap nights on sites treated with zinc phosphide and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

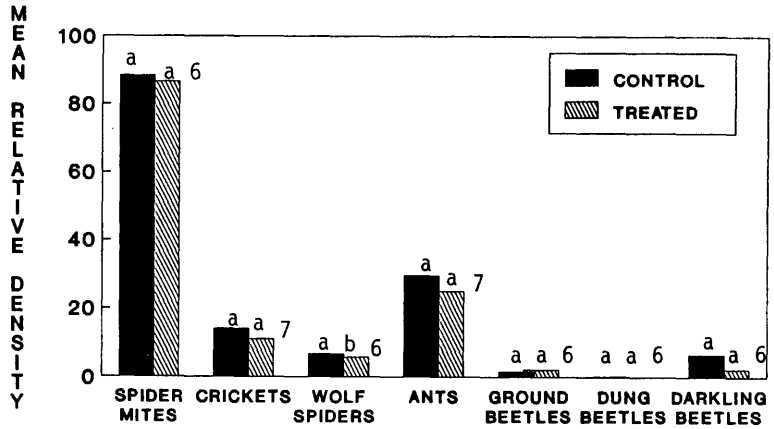
Figure 2.--Comparisons of invertebrate means/196 trap nights on sites treated with prebaited strychnine and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

Figure 3.--Comparisons of invertebrate means/196 trap nights on sites treated with strychnine and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

DISCUSSION

Immediate effects

Ecological literature lacks supportive information on direct and indirect effects of zinc phosphide and strychnine on nontarget invertebrates. Invertebrates will carry off and consume poisoned grain distributed for rodent control (Marsh 1962). Invertebrates on prairie dog towns that consume seeds were immediately effected by rodenticidal grain.

Ants were immediately reduced on zinc phosphide sites. Harvester ants (Pogonmyrex spp.) in western states feed principally on seeds and can be exterminated with poisoned grain (Furniss and Carolin 1977). Strychnine alone showed immediate reductions of wolf spider relative densities. It is questionable that strychnine directly reduced wolf spiders since these arachnids do not consume seeds (Lowrie 1973, Milne and Milne 1980). However, it is suggested that strychnine influenced the food base of the predatory spider.

Spider mites, crickets, darkling beetles, ground and dung beetles were not affected by the 3 rodenticides because of their food preference (Borror and White 1970, Milne and Milne 1980). Spider mites are equipped with piercing mouth parts for sucking plant juices and usually feed on live green vegetation. Crickets do not depend upon grain for their survival and feed on plant foliage, seedlings, dead and dying insects, hair, hide and carrion. Darkling beetles are detritivores but will consume small amounts of seeds (Kramm and Kramm 1972). Ground beetles are voracious predators. Dung beetles are scavengers and recycle dung, carrion, and decaying vegetative matter (Kramm and Kramm 1972).

Long-term impacts

In this study very few long term impacts occurred. Wolf spider densities increased the year following treatment with zinc phosphide and an increase ground beetles occured on the strychine treated areas. Vegetation height on treated prairie dog towns increases after elimination of prairie dogs (Klatt 1971, Potter 1980). Wolf spiders are active on soil surface and seek cover under vegetation and debris to hunt (Lowrie 1973). Change in vegetation structure provided greater cover and prey diversity (Murdock et al. 1972).

Dramatic ecological changes occur on prairie dog towns once these rodents have been poisoned and eliminated. Changes in plant communities (Uresk 1985), lack of suitable prairie dog borrows, and lack of continual soil mixing by prairie dogs, can influence insect density and diversity (Koford 1958).

Invertebrates have been overlooked in most ecological studies that pertain to nontarget losses due to rodenticides. These small fauna are important components of rangeland ecosystems (Hamm 1972, HeWitt et al. 1974, Agnew 1983, Sieg et al. 1985). Insects and archnids often make up a large percentage of animal protein matter in diets of mammal species that are associated with prairie dog towns. These include swift fox (Vulpes velox) (Uresk and Sharps 1986), burrowing owl (Athene cunicularis) (MacCracken et al. 1985), northern grasshopper mouse (Bailey and Sperry 1929), deer mouse (Flake 1973), and other insectivorous mammalian and avian species.

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Plant Compositional Change in a Colony of Black-Tailed Prairie Dogs in South Dakota[1]

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Abstract.--Peak season multi-species cover of vegetation and burrow mound density were estimated for 3 years along a transect that ran from the geometric center of a black-tailed prairie dog (Cynomys ludovicianus) colony, to its edge. The forb dominated core of the colony expanded 25 m in radius during the study, while plant composition changed dramatically in a small (<0.3 ha) zone midway between the edge and the core. We determined that year to year functional increases in multi-species canopy cover, described by the natural growth function (R^2=0.72, P<0.001), occurred only after shortgrasses were reduced below 75% cover. The density of burrow mounds was positively correlated to compositional change (r=0.58; P<0.01). We observed that burrow mounds provided early sites for the eatablishment of forbs. However, after the canopy cover of shortgrasses receded below 75% (in this location, probably from 4 to 7 years after initial inhabitancy by prairie dogs), extensive compositional changes occurred between burrow mounds.

INTRODUCTION

Largely because of the influence that the black-tailed prairie dog (Cynomys ludovicianus Ord) exerts on trend in rangeland vegetation, the species has been a target of extermination or intensive control since the early 1900's (Merriam 1902, Schenbeck 1982, Uresk 1987). Plant succession within colonies has been described as consisting of the initial disappearance of perennial grass cover, followed by an increase in shortgrasses (Bonham and Lerwick 1976), and an eventual increase and dominance by annual forbs and dwarf shrubs (Koford 1958, Garrett et al. 1982, Coppock et al. 1983, Archer et al. 1987). The pattern of plant composition appears to recapitulate colony expansion, i.e. as prairie dog colonies expand outward, a forb-dominated community follows. The objective of our study was to determine the extent, rate, and pattern of prairie dog induced changes in plant composition within a colony on mixed-grass prairie habitat.

MATERIALS AND METHODS

Study Area

The study was conducted in Badlands National Park, in southwestern South Dakota, in a colony of black-tailed prairie dogs situated in mixed-grass prairie, north of the edge of the White River Badlands. Vegetation of the area is wheatgrass-grama-buffalo grass type described by Kuchler (1975). Occurrence of flora and fauna in the area is described by Agnew et al. (1986). Descriptions of soils, topography and climate are available in Cincotta et al. (1987), and Uresk and Schenbeck (1987). The prairie dog colony selected was <10 years old at the beginning of the research. It was located approximately 1 km north of the valley ridge, or "wall", that marks the northern extent of

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the White River Badlands, about 16 km. south from Wall, South Dakota. When prairie dogs first became established, the location was a privately owned horse pasture. Livestock Bison (Bison bison) grazed on the colony, during the study, however livestock did not utilize the area.

Changes in Plant Composition

The colony was sampled once annually, from 1981 to 1983, during the peak period for biomass of ungrazed vegetation (the last week in July and first week in August). In order to intersect the full range of vegetation, the canopy cover of individual plant species was evaluated along three parallel center-to-edge transects, which we have collectively termed a profile. Five meters apart, the three replicates traced straight lines from the origin of the colony (the oldest burrows, pinpointed by the former property owner) near the geometric center of the colony, to points (525 m away) on the western edge of the colony.

Along the profile, we chose an interval of 25 m to separate sampling sites, S (S=0,1,2,..., 21), inside the colony (on-colony). At each S, we established three sampling transects, one on each replicate of the profile. To quantify local plant composition without prairie dogs, we extended the profile 50, 75, and 100 m beyond the colony, thus establishing a site, S', of nine sampling transects outside the colony (off-colony). Each transect was 29 m long, along which thirty (50 cm by 20 cm; 0.1 m^2) quadrats were placed, 1 m apart. Canopy cover per species was estimated by recording the appropriate class, from six possible cover classes (Daubenmire 1957), for each plant species present in the quadrat.

We defined plant composition as the canopy cover of plant species encountered, i.e. multi-species cover. To compare multi-dimensional data (on-colony vs off-colony) with a computer algorithm for the multi-response permutation procedure (MRPP; Berry and Mielke 1983), we reduced the data to 20 plant species (from 75 encountered) by selecting the twenty species with the highest maximum cover among pooled sites. These species (common and scientific names according to Van Bruggen 1985) were: western wheatgrass (Agropyron smithii Rydb.), red threeawn (Aristida purpurea Steud.), dwarf sagebrush (Artemisia cana Pursh), Aster falcatus Lindl., Japanese chess (Bromus japonicus Thunb.), cheat grass (B. tectorum L.), buffalo grass (Buchloe dactyloides (Nutt.) Engelm.), Carex eleocharis Bailey, Chenopodium strictum Roth, horseweed (Conyza canadensis (L.) Cronq.), six-weeks fescue (Festuca octoflora Walt.), summer cypress (Kochia scoparia (L.) Schrad.), poverty weed (Monolepis nuttalliana (Schultes) Greene), buckhorn (Plantago patagonica Jacq.), Russian thistle (Salsola iberica Sennen & Pau), tumble-grass (Schedonnardus panniculatus (Nutt.) Trel.), cut leaf nightshade (Solanum triflorum Nutt.), scarlet mallow (Sphaeralcea coccinea (Pursh) Rydb.), sand dropseed (Sporobolus cryptandrus (Torr.) A.Gray), and prostrate vervain (Verbena bracteata Lag. & Rodr.). All species with a cover value greater than 2.0% were retained, including nearly all local major forage species for livestock (Uresk 1986) and prairie dogs (Uresk 1984, Fagerstone et al. 1981). The absence of blue grama (Bouteloua gracilis (H.B.K.) Griffiths) from this list is due both to its paucity on this site and our inability to distinguish it from buffalo grass when the grasses were in a clipped condition.

The difference in cover between S and S', was calculated as the euclidean distance measure between multi-species means:

$$D_s=\left(\sum_{i-1}^{20} (C_{is}-C_{is'})^2\right)^{0.5}$$

where C_i is the cover of a species.

To test the null hypothesis, $H_0:D_s=0$ ($n_s=3$, $n_{s'}=9$), we used a permutation technique, MRPP (Mielke 1986, Mielke et al. 1981, Mielke et al. 1976). MRPP utilizes the sum of the euclidean distances (weighted for group size; Berry et al. 1983), d, between all possible within-group pairs to express concentration within a particular mutually exclusive, exhaustive grouping with group sizes $g_1,g_2,...,g_m$ (Berry et al. 1983; for detailed example, see Zimmerman et al. 1985). The null hypothesis actually proposed with MRPP, that all permutations of $g_1,g_2,...,g_m$ are equally likely, is tested by: (1) ordering the computed values of d, (2) locating the relative position of the statistic on the list and (3) determining the P-value as the proportion of all values of d less than or equal to the observed value of the a priori grouping. We assumed that the group mean at each S was different from S' when the P of more extreme distances was ≤ 0.05. The full set of species encountered in sampling was used in this computation.

Plant composition was further described by calculating the ratio of forb to grass cover at sampling sites. Forbs included all broad-leaved plants. Grasses included species from the taxonomic families of Poaceae and Cyperaceae (sedges). All species encountered during sampling were included in this computation.

Rate of Compositional Changes

Since we did not know the exact time of prairie dog establishment on all points along the profile, we calculated a growth rate relative to the previous year's state (Green 1979). Thus, we assumed that D[t+ t] was a function of D[t], where t equaled 1 year, and t was peak season during each of the first two study years. Since D has a finite upper limit (the maximum possible difference between compared cover samples), we fit a simple asymptotic growth curve, the natural growth function $[f(x)=a(1-e^{-bx})]$, to this data. Parameters (a,b) were estimated by least squares estimate using a non-linear regression algorithm (Marquardt 1963).

Effects of Burrowing

During the same period, the number of burrow mounds were counted within a 25 m x 25 m square (0.0625 ha) of which the sampling site was the center. We determined the relationship between the density (ha^{-1}) of burrow mounds (independent variable, random effect) and D (dependent variable) by regression. For calculations of r, significance ($P \leq 0.05$) was evaluated using the F-statistic (Cacoullos 1965).

RESULTS

Changes in Plant Composition

The off-colony site was dominated almost completely by buffalo grass, western wheatgrass, Japanese brome (Table 1), while sand dropseed and six-week fescue were minor community constituents (<5% cover). Other species present (<2.0% cover), though not among the 20 species use to calculate multi-species cover, were green needlegrass (Stipa viridula Trin.) and needle-and-thread (S. comata Trin. & Rupr.). On-colony sites near the edge had low forb:grass ratios (Fig. 1a) though most perennial mid-grasses, e.g. sand dropseed, green needlegrass and needle-and-thread were virtually absent (<0.5% cover). Forb: grass ratios were highest (1.73:1 in 1981, 1.62:1 in 1982, and 8.59:1 in 1983) in the core of the colony (from 0 to 50 m from the center). A taxonomically diverse array of annual forbs were dominant at the core, including prostrate vervain, buckhorn, cut leaf nightshade, rough pigweed (Amaranthus retroflexus L.), tumble- tumbleweed (A. albus L.), poverty weed and Russian thistle. Tumblegrass, a perennial graminoid that frequents disturbed soils, was also an important constituent of this community. Unexpectedly, forb: grass ratio increased from 0.08:1 (1981) to 1.21:1, two years later, in a small (<0.3 ha) mid-colony zone (MCZ) about 350 m from the colony center. This zone was completely surrounded by grass dominated communities. The dominant constituents of MCZ were prostrate vervain, horseweed, and red threeawn (a perennial grass).

TABLE 1. Canopy cover of plant species (>2.0% cover) in the off-colony site.

	Canopy cover (± SD) off-colony		
Species	1981 n=9	1982 n=9	1983 n=9
	%		
Buffalo grass	80 (6)	79 (12)	86 (8)
Western wheatgrass	5 (4)	6 (2)	5 (3)
Sand dropseed	2 (2)	2 (<1)	2 (<1)
Six-week fescue	3 (1)	4 (1)	2 (2)
Japanese brome	5 (1)	4 (3)	9 (5)

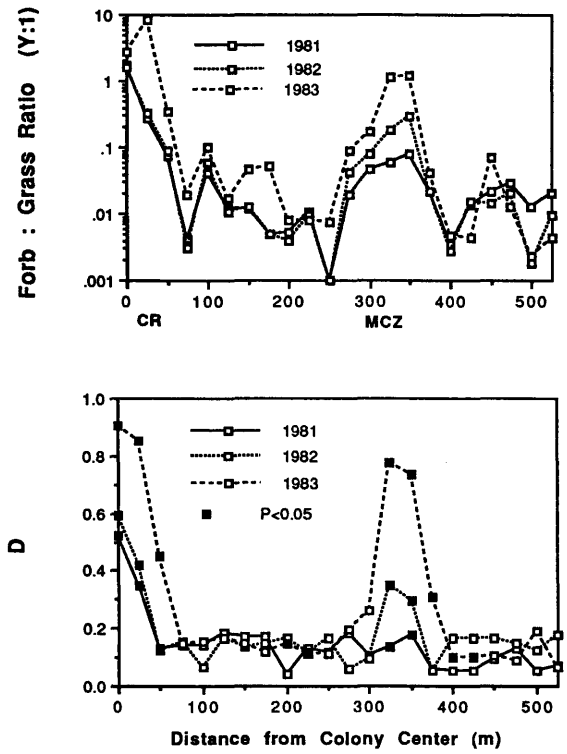

Figure 1.--Three year comparisons of: (a) the ratios of forb to grass cover along the colony profile; (b) the differences in multi-species (20 species) cover, D, between on-colony and off-colony sites along the profile. Locations of zones of extensive compositional change, the core (CR) and mid-colony zone (MCZ), are indicated.

During the study, D increased mainly in the core and surrounding MCZ (Fig. 1b). Also, D increased on sites adjacent to the original core, thus enlarging its radius by about 25 m in two years. Although there was a positive correlation between forb:grass ratio and D (r=0.72, F=6.14, 64 df, P<0.001), forb:grass ratio was not always a true indicator of change; some compositional changes involved the replacement of perennial grass species by other grasses (e.g., buffalo grass was sometimes replaced by red threeawn or tumblegrass).

Rate of Compositional Change

Upon plotting D[t+1] as a function of D[t], we noted a difference between points representing "highly disturbed" zones of the colony (the core and MCZ), and those from the remaining locations along the profile. Highly disturbed zones showed a high positive correlation between yearly states (r=0.84, F=11.5, 12 df, P<0.001). Application of the the natural growth function to these data (Fig. 2) yielded a good fit (R^2=0.72, P<0.001). The remaining points, where grasses dominated, were clumped near the origin. On these sites, yearly states were negatively correlated (r=-0.53, F=3.32, 28 df, P<0.01).

Effect of Burrowing

The density of burrow mounds and D (Fig. 3) were positively correlated ($r=0.58$; $F=3.76$, 64 df, $P<0.01$). However, linear, exponential, and polynomial regressions of these variables yielded poor fits ($R^2<0.38$). Burrow mounds, and disturbed soil directly adjacent to mounds were observed to be sites for initial establishment of annual forbs. In highly disturbed zones, annual forbs, dwarf shrubs (e.g., pasture sagebrush [Artemisia frigida Willd.]) and some "pioneer" perennial grasses (e.g., red threeawn and tumblegrass) occupied the ground surface between mounds.

Discussion

The differential extinction, replacement and resilience of plant species during prairie dog inhabitancy create the observed pattern of community change. Knowing the long-term response of similarly behaving plant species (Harper 1977; rather than taxonomic affinities) may help range and wildlife managers understand prairie dog induced succession. We considered species on the prairie dog colony to fall roughly into four categories: (1) perennials that quickly disappeared after initial prairie dog inhabitancy; primarily mid-grasses, e.g. sand dropseed, green needlegrass, and needle-and-thread; (2) shortgrasses that were initially resistant to the impacts of prairie dog grazing, e.g. buffalo grass (Fig. 4); (3) annuals that became established on recently disturbed soil associated with burrow mounds, e.g. buckhorn, prostrate vervain, and scarlet mallow; (4) annuals and perennials that only became established on the most disturbed sites, e.g. poverty weed. Although the

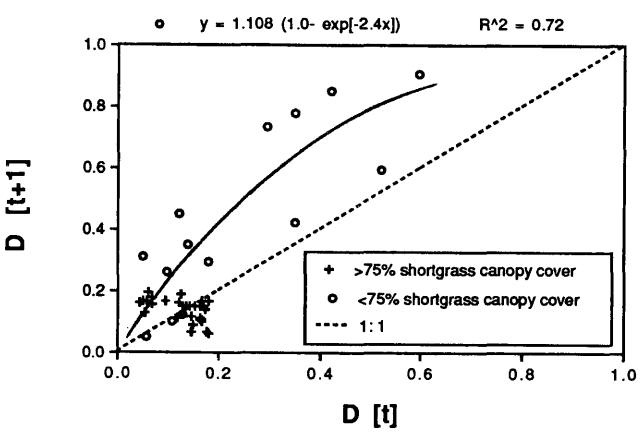

Figure 2.--Year to year changes in the difference between multi-species cover, D, between on-colony and off-colony sites. The natural growth function was fit to points (n=14) that went below 75% shortgrass canopy cover during the study. A year to year increase in D was not observed for points (n=30) above this threshold.

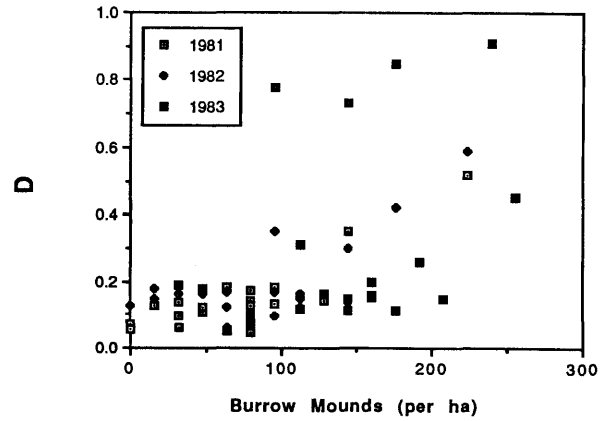

Figure 3.--The relationshp between the difference in multi-species cover between on-colony and off-colony sites, D, and the density of prairie dog burrow mounds.

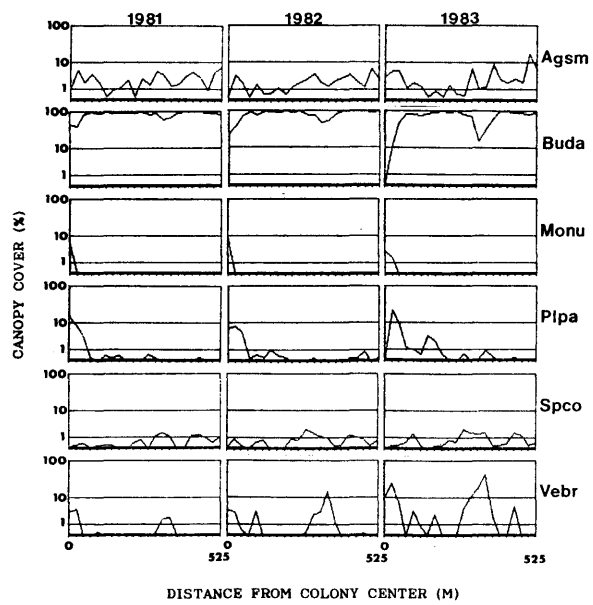

Figure 4. Mean canopy cover for six plant species along the colony profile for three consecutive years. The species are western wheatgrass (Agsm), buffalo grass (Buda), poverty weed (Monu), Patagonia Indianwheat (Plpa), scarlet mallow (Spco), and prostrate verfain (Vebr). The Y-axis is transformed using $Log_{10}(Y+1)$. Distance from the colony center to an edge 525 m distant was measured in 25 m intervals.

cover of western wheatgrass initially decreased with prairie dog inhabitancy, the species was not displaced entirely as were all other mid-grasses. The ability of this species to maintain a presence under intense prairie dog grazing may be due to the survival of decumbent "grazing" ecotypes that are known to occur in some prairie dog colonies (Detling and Painter 1983).

At the colony edge, plant composition was not radically affected by the loss of mid-grasses. Reduction of mid-grass cover, resulting from prairie dogs clipping tall plants for predator avoidance rather than for forage (King 1955), may have a greater consequence on more mesic grasslands (Archer et al. 1987). The initial 2 yr period of soil disturbance, resulting from building burrow mounds and allowing the introduction of some annual forbs, had a minor impact on the plant community. However, long-term inhabitancy of prairie dogs on mixed-grass prairie vegetation in our location (we estimate from 11 to 13 yrs) can cause the complete disappearance of perennial shortgrasses between mounds.

The nature of soil disturbance and plant community structure varied markedly between the two characteristic types of burrow mounds (King 1955, Sheets et al. 1971), (1) dome mounds and (2) crater mounds. Whereas these structures may reach 1 m in height and 2.5 m in diameter in an old colony (King 1955), all were less than half these dimensions in our colony. Dome mounds were composed of loosely packed subterranean soil spread widely over the ground surrounding the entrance. These mounds became sites for the establishment of a variety of forbs that assumed a prostrate habit, either as a consequence of their natural growth form (Warwick and Briggs 1980) or because they were heavily clipped by prairie dogs. Prostrate vervain, tumbling mustard, buffalo bur (Solanum rostratum Dunal), and cut leaf nightshade were frequent occupants of dome mound sites in our study colony.

"Crater mounds" were narrow, roughly cone-shaped structures that prairie dogs constructed from uprooted vegetation, displaced litter, humus, and mineral soil which they scraped from a patch adjacent to the burrow entrance. After a rain, prairie dogs packed the material tightly with their noses. Thus, surfaces of the crater mounds made poor sites for seedling establishment. However, adjacent "quarried" patches were invaded by annual forbs, most frequently buckhorn, during the following spring.

On our colony, the buffalo grass dominated community experienced a resilient period (probably from 4 to 7 yrs) during which little change occurred. This may be a period during which root carbohydrate reserves were being depleted (Santos and Trlica 1978), both to supply above ground regrowth and from increased microbial grazers below ground (Ingham and Detling 1984). A decisive shift in composition was experienced when shortgrass was replaced by a mixture of armed and/or sprawling grasses and forbs, aromatic dicots, and bare ground. The shortgrass "threshold" at our location was 75% cover; sites that went below this level experienced abrupt changes in composition during the following year. Thus, sites below threshold slipped from temporary stability into the asymptotic increase in D that we have described.

Although compositional changes in colonies are likely to be most evident in an expanding core, irregular patches closer to the periphery may undergo change, as well. Archer et al. (1987) concluded that the formation of forb dominated communities in prairie dog colonies could be attributed mostly to the length of time of sustained prairie dog activity. The initial amount of shortgrass cover may also affect the rate of prairie dog induced succession. Since prairie dog colonies are aggregates of highly territorial family groups (coteries) rather than a cooperating colonial entity (King 1955, Hoogland 1981), population and activity of prairie dogs is non-uniformly distributed across the colony. Whereas territories at the core are contiguous, those at the edge of expanding colonies are often spread spaciously amongst relatively undisturbed vegetation. Thus, compositional changes outside the core are likely to be patchy. In our study site, compositional changes outside the core area (in MCZ) appeared to result from sustained inhabitancy of a single coterie on a site with below average shortgrass cover.

In many colonies in the Badlands area, the presence of a shortgrass understory imparts resiliency to the plant community, delaying the eventual shift to annual forbs that is usually incompatible with range livestock management objectives. It should be noted, however, that prairie dog colonies provide valuable forage resources for native ruminants; pronghorns (Antilocapra americana) prefer the high quality herbage in colony cores (Krueger 1986), while bison are attracted to the highly nitrogenous, low fiber regrowth of grasses at the edges of colonies (Coppock et al. 1983). Extrapolation of results from this study to other prairie dog colonies should be done cautiously. In fact, where plant composition and herbivore use is much different from the single colony studied, extreme care should be used in extrapolating these results to other areas.

ACKNOWLEDGEMENTS

This study was sponsored by a research grant from the National Park Service (Contract No. CX12-00-1-B035) and logistic support from the US Forest Service Forest and Range Experiment Station in Rapid City, South Dakota. We thank Superintendent Gil Blinn, Chief Ranger Lloyd Kortje, District Ranger Mike Glass and the staff of Badlands National Park, as well as the US Forest Service Experiment Station technical staff, for their assistance. Invaluable assistance was rendered by colleagues in the field, including William Agnew, Debra Paul, Kelly Brown, Wangoi Migongo, and Bw. Mkuu S. Bauni. Monte Garrett and Layne Coppock at Wind Cave N.P. provided helpful suggestions based upon their own field observations. William Agnew compiled plant specimens invaluable to the research.

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Abstracts

CARNIVORES

Effect of Coyote Removal on Mule Deer Survival in Colorado. White, Gary C., Richard M. Bartmann and Len H. Carpenter.

The effect of coyote (Canis latrans) removals on the survival of mule deer (Odocoileus hemionus) fawns was evaluated in the Piceance Basin of northwest Colorado. Fawns were radio collared during November and survival monitored through the following June for the winter of 1981-82 through 1987-88. Coyotes were removed during the winters of 1985-86 through 1987-88. Overwinter fawn survival ranged from 3.5% (SE 2%) during the severe winter of 1983-84 up to 33% (SE 6%) in 1982-83. The proportion of fawns dying from predation decreased ($P = 0.001$), and the proportion of fawns dying from malnutrition increased ($P = 0.043$), but overwinter fawn survival did not increase ($P = 0.36$) during coyote removal.

Livestock Guard Dogs Protect Sheep from Coyote Predation in Colorado. Andelt, William F.

The effectiveness of livestock guard dogs for protecting domestic sheep (grazed in fenced pastures or on open range) from predators in Colorado was determined with two postal and two telephone surveys during 1986. A total of 174 of about 450 Colorado Wool Grower Association members responded to a general survey. Responses from 123 of the producers were used to estimate sheep losses for producers without guard dogs (respondents with guard dogs, individuals without sheep, and incomplete responses were eliminated). Responses from 21 of the non-respondents were obtained by telephone. Twenty-one of 30 producers suspected or known to use guard dogs with sheep responded to a second postal survey; the survey was completed by interviewing non-respondents by phone. Twenty-two responses were used to estimate sheep losses for producers using guard dogs with sheep (respondents without guard dogs or sheep, and incomplete responses were eliminated). Respondents and non-respondents to the postal survey that did not use guard dogs averaged 660 ewes and 846 lambs and 369 ewes and 460 lambs, respectively, whereas guard dog owners averaged 1217 ewes and 1518 lambs. Respondents and non-respondents without guard dogs reported an average of 1.1% and 1.1% of the ewes and 5.9% and 3.4% of the lambs lost to coyotes whereas producers using guard dogs reported 0.4% of the ewes and 0.9% of the lambs lost to coyotes during 1986.

URBAN

Controlling Raccoon Damage in Urban Areas. Riley, David G.

Raccons have become a serious problem in many urban and suburban areas. Damage to homes and buildings as well as the spread of diseases to pets are constant problems when high raccoon populations occur. Various control methods can be implemented with positive results.

An Evaluation of Hazing Methods for Urban Canada Geese. Aguilera, Elizabeth, Richard L. Knight, and John L. Cummings.

The efficacy and latency period of two hazing methods of Canada geese (Branta canadensis) were tested in Fort Collins, Colorado urban areas between November 1988 and January 1989. The hazing methods evaluated were screamer shells and alarm calls. Five replications of each method were addressed for a total of 10 experimental field trials. Each trial consisted of three periods: pre-treatment, treatment, and post-treatment. The first two periods lasted five days and the third depended on the time it took Canada geese to return to the area. Each method was applied for ten minutes two times a day until the geese left the area. The screamer shell was significant in reducing the number of geese at an area up to ten days after the treatment was stopped, however, the alarm call was not effective in hazing geese from an area.

Effects of Animal Welfare Philosophy on Wildlife Damage Control. Schmidt, Robert H.

Wildlife damage prevention and control activities are often criticized when they involve the deaths of wild animals. However, just as the nuclear industry has failed to convince the majority of the public that its industry is safe, education will fail to convince the public that all wildlife damage control techniques are humane. Animal welfare-related legislation,

university rules on the use of wild animals for research, and litigation are changing the working environment of our profession. This paper reviews aspects of the animal welfare movement as they affect the wildlife damage prevention and control profession and discusses future strategies for living with it.

BIG GAME

Characteristics of Deer Damage to Experimental Orchards in Ohio. Mower, Kerry J., Thomas W. Townsend, and William J. Tyznik.

We measured newly established apple trees (1) to compare growth differences between trees damaged by browsing deer (Odocoileus virginianus) and trees protected from deer, (2) to determine seasonal patterns of browsing, and (3) to determine if deer browsed selectively among Ohio's 3 most commonly planted apple cultivars. Experimental trees were measured from June 1986 through May 1988.

Experimental orchards were planted at research farms representative of areas where apples are grown commercially. All experimental orchards contained 20 trees each of red delicious, golden delicious, and red rome. Trees were planted randomly by cultivar pairs and one tree of each pair was enclosed in a welded wire cylinder 1.5 m high to exclude deer. Eight orchards were planted the first year; 5 additional orchards were planted the second year. At the beginning of the second year half of the tree pairs in the 8 original orchards were randomly selected and the exclosures switched from control to treatment trees. Trees were measured monthly the first year but bimonthly the second year because the trees had become much larger. Variables measured included branch length, number of leaves/branch, number of leaves/cm of branch length, and browsing frequency. Radial growth was determined by measuring trunk diameter at time of planting and each autumn thereafter.

Length of branches in all orchards but 3 were significantly reduced by browsing deer and browsed trees in all but 2 orchards had significantly reduced numbers of leaves ($p < 0.05$). Browsed branches were observed in all but 1 orchard. The reduction in branch length ranged from 0% in the single undamaged orchard to 98% in one of the most severely browsed orchards; reduction in number of leaves/branch ranged from 0% to 85%.

Significant seasonal effects were found in branch length, number of leaves/branch, and browsing frequency between browsed and control trees ($p < 0.05$). Two seasonal patterns existed among significantly browsed orchards. Browsing was concentrated either in early summer or autumn. Orchards with greatest branch and leaf reductions sustained significantly more browsing in early summer than any other season. Browsing in severely damaged orchards began as soon as trees began to grow and decreased only when trees failed to initiate new growth, became dormant, or died. Orchards with lower levels of browsing were damaged in late autumn and winter. Browsing began in the less severely damaged orchards at the time leaves dropped from trees in adjacent wooded areas. Leaves persisted on apple trees longer than in surrounding forest trees. Sporadic browsing continued into winter in such orchards.

No evidence was found that deer selectively feed on any of 3 cultivars tested. Browsing was severe enough to cause higher mortality among treated trees in 6 orchards ($p < 0.01$). Four orchards were moderately browsed; mortality rates between browsed and unbrowsed trees were not different but radial growth was reduced significantly among browsed trees. Three orchards were browsed lightly, but neither mortality rate nor radial growth was significantly different between browsed and unbrowsed trees.

After 2 growing seasons, most foliage was beyond the reach of deer. Browsing damage was most critical to small and immature trees. Under conditions of rapid growth, apple trees may reach a size beyond which deer browsing does not impact growth significantly. At some sites, protection might be needed only the first 2-3 years.

Impacts of Pronghorn Grazing on Winter Wheat. Torbit, Stephen C., R. Bruce Gill, James F. Liewer, and A. William Alldredge.

In 1983 a 3-year project was initiated to evaluate the impacts of pronghorn grazing on winter wheat in eastern Colorado. To fully assess the potential impacts of pronghorn grazing, the study was designed to achieve the following objectives:

1) Determine seasonal habitat use by pronghorn in areas containing both winter wheat fields and native grasslands;
2) Determine the relationship between winter wheat use by pronghorn and nutritional characteristics of winter wheat and native forage diets;
3) Measure the response of grain yield to foraging by free-ranging pronghorn;
4) Measure the response of grain yield to controlled foraging experiments with hand-reared pronghorn confined exclusively to wheat fields.

Systematic aerial surveys and reobservation of banded and telemetered pronghorn revealed a seasonal shift to wheat fields in November of each year, however, all pronghorn abandoned wheat fields by early May. Peak use of green wheat fields occurred from November through April. By radio-tracking pronghorn we also observed daily movements between wheat fields and native prairies. Native diet quality, as measured by percent cell contents and crude protein content, declined from October through February and increased after February. Forage quality of

winter wheat increased from October through February and declined thereafter. By May, native forages were nutritionally superior to winter wheat. Free-ranging pronghorn were excluded from grazing on a winter wheat field by a paired plot experiment. The impact of grazing by these pronghorn on final grain yield was not measurable. Hand-reared pronghorn were allowed to graze in fenced wheat pastures from November through May in a controlled experiment. Captive pronghorn removed measurable amounts of green biomass but this removal did not significantly ($P = 0.19$) reduce final grain yield. Grain yields were not affected despite a stocking rate approximately 80 times that observed with wild pronghorn. The alternating quality of native forage and winter wheat appear to induce a rotational grazing pattern with pronghorn. Wheat is exploited during its early growth when it is nutritionally superior to native forages. Wheat is also most resistant to grazing at this stage. By the time wheat reaches the elongation state when it is most susceptible to damage by grazing, native forages have eclipsed the nutritional quality of winter wheat and pronghorn shift their grazing from wheat to native grasslands. Our results demonstrate that pronghorn grazing on winter wheat is inconsequential when compared to other environmental factors (soil types, precipitation, etc.). It is apparent that winter wheat and pronghorn should be considered complementary resources in mixed rangeland-cropland habitats.

Analytical Chemistry in the Animal Damage Control Program. Mishalanie, Elizabeth A., and Edward W. Schafer, Jr.

Analytical methods related to current and potential Animal Damage Control (ADC) chemicals need to be developed and frequently updated to provide the necessary support for the research and registration-related activities of the ADC Program. Registration-related activities require the development of analytical methods to support the following: field efficacy trials; residue trials; laboratory feeding trials; quality control tests for baits and formulations; stability and longevity studies; soil, water, and vegetation accumulation and metabolism; animal metabolism; and the development of human health/application use restrictions. Other registration-related activities may involve one-time chemical studies such a hydrolysis and photodegradation studies. Analytical methods are also needed to assist in the search for new chemicals for use in vertebrate pest control, for the identification of safe and reliable physiological and mechanical markers used in tracking and migratory studies, and in the assessment of the efficacy and selectivity of baiting techniques.

BIRDS

Anthranilates as Bird Repellent Feed Additives for Reducing Feedlog Damage: An Overview. Glahn, James F.

Anthranilate derivatives, namely dimethy anthranilate (DMA) and methyl anthranilate (MA), which are human food flavorings, have a long history of study as potential bird repellents. Recent studies, initiated in 1984, investigating the potential use of these flavorings as bird repellent feed additives are summarized. These studies have included a number of laboratory, large pen, simulated field, and actual field studies at various concentrations of DMA and MA to evaluate their effectiveness in reducing feed loss damage by blackbirds and starlings. Companion studies on acceptance and performance of livestock with up to 1.0% DMA and MA in their rations are also summarized. Based on these studies and an economic assessment it appears that low concentrations of methyl anthranilate could be cost-effectively used to protect livestock feed with minimal effects on livestock.

RODENTS & LAGOMORPHS

Mound Building Rates of Plains Pocker Gophers *Geomys bursarius*, introduced on alfalfa fields. Luchsinger, James C., and Ronald M. Case.

Pocket gophers reduce forage yields by consuming vegetation and by the adverse effects of their tunneling and mound building (reducing plant vigor, smothering plants, and changing species composition). We are investigating the response of two different alfalfa varieties to the presence of pocket gophers in order to assess the possibility of using cultural methods to lessen the impact of pocket gophers on alfalfa yields.

Four paired plots were established for each alfalfa variety, a tap-rooted variety (Wrangler) and a fibrous-rooted variety (Spredor II). Each pair consisted of a control (no gophers) and experimental (gophers present) plot. Pocket gophers were stocked at a density of 6/hectare. Tunnel construction as indicated by the presence of surface mounds pushed up by pocket gophers, was checked at 3 to 13 day intervals. Our objective was to determine whether there was a difference in tunnel construction by pocket gophers in either of the alfalfa varieties.

We gathered data on 8 plains pocket gophers over at least 50 days. Mound production per pocket gopher ranged from 59 (over 57 days) to 154 (over 85 days). Mean mound production for the eight gophers was 100. The four gophers on Wrangler produced an average 1.2 mounds/day. The four gophers on Spredor II produced an average 1.6 mounds/day. We were unable to detect any significant differences in the rate of mound building among sex, age, or body size.

Efficacy of Three Formulations of Zinc Phosphide for Black-tailed Prairie Dog Control. Hygnstrom, Scott E., and Peter M. McDonald.

Studies have compared the efficacy of zinc phosphide to other toxicants, in particular strychnine and sodium monofluoroacetate, for controlling prairie dogs (Cynomys spp.). In most states, however, zinc phosphide is the only toxicant that is currently registered by the EPA for controlling black-tailed prairie dogs (C. ludovicianus). Various formulations of zinc phosphide are marketed but their relative efficacy is unknown. Prices and availability also vary. We compared the efficacy and cost of 3, 2.0% zinc phosphide baits for controlling black-tailed prairie dogs [2.0% zinc phosphide-treated steam rolled oats (ZP-rolled oats), Pocatello Supply Depot, U. S. Fish and Wildlife Service, Pocatello, Ida.; ZP Rodent Bait-AG crimped oats (ZP-crimped oats), Bell Laboratories, Inc., Madison, Wis.; and ZP Rodent Bait-AG pellets (ZP-pellets), Bell Laboratories, Inc., Madison, Wis.]. We conducted this study on 13 black-tailed prairie dog colonies in central Nebraska during November-December, 1988. We continuously searched the colonies (all were < 8 ha) during the study for evidence of black-footed ferrets (Mustela nigripes) but none was found. We established 66, 0.4-ha areas within these colonies to serve as treatment plots. A 0.4-ha control plot was established within 100 m of each treatment plot. We prebaited treatment plots with untreated stream-rolled oats according to zinc phosphide pesticide label recommendations. After 2-3 days, we randomly assigned and applied each zinc phosphide formulation, according to label recommendations, to 22 separate treatment plots. We used a plugged burrow technique to estimate the activity of prairie dogs 3 days after treatment. The differences in activity between the treatment and associated control plots were used to determine the relative efficacy of the 3 formulations. Active prairie dog burrows were reduced 80% with ZP-rolled oats, 78% with ZP-crimped oats, and 71% with ZP-pellets. A one-factor ANOVA revealed that there were no significant differences ($P = 0.322$) in efficacy among the 3 treatments. Data were independent, normally distributed, and variances among treatments were homogeneous. Material costs varied among treatments (ZP-rolled oats-$1.04/kg, ZP-crimped oats-$1.32/kg, and ZP-pellets-$2.21/kg). The costs of labor (@ $5.00/hr) for applying the prebait and bait were $18.07/ha for each treatment. The total costs per ha for 70-80% control of black-tailed prairie dogs were $18.71 for ZP-rolled oats, $18.82 for ZP-crimped oats, and $19.16 for ZP-pellets.

Responses of a Black-tailed Prairie Dog Population to Experimental Exploitation. Cox, Mike K., and William L. Franklin.

Survival, natality, movement, and body condition were examined in an exploited black-tailed prairie dog population in western Nebraska. Both colonies in the population were exploited at an average rate of 0.44 for two consecutive years. The nonremoval survival rate for the old colony decreased from 0.68 after the first removal, to 0.25 after the second removal. The new colony's nonremoval survival severely declined from 0.63 to 0.18, due in part to badger predation. The overall pregnancy rate of yearlings and adults in the population was 0.92, and the mean litter size ranged from 3.06 to 5.38 pup/lactating female. Because of the possible compensatory mortality in the winter months, disappearance in the summer months had the greatest impact on nonremoval survival.

Monofilament Lines Repel House Sparrows. Aguero, Danilo A., Ron J. Johnson, Kent M. Eskridge, James E. Knight, and Donald H. Steinegger.

Observations in New Mexico indicated that clear 8-pound-test monofilament line spaced at 30.5 cm (1 foot) intervals excluded house sparrows (Passer domesticus) from strawberries and stopped bird (species undetermined) damage to grapes. In other uses, it protected sprouting plants and peach trees from house sparrow and other bird damage, and effectively stopped barn swallow (Hirundo rustica) nest-building under eaves of a house. Five follow-up experiments with controls were conducted at the University of Nebraska. In experiment 1, lines spaced 30.5 cm apart around grape plants did not reduce American robin (Turdus migratorius) and European starling (Sturnus vulgaris) entries into the plants nor damage to grapes. Experiments 2 through 5 used baited stations to evaluate size (4-, 12-, and 20-pound-test weight), orientation (north-south, east-west, horizontal, vertical), color (clear and florescent yellow-orange), and spacing (30.5 and 61 cm) of monofilament line. Results of food consumption and bird count data indicate that all treatments repelled house sparrows. Blue jays (Cyanocitta cristata) and northern cardinals (Cardinalis cardinalis) were repelled somewhat but numbers of observations were small. Eleven other species at baited stations appeared not to be repelled by the lines. Although current experiments to refine management applications and to understand the underlying mechanism are not completed, we conclude that monofilament lines may effectively reduce house sparrow problems at some sites.

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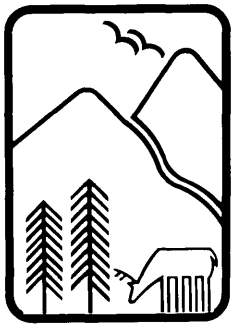
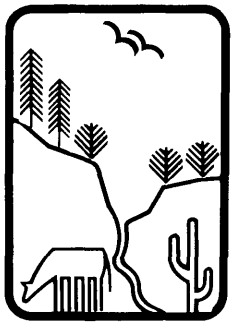


Rocky Mountains



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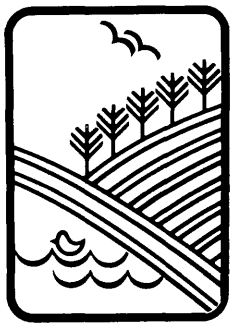

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

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Laramie, Wyoming
Lincoln, Nebraska
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*Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526