Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Prepared By: Rob Mound.
# Table of Contents

**Introduction**
- Needs Assessment Overview .......................................................... 4
- Organization of Information ......................................................... 5
- Comments on Sources of Information ............................................. 5
- Support Services and Regulators .................................................. 6
- Acknowledgments ........................................................................... 7

**Natural History of the Bay of Quinte Watershed** .................................. 8

**General**
- Results of Literature Survey ......................................................... 11
- Summary of Selected References .................................................. 13

**Beaver**
- Results of Grower Needs Assessment .............................................. 28
- Species Biology and Life History .................................................... 29
- Results of Literature Survey ........................................................ 33
- Summary of Selected References .................................................. 26

**Birds**
- Results of Grower Needs Assessment .............................................. 40
- Results of Literature Survey ........................................................ 42
- Summary of Selected References .................................................. 55

**Deer**
- Results of Grower Needs Assessment .............................................. 120
- Species Biology and Life History .................................................... 121
- Results of Literature Survey ........................................................ 125
- Summary of Selected References .................................................. 133

**Muskrat**
- Results of Grower Needs Assessment .............................................. 171
- Species Biology and Life History .................................................... 172
- Results of Literature Survey ........................................................ 175
- Summary of Selected References .................................................. 175
Introduction

The goal of the “Crop Protection and Wildlife Management Options for High Value Crops in the Bay of Quinte Watershed” project is to compile and provide in a more accessible manner information necessary to protect crops, crop lands and farm productivity and to reduce conflict between wildlife and growers through increased wildlife management awareness and adoption of best management practices. A grower needs assessment (appendix 3) was conducted during the month of April 1996. Growers in the Bay of Quinte watershed were asked to identify conflicts between agriculture and wildlife. Several important conflicts as well a variety of minor conflicts between agriculture and wildlife were identified. The results of the grower needs assessment were used to tailor the literature/information survey to the needs and concerns of area growers.

Needs Assessment Overview

White-tailed deer were repeatedly identified as having significant to very significant impacts on apple orchard productivity and overall orchard profitability. Damage was especially severe in young and high density plantings. Conflicts with deer were identified as escalating, and traditional management methods have not provided adequate damage control. Some growers controlled deer by shooting, but expressed interest in alternative crop protection practices.

Raccoons were often associated with significant to very significant impacts on corn production and overall farm profitability. Traditional control (shooting) was not always effective, and there was considerable interest in alternative crop protection practices.

Various bird species were also identified as causing significant to very significant damage to production and overall farm profitability for a variety of crops. Birds and crops included wild turkeys, crows, American robins, European starlings, red-winged blackbirds and ring billed gulls with apples, tomatoes, sweet corn, raspberries, strawberries and other small fruits. Traditional controls (bird-bangers, shooting and plastic owls) were not providing adequate crop protection for some Quinte area growers. Interest was expressed in other crop protection options.

Conflicts identified of less importance included porcupines eating corn, rabbits and voles damaging orchard trees and beavers flooding crop land.

Despite these conflicts, certain wildlife species were identified as complementing agriculture. The beaver was credited with creating ponds usable for irrigation. Some growers were trying to encourage birds of prey on their farms; red foxes and coyotes were identified as protecting crops from mice, rabbits and racoons. Indeed some orchardists have abandoned past crop protection
techniques for rabbits and voles because foxes and coyotes are controlling the populations. The Ministry of Natural Resources' Rabies Vaccine Program was generally considered to be responsible for the increasing predator populations.

Organization of Information

This document follows a standard format.

First, a summary is provided of the relationship of each wildlife species to agriculture in the Bay of Quinte watershed as identified by area producers. Then a description of the species biology and life history is given, followed by general conclusions about species biology, crop protection and wildlife management options. References for these general conclusions are provided. These references are followed by a summary of the selected references.

The selected reference section for each wildlife species also has a standardized format. The title, source, author and author's address are given for each article. (Addresses may have changed since publication; authors or institutions associated with more recent articles will be more useful sources of additional information.) Each article is then summarized. The most relevant articles are summarized in the most detail.

Comments on Sources of Information

This document is primarily a survey of academic, professional and scientific literature about the effectiveness and appropriateness of various techniques and devices for crop protection and wildlife management.

There is a difference between scientific knowledge and other kinds of knowledge. Science requires that the experiment can be repeated and under comparable conditions will yield statistically similar results. Scientific claims that a device or technology works are therefore different from a manufacturer's claim or a producer's claim. For producers to claim that a device is effective, they only have to believe that the device or technology worked for them. Manufacturers of commercial chemicals and devices have been accused of publishing "highly selected" reports which overestimate the effectiveness of their products. This is not intended to imply that scientific knowledge is 'better than' other types of knowledge. One should consider all sources of information before making important crop protection decisions.

Scientific studies may be flawed. Laboratory results may not be reproducible in actual field
situations. Results in one experiment may not be transferable to other crops, species, or regions. A test which has not been repeated in various contexts may not provide reliable information necessary to make sound management decisions. Further, methodological errors can lead to invalid conclusions. If, for example, in a scientific study the “test” and “control” fields are side by side, a device may move the animal causing damage from the test field to the control field. In this situation a comparison of test and control sites will greatly overestimate the effectiveness of the device. This methodological error was evident in some of the scientific literature surveyed.

When claims of effectiveness are made for any device, technology or technique one should first ask what, if any, scientific evidence supports the claim and secondly, did the experimental technique bias the results. If there is unbiased scientific evidence that demonstrates that the device is effective in a situation similar to one's own, then it is time to begin considering costs and benefits of the crop protection option.

Support Services and Regulators

This document is primarily a review of academic and professional literature and the author and supporting organization addresses are included. There are many other organizations which may have important information. OMAFRA can offer assistance identifying the pest species which may be damaging crops. It is critical that proper ‘pest’ identification occurs or crop protection and wildlife management measures will be ineffective.

Local farm suppliers, Ducks Unlimited, OMAFRA, MNR, your local Conservation Authority, or Local outfitter may be able to put you in touch with suppliers of various tools and techniques used for crop protection.

Before engaging in experimental, lethal, chemical or habitat altering management techniques it would be best to contact the MNR to find out what regulations and guidelines might apply to the activity. OMAFRA, MOE, Canadian Wildlife Service, or the local Conservation Authority may also have valuable information.
Acknowledgments

The author wishes to thank Barry Jones (Bay of Quinte Remedial Action Plan), Margaret Appleby (Ontario Ministry of Agriculture, Food and Rural Affairs), Anna Gibson, Jon Mound, Cheryl Mound, John Wise, Paul Hagerman (Ontario Ministry of Agriculture, Food and Rural Affairs), Bernie Solymar (Ontario Ministry of Agriculture, Food and Rural Affairs), Steve Knechtel (Cataraqui Region Conservation Authority), members of Bay of Quinte Wetlands/Woodlands/Wildlife Advisory Committee, and the producers who participated in the grower needs assessment.

Funding for this annotated literature survey and the Wetlands/Woodlands/Wildlife Quinte project, of which this is a part, is provided by the Canada/Ontario Agriculture Green Plan through Agriculture and Agri-Food Canada in Cooperation with the Ontario Ministry of Agriculture Food and Rural Affairs.
Natural History of the Bay of Quinte Watershed

The Bay of Quinte is the largest sub-watershed in the Great Lakes drainage basin with a drainage area of 17,315 km² (Hartig and Law 1994). The watershed’s borders include some or all of Victoria, Haliburton, Peterborough, Northumberland, Hastings, Lennox and Addington, Frontinac and Prince Edward counties (See Appendix 4). The distribution and abundance of wildlife populations within the Bay of Quinte watershed have been influenced by natural forces dating back millions of years. Until very recently bedrock geology and the soils and vegetation they supported, glacial landforms, temperature, snowfall and other natural processes determined range and behavior of wildlife populations. While these processes still operate to sustain life, in recent history (less than 500 years) it has been human activities that have most dramatically altered the ecosystems and habitat of wildlife.

People have lived in the Bay of Quinte watershed since 11,000 BC (Bowes). Significant populations (by pre-colonization standards) of indigenous people were practicing highly advanced agriculture within the Bay of Quinte watershed by 1400 AD (Bowes).

The composition of wildlife in the Bay of Quinte watershed has changed drastically with agriculturally induced environmental changes, colonization and settlement. Human activities have so dramatically changed this environment that they have become the primary factor effecting the distribution and behavior of many wildlife populations. This is especially true for species popularly considered to be pests, and these conflicts can be directly related to human induced land use changes.

Some changes in wildlife populations have been a result of hunting and trapping. For example, in 1900 the white-tailed deer was eliminated throughout 1.5 million square km of its original range (including the Bay of Quinte Watershed) by hunting pressures (Seton 1909a). The passenger pigeon, whose populations once numbered in the billions, have been hunted to extinction, and hunting has been partially responsible for the extirpation of wolf populations.

The greatest changes in wildlife populations are, however, a result of ecosystem manipulation. “In early Canada [settlement] involved mostly destroying forests so crops could be grown on the land.” (Dagg 1974). The resulting patchwork environment has been beneficial to some species but disastrous for others and has resulted in conflicts between agriculture and wildlife. Habitat alteration and large predator destruction have been credited with the rapid reestablishment of white-tailed deer in the areas where they had been eliminated (Seton 1909a).

In the agricultural areas of the Bay of Quinte watershed, the black bear, wolf, elk, snowshoe hare, lynx, wolverine and bobcat are some of the mammals which have suffered from environmental changes (Dagg 1974). Black bear, grey wolf, lynx, and bobcat are restricted primarily to the northern portions of the watershed; and elk have been eliminated from the entire area (Burt and Grossenheider 1980). “Only about 2,200 wolves remain in the United States, most of them in the forests of northern Minnesota. In Canada, wolves have been driven out of the southern prairies,
southern Ontario and Quebec, and the Atlantic provinces. Their total world population once numbered approximately half a million; today, an estimated 150,000 remain. Of these, about one-third live in Canada and Alaska." (Schneider 1996:20).

Other mammals and birds have expanded their ranges with the introduction and expansion of agricultural systems, including woodchucks, racoons, cottontail rabbits, meadow voles, deer mice and coyotes. Coyotes were non-existent in the watershed until the early 1900's (Seton 1909b). Dramatic fluctuations in scores of bird populations have been directly related to changes in agriculture or changes to the rural landscape as a result of agriculture (Jobin et al. 1995).

Conflicts between agriculture and wildlife need to be viewed as an agriculture induced problem rather than a wildlife problem if conflicts are to be reduced. Changes in agriculture are still occurring and can be expected to result in different conflicts with wildlife. Major changes in agriculture which will increase conflicts with wildlife include movement towards high density apple production, withdrawal of marginal land from production, increased production of sweet corn, increased production of specialty crops, habitat fragmentation and destruction (Jobin 1995, Ministry of Agriculture and Food 1994, Ministry of Agriculture and Food 1986). The conflicts which are likely to increase as a result of these changes are the conflicts which are already the most severe, namely conflicts with deer, racoons and various bird species.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

General

Prepared By: Rob Mound.
Completed: Fall 1996
General

This section includes supplementary information which may be valuable to people interested in wildlife management and crop protection; topics include chemosterilization, compatibility of agriculture and wildlife, conflicts between wildlife and agriculture, species at risk and the internet.

Results of Literature Survey

Chemosterilization
• Chemical Fertility Control and Wildlife Management
• Contraception in Striped Skunks with Norplant™ Implants
• Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
• Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (DES) on Predators
• New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
• Feral Horse Fertility Control: Potential and Limitations
• No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
• Remotely Delivered Immunocontraception in Feral Horses
• Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
• Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

Compatibility of Agriculture and Wildlife
• Evaluating the Wildlife of Agricultural Environments: an Aid to Conservation
• A Landscape Restoration Framework for Wildlife and Agriculture in the Rural Landscape
• Planning for an Optimal Mix of Agricultural and Wildlife Land Use
• Sustainable Agriculture: the Wildlife Connection

Conflicts Between Wildlife and Agriculture
• Agricultural Producers’ Perceptions of Wildlife-caused Losses
• How Governmental Wildlife Agencies Should Respond to Local Governments That Pass Antihunting Legislation
• How Governmental Wildlife Agencies Should Respond to Local Governments That Pass Antihunting Legislation- a Response
• Perceptions of Farmers and Non-farmers Toward Management of Problem Wildlife
• A Philosophy of Problem Wildlife Management
• Wildlife Damage to Crops: Perceptions of Agricultural and Wildlife Professionals in 1957 and 1987
Species at Risk
- 1996 Canadian Endangered Species and Other Wildlife at Risk
- Ontario Birds at Risk: Status and Conservation Needs

The Internet
- Computer Bulletin's Significance Growing Rapidly
- Cyberspace and Pest Management: the Internet and Electronic Mail Provide New Ways to Get Pest Control Information
- Virtual Orchard Puts Fruit Growing on the Internet: Great Lakes Fruit Growers News to Provide Information
Summary of Selected References

AGRICULTURAL PRODUCERS’ PERCEPTIONS OF WILDLIFE-CAUSED LOSSES
Alice P. Wywialowski. U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Policy and Program Development, 812 Federal Building, 6505 Belcrest Road, Hyattsville, MD 20782

The paper reports the results of a national assessment of losses attributed to wildlife by livestock and poultry producers, field crop producers and vegetable, fruit or nut producers in the United States. 20,001 producers were surveyed. The report concludes that since losses to wildlife are skewed, management and crop protection measures need to be specifically focused on those individuals receiving damage and that a large scale approach will be inefficient. A summary of the results of the survey for different producer classifications is included.

1996 CANADIAN ENDANGERED SPECIES AND OTHER WILDLIFE AT RISK
World Wildlife Fund, 90 Eglinton Avenue East, Suite 504, Toronto, Ontario M4P 2Z7
The Committee on the Status of Endangered Wildlife in Canada.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is comprised of federal, provincial and territorial wildlife officials and representatives from various conservation agencies including WWF. A total of 275 species are listed as extinct, extirpated, endangered, threatened or vulnerable in the 1996 edition. Considering the impacts wildlife management and crop protection practices may have on these species is an important component of responsible wildlife management.

CHEMICAL FERTILITY CONTROL AND WILDLIFE MANAGEMENT
Jay F. Kirkpatrick. Department of Biological Sciences, Eastern Montana State College, Billings, MT 59101
John W. Turner, Jr. Department of Physiology, Medical College of Ohio, Toledo, OH 43699

The authors refer to chemical fertility control as “a neglected yet potentially powerful wildlife management tool that represents an effective, inexpensive, and humane alternative to current control methods.... These compounds will not cause death, do not disturb social order, and can be manipulated to protect nontarget organisms” (p. 485). The history of use of these chemicals on dog, bird, cat, rodent, hoofed mammal and horse families is given. Chemicals discussed include DES (diethylstilbesol), melengestrol acetate, chlormadinone acetate, TEM (triethylene melamine), arasan, and the anticholesterol SC-12937 (22, 25-diazacholesterol), and gives references for studies which document antifertility effects of 50 plant families.
The authors conclude “Controlling overabundant wildlife populations through contraception is a potentially powerful management tool that has received surprisingly little attention. Continued human encroachment on critical habitat, coupled with increased public resistance to traditional control programs, will ultimately require new solutions to overpopulation problems. Much of the scientific knowledge necessary to provide safe, effective, and humane control is already at hand; wildlife managers must be bold enough to seek these new directions” (p.490).

COMPUTER BULLETIN’S SIGNIFICANCE GROWING RAPIDLY
Good Fruit Grower. p.6, April 1994.
annon.

The article is on the Tree Fruit Research and Extension Centers electronic bulletin board; “with 300 users at present it is rapidly growing into a university wide network” (p.6). A wide range of horticulture topics are covered including, tree-fruit diseases, pesticides research projects, harvest and storage information, etc. It is a closed network with no charge to join. Interested individuals should call (509) 663 8181 and ask for Jerry Tangren (technician) or Dave Grove (Washington State University researcher).

CONTRACEPTION IN STRIPED SKUNKS WITH NORPLANT™ IMPLANTS
Carrie A. Bickle and Jay F. Kirpatrick. Department of Biological Sciences, Eastern Montana College, Billings, MT 59101
John W. Turner, JR. Department of Physiology. Medical College of Ohio, Toledo, OH 43699

The authors state that leg hold traps have been banned in 50 countries and 10 states have partial or complete bans and that poisoning skunks only limits populations for short periods, kills non target animals and is not proven to be effective against rabid skunks. Beyond that, neither poison nor leghold traps are acceptable in urban environments. The study examines the effectiveness of hormone implants for skunk contraception.

In 171 non treated skunks 71.6% produced litters. Of the 18 skunks with levonorgestral-Norplant implants, none of them produced litters. The cost of the implants was $2.60 per implant plus $1.00 for anesthesia plus trapping costs. The implants have a life expectancy of 5 years in humans; if they are effective for 2-3 years in treated skunks, those skunks would be removed from the breeding population. The authors state that, “the preservation of a core population of skunks, albeit infertile, may slow the immigration of new skunks into treatment areas. Lethal controls and permanent removal of skunks in Billings have created habitat vacuums into which new animals migrate” (p.337).

The authors argue that effects on scavengers would be minimal as the passage of hormones
through the food chain is unlikely. The levonorgestral is stored in the flesh of an animal and will be passed on to the scavengers, but “it is unlikely that a given predator would consume a sufficient number of skunks or a dose of levonorgestral sufficiently large to cause infertility to itself... [further, the] prolonged contraceptive effects of Norplant are imparted only as an intramuscular implant. In the unlikely event that a predator did consume a whole implant and cause the release of levonorgestral in the gastrointestinal tract, the effects of oral levonorgestral would be short lived” (p.337).

CYBERSPACE AND PEST MANAGEMENT: THE INTERNET AND ELECTRONIC MAIL PROVIDE NEW WAYS TO GET PEST CONTROL INFORMATION
Rick Melnick

The article gives a general discussion of how the Internet works, ways the Internet can be used to access pest management information and things to think about when choosing an Internet provider. The article also provides a list of potentially useful web addresses.

Colorado State IPM
http://www.colostate.edu/depts/entemology/ent.htm

Cornell Biocontrol
http://www.nyaes.cornell.edu.ent/biocontrol

Fruit & Vegetable
http://www.cce.cornell.edu/l/cenet/submenul

Information Services for Agriculture, Inc.
Http://www.aginfo.com

IPM Site
http://www.ent.agn.umn.edu/academics/classes/ipm/ipmsite.htm

Midwest Biocontrol News
http://www.wise.edu/entemology/mbcn/mbcn.html

New York Apple Ipm Guide
http://www.nysaes.cornell.edu:80/ipmnet/nx/fruits/tree/tree_fruit/

North Carolina State IPM
http://ipmwww.ncsu.edu
EVALUATING THE WILDLIFE OF AGRICULTURAL ENVIRONMENTS: AN AID TO CONSERVATION
R. Cobham and J. Rowe. Cobham Resource Consultants, 19 Paradise Street, Oxford, 0X1 1LF, U.K.

The authors argue that it is necessary to reconcile agricultural and ecological interests if indigenous flora and fauna are to survive modernized and intensified agriculture. The authors present general and specific surveys which can provide information necessary for integrated land management on farms. Qualitative and quantitative survey techniques are described and explained using experience gained from previous application in real farm situations.
HORMONE SABOTAGE: SYNTHETIC CHEMICALS IN THE ENVIRONMENT MAY BE WRECKING HAVOC WITH THE ENDOCRINE SYSTEMS OF HUMANS AND ANIMALS
Natural History. 3:42-49, 1996.

The article summarizes information in the book, “Our Stolen Future: How We Are Threatening Our Fertility, Intelligence and Survival -- A Scientific Detective Story” and consensus statements by diverse groups of experts called “Chemically Induced Alterations in Sexual Development” and “Environmentally induced alterations in Development” and includes case studies of bald eagles, otters, mink, gulls and alligators.

The article describes how diethylsilbersol (DES) acts as a hormone mimic and how similar compounds alter normal biological operations, suppress normal hormone responses or elicit responses stronger or weaker than normal. In pregnant women, DES exposes a fetus to excessive estrogen levels by increasing the body’s estrogen production and disabling mechanisms which protect the fetus from estrogen. This increased estrogen exposure has in turn led to increased rates of cancer, miscarriage, premature delivery and ectopic pregnancy in women whose mothers were exposed to DES. The authors state, “The molecular structure of estradiol... is basically the same in all vertebrate animals. Such shared elements of physiology may explain why such a broad range of organisms are similarly vulnerable to hormone disruptors” (p.44).

The article also discusses the effects of p-nonylphenol, commonly used in polystyrene and polyvinyl chlorides (PACS) on breast cancer and cell division. Common household items with the potential of leaching biologically active plastics and hormone disruptors, including water jugs and plastic lining in canned food are identified. All of the article’s claims and conclusions are referenced.

INVESTIGATION OF THE SECONDARY STERILIZING EFFECT OF DIETHYLSILBESTROL (DES) ON PREDATORS
A. German. Unit of Vertebrate Pest Control, The Volcani Center, Bet Dagan, Israel
M. Rubina. Kimron Veterinary Institute, Bet Dagan, Israel

“The practical use of the chemosterilant diethylstilbestrol dipropionate (DES) for suppressing the reproduction of pest rodents is doubtful, mainly because of the potential risk of secondary effects on predators” (p.141). 2 barn owls, 5 cats and 10 substitute predators (lab rats) were fed voles which had consumed DES. The predators achieved 100% fertility but one male cat whose mother had consumed DES treated voles suffered from delayed sexual maturity and
one female rat whose mother had consumed DES treated voles developed large abscesses on its ovaries.

A LANDSCAPE RESTORATION FRAMEWORK FOR WILDLIFE AND AGRICULTURE IN THE RURAL LANDSCAPE
Landscape and Urban Planning. 27:7-17, 1993.
J. M. Fedorwick. School of Landscape Architecture, University of Guelph, 2665 Misener Crescent, Mississauga, Ontario, L5K 1M9

The paper discusses the ecological benefits of creating additional patches and corridors in fragmented rural environments. The diversification of fragmented landscapes leads to both agricultural benefits (erosion reduction and nutrient cycling) and wildlife benefits (habitat and movement corridors).

A case study of the application of a design for regional landscape restoration in southern Ontario is described and compared to three theoretical regional landscape designs. The likely structural and functional changes in the landscape for each of the designs are discussed.

NEW DEVELOPMENTS IN FERAL HORSE CONTRACEPTION AND THEIR POTENTIAL APPLICATIONS TO WILDLIFE
John W. Turner, JR. Department of Physiology. Medical College of Ohio, Toledo, OH 43699-0008
Jay F. Kirpatrick. Department of Biological Sciences, Eastern Montana College, Billings, MT 59101

This paper summarizes the main requirements of effective contraceptives. “First, it has to provide a high degree of effectiveness across a given breeding season. Second, it has to be free of harmful side effects to the animals receiving it, including pregnant animals. Third, the ideal contraceptive should be reversible [there are important ecological, social and political reasons for reversibility]. Forth, the agent will be inexpensive....Fifth, the ideal agent should have a flexible duration of action...Sixth, the agent should have minimal to no effect on social organization or behavior. Finally, the agent should be capable of being delivered remotely” (p.350).

Extensive research has been done into feral horse contraceptives, but the potential for applying these contraceptive technologies has not been fully explored. It may, however, be possible that by “carefully assessing the reproductive patterns, behavior, habits and environment of a given free roaming species .... to adopt existing contraceptive technology to assist in the management of some species”(p.355).
The paper comparatively examines current wildlife contraceptive delivery systems (capture and chute, live trap and restraint, chemical immobilizer, remote delivery and bait or food), administration techniques for the contraceptives (intramuscular injection and oral), agent type (synthetic steroids, natural steroids and immunological contraceptives) and the format of agent to be administered (subdermal implants, encapsulation, intrinsic long action, vaccination). The adaptability of delivery systems to characteristics of different animals is assessed according to animal size (small or large), the animal’s life style (secretive or exposed) and the animal’s habitat (open or cover).

Steroid contraceptives: are a group of “natural and synthetic sex steroids and immunotropic protein and peptide antigens” (p.355). Steroids may act over extended periods of time, are well researched relative to non-steroid and immunological contraceptives, may be delivered orally, and are effective against most vertebrates. The most serious and dangerous drawback of synthetic steroids are the possible consumption of the slowly biodegrading steroids by humans, predators and scavengers. These dangers severely limit steroid usability and potential for commercial registration.

Natural steroids: are quickly biodegraded and may therefore reduce health and environmental concerns about synthetic steroids. The effectiveness of these steroids requires high doses, usually achieved with surgical implants which requires capturing and handling each animal. These requirements limit the practicality of natural steroids.

Immunological contraception: in horses has a high degree of effectiveness and reversibility. The immunocontraceptive works by raising natural antibodies against proteins of peptides necessary for reproduction. According to the authors these chemicals “do not have the potential for contaminating the environment” (p.356). Nor do the chemicals have behavioral effects on horses. This technique has been successfully employed to reduce fertility in pigs (Sus scrofa), rats (Rattus norvegicus) and rabbits (Oryctolagus cuniculus). Disadvantages include, the possible necessity of more than one inoculation for immunization, the inability to effectively and predictably deliver orally with present microencapsulation technologies, and variable effectiveness across species. The potential long term side effects are unknown but could range from permanent infertility to immunity to the immunocontraceptive.

If a viable contraceptive is found, the delivery of the contraceptive (oral or intramuscular) is the next concern. The two approaches are remote delivery and delivery requiring the capture and handling of the animal. The use of capture, live trap and restraint methods are all costly and time consuming and not practical for many populations of animals. The use of chemical immobilizers may be more efficient than capture and restraint methods, but are expensive and can be dangerous for the animal involved.

Remote delivery: darts or plastic bullets fired from a gun or baits may be employed. Darting wild horses was found to be significantly more cost and time efficient than capturing and restraining animals. This technique will likely be limited to large animals in open areas. Baits
have the two major disadvantages of producing food aversions in target animals and effects on non-target organisms. Regardless, this approach “remains potentially viable for many species, especially for small mammals and birds” (p.357).

The authors predict future developments of anti-fertility agents and delivery techniques will lead to contraception’s increased importance in wildlife management. They conclude with the cautionary remark: “In the continuing development of contraceptive technology for wildlife, it is important to address, in addition to efficacy, issues of environmental and animal safety, reversibility and cost effectiveness” (p.357).

FERAL HORSE FERTILITY CONTROL: POTENTIAL AND LIMITATIONS
Robert A. Garrot. Department of Fisheries and Wildlife Conservation, University of Minnesota, St. Paul, MN 55108

The author modeled the effects of reducing fertility in mares on wild horse populations and made the following management recommendation: “There was no single treatment program that was well suited to all populations; therefore, contraceptive programs should be developed based on the population dynamics of individual feral horse herds. Any attempt to implement a generalized contraceptive program for all populations may result in inadequate control in some populations while precarious decline occur in others.” (p.58).

HOW GOVERNMENTAL WILDLIFE AGENCIES SHOULD RESPOND TO LOCAL GOVERNMENTS THAT PASS ANTIHUNTING LEGISLATION
William T. Hesselton, 43 Hall Road, Oxford, MA 01540

The author argues that in areas with antihunting legislation, wildlife agencies should not respond to nuisance wildlife complaints, stock fish or engage in other conservation measures.

HOW GOVERNMENTAL WILDLIFE AGENCIES SHOULD RESPOND TO LOCAL GOVERNMENTS THAT PASS ANTIHUNTING LEGISLATION- A RESPONSE
Gary S. Kania. Whitesands Road, P.O. Box 40, Modus, CT 06469
Michael R. Conover. Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210

The authors write, “In the United States and Canada, the wildlife resource belongs to all of the people, regardless of whether they are consumptive users, nonconsumptive users or nonusers.... Agencies need to adapt to these societal changes [decreased hunting] rather than
resist them. Agencies should adopt the principal that their mandate is to enhance the value of the wildlife resource for all its citizens. The danger of Hasselton's position is that if enacted by a governmental wildlife agency, the 90% of the citizens that do not hunt may realize that their wildlife agency is interested in managing their wildlife resource not for their benefit but for someone else's. If that happens, we submit that the wildlife agency will not be managing the public’s wildlife resource for much longer.” (p.224-225)

NO CONCEPTION; MASQUERADING AS SEX HORMONES, CHEMICALS UBIQUITOUS IN THE ENVIRONMENT COULD THREATEN OUR CHILDREN’S ABILITY TO REPRODUCE
Diana Lutz, editorial associate of The Sciences.

The article summarizes much of the research to date on common hormone disrupting chemicals in the environment and their links to reproduction and cancer. The chemicals described occur in detergents, paints, cosmetics, inks, pesticides and plumbing pipes as well as in plastic, paper and cardboard used in food packaging. Cancer and deformities caused by diethylsilbersol (DES) exposure in utero are discussed.

DES is also used to demonstrate the difference between naturally occurring hormone disruptors (such as those found in fruit) and synthetic ones. Plant derived estrogens bind quickly to proteins and are no longer physiologically active; DES does not bind to these proteins and therefore remains active.

Recent changes in human reproductive health including a 35% decrease in sperm counts over the last 20 years (2.1% per year), a doubling of testicular cancer in white men and tripling in black men since 1950 has been related to hormone disruptors, since these conditions can be created by in utero exposure as was observed in women exposed to DES.

The paper concludes, in part, “The whole field of toxicology grew out of industry concern over high-dose exposure of its workers. The goal was to protect against cancers at extremely low frequency. The method people came up with was to run one or two studies using exceedingly high doses, plot the responses and then draw a straight line down to some zero value. The assumption was that this gave you some idea of the risk at lower doses.... This method is criticized even within the cancer field but in the field of endocrine disrupters there is no argument about it whatsoever. It simply does not work. That is because there is no linear response in endocrinology. The response is shaped like an upside down U.... That means you can not extrapolate from a few high dose studies, and that, in turn, means no chemical in the environment today has been tested in a relevant fashion for its endocrine-disrupting ability” (p.15).
ONTARIO BIRDS AT RISK: STATUS AND CONSERVATION NEEDS
Federation of Ontario Naturalists, 355 Lesmill Road, Don Mills, Ontario, M3B 2W8

The book lists the bird species which have been most disrupted by human activities in Ontario. The history and present status of birds at risk are given. Birds are categorized into extinct, extirpated, endangered, threatened, rare, not in any category and insufficient information. A rationalization is given for the classification of each species. The history of the birds in Ontario, their breeding status, habitat, conservation needs and recommended readings are included.

Some of the birds at risk which breed in the Bay of Quinte Watershed are the least bittern (threatened), cattle egret (not in any category), black-crowned night-heron (rare), redhead (rare), ruddy duck (rare), bald eagle (endangered), Cooper’s hawk (rare), red-shouldered hawk (rare), king rail (endangered), American coot (rare), Wilson’s phalarope (rare), Caspian tern (rare), black tern (threatened), short-eared owl (threatened), loggerhead shrike (endangered), white-eyed vireo (rare), prairie warbler (threatened), Cerulean warbler (rare), Louisiana woodthrush (threatened), yellow-breasted chat (rare), Henslow’s sparrow (endangered) and the orchard oriole (rare).

Other birds at risk are found in the bay of Quinte watershed, but there is insufficient information to confirm breeding sites or they breed outside of the watershed and are only transient residents. Considering the impacts wildlife management and crop protection practices may have on these species is an important component of responsible wildlife management.

PLANNING FOR AN OPTIMAL MIX OF AGRICULTURAL AND WILDLIFE LAND USE
Joseph E. Powers. Southwest Fisheries Center, National Marine Fisheries Service, Box 271, La Jolla, CA 92038

A linear programming model is used to maximize profit on a theoretical farm, subject to wildlife and agricultural ecosystem restraints. The model allocates crops, determines field size, fertilizer levels, rotation rates with wildlife, and agricultural subsystems as constraints to maximize profit and efficiency. It is found that large field sizes maximize profit, and wildlife needs were then most efficiently met by placement and harvest rates of crops. To maintain the integrity of agricultural subsystems and wildlife habitat, profit was substantially reduced.
REMOTE DELIVERED IMMUNOCONTRACEPTION IN FERAL HORSES
Jay F. Kirpatrick. Department of Biological Sciences, Eastern Montana College, Billings, MT 59101
Irwin K. M. Liu. Department of Reproduction, School of Veterinary Medicine, University of California, Davis, CA 59616
John W. Turner, JR. Department of Physiology. Medical College of Ohio, Toledo, OH 43699

This study documents the effectiveness of remotely delivered immunocontraceptive, solubilized porcine zonae pellucidae (PZP) in female wild horses. This paper documents the first successful attempt to reduce fertility with remotely delivered immunocontraceptives in free roaming mammals. PZP inhibited fertility but did not affect horses that were already pregnant. The effects of PZP are reversible, cannot be passed through the food chain, and did not effect social behavior of horses. The authors used urinary and fecal samples to determine effects of PZP remotely.

STATEMENT FROM THE WORK SESSION ON CHEMICALLY-INDUCED ALTERATIONS IN SEXUAL DEVELOPMENT: THE WILDLIFE/HUMAN CONNECTION
Tel: 609-683-4750 or Fax: 609-683-0838

Between 26-28 of July 1991, 21 experts in the fields of anthropology, ecology, comparative endocrinology, histopathology, immunology, mammalogy, medicine, law, psychiatry, psychoneuropediatrics, reproductive physiology, toxicology, wildlife management, tumor biology and zoology prepared a consensus statement on compounds capable of disrupting the endocrine systems of fish, wildlife and humans. The names and address of each participant is included in the document. This paper was concerned primarily with the hazards of endocrine disruptors on human populations.

Chemicals known to disrupt the endocrine system include "DDT and its degradation products, DEHP (di(2-ethylhexyl)phthalate), dicofol, HCB (hexachlorobenzene), ketohene, kepone, lindane and other hexachlorocyclohexane congeners, methoxychlor, octachlorostyrene, synthetic pyrethroids, triazine herbicides, EBDC fungicides, certain PCB congeners, 2,3,7,8-TCDD and other dioxins, 2,3,7,8-TCDF and other furons, cadmium, lead, mercury, tributylin and other organo-tin compounds, alkyl phenols (non-biodegradable detergents and anti oxidants present in modified polystyrene and PCVs), styrene dimers and trimers, soy products, and laboratory animal and pet food products" (p1-2)

Many of the consensus statements may be relevant to present research into wildlife management and fertility control. For example:
"We are certain of the following.... Humans have been affected by compounds of this nature, too. The effects of DES (diethylsilberstrol), a synthetic therapeutic agent, like many of the compounds mentioned above, are estrogenic. Daughters born to mothers who took DES now suffer increased rates of vaginal clear cell adenocarcinoma, various genital tract abnormalities, abnormal pregnancies, and some changes to immune responses. Both sons and daughters exposed *in utero* experience congenital anomalies of their reproductive system and reduced fertility. The effects seen in *in utero* DES-exposed humans parallel those found in contaminated wildlife and laboratory animals, suggesting that humans may be at risk to the same environmental hazards as wildlife" (p.2)

"We estimate with confidence that.... The concentrations of a number of sex hormone agonists and antagonists measured in the U.S. human population today are well within the range and dosages at which effects are seen in wildlife populations. In fact, experimental results are being seen at the low end of current environmental concentrations...[and]...Unless the environmental load of synthetic hormone disruptors is abated and controlled, large scale dysfunction at the population level is possible. The scope and potential hazard to wildlife and humans are great because of the probability of repeated and/or constant exposure to numerous synthetic chemicals that are known to be endocrine disruptors" (p.2-3).

There are a total of 32 consensus statements in the paper.

**STATEMENT FROM THE WORK SESSION ON ENVIRONMENTALLY-INDUCED ALTERATIONS IN SEXUAL DEVELOPMENT: A FOCUS ON WILDLIFE**

Tel: 609-683-4750 or Fax: 609-683-0838

Between 10-12 of December 1993, 21 wildlife experts prepared a consensus statement on the magnitude and geographic scope of compounds capable of disrupting the reproductive, endocrine, immune and nervous systems of wildlife embryos. This paper examines the role of chemicals creating subtle biochemical and physiological change in severe and sudden declines of certain wildlife populations in the U.S. over the last five decades. Species discussed are alligators, bald eagles, beluga whales, boreal toads, bottle-nosed dolphins, Caspian terns, common terns, Florida panthers, Forster’s terns, great blue herons, herring gulls, leopard frogs, old squaw ducks, polar bears, roseate terns, scoters, sea turtles, slider turtles, spectacled eiders, water fleas, white croakers and wood ducks. The name and address of each participant is included in the document.

Some of the consensus statements are relevant to fertility control, poisoning, averse conditioning and chemical repellants used in wildlife management and crop protection. For example:

"We estimate with confidence that...When an animal is exposed at the same time to many
chemicals that individually are at non-toxic levels, additively, antagonism, potentiation and synergy can result in unpredictable consequences. Concomitant exposure to multiple chemicals can cause massive or subtle, but potentially tragic effects” (p.3).

“We believe that...Traditional assessments of risks posed by single chemicals are not adequate for assessing the risks for embryos exposed to multiple chemicals” (p.4).

There are a total of 31 consensus statements in the paper.

SUSTAINABLE AGRICULTURE: THE WILDLIFE CONNECTION
Ann Y. Robinson. Agricultural Specialist, Izaak Walton League of America, 801 Commerce Drive, Decorah, IA 52101

The paper discusses the wildlife benefits associated with shifts towards more sustainable farming systems, including reduced chemical use, greater crop and landscape diversity and better soil conservation. The benefits of reduced chemical use in agricultural systems are documented.

PERCEPTIONS OF FARMERS AND NON-FARMERS TOWARD MANAGEMENT OF PROBLEM WILDLIFE
McIvor, Donald E. and Michael R. Conover. Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210

The paper summarizes the results of a survey of 238 farmers during December 1991 in Utah and Lincoln County in Wyoming. Of the farmers that responded 92.8% were male and were 46-55 years old on average. The average farmer had a high school education and had been resident in their county for 46.2 years. “During 1991, 57.9% of agricultural producers in our survey experienced some level of damage from wildlife, while 66.4% experienced damage in prior years. When asked to estimate the most recent years loss, 15.6% reported losses <US$100, 56.5% reported losses from US$100-1 000, 23.1% between US$1 000-5 000, and 4.8% estimated losses >US$5 000.” (p212-213)

VIRTUAL ORCHARD PUTS FRUIT GROWING ON THE INTERNET: GREAT LAKES FRUIT GROWERS NEWS TO PROVIDE INFORMATION
The Great Lakes Fruit Growers News. p.12, April 1996.

Virtual Orchard was designed and managed by Win Cowgill (Rutgers Cooperative Extension
agricultural agent) and Jon Clements (research technician for the University of Vermont). They claim that Virtual Orchard is "grower friendly so that valuable information that was mainly available through Extension publications, horticultural Extension agents and university researchers is only a click away on the Internet" (p.12). The site includes production recommendations, newsletters, and pesticide recommendations for New Jersey and New England, as well as on line discussions. The Internet site address is: http://orchard.uvm.edu

To find out more send e-mail to apple-crop@orchard.uvm.edu with the word help in the subject line.

A PHILOSOPHY OF PROBLEM WILDLIFE MANAGEMENT
Michael J. Dorrance. Alberta Environmental Center, Vegreville, Alberta, CN T0B 4L0

This paper discusses some of the philosophical rational for wildlife management and reduction of conflict between wildlife and agriculture. The paper does a good job of summarizing some arguments related to damage prevention, damage compensation, animal control, public education, government extension services, program evaluation, research, land ownership, economics and other special considerations.

WILDLIFE DAMAGE TO CROPS: PERCEPTIONS OF AGRICULTURAL AND WILDLIFE PROFESSIONALS IN 1957 AND 1987
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504
Daniel J Decker. Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

The authors surveyed opinions of agricultural and wildlife professionals throughout America to identify the relative seriousness of major crop -- wildlife conflicts and determine if there was a difference in perceptions between professionals. 95% of state game agencies, 74% of state agricultural agencies, 97% of Animal Damage Control agents, 100% of Wildlife Extension Specialists and 86% of Farm Bureaus returned usable questionnaires. Full lists of crops and animals for each institution are presented in tables and summarized. Deer are identified as causing the most conflicts nationally, although 27 animals are identified at least once as being the most important. Changes in levels of wildlife damage and services offered by different institutions are listed. Of those surveyed, 48 report that wildlife damage has greatly decreased, moderately decreased or slightly decreased; 47 report that wildlife damage was about the same; and 404 report wildlife damage has significantly, moderately or greatly increased.
Changes in wildlife-human interactions have been quite dramatic in some cases. “For instance in 1957, 16 states reported that deer were either no problem or only caused localized problems, while in our survey, 15 of these same states stated that deer were now causing more damage to crops than any other wildlife species” (p.51). Overall, all organizations agreed that wildlife and agriculture conflicts were serious and increasing, but the relative importance of any specific species varied considerably across the United States.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Canadian Beaver

Prepared By: Rob Mound.
Completed: Fall 1996
Canadian Beaver (*Castor canadensis*)

Results of the Grower Needs Assessment

The Canadian Beaver was identified as having potential conflicts with agriculture, but was also identified as being beneficial and complementary to agriculture in the Bay of Quinte Watershed. Beavers were credited with creating ponds which could be used for irrigation and they create valuable wetland habitat important to rural biodiversity. Beavers are often controlled by shooting, trapping and dam destruction.

Species Biology and Life History

The Castoridae family has only one living genus (*Castor*).

*Castor canadensis* is a large semiaquatic rodent with dark chestnut fur, a squirrel shaped skull, short ears, a horizontal, flat, scaly tail and 4 mammae. Beavers have 20 teeth and lips which close behind large, orange incisors. They have five clawed toes on each foot, the hind feet are webbed and the second claw on each hind foot is split (Kurta 1995, Burt and Grossenheider 1980, Seton p.1909).

Total length: 900-1200 mm (35-47 in); tail length: 300-400 mm (12-16 in); weight: 12-27 kg (26-60 lb) (Kurta 1995). The beaver is most active in the morning and evening, although it is occasionally seen during the day (Burt and Grossenheider 1980). A beaver can live up to 21 years in the wild, but normal life expectancy is around 10 years (Kurta 1995).

RANGE

Beavers historically inhabited the majority of Canada and the United States, were exterminated throughout most of this range, have now reestablished themselves, and are currently found throughout the Bay of Quinte watershed (Burt and Grossenheider 1980). The beaver is common throughout the watershed, although it is less common in the more extensively farmed and urbanized southern portions (Kurta 1995).

HOME RANGE

Beavers usually construct a dam to regulate water levels and build a lodge to live in and raise their young, but occasionally they nest in burrows in river or stream banks (Cameron 1964). A mated pair of beavers will usually stay close to home, within 1 km of their den (Seton 1909). Young beavers leave the lodge at 2 years and travel as far as 240 km (150 mi.), although usually less than 10 km (6 mi.), from their birth place to the area where they build their own lodge (Burt and Grossenheider 1980). Beavers are quite territorial and will defend their home from other beavers (Burt and Grossenheider 1980).
ENVIRONMENT/HABITAT
Beavers prefer shallow, slow moving streams and small lakes, preferably with clay banks and wooded with poplar, alder and willow (Seton 1909, Burt and Grossenheider 1980).

SENSES
Beavers swim with their nose, eyes and ears out of the water. Their hearing and sense of smell is good, as is their ability to detect motion (Seton 1909).

COMMUNICATION
The best known beaver communication is the tail slap warning. Beavers are, however, capable of other communication. They are known to hiss when angry and make a churr-ing sound when happy (Seton 1909). Beavers are a social animal and work together to maintain their lodge and dam (Kurta 1995).

REPRODUCTION
The beaver is a monogamous animal capable of sexual reproduction at two years of age (Seton 1909). Beavers mate in mid winter and have a 128 day gestation period (Burt and Grossenheider 1980). Beavers generally have 2-5 young but may have up to 8, which are born fully furred and with eyes open in April-June (Burt and Grossenheider 1980). After 1 month the young begin to eat solid food and can be seen abroad with their mother (Seton 1909). At 6 weeks the young are fully weaned (Seton 1909). The young beavers stay with the parents and work together as a colony until they are 2 years old, at which time the young leave to create their own colonies (Cameron 1964).

MOVEMENT
Beavers are quite quick in the water and are comparatively clumsy and vulnerable on land (Seton 1909).

FOOD
Completely herbivorous, beavers eat pond lilly roots and marsh grasses, as well as the leaves and bark of young deciduous trees; beavers are not known to eat conifers (Seton 1909). Preferred trees include aspen, poplar, birch, maple, willow and alder, which beavers store underwater, near the den for the winter (Burt and Grossenheider 1980).

PREDATORS/LIMITING FACTORS
The beaver’s large size and lodge protect it from most threats. The grey wolf and coyote are the most common natural threats to the beaver; however, red fox, black bear, wolverine, lynx and even eagles sometimes prey on them(Kurta 1995, Seton 1909). The young are especially vulnerable to predation (Kurta p.145). Historically, people have had the largest impacts on beaver populations; the fur trade and agriculture had eliminated the beaver from much of its present range by the late 1800's (Kurta p.143).
NOTES
Beavers play an important role in forest and pond succession and are of great importance to Canadian landscape and culture.

Wetland values associated with beaver dams include:
1- Dams create reservoirs which keep water tables up; water table level can be especially important in summer months.
2- Dams slow water flow which mitigates erosion and increases nutrient retention.
3- Wetlands and wetland plants purify water.
4- The reservoirs created by beavers can be spawning and breeding areas for fisheries.
5- Wetlands are incredibly important to biological productivity and diversity in South Eastern Ontario. Many birds and mammals depend on beaver pond habitat for their survival.
6- While dams often cause local flooding, they also serve to mitigate greater flooding problems downstream during high flow periods in spring and fall.
7- Much of Canadian art and identity has been inspired by the beauty of nature and natural processes.

Beaver do not, however, build dams for these reasons. Beaver are most comfortable in the water and are comparatively clumsy and vulnerable on land.

Beavers build dams for three main reasons:
1- Dams enable beavers to access food without leaving the safety of the water.
2- Dams ensure that there is water around the lodge where the beavers live.
3- Beavers store their food under water. It is important to beavers that the water level is high enough that their food does not freeze.

Beavers have operated in this way for thousands of years and have become an integral part of Canadian ecosystems and landscape. The creation of beaver ponds follows a typical pond cycle.

Beaver pond cycle:
1- Dam construction floods the surrounding area creating a larger wetland than previously existed.
2- Eventually siltation and succession restricts the beaver's access to food supplies. The beaver tries to overcome this by building channels. These channels allow the beaver to get closer to food without leaving the water and often run along the edge of the forest. If the beaver eats all the food in the area or can no longer raise water levels or build channels to offset succession and siltation, the beaver leaves the pond and the unmaintained dam can wash out. In some cases, well established dams with a lot of vegetation growing on them do not give, in which cases the slow process of pond succession moves the pond back to its original forested state.
3- If the dam washes out or slowly releases water, the wetland drains promoting oxidization of the basin soils and release of nutrients; a grassy "beaver meadow" is created.
4- The meadow will slowly be transformed by succession into a forest, and with the regrowth of poplar, beavers will likely reinhabit the area and the cycle begins again.
Different numbers and types of wildlife and plant species are associated with each different stage of the beaver pond cycle. There is no species more important to ecological productivity and diversity in Eastern Ontario than the Canadian beaver.

Conflicts with beaver are fairly well known. Beaver dams raise water levels flooding may kill valuable trees, flood agricultural lands and/or raise water table affecting soil moisture and tile drains. Before developing a management strategy it is worth considering the exact nature of both the positive and negative aspects of beaver and the amount of resources it will require to remove the beaver or otherwise mitigate the problem.
Results of the Literature Survey

The information available suggests several options for reducing conflicts between beaver and agriculture in the Bay of Quinte watershed. General conclusions can be drawn from available information about beaver bafflers, beneficial aspects of beavers, dam destruction, general biology and life history, habitat management, hunting, natural predators, physical barriers, repellents, and trapping.

Beaver baffles, physical barriers and habitat management are options which in the right circumstances can lead to a long run win-win solution for beavers and agriculture. Depending on the situation these options may be quite cost effective. Hunting and trapping are short term solutions and it may be necessary to contact the Ministry of Natural Resources for approval. Dam destruction is the most common, but most ecologically damaging and often a very labor intensive approach to discouraging beaver. It will be most effective with new beaver dams, at older dame beaver are more persistent. Again it is best to contact the Ministry of Natural Resources as there are restrictions on timing of dam removal.

BEAVER BAFFLERS
• Beaver baffles are pipes which can be used to manage water levels or expel beavers from certain areas.
• This technology is especially suited for reducing conflicts between land owners and beavers while protecting both the beavers and the valuable habitat they create.
• Reducing water levels by greater than 50% can cause beavers to abandon their dams.
• Monthly cleaning is recommended.

References
• A Device for Control of Problem Beaver
• Managing Beaver Ponds
• Options for Controlling Beaver on Private Land

BENEFICIAL ASPECTS OF THE BEAVER
• Dams create reservoirs which keep water tables up.
• Dams slow water flow which mitigates erosion and increases nutrient retention.
• Dams create wetlands and wetland plants which purify water.
• The reservoirs created by beavers can be spawning and breeding areas for fisheries.
• Wetlands are incredibly important to biological productivity and diversity in South Eastern Ontario. Many birds and mammals depend on beaver pond habitat for their survival.
• While dams often cause local flooding, they also serve to mitigate greater flooding problems downstream during high flow periods in the spring and fall.
• Much of Canadian art and identity has been inspired by the beauty of nature and natural processes.
References
- L-1911 Controlling Beaver Damage
- Managing Beaver Ponds
- Options for Controlling Beaver on Private Land

DAM DESTRUCTION
- Is an ineffective long run way to discourage beavers or reduce conflicts.
- Will be most effective if the dam is new. It is harder to remove beavers from an area in which they have lived for many years.
- May be illegal, depending on the age of the dam, season and downstream effects.
- Results in increased tree cutting and dam building activities.
- Can be a very labor intensive approach to removing beaver.
- Encourages beaver to cut down more trees to rebuild their dam.

References
- Options for Controlling Beaver on Private Land

GENERAL BIOLOGY AND LIFE HISTORY
- Beavers' preferred food includes young aspen, poplar and ash.
- Beaver colonies most likely to have conflicts with agriculture are young beavers searching for new territory.

References
- Food Habits of Beaver in East-central Mississippi
- Managing Beaver Ponds
- Options for Controlling Beaver on Private Land
- Productivity, Size, Age and Sex Structure of Nuisance Beaver Colonies in Wisconsin

HABITAT MANAGEMENT
- Planting unpalatable tree types can make an area unsuitable for beavers.

References
- Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat

HUNTING
- Shooting beavers is a temporary solution, creating a habitat void which will be filled with new beavers.
References
◆ Options for Controlling Beaver on Private Land

PHYSICAL BARRIERS
◆ Physical barriers can be used to protect specific trees from beavers.

References
◆ Options for Controlling Beaver on Private Land

PREDATORS
◆ Wolves in the northern portions of the Bay of Quinte watershed rely on beavers for food. Up to 75% of a wolf’s summer diet in central Ontario may consist of beaver when other prey species are not abundant.

References
◆ Changes in Summer Foods of Wolves in Central Ontario

REPELLENTS
◆ Beavers will avoid food treated with digitalis extract in laboratory experiments.
◆ There is no effective beaver repellent available.

Reference
◆ Herbivore Avoidance of a Simple Digitalis Extract

TRAPPING
◆ Trapping beaver is a temporary solution, creating a habitat void which will be filled by new beavers.
◆ Live trapping and relocating beavers typically leads to conflicts between the introduced beaver and entrenched beaver colonies or other land owners.

References
◆ L-1911 Controlling Beaver Damage
◆ Modifications of the Baily Live Trap for Beaver
◆ Options for Controlling Beaver on Private Land
Summary of Selected References

A DEVICE FOR CONTROL OF PROBLEM BEAVER
Henry A. Laramie, JR. New Hampshire Fish and Game Department

This paper describes the use of wooden and fabric pipes by the New Hampshire Fish and Game Department to maintain water levels at desirable levels in beaver ponds without destroying dams or beavers. A 24 foot pipe with 1 inch holes along the bottom is plugged at one end and placed through the dam. The height of the mouth determines the water level. These pipes have been used successfully in watersheds, up to 25.9 km².

The author gives cost estimates (now inaccurate) and a list of materials necessary for construction. The author states that the entire job can be completed in one day but should be checked several days later and maintained once a month (this varies with season and area). Maintenance involves running a potato hoe, or one’s hand along the underside of the pipe to clear debris. Placing the pipe in a way which minimizes its potential contact with the bottom or floating debris minimizes maintenance. In practice, once flow volume is known or estimated, “the number of pipes required to accommodate the flow are assembled” (p.472). The paper does not, unfortunately, give the flow-volume capacity per pipe.

The paper contains photographs, diagrams and exact specifications for construction and installation of these devices.

Also described is a method for clearing culverts with a winch and a fencing method for stopping beavers from rebuilding.

CHANGES IN SUMMER FOODS OF WOLVES IN CENTRAL ONTARIO
Dennis R. Voigt and George B. Kolenosky. Fish and Wildlife Research Branch, Ministry of Natural Resources, Maple, Ontario, L0J 1E0
Douglas H. Pimlott. Department of Zoology, University of Toronto, Ontario M5S 1A1

The percentage of white-tailed deer and Canadian beaver in wolf scat from three areas, Algonquin Park, Pakesly (135 km west of Algonquin), and Marten River (135 km north of Algonquin) was analyzed. From 1963 to 1972, the scat makeup changed as deer decreased in availability in all three areas. The changes in scat composition were as follows: Algonquin park -- beaver up from 7 to 55% as deer fell from 76 to 33%; Pakesly -- beaver up from 59 to 75% as deer fell from 27 to 11%; Marten River -- beaver up from 37 to 74% as deer fell from 42 to 1%.
FOOD HABITS OF BEAVER IN EAST-CENTRAL MISSISSIPPI
Thomas H. Roberts and Dale H. Arner. Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS 39762

Food selection is not influenced by the sex or age of the beaver. Seasonal differences in food consumed are documented, and the monthly changes in percent dry weight of foods in beaver stomachs are ranked.

HERBIVORE AVOIDANCE OF A SIMPLE DIGITALIS EXTRACT
Bruce A. Kimball and Kevin L. Kelly. U. S. Department of Agriculture, Animal and Plant Health Inspection Center, Denver Wildlife Research Center, Building 16, Denver Federal Center, P. O. Box 25266, Denver, Colorado, 80225
Zhibin Zhang. Department of Animal Ecology, Institute of Zoology, Chinese Academy of Science, Beijing, People’s Republic of China

The study suggests that plants and plant derivatives naturally avoided by herbivores may contain aversive agents usable as repellents. The mountain beaver (Aplodontia rufa) avoided apple cubes treated with digitalis (Digitalis purpurea) extract. The paper concludes that since digitalis is abundant in western North America, most animals would have experience with the chemical and would recognize and avoid it or plants treated with it. According to the authors, animals having experience with the extract or similar agents are unlikely to habituate or be poisoned by the chemical.

L-1911 CONTROLLING BEAVER DAMAGE
1992 Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468
Bruce Leland

"Beavers are the largest rodents in North America and are important because their dams stabilize creek flow, slow runoff and create ponds. However, these same dams can negatively alter the flow of creeks. Other damage is caused by bank burrowing, tree cutting or flooding. Damage prevention and control are discussed, but the major focus of the leaflet is on the various trapping methods, such as live, leg hold and Conibear traps and snares. Beaver tracks and lodges are illustrated. This is a 4-page publication with 1 photograph and 4 illustrations."
MANAGING BEAVER PONDS
A cooperative Internet site provided by the North Carolina State University, North Carolina A & T State University, U.S. Department of Agriculture and local governments.
Questions and Comments: scott_payne@ncsu.edu

This article reviews the benefits of beaver ponds. Active ponds improve water quality downstream, are watering holes for wildlife and agriculture, are breeding areas for birds and fish, diversify wetland habitats and create important or critical habitat for many reptile, bat, amphibian, fish and bird species. Abandoned ponds provide important snag and nest cavities for insect eating birds and raptors, increase forest productivity, are valuable habitat for deer, bears, turkeys, grouse and many small mammals.

The paper also describes the use of a “Clemson beaver pond leveler”. The device is made with 40 foot, 10 inch diameter PVC pipe, mesh wire and an elbow joint. A smaller pipe would work in smaller watersheds and dams. The PVC pipe with hundreds of two inch holes in it, is encased in a wire cage located underwater upstream. It is necessary for 10 feet of pipe to be upstream. Downstream there is an elbow joint so that water levels may be altered. Drawing down the water more than 50% can make the beavers leave to seek new areas. Diagrams necessary for construction of the device are included.

MODIFICATIONS OF THE BAILY LIVE TRAP FOR BEAVER
Richard R. Buech. North Central Forest Experiment Station, 1992 Folwel Avenue, St Paul, MN 55108.

This paper examines the benefits and drawbacks of the Baily™ and Hancock™ live traps (Tomahawk Live Trap Company, P.O. Box 323, Tomahawk, WI 54487). These are the two most commonly used traps to capture live beavers. After discussion of limitations, the author suggests modifications to the release mechanism and locks of the Baily live trap and offers suggestions for trapping and handling beaver.

OPTIONS FOR CONTROLLING BEAVER ON PRIVATE LAND

This 4 page paper describes the ecological benefits of beaver activity, beaver behavior, food preferences (poplar ash and birch), and beaver management options and legalities.

Management of beaver on private lands is the responsibility of the landowner. One option is to wait and see; “in many situations the best way to manage beaver is to leave them alone and enjoy watching the natural cycle of a beaver pond and the wildlife that are dependent upon the wetland environment”(p.3). When ‘wait and see’ is not an option, other options may include
the beaver baffler, tree protection, trapping, shooting and dam destruction.

The beaver baffler is a pipe put through the dam. Beavers may leave ponds where they cannot control the water level. A diagram is included and the OMNR can provide information on planning and installation of the devices. Tree protection may be an option if one is concerned about protecting specific trees.

Trapping and shooting are described as “a quick but temporary solution...As long as there is suitable habitat, other beaver will quickly move in”(p.3-4). If a beaver is trapped, it is best to humanely kill it, rather than relocate it. Beavers are very territorial and are likely to attack introduced beavers.

Dam destruction is not recommended. It is ineffective and has serious legal consequences. It may cause flooding, and siltation downstream and depending on how many years the dam has been in place, its removal may violate the Canadian fisheries act, the lakes and rivers improvement act or the public lands act. Removal of a dam in the winter causing the beaver to starve and freeze is an offence under the Canadian criminal code.

PRODUCTIVITY, SIZE, AGE AND SEX STRUCTURE OF NUISANCE BEAVER COLONIES IN WISCONSIN

Ronald P. Peterson and Neil F. Payne. College of Natural Resources, University of Wisconsin-Stevens Point, Stevens Point, WI 54481

Beavers in nuisance beaver colonies averaged 1.64 years of age. The average number of beavers per colony was found to be 3.7. The paper concludes, “Young, dispersed beavers are easier to remove than entrenched families”(p.268). Management recommendations in the paper are not supported by the authors’ data.

WILDLIFE & AGRICULTURE (1): TREES AND SHRUBS FOR EROSION CONTROL AND WILDLIFE HABITAT

Ontario Federation of Anglers and Hunters
Wildlife Habitat Facilitator, OFAH, P.O. Box 28, Peterborough Ontario, K9J 6Y5 (705-708-6324)

The pamphlet suggests that it is possible to reduce conflicts with beavers by planting specific trees and shrubs: “beaver damage can be discouraged by planting the proper trees and shrubs”.

The facilitator can provide site-specific planting recommendations, recommendations for nuisance animal control and habitat enhancement information, as well as information about availability and cost of certain trees and shrubs.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Birds

Prepared By: Rob Mound.
Completed: Fall 1996
Birds

Results of the Grower Needs Assessment

Conflicts between agriculture and "birds" in the Bay of Quinte watershed were identified as being quite serious by area growers. The conflicts were described as escalating and involving new species while traditional management methods were decreasing in effectiveness. Turkeys and crows were each identified as having significant impacts on farm productivity at least once. Crows, "birds", "blackbirds", turkeys, ring-billed gulls, and robins were all identified as requiring some kind of control. Conflicts with robins and ring-billed gulls were escalating for some growers, and in some cases, lethal control was being used. Crops receiving the most damage were strawberries, raspberries, apples and other small fruits.

Some conflicts were identified only as being with "birds" or "blackbirds", and many crop protection options are equally applicable to different bird species. Therefore birds, bird management and crop protection are addressed as a group. Descriptions of species biology and crop protection options for each individual bird species are not included. Effects of crop protection or bird management practices on specific birds are identified whenever possible.
Results of Literature Survey

There is considerable information about various wildlife management and crop protection practices capable of reducing conflicts between birds and agriculture in the Bay of Quinte watershed. General conclusions can be drawn from available information about audio scarers, Bastian Mimicry and Averse Conditioning theories, beneficial aspects of depredating bird populations, chemical frightening agents (4-aminopyridine), chemosterilization, compensation, cultivar selection, general biology and population dynamics, habitat manipulation, lure crops, physical barriers, poisons, predators, repellents, trapping, visual scarers and wetting.

AUDIO SCARERS

◆ Propane cannons, recorded distress and alarm/escape calls and electronic warblers have all been used to reduce damage to crops.
◆ These devices have not always been cost efficient.
◆ Ultrasound, infrasound, devices which cause pain or are designed to "disorient" birds or disrupt bird communication have not been demonstrated to be useful for crop protection.
◆ Local topography may reduce sound travel and therefore reduce effectiveness of sonic scarers.
◆ Audio scarers which have biological significance (distress and alarm calls) are more effective than other scarers.
◆ Sounds of biological significance are almost always species specific.
◆ Alarm calls are more effective than distress calls.
◆ Some birds (rock doves) do not have alarm calls.
◆ Regional dialect may reduce effectiveness of alarm and distress calls.
◆ Quality of tapes and recording and broadcasting equipment will influence effectiveness of alarm and distress calls.
◆ High fidelity equipment is more effective than low fidelity equipment for broadcasting sounds of biological significance.
◆ Alarm and distress calls have been used to repel starlings, crows, ring-billed gulls, blue jays, robins, red-winged blackbird and Canadian geese.
◆ Propane canons are more effective than scaring devices without biological significance. It has been argued that the sound of propane canons has biological significance for birds.
◆ Changing the location, sound intervals or types of sounds generated will enhance the efficiency of audio scaring devices.
◆ Devices will be more effective when reinforced with real danger.
◆ Scalers are more effective when there are alternative food sources available.
◆ Audio scaring devices are less effective if birds have established the crop as a feeding area.
◆ If a sonic device is ineffective it should be removed; otherwise, birds may begin to associate the noise with a good food source and the device will concentrate damage.
◆ These devices may cause conflicts with neighbors.
◆ There are ways to minimize annoyance associated with audio scarers.
References

• Alarm Sounds and Responses of Birds and Their Application in Controlling Problem Species
• Auditory Repellents
• Balloons Make Birds Nervous, Not Growers
• Be Aware of Neighbors When Using Bird Scarers
• Bird Control in Cultivated Blueberries
• Bird Dispersal Recordings: an Overview
• Bird Behavior and Scaring by Sound
• Birds Have Good Taste... And They Prefer a Fuji
• A Comparison of Some Broadcasting Equipments and Recorded Distress Calls for Scaring Birds
• Comparative Effectiveness of Avitrol, Exploders and Hawk-kites in Reducing Blackbird Damage to Corn
• Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
• Differential Heart Rate Response of Starlings to Sound Stimuli of a Biological Origin
• Dispersal of Starlings from Woodland Roosts and the Use of Bio-acoustics
• Dispersal of Urban Roosts with Records of Starling Distress Calls
• Eastern Wild Turkey Responses to a Tape Recorded Chick Call
• The Effects of Scarers on the Presence of Starlings (Sturnus Vulgaris) in Cherry Orchards
• Efficacy Testing of an Ultrasonic Bird Repeller
• Experimental Use of Av-alarm for Repelling Quela from Rice in Somalia
• Fish and Wildlife Habitat Management: Best Management Practices
• Mobbing Behavior by Crows: the Effect of the “Crow in Distress” Model
• Noise Control on Farms
• Preliminary Studies on the Use of a Specific Sound to Repel Starlings (Sturnus Vulgarus) from Objectionable Roosts
• Prospects for Making Acoustic Super-stimuli
• Recorded Calls of the Eastern Crow as Attractants and Repellents
• Recorded Calls of the Herring Gulls (Larus Argentatus) as Repellents and Attractants
• Reducing Odor and Noise Conflicts Between Neighbors
• Responses of Instrumentally Conditioned Starlings to Aversive Acoustic Stimuli
• Sonic Deterrents in Animal Damage Control: a Review of Device Tests and Efficiency
• Sonic Systems for Controlling Bird Depredations
• Starling Response to Three Auditory Stimuli
• Status of Bio-sonics in Pest Bird Control
• Tape Recorded Calls Disperse American Crows from Urban Roosts
• Tests of Bird Control Measures in Sudan
• Visual Bird Scarers: an Ethological Approach
BASTIAN MIMICRY AND AVERSE CONDITIONING THEORIES

- Bastian Mimicry theory and Averse food Conditioning are the two theories used to predict bird responses to repellents, chemosterilants, chemical frightening agents and toxicants.
- These theories suggest different application techniques for chemicals with different desired effects.
- Averse Conditioning is the avoidance of foods which have caused illness in the past.
- Bastian Mimicry includes the central theory of Averse Conditioning, but also considers the importance of natural selection, social learning and visual cues in the development of aversions.
- The addition of visual cues (dyes, ribbons or simple patterns) can increase the effectiveness of chemical repellents.
- Birds may generalize aversions to color cues so that cues may be effective in the absence of the repellent.
- Conspicuous coloration is more broadly generalized than more common natural colors.
- Visual cues are more important than taste cues in developing aversions.
- Olfactory and tactile cues may be used to develop aversions.
- Familiarity with crops reduces the effects of repellents.
- Microencapsulation can be used to hide chemicals from birds.
- Birds may avert from crops when repellents, toxicants or frightening agents are not detectable.
- Birds may avert from the repellent, toxicant or frightening agent but not the crop when the chemicals are detectable.
- Visual cues may reduce the effectiveness of chemosterilants, chemical frightening agents and toxicants not directly applied to crops.

References

- Application of Mimicry Theory to Bird Damage Control
- Conditioned Taste Aversion: its Role in Bird Damage Control
- Effects of Seed and Background Colors on Seed Acceptance by Birds
- Exploitable Characteristics of Neophobia and Food Aversions for Improvements in Rodent and Bird Control
- Generalization of and Effects of Pre-exposure on Color-avoidance Learning by Red-winged Blackbirds (*Agelaius Phoeniceus*)
- Learned Aversion in Wild Birds: a Method for Testing Comparative Acute Repellency
- Importance of Color for Methiocarb Induced Food Aversions in Red-winged Blackbirds
- Relative Importance of Taste and Vision in Reducing Bird Damage to Crops with Methiocarb, a Chemical Repellent
- Response of Birds to Different Types of Food Repellents
- Responses of Caged Red-winged Blackbirds to Two Types of Repellants
- Some Characteristics of Conditioned Aversion in Red-winged Blackbirds
- Tests of the Enhancement of Avian Repellant Chemicals with Sensory Clues
- Using Conditioned Food Aversions to Protect Blueberries from Birds: Comparison of Two Carbamate Repellents
BENEFICIAL ASPECTS OF DEPREDATING BIRDS

Depredating birds (including starlings and red-winged blackbirds) eat weed seeds and insects.

References

- Cost-benefit Determination of Blackbird Damage Control for Cornfields
- Feeding Ecology of the Red-winged Blackbird in Field Corn in Ontario
- The Impact of Predation by Red-winged Blackbirds on European Corn Borer Populations
- Relationships Between Cornfield Characteristics and Blackbird Damage
- Status of Bio-sonics in Pest Bird Control
- Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat

CHEMICAL FRIGHTENING AGENTS (4-AMINOPYRIDINE)

- 4-aminopyridine (4-AP), also known as Avitrol, is the most commonly used frightening agent.
- Published reports have been criticized as being “selected” to put 4-AP in its best light.
- 4-AP causes birds to convulse, fly erratically, squawk and emit other distress signals before dying. This behavior then scares the rest of the flock from the field.
- This distress behavior does not always create a flock response.
- 4-AP is technically different than poisoning because it can be effective with less than 1% of the population directly effected.
- 4-AP has resulted in mortality rates in target organisms greater than 50%.
- The use of 4-AP is not always effective and was not considered to be cost efficient in Ontario.
- Birds may develop aversions to 4-AP but not the crop it is meant to protect.
- 4-AP applications may shift bird damage to areas which have never received damage before.
- There is usually non-target bird mortality associated with the chemical’s use.
- Field applications of 4-AP have been documented to kill red-winged blackbirds, yellow headed blackbirds, common grackles, mourning doves, brown-headed cowbirds, golden sparrows, savannah sparrows, “sparrows”, pigeons, gulls, crows, meadowlarks, “unidentified”, red-billed quela, red bishops, masked weavers, village weavers, Baltimore oriole, red-headed woodpecker, brown thrasher and black-headed grosbeak.
- The chemical has been used to successfully protect crops from red-winged blackbird, yellow headed blackbird and common grackle depredations.
- The use of 4-AP was responsible for the reduction of the largest post-breeding blackbird population in the great plains from 1.8 million birds to just over 100 000 birds.
- 4-AP has been demonstrated to have cumulative effects on fish and some bird species.
- Secondary hazards have been demonstrated for American kestrels and may exist for other predator and scavenger species.
- Crops protected include oil-sunflower, corn, sweet corn,
- Effectiveness of the bait is compromised by heavy rainfall.
- Cracked corn baits will not deliver uniform doses of 4-AP which makes the application ineffective.
- 4-AP will be most effective in fields with few weeds.
References

- 4-aminopyridine Baits on Baiting Lanes Protect Sunflower Fields from Blackbirds
- 4-aminopyridine Effectiveness Reevaluated for Reducing Blackbird Damage to Corn
- Applications of New Bird Control Chemicals
- The Avitrol Program in Ohio
- Bird Control Chemicals - Nature, Modes of Action and Toxicity
- Cost-benefit Determination of Blackbird Damage Control for Cornfields
- Current Status and Potential of Lethal Means of Reducing Bird Damage in Agriculture
- Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
- Decline of a Blackbird Population During Seven Years of Baiting with a Chemical Frightening Agent
- Exploitable Characteristics of Neophobia and Food Aversions for Improvements in Rodent and Bird Control
- L-1920 Controlling House Sparrows
- Long Term Effects of 4-aminopyridine Exposure to Birds and Fish
- A Method for Appraising the Bird Repellency of 4-aminopyridine
- New Materials for Bird Control
- Potential Secondary Hazards of Avitrol Baits to Sharp-shinned Hawks and American Kestrels
- Protecting Ripening Corn from Blackbirds by Broadcasting 4-aminopyridine Baits
- Protection of Ripening Sunflowers from Blackbird Damage by Baiting with Avitrol Fc Corn Chops-99
- Protecting Ripening Sweet Corn from Blackbirds in Wisconsin with 4-aminopyridine
- Protecting Uruguayan Crops from Bird Damage with Methiocarb and 4-Aminopyridine
- Rationale for Testing Vertebrate Pesticides and Devices in Actual Field Situations
- Repellency and Toxicity of Three Bird Control Chemicals to Four Species of African Grain-eating Birds
- Survey of Effectiveness of Avitrol Fc Corn Chops-99
- A Tableted Corn Bait to Deliver Uniform Dosage of 4-aminopyridine to Red-winged Blackbirds
- Tests of Bird Control Measures in Sudan
- Use of 4-aminopyridine in Cornfields under High Foraging Stress
- Use of 4-aminopyridine to Protect Ripening Corn from Blackbirds

CHEMOSTERILIZATION

- Azacosteral (Ornitrol or SC-12937), TEM, Arasan and mestranol have been demonstrated to reduce fertility in birds.
- Reproduction has been inhibited in pigeons, quail, house sparrows and red-winged blackbirds.
- Microencapsulation of chemosterilants improves bait acceptance.
- Current chemosterilant delivery techniques would effect non-target bird and possibly mammal populations in a rural environment.
- All vertebrate reproductive systems (including human systems) are very similar.
Chemosterilants therefore have an high inherent potential to impact on non-target organisms.
Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

Surgical sterilization of male birds has been effective in reducing fertility in Canada geese and may be useful for small local non-migratory goose populations.

References in "Bird" Section

- Bird Control Chemicals - Nature, Modes of Action and Toxicity
- Chemosterilants and Bird Control
- Chemical Inhibitors of Ovulation in the Pigeon
- Effects of 77 Chemicals on Reproduction in Male and Female Coturnix Quail
- Effects of Ornitrol on Wild Populations of Red-winged Blackbirds and Grackles
- Effects of the Chemosterilant Ornitrol\textsuperscript{tm} on House Sparrow Reproduction
- Evaluation of Canada Goose Sterilization for Population Control
- Ornitrol: Recent Developments
- Outlook for Ornitrol
- A Program for Developing Male Chemosterilants for Red-winged Blackbirds
- La Stérilisation Est-elle Une Avenue Fertile Pour Contrôler Les Populations D’oiseaux Nuisibles

References in "General" Section

- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant\textsuperscript{tm} Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immunocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

COMPENSATION

- Producers in the western provinces are compensated for crops lost to birds.
- Compensation is most feasible when the depredating species is rare or of economic value.
- 50\% of average farm income in the United States is a result of direct government payments, price supports or extension services.
References
◆ Farming: It’s for the Birds
◆ Farming for the Future

CULTIVAR SELECTION
◆ Birds show taste preferences between different varieties of apple and corn.
◆ Husk characteristics of corn and grain cultivars can reduce bird depredations.
◆ Bird resistant corn cultivars may produce lower yields than other cultivars in areas where bird damage is low.
◆ Early ripening corn varieties receive more damage than later ripening varieties.

References
◆ Birds Have Good Taste...And They Prefer a Fuji
◆ Blackbird-resistant Hybrid Corn Reduces Damage but Does Not Increase Yield
◆ Relationships Between Cornfield Characteristics and Blackbird Damage
◆ Taste Preferences of Male Red-winged Blackbirds among Dried Samples of Ten Corn Hybrids

GENERAL BIOLOGY AND POPULATION DYNAMICS
◆ Blackbird damage is highly skewed and correlated with distance from nearest roost.
◆ Turkey populations are limited by severe winter conditions.
◆ Blackbirds prefer natural foods, or show no preference between natural foods and corn and grain crops.
◆ Increasing conflicts between agriculture and birds are a result of agricultural practices and are likely to continue to increase.
◆ Bird population conflicts with agriculture are limited by breeding habitat and not food supplies.
◆ Blackbird damage has been correlated with insect populations in corn fields.

References
◆ Current Status and Potential of Lethal Means of Reducing Bird Damage in Agriculture
◆ Effects of Winter Conditions on Reproduction in a Northern Wild Turkey Population
◆ Feeding Ecology of the Red-winged Blackbird in Field Corn in Ontario
◆ Influence of Agricultural Land-use Practices on Bird Damage and Control
◆ Population Trends in Selected Species of Farmland Birds in Relation to Recent Developments in Agriculture in the St. Laurence Valley
◆ Relationships Between Cornfield Characteristics and Blackbird Damage
◆ Response of Blackbirds to Mesurol and Sevin Applications on Sweet Corn
◆ Some Predator-prey Relationships in Bird Damage and Population Control
◆ Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat
HABITAT MANIPULATION
- Removal or alteration of vegetation can be used to decrease or increase attractiveness of an area to certain bird populations.
- Increasing conflicts between agriculture and birds are the result of habitat alterations associated with changing agricultural practices and crops.
- Habitat alteration will likely affect non-target organisms as well as target species.
- Most birds having conflicts with agriculture are reasonably tolerant of habitat modification.
- Habitat modification can not be used effectively against migratory birds feeding in fields.
- Habitat alteration may increase attractiveness of an area to different birds which will then have conflicts with agriculture.
- Habitat manipulation efforts must be directed against the factors limiting bird populations if they are to be effective.
- The major limiting factor for most birds conflicting with agriculture is nesting habitat.

References
- Avian Use of Vertical Strata and Plantings in Farmstead Shelterbelts
- Bird Use of Fence-rows: Implications of Contemporary Fence Row Management Practices
- Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
- Fish and Wildlife Habitat Management: Best Management Practices
- Habitat Selection by Birds of Riparian Communities: Evaluating Effects of Habitat Alterations
- Habitat Selection by Roosting Blackbirds and Starlings: Management Implications
- Influence of Agricultural Land-use Practices on Bird Damage and Control
- Population Trends in Selected Species of Farmland Birds in Relation to Recent Developments in Agriculture in the St. Laurence Valley
- Seasonal Dynamics, Habitat Relationships, and Management of Avifauna in Farm Shelterbelts
- Some Predator-prey Relationships in Bird Damage and Population Control

LURE CROPS
- Repellents and scaring devices will be more effective if birds have alternate food sources or refuges.
- Female red-winged blackbirds prefer natural food sources to corn crops.
- Male red-winged blackbirds show no preference between corn crops and natural foods.
- In western Canada areas as large as 300 acres are planted with lure crops.
- Increasing conflicts between birds and agriculture are a result of landscape and habitat changes related to changing agricultural practices and crops.
- If bird populations are limited by food sources during the time period where lure crops are planted, bird populations may increase.
- Most bird populations are limited by nesting habitat, not food supplies. Planting lure crops is therefore unlikely to increase bird populations.
References

• Bird Dispersal Recordings: an Overview
• Birdsare Flash Tape Confuses Geese ...
• Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
• Influence of Agricultural Land-use Practices on Bird Damage and Control
• Farming: It’s for the Birds
• Feeding Ecology of the Red-winged Blackbird in Field Corn in Ontario
• Relationships Between Cornfield Characteristics and Blackbird Damage
• Some Predator-prey Relationships in Bird Damage and Population Control
• Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat

PHYSICAL BARRIERS

• Netting, screening and caging are effective in reducing bird depredations.
• In certain situations physical barriers will be the only effective and cost efficient approach to crop protection.
• Netting is not 100% effective.
• Netting may be damaged by high winds.

References

• Behavioral Techniques to Reduce Bird Damage to Blueberries: Methiocarb and a Hawk Kite Model
• Bird Control in Cultivated Blueberries
• The Effects of Scarers on the Presence of Starlings (Sturnus Vulgaris) in Cherry Orchards
• Fish and Wildlife Habitat Management: Best Management Practices
• L-1920 Controlling House Sparrows
• A Method for Applying and Removing Bird-exclusion Netting in Commercial Vineyards
• Use of Plastic Netting

POISONS

• Toxic baits (DRC-1339, thallium sulfate, starlicide and TEPP) and sprays (DRC 1347 and fenthion) have been used to poison birds.
• 4-Aminopyridine is sometimes classified as a poison although it is technically different from intentional poisoning of bird populations.
• Poisoning birds is usually an ineffective crop protection technique.
• Poisoning often leaves habitat voids which are filled by migratory birds or by increased reproductive efforts of the poisoned species.
• Poisoning will be most effective on geographically isolated, non-migratory bird populations.
• If poisoning increases winter survivorship, the result may be increased bird populations the following year.
• Non-target organisms, scavengers and predators may be affected.
PREDATORS
• May be of limited value for crop damage protection.

References
• Effects of Introducing Foxes and Racoons on Herring Gull Colonies
• Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat

REPELLENTS
• Of all repellents available, only methiocarb (Mesurol) and CURB (aluminum ammonium sulfate) have been particularly useful.
• Bastian Mimicry and Averse Conditioning are the theoretical foundations for using repellents (see previous section).
• Methiocarb does concentrate in tissues of target organisms.
• Methiocarb does not normally cause mortality or deformity in target organisms.
• Methiocarb has been used to protect grass, blueberries, sweet corn, corn, sweet cherries, sprouting rice, "sprouting crops", ripening sorghum, dendrobium orchards and corn seed.
• The use of methiocarb to protect the above crops has not always been cost efficient.
• Methiocarb has failed to protect ripening rice, blueberries and cherries.
• Methiocarb has effectively repelled Canadian Geese, American robins, European starlings, red-vented bulbuls, Japanese white-eyes, northern orioles, northern mockingbirds, brown thrashers, white-crowned sparrows, house sparrows, common grackles and house finches.
• Methiocarb is not equally effective on all bird species.
• Weathering reduces methiocarb's effectiveness.
• Addition of color cues may increase the effectiveness of methiocarb.
• CURB has been used to protect rice, millet and sorghum.
• CURB alters the taste of grapes and wine made with grapes.
• Other chemicals (lithium chloride, pulegone and ethyl cinnamate) have been demonstrated to repel certain birds in laboratory situations and may have future potential as repellents in agriculture.
• Repellents are most effective when alternate foods are available.
• Effective repellents will likely adversely effect target and possibly non-target organisms.

References
• Application of Avian Repellants to Eastern White Pine Seed
• Behavioral Techniques to Reduce Bird Damage to Blueberries: Methiocarb and a Hawk Kite Model
• Bird Control Chemicals - Nature, Modes of Action and Toxicity
• Conditioned Taste Aversion: its Role in Bird Damage Control
• Can Goose Damage to Grain Fields Be Prevented Through Methiocarb Induced Averse Conditioning?
• A Cage Test for the Evaluation of House Finch Repellents for Grapes
• Chemical Repellants - a Review
• Chemicals as Bird Repellants: Two Promising Agents
• Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
• Evaluating Curb as a Crop Repellent to West African Bird Pests
• Evaluation of Methiocarb for Repelling Blackbirds from Cultivated Wild Rice
• Evaluation of Methiocarb, Ziram, and Methyl Anthranilate as Bird Repellents Applied to Dendrobium Orchards
• Exploitable Characteristics of Neophobia and Food Aversions for Improvements in Rodent and Bird Control
• A Field Test of Methiocarb Efficacy in Reducing Bird Damage to Michigan Blueberries
• Generalization of and Effects of Pre-exposure on Color-avoidance Learning by Red-winged Blackbirds (Agelaius Phoeniceus)
• Learned Aversion in Wild Birds: a Method for Testing Comparative Acute Repellency
• L-1920 Controlling House Sparrows
• Methiocarb as a Bird Repellent for Mature Sweet Corn
• Methiocarb for Repelling Birds from Ripening Sweet Cherries
• Mesurol™ for Protecting Sprouting Rice from Blackbird Damage in Louisiana
• Mint Plant Derivatives as Blackbird Feeding Deterrents
• Naphthalene Shows No Repellency for Starlings
• New Materials for Bird Control
• Preliminary Laboratory and Field Trials of Curb, a Possible Avian Repellent
• Protecting Uruguayan Crops from Bird Damage with Methiocarb and 4-Aminopyridine
• Reducing Bird Damage to Highbush Blueberries with a Carbamate Repellent
• Relative Importance of Taste and Vision in Reducing Bird Damage to Crops with Methiocarb, a Chemical Repellent
• A Repellant for Protecting Corn Seed from Blackbirds and Crows
• Repellency and Toxicity of Three Bird Control Chemicals to Four Species of African Grain-
eating Birds
◆ Repellency of Cinnamic Acid Esters to Captive Red-winged Blackbirds
◆ Repellency of Methiocarb-treated Grapes to Three Species of Birds
◆ Response of Birds to Different Types of Food Repellents
◆ Responses of Caged Red-winged Blackbirds to Two Types of Repellants
◆ Tests of Bird Control Measures in Sudan
◆ Two Tests of the Avian Repellent, Methiocarb, in Michigan Sweet Cherry Orchards
◆ Using Conditioned Food Aversions to Protect Blueberries from Birds: Comparison of Two Carbamate Repellents
◆ Use of Methiocarb as a Blackbird Repellent in Field Corn

TRAPPING
◆ Traps have been used to capture starlings and common grackles.
◆ Traps are ineffective against robins and orioles.
◆ Non-target organisms can be released from live traps.
◆ Lethal control of birds is usually ineffective.
◆ It has not been possible to attract starlings into traps with starling “vocalizations” or decoys.

References
◆ Bird Control in Cultivated Blueberries
◆ L-1920 Controlling House Sparrows
◆ Reducing a Local Population of Starlings with Nest-box Traps
◆ Tests of a Potential Method for Decoying Starlings to Bait Stations
◆ Tests of Bird Control Measures in Sudan

VISUAL SCARERS
◆ Balloons, hawk-kites, plastic owls, reflective tapes, flags, windmills, scarecrows and coloration have been used to reduce damage to crops with some success.
◆ These devices have been cost efficient in some situations.
◆ Visual scarers with biological significance are more effective than scarers which simply rely on birds’ neophobia.
◆ Visual scarers which do not have biological significance will only be effective for a couple of days.
◆ A diversity of visual devices will be more effective than a single device.
◆ Changing location of devices will be more effective than leaving the device in one place.
◆ Visual scarers will be more effective when reinforced with real danger.
◆ Visual scarers are most effective when there are alternative food sources.

References
◆ Balloons Make Birds Nervous, Not Growers
◆ Behavioral Techniques to Reduce Bird Damage to Blueberries: Methiocarb and a Hawk Kite
Model
- Birds Have Good Taste...And They Prefer a Fuji
- Birdscare Flash Tape Confuses Geese ...
- Comparative Effectiveness of Avitrol, Exploders and Hawk-kites in Reducing Blackbird Damage to Corn
- Current Status and Potential of Non-lethal Means of Reducing Bird Damage in Agriculture
- The Effects of Scarers on the Presence of Starlings (Sturnus Vulgaris) in Cherry Orchards
- Effects of Seed and Background Colors on Seed Acceptance by Birds
- Fish and Wildlife Habitat Management: Best Management Practices
- Mobbing Behavior by Crows: the Effect of the “Crow in Distress” Model
- Protecting Vegetables from Crows Using an Animated Crow-killing Owl Model
- Reflecting Tape Fails to Protect Ripening Blueberries from Bird Damage
- Reflecting Tapes Fail to Reduce Blackbird Damage to Ripening Cornfields
- Reflecting Tapes Repel Blackbirds from Millet, Sunflowers, and Sweet Corn
- Responses of Pest Birds to Reflecting Tape in Agriculture
- Someone to Watch over Me
- Visual Bird Scarers: an Ethological Approach

WETTING
- PA-14 is a surfactant which keeps birds wet. This reduces the insulative capacity of bird feathers and raises the lower critical temperature 20-40°C.

References
- Bird Control Chemicals - Nature, Modes of Action and Toxicity
- Wetting as a Means of Bird Control
Summary of Selected References

4-AMINOPYRIDINE BAITS ON BAITING LANES PROTECT SUNFLOWER FIELDS FROM BLACKBIRDS

In several oil-sunflower fields (20-48 ha) 6.6 m swaths spaced 50 m apart were treated with 4-aminopyridine (AFCC-99S). Treatment was reapplied after 1 cm of rain. During the 12 day test period flocks of 5000-31000 birds (71% red-winged blackbird, 20% yellow-headed blackbird, 7% common grackle and 2% other) were observed in the fields. Although scavengers ate dead birds, making exact counts impossible, it was estimated that 24 mourning doves, 105 red-winged blackbirds, 43 yellow-headed blackbirds and 21 grackles were killed by the treatment. The treatment reduced expected damage to the crop by 43.3% and had a benefit: cost ratio of 1.75:1 (excluding labor costs).

The treated areas were marked with colored ribbons. The effect of this addition of a potential visual cue was not assessed.

4-AMINOPYRIDINE EFFECTIVENESS REEVALUATED FOR REDUCING BLACKBIRD DAMAGE TO CORN

4-aminopyridine (4-AP) was issued an EPA permit in 1972 and registered as the product Avitrol FC Corn Chopp's-99 ™ (FC-99). The label treatment rate is 1% of corn treated with 3% by weight 4-AP with an application rate of 3.3 kg/ha applied to 1/3 of the field with no limit to applications per year. This study examined the effectiveness of the product and the effects of tripling the application rate (3% of corn treated) on target and non-target bird populations.

The study found that more than three times as many red-winged blackbirds were killed with the increased application rate. “Because of rapid deterioration and disappearance of dead birds and the poor conditions of the dead birds located, we were unable to estimate the total number of birds killed by 4-AP treatments. Nevertheless, the data provided an index to bird mortality associated with each treatment form” (p.188). Dead birds in the sampled treatment fields included 1 mourning dove, 1 house sparrow, 8 red-winged blackbirds, 12 common grackles, 2 brown headed cowbirds and 2 unidentified birds.
The authors conclude that changes to the method of application and dilution rates could make 4-AP a more “effective and flexible management tool to help reduce blackbird damage to maturing corn” (p.184).

ALARM SOUNDS AND RESPONSES OF BIRDS AND THEIR APPLICATION IN CONTROLLING PROBLEM SPECIES
Gordon W. Boudreau. 2510 Glen Canyon Road, Santa Cruz, California

The paper discusses the potential of bio-acoustics, specifically alarm, distress and alert calls as a way to reduce bird conflicts with people. Responses of birds to bird calls in field tests are reviewed. Startle responses, interspecific responses differing responses to distress and alarm calls and bird attraction to strange sounds are also discussed.

The differences between alarm and distress calls limit how the sounds may be used. Birds are rarely attracted to alarm calls but may be attracted to distress calls. Alarm calls are produced when a species spots a predator or other danger and are functionally different from distress calls which are produced when a species is hurt, cornered, starving, poisoned, freezing or otherwise stressed. Descriptions of field equipment for reproducing sounds effectively is included.

ALLEVIATING NUISANCE CANADA GOOSE PROBLEMS THROUGH METHIOCARB-INDUCED AVERSIVE CONDITIONING
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06504

Use by Canada goose of grassy areas sprayed by methiocarb was significantly reduced for up to two weeks. Autopsies of tested geese did not detect any abnormalities attributable to methiocarb although 36% of geese had methiocarb concentrations of 0.4-1.4 ppm in fat tissue.

APPLICATION OF AVIAN REPELLENTS TO EASTERN WHITE PINE SEED
Herschel G. Abbott. University of Massachusetts, Amherst, Massachusetts

Four repellants, anthraquinone, Morkit, quinizarine and Arasan Seed Disinfectant and Protectant (50% tetramethyl thirum disulfide) were tested on white pine seed beds for
repellency of grackles, chipping sparrows, house sparrows and song sparrows. All four were found to have some repellency but percent of seed eaten was high overall. While 99% of seed was consumed on average in the five untreated sites, anthraquinone, Morkit, quinizarine and Arasan had an average of 75%, 61%, 51% and 69% consumed in five consecutive trials. The percent lost to birds increased on average with each trial so that anthraquinone, Morkit, quinizarine and Arasan had losses of 99%, 100%, 97% and 97% respectively in the fifth trial. The least damage occurred in the first or second use of the chemical, with anthraquinone, Morkit, quinizarine and Arasan having a best result of 7%, 4%, 4% and 16% respectively.

APPLICATION OF MIMICRY THEORY TO BIRD DAMAGE CONTROL
Michael L. Avery. Division of Wildlife and Fisheries Biology, University of California, Davis, CA 95616

House finches were exposed in a laboratory environment to methiocarb treated seed which included visual cues. In free choice experiments, average seed consumption was reduced from 60-79% when these visual cues were placed in untreated food. "These results are largely consistent with previous theoretical predictions and suggest that partial treatment of a crop with chemical repellent to reduce bird damage may be just as effective as the total treatment" (p.1116).

APPLICATIONS OF NEW BIRD CONTROL CHEMICALS
Lyle D. Goodhue. Phillips Petroleum Company, Bartsville, Oklahoma
F. M. Baumgartner. Department of Zoology, Oklahoma State University, Stillwater

Poisons, such as Avitrol 100™ and 200™, cause birds to act unusually, squawking, flying erratically and convulsing before death. Distress calls warn unaffected birds of danger and frighten them from the area. This approach is technically different from lethal control, although this paper demonstrates that mortality can be higher than 20%. The authors discuss the effects of different bait formulations of 4-nitropyridine-N-oxide (Avitrol 100™) and 4-aminopyridine (Avitrol 200™) on sparrows, pigeons, cowbirds and redwings. Gulls and crows are also affected by these chemicals. Primary poisoning of non target organisms does occur, but secondary poisonings have yet to be demonstrated, according to the authors. The paper suggests expanded use of the chemicals to protect orchard and nut crops, as well as grain and cereal crops.

Note: The senior author works for the company that produces Avitrol 100 and 200.
AUDITORY REPELLENTS
Thomas Stockdale. School of Natural Resources, Ohio State University, Columbus, Ohio 43210

The author describes the history and evolution of audio scaring devices. General conclusions are that the success of scaring devices depends on the topography of the area in which they are used and when they are applied. The author argues that birds are much more difficult to scare once they have begun feeding in an area.

AVIAN USE OF VERTICAL STRATA AND PLANTINGS IN FARMSTEAD SHELTERBELTS
Richard H. Yahner. Department of Entomology, Fisheries and Wildlife, University of Minnesota, St Paul, MN 55108

In a 2-year study of 7 farmstead shelterbelts in Minnesota, 60.7% of the 28 bird species observed were most often sighted on or near the ground as opposed to in midstory and canopy. The author makes management recommendations to increase vertical strata and increase biodiversity in shelterbelts. A total of 17 129 sightings are recorded, classified by stratum (ground, midstory or canopy) and genus of planting, and summarized in a seasonal strata index.

THE AVITROL PROGRAM IN OHIO
Richard Smith. Bureau of Sport Fisheries & Wildlife, Columbus Ohio

Avitrol™ was to be tested in Ohio, Michigan and Indiana. The use of Avitrol led to considerable controversy in the areas where it was to be used, and the Indiana Department of Conservation refused to permit the experiments in Indiana. In Michigan and Ohio the program moved birds to areas which had never had bird problems before and cost efficiency was not demonstrated. Scaring devices, however, seemed to be more effective when Avitrol was used and the author concludes: ”I think Avitrol must be used with other scaring devices for good control” (p.137).

BAITING STARLINGS WITH DRC-1339 AT A CATTLE FEEDLOT
Jerome F. Besser, Willis C. Royall, Jr. and John W. Degrazio. U.S. Bureau of Sport Fisheries and Wildlife, Denver, Colorado
A 10 pound application of 1% DRC-1339 treated poultry pellets killed 75% of 2,280 starlings and 4% of a brewers blackbird population within 48 hours. No other secondary poisonings were noted despite the presence of 7 other bird species.

**BALLOONS MAKE BIRDS NERVOUS, NOT GROWERS**

René Featherestone, freelance, Twisp, Washington

Allan Hurd is foreman of C&O Nursery’s orchard and prefers balloons to propane cannons for scaring birds from crops. The balloons are two foot diameter, yellow with red rings around black eyes or black with red rings around yellow eyes. Hurd has observed that Gala and Funji apple varieties receive more bird damage than other crops. Hurd cautions, “The balloons don’t keep birds away but they do make them so nervous that they don’t hang around” (p.22).

**BE AWARE OF NEIGHBORS WHEN USING BIRD SCARERS**

Burke McNeill. Horticultural Crop Advisor, OMAFRA, Niagra Vineland Station, Ontario

The article makes recommendations for reducing conflicts between farms using bird scaring devices and their neighbors. Recommendations includ deflecting noises away from neighbors with plywood barriers and reducing noise emission intervals. Other comments are, “The most common devices that work are cannons and Av-Alarms...Moving them around the field on a daily basis provides the element of surprise...The emission of sound once every 3 to 5 minutes is usually satisfactory to keep birds on the move, particularly if they do not know where the sound is coming from each day” (p.3).

**BEHAVIORAL TECHNIQUES TO REDUCE BIRD DAMAGE TO BLUEBERRIES: METHIOCARB AND A HAWK KITE MODEL**

Michael R. Conover. Department of Ecology and Climatology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504.

The experiment compared the effectiveness and cost efficiency of methiocarb (3,5-dimethyl, 4-methylphenyl methlhcarbamate) marketed as Mesero™, netting, and a helium hawk-kite predator model for reducing damage to blueberries by American robins (Turdus migratorius), starlings (Sturnus vulgaris), northern orioles (Icterus galbula), mockingbirds, (Mimus polyglottos), and brown thrashers (Toxostoma rufum). The authors found that netting reduced damage by 59.3%, methiocarb reduced damage by 54.6%, and hawk kite models reduced damage by 34.9%. While methiocarb had repellency value for all species studied, the
hawk kite predator model repelled robins, starlings and orioles but not mockingbirds and thrashers.

Netting was damaged in high winds, required "considerable maintenance" and under certain circumstances is unable to exclude birds. Installation costs were estimated to be U.S. $2,470/ha for materials and installation and U.S. $494-$617/ha, with a life expectancy of 5-10 years resulting in average yearly costs of U.S. $741-$111/ha/yr in 1982.

Methiocarb's effectiveness may be limited by days-to-harvest regulations, weathering or, in "pick your own" operations where customers are concerned about chemicals. Methiocarb was estimated to cost U.S. $39.70/ha for spraying, U.S. $12/ha for labor and U.S. $110 for 2.8kg of methiocarb per ha for a total of U.S. $246/ha/yr in 1982.

The hawk kite was tested in fields 0.8ha or less. It is uncertain whether several kites could protect larger fields. Further, the kite is effective against only certain species, is less effective when there is no wind, and may be damaged in high winds. The author suggests that the hawk kite may also be especially vulnerable to vandalism. The kite is estimated to cost less than U.S. $60 American dollars to purchase, the author does not include helium costs or labor costs to maintain the kite.

BIRD BEHAVIOR AND SCARING BY SOUND
Bird Problems in Agriculture, E. N. Wright Ed., Proceedings of "Understanding Agricultural Bird Problems" at Royal Holloway College, University of London, April 4-5 1979, p.105-114. P. J. B. Slater. School of biology, University of Sussex

Habituation and auditory localization are discussed in relation to scaring birds. Habituation results in birds ignoring the sound. Habituation is minimized by reducing and varying exposure to the sound and providing reinforcements (gunshots or model hawks for example). For a bird to flee from a sound, it must know from which direction the sound comes (auditory localization). If a bird does not know what direction the sound is coming from, it will freeze in place. Sounds which cover a range of frequencies are easier to locate than pure tones and are therefore more likely to make birds flee. Volume and amplitude give an idea of how far away a sound is. If a bird banger fires three reports, each getting louder, the impression that the object creating the noise is getting closer will be created. This perception may increase the likelihood of birds fleeing the area.

BIRD CONTROL CHEMICALS - NATURE, MODES OF ACTION AND TOXICITY
This paper is a technical review of major chemicals and groups of chemicals used to kill or control birds over the last 300 years. It details how the chemicals are typically applied, how widespread their use has been historically, chemical composition, active ingredients and known effects on organisms are detailed. Unknowns are also identified. Chemicals discussed are toxicants, repellents, soporifics and chemosterilants.

Toxicants included are: organophosphates (fenthion, mevinphos and parathion), chlorinated hydrocarbons (endrin), metallic salts (thallium), alkaloids, (strychnine and nicotine), Organometallic salts (sodium floroacetate and sodium floracetamide), and aniline derivatives (DRC-1339, CPT and CAT).

Repellents are divided into tactile, taste, physiological and other. Tactile repellents included are: hydrocarbons (mineral oil, butenes, polyisobutenes and other petroleum and coal derivatives). Taste repellents included are: fungicides (captan and thiram), coal tar, cupric oxalate, Alum-based materials (CURB and RETA), and quinones (p-Quinone and anthraquinone). Physiological repellents included are lindane, (lindane and endrin), methiocarb and U-12171. Other repellents included are 4-aminopyridine (Avitrol), and naphthalene.

Soporifics are chemicals which immobilize birds. Soporifics included are: \( \alpha \)-chloratose, tribromoethanol and methiocarb.

Reproductive inhibitors included are: azacosterol (Ornitrol), and TEM.

PA-14 is identified as a wetting surfactant which interferes with bird insulation and leads to death by exposure.

**BIRD CONTROL IN CULTIVATED BLUEBERRIES**


John W. Nelson. Virginia Department of Agriculture and Commerce, Richmond, Virginia.

Shotguns, fire crackers and carbide guns were somewhat effective but were expensive and time consuming. Traps were somewhat effective, (one grower caught 35 000 starlings and grackles) but they were ineffective against orioles and robins. Caging increased production from 11 to 17 pounds per bush (a 54% increase in production) but may not be practical in some situations.

Biosonic taped scare calls and Av-Alarm were also tested. The devices were turned on in the morning and off at night with a photocell. Growers reporting the best control varied the sounds produced by the device or used other scaring devices in addition to the Av-Alarm. No cost estimates or damage reduction data were given for either device.
Shouting, arm-flapping, banging sticks on metal pans, scarecrows, bird decoys, raptor kites and balloons, falconry, shooting, propane exploders, pyrotechnics, synthetic alarm devices, recorded bird sounds, rock music, microwave radiation, ultrasonic sounds, chemical repellents, frightening agents, cultural practices and habitat manipulation all have one or more of the following drawbacks: “(1) the small range of influence for many devices, (2) the ability of birds to habituate to certain audio and visual stimuli, (3) the fact that many techniques are labor intensive and/or (4) an annoyance factor caused by disturbance to the human environment” (p.45).

The paper describes bird alarm recordings as “a valuable tool in integrated bird damage control programs” (p.60) and discusses, “evolutionary, theoretical and applied aspects of bird communication...as they relate to bird dispersal, the repellency of recorded sounds, habituation rate and effects of regional dialects” (p.43). Vocalization and hearing ranges of specific birds, use and characterization of recording and broadcasting equipment (microphones, reflectors, recorders and tapes), potential hazards and practical field application recommendations are included. The paper has five pages of references.

Bird vocalization ranges listed for species that are of importance to Bay of Quinte growers include American crow (Corvus brachyrhynchos) 1450-1650 Hz, American robin (Turdus migratorius) 2200-3300 Hz, starling (Sturnus vulgaris) 1100-8225, and red-winged blackbird (A. Phoeniceus) 1450-4375 Hz.

The authors note that alarm calls are more effective than distress calls, that regional dialects do exist, and that “birds only respond to calls of their own species and sometimes only to those from the same region”(p.53). The authors emphasize the use of an integrated program to reduce bird damage, including models and other visual frightening devices, shooting or habitat manipulation to make an area more or less attractive than another.

This article documents the successful use of ‘Birdscare Flash Tape’ and ‘Grass Lure-Crop Buffer Strips’ to protect corn and wheat from Canadian geese. Twenty Five dollars of tape is
said to have protected up to 3 acres of corn. The project was completed with the assistance of Ducks Unlimited Canada and the Canada-Ontario Agricultural Green Plan. For more information on the tape contact Ducks Unlimited at (705)-721-4444.

**BIRDS HAVE GOOD TASTE...AND THEY PREFER A FUJI**


Geraldine Warner, Editor, Good Fruit Grower, Wenatchee, Washington

The article reports that Mike Robinson, manager of Auvil Fruit Company’s Auvil ranch believes, that birds “prefer” (do more damage to) Fuji than Granny Smith, Red Delicious or Gala apples. He says that birds flock to Fuji planted right beside these other varieties. To control the problem he stresses a “multi pronged attack with some element of surprise, and the deterrents should not be put out too soon” (p.21). The company uses reflective tape (6000 feet/acre), but says it is quite labor intensive. The company supplements the tape with “scary-eye balloons, plastic owls, and propane-fired cannons mounted on swivels above the tree canopies” (p.21).

The article speculates about reasons of increasing bird damage and makes reference to “a new non-toxic, biodegradable bird repellent” which is being reviewed by the EPA in the United States. Leonard Askham (retired vertebrate control specialist at Washington State University) says that birds can “sniff out” Fuji better than other fruit. Regarding control measures, he says, “The worst thing a grower can do is put out one device and leave it” (p.22). Recommendations include using a diversity of bird scaring devices and moving them regularly. Further recommendations are use of propane cannons mounted on swivels and running them when birds are most active, just after sunrise and before sunset.

**BIRD USE OF FENCE-ROWS: IMPLICATIONS OF CONTEMPORARY FENCE ROW MANAGEMENT PRACTICES**


Louis B. Best. Department of Animal Ecology, Iowa State University, IA 50011

This study looks at fence-rows in the Midwest United States and great plains where bird populations and the relative importance of fence-rows as habitat are quite different from those factors in the Bay of Quinte agricultural ecosystem. On the plains, farming units are increasing in size and fence-row coverage is decreasing. Further, current fence-row management practices are reducing both width and density of vegetation. In the great plains, these changes represent a considerable threat to ecological diversity, stability and health because “fence-rows represent one of the last vestiges of wildlife habitat within regions of the Midwest” (p.343).

In areas where habitat is scarce or critical, its removal could be an effective way to reduce
depredating bird populations. Removal of fence-rows or shrubby and herbaceous vegetation will reduce habitat quality and therefore bird populations. This approach, however, is not species specific and one should balance “wildlife’s dependence on fence-rows ....[as well as] soil and water conservation against short term economic gains”(p.347).

BLACKBIRD-RESISTANT HYBRID CORN REDUCES DAMAGE BUT DOES NOT INCREASE YIELD
Richard A. Dolbeer, Paul P. Woronecki and Robert A. Stehn. U.S. Fish and Wildlife Service, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870

Gries 622A was less susceptible than U.S. Steel 1010 to bird damage but its use resulted in lower total yields. The 17 study fields were selected because of grower concern about bird damage; 6 of the fields had a historic loss of >600 kg/ha (10 bus./acre). Only 0.5% of farms in Ohio have >600 kg/ha loss to birds. “Thus for the vast majority of farmers with only light to moderate bird pressure, their primary concern in choosing a corn hybrid should be potential yield and not bird resistance”(p.300).

A CAGE TEST FOR THE EVALUATION OF HOUSE FINCH REPELLENTS FOR GRAPES
F. T. Crase. Environmental Specialist, Bureau of Reclamation, Billings, Montana 59103
R. W. DeHaven. Wildlife Biologist, U.S. Fish and Wildlife Service, Denver Wildlife Research Center Field Station, Davis, California, 95616

The authors report that 0.90 ± 0.19 g of active methiocarb/liter of water sprayed on grapes repelled 50% of house finches in cage tests.

CAN GOOSE DAMAGE TO GRAIN FIELDS BE PREVENTED THROUGH METHIOCARB INDUCED AVERSE CONDITIONING?
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106

The experiment found that methiocarb (3-5-dimethyl-4-[methylthio]phenol methylcarbamate) sold as Mesurol\textsuperscript{TM} reduced feeding of Canada geese in an enclosed rye plot during a two day test period. Methiocarb was not found to be effective at deterring free ranging Canada geese in field situations. After 2 months, no difference in damage to test and control plots was observed.
CHEMICALS AS BIRD REPELLENTS: TWO PROMISING AGENTS
Edward W. Schafer, Jr. and Ronald B. Brunton. U.S. Bureau of Sport Fisheries and Wildlife, Federal Center, Denver, Colorado

Methiocarb (4-methylthio-3,5 xylyl N-methylcarbamate) and DRC-3324 (2-methyl-α,α-diphenyl-1-pyrrolidinebutyramide) were found to be effective against red-winged blackbirds, house sparrows, grackles, pheasants, tricoloured blackbirds, brown-headed cowbirds and California quail. Repellency and toxicity data are given.

CHEMICAL INHIBITORS OF OVULATION IN THE PIGEON
William H. Elder. Department of Zoology, University of Missouri, Columbia

An array of chemicals were tested against pigeons (Columbia livia) in an attempt to find a useful antifertility agent. Compounds tested included: “tranquilizers, gametocides, antithyroid compounds, hypophyseal inhibitors, insecticides, fungicides, and coccidiostats” (p.556). Most were found to be ineffective, even at near lethal doses. Two chemicals, provera at 0.1% of diet and Arasan at 0.35% of diet, inhibited ovulation as long as they were in the birds’ food. The antifertility effects were lost if levels of the chemical fell.

One anti-cholesterol compound, SC-12937 (22, 25-diazacholesterol dihydrochloride) at 0.1% of diet for 10 days, eliminated fertility for 3 months and suppressed fertility in 75% of the population for six months after treatment.

CHEMICAL REPELLENTS - A REVIEW
E. N. Wright. Ministry of Agriculture, Fisheries and Food, Worplesdon Laboratory

The paper examines to what extent sensory cues created by non-toxic chemicals govern food selection by birds and how findings could be applied to crop protection techniques. Smell cannot be used to effectively protect crops from birds. Ammonia (at concentrations that are physically painful to people) has been used to disperse roosting birds, but this is hardly a useful wildlife management or crop protection tool. While birds are likely able to taste their food, “taste per se is not very important to birds and this suggests that unpleasant, but harmless, flavors are unlikely to prove repellent” (p.167). Chemicals are capable of effecting visual and tactile characteristics of crops and may be of use as repellents in this way. No pheremones or similar chemical communication mechanisms
have been identified in bird species.

Evolutionary theory suggests that species select food to minimize intra- and inter-species competition. Composition of diets for many birds varies dramatically over time with availability and nutritional requirements; “It is also becoming clear that the minor chemical constituents of plants play an important role in determining their acceptability as animal food” (p.170). Research in this area is likely to lead to more effective repellents and theoretical approaches to repellency.

CHEMOSTERILANTS AND BIRD CONTROL
Dr. M. R. Woulfe. Animal Products Research, G. D. Searle and Co., Chicago

The paper summarizes lab and field results of Searle and Co.’s Ornitol (SC-12937, azacosterol) and then discusses the potential role of chemosterilants in bird control. Azacosterol blocks the synthesis of cholesterol necessary for egg yolk formation. The most effective lab tests involved ten pairs of pigeons “given 1% of drug by weight of diet for 14 days....After 15 months half were still anovulatory, the others were laying intermittently and only partially fertile” (p.147).

In field tests, urban pigeon populations were reduced from over 3000 to about 500 birds with two treatments in two years. The author believes the most beneficial aspect of chemosterilization is that it avoids the population “rebound effect” which occurs with toxicant control.

COMPARATIVE EFFECTIVENESS OF AVITROL, EXPLODERS AND HAWK-KITES IN REDUCING BLACKBIRD DAMAGE TO CORN
Michael R. Conover. Department of Ecology and Climatology, The Connecticut Agriculture Experiment Station, Box 1106, New Haven, CT 06504

“The ability of chemical (Avitrol FC-99), auditory (propane crackers), and visual (hawk-kites) stimuli to reduce bird damage to field corn was compared. In unprotected fields, birds destroyed an average of 1.587 kg of grain/ha, reducing yield by 22%. Avitrol FC-99 was the least successful and was not cost effective. Exploders reduced bird damage by 77% and were the most cost effective of the three techniques with a cost: benefit ratio of 6.1:1. Hawk-kites reduced damage by 83% and had a cost: benefit ratio of 3.5:1. Most of their cost was associated with maintaining the helium balloons used to keep the kites aloft” (p.109).
A COMPARISON OF SOME BROADCASTING EQUIPMENTS AND RECORDED DISTRESS CALLS FOR SCARING BIRDS
J.-C. Bermond, PH. Gramet, T. Brough and E. Wright. Labratoire de Physiologie Acoustique and Labratoire des Petits Vertébrés, France and MAFF Infestation Control Laboratory, Worplesdon, Surrey

Over 250 broadcasts of distress calls to gulls and corvids (crows, blue jays etc.) were made with high and low fidelity equipment, using calls of different recorded clarity, in France and Britain. Under favorable conditions, high and low fidelity equipment gave similar results; but in poor conditions and especially in windy situations, high fidelity equipment was more effective. Usually calls of better quality gave better results; but in some situations, regional variability or dialect was different enough that this regional variability was a more important factor for stimulating a response in birds than quality of recording. The paper also notes that when calls are reproduced, gulls and corvids “usually approach the source of the noise and fly overhead for some time before dispersing and completely deserting the area” (p. 521).

CONDITIONED TASTE AVERSION: ITS ROLE IN BIRD DAMAGE CONTROL

The paper reviews laboratory and field tests which demonstrate conditioned aversions in economically important bird species. Experiments that demonstrate that methiocarb elicits conditioned behavioral response are also discussed. After a review of literature, the author concludes that “the inescapable conclusion [is] that the conditioned aversion mode of action will be emphasized in developing effective taste-acting repellents to protecting agricultural crops from birds” (p. 178).

The author further concludes that these future repellents will reduce, but will not eliminate damage; repellents may not be effective for all crops or all pest birds. Averse conditioning leading to alteration of feeding behavior will not necessarily be a result of bad taste. Repellents will have an adverse effect on the physiology of the target species and possibly on non-target species. The paper concludes that these repellents will be most effective when an alternative food source is available.

COST-BENEFIT DETERMINATION OF BLACKBIRD DAMAGE CONTROL FOR CORNFIELDS
Richard A. Dolbeer. U.S. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sanduskey, OH 44870
Dolbeer points out that while blackbird damage is not significant in terms of total national production, blackbird damage is highly skewed and very damaging for specific growers. These specific situations may justify the use of control measures. The paper examined the cost efficacy of Avitrol FC-99 and found that its use was economically inappropriate for most farmers.

Dolbeer also notes that bird damage is inversely related to distance from nearest roost. “In Ohio fields with losses of 9% or more have been within 5 km of a major late summer roost whereas fields >8 km from a roost, usually have received <5% loss” (p. 49).

The cost benefit analysis did not include any possible beneficial aspects of depredating birds, external costs or benefits of control, aesthetic or nuisance aspects of blackbird populations. The paper states that blackbirds are known to consume corn borers, rootworm beetles, and earworms but that these beneficial aspects of depredating birds have not been investigated thoroughly.

Dolbeer concludes: “Pest control workers should put as much emphasis on developing guidelines for the economically justifiable use of management tools as now goes into research and development of new tools” (p. 50).

CURRENT STATUS AND POTENTIAL OF LETHAL MEANS OF REDUCING BIRD DAMAGE IN AGRICULTURE

Richard A. Dolbeer. U. S. Department of Agriculture, 6100 Columbus Avenue, Sandusky, Ohio 44870

The paper reviews lethal means of bird control used world wide on populations numbering into the millions. These controls included toxic baits (thallium sulfate, TEPP, DRC 1339, 4-aminopyridine), roost spraying with toxicants (DRC-1347, fenthion), and surfactants (PA-14), trapping, mist netting and dynamiting of roosts as well as shooting. The author notes, “Most field evaluations of lethal-control techniques have put far more emphasis on the number of birds killed than on how much damage was eliminated in relation to the cost of control. Developmental and operational costs of lethal-control techniques need to be considered in relation to the extent of damage reduction to ensure that future control programs are cost effective” (p. 474).

Loss of crops to birds is less than 1% on average, but the distribution of that damage is highly skewed and is concentrated on approximately 5% of farmers with the remainder receiving insignificant losses. Control programs, “whether lethal or nonlethal, should therefore be aimed at the relatively few farmers with high losses and not the entire farming community” (p. 475).
4-aminopyridine is registered as a frightening agent, but is included in toxic controls because in practice it can lead to over 50% mortality in 3 days.

In many situations, lethal controls have been quite successful at killing large numbers of birds, but have had little effect on overall population size or population size the next year, and even less effect on crop production. Lethal controls have been successful at increasing farm productivity when used on an isolated population of non-migratory birds, or when only short term relief is required. Generally lethal controls eliminate beneficial aspects of the pest bird species and pose risks to non-target organisms, while being of questionable value to agricultural production. The use of toxicants is a last resort. “Considering the limited situations in which such toxicants could be used and the high cost of registration in relation to the overall level of damage reduction, the pursuit of such a lethal control strategy may not be cost effective, especially when alternative means of reducing damage are available” (p. 481).

CURRENT STATUS AND POTENTIAL OF NON-LETHAL MEANS OF REDUCING BIRD DAMAGE IN AGRICULTURE

The paper reviews literature dealing with farm management practices to avoid creating situations where bird damage will occur: use of chemical repellents, unattractive crop varieties, color cues and scaring devices (artificial and of biological significance).

Trends in agriculture are identified as the cause of increasing bird damage and conflict. In some situations, increased damage has actually reversed the agricultural trends which stimulated it. For example, some farmers in the U.K. have been driven out of oilseed production by woodpigeon damage. Examples of altering farming practices include using less palatable varieties, using varieties that ripen earlier or later, synchronized harvesting and sowing to spread damage over several farms, presenting stock feed before starlings arrive or after starlings leave, grinding barley in silage rather than crushing it, using dwarf tree fruit varieties which may be enclosed, etc.

The paper suggests that removing roost, watering or perch sites or the provision of alternate foods may provide relief. For this to work, however, an understanding of the birds' biology, feeding behavior and local limiting factors are important. If food supplies are the main factor limiting a population, then provision of food can increase populations. “The provision of alternative resources can be of value when used in conjunction with other deterrent techniques. The provision of undisturbed refuges to which birds can be scared from valuable crops enhances the efficacy of scarers” (p. 496).
Compensation may be an option in situations where the species is of economic or ecological importance (game or endangered species).

The potential of poisoning (as with 4-AP) and unacceptable residues (as with methiocarb) are limitations to the use of chemical repellents. Research into chemicals evolved by plants may be valuable in the future as repellents and for developing bird resistant varieties. The theory of Batesian mimicry suggests, and field testing has demonstrated, that color cues can increase effectiveness of repellents and generalization of aversive conditioning to untreated portions of the crop.

Scarers are effective because of their biological significance or because birds are neophobic. Neophobia is the fear of something new or unexpected such as flags, ribbons, windmills and other simple visual scarers. These types of simple devices are rarely effective for more than a few days. Kites flown in the sky have been effective at reducing bird damage, and it has been suggested that these objects mimic raptors. In several oilseed fields, a kite was flown once every two weeks, twice and four times a week; damage from birds was 65%, 27% and 10% respectively. The kites often fall from the sky and must be refilled by helium; “The very fact that kites are often grounded may increase their effectiveness by reducing their exposure time and thereby slowing habituation” (p.499).

Propane gas exploders are more effective than other acoustic scarers of non-biological origin; “none has been found to be more efficient than the exploder” (p.500). The results suggest that the sound of a gun or propane cannon has some biological significance to birds. The paper notes that a scarer which relies on being a new stimuli will be more effective the less it is used in a region and suggests a range of devices rather than several of the same type of scarer. The author also cautions, “Once birds have started to ignore a ‘neophobic’ scarer, it is important to remove the device as they may then associate the previously novel stimulus with a good source of food” (p.500).

Scarers of biological significance are more effective than the neophobic scarers. Kites held aloft by balloons and raptor models held aloft by nylon lines strung between trees have been effective. Raptor models with a model crow that flapped its wings and with tethered starlings were found to be more effective than conventional models. Raptor models accompanied by recorded alarm calls were more effective than the calls or the models by themselves. Models of birds with postures used to communicate alarm can reduce attractiveness of an area to birds flying overhead. The author concludes that while bioacoustics have been used effectively at airfields, they have been less successful in agricultural situations.
DECLINE OF A BLACKBIRD POPULATION DURING SEVEN YEARS OF BAITING WITH A CHEMICAL FRIGHTENING AGENT

4000 acres of cattail in the Sand Lake National Wildlife Refuge in South Dakota serve as a refuge for post-breeding blackbirds from South Dakota, North Dakota and Canada. It was the largest late-summer blackbird congregation in the northern great plains with an estimated population of 1.8 million birds. Seven years of coordinated baiting with 4-aminopyridine by surrounding corn growers reduced the population by over 80% to approximately 130,000 birds. The authors attribute this reduction to changes in migratory patterns as a result of the treatment, but did not estimate the number of birds killed by 4-AP.

DIFFERENTIAL HEART RATE RESPONSE OF STARLINGS TO SOUND STIMULI OF A BIOLOGICAL ORIGIN

The study tests five sounds -- the human voice and the four starling calls (distress, escape/alarm, drug-induced and feeding) -- to assess their potential for auditory repellants. Heart rate above baseline was measured per hour, as well as the number of times the sound could be repeated before habituation. The starling distress call was the most effective sound. It raised the hourly heartbeat significantly more than any other sound and was repeated on average 8.1 times before habituation. The human voice, escape call and drug induced call also raised heart rates and could be repeated 2.5-2.9 times before habituation. The feeding call barely affected heart rates and habituation occurred after 1.2 applications. The study did not measure effects of intermixing sounds or varying intensity of sound on heart rates and habituation times.

DISPERAL OF STARLINGS FROM WOODLAND ROOSTS AND THE USE OF BIO­ACOUSTICS
T. Brough. Ministry of Agriculture, Fisheries and Food, Infestation Control Laboratory, Worplesdon, Surrey

As the area to be restricted to starlings is increased, the use of bio-acoustics and other scaring devices will be more difficult. Simply stated, the birds need somewhere to roost and feed. Using portable equipment (described in the article) the author successfully dispersed a rural
starling roost. Without doing any comparative or cost benefit analysis, the author concludes that bio-acoustics is the most effective and easiest to use of all scaring methods.

**DISPERAL OF URBAN ROOSTS WITH RECORDS OF STARLING DISTRESS CALLS**
Erwin W. Pearson, Paul R. Skon and George W. Corner. U.S. Bureau of Sport Fisheries and Wildlife, Federal Center, Denver, Colorado

This paper describes the successful dispersal of flocks of Starlings and grackles from their roosts by urban residents using recordings of European starling, common grackle and American robin distress calls. In an urban setting, 85% of these birds moved to areas where they were not a nuisance. One surprising result was that “contrary to observations by previous workers, habituation to calls did not materialize, despite almost continuous playing by several residents in each roost area” (p.502). The authors caution that some of the birds may simply move to other locations where they will continue to be a nuisance, requiring further dispersal.

**EASTERN WILD TURKEY RESPONSES TO A TAPE-RECORDED CHICK CALL**
V. L. Kimmel and W. M. Tzilkowski. School of Forest Resources, Pennsylvania State University, University Park, PA 16802

The paper demonstrates the ability of tape recorded chick calls to elicit responses from 67% of female turkeys (Meleagris gallopavo silvestris) with broods. Male turkeys and female turkeys without broods did not respond to the calls. The paper suggests chick calls may have potential for population surveys.

**EFFECTS OF 77 CHEMICALS ON REPRODUCTION IN MALE AND FEMALE COTURNIX QUAIL**
Ecotoxicology and Environmental Safety. 6:149-156, 1982.

71 chemicals were tested on male coturnix quail at 50% LD_{50p} and 6 chemicals were tested on female coturnix quail at 24-56% LD_{50}. Only 1 chemical, P,P-bis(1-aziridinyl)-N-phenylphosphinic amide, reduced egg fertility by >50%, (56%). This chemical also, however, resulted in the death of 57% (4/7) of the birds treated. Chemical name, CAS registry number, LD_{50} values, treatment rate, fertility (1-35 days and 20-35 days), male testes weight and male and female mortality rates are given.
EFFECTS OF INTRODUCING FOXES AND RACOONS ON HERRING GULL COLONIES
John A. Kadlec. Patuxent Wildlife Research Center, Laurel, Maryland

The introduction of red fox \((Vulpes fulva)\) and raccoons \((Procyon Lotor)\) to islands with herring gull \((Larus argentatus)\) colonies eliminated recruitment of young gulls in Massachusetts. These introductions led to decreased regional populations and local colony abandonment for several years. “The introduction of predators are, in most cases, difficult to maintain on islands; this restricts their utility in population management”(p.625).

EFFECTS OF ORNITROL ON WILD POPULATIONS OF RED-WINGED BLACKBIRDS AND GRACKLES
Robert C. Fringer. N. J. Department of Agriculture, Trenton, New Jersey
Phillip Granett. Department of Entomology and Economics, Rutgers State University, New Brunswick, New Jersey.

In field tests, triethylene melamine (TEM) proved ineffective as a reproductive inhibitor in red-winged blackbirds. In field tests, Ornitrol \((20, 25\text{-diazocholesterol dihydrochloride})\) was successful at reducing reproduction in red-winged blackbirds and common grackles. Ornitrol works by disrupting yolk formation and apparently thinning egg shells. The authors conclude that Ornitrol is a successful chemosterilant, but believe that effects on non-target organisms need to be evaluated before it is recommended for use.

THE EFFECTS OF SCARERS ON THE PRESENCE OF STARLINGS \((STURNUS VULGARIS)\) IN CHERRY ORCHARDS
Crop Protection. 4:520-528, 1985.
R. W. Summers. Ministry of Agriculture Fisheries and Food, Cypypu Research Laboratory, Jupiter Road, Norwich, NR6 6SP, UK

The response of 17 radio tagged starlings to bird scarers was observed in cherry orchards. The birds continued to feed in the orchard despite the use of “Razzo-(an explosive device which propels a set of spinning blades to the top of a 6-m pole, the blades return by gravity); four gas bangers; 18 traditional scarecrows; 10 suspended tins which clang when the wind blows; tapes which hum in the wind and 15 loudspeakers broadcasting starling distress calls for about 80 seconds every 10 minutes from 0500h to 1900h GMT. In addition, a man was employed to shoot and scare birds using a variety of sounds, including riding a motor cycle, minus its silencer, through the orchard. Four traps were baited with cherries and between 500
and 1000 starlings were killed annually” (p.521).

The distress calls played were most effective at scaring birds from the orchard, but habituation occurred by 7-13 days.

The author concludes, “An alternative method for reducing starling damage in cherry orchards is to use netting to exclude birds. As well as preventing damage by starlings and by other birds, such as thrushes, this produces an enhanced microclimate in the orchards, brought about by reduced wind speeds. Furthermore, the cherries may be left on the trees until they have attained peak weights before picking. These two advantages go a long way towards offsetting the initial cost of netting and appear to offer a better long term solution to starling damage than scaring” (p.527).

EFFECTS OF SEED AND BACKGROUND COLORS ON SEED ACCEPTANCE BY BIRDS
Larry F. Panko U.S. Fish and Wildlife Service, Forest-Animal Damage Research Station, Olympia, Washington 98502

The study found that seed treated with coloring agents were accepted less than untreated seed by varied thrushes (Ixoreus naevius), Oregon juncos (Junco hyemalis) and California quail (Lophortyx californicus). The seeds used in the study were Douglas fir (Pseudotsuga menziesii). Interaction between seed color and background color did not effect seed consumption unless the coloring acted as camouflage. Coloring agents which altered the texture of seed were least preferred, and of all the coloring agents of this type, Monastral Fast Green and animal charcoal were most effective at reducing seed consumption.

EFFECTS OF THE CHEMOSTERILANT ORNITROL™ ON HOUSE SPARROW REPRODUCTION
Carl J. Mitchell, Richard O. Hayes and T. B. Hughes, Jr. U. S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, Bureau of Laboratories, Vector-borne Diseases Division, P. O. Box 2087 Fort Collins Colorado 80522

Ornitrol (20, 25-diazacholest enol dihydro-chloride) at 1% concentrations in the food of house sparrows led to 0% hatching success in treated groups while control groups achieved 64% hatching success. After 4-5 weeks, there was no significant difference between control and treated groups, a finding which demonstrates reversability. The authors caution that “delivery of the chemosterilant to the target species...while protecting other graniverous birds in an area will almost certainly prove difficult” (p.445).
EFFECTS OF WINTER CONDITIONS ON REPRODUCTION IN A NORTHERN WILD TURKEY POPULATION
William F. Porter. College of Environmental Science and Forestry, State University of New York, Syracuse, NY 13210
Gary C. Nelson. Minnesota Department of Natural Resources, Altura, MN 55910
Kim Mattson. Department of Biology, University of Minnesota, Minneapolis, MN 55455

Aspects of reproductive performance of female wild turkeys (Meleagris gallopavo) were measured in Minnesota. “Strong correlations were observed between survivorship within winter flocks and reproductive performance of females that survived to breed. Severe winter conditions appeared to reduce both egg hatching success among yearling females and recruitment of young among adults. Population modeling demonstrated that winter mortality and impaired reproductive performance can result in a significant decline in the population. At least 2 breeding seasons are necessary for population recovery” (p.281). Heterogeneity of winter conditions, leading to severe conditions in localized areas and implications for hunting quotas are discussed.

EFFICACY TESTING OF AN ULTRASONIC BIRD REPELLER

The device created a complex mixture of sonic and ultrasonic sounds rather than a single frequency. The device created three 112dB (at 0.3-m) pulsed output ranges: 5-50kHz, 1-50 kHz, and 20-50 kHz. The device was tested against the house finch, junco, chickadee, nuthatch and bluejay. The report concludes, “It is unlikely that the tested device, or other devices with the same type of sound output can repel the bird species studied from highly attractive feeding sites or reduce house sparrow activity around buildings. Neither the ultrasonic frequencies (20 to 50 kHz) nor the combined sonic and ultrasonic frequencies (1 to 50 kHz) had a noticeable effect on bird activity at baited sites” (p.62).

EVALUATING CURB AS A CROP REPELLENT TO WEST AFRICAN BIRD PES
CURB (aluminum ammonium sulfate) applied in a single treatment of 8-16 kg/ha protected ripening rice, millet and sorghum for 1-2 weeks from graniverous birds. Two treatments would be necessary for protection over the entire vulnerable period.

EVALUATION OF CANADA GOOSE STERILIZATION FOR POPULATION CONTROL
Kathryn A. Converse. National Biological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA 01002
James J. Kennelly. National Biological Survey, National Wildlife Health Research Center, 6006 Schroder Road, Madison, WI 53711

The objective of the experiment was to evaluate the effects of sterilization on male Canadian geese. The findings are of use for management of non-migratory geese populations only. Selection of males for sterilization had the advantage of increasing “the probability of a pair returning to the same site and defending against ingress of fertile pairs” (p.268). This advantage does not exist for species where females are not monogamous.

The paper concludes that “Surgically induced sterility may be cost effective for use in flocks in which capture and sterilization all of males would reduce yearly recruitment of goslings in surrounding locations.” The sterilization of 81 male geese cost U.S. $200 for equipment and supplies plus the labor of a trained veterinarian.

EVALUATION OF METHIOCARB FOR REPELLING BLACKBIRDS FROM CULTIVATED WILD RICE
Daniel W. Moulton. Department of Entomology, Fisheries and Wildlife, University of Minnesota, St Paul, MN 55108

The trials could not demonstrate that methiocarb [4(methylthio)-3,5 xylyl N-methyl carbamate], marketed as Mesurol™ was effective at deterring red-winged blackbirds (Agelatus phoniceus) from feeding on wild rice in Minnesota despite high concentrations of the chemical. The residues were found primarily on the husks and not on the rice which the birds fed upon. It is therefore unlikely that methiocarb is an environmentally or economically sound way to protect rice from blackbirds.

EVALUATION OF METHIOCARB, ZIRAM, AND METHYL ANTHRANILATE AS BIRD REPELLENTS APPLIED TO DENDROBIUM ORCHARDS
John L. Cummings, David L. Otis and James E. Davis, Jr. U.S. Department of Agriculture,
Methyl anthranilate - a human food flavoring offensive to birds, Methiocarb (3,5-dimethyl-4-methylthiophenol methylcarbamate) - an insecticide which mildly poisons birds that creates a conditioned aversion, and Ziram (zinc dimethyl-dithio-carbamate) - a fungicide which repels birds for unknown reasons were cage tested for repellency to red-vented bulbuls (Pyconotus cafer) and Japanese white-eyes (Zosterops japonicus). After cage tests Ziram and Methiocarb were evaluated in the field.

All three of the chemicals were found to repel birds in cage tests and methiocarb was found to repel birds in the field. Methyl anthranilate was not tested in the field and is not registered for use but it is considered to be of potential future importance since it has very low toxicity to vertebrates.

EXPERIMENTAL USE OF AV-ALARMS FOR REPELLING QUELA FROM RICE IN SOMALIA
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.275-277
Larry C. Holcomb. Food and Agriculture Organization, Mogadiscio, Somalia

Av-Alarm was tested against the quela and red bishop in rice fields in Somolia. Bird damage assessments in 50 meter intervals, from 0-250 meters from the device, showed that Av-Alarm has a repelling effect on quela up to 150 meters.

EXPERIMENTS COMPARING THE USE OF KITES AND GAS BANGERS TO PROTECT CROPS FROM WOODPIGEON DAMAGE

The authors demonstrated that wood pigeon damage to spring cabbage on two farms in Britain could be reduced when a large kite was flown over the field. The gas banger was less efficient and a “humming line” was completely ineffective after one week. The kite was effective for a 250-m radius for three months with no signs of habituation occurring.
EXPLOITABLE CHARACTERISTICS OF NEOPHOBIA AND FOOD AVERSIONS FOR IMPROVEMENTS IN RODENT AND BIRD CONTROL


J. Russell Mason. Assistant member, Monell Chemical Senses Center, Philadelphia, Pa. 19104

The paper reviews important behavioral defenses against dietary poisoning in birds and rodents including neophobia (avoidance of new foods and flavors), primary food aversion (avoidance of bad or bitter tastes) and learned food aversion (avoidance of foods which have caused illness in the past). Social learning and observation of other flock members can lead to food aversions of birds. Visual and taste cues are identified as an important part of a birds’ defense system. The paper also discusses characteristics of animal behaviors, masking agents, microencapsulation and prebaits as possibilities for overcoming these defenses.

The authors state that Bastian mimicry is a more inclusive concept than food aversion learning. “Bastian mimicry probably offers advantages over food aversion learning as the conceptual basis of repellency. Use of visual cues with repellents might improve aversion learning...We suggest that problems associated with 4-aminopyridine are roughly analogous to problems associated with the use of baits to induce crop aversions in rodents. That is, it would not be surprising if, on some occasions, birds observing the lethal consequences of a toxicant on conspecifics develop aversions to the bait rather than the crop...Unlike 4-aminopyridine, the repellent methiocarb has considerable potential from the perspective of bastian mimicry. As currently applied, it is colorless and presumably non-conspicuous, which perhaps explains why, in the absence of distinctive color cues, methiocarb is sometimes poor...birds may be familiar with the cues presented by the crop. Such familiarity with conditioned stimuli weakens learned food aversions in the laboratory, and the evidence indicates that methiocarb applications are less effective if depredating birds have been damaging a planting for several days before application. The addition of conspicuous color cues (that is, bright colors or simple patterns) should reduce, if not eliminate, familiarity effects”(p.20,34).

In the laboratory, mimics (color cues previously associated with poisons) can be applied to different foods and still be effective. In situations with 70% mimics and only 30% models (actual treated areas), areas have been somewhat protected by mimics. “Even if a high number of [treated areas] were required to protect mimics, reductions in the cost of methiocarb through the application of inexpensive dyes could produce a net economic benefit”(p.35).
FARMING: IT’S FOR THE BIRDS
Marilyn Crabbe

The article discusses differences in approach to agricultural loss to wildlife in western and eastern Canada. In western Canada, farmers can be compensated for crop losses and there are provincially funded programs to help reduce crop damage. In Saskatchewan, the province pays $50/acre to a total of $2,500 to compensate for crop losses. In Alberta payouts are $54/acre or 75% of damage, whichever is less. There is also a federal-provincial program, The Prairie Farm Rehabilitation Administration, which compensates 50% of crop losses from water fowl, (this percent may be raised to 80-100%). A total of 5-6 million has been paid out annually.

In the Halton region, the Halton Federation of Agriculture found 44% of field crops (not orchards) suffered from wildlife damage with average crop loss to be under 7 dollars per acre, (approximately $210,000 on 31,399 acres).

Wildlife management services in western Canada also run several programs which stress co-existence. Lynn Chambers says that the Prairie Farm Rehabilitation Administration has paid for planting of up to 300 acres of lure crops in some areas; they have also paid for bloodmeal and in rare cases, fencing. The programs do seem to reduce wildlife damage although they are not 100% effective.

FARMING WITH A FUTURE
Chris Dorsy

The paper reviews benefits of non-till agriculture and other conservation techniques to agriculture and wildlife. The article then goes on to ask: "Who will pay for farm conservation... Net U.S. farm income was $40 billion last year and roughly half of that was public money -- some 17 billion in direct farm payments and price supports and an additional $3 billion in services from state and federal agencies" (p.42).

FEEDING ECOLOGY OF THE RED-WINGED BLACKBIRD IN FIELD CORN IN ONTARIO
R.G. Garthshore, R. J. Brooks, J. D. Somers and F. F. Gilbert. Department of Zoology, University of Guelph, Guelph, Ontario, N1G 2W1

The paper studies consumption of corn and natural foods (weed seeds and animal) by red-winged blackbirds in 4 Ontario corn fields with differing natural food availability. Results are
analyzed by sex. Males ate 99.1% plant and 0.9% animal matter and females ate 99.5% plant and 0.5% animal matter. It is observed that "males ate most species of weeds in proportions approximating availability, whereas females ate most species of weed seeds in proportions exceeding availability" (p. 438).

The article lists most common weed seeds and insects (including pest species) found in bird crops.

A FIELD TEST OF METHIOCARB EFFICACY IN REDUCING BIRD DAMAGE TO MICHIGAN BLUEBERRIES
Richard A. Dolbeer, Charles R. Ingram and Allan R. Stickly, Jr. U. S. Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, Ohio Field Station, Sandusky, Ohio 44870

The use of methiocarb (3,5-methyl-4-(methylthio) phenol methylcarbamate) on blueberries at concentration of 1 lb active ingredient per 25 gallons and rate of spray of 50 gallons per acre applied 14 days before harvest was completely ineffective at reducing bird damage.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES
Agriculture and Agri-Food Canada, 1996.

This document offers "Best Management Practices" determined by a team of "farmers, researchers, resource managers, extension staff, and agribusiness professionals" to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, raccoons, deer and birds are also included.

Options to protect crops from bird damage include netting, porcupine wire on ledges to discourage roosting; noisemakers, kites and flagging tape may be useful for short periods of time.
GENERALIZATION OF AND EFFECTS OF PRE-EXPOSURE ON COLOR-AVOIDANCE LEARNING BY RED-WINGED BLACKBIRDS (AGELAIUS PHOENICEUS)

The Auk. 100:461-468, 1983.
J. Russell Mason and Russell F. Reidinger, Jr. Monell Chemical Senses Center, Philadelphia, Pennsylvania 19104

The paper describes two experiments testing the effects of two shades of red and green paired with toxicants (methiocarb and propylene glycol) that produce sickness after feeding are. Pre-exposure to the coloring reduced effects of color aversions after exposure. Reduced learned color aversion was greater with green than red. Further, greater aversions were demonstrated for more intense shades of red (i.e. learned color aversion was greater and more broadly generalized with more conspicuous coloration). “It would appear adaptive for birds to generalize avoidance learning broadly for conspicuously colored, noxious prey and to exhibit such learning regardless of prior experience with the color. Conversely, because few cryptically colored (e.g. green) prey are noxious, it would be adaptive for learning to be specific for the noxious individuals alone”(p.461).

HABITAT SELECTION BY BIRDS OF RIPARIAN COMMUNITIES: EVALUATING EFFECTS OF HABITAT ALTERATIONS

Anthony R. Greier and Louis B. Best. Department of Animal ecology, Iowa State University, Ames, IA 50011

Riparian communities were classified into 6 general habitat types in Iowa (herbaceous, savannah, scrub, wooded edge, floodplain woodland and upland woodland). The abundance of animals increased with the size of wooded area. Wooded areas supported 32 species while herbaceous areas supported 8. The 41 observed bird species in these communities were assessed for tolerance to habitat alteration. 36 vegetative variables were analyzed for each bird to determine extent of micro-habitat selection. The likely effects of habitat alterations on birds are then described. Of interest to Bay of Quinte growers, the report examined microhabitat variables which influence the distribution of American robins, red-winged blackbirds and starlings.

Unlike most other species, none of the three species’ nesting habits were limited by width of woody area. 100% of robin nests were located in deciduous trees. Red-winged blackbird nests were distributed as follows: forb (20%), grass (48%), shrub (19%), deciduous sapling (10%) and deciduous tree (3%). Starling nests were found in snags (68%), dead limbs (18%) or live trees (14%). Tolerance indexes showed that of the 41 bird species, robins were the least tolerant of nesting habitat modifications, red-winged blackbirds were the most tolerant and starlings were somewhat tolerant of changes in micro-habitat variables related to nesting.
Distribution among habitat types was documented for each species so that tolerance to loss or alteration of general habitats (herbaceous, savannah, scrub, wooded edge, floodplain woodland, upland woodland) could be accessed. All three species were represented somewhat in each habitat category with the exception of starling/herbaceous. This implies that no general habitat type is critical or limiting for the species.

Birds were then positively and negatively correlated with micro-habitat variables. Significant results for robins included negative correlation with slope, positive correlation with grasses, and positive correlation with snags less than 3 m in height. Significant correlations for red-winged blackbirds included a negative correlation with sapling and tree richness, a positive correlation with grasses, a negative correlation with plant diversity, and a negative correlation with plant density. Significant correlations for starlings included positive correlation with tree and sapling size, negative correlation with vertical stratification in vegetation greater than 9 meters and positive correlation with average snag size.

The paper concludes with habitat alterations likely to affect the 41 bird species. Based on their data set, the elimination of all woody vegetation leading to an environment dominated by pastures and hayfields would eliminate starling and robin populations but increase red-winged blackbird populations locally. The transformation of large wooded areas into strips of vegetation would increase red-winged blackbird and robin populations. The partial removal of woody canopies would increase robin and starling populations; the partial removal of woody canopies accompanied with thinning of under-story would increase robin and starling populations; and the removal of snags would lead to the reduction of starling populations.

The use of habitat alteration for bird species is a rather blunt management tool. The removal of all woody vegetation, for example, would eliminate 32 of the 41 species studied, negatively impact on 6 species and be beneficial to 4. Removal of snags has negative or uncertain impacts on 12 species and is beneficial to none.

Overall the paper rates red-winged blackbirds and robins as moderately tolerant and starlings as tolerant to habitat alterations. 10 other species are identified as having low tolerance or being intolerant to habitat alterations. The data set used to make predictions is derived from species use of natural habitat. Use of people-made structure for nesting by robins and starlings, for example, might increase these birds’ tolerance to certain habitat alterations.

HABITAT SELECTION BY ROOSTING BLACKBIRDS AND STARLINGS: MANAGEMENT IMPLICATIONS
Linda A Lyon. Graduate Program in Ecology, Rutgers-State University of New Jersey, New Brunswick, NJ 08910
Donald F. Caccamise. Department of Entomology and Economic Zoology, Cook College, Rutgers-State University of New Jersey, New Brunswick, NJ 08910

82
The analysis of 25 roost sites in central New Jersey found that site selection is influenced by characteristics related to stand age and forest management. Specifically, starlings were found predominantly in structurally homogeneous even-aged areas. The article suggests habitat modification as a possibility for starling management.

THE IMPACT OF PREDATION BY RED-WINGED BLACKBIRDS ON EUROPEAN CORN BORER POPULATIONS
Barry E. Bendell. Department of Entomology, Macdonald Campus of McGill University, Ste. Anne de Bellevue, P.Q., H9X 1C0
Patrick J. Weatherhead and Robin K. Stewart. Department of Renewable Resources, Macdonald Campus of McGill University, Ste. Anne de Bellevue, P.Q., H9X 1C0

Corn borer populations were positively correlated with distance from a blackbird roost in Quebec. It was estimated that red-winged blackbirds “through predation on corn borers compensated for approximately 20% of the damage the birds did to standing corn” (p. 1535).

IMPACT OF ROOST CONTROL ON LOCAL URBAN AND AGRICULTURAL BLACKBIRD PROBLEMS
James F. Glahn, John F. Heisterberg and Don F. Mott. U.S. Department of Agriculture, APHIS, Science and Technology, Denver Wildlife Research Center, Kentucky Research Station, 334 15th Street, Bowling Green, KY 42101
Allen R. Stickley Jr. Department of Agriculture, APHIS, Science and Technology, Denver Wildlife Research Center, Kentucky Research Station, 334 15th street, Bowling Green, KY 42101

“Blackbirds” in this paper refers to common grackles (Quiscalus quiscula), red-winged blackbirds (Agelaius quiscula), brown-headed cowbirds (Molothrus ater), and European starlings (Sturnus vulgaris). The use of lethal control of nearby roosting populations has led to only short term reductions in loss to nearby crops and feedlots. The authors therefore believe that “the strategy of reducing roosting populations to relieve agricultural conflicts should be reassessed” (p. 511). The authors examine the impact of roost spraying with surfactants PA-14 and DRC-6749 in Alabama, Kentucky and Tennessee on foraging blackbird populations at livestock feedlots and other surrounding habitats.

Agricultural damage attributed to blackbirds is mostly a result of starling depredations. Lethal control resulted in 23-96% mortality in the 9 test sites and stopped the roosts from reforming for over 1 year; however, blackbird/starling populations were reduced at local feedlots for only 1-2 weeks in normal situations. In situations where the roost targeted was the only one within 50 km, damage at local feedlots was reduced for 1 month. The authors conclude that
the surfactant cost of US$670/ha reduces damage only in certain situations and that other methods of control are more predictable, selective and cost efficient in the long run. The authors further conclude that the "geographic isolation of treated roosts, and fidelity of foraging starlings to that roost appeared to be the primary factors influencing weather roost treatments would be successful for reducing agricultural damage in the long run" (p.521).

IMPORTANCE OF COLOR FOR METHIOCARB INDUCED FOOD AVERSIONS IN RED-WINGED BLACKBIRDS
J. Russell Mason. Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104
Russell F. Reidinger JR. U.S. Fish and Wildlife Service, c/o Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104

The experiment found that red-winged blackbirds (Agelaius phoeniceus), mildly poisoned with methiocarb after eating familiar bird chow with colored triangles, developed aversions to the bird-chow only when it contained appropriately colored triangles. The authors state, "Use of distinctive cues may improve the efficacy of methiocarb as a bird repellent, visual cues may be effective without actually coloring the crop (i.e. colored flags) and Bastian mimicry could serve as the conceptual basis for studies of methiocarb as a bird repellant" (p.383). The authors go on to suggest that visual cues may act synergistically with food type cues to strengthen food aversions in red-winged blackbirds.

The paper briefly describes central concepts of Batesian Mimicry: (1) Food aversion learning is a fundamental mechanism by which predators learn to avoid food; (2) Other mechanisms such as observational learning also affect predators' feeding choices; and (3) Bastian mimicry is based on evolutionary theory of populations and therefore provides "a basis for management of blackbirds at the population level rather than at the individual level" (p.383).

INEFFECTIVENESS OF A SONIC SCARING DEVICE FOR DETERRING STARLINGS
Mary Bomford, CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, ACT, 2602, Australia

The paper examines the efficiency of Ho-tec Electronic Scarecrow™ (a audio-visual scarer) and finds it completely inefficient at repelling starlings already established at the site, or at deterring more starlings from feeding in the field, despite sales material which claimed otherwise. The author cautions that "proven performance" in sales literature means that someone believes a product reduced animal damage, but that "proven performance" in scientific terms means that a product has "been tested by a controlled, replicated experiment and a statistically significant result recorded"(p.151). The author notes that many tests are statistically inconclusive or contain serious design flaws. A list of typical design flaws and
inappropriate methodology accompanies the paper as well as a full description of the scarecrow’s features and capabilities.

**INFLUENCE OF AGRICULTURAL LAND-USE PRACTICES ON BIRD DAMAGE AND CONTROL**

R. G. Clark, R. D. Titman and J. R. Bider. Department of Renewable Resources, Macdonald Campus of McGill University, 21 111 Lakeshore Road, Ste. Anne de Bellevue, Que. H9X 1C0
H. Greenwood. Oikos Ecological Research Association Ltd., P. O. Box 8818, Saskatoon, Sask. S7K 6S7

The paper examines the influence of land use practices on (1) red-winged blackbird populations and distribution of corn damage in Quebec and (2) mallard duck populations and distribution of damage to grain crops in prairie Canada. “Agricultural land use changes have caused red-winged blackbird populations to increase in size and mallard populations to decrease in size, but levels of crop damage have increased in both cases” (p.464). Other examples of agricultural changes leading to increased crop damage are also referenced.

The authors state that it is changes in farming methods and therefore rural habitats over the last 40 years which are the major cause of crop depredation losses worldwide. Agriculture has increasingly concentrated food for granivorous and frugivorous birds to a point where it is more efficient for the birds to feed in agroecosystems than in natural ecosystems. This problem has been exaggerated by loss of natural habitats and food for some species. These two factors lead to a situation where agricultural crops have become energetically more accessible than natural foods. It is therefore no longer availability of natural food supplies but abundance and distribution of breeding habitats which limit bird populations and therefore levels and distribution of crop damage. “In most crop-damage situations, a direct cause-and-effect relationship can be identified between concentrated, profitable (agricultural) foods and efficient foraging. Because birds are very mobile, population reduction by either modifying local landscapes or killing is unlikely to reduce damage appreciably”(p.470).

Viewing crop damage as an agricultural landscape problem and not a wildlife problem suggests a shift in crop protection techniques towards techniques which increase foraging-energy expenditures for birds or providing lure crops.

**L-1920 CONTROLLING HOUSE SPARROWS**

1996. Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
John Hobbs
"The small English or house sparrow is common in urban and suburban areas. Their droppings kill vegetation and damage car finishes. They also carry diseases, parasites and insects. Sparrows can be controlled by screening, habitat modification, chemical repellants, poisoning, trapping and nest destruction. Restrictions on control methods are given. Illustrations show "porcupine wires" and sieve-type and funnel traps. This 3-page publication has 1 photo and 3 illustrations."

LEARNED AVERSION IN WILD BIRDS: A METHOD FOR TESTING COMPARATIVE ACUTE REPELLENCY

Learned aversion by the robin, brown headed cowbird, white crowned sparrow, house sparrow, starling, common grackle and red-winged blackbird to methiocarb and thiram was examined in an 11 week study. "Methiocarb produced the stronger and more lasting response in most species; thiram was much more variable in its acute effects and the intensity and duration of the learned response tended to be weaker and shorter" (p.186).

LONG TERM EFFECTS OF 4-AMINOPYRIDINE EXPOSURE TO BIRDS AND FISH

Five bird species (Bobwhite quail, mourning dove, ring necked pheasant, cortnix quail and starling) and 2 fish species (catfish and bluegill) were exposed to 4-AP to assess long term exposure hazard to non-target species. The authors conclude that 4-AP did not have a cumulative effect in two bird species although "data for doves and young pheasants indicated some hazard to individuals of these species or age classes"(p.810). Fish species were more significantly impacted and became "increasingly sensitive"; however, lethal concentrations which kill 50% of fish in 96 hours were found to be "less toxic than many commonly used pesticides" (p.811).
METHIOCARB AS A BIRD REPELLENT FOR MATURE SWEET CORN
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov. 1976, p. 228-233.
Allan R. Stickley Jr., and Charles R. Ingram. U. S. Fish and Wildlife Services, Denver Wildlife Research Center, Ohio Field Station, Sandusky, Ohio

2.24 kg/ha of 75% methiocarb (3,5-dimethyl-4-(methylthio)-phenyl methylcarbamate) was applied at two different treatment levels (once 12 days before estimated harvest date and once 12 days before estimated harvest date with a second application 7 days latter) to two small fields of sweet corn. The treatments reduced the total number of ears damaged from 8.25% in the control to 5.5 and 5.75% in the field that received one and two treatments respectively. One treatment with methiocarb seemed to be as effective as two treatments at the given application rate.

METHIOCARB FOR REPELLING BIRDS FROM RIPENING SWEET CHERRIES

Methiocarb trials were run on 10 early Burlat and 12 Bing cherry orchards in California and Washington. The average orchard size ranged from 0.7 - 2.4 ha. Pooled results found overall damage to be 3.53% in control orchards and 1.24% in orchards treated with methiocarb, a 65% reduction. The “repellent effect was similar in the two test areas which had different varieties of cherries, species of birds and macro-habitats” (p. 14).

A METHOD FOR APPLYING AND REMOVING BIRD-EXCLUSION NETTING IN COMMERCIAL VINEYARDS
Lawrence D. Fuller-Perrine. Department of Horticultural Sciences, Cornell University, Long Island Horticultural Research Laboratory, 39 Sound Avenue, Riverhead, NY 11971
Mark E. Tobin. U.S. Department of Agriculture, Denver Wildlife Research Center, P. O. Box 10880, Hilo, HI 96721

The cost effectiveness of installing and removing nets with tractor mounted hydraulic machines in a vineyard is assessed. The characteristics of the netting and net applicators are described. The paper concludes: “Two types of tractor mounted, hydraulically powered units were developed for applying and removing bird exclusion netting from grape vines. The netting system provided cost effective protection where high levels of damage (>6% on 6804 kg/ha yields) were anticipated, but may not be practical in small vineyards where low levels of damage are expected. ... Vegetative growth after the onset of grape ripening and the resultant entanglement of vine shoots in the netting may preclude cost-effective use of bird-protective
netting with vigorous varieties” (p.50).

A METHOD FOR APPRAISING THE BIRD REPELLENCY OF 4-AMINOPYRIDINE
Allan R. Stickly, Jr., Robert T. Mitchell and Robert G. Heath. Bureau of Sport Fisheries and
Wildlife, Patuxent Wildlife Research Center, Ohio Field Station, Sandusky, Ohio 44870
Charles R. Ingram and Edwin L. Bradley, Jr. Bureau of Sport Fisheries and Wildlife, Patuxent
Wildlife Research Center, Gainsville Field Station, Gainsville, Florida

The primary purpose of the paper is to describe a “definitive testing procedure for determining
the efficacy of chemicals that cause depredating birds to be repelled from crop fields” (p.1313).

The paper also, however, assesses the effectiveness of propane exploders and 4-aminopyridine
in protecting ripening corn fields from blackbirds in Ohio. 4-aminopyridine causes birds to
die violently (symptoms of poisoning include: squawking, erratic flight, tremors and
convulsions) which scares other birds from the area. Propane exploders and 4-aminopyridine
reduced damage, 81 and 56% respectively.

One treatment of 4-aminopyridine killed at least 80 blackbirds and 1 mourning dove when
applied to 27.5 acres of corn. It is, however, possible that many birds died off site or were
removed by scavengers; “in several fields numerous affected birds were observed, yet we were
unable to find many dead birds” (p.1314).

MESUROL™ FOR PROTECTING SPROUTING RICE FROM BLACKBIRD DAMAGE
IN LOUISIANA
Wildlife Society Bulletin. 10:165-170, 1982
Research Center, Gainsville, FL 32601
Howard P. Naquin. Rice Experiment Station, Louisiana State University, Crowley, LA 70526
Research Center, Denver, CO 80225

Methiocarb [4(methylthio)-3,5 xylyl N-methyl carbamate], marketed as Mesurol™ was
effective at reducing sprout damage by blackbirds. No “significant hazard” to non-target
organisms was observed but the authors suggest further studies.
"Naturally occurring plant constituents are potentially useful as avian feeding deterrents. In a series of cage trials, pulegone, a compound found in various species of mint, suppressed consumption of rice seed by red-winged blackbirds (*Agelaius phoeniceus*) more efficiently than methyl anthranilate. Furthermore, pennyroyal oil, from which pulegone is obtained, was nearly as effective as pulegone itself. Brown-headed cowbirds (*Molothrus ater*) were more sensitive to pulegone than were redwings, but female boat-tailed grackles (*Quiscalus major*) were less sensitive. Because pulegone produces both sensory irritation and post-ingestion distress, it has potential for seed treatment and other bird deterrent applications" (p. 461).

---

MOBBING BEHAVIOR BY CROWS: THE EFFECT OF THE "CROW IN DISTRESS" MODEL

The Condor. 78:120, 1976.

David P. Barash. Departments of Psychology and Zoology, University of Washington, Seattle, Washington 98190

The use of a plastic owl, a plastic owl with a plastic crow in its feet, and a plastic owl with a black cloth attached to its feet resulted in mobbing behavior in crows. The plastic owl with a plastic crow in its talons and the plastic owl with a black cloth attached to its feet had the greatest response with 14.7 and 12.9 crows mobbing the replica with calls averaging 41 and 36 decibels respectively. The owl alone was mobbed by 6.2 crows with calls averaging 18 decibels.

---

NAPHTHALENE SHOWS NO REPELLENCY FOR STARLINGS


Richard A. Dolber, Mark A. Link and Paul P. Woronecki. U.S. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870

Naphthalene is a crystalline aromatic hydrocarbon, more commonly known as mothballs. This chemical was found to be ineffective for repelling starlings (*Sturnus vulgarus*), even at levels 2.5 to 32.5 times those allowed by the U.S. EPA. A common grackle (*Quiscalus quiscula*) was observed "in the wild to pick up a naphthalene crystal in its bill and rub it vigorously against its body" (p. 64).

The authors note that olfactory system complexity and functional significance vary widely among bird species and that passeriform species (the largest order of birds, including over half of all bird species, specifically song birds and those with specialized vocal abilities) have the...
least capable olfactory systems of all bird orders. Since starlings are a passeriform species, smell repellants may be less effective.

NEW MATERIALS FOR BIRD CONTROL
John W. De Grazio. Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado

The paper discusses the best results of research in initial and final stages at the Denver Wildlife Research Center.

Research in the initial stages included: (1) DRC-736 (4-methylthio-3,5-xylyl N-methyl-carbamate), an immobilizing and frightening agent in standing sorghum. It was found that hawks consumed many of the immobilized birds. No assessment of secondary poisoning hazard was given. (2) DRC-1347, (3-chloro-p-toluidine), a contact perch toxicant killed between 70-97% of small starling flocks in field tests. (3) DRC-736 (4-methylthio-3,5-xylyl N-methyl-carbamate), was used as a seed repellent in several distinct geographic areas on common grackles (Quiscalus quiscula), boat-tailed grackles (Cassidix mexicanus), common crows (Corvus brachyrhynchos), and pheasants (Phasianus colchicus). Damage reduction up to 90% has been achieved in field trials.

Research nearing completion included: (1) DRC-1339 (3-chloro-p-toluidine hydrochloride, trade name-Starlicide) was used as a starling toxicant to reduce a population of a quarter of a million birds by 60%. (2) DRC-736 (4-methylthio-3,5-xylyl N-methyl-carbamate) was used to repel red-winged blackbirds from feedlots. (3) DRC-1327 (4-amino-pyridine) "is a fright-inducing chemical that causes affected birds to fly erratically and emit distress cries. Flocks have been cleared from fields when less than 1% of the population was effected"(p.166).

NOISE CONTROL ON FARMS
Michael Toombs. P. Eng., Rural/Urban Interface Specialist

Legal aspects of noise control and the physics of sound travel and diffusion are discussed. Recommendations for reducing conflicts with neighbors include using electronic warblers rather than propane bangers. "Use bird scaring devices only when required for protection of specific crops and only when a problem is evident. Operate bird-scaring devices only between dawn and dusk. Where possible, use directional bird-scaring devices aimed away from neighbors....Locate devices as far from neighbors as possible....Erect a noise barrier to keep noise from neighbors." (p.3).
**ORCHARD BIRD CONTROL WITH DECOY TRAPS**

The paper discusses the use of traps for reducing bird depredations on farms. Live trapping has the benefit of selectivity which other control techniques lack.

**ORNITROL: RECENT DEVELOPMENTS**

Ornitrol is a chemosterilant. Its active ingredient is an axocholesterol coded as SC-12937. The chemical disrupts formation of cholesterol necessary for egg yolk formation. The half-life of SC-12937 is 28 days. It was used in an urban area in Maine to reduce a pigeon population from 2500 to 400 birds in two years' time.

**OUTLOOK FOR ORNITROL**

Poisoning leads to a habitat vacuum which is quickly refilled by increased reproductive efforts of pest bird populations. The author envisions the use of chemosterilants such as Ornitrol as a way to eliminate this bounce back tendency of bird populations. The chemical seems to have practical application in urban settings where risks to non-target birds are low and the target population is non-migratory.

**PERCEIVED AND REAL CROP DAMAGE BY WILD TURKEYS IN NORTHEASTERN IOWA**
Stephen W. Gabrey. Department of Animal Ecology, Iowa State University, Ames, IA 50011
Paul A. Vohs. U. S. Fish and Wildlife Service, Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames 50011
DeWaine H. Jackson. Iowa Department of Natural Resources, Rural Route 1, Boone, IA 50036

The believed and real damage to corn in a mixed forest-agriculture ecosystem was examined. There have been recent increases in turkey populations with reintroduction efforts. Only 14-20% of farmers reporting turkey damage could quantifies the amount of damage, and damage
could easily have been confused with that of blackbirds or squirrels. “Our results suggest that spring damage attributed to turkeys was caused by other less visible wildlife such as deer or squirrel” (p.44). The authors conclude that turkey damage is severe in some areas, but in others turkeys have been misidentified as the depredating species. In the latter areas, reducing turkey populations as a means of control will not prevent crop damage, but will reduce benefits of turkeys including insect eating, licence revenues and tourism dollars associated with hunting.

PERCHES AND REPELLENTS
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.102-105.
Gene Meester. Presto-X Company, Omaha, Nebraska

The paper reports the abilities of the “Rid-A-Bird perch”. The perch is not practical in rural areas because of its effect on non-target organisms.

POPULATION TRENDS IN SELECTED SPECIES OF FARMLAND BIRDS IN RELATION TO RECENT DEVELOPMENTS IN AGRICULTURE IN THE ST. LAURENCE VALLEY
Benoît Jobin. Gauthier & Guillemette Consultants Inc. 225 Montford St., St. Romuald, Que. G6W 3L8
Céline Boutin. National Wildlife Research Center, Canadian Wildlife Service, Environment Canada, 100 Gamelin Blvd., Hull, Que. K1A 0H3

Populations in 28 bird species common to farmland ecosystems are related to changes in agriculture. Agricultural habitats were broadly divided into 4 categories: ‘cash crops’ (corn, wheat, soybean), ‘forage crops and pasture land’, ‘crops and livestock raising’ and ‘heterogeneous landscape’. Species richness and abundance was greatest in heterogeneous areas and lowest in areas where cash crops are grown. In the past 25 years there has been a marked decrease in dairy farming and an increase in cash cropping in the St. Lawrence lowlands. The authors describe the two major ecological results: “First, many marginally productive farms have been abandoned and the land has been given over to natural regeneration, plantations and urban sprawl. Second, intensive farming in the most fertile areas has resulted in the destruction of wildlife habitats to increase the amount of land under cultivation” (p.112).

These changes appear to be responsible for population fluctuations in a number of species associated with farmlands. Species whose populations have significantly changed as a result
of regional landscape and habitat alterations include the barn swallow, brown-headed cowbird, eastern meadowlark, savannah sparrow, vesper sparrow, red-winged blackbird, American crow, ring billed gull, rock dove, killdeer and mourning dove. Changes "to the rural landscape may be very detrimental to farmland birds that use the habitats for feeding or nesting" (p.112).

Species which nest or feed in pasture lands and hayfields have been, or will likely be, negatively affected by their disappearance. Species which nest in these areas include the savannah sparrow, vesper sparrow, bobolink, killdeer, eastern meadowlark and red-winged blackbird. Species which feed in these habitats include the European starling and brown-headed cowbird. The intensification of agriculture has led to increased herbicide use, decreased plant diversity and therefore decreased insect diversity. It is speculated that this may be the cause of decreasing sparrow and killdeer populations, as has been the case in other areas.

Other species are likely to increase in abundance. Species which nest in shrubby areas have taken advantage of succession on abandoned farms. These species include the song sparrow, yellow warbler, eastern kingbird and American crow. Birds that forage on cash crops, such as rock doves and ring-billed gulls have and will likely continue to benefit and increase their populations.

Populations of birds are influenced by factors other than the changes in agriculture in the St Lawrence lowlands. Winter bird-feeders are credited with increasing mourning dove populations, and winter bird control in the United States may be causing significant mortality in European starling, red-winged blackbirds, brown-headed cowbirds and common grackles.

POTENTIAL SECONDARY HAZARDS OF AVITROL BAITS TO SHARP-SHINNED HAWKS AND AMERICAN KESTRELS
Nicholas R. Holler. U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Gainsville, FL 32601

While acute oral toxicities of Avitrol™ formulations containing 4-aminopyridine are high and well documented, the subacute and chronic toxicity data to support claims about secondary poisoning hazards to predators and scavengers are not substantial. This study evaluated secondary poisoning hazards to sharp-shinned hawks and American kestrels under laboratory conditions. 'Hazard' in this study was taken to mean death or gross structural or function tissue changes induced by the 4-AP. After a 7 day treatment period, where the birds were allowed to feed on blackbirds killed by 4-AP, and a 14 day observation period, none of the sharp-shinned hawks had died or displayed abnormal behavior or tissue changes. 10% (2 of
American kestrels were, however, killed by acute 4-AP poisoning.

PRELIMINARY LABORATORY AND FIELD TRIALS OF CURB, A POSSIBLE AVIAN REPELLENT
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.239-241.
Ken Ewing. Monterey County Department of Agriculture, Salinas, California
A. Charles Crab. Institute of Ecology, University of California, Davis, California
Lee R. Martin. California Department of Food and Agriculture, Fresno, California
Roger Moitoso. General Vineyard Services, Gonzales, California

CURB (aluminum ammonium sulfate) was tested on grapes in limited short term experiments and “there appears to be some reduction in bird damage to grapes treated with curb” (p.240). Wine made from both washed and unwashed grapes was judged by wine tasters to have an acidic metallic flavor attributed to CURB which wine producers dislike.

PRELIMINARY STUDIES ON THE USE OF A SPECIFIC SOUND TO REPEL STARLINGS (STURNUS VULGARUS) FROM OBJECTIONABLE ROOSTS
Science. 113:318-319, 1954
Hubert Frings and Joseph Jumber. Department of Zoology and Entomology, Pennsylvania State University, State College.

The paper describes the use of distress calls to remove 20 000 starlings from trees lining a 1/4 mile of street. The call was found to be species specific; American robins and common grackles were not affected. The authors conclude “If the principle is valid, it may be possible to repel other birds from objectionable roosts or from molested crops by using their distress calls. It might also be possible to repel rodents or other mammals, or even insects such as moths” (p.319).

A PROGRAM FOR DEVELOPING MALE CHEMOSTERILANTS FOR RED-WINGED BLACKBIRDS

The paper reports the use of triethylene (TEM) in laboratory tests which demonstrated that TEM can reduce fertility in quail. An experiment with male red-winged blackbird vasectomy demonstrated that male sterilization could be used to reduce fertility, and a migration survey showed that blackbirds often return to the same area to breed. These two experiments
suggested that chemosterilization of red-winged blackbirds could be an effective method of population control. Small-scale field tests were in process in Colorado but no results were given and regional tests were planned if the small-scale tests were effective.

PROSPECTS FOR MAKING ACOUSTIC SUPER-STIMULI


J. C. Brémond. Center National de la Recherche Scientifique, Labratoire d’Ethologie Experimentale, France

Birds can alter the parameters of their distress and alarm calls depending on their “particular motivational states”. These altered calls can elicit stronger responses in other birds than a normal call would have. The author suggests that a super-stimuli or super-normal-signal can be synthesized by emphasizing specific characteristics of a normal call to make acoustic scaring devices relying on sounds of biological significance more effective.

PROTECTING RIPENING CORN FROM BLACKBIRDS BY BROADCASTING 4-AMINOPYRIDINE BAITS


In this study, application of 4-aminopyridine was found to reduce damage to ripening corn from an expected 5.58 bushels/acre (based on historic loss) to a loss of 0.82 bushels/acre, (a reduction of 85%). 4-aminopyridine causes birds to die violently; symptoms of poisoning include squawking, erratic flight, tremors and convulsions. In this study these symptoms scared other members of the flock from the treated field with less than 1% of the population directly affected. It was estimated that US$6 449 of corn was saved with $634 of 4-AP in 1972. One person could bait about 30 acres per hour (a total of 1129 acres was baited). Treatment rate was 1 pound of corn per acre treated 3% by weight with 4-aminopyridine.

Extrapolating dead bird counts, an estimated total of 7 500 red-winged blackbirds and 425 non-target birds (yellow headed blackbirds, common grackles, meadowlarks, savannah sparrows mourning doves and possibly others) were killed over the 1 129 acres. Effects on scavenger populations were not examined.

PROTECTION OF RIPENING SUNFLOWERS FROM BLACKBIRD DAMAGE BY BAITING WITH AVITROL FC CORN CHOPS-99

Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.200-201.

95
The paper reports on the results of several large scale applications of Avitrol to ripening sunflower fields. Between 2 and 14 baitings were used on each field. Using 1976 American material and labor costs and sunflower seed prices, benefit-cost ratios ranged from $0.42 to $9.00 returns for every $1.00 invested in control. A hazard to non-target organisms was noted.

PROTECTING RIPENING SWEET CORN FROM BLACKBIRDS IN WISCONSIN WITH 4-AMINOPYRIDINE
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.188-19.

The paper reports on the studies used for the registration of Avitrol FC Corn Chops-99. The experiments found bird damage to be 5.7 times greater in control fields.

PROTECTING URUGUAYAN CROPS FROM BIRD DAMAGE WITH METHIOCARB AND 4-AMINOPYRIDINE
Carlos Calvi. Ministerio de Agricultura y Pesca, Dirección de Sanidad Vegetal, Montevideo, Uruguay
Jerome F. Besser, John W. De Grazio and Donald F. Mott. Wildlife Research Center, U. S. Fish and Wildlife Research Center, Denver Colorado

Soybeans, rice, sorghum, corn and sunflowers were treated with Avitrol, methiocarb or both and compared to controls. Methiocarb was found to be effective on sprouting crops and ripening sorghum grain and 4-AP was found to be effective on corn.

PROTECTING VEGETABLES FROM CROWS USING AN ANIMATED CROW-KILLING OWL MODEL
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06504

Several model owls were mounted on weather vanes and equipped with either a crow model that would move in the breeze or a battery-powered model crow that would move whether
there was a breeze or not. Damage assessments of tomatoes and cantaloupes demonstrated that while plastic owls did reduce damage to crops, the addition of model crows and the placement on weather vanes (so that the model owls moved) increased the effectiveness of the scarers. The plastic owl and crow cost $6 and $4 respectively, the wind powered animated version was built for less than $20, and the battery powered device cost approximately $60.

RATIONALE FOR TESTING VERTEBRATE PESTICIDES AND DEVICES IN ACTUAL FIELD SITUATIONS
J. R. Beck. Biological Environmental Consultant Services, Birmingham, Michigan. 48008
H. S. Stein, Jr. President, Crane Pest Control, San Francisco, California. 94118

The paper discusses problems, limitations and failures resulting from the extrapolation of laboratory and limited field test results to actual field situations. 9 cases in the last 25 years are described. One case study was related to the use of Avitrol in cornfields in the Eastern United States where it was found to be ineffective despite “excellent results” in western and northern Midwest states. It was later discovered that “Eastern fields had, at that time, vastly different varieties of corn, different sizes of fields, more crop diversity, many more weeds, higher plant populations per acre, more natural foods for pests, different growing seasons, higher rainfall, different purposes for crops....Furthermore, much of the eastern seaboard’s “blackbird” depredation problem is from “long tailed blackbirds” (grackles), whereas the western and Midwestern corn depredation problem is primarily caused by red-winged blackbirds” (p.291).

General conclusions are that one should ask for tests conducted by unbiased and qualified final applicators under market conditions.

RECORDED CALLS OF THE EASTERN CROW AS ATTRACTANTS AND REPELLENTS
Hubert Frings and Mable Frings. Department of Zoology and Entomology, Pennsylvania State University; and Mount Desert Island Biological Laboratory, Salisbury Cove, Maine.

The researchers were able to manipulate crow behavior with pre-recorded alarm and assembly calls: “These results confirm our previous reports that biologically significant sounds may have practical value for attracting desirable species or repelling pest species. They are usually specific, harmless to the birds and easily controlled in application” (p.91).
RECORDED CALLS OF THE HERRING GULLS (LARUS ARGENTATUS) AS REPELLENTS AND ATTRACTANTS
Hubert Frings, Mable Frings, Beverly Cox and Lorraine Peissner. Department of Zoology and Entomology, Pennsylvania State University, State College

The paper describes the herring gull distress call and its use to repel birds in 27 trials at dumps, a sardine cannery, the seashore and a fish meal factory. Great black-backed gulls (Larus marinus), and laughing gulls (Larus atricilla) were also affected by the herring gull alarm call. The call could keep birds away for 15-90 minutes. The feeding call could be used to attract gulls to an area and then the gulls could be repelled by the alarm call at the same intensity. This study demonstrates that it is the biological significance and not sound that was repelling gulls. The authors also suggest that "If habituation to the alarm call sets in, a shift to the attractive call, broadcast from some spot away from the area to be cleared, may give the desired result" (p.341).

REDUCING BIRD DAMAGE TO Highbush Blueberries WITH A CARBAMATE REPELLENT

The paper reviews inefficiencies in most avian control techniques and suggests chemical controls may be more efficient and effective in some situations. Methiocarb [4(methylthio)-3,5 xylyl N-methyl carbamate] was applied at a rate of 1 pound / 100 gallons of water to a test field of highbush blueberries in Michigan. The sprayed field produced an estimated 1.49 times more blueberries than the control (unsprayed) field. The control field had a 44.2% loss while the sprayed field suffered a 16.7% loss. The depredating birds were primarily starlings (Sternus vulgarus) and robins (Turdus migratorius).

REDUCING A LOCAL POPULATION OF STARLINGS WITH NEST-BOX TRAPS

The paper suggests that the use of multi-capture live-traps which exclude non-target species or allow for their release could be useful. The traps used in the experiment captured 5.2
REDUCING ODOR AND NOISE CONFLICTS BETWEEN RURAL NEIGHBORS
Ministry of Agriculture and Food, Fact sheet. AGDEX 711/538, June 1992
Hugh F. Frazer. P. Eng. Resources Management Branch

The fact sheet discusses changing rural demographics and identifies wildlife scaring devices as one reason for increasing conflicts between farmers and rural neighbors. The paper discusses ways to reduce the annoyance factor associated with scaring devices such as building noise deflectors, moving scaring devices to different parts of fields and using bird scarers only during the day. Increasing communication with neighbors is described as the best way to reduce conflicts.

RED-WINGED BLACKBIRD FLOCK BEHAVIOR IN RESPONSE TO REPPELLENT STRESS
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.204-213.
M. I. Dyer. Natural Resource Ecology Laboratory and Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado

The author claims that the effectiveness of 4-aminopyridine is questionable at best. He gives examples to sustain his argument and states that “opinions about this repellent are anecdotal [and]...it is not altogether clear whether this ‘repellent’ material and other such chemical compounds are useful in either ecological or economic senses,...published reports to date appear to be highly selected to put this work in its best possible light, and critical tests of the employment of avian repellants in agricultural ecosystems per se are lacking. We (the public) have been provided with ‘demonstrations’ of efficacy in bird-corn crop associations, with broadly stated extrapolations to other crops; but there is not clear scientific evidence about whether this approach, let alone this particular compound, is effective and how it relates to sound management practices of wildlife-oriented problems in agricultural ecosystems” (p.204).

The author goes on to suggest a hierarchy of questions which need to be answered before one can conclude that Avitrol is effective and then surveys literature to determine if these questions have been answered. The six questions relate to: “(1) Organ physiology when perturbed by repellent chemicals such as 4-aminopyridine, (2) Behavior of the individual when subject to a repellent, (3) Behavior of social units, up to and including populations, (4) Biological reactions in the biotic community, (5) Biological reactions and sociobiological outcomes in the local ecosystem, and (6) Biological and sociobiological outcomes in the regional ecosystem” (p.205).
The author’s review of the literature finds many of his questions to be unanswered or to have inconclusive or negative answers. Literature indicates that feedbacks in an agricultural ecosystem will ensure that repellents will work well when there is little depredation and work poorly when the depredation problems are greatest. The author concludes, “I feel the scientific community ought to reconsider the use of repellents” (p.208).

**REFLECTING TAPE FAILS TO PROTECT RIPENING BLUEBERRIES FROM BIRD DAMAGE**


M.E. Tobin. Department of Natural Resources, Cornell University, Hudson Valley Laboratory, P.O. Nox 727, Highland, N.Y. 12528

P. P. Woronecki and R. A. Dolbeer. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870

R. L. Bruggers. U.S. Department of Agriculture, Denver Wildlife Research Center, Building 16, Federal Center, Denver, CO 80225

Bird Scaring Reflective Tapes™ are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other; they flash in the sun and make a humming sound in the wind. This study examined the effectiveness of these tapes at protecting blueberries from small groups of birds.

The study found the tape to be ineffective in preventing crop loss or altering bird behavior. European starlings, American robins, house finches, northern mockingbirds and grey catbirds all ignored the tape. Birds were even observed perching on the tapes. The authors speculate that birds habituate rapidly to the tapes which may, therefore, not be effective on crops which ripen over several weeks. The authors also suggest that the tapes may be less effective on solitary or small groups of birds. Another hypothesis is that the tapes are more effective for shorter crops where birds have less room to feed under the tapes. The authors make reference to personal communications with the U.S. Department of Agriculture who report that the tape is effective when used on strawberries.

**REFLECTING TAPE FAILS TO REDUCE BLACKBIRD DAMAGE TO RIPENING CORNFIELDS**


Michael R. Conover. The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

Richard A. Dolbeer. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870

Bird Scaring Reflective Tapes™ are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other; they flash in the sun and make a humming sound in the wind.
In this experiment, the tapes were spaced 16 m apart and suspended 4 m above the ground on poles. Tapes are usually spaced <10 m apart. While reflective tapes are usually placed less than 10 m apart, this experiment placed tapes 16 m apart to see if the tapes would be cost effective in lower value crops and crops that sustain less damage.

The tapes were found to be ineffective at the 16 m spacing, providing no control of blackbirds. Further, the tapes are susceptible to high winds and over 50% were lost twice during the trial. When spaced 16 m apart it required 7.3 person hours/ha to erect the posts and tape and 2 person hours/ha to maintain them throughout the ripening period. Much of the labor resulted from the need to place the tapes 4 m high, above the corn canopy. The paper concludes “Our results indicate that these tapes will be cost effective only for high value crops that grow low to the ground and suffer considerable damage from birds” (p.443).

REFLECTING TAPES REPEL BLACKBIRDS FROM MILLET, SUNFLOWERS, AND SWEET CORN
Richard A. Dolbeer and Paul P. Woronocki. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870
Richard L. Bruggers. US Department of Agriculture, Denver Wildlife Research Center, Building 16, Federal Center, Denver, CO 80225

The study evaluated the performance and cost of Bird Scaring Reflective Tape at different spacing intervals (3, 5 and 7 m) in millet, sunflowers and sweet corn. The tapes are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other. The tapes were suspended 1.5 m above the ground on poles and can make a roaring sound under certain wind conditions.

The report gives estimates on costs depending on variables such as materials used, labor, replacement cost, etc. The report estimates US$83/ha to install reflecting tape from 3 m poles with tapes 3 m apart. The report also assesses breakage and describes techniques for minimizing breakage. About costs, the report says, “The cost of material and labor and the maintenance effort required make reflecting tape generally impractical for large (e.g., >4 ha) fields of crops, such as field corn, sunflowers and rice...However, for small fields of high value crops (e.g., sweet corn, fruits, farm plots in developing countries, experiment station plantings) reflecting tapes may offer a simple and safe means to reduce damage by certain avian species” (p.424).

Crop damage from red-winged blackbird (Agelaius phoeniceus), brown-headed cowbird (Molothrus ater), European starling (Sturnus vulgaris), mourning dove (Zenaida macroura), and house sparrow (Passer domesticus) was reduced.
The report finds that 3 m spacing is most effective but that 5 and 7 m spacing also provides repellency. The report hypothesizes that birds which depend on visual and auditory communication to maintain flock cohesiveness are more successfully repelled by reflective tape. Birds which feed in cohesive flocks, such as red-winged blackbirds, cowbirds and house sparrows, avoided taped fields, but goldfinches and mourning doves were much less affected.

The report cautions that there is still some damage and that during their study there were other easily accessible food sources for the birds to feed. The paper concludes, “As with all pest management programs, the tapes should be used as part of an integrated approach to reducing damage. Additional repellent devices, alternate food sources, and cultural methods such as bird resistant cultivars may have to be used in combination with the tapes to achieve maximum protection or repellency” (p.424).

RELATIONSHIPS BETWEEN CORNFIELD CHARACTERISTICS AND BLACKBIRD DAMAGE
William T. Bridgeland and James W. Caslick. Department of Natural Resources, New York State College of Agricultural and Life Sciences, Cornell University, NY 14853

This paper examines relationships between cornfield characteristics and blackbird foraging behavior in New York and makes management recommendations. The authors also construct a model to explain patchy damage by red-winged blackbirds.

For unknown reasons, blackbirds begin to shift from a primarily insect dominated diet in the spring and summer to a diet of grains and seeds in the late summer and fall. Corn damaged by blackbirds is greatest on early maturing fields when the blackbirds are shifting to their fall diet, but seeds commonly eaten by red-wings are not yet abundant. Two factors converge to reduce damage to latter-maturing corn crops: (1) as the total area of ripe corn increases, it is less likely that a large flock will feed on a single field for an extended period of time, and (2) preferred weed seeds provide an abundant alternative food source. “This latter factor becomes important enough to offset what might otherwise become increased bird pressure on the relatively few late-maturing fields” (p.827).

Two important conclusions can be derived from this model. “First, it is a clear example of the benefit of maintaining plant diversity in an agricultural system, i.e. providing alternate foods that relieve pest pressure on a crop. Second, it counters the argument that non-lethal bird control methods merely shift bird damage to other fields. Although this may occur, for at least most of the damage season the birds have non-crop alternative foods. Indeed, they apparently choose to feed on weeds rather than on corn to some extent, even without influence of man” (p.827-828).
The paper concludes that in New York "a farmer may benefit by not having early-maturing corn through adjustment of planting time or by planting later-maturing varieties. The potential savings from lowered bird damage must be weighed against risks as increased insect damage and weather related yield reduction in the later-maturing fields. If manipulation of corn maturity is not feasible, then a farmer should concentrate bird control measures in the earliest maturing fields" (p.828).

RELATIVE IMPORTANCE OF TASTE AND VISION IN REDUCING BIRD DAMAGE TO CROPS WITH METHIOCARB, A CHEMICAL REPELLENT
Michael L. Avery. Division of Wildlife and Fisheries Biology, University of California, Davis, CA 95616

The experiment found that vision is relatively more important than taste for methiocarb induced food aversions in house finches; "In an experiment to assess the effects of an added visual signal, pairs of finches given methiocarb-treated hulled oats with red tape on their food bowl showed more aversion to the treated food than did pairs without tape. These and other findings suggest that methods to reduce bird damage to crops with chemical repellents should emphasize visual cues rather than taste" (p.299).

A REPELLENT FOR PROTECTING CORN SEED FROM BLACKBIRDS AND CROWS
Allan R. Stickly, Jr. Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, and Gainsville, Florida Field Station
Joseph L. Guarino. Bureau of Sport Fisheries and Wildlife, Denver Wildlife Research Center, Denver, Colorado

Of 8 fields of corn within a 0.25 Mi² area, 4 were treated with methiocarb and 4 were left as control fields. Sprout damage averaged 44% in control fields but only 0.3% in test fields. This experiment demonstrates repellency, but since control and test fields are not independent, conclusions about damage reduction cannot be made.

REPELLENCY AND TOXICITY OF THREE BIRD CONTROL CHEMICALS TO FOUR SPECIES OF AFRICAN GRAIN-EATING BIRDS

An avicide, Starlicide™ (3-chloro-4 methylbenzenamine), a repellent, Methiocarb (3,5-
dimethyl-4-{(methylthio)phenyl methylcarbamate} and a frightening agent, Avitrol™ (4-aminopyridine) were tested against the red-billed quelea (Quelea quelea), village weavers (Ploceus cucullatus), golden sparrows (Passer luteus), red bishops (Euplectus orix) and masked weavers (Ploceus taeniopyerus) in Sudan. Repellency and toxicity data are given.

**REPELLENCY OF CINNAMIC ACID ESTERS TO CAPTIVE RED-WINGED BLACKBIRDS**
Michael L. Avery and David G. Decker. USDA/APHIS, Denver Wildlife Research Center.
Florida Field Station, 2820 E. University Avenue, Gainesville FL 32610

Methyl cinnamate and ethyl cinnamate are naturally occurring esters in cinnamic acid. Cinnamic acid is a food additive approved for use in the U.S. The chemicals were tested for repellency to red-winged blackbirds on rice in the laboratory. At 1% concentrations, methyl cinnamate “virtually eliminated” rice consumption and ethyl cinnamate proved to be “moderately deterrent”.

**REPELLENCY OF METHIOCARB-TREATED GRAPES TO THREE SPECIES OF BIRDS**
Mark E. Tobin. Division of Wildlife and Fisheries Biology, University of California, Davis, CA 95616
Richard W. DeHaven. U.S. Fish and Wildlife Service, Denver Wildlife research Center Field Station, 6924 Tremont Road, Dixon, CA 95620

In no-choice lab tests, methiocarb was evaluated for repellency to starlings, robins and house finches. Grapes were treated with methiocarb in a fashion which simulated spray coverage. Methiocarb was found to be most effective at repelling house finches from grapes (50% repelled with 0.3-0.9 grams of methiocarb per liter of water on the first day and decreased feeding after that) and least effective at repelling starlings (who were repelled for only 3 days with 7.3 grams methiocarb per liter at which point feeding increased to pre-treatment levels). Methiocarb’s ability to repel robins was more uniform with 50% repellency at 2.8 grams per liter with no increase or decrease in repellency over the five day trial. The authors conclude that “Field application rates of methiocarb needed to repel finches are probably much lower than the rates needed to repel robins and starlings” (p.296).

**RESPONSE OF BIRDS TO DIFFERENT TYPES OF FOOD REPELLENTS**
Michael R. Conover. Department of Ecology and Climatology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, Connecticut 06504
The taste repellent copper oxalate (CuC₂H₂O₄) and two averse conditioners, lithium chloride (LiCl) and Methiocarb (3-5-dimethyl, 4-methylthiophenol methylcarbamate, are compared in lab and field situations. All three reduced red-winged blackbird consumption of cracked corn, canary seed, red millet and sunflower seeds in laboratory situations, but copper oxalate was ineffective in field trials.

In lab tests birds consumed foods previously treated with methiocarb and copper oxalate when the chemicals were removed. “Birds, however, continued to avoid foods previously treated with LiCl that was disguised by microencapsulation... These results indicate that birds avert from the taste or sight of the repellent when it is detectable and avert from the food when the repellent is undetectable. Hence, non-detectable aversive conditioners have a greater potential to protect untreated food sources” (p.437).

RESPONSES OF CAGED RED-WINGED BLACKBIRDS TO TWO TYPES OF REPELLENTS
John G. Rogers. U.S. Fish and Wildlife Service, Monell Chemical Senses Center, University of Pennsylvania, Philadelphia 19104

The study compares the effectiveness of sucrose octaacetate (which tastes bad) and lithium chloride (which produces a conditioned aversion). The chemically treated foods were evaluated against alternate foods which varied from “equal to highly offensive but non-toxic”. The study found that only lithium chloride was consistently effective, regardless of the alternate food source, while sucrose octaacetate was not. The authors conclude “the data suggest that the most likely candidates for effective repellants will come from those chemicals that are capable of producing conditioned aversions in target species” (p.418).

RESPONSE OF BLACKBIRDS TO MESUROL AND SEVIN APPLICATIONS ON SWEET CORN

The paper documents the effects of Mesurol and Sevin on insect numbers and blackbird damage. The authors found a positive correlation between insect populations and bird damage. The authors speculate that reduced insect populations reduce attractiveness of corn fields to blackbirds. Evidence to support this hypothesis is inconclusive.
RESPONSES OF INSTRUMENTALLY CONDITIONED STARLINGS TO AVERSIVE ACOUSTIC STIMULI
David J. Langowski and Howard M. Wight. Department of Fisheries and Wildlife, Oregon State University, Corvallis
John N. Jacobson. Federal Water Pollution Control Administration, Pacific Northwest Water Laboratory, Corvallis

Responses of starlings (Sturnus vulgaris) to pure tone and distress calls were measured. There was a direct relationship between repellency and intensity of both the pure tone and the distress call. Juveniles were less affected than were adults by both stimuli. Different frequencies of tone (1000-7500 cps) had similar repellency. Repeated playing of the distress call led to habituation more quickly than irregular and slower playing of the distress call. The average repellency of the distress call was 11 times greater than a pure tone at the same decibel level.

RESPONSES OF PEST BIRDS TO REFLECTING TAPE IN AGRICULTURE
R.L. Bruggers, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, CO 80225
J.E. Brooks, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, c/o Vertebrate Pest Control Laboratory, Dhaka, Bangladesh
R.K. Pandit, Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh
T. Tarimo, National Bird Control Unit, Arusha, Tanzania
All-India Co-Ordinated Research Project on Economic Ornithology, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad-500 030, India
H. Hoque, National Crop Protection Center, Los Banos, Philippines

The study notes that birds quickly become accustomed to most visual and auditory scare techniques, but that these techniques are also inexpensive, safe, easily obtainable and usable. The study evaluates the effectiveness of Bird-Scaring Reflective Tape™ in a variety of situations where birds were depredating crops, including:

Bangladesh: sunflowers -- rose-ringed parakeets (Psittacula krameri); foxtail millet -- munias, (Lonchura spp.); corn (maize) -- parakeets, corn -- jungle crows (Corvus macrorhynchos).

Phillippines: sorghum -- European tree sparrows, (Passer montanus).

India: sunflowers-rose -- ringed parakeets; sweet corn -- house crows (C. Splendens).
United States: corn -- red-winged blackbirds (*Agelaius phoeniceus*) and yellow-headed blackbirds (*Xanthocephalus xanthocephalus*); finger millet -- red-winged blackbirds; sunflowers -- American goldfinches (*Carduelis tristis*); raspberries and strawberries -- brewers blackbirds (*Euphagus cyanocephalus*) and robins (*Turdus migratorius*).

Haiti: sorghum -- village weavers (*Ploceus cucullatus*) and yellow-faced grassquits (*Tiarus divaces*).

Kenya: tomatoes -- speckled mousebirds (*Colius striatus*).

Nepal: corn -- house crows.

Bird Scaring Reflecting Tape™ is a colored, elastic, transparent strip, (0.025 mm thick, 11 mm wide and sold in 82 or 100 m rolls). The color used in the trials was red although other colors are available. “The tape reflects sunlight to produce a flashing effect and, when stretched, it pulsates and produces a loud, humming, or sometimes thunder-like noise in the wind” (p.161).

The paper describes the field sizes, bird counts before and after installation of the tape and includes statistics on how fast the birds came back. The tape was found to be effective on most species in most situations. Village weavers and munias, in the absence of other food sources, were unaffected by the tape. Red-winged blackbirds began to return to fields of corn when there was an unprotected portion of field. Crows and parakeets avoided areas where tape was installed.

The authors suggest this tape is most suitably used in small fields and traditional types of agriculture.

In 1986, the tape could be purchased from distributors in Japan for US$0.36/82 m roll, (Maruzen Trading Co Ltd) or U.S. $0.75/100 m roll (Nishizawa Ltd), shipping not included. The cost of tape (at $0.36/82 m) for use at 10 m intervals over 1 ha would be $4.68 (labor not included).

SEASONAL DYNAMICS, HABITAT RELATIONSHIPS, AND MANAGEMENT OF AVIFAUNA IN FARM SHELTERBELTS


Richard H Yahner. Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108

This paper describes seasonal habitat relationships of bird populations and communities in farmstead shelterbelts in southern Minnesota. The paper finds that species richness is greatest in shelterbelts with large perimeters and was affected by such variables as proportion of...
cropland to pastures, distance to wild forest habitats and number of nearby buildings.

The great plains ecosystem has been almost completely appropriated for human use, leaving remaining animal populations dependent of fencerows and shelterbelts. The majority of avian species found in these shelterbelts were not those typically considered pests in that region. The paper lists species dependent on these areas and includes management recommendations and maintenance techniques which will protect ecosystem diversity. These include no-tillage or minimum tillage systems, planting several extra rows of trees to increase shelterbelt size, placing several rows of standing crops, food plots or artificial feeders in or near shelterbelts.

The opposite of these practices could be used as a wildlife management technique, but it is important to recognize that intentionally degrading habitats for one animal species will likely negatively impact many non-target species, including beneficial ones.

SOME CHARACTERISTICS OF CONDITIONED AVERSION IN RED-WINGED BLACKBIRDS

Three cage experiments with red-winged blackbirds and methiocarb were conducted. The experiments found that while birds ate less of their food when methiocarb was present, it took two exposures before aversion developed. There will therefore necessarily be some crop loss in the creation of the aversion.

The paper also demonstrated that birds can detect when methiocarb is present in their food so aversion is to the chemical and not the food. The chemical must therefore be consistently present if it is to be affected and untreated portions of crops may suffer greater damage.

SOMEONE TO WATCH OVER ME
Belleville Intelligencer, Sat May 18, 1996.
Frank O’Conner

The photograph documents the ineffectiveness of plastic owls in deterring American robin nesting. The picture shows an adult robin feeding its young. The nest is built on a wooden fence right beside a plastic owl.
SOME PREDATOR-PREY RELATIONSHIPS IN BIRD DAMAGE AND POPULATION CONTROL


The paper focuses on factors affecting the effectiveness of artificial population control programs. First, it is necessary to understand factors related to natural reproduction and mortality rates before a control strategy is implemented. It is also necessary to examine how the strategy may disrupt sex, age or flock structure. In some situations, bird control measures have led to increased winter survivorship and more effective breeding the following spring. This result could have been predicted had the natural limits to the bird population been examined.

SONIC DETERRENTS IN ANIMAL DAMAGE CONTROL: A REVIEW OF DEVICE TESTS AND EFFICIENCY

Mary Bomford, CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, ACT, 2602, Australia
Peter H. O'Brian, Bureau of Rural Resources, G.P.O. Box 858, Canberra, ACT, 2601, Australia

This paper is an extensive review of studies about the effectiveness of sonic scaring devices for wildlife management and animal damage control purposes. It reviews the different mechanisms by which these devices work, evaluates published studies, critiques bias in experiment designs and describes devices and mechanisms which are most effective. The paper recognizes that not all audible devices work the same way and categorizes repellency effectiveness according to mechanisms of pain, fear, communication disruption, disorientation, audiogenic seizure, internal thermal effects, alarm and distress mimics and ultrasound.

General descriptions and conclusions grouped by mode of action of acoustic devices.

Devices designed to cause pain. Noises of 130 dB, as well as infrasonic and ultrasonic sound greater than 140 dB, can cause pain or sickness in vertebrates, but these noises are technically difficult to create and radiate, can be a nuisance and are objectionable in terms of animal welfare. There is evidence that European starlings as well as other animals will habituate to these noises. The authors conclude that devices which operate by this mechanism are not currently practical for wildlife management.

Biosonic Devices. These devices mimic or broadcast alarm and distress calls of birds. These devices have been found to be effective against gulls, Canada geese, crows, European starlings and house sparrows among others. Summaries of experimental findings for these
species are included in the text. These devices are species specific so it is important to properly identify the animals. The authors conclude that the “use of biosonics has potential in vertebrate pest control” (p. 413).

**Nonbiosonic devices.** This includes bird bangers, sirens and electronic devices designed to startle or scare animals away. Lists of sound scientific studies documenting various devices successful at scaring specific species from specific crops are included in the paper. These devices were found to be at least somewhat successful on wildfowl, gulls, starlings, red-winged blackbirds, cowbirds and common grackles.

The conclusions about nonbiosonic devices were: “(1) loud sounds are more aversive than quiet sounds; (2) sounds of a wider frequency range are more aversive than pure tones; (3) adult birds are more easily scared than juveniles; and (4) all species habituated to nearly all sounds tested.” (p. 416).

The paper goes on to state that “the value of bangers, clangers, poppers, bombers, sirens, and most electrical noises on birds and mammals tested is almost entirely limited to short-term control. The best effects are obtained when (1) sound is presented at random intervals; (2) a range of different sounds are used; (3) the sound source is moved frequently; (4) sounds are supported by additional methods, such as distress calls or visual devices; and (5) sounds are reinforced by real danger, such as shooting. Because of these complexities, the success of sound deterrents is largely a function of the skill and motivation of the operator” (p. 416).

**Devices to jam communication.** Devices designed to disrupt communication are yet to be scientifically proven to be effective in any practical field situation, according to this paper.

**Ultrasound devices.** Sounds greater than 20 kHz can not be demonstrated to have meaning for birds or impact on bird behavior. It is also not demonstrated that high frequency sounds have especially annoying properties even for animals which can hear them. Further these sounds require more energy to generate, dissipate more rapidly and travel inefficiently around barriers. Ultrasound was found impractical for rodent control, having only temporary repelling value. The devices have been proven completely ineffective at repelling gulls, house finch, blue jay, dark-eyed junco and white-breasted nuthatch and are considered to have little practical value in wildlife management.

**Disorientation devices.** The paper suggests that there is no evidence to support claims that any device will produce a sound to disorient animals and therefore be useful for wildlife management.
SONIC SYSTEMS FOR CONTROLLING BIRD DEPREDATIONS
William D. Fitzwater. Extension Wildlife Specialist, University of California, Davis, California 95616

The paper reports that disturbing noises such as propane exploders and hand clapping are useful when control is needed for short periods of time. Ultrasonics (sounds over 20,000 cps) are beyond the hearing range of birds and therefore not useful scaring devices. Starlings hearing ranges from 100-1600 cps but are most sensitive to sounds of 2000 cps; crows can hear sounds between 300-8000 cps but hear sounds between 1000-2000 cps best. Biosonics, specifically alarm and distress calls, are more useful for long term bird control, but expense of equipment limits the viability of this option.

The paper describes differences between alarm and distress calls and notes that some species do not have alarm calls. The paper notes that regional dialects can be an important factor influencing repellency. It is also important to use the distress or alarm calls when birds first enter a field so that they do not get used to feeding there.

The author recommends the use of guns or exploders preceding recorded alarm calls. “Birds can habituate to almost any situation that is not genuinely hazardous. Therefore, broadcasting alarm calls without additional reinforcing stimuli loses its effect with time” (p.114). The use of a taped alarm call and a shellcracker together was found to be more effective on gulls, corvids (crows and jays) and starlings than either of the devices alone.

When purchasing equipment, high fidelity equipment is considered to be best overall, although low fidelity equipment works slightly better in low wind situations.

STARLING RESPONSE TO THREE AUDITORY STIMULI
Ron J. Johnson and Patrick H. Cole. Department of Forestry, Fisheries and Wildlife, 202 Natural Resources Hall, University of Nebraska, Lincoln, NE 68583-1819
Walter W. Stroup. Biometrics Information Systems Center, 103 Miller Hall, University of Nebraska, Lincoln, NE 68583-0712

Starlings were exposed to recordings of their distress call, white noise and a 917 Hz pure tone. The pure tone elicited no response, while the white noise and distress call elicited a response on the first two days: after two days only the distress call received a response from the birds.
STATUS OF BIO-SONICS IN PEST BIRD CONTROL
Gordon W. Boudreau. Jennings Industries, Santa Cruz, California

Bioacoustics is the study of sounds of biological significance such as distress and alarm calls in birds. The author has recorded alarm and distress calls of 165 different species of 42 families and 14 orders and reviews the use, potential use and problems associated with bioacoustics.

There are many problems associated with bioacoustics. Incorrect identification of the species causing the damage is a major problem since bioacoustics are almost universally species specific. Some species can not be removed from areas where they nest. The difference of meaning of the same call in different seasons can further complicate use of bioacoustics. Bird responses to alarm and distress calls fall into 4 categories: the bird can freeze in place, fly to cover, fly out of the area or do nothing. Some individuals within a species may “exhibit individual behavior patterns which defy interpretation” (p.40). Birds which freeze in place or do nothing cannot effectively be removed from areas by bioacoustics.

There are, however, considerable potential benefits. “Sound has been used to protect many fruit crops from starlings, robins, finches, and several minor species. These crops are in wine and table growing vineyards, cherry orchards, berry crops, apples, pear and figs. Biosonics has successfully kept industrial areas clear of starlings and gulls and it has cleared many objectionable roosts of starlings” (p.41). Since bioacoustics have biological significance, birds do not habituate as quickly. In situations where there could be “incessant exposure” habituation may be overcome by varying the basic alarm sound.

The author describes bioacoustics as a good way to protect crops while they ripen. He also claims that it is a more effective approach than using toxicants to reduce regional populations. It states, “...no permanent results have ever been achieved by killing birds. Actually, these methods more often aggravate the condition by reducing populations to more favorable points on the population curve and stimulating increased reproductive efforts. In a few years you have more birds than before and, like insects, they probably will develop immunity to your toxicants. Also, no one can predict as yet, the ecological effects of a bird extermination program. Even starlings are 50% beneficial and...are one of our very few species which relish hairy caterpillars” (p.42).

LA STÉRILISATION EST-ELLE UNE AVENUE FERTILE POUR CONTRÔLER LES POPULATIONS D'OISEAUX NUISIBLES
André Cyr et Diana Lacombe. Département de biologie, Université de sherbrooke, Sherbrooke, Qué. J1K 2R1
Paper in French
The paper reviews experiments on chemosterilization and assesses the potential of chemosterilants (mastranol, Ornitrol, TEM and others) to manage bird populations. The costs of chemosterilization and difficulty of maintaining populations at an ecologically and economically viable level are both mentioned as drawbacks. Biosterilization is a new development which utilizes biofeedback mechanisms to disrupt reproductive physiology of male birds. This will only be effective in species that are primarily monogamous and where reproductive behavior is unaffected. At present chemosterilization is not considered to be a practical or efficient method of controlling nuisance bird populations.

SURVEY OF EFFECTIVENESS OF AVITROL FC CORN CHOPS-99

The application of Avitrol FC Corn Chops-99 to sunflowers in North Dakota was ineffective because of unusually heavy rainfall. The cost effectiveness of the treatment was therefore negative. There was little bird damage statewide, so, even if the agent been effective, it may not have been cost efficient.

A TABLETED CORN BAIT TO DELIVER UNIFORM DOSAGE OF 4-AMINOPYRIDINE TO RED-WINGED BLACKBIRDS
Melvyn V Garrison, Donald F. Mott, Mary R. Ouellette and Gilbert Holquin. U.S. Fish and Wildlife Service, Wildlife Research Center, Denver, CO 80225

4-aminopyridine causes birds to die violently; symptoms of poisoning include squawking, erratic flight, tremors and convulsions. The distress behavior of poisoned birds frighten other members of the flock from the area thereby protecting the crop. The poison is typically delivered in cracked corn. The authors report that “variation in size of cracked corn particles and the differences in proportion of hull to endosperm can result in large variations of chemical concentration” (p.743). The result is that birds often receive the poison in levels too low or too high to cause distress behavior. The authors found that baits with 2.5% 4-aminopyridine concentrations were effective at scaring birds from fields within 55 minutes with mortality ranging from 0.8-3% of flocks. No non-target mortality was attributed to the treatment.
TAPE RECORDED CALLS DISPERSE AMERICAN CROWS FROM URBAN ROOSTS
W. Paul Gorenzel and Terrell P. Salmon. Department of Wildlife and Fisheries Biology, Cooperative Extension, University of California, Davis, CA 95616

Use of shouting, clapping of hands and boards, and owl decoys have been found to be ineffective at scaring American crows (Corvus brachyrhynchos) from roosts, and methods such as shooting, trapping, poisoning and propane cannons are sometimes inappropriate. This paper evaluates the effectiveness of tape-recorded crow calls at dispersing crows from urban roosts and finds the distress calls effective every time. The project was “large-scale only in terms of the number of roosts we treated, but was not truly large scale in the sense of a city wide control effort. Attempts to disperse crows from an entire community have not been tried, but would likely result in new roosts in the urban area. Some of the new roosts could be objectionable whereas others might not conflict with human interests. The site-specific technique of tape recorded calls would create a situation of control personnel chasing crows from one roost to another, until the crows roosted in an acceptable site(s)” (p.338).

TASTE PREFERENCES OF MALE RED-WINGED BLACKBIRDS AMONG DRIED SAMPLES OF TEN CORN HYBRIDS
J. Russell Mason and Russell F. Reidinger. Monell Chemical Senses Center, 3500 Market Street, Philadelphia, PA 19104

The amount of corn consumed by red-winged blackbirds in laboratory studies ranged from 0.8 to 0.28 g. In order of apparent taste-preference for red-winged blackbirds the hybrids are: Gries 622 A, Muncie Chief 777, U. S. Steel 1010, Gries 500, Gries 615, Muncie Chief 460, Pioneer 3535, Muncie Chief 662, Muncie Chief 878 and Pioneer 2780. The authors conclude that “Because husk characteristics were related to depredation by red-winged blackbirds in the field, we propose that blackbirds in the field more frequently choose among hybrids on the basis of mechanical factors associated with the husk rather than on the basis of taste” (p.615).

TESTS OF A POTENTIAL METHOD FOR DECOYING STARLINGS TO BAIT STATIONS
Robert E. Williams. Department of Biology, Bowling Green State University, Bowling Green, Ohio 43403
Robert C. Schwab. Division of Wildlife and Fisheries Biology, University of California, Davis, California 95616
Trapping with “cotton trailer” traps is used in California to kill thousands of starlings every year. Attempts to increase attractiveness of these traps to starlings by changing bait types, addition of starling “vocalizations”, addition of decoys, changing locations of traps and trap types were all unsuccessful.

TESTS OF BIRD CONTROL MEASURES IN SUDAN
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.259-263.
Lee R. Martin. FAO Regional Project, Sudan

The Av-Alarm scaring device, Queletox (60% fenthion), methiocarb (3,5 dimethyl-4-(methylthio) phenol methylcarbamate), Avitrol (4-aminopyridine) and a modified Australian crow trap were tested for efficiency in reducing bird damage. Birds in the study area included the village weaver, red-billed quelea, golden sparrow, house sparrow, red bishop, doves, glossy starling, parakeets and some waterfowl.

Ground sprays with Queletox (60% fenthion) killed large numbers of birds but did not significantly reduce damage to maturing wheat.

The Av-Alarm was ineffective. In one trial it was effective for four days, and in another trial damage was concentrated around the device. The author suggests that it may be more effective in an integrated system.

Trapping proved to be highly variable and ineffective although the author suggest that it may be of more use if birds could be attracted into the trap.

Methiocarb did not reduce damage below that received by the control.

Avitrol was successful at moving bird species only 200 m away from the treated site, and no flock alarm reaction was observed despite alarms given by dying birds.

TESTS OF THE ENHANCEMENT OF AVIAN REPELLENT CHEMICALS WITH SENSORY CLUES

Primary bird repellents affect birds immediately and only once. Secondary repellents are ones
which induce conditioned aversions. “Secondary repellents more reliably resist high bird depredation of these [treated] crops over time. Unfortunately, most pest bird species are not able to detect some secondary repellents at levels which induce conditioned aversion.” (p.66).

The paper refers to methiocarb (3,5-dimethyl-4-(methylthio)-phenol methylcarbamate) as “the most effective avian repellent for field crops” and reviews experiments demonstrating increased effectiveness with the addition of olfactory, tactile and visual cues.

TOXICITY OF DRC-1339 TO STARLINGS
Thomas J. Decino, Donald J. Cunningham and Edward W. Schafer. U.S. Bureau of Sport Fisheries and Wildlife, Federal Center, Denver, Colorado

From 1961 to 1965 the Denver Wildlife Research Center conducted research into chemical compounds which would be most effective for poisoning starlings. Of over 400 chemicals tested, the effects of DRC-1339 (3-chloro-p-tolidine hydrochloride) most closely resembled the properties they were looking for.

The paper describes the toxicological characteristics of DRC 1339.

TWO TESTS OF THE AVIAN REPELLENT, METHIOCARB, IN MICHIGAN SWEET CHERRY ORCHARDS
Allan R. Stickly and Charles R. Ingram. U. S. Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, Ohio Field Station, Sandusky, Ohio 44870

Methiocarb was found to be ineffective at reducing cherry loss. The authors speculate that the inefficiency was a result of poor experimental design, and not the chemical, and reference other reports which found methiocarb to be more effective on cherry crops.

USING CONDITIONED FOOD AVERSIONS TO PROTECT BLUEBERRIES FROM BIRDS: COMPARISON OF TWO CARBAMATE REPELLENTS
Michael R. Conover. Department of Ecology and Climatology, The Connecticut Agricultural Experiment Station, Box 1106, New Haven, CT 06504

Methiocarb (3-5-dimethyl-4-methylthiophenol methylcarbamate) and trimethacarb (2,3,5-tri-methylphenyl carbamate) were used to protect blueberry fields from depredations by northern mockingbirds, European starlings and northern orioles. Blueberry loss was reduced 25 and 52% respectively for one week after application; however, neither repellent reduced loss in
adjacent untreated plots. “These results indicate that both repellents caused birds to avert only from treated berries, and not from the taste or sight of blueberries themselves” (p.383).

USE OF 4-AMINOPYRIDINE IN CORNFIELDS UNDER HIGH FORAGING STRESS
J. D. Somers, F. F. Gilbert, D. E. Joyner, R. J. Brooks and R. G. Garthshore. Department of Zoology, University of Guelph, Guelph, Ontario, N1G 2W1

The efficiency and hazards of 4-aminopyridine (4-AP) treated corn was evaluated in Kent and Simcoe counties. This data base was used for the registration of 4-AP in Ontario. 4-AP applications did reduce overall bird damage and non-target mortality was considered to be low; however, under high foraging stress, 4-AP was found to be cost effective in only 6 of 16 fields.

The authors repeatedly refer to the use of 4-AP as economically unjustifiable; “cost: benefit analysis revealed that use of 4-AP to protect cornfields under conditions of high depredation was not economically advantageous to most farmers....the location variability of corn damage and the cost:benefit profile indicated that even in areas under severe feeding pressure, an individual grower could not be assured of satisfactory protection by using the commercially available 1% 4-AP repellent...present results suggest that in areas subjected to heavy bird pressure, many farmers would not receive cost benefits by using 4-AP bait....” (p.707-708)

The authors note that 4-AP only led to positive benefit:cost ratios in fields without weeds and 80% of bird mortality and flock responses occurred in non-weedy fields. Weeds, especially tall grass, hide the 4-AP treated corn, making it ineffective.

USE OF 4-AMINOPYRIDINE TO PROTECT RIPENING CORN FROM BLACKBIRDS

Application of 4-aminopyridine resulted in 70% protection to 1000 acres of corn fields from red-winged blackbird damage. A minimum of 3158 red-winged blackbirds, 62 yellow-headed blackbirds and 35 grackles were killed. Also killed were Baltimore Oriole, red-headed woodpecker**, brown thrasher and black headed grosbeak.

**Just listed as vulnerable in the 1996 “Canadian Endangered Species and Other Species at Risk”
USE OF METHIOCARB AS A BLACKBIRD REPELLENT IN FIELD CORN
D. E. Joyner, J. D. Somers, F. F. Gilbert and R. J. Brooks. Department of Zoology, University of Guelph, Guelph, Ontario, N1G 2W1

An experiment to create a data base to determine the cost:benefit ratio for methiocarb as a bird repellent in Ontario was run in Simcoe County. The paper concludes even without “any environmental retardation of methiocarb efficiency...cost:benefit analysis showed that methiocarb costs exceeded the practical limits for use in field corn. Accordingly, use of methiocarb probably will be limited to crops that produce a higher economic return per unit area to compensate for the costs of application and chemical” (p.675).

USE OF PLASTIC NETTING
John T. Stuckly. Plastics Division, Conwed Corporation, Minneapolis, Minnesota 55414

The author describes the use of a black, ultraviolet-light-resistant netting in vineyards and blueberry crops. Photographs show how the net can be wrapped around bushes or placed over frames. Netting is nearly 100% effective, non-toxic, noiseless, harmless to fruit, and is reusable when stored properly.

UTILITY OF PYROTHECNICS IN BIRD CONTROL

The author recommends using pyrotechnics when fire hazard is low, when control is needed for only a short period of time, and when alternatives are not affordable or available. He describes the devices as dangerous and relatively expensive.

VISUAL BIRD SCARERS: AN ETHOLOGICAL APPROACH
I. R. Inglis. Ministry of Agriculture, Fisheries and Food, Worpleston Laboratory

The paper argues that scarers which rely on novel stimuli will be ineffective unless they are reinforced or accompanied by real danger. The paper continues to argue that if this reinforcement does not occur, the birds will associate the stimuli with a good source of food and the ‘scarer’ will become an attractant. The author argues that scarers of biological
importance will be more effective. The paper then lists some bio-visual scarers: eyespot mimics, raptor mimics, the Markgren effect (mimicking the flapping wings of an approaching raptor), unnatural body poses, “crucified” gulls, and pre-flight and alarm posture models. The author argues for the absolute necessity and practicality of integrated bio-acoustic and bio-visual scarers, but concludes, “Unfortunately, in spite of the potential of bio-visual and bio-acoustic devices, there appears at present to be relatively little research directly based upon an ethological approach to bird scaring” (p.140).

WETTING AS A MEANS OF BIRD CONTROL
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.41-47
Sheldon Lustick. Department of Zoology, Ohio State University, Columbus Ohio

The laboratory tests conducted show that wetting bird feathers decreases insulative efficiency for starlings and grackles and can lead to mortality at temperatures 20 to 40°C higher than the normal lower critical temperature.

WILDLIFE & AGRICULTURE (1): TREES AND SHRUBS FOR EROSION CONTROL AND WILDLIFE HABITAT
Ontario Federation of Anglers and Hunters
Wildlife Habitat Facilitator, OFAH, P.O. Box 28, Peterborough Ontario, K9J 6Y5 (705-708-6324)

The pamphlet suggests that it is possible to reduce crop loss by planting specific trees and shrubs. “Many species of birds eat hundreds of insects and larvae per day...some species of birds prefer small weed seeds over grains...rodent and blackbird damage may be discouraged by establishing roosts for raptors such as hawks and owls.”

The facilitator with the OFAH can provide site-specific planting recommendations, recommendations for nuisance animal control, and information about habitat enhancement and availability and cost of certain trees and shrubs.

119
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

White-Tailed Deer

Prepared By: Rob Mound.
Completed: Fall 1996
White-tailed Deer (*Odocoileus virginianus*)

**Results of the Grower Needs Assessment**

The white-tailed deer was repeatedly identified as a significant source of conflict with agriculture in the Bay of Quinte watershed. The conflicts were especially severe in young orchards, and were identified as having significant or very significant impacts on overall orchard productivity by some growers. Conflicts were described as increasing and past crop protection options were generally ineffective.

**Species Biology and Life History**

The Cervidae Family are hoofed mammals with solid antlers that are grown and shed each year. They all chew their cud and have no upper incisors. They have four hoofs on each foot, the front pair much larger than the back; no gall bladder; 4 mammae; and a well developed tear pit in the inner eye. (Seton 1909a).

In addition to these family characteristics *Odocoileus virginianus* has the following characteristics:

- **Height:** 91-107 cm (3-3½ feet)
- **Weight:** males 34-180 kg, (75-400 lb) females 22.5-112.5 kg, (50-250 lb), 32 teeth; males occasionally have upper canine teeth , (Burt and Grossenheider 1980).
- **Sexes alike but only male grows antlers.** Their coat is reddish or yellow-brown in summer, blue-grey in winter; darker on upper side and paler around the eyes (Burt and Grossenheider 1980).
- **Range**
  - The white-tailed deer is typically much larger in the Bay of Quinte region than it is throughout its southern range. In the Florida Keys, a race of white-tailed deer called the key deer averages 22.5 kg (50 lb) (Burt and Grossenheider 1980). Seton writes, “There is a complete gradation of size from the pigmy Acapulco deer, (30-40 lb) found in Florida, to the Florida deer, (150-200 lb) to the giant form of Maine and Manitoba” (Seton 1909a:69).

By 1890, the white-tailed deer was eliminated throughout most of its central and eastern range including the Bay of Quinte watershed. The map on the following page shows the white-tailed deer’s range in 1900, the heavy line shows the original range and the white area in the center of the range shows where the species had been eliminated. The expanded range of the white-tailed
This map is founded on much personal experience and the records of several hundred ancient and modern travellers. The heavy line shows the original range. The central area left blank shows where the species has been exterminated. In New England and Canada the Deer has followed the settler and gained much territory. Similarly the recent extension into Utah is a result of irrigation. The many forms south of the Rio Grande have not yet been worked out.

The following are entered and complete the list north of Panama:

- Odocoileus virginianus (Bodd.) with its 7 races,
- Odocoileus cervus (Coues and Yarrow),
- Odocoileus balticus Allen,
- Odocoileus similans Allen

The following are entered and complete the list north of Panama:

- Odocoileus lichtensteini (Allen),
- Odocoileus rothshieldi (Thomas),
- Odocoileus thomas Merriam,
- Odocoileus nemoralis (H. Smith),
- Odocoileus costaricensis Miller,
- Odocoileus costaricensis Miller

deer in northern Canada and Utah is a result of habitat modification created by settlement and agriculture in the 1880's, (Seton 1909a).

Seton wrote in 1909 that “we must consider the [white-tailed deer] species as being practically absent from Ohio, Indiana, Illinois, Iowa, Nebraska, Kansas, Kentucky, the northern half of Michigan and the southern halves of Minnesota, Wisconsin, New York and Ontario....A total of about 600 000 square miles [1.5 million km²] of their best country.” (Seton 1909a:78)

HOME RANGE
The home range of a white-tailed deer is the smallest of any in the North American deer family. Seton describes white-tailed deer as being “entirely non-migratory” and estimates that between 200 and 300 acres will provide for a family of deer, but notes that deer can range as far as 5 miles between bedding and foraging areas (1909a:74). Burt and Grossenheider note that the home range is rarely more than 1.6 km (1 mile) across. (1980)

White-tailed deer are usually found in groups of two or three (doe and fawns) or by themselves (males). In the winter, however, white-tailed deer often migrate to cedar swamps called deer yards where 25 or more deer may be found (Burt and Grossenheider 1980).

ENVIRONMENT/HABITAT
Deer prefer a mixture of dense forest, swamps, streams, thickets and open areas. The introduction and expansion of agriculture and logging to southern Ontario has created our present patchwork landscape of different habitat types which has greatly benefitted the white-tailed deer.

SENSES
White-tailed deer have good hearing and a keen sense of smell but poor eyesight (Seton 1909a). A white-tailed deer can rotate its ears independently to listen to sounds from different directions without turning its head (Raycroft 1994). The location of the eyes allows the deer to have a very wide range of vision; however, the white-tailed deer see motion better than it distinguishes shape (Raycroft 1994). The deer’s nose is very sensitive and can pick up the smell of a person over 1.5 km away (Raycroft 1994).

COMMUNICATION
Deer have a variety of ways to communicate. Although the voice is rarely heard, the young make a low bleating noise, the bucks grunt during the rut and both sexes make a snort-wheeze sound when startled (Raycroft 1994). Deer stomp their feet and raise their tails when they are approached by other animals (Raycroft 1994). These signals alert other deer and may encourage the intruding animal to expose itself to the deer (Raycroft 1994). Also, deer possess pheromone glands on their back legs, their foreheads and between their hooves which, in addition to pheromones in urine, are believed to be important during mating season (Raycroft 1994).
REPRODUCTION

Mating occurs between October and December. Gestation lasts 201 days, about 6½ months (Burt and Grossenheider 1980). Males are sexually mature at 1 ½ years and some females mature at six months (Trefethen 1964). Especially harsh winters reduce birth rate in deer. Deep snow, and lack of food stress the doe and can cause the reabsorption of the fetus or fetuses. This reduces production that year but allows the doe enough energy to survive and reproduce the next year (Raycroft 1994).

Does usually give birth to one to three fawns in May or June, one fawn their first year and two or three every year after that. Fawns are a dull rusty brown color with white spots. Fawns hide during their first month of life and their mother comes to suckle them half a dozen times a day (Seton 1909a). At four or five weeks, the fawns begin to follow the mother. At four months, the fawns are weaned and lose their coat, but they accompany their mother for up to a year (Seton 1909a).

In 1890 there were fewer than 500 000 deer in all of the United States (Trefethen 1964). Pennsylvania had almost no deer at all in 1900, but with the ideal habitat created by logging and agriculture, the deer populations in Pennsylvania grew to almost one million by 1920 (Trefethen 1964).

MOVEMENT

The white-tailed deer can run up to 55-65 kph, (35-40 mph), can jump 9 m, (30 feet) horizontally and 2.5 meters, (8½ feet) vertically (Burton and Grossenheider 1980). Seton reports that a deer can swim 7 kph (4 mph) and have been found swimming up to 8 km (5 mi) from shore (1909).

FOOD

White-tailed deer feed mostly in the evening and early morning, but this pattern may be affected by weather. Deer browse on hardwood saplings, shrubs, mixed evergreens, fungi, acorns, grasses and herbs. This causes “considerable damage” to young orchards and some vegetables (Burton and Grossenheider 19890:218). Raycroft writes, “Favorite food sources such as apple trees are often browsed heavily by deer creating a browse line. As more of the tree is eaten, the browse line is raised. Eventually the deer must stand on their hind legs to reach their food.” (1994:20)

In addition to apple trees, acorns and salt are favorites of deer. Seton writes, “...it is astonishing to see how rapidly a buck or a doe will improve as soon as the acorns begin to fall. Ten days are sufficient to change a poor deer to a fat one.” (1909a:104) and “All ruminants have a great fondness for salt and eagerly seek out anything of a salty nature they can find within their range.” (1909a:96). A knowledge of food preferences may be employed for management purposes; elk have been drawn away from hayfields by placing salt blocks near natural feeding areas (Trefethen 1964). This has the advantage of luring elk away from crops without increasing the carrying capacity of the area.
PREDATORS/LIMITING FACTORS
Trefethen writes that since wolves, large cats and other large predator populations have been so “drastically reduced”, they no longer have much impact on deer populations (1964:61). In the Bay of Quinte watershed, deep snow is the major factor limiting deer populations, concealing the deer’s food and leaving them more vulnerable to predators (Burton and Grossenheider 1980, Seton 1909a).

Cougars, if present, feed primarily on deer and are a major limiting factor (Kurta 1995). Bears, wolves, panthers, lynx, and fishers all prey on deer, especially in the winter (Kurta 1995, Seton 1909a). Eagles and foxes have taken unprotected fawns (Seton 1909a). Dogs occasionally kill deer but usually only chase them. The chase may increase deer mortality by forcing deer to expend extra energy, making them more vulnerable to other limiting factors and lowering reproductive success (Raycroft 1994). Mosquitoes, ticks and deer flies torment deer which are known to submerge themselves in water to escape insects or to spend time in open fields where a breeze may keep the insects away (Seton 1909a).

NOTES
The White-tailed Deer “is the least migratory, the least polygamous, the least roving as well as the swiftest, keenest, shiest, wisest, most prolific, and most successful of our deer. It is the only deer that has added to its range...I have no doubt that whatever other species drop out of the hard fight, the White-tailed deer will flourish in all the regions of the plough as long as there are settlements and laws to give it a time of respite each year during its breeding season.” (Seton 1909a:112-113)
Results of Literature Survey
Information available suggests a few options for controlling deer depredations in the Bay of Quinte watershed. General conclusions can be drawn from available literature about compensation, crop losses, fertility control, food and habitat preferences, hunting, “invisible fencing”, lure crops, physical barriers, predators and other factors limiting populations, repellents, trapping and visual and audio scarers.

COMPENSATION
♦ Some states compensate landowners for damage done by white-tailed deer and western provinces compensate growers for damage done by waterfowl.
♦ Some form of compensation or payments for fencing may reduce conflicts between deer and orchardists while maintaining high deer densities which hunters prefer.
♦ Compensation is most feasible when the depredating species is rare or of economic value.
♦ 50% of average farm incomes in the United States are the result of price supports, direct government payments of extension services.

References
♦ Crop Damage and Control
♦ Farming: It’s for the Birds
♦ Farming for the Future

CROP LOSSES
♦ Deer are the most common cause of animal damage to agricultural crops.
♦ Deer conflicts have been increasing over the last 30 years.
♦ Increasing conflicts are a result of changing agricultural practices and rural landscapes and will likely continue to increase.
♦ Deer damage is often localized.
♦ Crop damage is most likely in fields near woodlots.
♦ Apple orchards are the crops most vulnerable to deer damage.
♦ Mature apple trees can tolerate more deer browsing than young apple trees.

References
♦ Alfalfa Losses to White-tailed Deer
♦ Crop Damage and Control
♦ Effects of Simulated Deer Browsing on Branches of Apple Trees
♦ Evaluating Production Losses from Mule Deer Depredation in Apple Orchards
♦ Factors Influencing Diet Selection by White-tailed Deer
♦ Fruit Growers’ V.s. Other Farmers’ Attitudes Towards Deer in New York
♦ Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Their Crops
♦ Wildlife Damage to Crops: Perceptions of Agricultural and Wildlife Professionals in 1957 and 1987
FERTILITY CONTROL

- White-tailed deer fertility may be reduced with chemical or mechanical devices.
- DES (diethylstilbesterol), MGA (melengestrol acetate), DRC-6246 (11α-allyl-17β-hydroxy-3-oxoestra-4,9,11-triene) and PZP (porcine zona pellucidae) have been used to reduce fertility in deer.
- Intraterine devices have been used to reduce fertility in deer with limited success.
- Implants will only be effective in small enclosed or isolated deer populations.
- Intramuscular applications are more effective than oral applications.
- Microencapsulation of chemosterilants improves bait acceptance.
- Fertility control may be used to reduce deer populations but is not an effective crop protection technique.
- All vertebrate reproductive systems (including human systems) are very similar. Chemosterilants therefore have a high inherent potential to effect non-target organisms.
- Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

References in “Deer” Section

- Antifertility Action of Two Synthetic Progestins in Female White Tailed Deer
- Effectiveness, Reversibility, and Serum Antibody Titers Associated with Immuonocontraception in Captive White-tailed Deer
- Effect of Diethylstilbestrol on Reproductive Performance of White-tailed Deer
- Fertility Control in White-tailed Deer by Steroid Implants
- Hormone Implants Control Reproduction in White-tailed Deer
- Microencapsulated Diethylstilbestrol as an Oral Contraceptive in White-tailed Deer
- Non-efficacy of Mechanical Birth Control Devices for White-tailed Deer

References in “General” Section

- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant™ Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immuonocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife
FOOD AND HABITAT PREFERENCES

• White-tailed deer are selective foragers.
• Apple trees are a preferred food for white-tailed deer, consumed well in excess of abundance.
• Aspen, beaked hazel, strawberry, willow, choke cherry leaves and aster leaves and flowers averaged 66-80% of white-tailed deer diet in northern Michigan.
• White-tailed deer are attracted to mineral and salt licks.
• White-tailed deer are attracted to early successional environments such as those created by agriculture.
• Deer prefer to feed on fertilized crops.
• Deer shift diet strategies in the winter and become diet generalists. Remaining in a sheltered area becomes more important than food preferences or in some cases, eating at all.
• Deer prefer sheltered, conifer dominated sites for winter bed sites.

References

• Browsing Preference of White-tailed Deer for Different Ornamental Species
• Characterization of Deer Damage to Soybean Plants
• Crop Damage and Control
• Effects of Supplemental Mineral Licks on White-tailed Deer
• Factors Influencing Diet Selection by White-tailed Deer
• Food Habits of a Supplementally Fed Captive Herd of White-tailed Deer
• Forage “Preference”: Theoretical Considerations of Diet Selection by Deer
• Influence of Sewage Sludge Fertilization on Food Habits of Deer in Western Washington
• L-2393 Factors Affecting Deer Diets and Nutrition
• L-2457 Supplemental Forage Management for East Texas White-tailed Deer
• L-5000 Key Food Items for East Texas White-tailed Deer
• Movements and Use Patterns of White-tailed Deer Visiting Natural Licks
• Saskatoon Serviceberry Toxic to Deer
• Seasonal Food Selection and Digestibility by Tame White Tailed Deer in Central Maine
• Summer Forage Use by Tame Deer in Northern Michigan
• White-tailed Deer Habitat and Cottage Development in Central Ontario
• Winter Bed-site Selection by White-tailed Deer in Central Ontario
• Winter Use of Riparian Habitat by White-tailed Deer: Site Selection or Coincidence

HUNTING

• Although hunting may lower deer densities, it has not been an effective crop protection technique in most situations.
• Deer may not legally be shot in the defence of property in Ontario.
• Shooting deer which damage crops is generally quite controversial with hunters and proponents of animal rights.
• Wildlife damage is more common when the farm or surrounding area is posted “No Hunting”.

127
References

- Bowhunting White-tailed Deer with Succinylcholine Chloride-treated Arrows
- Cooperative Management of White-tailed Deer on Private Lands in Mississippi Deer
- Fish and Wildlife Habitat Management: Best Management Practices
- Fruit Growers’ V.s. Other Farmers’ Attitudes Towards Deer in New York
- Incorporating Farmers Attitudes into Management of White-tailed Deer in New York
- L-2334 the Texas Deer Lease
- Methods Used by Selected Ohio Growers to Control Damage by Deer
- Motivations for Deer Hunting: Implications for Antlerless Deer Harvest as a Management Tool
- The Need for Hunter Education in Deer Management: Insights from New York
- Private Land Hunting Restriction and Game Damage Complaints in Montana
- Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Th Ruin Some Operations
- Relationships Between Characteristics of Nurseries and Deer Browsing
- Review of a Program to Alleviate Localized Deer Damage
- Willingness of New York Farmers to Incur White-tailed Deer Damage

“INVISIBLE FENCING”

- Despite repeated calls, Off Limits™ producers were unable to provide documents to support claims of “80-99%” effectiveness.
- Dogs contained by a similar system have been used to reduce browsing damage to a white pine plantation by 76%.
- It is an offence under the Game and Fish Act to allow dogs to chase deer.

References

- Deer Feed: $50 a Day, Dog Food: $1 a Day
- Deer Go. Crops Grow. Or We Pay.
- Fish and Wildlife Habitat Management: Best Management Practices
- Use of Dogs to Reduce Damage by Deer to a White Pine Plantation

LURE CROPS

- Salt licks and lure crops have been used to manipulate deer movements with limited success.
- If deer populations are limited by food sources during the time period where lure crops are planted, deer populations may increase.
- Deer populations are limited by suitable winter habitat, predators, hunting, severe winters and nitrogen and micronutrients in food sources but not by food supplies. Planting lure crops is therefore unlikely to increase deer populations.
References

- Crop Damage and Control
- Effects of Supplemental Mineral Licks on White-tailed Deer
- Movements and Use Patterns of White-tailed Deer Visiting Natural Licks
- Some Predator-prey Relationships in Bird Damage and Population Control

PHYSICAL BARRIERS

- 2.4 meter woven wire or page wire fences are almost 100% effective.
- Fencing is cost effective for high value crops receiving high amounts of damage.
- Fencing is the only reliable method to reduce deer damage to orchards.
- Deer are capable of jumping 2.5 m fences but this is rare.
- Fences with gaps greater than 23 cm may be breached by deer.
- Fences slanting away from crops use less material than upright fences and have been effective. A 1.3 m tall fence built at a 45° requires only 1.6 meters of fence to build.
- Slanting fences need to be staked regularly so that deer can not squeeze under them.
- In some situations fencing or caging individual young trees may be appropriate. 1.6 m poultry wire supported by 3 stakes will be effective.
- Various electric fence designs have been used to successfully and cost effectively protect areas.
- A charger capable of producing a minimum of 4000 volts is most effective.
- Wires should not be spaced close together or deer will try to jump the electric fence.
- Peanut butter may be applied to an electric fence to encourage deer to touch the wires.

References

- A Baited Electric Fence for Controlling Deer Damage to Orchard Seedlings
- Controlling Deer Use of Forest Vegetation with Electric Fences
- Crop Damage and Control
- Deer
- Deer Control Help Needed
- Deer Fence
- Deer Fence Construction and Costs
- Economic Feasibility of a Deer-proof Fence for Apple Growers
- Effects of Electric Predator-excluding Fences on Movements of Mule Deer in Pinyon/juniper Woodlands
- Electric Fences and Commercial Repellants for Reducing Deer Damage in Cornfields
- Fish and Wildlife Habitat Management: Best Management Practices
- Highway Right-of-way Fences as Deer Deterrents
- ?Keeping Deer out of a Veggie Garden
- Methods Used by Selected Ohio Growers to Control Damage by Deer
- Options Available to Keep Deer, Birds from a Blueberry Meal
- Overhanging Deer Fences
- A Practical Fence to Reduce Deer Damage
Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Th Ruin Some Operations

Reducing Deer Damage

Rodent and Deer Control in Orchards

Strawberry Grower Has “Deer” Problems

Western Canadian Deer Problem Not as Serious

PREDATORS AND OTHER FACTORS LIMITING POPULATION

White-tailed deer may represent up to 76% of the summer diet of wolf populations in the northern portions of the Bay of Quinte watershed when other prey are scarce.

Grey wolves were responsible for up to 29% mortality of white-tailed deer in northeastern Minnesota.

Grey wolf predation in northeastern Minnesota was greatest when snow depth was greatest.

43% of coyote food in the Black Hills of South Dakota was found to be White-tailed deer.

43% of coyote food in Maine was found to be White-tailed deer.

Coyotes prey on fawns rather than adult deer.

90% of mule deer fawn mortality is a result of coyote predation.

Removal of Coyotes has been demonstrated to increase white-tailed fawn survivorship by an average of 154% in Oklahoma.

Predation reduces the size of deer herds.

Red foxes and domestic and wild dogs are not successful predators for white-tailed deer.

Deer foraging on plants fertilized with nitrogen and micronutrients have increased crude protein intake which has been related to increased fertility.

Severe winters and not food availability have been demonstrated to limit deer populations in Quebec.

References

Changes in Summer Foods of Wolves in Central Ontario

Coyote Foods in the Black Hills, South Dakota

Coyote-mule Deer Interaction Observations in Central Wyoming

Domestic Dogs as Predators on Wild Deer

Effects of Coyote Reduction on White Tailed Deer Productivity on Fort Sill, Oklahoma

Estimating Carrying Capacity of a White-tailed Deer Wintering Area in Québec

Feral Dog and White-tailed Deer Interactions in Alabama

Foods of Adult Maine Coyotes and Their Known Age Pups

Influence of Sewage Sludge Fertilization on Food Habits of Deer in Western Washington

Observations of Coyote Predation on Mule Deer Fawns in Arizona

Rate of Increase of White Tailed Deer on the George Reserve: a Re-evaluation

Rate of Increase of White Tailed Deer on the George Reserve: a Response

Red Fox Feeding Habits in Relation to Fawn Mortality

Relationships among Mule Deer Fawn Mortality, Coyotes, and Alternate Prey Species During Summer
• Relationship Between Snow Depth and Gray Wolf Predation on White-tailed Deer
• Western Canadian Deer Problems Not as Serious

REPELLENTS

• Predator fecal odors, Hot Sauce Animal Repellant, BGR-P (36% egg solids), soap perfumes and soap products placed every 1 meter are the most effective repellent products.
• All repellents appear to be inconsistent and only variably effective.
• Repellents are most useful for short term crop protection.
• Repellents are least effective when deer densities are highest and most effective when densities are lowest.
• Fermented egg products repel deer and attract coyotes.

References

• Crop Damage and Control
• Deer
• Effectiveness of Predator Fecal Odors as Black-tailed Deer Repellents
• Electric Fences and Commercial Repellants for Reducing Deer Damage in Cornfields
• Evaluation of Two Mammal Repellants Applied to Browse Species in the Black Hills
• Fish and Wildlife Habitat Management: Best Management Practices
• Keeping Deer out of a Veggie Garden
• Methods Used by Selected Ohio Growers to Control Damage by Deer
• Preliminary Screening of White-tailed Deer Repellents
• Preparation and Evaluation of a Synthetic Fermented Egg Coyote Attractant and Deer Repellent
• Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Their Operations
• Reducing Deer Damage to Yews and Apple Trees: Testing Big Game Repellent\textsuperscript{\textregistered}, Ropel\textsuperscript{\textregistered}, and Soap as Repellents
• Red-winged Blackbird Flock Behavior in Response to Repellent Stress
• Rodent and Deer Control in Orchards
• Screening of Odor and Taste Repellents for Control of White Tailed Deer Browse to Apples or Apple Shoots
• Strawberry Grower Has “Deer” Problems
• Volatile Components of Fermented Egg, an Animal Attractant and Repellent

TRAPPING

• Live trapping often results in mortality.
• Trapping is expensive and inefficient except for small enclosed or isolated populations of deer.
References
◆ Comparison of Net-gun and Drive-net Capture for White Tailed Deer
◆ Crop Damage and Control
◆ Notes on Field Immobilization of White Tailed Deer with Nicotine
◆ Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Th Ruin Some Operations
◆ Removal Techniques to Control an Enclosed Deer Herd

VISUAL AND AUDIO SCARERS
◆ These scarers are of limited value for short periods of time.
◆ Scarers will be most effective if they are moved often.

References
◆ Crop Damage and Control
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Methods Used by Selected Ohio Growers to Control Damage by Deer
◆ Quebec Producers Watch Deer Take a Bite out of Their Crop: Orchard Owners Are Trying Different Methods to Deter Deer That Threaten Th Ruin Some Operations
◆ Reflecting Tapes Repel Blackbirds from Millet, Sunflowers, and Sweet Corn
◆ Responses of Pest Birds to Reflecting Tape in Agriculture
◆ Strawberry Grower Has “Deer” Problems
Summary of Selected References

ALFALFA LOSSES TO WHITE-TAILED DEER
William L. Palmer, George M. Kelly and John L. George. The Pennsylvania State University, University Park, PA 16802

The study was designed to determine the magnitude of alfalfa loss to deer in field situations and found that deer will not only remove crops but will also effect future productivity of alfalfa by trampling and thinning stands. Statistically and economically significant losses were observed up to 20% of total crop value.

A BAITED ELECTRIC FENCE FOR CONTROLLING DEER DAMAGE TO ORCHARD SEEDLINGS
William F. Porter. Department of Environmental and Forest Biology, State University of New York, College of Environmental Science and Forestry, Syracuse, NY 13210

This study examines the cost effectiveness and ability of a modified electric fence in reducing deer damage to young orchards in New York State. The fence was a single strand of smooth wire suspended 1 m above the ground to which aluminum flags coated in peanut butter were attached. The flags were intended to encourage the deer to touch the fence with their noses. The initial cost of such a fence is considerably lower than the initial cost of a woven wire fence, ($0.15/m and $4.10/m respectively). Although costs are in 1983 U.S. dollars and assume U.S. labor prices, the ratio is still significant. The labor required for maintenance is “8 hours/month”. The study does not say how much fence is maintained in that month, nor does the study include the cost of the energizer or electricity required to power the fence.

The study found that the fence reduced browsing to less than 1% of branches in the first year and less than 3% in the second year, as opposed to 89% and 37% of branches browsed in the control plots. Although statistics were not kept in the third year, similar results were achieved. No reduction in efficiency was measured between a 1 and 5 ha field. Since deer can get around this type of fencing, studies on larger areas with high population densities are still required.

ANTIFERTILITY ACTION OF TWO SYNTHETIC PROGESTINS IN FEMALE WHITE TAILED DEER
Two synthetic progesterins, MGA (17α-acetoxy-6-methyl-16-methylene-4,6-pregnadiene-3,20-dione) and DRC 6246 (11α-allyl-17β-hydroxy-3-oxoestra-4,9,11-triene) were tested at three different feeding regimes on white-tailed deer. The synthetic agents did not delay or prohibit pregnancy despite good oral acceptance. The author writes, “These data support the hypothesis that exogenously administered progesterins are not accumulated in sufficient quantities in the body fat to provide prolonged hormonal storage from which target organs are supplied” (p.194).

BOWHUNTING WHITE-TAILED DEER WITH SUCCINYLCHOLINE CHLORIDE-TREATED ARROWS
Keith Causey and J. E. Kennamer. Department of Zoology-Entomology, Auburn University Agricultural Experiment Station, Auburn, AL 36830
Joe Logan. South Carolina Wildlife and Marine Resources, Fisheries, Columbia, SC 29201
J. I. Chapman, JR. Groton Plantation, Luray, SC 29932

This paper documents killing efficiency and recovery rates associated with several arrow technologies.

BROWSING PREFERENCE OF WHITE-TAILED DEER FOR DIFFERENT ORNAMENTAL SPECIES
Michael R. Conover and Gary S. Kania. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

The authors examined the deer browsing over 3 winters at a landscaping company’s nursery in Connecticut. There were 61 tree and shrub species at the site. Deer were extremely selective feeders with the average percentage of shoots removed ranging from 97 to 0%. Of the 61 species analyzed, 15% received no browsing, 52% suffered less than 10% browsing, 23% received 10-50% browsing and 10% of the species had over 50% of their shoots browsed. Differences in browsing within a genus were noted. Apple trees received 13.6% browsing and pear trees received 0% browsing on average over three winters.

The authors caution that browsing on any particular species in any winter depends on the number of deer in the area, winter weather conditions and alternative sources of food. The authors suggest that by using this information, conflicts with deer may be eliminated by planting unpalatable species where deer damage is likely to occur and palatable species where it is least likely to occur. The complete list of species examined and damage received are listed.
CHANGES IN SUMMER FOODS OF WOLVES IN CENTRAL ONTARIO
Dennis R. Voigt and George B. Kolenosky. Fish and Wildlife Research Branch, Ministry of Natural Resources, Maple, Ontario, L0J 1E0
Douglas H. Pimlott. Department of Zoology, University of Toronto, Ontario M5S 1A1

The percentage of white-tailed deer and Canadian beaver in wolf scat in three areas, Algonquin Park, Pakesly (135 km west of Algonquin), and Marten River (135 km north of Algonquin) was analyzed. From 1963 to 1972 the scat makeup changed as deer decreased in availability in all three areas. The changes in scat composition were as follows: Algonquin park -- beaver up from 7 to 55% as deer fell from 76 to 33%; Pakesly -- beaver up from 59 to 75% as deer fell from 27 to 11%; Martin River -- beaver up from 37 to 74% and deer fell from 42 to 1% of scat.

CHARACTERIZATION OF DEER DAMAGE TO SOYBEAN PLANTS
David S. DeCalesta and David B. Schwendemad. Department of Zoology, North Carolina State University, Raleigh, NC 27607

The paper points out that successful use of scaring devices and repellents require proper timing if they are to be successful in protecting crops in general. Specifically, the paper documents when white-tailed deer damage to soybeans began; how long it lasted, the proportion of vegetation eaten; the effect on production; and the relationships between deer damage and location of plants within fields, field size and abundance of woodlots surrounding the fields.

COMPARISON OF NET-GUN AND DRIVE-NET CAPTURE FOR WHITE TAILED DEER
Charles A. DeYoung. Caesar Kleber Wildlife Research Institute, Texas A&I University, Kingsville, TX 78363

The article compares deer capture technologies. Using the drive-net capture technique, under ideal conditions, over 40 deer may be captured per day. The method requires a helicopter and a crew of 15-25 people. The author compares four methods of processing deer caught with a net-gun in Texas and then compares the most efficient net-gun technique with the drive-net technique. Deer mortality of the drive net is considered to be less than 3%. The capture of 44 deer with the net-gun technique resulted in 2 deaths or less than 5% mortality. The net-gun is considered to be more efficient than the drive-net method in this study.
CONTROLLING DEER USE OF FOREST VEGETATION WITH ELECTRIC FENCES
William C. Tierson. The Archer and Anna Huntington Wildlife Forest Station, State University of New York, College of Forestry, Syracuse University

This paper describes the results of fencing to protect new growth in part of a 500 acre clear cut in the Adedack Mountains. Deer browsing was significantly reduced inside the fence; however, the author concludes that the savings were too marginal and the costs too great to recommend the use of the electric fence, because similar expenditures could create fencing with complete exclusion abilities.

The authors made observations which may be of use for other fences. "(1) Only steel wire, galvanized or copper clad should be used; (2) Vegetation must be controlled to prevent grounding; (3) Available commercial fence chargers did not provide adequate shocking characteristics to control deer under our circumstances; (4) Wire must be properly spaced and well-tensioned. All connections must be tight and permanent splices soldered. Fence controllers must be properly grounded. (5) Following modification in 1963, maintenance of lines, wires, insulators and brackets required about 1 man-day per year; and (6) Deer encountering the fence showed wide variation in response. Some appeared unaffected, other reacted violently, even falling down. Running animals usually penetrated the fence. Walking animals appeared to ‘test’ the fence at several points, occasionally penetrating but often turning away" (p.925).

COOPERATIVE MANAGEMENT OF WHITE-TAILED DEER ON PRIVATE LANDS IN MISSISSIPPI
David C. Guynn, Jr., Sarah P. Mott and Harry A. Jacobson. Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS 39762
William D. Cotton. Department of Wildlife Conservation, Jackson, MS 39205

The authors discuss reasons for difficulties in obtaining information necessary for deer management and describe measures the Mississippi Department of Wildlife Conservation (MDWC) took through their Mississippi Cooperative Deer Management Program (MCDMP) to solve these problems. The four goals of the program were, (1) to develop a better system for collection, analysis and reporting of harvest data; (2) to involve sport hunters in management decisions; (3) to reduce deer densities and crop damage; and (4) to increase the deer harvest quality. The paper evaluates the program over its first four hunting seasons.

The authors found that the program increased public acceptance of antlerless deer harvests, improved herd condition and provided the MDWC with better management information. The paper did not study the effects on agriculture despite claiming that this was one of the four main goals of the program. The main limiting factor for the program was the expense of
facilitating public participation.

**COYOTE FOODS IN THE BLACK HILLS, SOUTH DAKOTA**
James G. MacCracken. Agricultural Experiment Station, University of Alaska, Palmer Research Center, P. O. Box AE Palmer, AK 99645
Daniel W. Uresk. USDA, Forest Service, Rocky Mountain Forest Service, Rocky Mountain Forest and Range Experiment Station, Rapid City, SD 57701

Prey remains (expressed as % dry matter) in coyote scat are broken down by season and species. Overall 43.5% of coyote food was white-tailed deer, 16.2% was mountain cottontail and 12.2% was various mouse species.

**COYOTE-MULE DEER INTERACTION OBSERVATIONS IN CENTRAL WYOMING**
C. R. Wenger. Game and Fish Laboratory, University of Wyoming. P. O. Box 3312, Laramie, WY 82071

The paper documents successive attempts of a coyote to take mule deer fawns. The paper concludes that aggressive behavior of does offers protection to fawns that are old enough to travel with their mother. Since both mule deer and white-tailed deer do not travel with their mothers until they are two weeks old, they are therefore most vulnerable to coyote predation in their first two weeks of life.

**CROP DAMAGE AND CONTROL**

David S. deCalestra. Associate Professor, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon
John D. Harder. Associate Professor, Department of Zoology, Ohio State University, Columbus, Ohio.

This chapter reviews the history of deer damage to field crops, orchards and trees. Farms in heavily wooded areas and fields bordering woodlands receive more damage than farms in lightly wooded areas or fields more than 670 m (2200 feet) from forests. Also, “Damage is intensified on fertilized crops, and by dry weather, heavy snows and low quality of native forage” (p.647).

The paper then reviews the following control measures: population control, trapping and
translocating, scare devices, supplemental planting/lure crops, chemicals/repellents, mechanical devices, fencing and compensation, as well as possible future methods for control.

DEER

The publication lists control options. Only the use of a 2.4 m wire mesh fence with sturdy posts is listed with any confidence. “Electric fences may also provide some control. Repellents are generally not that effective against deer browsing” (p.12). The report recommends that if repellents are to be used, they should be used on the windward perimeter and replaced every 4-6 weeks. Hunting is legal only during the season set by the Ministry of Natural Resources.

DEER CONTROL HELP NEEDED
Reply from Lawrence F. London at london@sunSITE.unc.edu to TroyBogdan@aol.com

TroyBogdan@aol.com asked for proven fence setups since “it seems like every company recommends a different fence set up”. London@sunSITE.unc.edu says he is an organic grower who has used fencing in the past and will be fencing an additional 2-3 acres. He recommends an electric fence that “will absolutely keep them out of your garden. Nothing less will work and no more is necessary”. The fence he recommends uses 8 foot galvanized T-posts with plastic screw on insulators, “the hottest charger you can get”, preferably a New Zealand variety although he calls International “a good brand”, 1-3 8 foot copper (10 gauge minimum) ground rods, 14 gauge (minimum) galvanized steel (never aluminum) wire and 12 ½ gauge high tensile 200 lb. test wire for lines the deer are likely to run into. He recommends spacing of 16-28 inches for the first four lines and slightly greater spacing for the rest and says “turn the fence charger off as infrequently as possible. He concludes, “Initially, bait the fence with peanut butter and corn in aluminum foil boats hung from the middle wire (about 3 feet from the ground). They quickly catch on and avoid the fence. Their feeding pattern is disrupted and they move to other areas. They always know when the fence is on and will avoid it - they usually won’t come closer than 30-40 feet.”

DEER FEED: $50 A DAY, DOG FOOD: $1 A DAY
Ontario Fruit Grower. P.19, Mar 96
Invisible Fence Co.

This advertisement makes the following claims: “The Off Limits System has been tested by farmers, orchardists, universities and departments of conservation. Control tests show deer damage reduced between 80 and 99%” and “two Off Limits dogs, who together cost less than
$1000 a year to feed, medicate and care for... return on investment for the system is far less than one year. Most farmers report it pays for itself within the first two months”. The advertisement also offers a “One Year Performance Guarantee” to refund equipment cost if there is no reduction in deer damage. Free information video and brochure 1-800-923-7378.

DEER FENCE
Articles 13526 and 13528 of the news group rural.misc
Mark Zallar (MarkZall@ix.netcom.com), Larry E. Hoover (lhoover@trentu.ca) and Melinda Shore (shore@dinah.tc.cornell.edu)

Mark Zallar found that there is a bylaw that fences greater than 6 ft must be set back 50 ft from the road, so instead of a 8 ft fence he was considering a 6 foot fence 2.5-3.5 ft in from the barbed wire fence already in place. Larry Hoover responds that an 8 ft fence is necessary and even then deer farmers have found that “a truly motivated deer *can* clear one of these”. He then suggests that a T-shaped top might prevent the deer from jumping the fence. Melinda Shore responds that a T-shaped piece will not prevent deer from jumping a six ft fence.

DEER FENCE CONSTRUCTION AND COSTS
L. K. Halls. Southern Forest Extension Station, U.S. Forest Service, Nacogdoches, Texas
C.E. Boyd. Texas Parks and Wildlife Department, Nacogdoches, Texas
D. W. Lay. Texas Parks and Wildlife Department, Buna, Texas
P. D. Goodrum. U.S. Bureau of Sport Fisheries and Wildlife, Nacogdoches, Texas

In 1964 two 153 acre deer pens and several 1/4 acre enclosures consisting of 5.2 miles of 8 ½ foot fence were constructed in Texas. The total cost in 1964 U.S. dollars was 16, 429 ($6816 for labor and right of way clearing, $9613 for materials). The construction required a total of 2907 labor hours. The materials used are listed in the report.

DEER GO. CROPS GROW. OR WE PAY.
The Great Lakes Fruit Growers News. 35(4), April 1996.
Invisible Fence Co.

This advertisement for OffLimits™ claims; “Since 1990, Offlimits Systems have been tested by farmers, orchardists, universities and departments of conservation. Tests show deer damage reduced between 80 and 99%”. Free information video and brochure 1-800-923-7378.
DOMESTIC DOGS AS PREDATORS ON WILD DEER
Dwain A Lowry. Idaho Fish and Game Department, 512 E. Larch, Box 866, Osburn 83849.

The paper examines predator/prey relationships between wild and free roaming dogs and deer. It includes a review of literature for and against the hypothesis that dogs kill deer. It states, with statistical proof, that dogs increase deer mortality directly, as well as increasing mortality indirectly by increasing stress and probability of injury as deer flee dogs. Deer are most vulnerable to dogs during February and March.

ECONOMIC FEASIBILITY OF A DEER-PROOF FENCE FOR APPLE GROWERS
James W. Caslick and Daniel J Decker. Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY 14853.

The cost estimates are fairly dated, (1979 U.S. dollars); however, building materials, specifications, average installation time and methodology for assessing cost effectiveness may be useful. The paper assesses the cost of erecting a 2.44 m woven wire fence. The installation rate was 3 m/hour.

EFFECTIVENESS OF PREDATOR FECAL ODORS AS BLACK-TAILED DEER REPELLENTS
M. Anthony Melchiors and Charles A. Leslie. Western Forestry Research Center, Weyerhaeuser Company, Centralia, WA 98531.

Extracts from predator scat were more effective than Big Game Repellant - BGR (4.9% egg solids) and just as effective as BGR-P (36% egg solids) at reducing feeding by black-tailed deer in laboratory experiments. Browsing was reduced 51% by bobcat feces and 27, 17 and 8% with mountain lion, wolf and coyote scat respectively. Inefficiency of collecting predator scats is the major factor limiting their use, but they seem to be as effective as egg based repellents for reducing browsing by black tailed deer.
EFFECTIVENESS, REVERSIBILITY, AND SERUM ANTIBODY TITERS ASSOCIATED WITH IMMUNOCONTRACEPTION IN CAPTIVE WHITE-TAILED DEER

John W. Turner, Jr. Department of Physiology and Molecular Medicine, Medical College of Ohio, Toledo, OH 43699
Jay F. Kirtpatrick. Deaconess Research Institute, Billings, MT 59101
Irwin K. M. Liu. Department of Population, Health and Reproduction, School of Veterinary Medicine, University of California, Davis, CA 59616

This paper details the physiological effects of several experiments with 1, 2 and 3 porcine zona pellucidae (PZP) injection immunocontraception in white-tailed deer. Sample sizes were less than 10 in each experiment. In all the tests, PZP-treated does did not produce fawns in the first year after treatment while 93.8% of control deer produced at least one fawn. In the second year fertility was 75% in deer treated with PZP, which demonstrates reversibility of the PZP treatment. Deer which received 2 or 3 injections were more likely (82%) to have antibody titers >50% maximum while only 50% of deer receiving 1 injection had antibody titers >50% maximum 32-40 weeks after injection. “Formulations of microsphers which release PZP as a pulse (mimicking an injection), rather than gradually, may be necessary to increase effectiveness and the life span of the vaccine” (p. 51).

EFFECTS OF COYOTE REDUCTION ON WHITE TAILED DEER PRODUCTIVITY ON FORT SILL, OKLAHOMA

Gene G. Stout. Fish and Wildlife Branch, Directorate of Engineering and Housing, Fort Sill, OK 73503

Coyotes were removed from three deer ranges in Oklahoma to determine the effects on deer populations. The study areas showed an increase in fawn: doe ratios of 262%, 92% and 167% in the summer following coyote reduction. Prior to coyote reduction fawn production was 0.37 fawns per doe. Fawn production rose to 0.94 fawns per doe the year following coyote removal for an overall study increase of 154%.

The paper references other sources which may support their findings. The paper does not, however, report on differences in winter conditions which may have impacted on deer populations. Despite this, predation in general has been identified as a limiting factor on wildlife populations and coyotes may have a significant role in reducing deer populations in some areas by limiting yearly recruitment rates.
EFFECT OF DIETHYLSTILBESTROL ON REPRODUCTIVE PERFORMANCE OF WHITE-TAILED DEER
John D. Harder. Department of Zoology, State University College, Oswego, New York 13126
Tony J. Peterle. Department of Zoology, The Ohio State University, Columbus 43210

Oral and intermuscular administration of DES before breeding and to pregnant white-tailed deer were assessed for their practical utility in population reduction. The control population of mature white-tailed deer had an average of 1.87 fetuses per doe. Does treated orally with DES had 1.48 fetuses per doe and those treated intermuscularly had 0.29 fetuses per doe. “Treated deer that remained pregnant carried a significantly larger proportion of male fetuses than the control does: 64 percent in does fed DES and 80% in does injected with DES. Fifty-two percent of the fetuses carried by control does were male” (p.183). It is estimated that oral application of DES would not be an effective way to reduce deer populations and intermuscular injections would only be practical on small populations of 100-200 deer.

EFFECTS OF ELECTRIC PREDATOR-EXCLUDING FENCES ON MOVEMENTS OF MULE DEER IN PINYON/JUNIPER WOODLANDS
V. W. Howard Jr., Department of Fisheries and Wildlife Sciences, New Mexico State University, Las Cruces, NM 88003-0003

Primarily concerned with animal welfare, this study examines effects on major movement or migration routes of mule deer. Fence height was found to be an important factor. Fences greater than 1.5 meters restricted movements of both young and old deer. A fence only 1.2 meters in height will only restrict the movement of young deer but not the adults.

EFFECTS OF SIMULATED DEER BROWSING ON BRANCHES OF APPLE TREES
Dale E. Katsma and Donald H. Rusch. Wisconsin Cooperative Wildlife Research Unit, University of Wisconsin, Madison, WI 53706

This paper documents the effects of simulated browsing at 20, 40, 60 and 80% on mature apple trees on the following year’s apple production. The authors note that results are highly variable but that McIntosh trees responded by producing more fruit per cluster. The paper does not look at effects on young trees nor does it examine loss of productive potential beyond the following growing season.
EFFECTS OF SUPPLEMENTAL MINERAL LICKS ON WHITE-TAILED DEER
Stephen R. Schultz and Mark K. Johnson. School of Forestry, Wildlife and Fisheries, Louisiana State University Agricultural Center, Baton Rouge, LA 70803

This study evaluated the effects of commercial mineral lick use on antler development and body mass of white-tailed deer in areas where mineral consumption is well below those necessary for optimal growth. High levels of mineral consumption did not improve antler growth or body weight. The paper concludes, “Wildlife managers should be cautious in promoting mineral supplementation for deer in any area before effects have been demonstrated” (p.307).

ELECTRIC FENCES AND COMMERCIAL REPPELLANTS FOR REDUCING DEER DAMAGE IN CORNFIELDS
Scott E. Hygnstrom and Scott R. Craven. Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53706

The paper examined the cost effectiveness of 2 commercial repellants, Hinder™ (A.I. ammonia soaps), and Magic Circle™ (A.I. bone tar oil) and three electric fences, a 1.4 mm (17-gauge) smooth steel wire coated with a paint roller with a 1:1 peanut butter:vegetable oil mixture (PB), Sockman Visible Grazing Systems™ yellow polytape (VGS), and Glogard™ aluminum foil ribbon (GG) at protecting corn fields from deer damage.

Material and labor costs are given in 1987 US dollars. All three fences had similar efficiency at repelling deer from corn crops as well as positive benefit: cost ratios for PB, VGS and GG of 1.7, 1.2 and 1.1 respectively in the first year and benefit: cost ratios of 4.5, 3.7 and 3.6 respectively over 5 years. Both Hinder and Magic Circle were considered inconsistent at repelling deer and controlling crop damage and had negative benefit: cost ratios in the first and following years.

ESTIMATING CARRYING CAPACITY OF A WHITE-TAILED DEER WINTERING AREA IN QUÉBEC
Francois Potvin and Jean Hout. Département de Biologie, Université Laval, Sainte-Foy, Québec, G1K 7P4

Carrying capacity is defined as the number of animals a habitat can sustain indefinitely in a healthy condition. The carrying capacity of the deer yard was estimated to be between 15 and 28 deer/km². Characteristics examined included food availability, surface area, nutrient requirements, cover types, available forage biomass, snow depth and the energy cost of
walking.

The authors conclude that “under Québec conditions, periodic severe winters can act independently of deer density to prevent overuse of the range. Mortality is not related to chronic overpopulation [as] sufficient browse is still present...range can be protected from chronic overuse by periodic adverse snow conditions” (p.474).

EVALUATING PRODUCTION LOSSES FROM MULE DEER DEPREDATION IN APPLE ORCHARDS
Dennis D. Austin and Phillip J. Urness. Department of Range Science, Utah State University, Logan, UT 84322-5230

This paper describes a method of determining apple losses on mature apple trees in the season following depredation by mule deer (*Odocoileus hemionus*). It does not assess damage to non-bearing trees, nor does it examine diminished productive capacity or increased production costs associated with deer damage.

EVALUATION OF TWO MAMMAL REPELLENTS APPLIED TO BROWSE SPECIES IN THE BLACK HILLS
Donald R Dietz. Rocky Mountain Forest and Range Experiment Station, Rapid City, South Dakota
James R. Tigner, Wildlife Research Center, Denver, Colorado

Zinc dimethyldithiocarbamate cyclohexylamine (ZAK) and tetramethylthiuram disulfide (TMTD) were used to effectively protect choke cherry, American plum, aspen and caragana from white-tailed and mule deer in the Black Hills of South Dakota. Both wild and nursery stock trees were protected. The paper gives chemical properties and application methods and compares repellent success rates for each chemical.

EVALUATION OF WHITE-TAILED DEER REPELLENTS
William L. Palmer, Robert G. Wingard and John L. George. The Pennsylvania State University, University Park, PA 16802

This paper is a continuation of the study “Preliminary Screening of White-tailed Deer Repellants” by Mark T. Harris, William L. Palmer and John L. George, published in the Journal of Wildlife Management 47(2):516-519, 1983.
The Harris study compared the effectiveness of 14 commonly used deer repellents, but recommended continued testing of only 9: meat meal, Big Game Repellant (BGR), feather meal, Hinder, hot sauce, Chew-not, Chaperone, Gustafson 42-S and Spotrete-F.

This paper was designed to further evaluate the repellents under semi-field conditions. Since Chew-not, Chaperone, Gustafson 42-S and Spotrete-F all have the same active ingredient (Thiram), Spotrete-F was used as a representative of all the Thiram products. Of repellents tested, only Big Game Repellant consistently reduced deer feeding and should be considered for further field tests, according to the authors. Even though BGR was statistically effective, damage still occurred and the product may not provide effective control.

The paper concludes that repellents currently available are inconsistent and only variably effective.

FACTORS INFLUENCING DIET SELECTION BY WHITE-TAILED DEER
Larry D. Vangilder. School of Forestry, Fisheries and Wildlife, 112 Stephen Hall, University of Missouri, Columbia, MD 65211
Oliver Torgerson. Missouri Department of Conservation, Jefferson City MO 65101
Wayne R. Porath. Missouri Department of Conservation, Columbia, MO 65101

The paper examines the variation of frequency, digestibility, solubility and chemical and structural composition of 34 spring and summer foods of the white-tailed deer in Missouri. The paper found that the deer is adapted to the changing chemical and structural composition in early successional habitats. Agriculture results in the suppression of successional process and creates a greater species diversity to which deer are adapted; therefore, the practice of agriculture inherently increases an area's carrying capacity for deer.

FARM FENCING SYSTEMS
R. P. Stone. Engineering Resources Unit, Resources Management Branch
Mark Leahy. Agricultural Representatives Branch

The paper describes various fencing types and their characteristics. Page wire (9 strand), standard barbed wire (4 wires), suspension (smooth wire, 12.5 gauge, 5 wire), suspension barbed wire (4 wires), permanent electric fence (12.5 gauge, 2 wire), non permanent electric fence and cedar rail fences are all discussed. Fencing costs of each type of fence using 1991 material costs and a labor rate of $16/hour are provided for 1/4 mile of fence.
The article discusses differences in approach to agricultural loss to wildlife in western and eastern Canada. In western Canada, farmers can be compensated for crop losses, and there are provincially funded programs to help reduce crop damage. In Saskatchewan, the province pays $50/acre to a total of $2,500 to compensate for crop losses. In Alberta, payouts are $54/acre or 75% of damage, whichever is less. There is also a federal-provincial program, The Prairie Farm Rehabilitation Administration, which compensates 50% of crop losses from water fowl, (this percent may be raised to 80-100%). A total of 5-6 million has been paid out annually.

In the Halton region, the Halton Federation of Agriculture found 44% of field crops (not orchards) suffered from wildlife damage with average crop loss to be under $7 per acre, (approximately $210,000 on 31,399 acres).

Wildlife management services in western Canada also run several programs which emphasize co-existence. Lynn Chambers says that the Prairie Farm Rehabilitation Administration has paid for planting of up to 300 acres of lure crops in some areas, they have also paid for bloodmeal and in rare cases, fencing. The programs do seem to reduce wildlife damage, although they are not 100% effective.

The paper reviews benefits of non-till agriculture and other conservation techniques to agriculture and wildlife. The article then goes on to ask, “Who will pay for farm conservation...Net U.S. farm income was $40 billion last year and roughly half of that was public money -- some 17 billion in direct farm payments and price supports and an additional $3 billion in services from state and federal agencies” (p.42).

The study examined interactions of wild dogs and deer for a year in Fort Rucker Military Reservation, Alabama, where populations of both species are high. While wild dogs were observed pursuing white-tailed deer, they were not observed capturing or killing a deer. The
dogs were observed feeding on small rodents, cottontail rabbits, tortoises, various forms of carrion and at landfills. The paper concludes, “Our study indicates that feral dogs are not efficient predators of adult white-tailed deer.... and conclude[s] that dogs, including feral dogs, are hardly more than a nuisance to adult white-tailed deer” (p.483).

FERTILITY CONTROL IN WHITE-TAILED DEER BY STEROID IMPLANTS

A synthetic estrogen, diethylstilbersol (DES), a synthetic progestin 11α-allyl-17β-hydroxy-3-oxoestra-4,9,11-triene, (DRC 6246) and placebo silastic implants were implanted in female white-tailed deer before breeding season. After breeding season, none of the treated deer was pregnant while all of the control deer were pregnant. The use of the implant is considered to be more effective and practical than oral administration or daily injections. The authors state that there “is less accumulation of drugs and metabolites in many tissues than in oral administration” (p. 731).

Field tests suggest that the life expectancy of the DES implant is 1-2 years and the life expectancy of the DRC 6246 implant is 3 years. The authors suggest that implants that are functional only during the breeding season would increase life expectancy of the implant and reduce negative side effects associated with prolonged steroid treatment.

The authors note that “mortality” has been associated with these types of contraceptive chemicals in women. The authors suggest, but did not analyze the potential risks to the treated animals; there may also be secondary hazards to predators and humans which may feed on treated deer.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES
Agriculture and Agri-Food Canada, 1996.

This document offers “Best Management Practices” determined by a team of “farmers, researchers, resource managers, extension staff, and agribusiness professionals” to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, raccoons, deer and birds are also included.

Crop protection options include a variety of fence types (baited electric, high tensile, parallel
electric and mesh), caging for individual trees, removing fencerows and windbreaks near orchards, hunting in season and a variety of noise makers and repellents for short term use. The authors state that owners may be charged under the Game and Fish act if dogs are caught chasing deer so using untethered dogs is not an option.

**FOOD HABITS OF A SUPPLEMENTALLY FED CAPTIVE HERD OF WHITE-TAILED DEER**
George F Hubert, Jr. and George Post. Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523
Alan Woolf. Rachelwood Wildlife Research Preserve, New Florance, PA 15944

The study examines the use of natural forage in a depleted range by a high density, supplementally fed deer population in Rachelwood Wildlife Research Preserve in Pennsylvania. The study’s primary focus is food habits, although variation in use of natural and supplemental forage among age and sex classes are also examined. One of their findings is: “The use of other natural forages appeared to be related to feeding preferences and/or availability. Apple fruits are recognized as a preferred deer food. Few apple trees were present at Rachelwood, yet apples made up 5% by volume of all foods consumed. Apples are apparently a highly preferred food at Rachelwood in spite of limited distribution and availability” (p.745).

**FOODS OF ADULT COYOTES AND THEIR KNOWN AGE PUPS**
Daniel J. Harrison and Joyce A. Harrison. Main Cooperative Wildlife research Unit, 240 Nutting Hall, Orono, ME 04469

The paper documents percentage occurrence of food items in adult and pup coyote scats from May to October. White-tailed deer was detected in 43% of scats, snowshoe hare in 30% and small mammals in 21% of all coyote scats.

**FORAGE “PREFERENCE”: THEORETICAL CONSIDERATIONS OF DIET SELECTION BY DEER**
Thomas D. Nudds. Department of Biology, University of Windsor, Windsor, Ontario N9B 3P4

The author argues that food standard preference ratings may be skewed by data collection methods and statistical techniques used to quantify preferences. The author summarizes groups of models into energy maximizing and nutrient optimizing models and gives examples where central assumptions of the models may be inappropriate. The author argues, “Shifts in
diet strategies imply that winter is a critical energy-limited period and that there should be a selective premium on shelter seeking behavior for energy conservation. Deer in northern latitudes use sheltered, conifer dominated habitats in winter. In fact, it seems to be energetically less costly to remain in sheltered habitats and fast than to forage in exposed habitats...Thus deer, and probably other temperate-latitude ungulates as well, are habitat specialists but diet generalists in winter. Manipulating winter habitats of deer by increasing densities of “preferred” foods will not be warranted when the “preferred” designation is an artifact of fieldwork designs or data analysis” (p.739).

FRUIT GROWERS’ V.S. OTHER FARMERS’ ATTITUDES TOWARDS DEER IN NEW YORK
Daniel J Deckler and Tommy L Brown. Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

This paper recognizes the importance of integrating farmer opinions into decisions about optimum population and harvest levels. There are, however, differences in opinion of full time fruit growers and other full time farmers. “Farmers have considerable tolerance for deer damage and generally accept the presence of deer...a few farmers incur severe, sometimes devastating, crop damage from deer. Fruit growers are often hardest hit...” (p.150). The authors predict that the difference of opinions will increase as the fruit tree industry moves towards dwarf and semi-dwarf apple plantings and deer populations rise. The paper makes suggestions for evaluating and integrating different opinions of full time farmers into deer management programs.

HIGHWAY RIGHT-OF-WAY FENCES AS DEER DETERRENTS
N. W. Falk. Department of Biology, Messiah College, Grantham, Pennsylvania 17027
H. B. Graves. Department of Biology and Department of Poultry Science, Pennsylvania State University, University Park 16802
E. D. Bellis. Department of Biology, Pennsylvania State University, University Park 16802

The study evaluated the effectiveness of a 2.26 m fence designed to keep deer off a four lane highway in Pennsylvania. Deer hairs attached to the underside of fences suggest that deer may cross under fences with gaps of 23 cm or greater. The fence examined did not deter deer because of the critical weakness of gaps (87 gaps 23-67 cm along 6.8 km of fence). Even if these gaps were to be repaired, the paper shows that the 2.26 m fence will be jumped by “significant numbers” of deer when food is plentiful in highway margins and scarce in the forest.
HORMONE IMPLANTS CONTROL REPRODUCTION IN WHITE-TAILED DEER
Ronald L. Bell, Ohio Cooperative Wildlife Research Unit, The Ohio State University, Columbus, Ohio 43210.
Tony J. Peterle, Department of Zoology, The Ohio State University, Columbus, Ohio 43210.

The effects of intramuscular injection of anti-fertility hormones wears off quickly and deer develop aversions to oral treatment with hormones. The paper describes the effects and costs of artificial hormone implants placed under the front foreleg of white-tailed deer. The hormones, MGA (melengestrol acetate) or DES (diethylstilbestrol), were implanted into 144 deer and successfully reduced reproductive rates for 1, and sometimes 2 years. DES was found to be effective if administered before or after conception; MGA however, was only effective if implanted before conception.

When killed and examined, untreated control yearlings averaged 1 fetus, while untreated mature does (2.5+ years of age) averaged 1.55 fetuses. Of yearlings treated with 100 or 150 mg MGA implants, 2 of 11 were found to be pregnant. The 39 mature deer treated with 50, 100 and 150 mg of MGA were found to have 0.47, 0.33 and 0.14 fetuses respectively. One mature doe of 12 (2 yearling, 10 mature) treated with 75 mg of DES was found to be pregnant. Of the deer that were found to be pregnant, 50% had apparently lost their implants. The authors conclude that this may be an effective management strategy for "enclosed deer populations that can be efficiently trapped and where other means of removal or harvest are not acceptable" (p.156).

INCORPORATING FARMERS ATTITUDES INTO MANAGEMENT OF WHITE-TAILED DEER IN NEW YORK
Tommy L. Brown and Daniel J. Decker. Department of Natural resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

The paper presents a method for evaluating and incorporating farmer attitudes into white-tailed deer management programs in the six New York State counties bordering the southern shores of Lake Ontario and Lake Erie. The authors claim that assessing farmer's attitudes is more accurate than using complaint levels to determine the attitudes of farmers. Using this method, the authors claim that farmers would support an increase of 0.2 bucks/km². The paper concludes, "While most farmers would be satisfied with a deer population managed at the level designated, some will have unreasonable or intolerable deer damage because of the location of their farms or the types of crops they grow. These farmers should be given special consideration, such as an alternative emergency system to remove damage-causing deer (e.g., permits to shoot them in a localized post season deer hunt), or financial remuneration for damage incurred"(p.238).
INFLUENCE OF SEWAGE SLUDGE FERTILIZATION ON FOOD HABITS OF DEER IN WESTERN WASHINGTON

David A. Anderson, Alaska Department of Fish and Game, P. O. Box 1184, Nome, AK 99762

This study examines the effects of nitrogen finds plant micro-nutrients in sewage sludge on forage quality and quantity for deer. The study found increased crude protein intake associated with fertilization which has been demonstrated to increase reproductive success in white-tailed deer.

INTERCEPT FEEDING AS A MEANS OF REDUCING DEER-VEHICLE COLLISIONS

Peggy Wood and Michael L. Wolfe. Department of Fisheries and Wildlife, Utah State University, Logan, UT 84332-5210

This study examines the use of supplemental feeding to lure deer away from roads. Three highways in Utah were divided into control and treatment areas with a buffer zone between. The test and control sections of road were reversed in the second year. Collisions and sightings of deer were reduced, on average, in the treated areas. The authors caution that supplemental feeding may increase deer populations and attract deer towards the road. They do not suggest the use of intercept feeding in the long-run, but suggest that in the short-run "intercept feeding might be expected do reduce deer-vehicle collisions by <50%, requiring the application of additional or alternate control methods" (p.379).

KEEPING DEER OUT OF A VEGGIE GARDEN

Articles 1,4,5,7,11 and 12 of misc.consumers.house
Laura Gold (saslsq@unx.sas.com), Bruce Dodd (ag187@freeNet.Carleton.CA), Erik Djukastein (Erik@scatMat.com), Andy Wing (adwing@astro.scis.tempo.edu), John Nedimyer (nedimyer@buffet.net), Stephen M. Henning (shenning@fast.net) and Jo Hindriks (chindriksstolker@worldbank.org)

Laura Gold asked for harmless ideas for keeping deer from a vegetable garden. Erik Djukastein reports on a new scarecrow that is being developed by Conotech electronics that uses a motion detector and sprays water at intruding deer. Andy Wing suggests that the deer will then get a free drink as well as a free meal but, Erik Djukastein says it is the manufacturer’s “considered opinion” that it will be more effective than taste repellents and “since we offer a money back guarantee, a person in that situation should not be afraid to try!”

Bruce Dodd says that a retired U.S. Secretary of Agriculture (who’s name he can’t remember) used wooden snow fencing at a 45° angle to stop deer from reaching his crops. Similarly, Jo Hindrix says he read in a book that two 4 foot fences 3 feet apart will stop deer. Stephen
Henning says that Ivory soap, human hare, lion and tiger feces and commercial repellents “guaranteed to work” have all failed him and concludes that “Only a physical barrier is foolproof.”

John Nedimyed suggests putting a radio under a metal bucket and blasting rock music.

L-2334  THE TEXAS DEER LEASE
Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Judon Fambrough and James C. Stribling

“Deer hunting is big business in Texas and provides a substantial source of income for many landowners. The various elements of a lease agreement and aspects of landowners' liability are covered. This 4-page publication contains 3 photographs.”

L-2393  FACTORS AFFECTING DEER DIETS AND NUTRITION
1992 Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
C. Wayne Hanselka

“Increasing prices of wildlife hunting leases have encouraged ranchers to focus on growing grass for deer as well as cattle production. This leaflet focuses on three important aspects of maintaining a healthy, productive deer herd: nutritional requirements of deer relative to sex, age and physiological state; nutritional value of the habitat relative to the availability and quality of forage; and competition among deer and other animals for the available forage. A table lists the typical nutrient contents of selected South Texas browse species. This 6-page publication contains 1 table.”

L-2457  SUPPLEMENTAL FORAGE MANAGEMENT FOR EAST TEXAS WHITE-TAILED DEER
Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Billy Higginbotham

“The white-tailed deer is the most popular big game species in Texas. Supplemental food plots can increase the forage available for deer. The basics of planning and planting food plots are
discussed, and recommendations are included for several food plant species. This 6-page publication contains 4 photos, 2 tables and 2 illustrations.”

L-5000 KEY FOOD ITEMS FOR EAST TEXAS WHITE-TAILED DEER
Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Billy Higgenbotham

“This 17-inch by 22-inch poster depicts 16 food plants important in the diets of white-tailed deer in East Texas. This publication contains 16 color photographs.”

METHODS USED BY SELECTED OHIO GROWERS TO CONTROL DAMAGE BY DEER
Joel D. Scott and Thomas W. Townsend. The Ohio State University, School of Natural Resources, 365 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210

The report found that 43.1% of Christmas tree, 41.3% of orchard, 32.5% of nursery, 7.7% of vineyard, 16.1% of vegetable and 10.9% of small fruit growers reported damage from deer. It reports on what percent of farmers use repellents, use scare devices, allow hunting, have applied for doe permits or have applied for out of season permits. Repellents (human hair, tankage, hinder, hot sauce, Thiram, soap and bone tar oil) and scaring devices (guns, exploder, items hung in trees, scarecrow and dogs) were categorically rated as giving complete protection, helped a lot, helped a little or helped not at all. “Fencing may be the only viable control method for growers with hunting restrictions, high value crops or severe damage” (p.237). 5-strand high tensile electric fence or a baited electric fence are recommended. Also recommended is using a variety of control measures; “Integrating several damage control measures into a planned program may offset inconsistent or temporary effectiveness of repellents by inducing a continual state of neophobia in deer during crop susceptibility” (p.239).

MICROENCAPSULATED DIETHYLSTILBESTROL AS AN ORAL CONTRACEPTIVE IN WHITE-TAILED DEER
George H. Matschke, Wildlife Research Center, U.S. Fish and Wildlife Service, Denver, Colorado 80225

The U.S. Park Service has been investigating oral anti-fertility agents to control white-tailed deer populations in national parks. Diethylstilbestrol (DES) is a commercially available
estrogen compound which induces spontaneous abortion in cattle. A combination of taste, smell and metabolic aversions make oral administration of estrogen compounds difficult. Further, ingested agents are absorbed only 1/10th as well as injected agents, so that large doses must be applied. This experiment attempted to mask aversions to large doses of DES with microencapsulation.

The experiment was conducted on captive white-tailed deer. After the first DES feeding pregnancy was interrupted in 80% of deer, these deer bred again within two weeks and a second DES feeding was applied. Due to decreasing acceptance of DES only 50% of these pregnancies were interrupted. The third feeding of DES was so poorly accepted that there was no effect on pregnancy. “Because of progressively poor acceptance, the need for high doses and the likelihood of prompt re-breeding after abortion, [oral administration of] DES...is not useful in population control of white-tailed deer” (p.87).

MOTIVATIONS FOR DEER HUNTING: IMPLICATIONS FOR ANTLERLESS DEER HARVEST AS A MANAGEMENT TOOL
Daniel J Decker and Nancy A. Connelly. Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY 14853

In New York State, white-tailed deer were extirpated during the late 1800's but by the 1970's had reached population levels described as “overabundant” in the paper. The primary population management tool employed by New York State is the deer management permit (DMP) system which allocates antlerless deer permits in addition to buck permits. The paper states, “It is not feasible to regulate deer populations on a State wide basis without harvesting adult female deer through recreational hunting” (p.455).

The paper examines characteristics of hunter demographics and motivations of hunters which are resulting in both a smaller number of hunters and a less successful harvest rate per hunter, trends which in turn are hampering efforts to control deer populations in New York State. The paper concludes, “In situations where antlerless-deer-harvest systems are not achieving the desired degree of deer population control because of inadequate harvests, it is important for deer managers to develop ways to encourage harvest opportunities that reflect various motivational orientations of hunters” (p.461).

MOVEMENTS AND USE PATTERNS OF WHITE-TAILED DEER VISITING NATURAL LICKS
Gary J. Wiles and Harmon P. Weeks, Jr. Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907
The paper examines the use of natural salt and mineral licks by white-tailed deer. It finds that the maximum distance and average of trips outside of a deer’s home range to salt licks are 3.2 km and less than 1.5 km respectively, average number of licks used is 1.9, frequency of visits is once every 1.2-12.3 days and visits usually occur 1-2 hours after dark. Adults and females are more likely to use licks than younger males. The authors also report that “salting programs have been advocated to...reduce crop depredations...However attempts...to improve ungulate distribution through the use of artificial licks met with limited success” (p.494).

THE NEED FOR HUNTER EDUCATION IN DEER MANAGEMENT: INSIGHTS FROM NEW YORK
Daniel J Deckler and Nancy A. Connelly. Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY 14853

The authors point out that recreational hunting is an essential deer management tool in New York State and that the deer population is increasing. They point out that increasing deer and human populations will lead to increasing conflicts and increased importance of management. They outline major factors converging which will make hunting a less effective management technique and propose an aggressive hunter education program to improve and continue effectiveness of recreational hunting as a wildlife management technique.

NOISE CONTROL ON FARMS
Michael Toombs. P. Eng., Rural/Urban Interface Specialist

The sheet discusses legal aspects of noise control and the physics of sound travel and diffusion. Recommendations for reducing conflicts with neighbors included using electronic warblers rather than propane bangers. “Use bird scaring devices only when required for protection of specific crops and only when a problem is evident. Operate bird-scaring devices only between dawn and dusk. Where possible, use directional bird-scaring devices aimed away from neighbors.... Locate devices as far from neighbors as possible.... Erect a noise barrier to keep noise from neighbors.” (p.3).

NON-EFFICACY OF MECHANICAL BIRTH CONTROL DEVICES FOR WHITE-TAILED DEER
George H. Matschle. U.S. Fish and Wildlife Service, Wildlife Research Center, Denver, Colorado 80225

The study compares the effects of ABCD™ (a mechanical implant almost 100% effective on
dogs) and Silastic™ (a chemical tube implant) adapted for use on white-tailed deer. If effective, the use of mechanical devices would be preferable to chemical means in terms of device life expectancy and environmental and human safety. In the studies, both devices were found to be ineffective at delaying or preventing conception in the test deer. Control and test deer both averaged 1.8 fetuses per deer.

NOTES ON FIELD IMMOBILIZATION OF WHITE TAILED DEER WITH NICOTINE
Donald F. Behrend. State University College of Forestry, Newcomb, New York

In a field-capture situation in New York, a Cap-Chur gun, which delivers a nicotine alkaloid was used to immobilize deer. The gun was used on 37 white-tailed deer: only 26 were recovered; and of those, only 18 survived (8 were known to have died). The “Cap-Chur” live capture rate was therefore only 49% and killed at least 22% of target deer.

NUISANCE WILDLIFE: PROBLEMS AND SOLUTIONS
D. J. Decker. Department of Natural Resources, Cornell University, Ithaca, NY

The paper argues that conflicts between wildlife and people are largely a result of land use and wildlife management practices. Examples in the forestry and agriculture industry are given. The author estimates that deer cause millions of dollars in agricultural damage in New York each year.

OBSERVATIONS OF COYOTE PREDATION ON MULE DEER FAWNS IN ARIZONA
Joe C Truett. LGL Ecological Research Associates, Box 1745, Grand Junction, CO 81501.

The paper describes 3 instances of coyote predation on mule deer fawns. The paper concludes that coyote predation is directed at mule deer fawns rather than adult deer.

OPTIONS AVAILABLE TO KEEP DEER, BIRDS FROM A BLUEBERRY MEAL
Dr. Glenn Dudderar. Department of Fisheries and Wildlife, Michigan State University

The article summarizes a speech on animal control options by Dr. Glenn Dudderar to a group of Michigan blueberry growers. Permanent fencing is described as the “primary deer control option” but costs of US $4-$6 per foot eliminates this option for many growers. He then recommends a variety of temporary fencing options. Electric fences must have at least 4000 volts to be effective, according to the article. Dudderar is quoted as saying, “Whatever you
do, don’t cut costs on the charger” (p.32). He also cautions that spacing electric fence lines too close means that the deer will see a solid fence and jump over it. He recommends the method of using aluminum foil flags coated with peanut butter described by William F. Porter (a baited electric fence for controlling deer damage to orchard seedlings, Wildlife Society Bulletin. 14:325-327, 1983). About “invisible fencing” Dr. Dudderar “doesn’t believe it’s necessary to bury the wire if you can train the dogs not to cross it” (p.32).

OVERHANGING DEER FENCES
Milton B. Jones and William M. Longhurst. University of California, Hopland Field Station, Hopland, California

The use of 3 types of sloping and overhanging fences are described in this paper. The cheapest fence constructed was made of a 6 foot role of chicken wire staked to the ground and then rising at a 49° angle to four and a half foot posts. The area was baited with apples, pears and mistletoe and after a 3 month period all the bait outside the fence, and that which was attached to the fence, was eaten, but none of the bait inside the fenced enclosure was eaten. The enclosure was 75 feet square. The fence is a one way only fence, if the fence slopes towards the field it will be trampled. The paper includes diagrams.

A PRACTICAL FENCE TO REDUCE DEER DAMAGE
William L. Palmer, Jack M. Payne, Robert G. Wingard and John L. George. School of Forest Resources, The Pennsylvania State university, University park, PA 16802

The 2.4 m woven wire fence is deer proof but expensive. The paper examined 5 alternative fence designs. They were the Penn State vertical electric deer fence, a slanting high tensile deer fence, a modified New Hampshire electric deer fence, a modified stock fence and a slanting or overhanging fence (diagrams and specifications for each fence are included). All fences but the Penn State fence were penetrated by deer at least once in semi-lab tests. The Penn State fence was also effective in 10 field tests and 1 year cost:benefit ratios were determined. Costs included materials but not labor or maintenance, although “maintenance costs tended to be minimal” (p.242). Benefits included increased crop yields in the following growing season but not any benefits in terms of future productive capacity.

Cost:benefit ratios were 1:1 for alfalfa, 1:1 for corn, 1:6 for fruit trees, 1:6 for vegetables and 1:10 for several research crops. The key components and design of the Penn State fence are “high tensile, smooth steel wire (200 000 psi, 12 ½ gauge); special accessories to maintain 114 kg wire tension [indicator spring, in-line wire strainer, crimping sleeves, tube insulator and wrap around insulator]; and high voltage low impedance energizers”(p.243). The first wire was positioned 25.4 cm above the ground with the following 4 wires spaced 30.5 cm
apart (1.5 m). The authors caution that, "Field experience and observations of woven-wire fences have indicated that deer will normally jump over these obstacles to enter a field crop. The experimental vertical fence, therefore, should never be located directly adjacent to old woven-wire fences, woody fencerows or brushy cover. Field observations indicate that a 2-3 m open strip should be left outside the perimeter of fences" (p.242).

PRELIMINARY SCREENING OF WHITE-TAILED DEER REPELLENTS
Mark T. Harris, William L. Palmer and John L. George. School of Forest Resources, The Pennsylvania State University, University Park, PA 16802

This study compares the effectiveness of 14 commonly used deer repellents on 9 deer of mixed ages and sexes in pen conditions. The study lists active ingredient and application process for home remedies as well as registered (EPA) deer repellants. The deer were deprived of food for 2 hours each day before testing and were then made to choose between treated materials as in food preference studies. Each repellent was tested 360 times against other repellents or controls.

While all 14 repellents had some effect, five repellents, (moth balls, creosote, human hair, magic circle and bloodmeal)\(^1\) were found to be the least effective. The other repellents (meat meal, BGR, feather meal, Hinder, hot sauce, Chew-not, Chaperone, Gustafson 42-S and Spotrete-F)\(^2\) were found to be significantly more effective.

Note: Chew-not, Chaperone, Gustafson 42-S and Spotrete-F all have the same active ingredient (Thiram) although with different concentrations (2-10%).

\(^1\)Listed in order of least effective.
\(^2\)Listed in order of most effective.

PREPARATION AND EVALUATION OF A SYNTHETIC FERMENTED EGG COYOTE ATTRACTANT AND DEER REPELLENT

The 72 chemical composition of a synthetic formulation suitable as a replacement for fermented egg product used for attracting coyotes and repelling deer is given with ingredients expressed by percent weight. The authors write, "Behavioral tests showed that activity of the synthetic product duplicated the natural product in repelling deer and attracting coyotes. The formulation shows considerable promise as a safe means of controlling deer damage to forest and agricultural crops and as a tool for estimating coyote populations" (p.160).
PRIVATE LAND HUNTING RESTRICTION AND GAME DAMAGE COMPLAINTS IN MONTANA
Raymond J. Adkins and Lynn R. Irby. Department of Biology, Montana State University, Bozeman, MT 59717

The paper reports that 66% of complaints filed with the Montana Department of Fish Wildlife and Parks involved situations where the land or adjoining land was posted no hunting. The authors find that “areas with restricted hunter access are more likely to have game damage problems than areas with greater hunting opportunities” (p.521).

QUEBEC PRODUCERS WATCH DEER TAKE A BITE OUT OF THEIR CROP: ORCHARD OWNERS ARE TRYING DIFFERENT METHODS TO DETER DEER THAT THREATEN TO RUIN SOME OPERATIONS
Susanne J. Brown. Quebec Farmers Advocate

The author interviews David Bird (Department of Natural Resources, Macdonald Campus, McGill University) who has just completed a publication entitled “Prevention and Control of Wildlife Damage”. The paper suggests that an 8 foot fence made with two 4-foot widths of hog wire attached to 12 foot posts or a shorter fence built at a 45° angle are the best options. David Bird says that gas exploders, human hair, bone tar oil, mothballs, thiram, large cat feces and encouraging hunting on the property may also be of some value, but that live rapping is described as expensive, time consuming and often unsuccessful.

RATE OF INCREASE OF WHITE TAILED DEER ON THE GEORGE RESERVE: A RE-EVALUATION
Victor Van Ballenberghe. USDA Forest Service, Institute of Northern Forestry, 308 Tanana Drive, Fairbanks, AK 99701

The paper exposes methodological and conceptual errors in a paper by D. R. McCullough, “Population growth rate of the George Reserve deer herd”. J. Wildlife Manage. 46:1079-1083, 1982. The paper compares an observed exponential growth rate (r) of white-tailed deer in southern Michigan between 1928-1935 and 1975-1981. The author writes, “I identify these problems in a constructive spirit because the estimates of r in this paper will be cited widely, because the data set from the George Reserve is unique and important to cervid population biologists, and because the issue of whether or not a deer population can achieve an r close to r_m (intrinsic rate of increase) after being reduced from high density has important management implications” (p.1245). The criticisms are of statistical interpretations and logarithmic calculations.
RATE OF INCREASE OF WHITE TAILED DEER ON THE GEORGE RESERVE: A RESPONSE
Dale R. McCullough. Department of Forestry and Resource Management, University of California, Berkeley, CA 94720

The author acknowledges his error and recalculates the growth rates of white-tailed deer in the George Reserve. The author maintains that the conclusions of the original paper are not affected by the slight change in “r” value and that the growth rate of a decimated deer population will be similar to the rate of an introduced population.

RED FOX FEEDING HABITS IN RELATION TO FAWN MORTALITY
John J. Ozoga, Craig S. Bienz and Louis J. Verme. Michigan Department of Natural Resources, Shingleton, MI 49884

Red fox (Vulpes vulpes) is reported to prey on white-tailed deer fawns, based on scat samples with fawn remains. Foxes are also scavengers. The study examined the diet of foxes in Michigan’s Upper Peninsula. Snowshoe hare were a dominant food during early may, insects were dominant from mid-may to June and fruit was dominant during July and August. Meadow voles and deer mice were well represented in scat counts throughout the year and may be considered a staple in fox diets. The report finds that fox do not prey in any significant way on deer fawns; rather, they feed on fawn carcases. The presence of fawn remains in scat may therefore be an index of overall fawning loss but not predation.

REDUCING DEER DAMAGE
Cornell University Resource Center, 8BOT, Ithaca, NY 14850. Fax: 607 255 9946
Blain P. Friedlander Jr.

This pamphlet is available for US$3.50 from Cornell. It describes deer biology and feeding and gives recommendations for practical fences and proper fencing techniques.

REDUCING DEER DAMAGE TO YEW'S AND APPLE TREES: TESTING BIG GAME REPELLENT™, RO'PEL™, AND SOAP AS REPELLENTS
Robert K. Swihart and Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

Big Game Repellent™ (BGR), which smells like rotten eggs, repels deer by smell alone and was estimated to cost US$444 per ha. BGR was found to be the most effective of the three
repellants, reducing damage by 76%. Soap reduced damage by 37.6% but Ro Pel™ did not reduce deer damage. Manufacturers of Ro Pel™ claim the bitter tasting product (containing 0.065% benzylidethyl [2,6 xylyl carbamoyl] methyl ammonium saccharide, 0.025% thymol and solvents) is absorbed into plant tissues, increasing product durability and efficiency. This is yet to be demonstrated in field trials.

Different soap types were tested against each other and empty soap wrappers for repellency. Radius of repellency of soap was measured as well. While differences between soap brands occurred, these were statistically insignificant. Repellency of soap occurs to a maximum of 9m. Damage 9-11m away from soap was the same as at control sites. Within one meter of a bar of soap, however, browsing was reduced by 70% relative to control sites. At one meter soap wrappers alone were found to reduce deer damage which suggests that soap is a visual as well as smell repellent. At greater than 1m soap was not found to reduce deer browsing. The authors estimate that it would take 25 person-hours to treat 1 ha of trees with 3000 soap bars spaced 1m apart. They estimate the cost of 3000 soap bars to be US$1 170 for 99g bars or $300 for 14g bars. The authors conclude that soap is a competitive alternative to BGR.

REDUCING ODOR AND NOISE CONFLICTS BETWEEN RURAL NEIGHBORS
Hugh F. Frazer. P. Eng. Resources Management Branch

The fact sheet discusses changing rural demographics and identifies wildlife scaring devices as one reason for increasing conflicts between farmers and rural neighbors. Ways to reduce the annoyance factor associated with scaring devices are suggested. These include building noise deflectors, moving scaring devices to different parts of fields, using bird scarers only during the day and increasing communication with neighbors.

RED-WINGED BLACKBIRD FLOCK BEHAVIOR IN RESPONSE TO REPELLENT STRESS
Proceedings of the Seventh Bird Control Seminar, Bowling Green State University, Bowling Green, Ohio, 9-11 Nov 1976, p.204-213.
M. I. Dyer. Natural Resource Ecology Laboratory and Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado

The author is primarily concerned with the use of 4-AP as a bird repellent; however, his conclusions are relevant to other species such as white-tailed deer.

After reviewing the literature, Dyer found many questions related to effectiveness of repellents are unanswered or have inconclusive or negative answers. Literature indicates that feedbacks in an agricultural ecosystem will ensure that repellents will work well when there is little depredation and work poorly when the depredation problems are greatest. He concludes, “I
feel the scientific community ought to reconsider the use of repellents” (p.208).

REFLECTING TAPES REPEL BLACKBIRDS FROM MILLET, SUNFLOWERS, AND SWEET CORN
Richard A. Dolbeer and Paul P Woronecki. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870.

The study evaluates the performance and cost of Bird Scaring Reflective Tape™ at different spacing intervals (3, 5 and 7 meters) in millet, sunflowers and sweet corn. The tapes are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other. The tapes were suspended 1.5 meters above the ground on poles and can make a roaring sound under certain wind conditions.

Mammal damage evaluated includes that done by white-tailed deer (Odocoileus virginianus) and racoon (Procyon lotor). The report finds, “no differences (P > 0.10) among the 3 treatments in damage caused by mammals at 25 or 35 days after silking” (p.421) and, “noted no deterrent affect on deer which fed primarily at night when the flashing phenomena was minimal” (p.424).

RELATIONSHIPS AMONG MULE DEER FAWN MORTALITY, COYOTES, AND ALTERNATE PREY SPECIES DURING SUMMER
Kenneth L. Hamlin and Duane Pyrah. Montana Department Fish, Wildlife And Parks, 716 Dixon St., Lewistown, MT 59457
Shawn J. Riley. Montana Department Fish, Wildlife And Parks, Kalispell, MT 59901
Arnold R. Dood. Montana Department Fish, Wildlife And Parks, Glendive, MT 59930
Richard J. Mackie. Montana State University, Bozeman, MT 59717

Mule deer fawn mortality is correlated with coyote population levels and alternate prey population levels. At least 90% of summer fawn mortality is considered to be a result of coyote predation. The mortality of fawns is lowest when populations of rodents is highest.

RELATIONSHIP BETWEEN SNOW DEPTH AND GRAY WOLF PREDATION ON WHITE-TAILED DEER
A total of 203 yearling and adult white-tailed deer in northeastern Minnesota were monitored over 10 winters for a total of 23,441 deer days, an average of 115 days each. Gray wolves are found to be the primary cause of mortality, responsible for an average of 0-29% of mortality in different winters. Analysis of variance finds 51% of the variation in mortality to be related to snow depth. Wolf predation rates are influenced by severity of winter temperatures, but snow depth has an even greater influence on hunting success.

RELATIONSHIPS BETWEEN CHARACTERISTICS OF NURSERIES AND DEER BROWSING
Michael R. Conover, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504.

Deer damage is unevenly distributed. Reasons for this are unclear, although field size, distribution of other fields and proximity to natural cover are believed to be important. A correlation between deer densities and damage has not been firmly established. The author compares amount of deer browsing at 12 commercial nurseries with independent variables of those sites in an attempt to predict browsing patterns and therefore vulnerability of certain fields to browsing by deer. The independent variables studied include: percentage of yew shoots browsed, distance to house, distance to road, nursery-woodlot perimeter, adjacent woodlots, woodlots within 2 km, percentage yew browsed in adjacent woodlots, percentage yew browsed in woodlots within 2 km, deer pellet density, deer pellet numbers, birch-cherry index and the percent of all species browsed on adjacent woodlots.

Browsing levels are not found to be correlated with any of the characteristics of the nursery itself. The only correlations are between number of deer pellet groups in adjacent woodlots and the proportion of browse in the adjacent woodlots that had been eaten.

REMOVAL TECHNIQUES TO CONTROL AN ENCLOSED DEER HERD
Donald T. Palmer. U.S. Fish and Wildlife Service, Jacksonville, FL 32202
Douglas A Andrews. U.S. Fish and Wildlife Service, Columbus, OH 43215
John W. Francis. U.S. Fish and Wildlife Service, McGregor, MN 55760

The paper examines the efficiency of several management techniques for population reduction of a herd of deer within a 2,176 ha enclosure. Efficiency was measured in person-hours per deer and the authors conclude that, "Public deer hunts were the most efficient method of deer removal at 1.8 man-hours per deer, followed by box traps at 2.8 man-hours per deer, population reduction collections at 3.0 man-hours per deer, immobilization darts at 4.1 man-hours per deer, rocket nets at 6.9 man-hours per deer and scientific collections at 8.5 man-
hours per deer” (p.29). Each approach is described and reasons for differences in efficiency are offered.

RESPONSES OF PEST BIRDS TO REFLECTING TAPE IN AGRICULTURE
J.E. Brooks. U.S. Fish and Wildlife Service, Denver Wildlife Research Center, c/o Vertebrate Pest Control Laboratory, Dhaka, Bangladesh
R.K. Pandit. Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh
T. Tarimo. National Bird Control Unit, Arusha, Tanzania
All-India Co-Ordinated Research Project on Economic Ornithology, Andrah Pradesh Agricultural University, Rajendranagar, Hyderabad-500 030, India
H. Hoque. National Crop Protection Center, Los Banos, Phillipines

Bird Scaring Reflecting Tape™ is an elastic, transparent strip, (0.025 mm thick, 11 mm wide and sold in 82- or 100-m rolls) coated with a colored resin. The color used in the trials was red although other colors are available. “The tape reflects sunlight to produce a flashing effect and, when stretched, it pulsates and produces a loud, humming, or sometimes thunder-like noise in the wind” (p.161).

Subjective accounts suggest that this tape may have a repellent effect on white-tailed deer (Odocoileus virginianus). During morning bird counts in a corn plot, 3-8 deer were observed on each of 6 mornings before installing the reflecting tape. On the following 6 days, no deer were observed.

In 1986, tape could be purchased from distributors in Japan for US$0.36/82 m roll, (Maruzen Trading Co Ltd) or US$0.75/100 m roll (Nishizawa Ltd), shipping not included. The cost of tape (at $0.36/82 m) for use at 10-m intervals over 1 ha would be $4.68.

REVIEW OF A PROGRAM TO ALLEVIATE LOCALIZED DEER DAMAGE
David W. Erickson and Norbert F. Giessman. Wildlife Administration Section, Missouri Department of Conservation, Jefferson City, MO 65102

The authors state that, “Although various control techniques are available (e.g., scare devices, fences, chemical repellants, lure crops, translocation, out of season shooting), these are often marginally effective, costly, or require a significant labor investment” (p.544). This paper discusses the deer-crop damage permit (CDP) implemented by the Missouri Department of
Conservation (MDC). The system was intended to decrease deer populations in problem areas with precision that the state hunting regulations could not achieve through the use of special permits for use on properties where damage had been documented by MDC staff.

Permits were given for the following crops, in order of frequency: soybeans, corn, alfalfa, milo, red clover, wheat, apple/peach orchards, vineyards, various produce crops, and specialty trees. The program ran for 10 years; deer damage complaints and requests for permits rose 1257% in the last 4 years of the program, with deer increasing from 4.9% to 53% of total complaints from 1982 to 1985 overwhelming the 4 staff. The majority of complaints and requests came during August-October; and the administrative requirements for site inspections, reporting requirements, special instructions, etc, created delays and frustration. The program was quite controversial; hunters on nearby properties complained and some farmers complained of favoritism. During the last 5 years of the program, less than 20% of growers believed the program was successful at reducing damage on their property. The program was discontinued when, "Based on field investigations, post season cooperator (land owner) reports, and opinions of staff, [the] MDC concluded in 1984 that the CDP program was neither effectively solving damage problems nor satisfying concerns of agriculturalists" (p.547).

The new approach to dealing with wildlife management was to increase “any-deer” permits 40 and 96% in 1984 and 1985 respectively and develop a “comprehensive white-tailed deer management plan”. The number of deer management units was increased from 23 to 57 to more effectively deal with localized deer populations. These divisions were based on forest habitat studies, harvest statistics, deer population trends, crop damage, and regional demands for recreational hunting. In addition, out of season hunting on farms with significant crop losses was authorized more frequently.

RODENT AND DEER CONTROL IN ORCHARDS
Kevin W. Ker and Ken Wilson. Plant Industries Branch

Deer fencing is described as the most expensive way to exclude deer from an area, but the alternative, repellents, are described as being of variable value at best.

SASKATOON SERVICEBERRY TOXIC TO DEER
Dee A. Quinton. Agriculture Canada Service Station, Kamloops, British Columbia V2B 8A9

Consumption of Saskatoon serviceberry leads to labored breathing, muscle tremors and spasms and death in mule deer.
SEASONAL FOOD SELECTION AND DIGESTIBILITY BY TAME WHITE TAILED DEER IN CENTRAL MAIN
Hewlette S. Crawford. USDA Forest Service, Northeastern Forest Experiment Station, University of Maine, Orono, ME 04469

Seasonal variability of food selection and digestibility by tame white-tailed deer were studied in white pine-Canada hemlock and lowland conifer ecosystems. Deer foods consumed in late spring, summer and early fall were highly digestible (forbs, growing points on hardwood plants in late spring and summer, mushrooms and hardwood leaves in the fall); foods consumed in the winter and early spring were found to be less digestible (green and dry conifer and deciduous leaves on the snow surface in the winter, and early grasses and dry red maple leaves when the snow retreats in the early spring).

SCREENING OF ODOR AND TASTE REPELLENTS FOR CONTROL OF WHITE TAILED DEER BROWSE TO APPLES OR APPLE SHOOTS
R. E. Byers, D. H. Carbaugh and C. N. Presley

Big Game Repellent (putrescent whole egg solids), Hot Sauce Animal Repellent, Lifeboy bars soap, Lifeboy soap chips without perfume, Lifeboy perfume, Hinder Deer and Rabbit Repellent, Thiram 65WP, Off-Shoot T, bubble gum flavor, baby powder fragrance, Diallyl sulfide, piperine, broccoli extract, Pine Sol, tree paint, ICI L-22, dried cabbage, cedar leaf oil, Vapor Gard and Deer Blood were assessed in areas of high deer populations and browsing pressure. The three Lifeboy soap products, Hot Sauce Animal Repellent and Big Game Repellent were most successful, deterring deer for 1-3 days, but by day 6 all browse was significantly damaged. The other products were less effective and browse showed up to 100% damage within the first day or two.

SOME PREDATOR-PREY RELATIONSHIPS IN BIRD DAMAGE AND POPULATION CONTROL

Although the article is primarily concerned with bird control, the same considerations should be given to managing populations of white-tailed deer. The paper focuses on factors affecting the effectiveness of artificial population control programs. First, it is necessary to understand factors related to natural reproduction and mortality rates before a control strategy is implemented. It is also necessary to examine how the strategy may disrupt sex, age or flock
[herd] structure. In some situations control measures have led to increased winter survivorship and more effective breeding the following spring. This would have been predicted had the natural factors limiting the population been examined.

**STRAWBERRY GROWER HAS “DEER” PROBLEMS**

Joan Le Blanc

The article describes strawberry grower Bruce Coats’ experience with deer on his farm in New Brunswick. He has seen up to 60 deer at a time in a 3 ½ acre strawberry field. Although the article does not describe properties of devices or exactly how Coats used certain devices, the following experience was documented. A propane gun worked for only a few days, 4-strand electric fence coated in peanut butter was ineffective (deer leapt over and threw the fence); the fence voltage and wire spacing was not given. Human hair was ineffective, wildcat scat from a local zoo was effective for several days “until they [the deer] discovered there was no cat”. Coats plans to build an 8-10 foot fence.

**SUMMER FORAGE USE BY TAME DEER IN NORTHERN MICHIGAN**

Fred A. Stormer and William A. Bauer. Department of Forestry, Michigan Technological University, Houghton, MI 49931

The importance of Trembling (*Populus tremuloides*) and Big-toothed (*P. Grandidentata*) aspen cover for white-tailed deer populations in northern lake states was studied. Food habits, food preferences and habitat use of a mature-aspen and aspen-clear-cut edge were studied. Aspen, Beaked Hazel (*Corylus cornuta*), strawberry (*Fragaria virginiana*), willow (*Salix spp.*), choke cherry (*Prunus virginiana*) leaves and aster (*Aster spp.*) leaves and flowers averaged 66-80% of monthly forage. Other preferred foods included red maple (*Acer rubrum*) and the fruit of brambles (*Rubus spp.*).

**USE OF DOGS TO REDUCE DAMAGE BY DEER TO A WHITE PINE PLANTATION**

Jeff Beringer and Lonnie P. Hansen. Missouri Department of Conservation, 1110 South College Avenue, Columbia, MO 65201
Rosemary A. Heinen and Norbert F Giesman. Missouri Department of Conservation, 1907 Hillcrest, Columbia, MO 65201

The paper begins by describing limitations and inefficiencies of hunting, repellents and fencing for reducing deer damage to crops and forest lands. The effectiveness of electronically contained dogs in protecting white pine plantations from browsing by deer was compared to
Hinder repellent and to no control. "Browse rates in plots protected by dogs, Hinder and no protection averaged 13, 37 and 56% respectively, over the three year study. In other words Hinder was 34% effective and the dogs were 76% effective at reducing damage from deer. Mean weights of browsed seedlings were heaviest in plots protected by dogs during 2-3 years, suggesting browsing severity was lower in these plots" (p.631).

The authors recommend using a herding breed of dog (Australian Shepard, blue heeler or border collie). They suggest that a long haired dog will be more active and effective in the winter. They recommend spaying, neutering and keeping two dogs in each plot to "decrease attempts to leave in search of social interaction" (p.631). The authors also recommend "a mowed buffer strip of 10m between the fence and the crop being protected. Dogs tend to make a trail and scent mark the outside perimeter, and this buffer helps their ability to patrol" (p.631).

Benefits include fence mobility, ease of installation and usefulness in rough topography. Also, the electronic fence does not need to be buried, although this reduces the likelihood of damage. The fence can be attached to existing fences, or laid on the ground.

VOLATILE COMPONENTS OF FERMENTED EGG, AN ANIMAL ATTRACTANT AND REPELLENT

In field tests, the smell of fermented egg product (FEP) has been found to be a repellent for deer and an attractant for coyotes and therefore potentially useful for agricultural purposes. The paper discusses key volatile components and relative concentrations necessary to create a synthetic chemical with the same smell characteristics as the real thing. 76 chemicals are listed, 54 are listed with concentration values ranging from 33 to 0.06%.

WESTERN CANADIAN DEER PROBLEM NOT AS SERIOUS
Dan Wilkes

The author discusses differences between agriculture and deer conflicts in western and eastern Canada with Graeme Skinner of Margo Supplies, a wildlife control company located in Calgary. The lack of active wolf packs is identified as the major factor contributing to large congregations of deer. Where there is predation pressure, herds only rarely number 20, according to Skinner.
Suggestions for deer control include using 8-12 foot minimum deer fences and applying deer repellents to grassy borders surrounding crops which can not be sprayed.

WILDLIFE DAMAGE TO CROPS: PERCEPTIONS OF AGRICULTURAL AND WILDLIFE PROFESSIONALS IN 1957 AND 1987
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504
Daniel J Decker. Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

The authors surveyed opinions of agricultural and wildlife professionals throughout America to identify the relative seriousness of major crop-wildlife conflicts and determine if there was a difference in perceptions between professionals. 95% of state game agencies, 74% of state agricultural agencies, 97% of Animal Damage Control agents, 100% of Wildlife Extension Specialists and 86% of Farm Bureaus returned usable questionnaires. Full lists of crops and animals for each institution are presented in tables and summarized. Deer were identified as causing the most conflicts nationally.

Changes in wildlife-human interactions have been quite dramatic in some cases. "For instance in 1957, 16 states reported that deer were either no problem or only caused localized problems, while in our survey, 15 of these same states stated that deer were now causing more damage to crops than any other wildlife species" (p.51). Overall, all organizations agreed that wildlife and agriculture conflicts were serious and increasing, but the relative importance of any specific species varied considerably across the United States.

WHITE-TAILED DEER HABITAT AND COTTAGE DEVELOPMENT IN CENTRAL ONTARIO
Edward Armstrong, David Euler and Gerald Racey. Ontario Ministry of Natural Resources, Wildlife Branch, Queens Park, Toronto, Ontario M7A 1W3

The authors use characteristics of white-tailed deer bed-sites at Lake Muskoka in the Regional Municipality of Muskoka and Percy-Haliburton Lakes in Haliburton County to develop a model of deer habitat quality. Habitat characteristics were separated by function, canopy closure, coniferous and deciduous browse units, vegetation volume and number of dead branches. The paper documents the importance of diversity of habitat structures for white-tailed deer in the winter. Shoreline cottage development and associated ecosystem modifications in the study areas fragmented coniferous areas reducing their value as travel lanes and night bedding sites. "Cottage development in areas used by deer reduced the quality of winter habitat" (p.605).
WILLINGNESS OF NEW YORK FARMERS TO INCUR WHITE-TAILED DEER DAMAGE
Tommy L. Brown, Daniel J. Deckler and Chad P. Dawson. Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853

This is a sociological study which gives recommendations to deer managers on how to interpret complaints of deer damage and set ranges for white-tail deer populations. It found that agricultural producers in New York value deer for hunting and aesthetic reasons and are willing to sustain several hundred U.S. dollars damage to maintain local deer populations.

WINTER BED-SITE SELECTION BY WHITE-TAILED DEER IN CENTRAL ONTARIO
Edward Armstrong, David Euler and Gerald Racey. Ontario Ministry of Natural Resources, Wildlife Branch, Queens Park, Toronto, Ontario M7A 1W3

The paper describes the characteristics and principal components of day and night bedding sites of white-tailed deer winter bed-sites in central Ontario. Specifically, it describes the characteristics of bed-sites at Lake Muskoka in the Regional Municipality of Muskoka and Percy-Haliburton Lakes in Haliburton County. The authors demonstrate specific habitat selection to reduce energy expenditure by white-tailed deer during late winter.

WINTER USE OF RIPARIAN HABITAT BY WHITE-TAILED DEER: SITE SELECTION OR COINCIDENCE
P. Larue, L. Belanger and J. Hout. Ministry of Environment, et Faune 150 boul, Rene-Levesque Est, Quebec G1R 4Y1
Article in french.

The article reports on a survey of habitat features important to white-tailed deer winter yards and finds that proximity to a riparian zone is of most importance for yard selection. Riparian stands of balsam fir and white cedar are found to be used twice as often as non-riparian stands with similar tree and gradient characteristics. The paper concludes that riparian fir and cedar stands are essential habitats for deer.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Muskurat

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed: Fall 1996
Muskrat (*Ondatra zibethica*)

**Results of the Grower Needs Assessment**

The Muskrat (*Ondatra zibethica*) was identified as having few conflicts with agriculture in the Bay of Quinte watershed. The muskrat was identified as causing erosion in drainage ditches and options to control erosion without disturbing muskrat were of interest.

**Species Biology and Life History**

The Muridae Family consists of small and medium sized rodents including rats, mice, lemmings and voles. It is the largest mammal family, with over 1300 living species (Kurta 1995). This family first appeared in the fossil record 35 million years ago and inhabit all continents except Antarctica (Kurta 1995). Until recently Muskrats were included in the Cricetidae or “new world” family, but current academic work groups “new” and “old world” species together in family Muridae (Kurta 1995).

There are very few generalizations which can be made about this diverse family. Most have a small body 50 -250 mm (2-10 in) and a tail length of 10-200 mm (1-8 in) (Burt and Grossenheider 1980). Most of these animals are nocturnal, primarily herbivorous, active year round and are terrestrial, but there are many exceptions (Kurta 1995). All members of this family have 16 teeth; 4 gnawing and 12 chewing (Burt and Grossenheider 1980).

The Muskrat *Ondatra zibethica* does not conform to most family characteristics. Instead, the muskrat has the following characteristics:

Total length: 470-630 mm (18-25 in); tail length: 200-270 mm (8-11 in) weight: 900-1800g (2-4 lb) (Kurta 1995, Burt and Grossenheider 1980). The muskrat has glossy dark brown waterproof fur and a long, black, latterly compressed, scaled tail which is unlike the tail of any other mammal (Carpentier 1987, Burt and Grossenheider 1980). Unlike most other rodents, the muskrat is active throughout the day (Kurta 1995). Other characteristics of the muskrat include webbed hind feet, 6 mammae and a maximum lifetime in the wild of 3-4 years (Kurta 1995, Burt and Grossenheider 1980).

**RANGE**

Muskrats are found almost everywhere in Canada and throughout the Bay of Quinte watershed (Kurta 1995).

**HOME RANGE**

The home range of a muskrat is determined primarily by the abundance of food. The muskrat will
usually be found foraging, playing or sunning itself within 15 meters of its home and is rarely more than 150m away (Kurta 1995, Seton 1909a). In September, muskrats may be seen migrating overland in search of suitable new habitat (Seton 1909a).

ENVIRONMENT/HABITAT
A muskrat's preferred habitat is cattail marshes, but any standing or slow moving water such as streams, edges of ponds or lakes and even ditches can be suitable (Carpentier 1987, Burt and Grossenheider 1980). Water around muskrat homes is typically 1.5-2 m (4-6 ft) deep and is capable of supporting a large number of aquatic plants without freezing to the bottom in the winter (Kurta 1995).

Muskrats build various structures including a den, various feeding platforms, canals and tunnels (Carpentier 1987). Muskrats often build summer dens in river banks at different elevations with entrances below the waterline (Seton 1909a). If water levels drop, the animal will cover or plug the old den with sticks and move to the new den. Muskrats winter in homes built from mud and aquatic plants such as cattail, bur-reed and bulrush (Kurta 1995). These homes have an underwater exit to allow the animal to leave and feed throughout the winter. The muskrat then builds canals through the marsh vegetation and in the early winter pushes aquatic vegetation through the forming ice (Kurta 1995). This creates a breathing and resting spot used by the muskrat when foraging in the winter (Kurta 1995).

COMMUNICATION
Muskrats are a social animal and sometimes work together to build their den and lodges (Carpentier 1987). Family groups live together in the same area and defend their territory against other muskrat colonies (Carpentier 1987).

REPRODUCTION
The Muskrat produces 1-3 litters a year with 1-11 (usually 5-6) young in each litter (Carpentier 1987, Burt and Grossenheider 1980). Within the Bay of Quinte watershed, muskrats usually raise only 2 litters a year, the first as early as mid May (Carpentier 1987). The muskrat is born naked and with eyes closed, but has fur at five days and opens its eyes at 15 days (Carpentier 1987). At 15 days the muskrat can swim on its own and is weaned between 21-28 days (Kurta 1995, Carpentier 1987).

Muskrats are monogamous but the male does not take any part in raising the young (Kurta 1995). The young are sexually mature at 6 months but do not reproduce until the following year (Carpentier 1987).

MOVEMENT
The muskrat can move “freely and well” on land but is found most often in water (Carpentier 1987:62). Seton reports that a muskrat can swim 5 km/h underwater and move over 100m without air but will typically move slower than this (1909a).
FOOD
Muskrats are primarily herbivores subsisting on reed and lily stalks and roots (Seton 1909a). Muskrats do, however, eat some animals including fish, crayfish, fresh water muscles, frogs, turtles, insects, and even young birds (Kurta 1995, Seton 1909a). Muskrats sometimes line their dens with edible plants and have been known to eat their lodges in late winter (Seton 1909a).

PREDATORS/LIMITING FACTORS
The main factors influencing muskrat populations are weather, available habitat and human activities. A combination of a dry fall and harsh winter is devastating and entire muskrat populations over very large areas can starve (Seton 1909a). The destruction of suitable habitat, especially in urban areas continues to limit populations of many wild species, including muskrats. Millions of muskrats are trapped each year or are killed on highways during the fall (Kurta 1995).

The muskrat has many predators, the most important of which are racoon and mink (Kurta 1995). Other predators include lynx, great horned owl, red fox, eagles, hawks, snapping turtles and weasels (Kurta 1995, Carpentier 1987, Seton 1909a). Cameron reports that disease and parasites also limit population sizes (1964).
Results of Literature Survey

There is very little information available about non-lethal options for reducing conflicts between muskrats and land owners. The only information related to trapping and live capture techniques.

Summary of Selected References

AN EFFICIENT LIVE CAPTURE TECHNIQUE FOR MUSKRATS
Thomas R. McCabe. Wildlife and Fisheries Sciences Department, Utah State University, Logan, UT 84322.
Glenn Elison. Fish Springs National Wildlife Refuge, Dugway, UT 84022.

The report describes a technique for live capture of muskrats after failure of conventional bait scent and trail sets. 2000 trap-nights in good muskrat habitat resulted in only 17 captures using Tomahawk #202 and 203 live traps. The new method requires 3 people a boat, spotlights, nets and holding cages and will result in up to 10-12 muskrats per hour.

AN EVALUATION OF TRAP TYPES FOR HARVESTING MUSKRATS IN NEW BRUNSWICK
G.R.Parker. Canadian Wildlife Service, Environment Canada, Sackville, New Brunswick E0A 3C0

This study examines seasonal productivity and humaneness of several leg hold and kill traps used on muskrats in New Brunswick. The study found that efficiency of trap types was season dependent. It also evaluates trap types for likelihood to trap nontarget species.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Porcupine

Prepared By: Rob Mound.
Completed: Fall 1996
Porcupine (*Erethizon Dorsatum*)

**Results of the Grower Needs Assessment**

The porcupine (*Erethizon Dorsatum*) was described as having minor conflicts with corn production. The primary method of control was to shoot the animal.

**Species Biology and Life History**

The Erethizontidae family first appeared in the fossil record in South America during the Oligocene epoch 30 million years ago (Kurta 1995, Burt and Grossenheider 1980). Today only 12 living species exist, 11 of which still live in South and Central America (Kurta 1995). All of these rodents are slow moving but are covered with sharp spines, especially on their tail and rump, to deter predators (Kurta 1995, Burt and Grossenheider 1980).

All members of this family have special adaptations which allow them to spend most of their time in trees. Their feet are long and broad, with long curved claws and rough slip resistant soles (Kurta 1995). Most of the South American species also have a monkey like tail, capable of grasping (Kurta 1995).

In addition to these family characteristics, *Erethizon Dorsatum* has the following characteristics:

Total length: 600-900 mm (24-35 in); tail length: 160-220 mm (6.3-8.7 in); weight: 5-14 kg (11-31 lb) (Kurta 1995). The porcupine is a heavy set, short legged rodent with dark brown or black fur highlighted by approximately 30,000 silver-gray quills everywhere but the face (Kurta 1995, Carpentier 1987, Burt and Grossenheider 1980). Next to the beaver it is the largest rodent in the Bay of Quinte watershed (Kurta 1995).

The porcupine is active year round and more active at night than during the day (Carpentier 1987). It has five toes on its hind feet and four on its front, 4 mammae and 20 teeth, 10 above and 10 below (Kurta 1995, Carpentier 1987, Burt and Grossenheider 1980). The maximum life span of a wild porcupine is about 10 years (Kurta 1995).

**RANGE**

The porcupine is found throughout most of Canada and the western United States and is common in most of the Bay of Quinte watershed (Kurta 1995 Carpentier 1987). The porcupine was once common throughout the great lakes drainage basin but has been exterminated in southern Ontario and parts of the lake states (Kurta 1995). Within the Bay of Quinte watershed, the porcupine is less frequent in the southern agricultural portions (Carpentier 1987).
HOME RANGE
The home range of an individual is 12-14 ha (Carpentier 1987). Within this range, the porcupine makes its home in a hollow tree, log or cave (Kurta 1995). The porcupine uses the same den site throughout its life and most often forages very close to home (Kurta 1995). In the summer the porcupine spends less time in its den and is more likely to be seen during the day sleeping in a treetop (Kurta 1995).

ENVIRONMENT/HABITAT
Porcupines are most often found in forested areas, especially ones with pine and hemlock (Kurta 1995, Burt and Grossenheider 1980, Cameron 1964). The porcupine is occasionally seen away from the forest but always in brushy areas (Burt and Grossenheider 1980).

SENSES
The porcupine has a good sense of smell and hearing (Carpentier 1987).

COMMUNICATION
The porcupines make grunts, groans, and high pitched screams which may travel considerable distances (0.5km) (Burt and Grossenheider 1980). When fighting each other porcupines make “high-pitched cat like screams” (Kurta 1995:199).

During the mating season, porcupines perform a “comical dance whereby they roll, tumble, stand on their hind legs and cuff each other” (Carpentier 1987:75).

REPRODUCTION
Porcupines have 1 young (sometimes 2) per year which is born in April-May after a 7 month gestation period (Kurta 1995, Burt and Grossenheider 1980). The young are born with fur and eyes open (Burt and Grossenheider 1980). The quills become hard and effective within a few minutes and the new born can climb and eat solid food within a few hours but is not weaned until 2 weeks of age (Kurta 1995, Burt and Grossenheider 1980). The porcupine stays with its mother until 6 months and is sexually mature at 3 years of age (Kurta 1995, Burt and Grossenheider 1980).

MOVEMENT
The porcupine is rather slow on land, although it can run poorly for short distances (Carpentier 1987). It is, however, “an excellent swimmer and a superb climber” (Carpentier 1987:74).

FOOD
The porcupine is a herbivore which makes trails to its favored feeding sites. In the winter these trails may be located under the snow (Carpentier 1987). The most common summer food is new leaves on deciduous trees and shrubs, although porcupines are known to eat semi aquatic plants around streams and lakes (Carpentier 1987, Cameron 1964). Winter food consists primarily of conifer needles, buds and inner bark (Kurta 1995). Preferred trees include white pine, hemlock, sugar maple and birch, although basswood, aspen and elm are of importance in the summer.
In addition to these staples, the porcupine eats roots, flowers, fruits, seeds and nuts when they are available (Kurta 1995). Porcupines will gnaw animal bones or antlers as a source of calcium (Raycroft 1994, Carpentier 197). Porcupines are well known to be attracted to salt and are often found near roads which have been salted (Carpentier 1987). Porcupines have been known to gnaw at almost anything which contains salt including, “handles of shovels or axes used by a person who has been perspiring” (Cameron 1964:73).

PREDATORS/LIMITING FACTORS
The porcupine has very few predators. The fisher, bobcat and wolverine are the most successful predators, although the bear and great horned owl are also reasonably successful (Carpentier 1987, Seton 1909a). Most other predators either avoid porcupines or are unsuccessful and often die as a result of a failed attempt (Carpentier 1987).

People represent the most significant limiting factor to porcupine populations. Porcupines have a very low reproductive potential, reaching sexual maturity slowly and having only one young per year. The impact of hunting, land clearing and highway deaths are therefore much more important to porcupine populations. The porcupine has been exterminated where industrialization and agriculture have the biggest impacts on the landscape and no longer exists in some of its former range in the southern great lakes basin (Kurta 1995, Carpentier 1987).
Results of Literature Survey

There were relatively few references to crop protection options or wildlife management techniques which may be used to reduce conflicts between agriculture and porcupines in the Bay of Quinte watershed. Options identified included hunting, trapping, clubbing, poisoning, fencing, lure crops and encouraging natural predators. Food preferences were also identified.

Summary of Selected References

PORCUPINES
W. Robert Eadic. Cornell University

After briefly describing the animal and its habits, the author suggests a range of control techniques. Hunting in the winter in good weather is described as relatively easy. Trapping and clubbing are also mentioned. Poison has been used with some success but has impacts on non target species. Other natural and non-lethal approaches are also described: “Wire mesh fences may be modified to keep porcupines from agricultural areas by mounting a single, electrically charged wire a foot or more above the ground surface and two inches from the outer side of the fence, with proper insulation and supports” (p.194).

Natural controls include leaving preferred forage trees to buffer damage to other areas. Also, “The porcupine is not as immune to enemies as is commonly supposed. It is taken fairly frequently by the bobcat and fisher and lynx, fox, mountain lions, coyotes, wolves, bears and wolverines are known enemies” (p.195).

WINTER FOOD PREFERENCES OF PORCUPINES
Cheryl Tenneson and Lewis W. Oring. Department of Biology, University of North Dakota, Grand Forks, ND 58202

The article lists the frequency of porcupine damage to and sightings in various tree species. White pine appears to be the most preferred species of tree, and porcupine populations are related to pine abundance, although porcupines will use a variety of trees in the absence of white pine. Porcupines always prefer larger trees to smaller trees regardless of tree species.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Raccoon

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed Fall 1996
Results of Literature Survey

The information available suggests several options for reducing conflicts between raccoons and corn producers in the Bay of Quinte watershed. General conclusions can be drawn from available information about chemosterilization, conditioned food aversions, physical barriers, repellents, reproduction, scaring and trapping.

CHEMOSTERILIZATION

- It is possible to reduce raccoon reproduction with chemosterilants.
- Current baits are not selective and will reach many non-target organisms.
- All vertebrate reproductive systems (including human systems) are very similar. Chemosterilants therefore have a high inherent potential to effect non-target organisms.
- Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

References in “Racoon” Section

- Efficacy and Selectivity of Eggs and Tallow Baits for Skunk Control
- Percentage of Racoons and Skunks Reached by Egg Baits

References in “General” Section

- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant™ Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immunocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

CONDITIONED FOOD AVERSION

- Emetine dithrochloride can create conditioned food aversions in raccoons.
- Emetine dithrochloride is highly toxic to humans.

References

- Potential Compounds for Establishing Conditioned Food Aversions in Raccoons
PHYSICAL BARRIERS
◆ 5-6 foot metal barriers can stop racoons from climbing trees.
◆ A single electric wire 6-8 inches high has been used to protect small areas from racoons.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Racoons

REPELLENTS
◆ Repellents may be used to protect an container or expel a racoon from a building.
◆ There are no repellents which can be used on agricultural crops.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ L-1902 Controlling Racoon Damage
◆ Racoons

REPRODUCTION
◆ A racoon’s reproductive potential peaks at about age four.
◆ Racoon populations have been increasing and expanding their range with continuing settlement.

References
◆ Age Related Reproductive Success of Female Racoons
◆ Comments on Racoon Population Eruptions

SCARING
◆ Racoons may avoid brightly lit areas.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Reflecting Tapes Repel Blackbirds from Millet, Sunflowers, and Sweet Corn
TRAPPING
• Non-target organisms can be released from live traps.
• Young corn, melon, prunes, peanut butter, bread soaked in syrup or honey, fish, bacon, and eggs can be used as baits.

References
• Facts about Pesticides: Racoons
• Fish and Wildlife Habitat Management: Best Management Practices
• L-1902 Controlling Raccoon Damage
• Percentage of Racoons and Skunks Reached by Egg Baits
Summary of Selected References

AGE RELATED REPRODUCTIVE SUCCESS OF FEMALE RACOONS
Randall E. Junge. University of Illinois, Urbana, IL 61820
Glen C. Sanderson. Illinois Natural History Survey, Champaign, IL 61820

The paper found that reproductive success increased slightly for the first four years of life and then fell as racoons aged further.

COMMENTS ON RACOON POPULATION ERUPTIONS
Erik K. Fritzell. Department of Forestry, Fisheries and Wildlife, University of Missouri, Columbia, MO 65211

"Eruptive" populations are those which have sudden severe increases (>50%) in density and then, after a variable length of time, quickly decrease to their previous population density. The author argues that the racoon population has been increasing and expanding its range but has not, and never has, been an eruptive population, despite the fact that it is often characterized as such. The mistaken characterization of racoon population as eruptive is a result of improper interpretation of trapping records.

EFFICACY AND SELECTIVITY OF EGGS AND TALLOW BAITS FOR SKUNK CONTROL
Laurence D. Roy. Alberta Environmental Center, Postal Bag 4000, Vegreville, Alberta T9C 1T4
Michael J. Dorrance. Alberta Agriculture, 7000-113 Street, Edmonton, Alberta, T6H 5T6

This paper describes the selectivity and efficiency of egg and tallow baits for striped skunks (Mephitis mephitis) but is relevant to those who attempt to use similar baits for racoons. The study found that skunks do not always recognize eggs as food, especially clean and sanitized eggs which are less attractive than ones associated with poultry smells.

In the study area (Saskatchewan-Alberta border) non target organisms which were observed to feed on chicken egg and tallow baits include the coyote, red fox, domestic dog, weasel and black-billed magpie. Nontarget organisms observed to feed on tallow baits included ground squirrels, red squirrels, rats, cats, snowshoe hares and porcupines. The authors recommend placing traps in sites with evidence of skunks to increase efficiency and selectivity.
FACTS ABOUT PESTICIDES: RACOONS
Anon.

The fact sheet lists bobcat, fox and coyote as natural enemies. For excluding raccoons from a garbage can the sheet recommends using sealable metal containers. Use of 5-6 foot metal barriers around trees and T.V. towers are suggested to limit raccoon access to nearby buildings. The sheet lists lights, oil of mustard and cayenne pepper as possible repellents.

Live traps recommended include Tomahawk (#108, 109, 207, 608 or 609.5) and Havahart (#3 or 3A) or other similar traps. The sheet recommends young corn, melon, prunes, peanut butter, syrup or honey soaked bread, fish and bacon as good baits.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES
Agriculture and Agri-Food Canada, 1996.

This document offers “Best Management Practices” determined by a team of “farmers, researchers, resource managers, extension staff, and agribusiness professionals” to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, raccoons, deer and birds are also included.

For reducing raccoon damage the authors suggest making chicken wire fences around crops, shining bright lights, planting pumpkin vines among sweet corn, dogs and encouraging hunting and trapping.

L-1902 CONTROLLING RACOON DAMAGE
1992 Texas Agricultural Extension Service WWW / Gopher Server Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
William H. Clay

“Raccoons can cause a great deal of damage to attics, roofs, hen houses, gardens, orchards, lawns, pets and people. This leaflet describes methods of control, including traps and repellents. It also tells how to prevent raccoon infestation by removing their food and water supplies and destroying their shelters. This is a 2-page publication.”

200
PERCENTAGE OF RACOONS AND SKUNKS REACHED BY EGG BAITS
Richard L. Nelson and Raymond L. Linder. South Dakota Cooperative Wildlife Research Unit, Brookings

Chicken eggs containing DMCT (a physiological marker) were distributed in a 25-mi² study area to assess the efficiency of these baits at reaching target organisms. 99.5% of baits were consumed within 6 days. The study found that 87% of racoons, 31% of coyotes and 29% of skunks had eaten the treated eggs. Six wild cats and 2 badgers were checked but did not have traces of DMCT in their system. The paper concludes that since egg baits reached 87% of racoons, they may be an effective way to deploy chemosterilants in the future. The paper suggests that the effects of a chemosterilant on skunk populations is difficult to evaluate and makes no mention of possible effects on non-target organisms.

POTENTIAL COMPOUNDS FOR ESTABLISHING CONDITIONED FOOD AVERSIONS IN RACOONS
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

A conditioned food aversion is a learned avoidance of a specific food by animals. It has been used as a successful wildlife management tool for birds and coyotes. This experiment tested 17 chemical compounds used previously to form conditioned food aversions in other animals or known to produce illness in racoons. The test examined the tendency of racoons to generalize aversion from treated foods to untreated foods. A conditioned food aversion was created for eggs in the racoons tested when food was treated with 0.02-0.05 g of emettine dithdrochloride. The animals continued to avoid eating the previously treated food when other food was available, but were found to slowly start eating the previously treated food if there was no alternative provided.

Emettine dithdrochloride is highly toxic to humans, may persist in tissues, and should not be used in situations where food could be consumed by humans. The author recommends further testing to study the likelihood of chronic, non target and secondary poisonings.

RACOONS
Animal Control in Field, Farm and Forest. p.20-26, 1954.
W. Robert Eadie. Cornell University

The author describes identifying features and biology and then gives management recommendations. Racoons can be trapped or hunted with dogs and lights, although electric fencing may also be used. "Electric fences of various types have been used to effectively..."
exclude racoons from game farms or poultry yards. Generally, a single wire strung six- to eight-inches above the ground on the outside of an ordinary wire fence, as for foxes, will be effective. An additional electrified wire at the top of the fence is sometimes used... No successful repellents against racoons are known that can be used on corn or other vegetables.

REFLECTING TAPES REPEL BLACKBIRDS FROM MILLET, SUNFLOWERS, AND SWEET CORN
Richard A. Dolbeer and Paul P Woronecki. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870
Richard L. Bruggers. US Department of Agriculture, Denver Wildlife Research Center, Building 16, Federal Center, Denver, CO 80225

The study evaluated the performance and cost of Bird Scaring Reflective Tape™ at different spacing intervals (3, 5 and 7 meters) in millet, sunflowers and sweet corn. The tapes are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other. The tapes were suspended 1.5 meters above the ground on poles and can make a roaring sound under certain wind conditions.

Mammal damage evaluated included that done by white-tailed deer (Odocoileus virginianus) and raccoon (Procyon lotor). The report finds “There were no differences (P > 0.10) among the 3 treatments in damage caused by mammals at 25 or 35 days after silking” (p.421).
Racoon (*Procyon lotor*)

**Results of the Grower Needs Assessment**

The raccoon (*Procyon lotor*) was repeatedly identified as having significant or very significant impacts on overall farm productivity. The conflicts were between racoons and corn producers. Shooting racoons is the traditional control measure but has limitations and interest in alternative crop protection options was expressed.

**Species Biology and Life History**

The Procyonidae Family is a group of medium sized animals, related to bears, having five well developed toes with non retractable claws and naked soles on each foot. Their step is plantigrade. Their nose and ears are long and pointed and they have a long ringed bushy tail (Seton 1909b).

In addition to these family characteristics *Procyon lotor* has the following characteristics:

- **Total length:** 660-1010 mm, (18-28 in.); **tail length:** 200-300 mm, (8-12 in.); **weight:** 5.5-16 kg (12-35 lb.) (Kurta 1995). Sexes look alike, grey, white and black with a black mask and alternating bands of yellow and black on the tail. Racoons are mostly nocturnal although are occasionally seen abroad during the day. They have 6 mammae and 40 teeth and live to a maximum of about 14 years (Burt and Grossenheider 1980 Seton 1909b).

**RANGE**

The racoon is found throughout the Bay of Quinte watershed. Seton writes, “Coons have increased in recent years because of the abundant food supply provided by settler's crops and the destruction of animals which prey upon coons... [The] racoon increases in the northern region as the fisher is exterminated by the trapper.” (1909b:1028)

**HOME RANGE**

The home range of a racoon can be surprisingly large, up to 9 km² (4 mi²) but is usually less than 2 km² (1 mi²) (Burt and Grossenheider 1980). The young have been known to disperse up to 265 km (165 mi.) from their birth place, but usually less than 50 km, (30 mi.) (Burt and Grossenheider 1980). Within their home range, populations have been recorded as high as 1 racoon per 0.4 hectares (1 acre) although 1 racoon per 6 ha (15 acres) is generally considered high (Burt and Grossenheider 1980).

**ENVIRONMENT/HABITAT**

The racoon prefers hardwood edges. Conifers are not as attractive since the racoon most often dens in hollow trees. Racoons always have streams or lakes in their home range and have the
habit of washing food before eating it (Seton 1909b).

Raccoons prefer to den in a hollow branch high in a large tree exposed to the sun, although hollow trunks are acceptable as well, even if the trunk has fallen (Seton 1909b). If such a space is not available, a raccoon will den in caves, rocky crannies, hollow logs, abandoned burrows, culverts and houses (Carpentier 1987). Within its home range, the raccoon “maintains a central home den and several hunting lodges scattered in convenient proximity to favorite and remote hunting grounds” (Seton 1909:1018).

SENSES
Raccoons are well known for their well developed tactile abilities. Raccoons have incredibly dexterous hands, and are quite clever, which allows them to get just about anywhere they want to. Raccoons are capable of climbing fences, opening doors and have even mastered simple locks (Cameron 1964). Raccoons have excellent night vision and primarily forage at night (Carpentier 1987).

COMMUNICATION
Raccoons have limited verbal communications, the female makes a low twittering sound to reassure her young and adults growl and snarl when threatened (Burt and Grossenheider 1980).

REPRODUCTION
Mating occurs in late February or March in the Bay of Quinte watershed. Gestation lasts 63 days and on average 4 young are born in April or May but 2 to 7 is a normal range (Burt and Grossenheider 1980). Eyes open at 3 weeks and the young can be seen abroad with the mother in June. By July, young are weaned and begin to hunt with parents but leave before the next spring when room is needed for the next litter (Seton 1909). Some females mate in their first year of life (Burt and Grossenheider 1980).

MOVEMENT
Raccoons can swim but are generally found out of water (Seton 1909). Raccoons are excellent climbers but are not particularly fast on the ground; they will climb a tree if threatened (Carpentier 1987).

FOOD
Raccoons do not store food, but rely on fat reserves to get them through the winter (Burt and Grossenheider 1980, Seton 1909). Primarily nocturnal and completely omnivorous, a racoon can and does eat most everything. In the wild, a racoon’s summer diet consists primarily of frogs and mice but they also eat crayfish, slugs, insects, fish, fowl, bird and turtle eggs, reptiles, shellfish, fruit, nuts, grain, vegetables and anything else available (Burt and Grossenheider 1980, Carpentier 1987, Seton 1909). Raccoons often wash, or dunk food in water before eating it and therefore prefer to feed near water (Seton 1909).
PREDATORS/LIMITING FACTORS
Besides people and available food supply, the racoon has few limiting factors. Historically the main predator was the fisher. According to Seton, "[The] racoon increases in the northern region as the fisher is exterminated by the trapper" (1909b:1028). The fisher is a forest predator which prefers to live near wetlands, and has a home range of approximately 2600 ha (10 square miles) (Burt and Grossenheider 1980).

In 1877 Dr. Coves wrote, "It may not be generally known that the Pekan [also known as fisher, blackcat, pennant martin] successfully assault animals as large as a racoon; Indeed that the abundance of the latter depends in a measure, upon the rarity of the former" (Coves 1877:73-74).

In 1857 Peter Ried wrote, "Racoons are now more numerous than they were at the first settlement of the county [Washington County N.Y.] or for some time subsequent. Thirty years ago [1827] they were so seldom found that many boys age 15 to 18 had scarcely seen one.... The fisher has been nearly extinct from these parts for about 25 years and that to my mind accounts for the great increase in the numbers of the racoon" (Ried 1857).

With the scarcity of large predators in the southern Bay of Quinte watershed, people have become the main factor limiting racoon populations, they are often seen dead along roads or are shot by farmers.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Eastern Cottontail Rabbit

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed: Fall 1996
Eastern Cottontail Rabbit (*Sylvilagus, floridanus*)

**Results of the Grower Needs Assessment**

Cottontail rabbits (*Sylvilagus, floridanus*) were identified as having minor conflicts with orchards in the Bay of Quinte Watershed with little impact on overall farm productivity. These conflicts were characterized as declining in importance and no longer requiring management efforts. Natural predators (foxes and coyotes) were identified as the main controlling factor and the rabies bait program was credited as having a major positive influence on predator populations. Traditional crop protection methods (shooting, thiram paint and tree guards) were described as being of limited use.

**Species Biology and Life History**

The family Leporidae (the rabbit and hare family) can be found in almost any habitat on all continents except Antarctica (Kurta 1995). All members of this family have distinguishing long ears, long hind legs, soft fur and a cottony tail (Burt and Grossenheider 1980). Within the Bay of Quinte watershed, 3 members of this family may be found: the snowshoe hare, the European hare and the eastern cottontail (Kurta 1995).

The snowshoe hare’s winter food consists primarily of maple, willow, poplar, hazelnut and the needles of most conifers and therefore does not conflict with agriculture (Kurta 1995). The European hare was introduced to Brantford in 1912 and is still well established in southern Ontario, but it is less common elsewhere (Kurta 1995). The hare is known to cause considerable damage to crops where it occurs in large numbers (Kurta 1995, Burt and Grossenheider 1980). The eastern cottontail (*Sylvilagus, floridanus*), however, is the only Leporidae which often comes into conflict with agriculture within the Bay of Quinte watershed.

In addition to family characteristics *Sylvilagus, floridanus* has the following characteristics:

Total length: 375-475 mm (15-19 in); Tail length: 35-70 mm (1.4-2.8 in); weight: 0.9-1.8 kg (2-4 lb) (Kurta 1995). The eastern cottontails body is a mix of brown, tan, yellow and grey; its tail is white underneath and brown on top (Kurta 1995). The cottontail rabbit does not turn white in the winter (Carpentier 1987). The cottontail is a solitary animal that is most active at dawn and dusk but may be seen during the day (Kurta 1995, Carpentier 1987). The cottontail has 28 teeth, 8 mammae and a life expectancy of 6 months although a rabbit may live up to 4 years in the wild (Kurta 1995, Carpentier 1987, Burt and Grossenheider 1980).

**RANGE**

The cottontail is found throughout Mexico, the eastern United States and southern Canada.
including the Bay of Quinte region (Kurta 1995). The cottontail had been present in the Bay of Quinte region thousands of years ago, but had disappeared before colonization and did not reestablish itself until the late 19th century when agriculture began to transform the forested landscape of Ontario to the patchwork habitat we see today (Carpentier 1987).

HOME RANGE
The home range is between 0.4-1.5 ha. It is larger for males than females and larger during the breeding season (Kurta 1995, Carpentier 1987). The home range is aggressively defended by the female, especially during mating season (Carpentier 1987). A favorable habitat will support 8 rabbits/ha (3/acre), although density may be greater during peak years and in areas where rabbits congregate during the winter (Kurta 1995, Burt and Grossenheider 1980).

The rabbit sleeps in a “form” during the summer. A “form” is a depression in the ground which is concealed by dense brush or grass (Kurta 1995). In the winter the cottontail will usually move into an abandoned woodchuck hole (Kurta 1995).

ENVIRONMENT/HABITAT
The cottontail is found most often where there is plenty of herbaceous growth and sheltered areas. The rabbit avoids open areas and forests which do not offer sufficient cover (Kurta 1995). The cottontails preferred habitat includes heavy brush, strips of forest or fence rows beside open areas, edges of swamps or weedy areas (Burt and Grossenheider 1980). The rabbit thrives in the patchwork environment created by agriculture. Carpentier writes, “Favoring meadows, fence rows, and urban yards over deep forests, conflicts with man are expected and frequent” (Carpentier 1987:40).

COMMUNICATION
The cottontail is a solitary animal (Kurta 1995). The female will defend its territory, especially during mating season (Kurta 1995, Carpentier 1987).

REPRODUCTION
Breeding begins in February and continues to September (Carpentier 1987). The cottontail will have 3-4 litters/year, (gestation period 26-30 days), with 4-7 young in each litter (Burt and Grossenheider 1980). The young are born naked and blind and are left in a grass and fur lined depression concealed by brush or tall grass (Carpentier 1987, Burt and Grossenheider 1980). Occasionally nests are communal with up to 15 young in them at one time (Carpentier 1987).

The young open their eyes at one week of age and have fur at two weeks when they first venture out of the nest (Kurta 1995). Young are weaned by 3 weeks and are on their own at 5 weeks of age when the female breeds again (Kurta 1995, Carpentier 1987). Young are sexually mature at 2-3 months, but about half do not reproduce until the next year (Kurta 1995, Carpentier 1987).

MOVEMENT
The eastern cottontail may run up to 45 km/hour for short distances (Seton 1909b).
FOOD
The cottontail’s summer food consists of grasses and herbs, but in the winter the rabbit resorts to twigs and bark. Summer foods in the wild include grasses, flowering plants, clover, plantain, dandelion, goldenrod and wild carrot, but in more human dominated environments their favored foods also include beans, peas, lettuce, carrots and other garden crops (Kurta 1995, Carpentier 1987). Favored winter foods include the bark, twigs and buds of raspberry, apple, maple, honey locust, sumac, black cherry and many others (Kurta 1995). Overall the rabbit is capable of “doing considerable damage to gardens, shrubs and small trees” (Burt and Grossenheider 1980:209).

PREDATORS/LIMITING FACTORS
The eastern cottontail has many predators including foxes, coyotes, dogs, wolves, hawks and owls (Kurta 1995). Since the rabbit does not turn white in the winter and is therefore not camouflaged, predation is more of a limiting factor in the Bay of Quinte watershed than it is in the rest of the rabbit’s range (Kurta 1995). People also have some impact on rabbit populations, some are killed on roads and the cottontail is often hunted (Kurta 1995, Burt and Grossenheider 1980). The rabbits high reproductive potential, however, allows populations to quickly bounce back from any declines (Carpentier 1987).

Cottontails suffer from a disease called tularemia which is transferrable to humans. This disease is more widespread in southern populations and does not pose much of a threat to either rabbit or human populations in the Bay of Quinte watershed (Kurta 1995).
Results of Literature Survey

The information available suggests several options for reducing conflicts between cottontail rabbits and agriculture in the Bay of Quinte watershed. General conclusions can be drawn from available information about acoustic scaring devices, habitat alteration, hunting, physical barriers, predators, repellents and trapping.

ACOUSTIC SCARING DEVICES
♦ These devices are of little use for protecting crops from rabbit damage.

References
♦ An Acoustic Scaring Device Tested Against European Hares

HABITAT ALTERATION
♦ Removing cover habitat will make an area less attractive to rabbits.
♦ Habitat modifications will be more effective when habitat is scarce.

References
♦ Animal Pests
♦ Use of Forest Edge and Strip Vegetation by Eastern Cottontails

HUNTING
♦ Hunting can not be relied upon for crop protection.
♦ Hunting can be expected to increase annual mortality rates of rabbits by approximately 10%.

References
♦ L-1910 Controlling Cottontail and Jackrabbit Damage
♦ Mortality Rates of Tagged Adult Cottontail Rabbits
♦ Rabbit
♦ Rodent and Deer Control

PREDATORS
♦ Mountain cottontail make up 12.2% of coyote diet in the Black Hills of South Dakota.
♦ Snowshoe hare make up 30% of coyote diet in Maine.
♦ Snowshoe hares can make up as much as 77% of coyote diet in Alberta.
♦ In Michigan, snowshoe hare was found to be the dominant food for red foxes in May.
♦ Rabbits are the second most important food for foxes in the United States.

References
♦ Coyote Demography During a Snowshoe Hare Decline in Alberta
PHYSICAL BARRIERS
- A 60 cm (2-3 foot) fence made with poultry wire will be effective.
- Rabbits will not generally burrow under fences.
- Fences should be staked every 2m so that rabbits cannot squeeze under them.
- Electric fences are initially cheaper but have higher maintenance costs.

References
- Animal Pests
- Effectiveness of Fences to Exclude European Rabbits from Crops
- L-1910 Controlling Cottontail and Jackrabbit Damage
- Rabbit

REPELLENTS
- Hinder, thiram and Scoot mixed in latex paint and a rosin ethyl alcohol mixture have been used to repel rabbits.
- Oil paints are toxic to trees.
- Repellents suffer from weathering.
- Repellents are most effective when there are alternate food sources available.

References
- Animal Pests
- An Effective Repellent for European Hare in Brazil
- Rabbit
- Rodent and Deer Control in Orchards

TRAPPING
- Trapping is not an effective crop protection technique.
- Corn cobs, dried alfalfa and clover are good baits in cold weather.
- Apples, carrots, lettuce and cabbage are the best baits in warm weather.

References
- Animal Pests
- L-1910 Controlling Cottontail and Jackrabbit Damage
- Rabbit
Summary of Selected References

AN ACOUSTIC SCARING DEVICE TESTED AGAINST EUROPEAN HARES
Charles J. Wilson and I. Gordon, McKillop. Ministry of Agriculture, Fisheries and Food, Worpplesdon Laboratory, Tanglely Place, Guildford, Surrey GU3 3LQ, England

This experiment looked at the effectiveness of high frequency acoustic scaring devices on European rabbit (Oryctolagus cuniculus). The device tested produced frequencies between 9 and 15 kilohertz audible up to 150m. Sound levels at 0.01, 3 and 15 m were 121-123, 90-95 and 77-83 decibels respectively. Batteries were changed 3 times in 11 days.

The experiment found reduction in bait consumption only within 3m of the device which lasted only one week. Authors suggest that the sound is rapidly habituated, and that without alternative food sources, the acoustic device would have no effect on rabbit feeding behavior. They conclude that “acoustic devices with the physical characteristics described earlier may be ineffective against European rabbits” (p411).

ANIMAL PESTS
Internet (address lost)

To alleviate rabbit problems, the article suggests modifying habitat (removing brush piles, weedy patches, lumber piles and other shelter) that rabbits depend upon. This practice is most effective in suburban areas where habitat is more critical. A 2-3 foot rabbit fence made from poultry netting, repellents and live trapping are also options. The article says that corn cobs, dried alfalfa and clover are good baits in cold weather and apples, carrots, lettuce and cabbage are good baits in the summer.

COYOTE DEMOGRAPHY DURING A SNOWSHOE HARE DECLINE IN ALBERTA
Arlen W. Todd. Department of Energy and Natural Resources, Edmonton, Alberta T5K 2C9
Lloyd B. Keith. Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53706

During a decline in the snowshoe hare population in the Canadian prairies, coyotes decreased consumption of hares 62-71% and substituted mice, voles and carrion. As coyote’s average consumption of food fell, demographic changes occurred in the population. Pregnancy rates and litter sizes fell, reducing total reproduction, the proportion of juveniles fell from 64% to 41-44% and sex ratios changed from equal to ratios with significantly more male coyotes than females.
COYOTE FOODS IN THE BLACK HILLS, SOUTH DAKOTA
James G. MacCracken. Agricultural Experiment Station, University of Alaska, Palmer Research Center, P. O. Box AE Palmer, AK 99645
Daniel W. Uresk. USDA, Forest Service, Rocky Mountain Forest Service, Rocky Mountain Forest and Range Experiment Station, Rapid City, SD 57701

Prey remains (expressed as % dry matter) in coyote scat are broken down by season and species. Overall, 43.5% of coyote food was white-tailed deer, 16.2% was mountain cottontail and 12.2% was various mouse species.

THE ECOLOGY OF RED FOXES, GRAY FOXES AND RABIES IN THE EASTERN UNITED STATES
Andrew B. Carey. USDA Forest Service, 180 Canford Street, Morganstown, WV 26505

The paper identifies the most important food items for foxes to be rodents (Microtus then Peromyscus), lagomorphs (rabbits, hares and picas), vegetation (including fruit) and insects in that order. Other foods of less importance include fish, carrion, reptiles and amphibians. The paper's primary focus is rabies ecology and what causes its localization. The paper finds rabies distribution is not directly related to landscape features or food preferences. The paper goes on to discuss possible mechanisms maintaining the virus in nature and suggests future study.

AN EFFECTIVE REPELLENT FOR EUROPEAN HARE IN BRAZIL
H. A. Cardinell. Michigan State University, East Lansing, Michigan

Young deciduous fruit trees were protected from the European hare with a wood rosin ethyl alcohol solution. The author reports that this has been proven effective on cottontails in Michigan in 1941. Trees treated with the rosin-alcohol varnish received 0% damage in the first winter and 2% the second. In both years “considerable fresh feeding” was noted on untreated trees.

EFFECTIVENESS OF FENCES TO EXCLUDE EUROPEAN RABBITS FROM CROPS
Charles J. Wilson and I. Gordon, McKillop. Ministry of Agriculture, Fisheries and Food, Worpplesdon Laboratory, Tangley Place, Guildford, Surrey GU3 3LQ, United Kingdom.

This paper compares the effectiveness of two brands of electric fencing, (both with and without electrification) and two types of wire netting fences. Fence erection specifications
and fence inspection and maintenance costs are given. The fences inspected are Flexinet™, Livestok™, The British Ministry of Agriculture, Fisheries and Food’s recommended design and the Forestry Commission’s recommended design.

The paper found that “All 4 were equally effective initially, reducing the number of [European] rabbits seen on fields by 80%. However, the effectiveness of the Livestok™ fence decreased over 3-4 months when 16% fewer rabbits were excluded from the protected fields” (p.401). Electric fences are cheaper initially but have generally higher maintenance costs.

The paper concludes “Where wire-netting fences are to be used, these results indicate that the FC-type is to be preferred because it is 32% cheaper than the MAFF-type, and maintenance costs, although higher, are not sufficiently high to offset the initial saving” (p.401).

FOODS OF ADULT MAINE COYOTES AND THEIR KNOWN AGE PUPS
Daniel J. Harrison and Joyce A. Harrison. Main Cooperative Wildlife research Unit, 240 Nutting Hall, Orono, ME 04469

The paper documents percent occurrence of food items in adult and pup coyote scats from May to October. White-tailed deer was detected in 43% of scats, snowshoe hare in 30% and small mammals in 21% of all coyote scats.

L-1910 CONTROLLING COTTONTAIL AND JACKRABBIT DAMAGE
Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Mark Mapston

“Jackrabbits have long ears and long legs and live in open or semi-open rangelands, pasture lands or desert areas. Cottontails are the reddish-brown to brown rabbits with small ears and legs that are found in brush land and marginal areas and seldom venture far from brushy cover. This leaflet discusses the characteristics of and the damage caused by each, as well as methods of control such as habitat control, fencing, trapping, poisoning and shooting. This is a 2-page publication containing 2 photos.”

MORTALITY RATES OF TAGGED ADULT COTTONTAIL RABBITS
George B. Rose. Illinois State Natural History Survey, Urbana 61801

The average annual mortality rate for adult white-tailed rabbit was 79% in east central Illinois.
In years when hunting was allowed the mortality rate was 84%. In years without hunting, the mortality rate was 75%.

POPULATION ECOLOGY OF COYOTES DURING A FLUCTUATE OF SNOWSHOE HARES
Arlen W. Todd, Lloyd B. Keith and Charles A. Fischer. Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53706

This was the first study of coyote response to snowshoe hare cycles. In a mixed farming-boreal forest ecosystem, north of Edmonton Alberta, coyote populations were directly related to hare abundance. Coyote populations fluctuated 3-6 fold as hare populations fluctuated 20-40 fold. Percent biomass of hares in coyote diet ranged from 0-77%. During years of scarcity breeding rates fell 50% and litter size fell by 25%.

RABBIT

No control option is presented with confidence here. All recommendations are qualified with “may discourage” or “may provide”. Control options listed include using repellents (Hinder, Thiram or Scoot) in white exterior latex paint, tree guards, a 60 cm fence (made with 25 mm mesh staked every 2 m), shooting, trapping and encouraging natural predators.

RABBIT CONTROL IN NEW ZEALAND: THE USE OF ACUTE POISON AND THE DEVELOPMENT OF ANTICOAGULANT CONTROL STRATEGIES
J. M. Williams, J. Bell, T. M. Broad, D. L. Robson and W. D. Ross. Research Division, Ministry of Agriculture and Fisheries, P. O. Box 24 Lincoln, New Zealand.

The use of compound 1080 for the last 30 years in New Zealand has led to “bait avoidance (neophobic) behavior with the result that, on average, 30% will not now accept baits” (p.217). The paper examines studies on the use of an anticoagulant control strategy and discusses future control possibilities. Brodifacoum is recommended as an alternative to compound 1080. The paper describes brodifacoum as just as effective, with a lower hazard to dogs and similar hazards to non-target wildlife and rabbit predators.

The paper also concludes, “Continual poisoning of a rabbit population with any compound must apply constant selection pressure for neophobia... It would therefore be desirable to implement a variety of control techniques, including conventional baiting, acute and chronic
poisoning of natural vegetation, shooting and trapping... [with] the effect of reducing behavioral selection pressures, leading ultimately to more effective control” (p.220).

REDFOX FEEDING HABITS IN RELATION TO FAWN MORTALITY
John J. Ozoga, Craig S. Bienz and Louis J. Verme. Michigan Department of Natural Resources, Shingleton, MI 49884

Red fox (Vulpes vulpes) is reported to prey on white-tailed deer fawns, based on scat samples with fawn remains. Foxes are also scavengers. The study examined the diet of foxes in Michigan’s Upper Peninsula. Snowshoe hare (Lepus americanus) were a dominant food during early May, insects were dominant from mid-May to June and fruit was dominant during July and August. Meadow voles and deer mice were well represented in scat counts throughout the year and may be considered a staple in fox diets.

RODENT AND DEER CONTROL IN ORCHARDS
Kevin W. Ker and Ken Wilson. Plant Industries Branch

Description of rabbit damage to trees and the use of Thiram-latex paint mixtures are discussed. The Fact Sheet suggests hunting as an option but cautions that “this method alone can not be depended upon to provide adequate control” (p.4).

USE OF FOREST EDGE AND STRIP VEGETATION BY EASTERN COTTONTAILS
Kevin A. Morgan and J. Edward Gates. Appalachian Environmental Laboratory, Center for Environmental and Estuarine Studies, University of Maryland, Frostburg State College Campus, Gunter Hall, Frostburg, MD 21532

This study evaluated use of 6 different categories of strip vegetation over 17 months by Cottontail rabbits (Sylvilagus spp.). The paper concludes that “cottontails respond to vegetative structure that allows a clear view of their surroundings and permits them to move with speed and agility through and under it. Thus, management should stress cover structure that allows use of these escape mechanisms” (p.263).
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Raccoon

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed: Fall 1996
Results of Literature Survey

The information available suggests several options for reducing conflicts between raccoons and corn producers in the Bay of Quinte watershed. General conclusions can be drawn from available information about chemosterilization, conditioned food aversions, physical barriers, repellents, reproduction, scaring and trapping.

CHEMOSTERILIZATION
- It is possible to reduce raccoon reproduction with chemosterilants.
- Current baits are not selective and will reach many non-target organisms.
- All vertebrate reproductive systems (including human systems) are very similar. Chemosterilants therefore have an high inherent potential to effect non-target organisms.
- Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

References in “Racoon” Section
- Efficacy and Selectivity of Eggs and Tallow Baits for Skunk Control
- Percentage of Raccoons and Skunks Reached by Egg Baits

References in “General” Section
- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant™ Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception, Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immuocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

CONDITIONED FOOD AVERSION
- Emetrine dithrochloride can create conditioned food aversions in raccoons.
- Emetrine dithrochloride is highly toxic to humans.

References
- Potential Compounds for Establishing Conditioned Food Aversions in Raccoons
PHYSICAL BARRIERS
◆ 5-6 foot metal barriers can stop racoons from climbing trees.
◆ A single electric wire 6-8 inches high has been used to protect small areas from racoons.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Racoons

REPELLENTS
◆ Repellents may be used to protect an container or expel a racoon from a building.
◆ There are no repellents which can be used on agricultural crops.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ L-1902 Controlling Racoon Damage
◆ Racoons

REPRODUCTION
◆ A racoon’s reproductive potential peaks at about age four.
◆ Racoon populations have been increasing and expanding their range with continuing settlement.

References
◆ Age Related Reproductive Success of Female Racoons
◆ Comments on Racoon Population Eruptions

SCARING
◆ Racoons may avoid brightly lit areas.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Reflecting Tapes Repel Blackbirds from Millet, Sunflowers, and Sweet Corn
TRAPPING
◆ Non-target organisms can be released from live traps.
◆ Young corn, melon, prunes, peanut butter, bread soaked in syrup or honey, fish, bacon, and eggs can be used as baits.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ L-1902 Controlling Raccoon Damage
◆ Percentage of Raccoons and Skunks Reached by Egg Baits
Summary of Selected References

AGE RELATED REPRODUCTIVE SUCCESS OF FEMALE RACOONS
Randall E. Junge. University of Illinois, Urbana, Ill 61820
Glen C. Sanderson. Illinois Natural History Survey, Champaign, IL 61820

The paper found that reproductive success increased slightly for the first four years of life and then fell as racoons aged further.

COMMENTS ON RACOON POPULATION ERUPTIONS
Erik K. Fritzell. Department of Forestry, Fisheries and Wildlife, University of Missouri, Columbia, MO 65211

"Eruptive" populations are those which have sudden severe increases (>50%) in density and then, after a variable length of time, quickly decrease to their previous population density. The author argues that the raccoon population has been increasing and expanding its range but has not, and never has, been an eruptive population, despite the fact that it is often characterized as such. The mistaken characterization of raccoon population as eruptive is a result of improper interpretation of trapping records.

EFFICACY AND SELECTIVITY OF EGGS AND TALLOW BAITS FOR SKUNK CONTROL
Laurence D. Roy. Alberta Environmental Center, Postal Bag 4000, Vegreville, Alberta T9C 1T4
Michael J. Dorrance. Alberta Agriculture, 7000-113 Street, Edmonton, Alberta, T6H 5T6

This paper describes the selectivity and efficiency of egg and tallow baits for striped skunks (Mephitis mephitis) but is relevant to those who attempt to use similar baits for racoons. The study found that skunks do not always recognize eggs as food, especially clean and sanitized eggs which are less attractive than ones associated with poultry smells.

In the study area (Saskatchewan-Alberta border) non target organisms which were observed to feed on chicken egg and tallow baits include the coyote, red fox, domestic dog, weasel and black-billed magpie. Nontarget organisms observed to feed on tallow baits included ground squirrels, red squirrels, rats, cats, snowshoe hares and porcupines. The authors recommend placing traps in sites with evidence of skunks to increase efficiency and selectivity.
FACTS ABOUT PESTICIDES: RACOONS
Anon.

The fact sheet lists bobcat, fox and coyote as natural enemies. For excluding raccoons from a garbage can the sheet recommends using sealable metal containers. Use of 5-6 foot metal barriers around trees and T.V. towers are suggested to limit raccoon access to nearby buildings. The sheet lists lights, oil of mustard and cayenne pepper as possible repellents.

Live traps recommended include Tomahawk (#108, 109, 207, 608 or 609.5) and Havahart (#3 or 3A) or other similar traps. The sheet recommends young corn, melon, prunes, peanut butter, syrup or honey soaked bread, fish and bacon as good baits.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES
Agriculture and Agri-Food Canada, 1996.

This document offers “Best Management Practices” determined by a team of “farmers, researchers, resource managers, extension staff, and agribusiness professionals” to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, racoons, deer and birds are also included.

For reducing racoon damage the authors suggest making chicken wire fences around crops, shining bright lights, planting pumpkin vines among sweet corn, dogs and encouraging hunting and trapping.

L-1902 CONTROLLING RACOON DAMAGE
1992 Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
William H. Clay

“Raccoons can cause a great deal of damage to attics, roofs, hen houses, gardens, orchards, lawns, pets and people. This leaflet describes methods of control, including traps and repellents. It also tells how to prevent racoon infestation by removing their food and water supplies and destroying their shelters. This is a 2-page publication.”
PERCENTAGE OF RACOONS AND SKUNKS REACHED BY EGG BAITS
Richard L. Nelson and Raymond L. Linder. South Dakota Cooperative Wildlife Research Unit, Brookings

Chicken eggs containing DMCT (a physiological marker) were distributed in a 25-mi² study area to assess the efficiency of these baits at reaching target organisms. 99.5% of baits were consumed within 6 days. The study found that 87% of racoons, 31% of coyotes and 29% of skunks had eaten the treated eggs. Six wild cats and 2 badgers were checked but did not have traces of DMCT in their system. The paper concludes that since egg baits reached 87% of racoons, they may be an effective way to deploy chemosterilants in the future. The paper suggests that the effects of a chemosterilant on skunk populations is difficult to evaluate and makes no mention of possible effects on non-target organisms.

POTENTIAL COMPOUNDS FOR ESTABLISHING CONDITIONED FOOD AVERSIONS IN RACOONS
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

A conditioned food aversion is a learned avoidance of a specific food by animals. It has been used as a successful wildlife management tool for birds and coyotes. This experiment tested 17 chemical compounds used previously to form conditioned food aversions in other animals or known to produce illness in racoons. The test examined the tendency of racoons to generalize aversion from treated foods to untreated foods. A conditioned food aversion was created for eggs in the racoons tested when food was treated with 0.02-0.05 g of emettine dithdrochloride. The animals continued to avoid eating the previously treated food when other food was available, but were found to slowly start eating the previously treated food if there was no alternative provided.

Emettine dithdrochloride is highly toxic to humans, may persist in tissues, and should not be used in situations where food could be consumed by humans. The author recommends further testing to study the likelihood of chronic, non target and secondary poisonings.

RACOONS
Animal Control in Field, Farm and Forest. p.20-26, 1954.
W. Robert Eadie. Cornell University

The author describes identifying features and biology and then gives management recommendations. Racoons can be trapped or hunted with dogs and lights, although electric fencing may also be used. “Electric fences of various types have been used to effectively
exclude racoons from game farms or poultry yards. Generally, a single wire strung six- to eight-inches above the ground on the outside of an ordinary wire fence, as for foxes, will be effective. An additional electrified wire at the top of the fence is sometimes used.... No successful repellents against racoons are known that can be used on corn or other vegetables.”

**REFLECTING TAPES REPEL BLACKBIRDS FROM MILLET, SUNFLOWERS, AND SWEET CORN**

Richard A. Dolbeer and Paul P Woronecki. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870
Richard L. Bruggers. U.S. Department of Agriculture, Denver Wildlife Research Center, Building 16, Federal Center, Denver, CO 80225

The study evaluated the performance and cost of Bird Scaring Reflective Tape™ at different spacing intervals (3, 5 and 7 meters) in millet, sunflowers and sweet corn. The tapes are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other. The tapes were suspended 1.5 meters above the ground on poles and can make a roaring sound under certain wind conditions.

Mammal damage evaluated included that done by white-tailed deer (*Odocoileus virginianus*) and racoon (*Procyon lotor*). The report finds “There were no differences (P > 0.10) among the 3 treatments in damage caused by mammals at 25 or 35 days after silking” (p.421).
Racoon (*Procyon lotor*)

Results of the Grower Needs Assessment

The racoon (*Procyon lotor*) was repeatedly identified as having significant or very significant impacts on overall farm productivity. The conflicts were between racoons and corn producers. Shooting racoons is the traditional control measure but has limitations and interest in alternative crop protection options was expressed.

Species Biology and Life History

The *Procyonidae* Family is a group of medium sized animals, related to bears, having five well developed toes with non retractable claws and naked soles on each foot. Their step is plantigrade. Their nose and ears are long and pointed and they have a long ringed bushy tail (Seton 1909b).

In addition to these family characteristics *Procyon lotor* has the following characteristics:

Total length: 660-1010 mm, (18-28 in.); tail length: 200-300 mm, (8-12 in.); weight: 5.5-16 kg (12-35 lb.) (Kurta 1995). Sexes look alike, grey, white and black with a black mask and alternating bands of yellow and black on the tail. Racoons are mostly nocturnal although are occasionally seen abroad during the day. They have 6 mammae and 40 teeth and live to a maximum of about 14 years (Burt and Grossenheider 1980 Seton 1909b).

RANGE

The racoon is found throughout the Bay of Quinte watershed. Seton writes, “Coons have increased in recent years because of the abundant food supply provided by settler’s crops and the destruction of animals which prey upon coons....[The] racoon increases in the northern region as the fisher is exterminated by the trapper.” (1909b:1028)

HOME RANGE

The home range of a racoon can be surprisingly large, up to 9 km² (4 mi²) but is usually less than 2 km² (1 mi²) (Burt and Grossenheider 1980). The young have been known to disperse up to 265 km (165 mi.) from their birth place, but usually less than 50 km, (30 mi.) (Burt and Grossenheider 1980). Within their home range, populations have been recorded as high as 1 racoon per 0.4 hectares (1 acre) although 1 racoon per 6 ha (15 acres) is generally considered high (Burt and Grossenheider 1980).

ENVIRONMENT/HABITAT

The racoon prefers hardwood edges. Conifers are not as attractive since the racoon most often dens in hollow trees. Racoons always have streams or lakes in their home range and have the
habit of washing food before eating it (Seton 1909b).

Raccoons prefer to den in a hollow branch high in a large tree exposed to the sun, although hollow trunks are acceptable as well, even if the trunk has fallen (Seton 1909b). If such a space is not available, a raccoon will den in caves, rocky crannies, hollow logs, abandoned burrows, culverts and houses (Carpentier 1987). Within its home range, the raccoon “maintains a central home den and several hunting lodges scattered in convenient proximity to favorite and remote hunting grounds” (Seton 1909:1018).

SENSES
Raccoons are well known for their well developed tactile abilities. Raccoons have incredibly dexterous hands, and are quite clever, which allows them to get just about anywhere they want to. Raccoons are capable of climbing fences, opening doors and have even mastered simple locks (Cameron 1964). Raccoons have excellent night vision and primarily forage at night (Carpentier 1987).

COMMUNICATION
Raccoons have limited verbal communications, the female makes a low twittering sound to reassure her young and adults growl and snarl when threatened (Burt and Grossenheider 1980).

REPRODUCTION
Mating occurs in late February or March in the Bay of Quinte watershed. Gestation lasts 63 days and on average 4 young are born in April or May but 2 to 7 is a normal range (Burt and Grossenheider 1980). Eyes open at 3 weeks and the young can be seen abroad with the mother in June. By July, young are weaned and begin to hunt with parents but leave before the next spring when room is needed for the next litter (Seton 1909). Some females mate in their first year of life (Burt and Grossenheider 1980).

MOVEMENT
Raccoons can swim but are generally found out of water (Seton 1909). Raccoons are excellent climbers but are not particularly fast on the ground; they will climb a tree if threatened (Carpentier 1987).

FOOD
Raccoons do not store food, but rely on fat reserves to get them through the winter (Burt and Grossenheider 1980, Seton 1909). Primarily nocturnal and completely omnivorous, a raccoon can and does eat most everything. In the wild, a racoon’s summer diet consists primarily of frogs and mice but they also eat crayfish, slugs, insects, fish, fowl, bird and turtle eggs, reptiles, shellfish, fruit, nuts, grain, vegetables and anything else available (Burt and Grossenheider 1980, Carpentier 1987, Seton 1909). Raccoons often wash, or dunk food in water before eating it and therefore prefer to feed near water (Seton 1909).
PREDATORS/LIMITING FACTORS
Besides people and available food supply, the racoon has few limiting factors. Historically the main predator was the fisher. According to Seton, "[The] racoon increases in the northern region as the fisher is exterminated by the trapper" (1909b:1028). The fisher is a forest predator which prefers to live near wetlands, and has a home range of approximately 2600 ha (10 square miles) (Burt and Grossenheider 1980).

In 1877 Dr. Coves wrote, "It may not be generally known that the Pekan [also known as fisher, blackcat, pennant martin] successfully assault animals as large as a racoon; Indeed that the abundance of the latter depends in a measure, upon the rarity of the former" (Coves 1877:73-74).

In 1857 Peter Ried wrote, "Racoons are now more numerous than they were at the first settlement of the county [Washington County N.Y.] or for some time subsequent. Thirty years ago [1827] they were so seldom found that many boys age 15 to 18 had scarcely seen one.... The fisher has been nearly extinct from these parts for about 25 years and that to my mind accounts for the great increase in the numbers of the racoon" (Ried 1857).

With the scarcity of large predators in the southern Bay of Quinte watershed, people have become the main factor limiting racoon populations; they are often seen dead along roads or are shot by farmers.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Meadow Vole

Prepared By: Rob Mound.
Completed: Fall 1996
Meadow Vole (*Microtus pennsylvanicus*)

Results of the Grower Needs Assessment

The meadow vole (*Microtus pennsylvanicus*) was identified as having minor conflicts with orchards in the Bay of Quinte watershed by area growers. These conflicts were characterized as declining in importance and no longer requiring control in some instances. Poison and cultural methods were identified as the methods most often used to control vole populations and natural predators were credited with being partially responsible for the control of vole populations.

Species Biology and Life History

The Muridae Family consists of small and medium sized rodents including rats, mice, lemmings, and voles. It is the largest mammal family, with over 1300 living species (Kurta 1995). This family first appeared in the fossil record 35 million years ago and inhabits all continents except Antarctica (Kurta 1995).

There are very few generalizations which can be made about this diverse family. Most have a small body 50-250 mm (2-10 in) and a tail length of 10-200 mm (1-8 in) (Burt and Grossenheider 1980). Most of these animals are nocturnal, primarily herbivorous, active year round and terrestrial, but there are exceptions to all these generalizations (Kurta 1995). One commonality is that all members of this family have 16 teeth; 4 gnawing and 12 chewing (Burt and Grossenheider 1980).

In addition to these family characteristics *Microtus pennsylvanicus* has the following characteristics:

Total length: 130-185 mm (5.1-7.3 in); tail length 35-60 mm (1.4-2.4 in); weight: 35-60 g (1.2-2.1 oz) (Kurta 1995). The vole’s fur is dark brown or black on its back but a grey or silver color on its belly. The meadow vole may be active day or night throughout the year (Carpentier 1987, Burt and Grossenheider 1980). The meadow vole has 8 mammae and a maximum life span of about 1 year in the wild; however, 90% fail to reach 1 month of age (Kurta 1995).

RANGE

The meadow vole ranges from Alaska to Mexico, from the east coast to the west and is “extremely common” in the Bay of Quinte watershed (Carpentier 1987:64).

HOME RANGE

The home range of this mammal averages less than 0.3 ha (0.7 acre) according to Kurta (1995). Carpentier puts the range at 0.1 ha (0.2 acre) (1987). The range of the vole varies throughout the year and with habitat type. The range is larger during the summer than in the winter and larger in
marshes than in meadows (Kurta 1995). Within its home range, the meadow vole builds a nest which is concealed in dense grasses. The nest has a single exit into a network of trails leading to feeding sites and the latrine (Carpentier 1987). The immediate area around the nest (40 m²) is defended vigorously by the meadow vole (Kurta 1995).

ENVIRONMENT/HABITAT
Meadow voles are most commonly found in damp meadows, apple orchards not treated by herbicide and grassy fields, especially those near steams or swamps (Burt and Grossenheider 1980). Meadow voles are occasionally found in forests and are rarely found in dry grasslands (Carpentier 1987, Burt and Grossenheider 1980).

COMMUNICATION
Meadow voles are described as a “social animal” and the family unit seems to work together (Carpentier 1987:64). They are, however, quite territorial towards other voles. The male is especially aggressive during peek breeding and the female defends the area around the nest year round (Carpentier 1987).

REPRODUCTION
Meadow voles have a gestation period of 21 days and breed year round, although peak breeding occurs from April-October (Carpentier 1987, Burt and Grossenheider 1980). In captivity, a meadow vole can have as many as 17 litters a year, but 4-8 is normal in the wild (Kurta 1995, Burt and Grossenheider 1980). The number of litters per year depends on the available food supply (Carpentier 1987). Each litter has 1-11 young (average 6), which are born naked and blind (Kurta 1995, Carpentier 1987). The young grow hair and teeth and open their eyes at one week (Carpentier 1987). The young are weaned and leave the nest at 2 weeks of age; females are sexually mature at 4-5 weeks and will breed immediately (Kurta 1995, Carpentier 1987).

Meadow vole populations have the ability to expand very rapidly. For unknown reasons, meadow vole populations expand to 4-40 times their usual numbers every 3-4 years (Kurta 1995, Carpentier 1987, Burt and Grossenheider 1980). It is during the winters of these huge peaks that meadow voles do the most damage to orchards (Kurta 1995).

MOVEMENT
“Although it is terrestrial, [the meadow vole] can climb well, swim freely and will dive to escape predators” (Carpentier 1987:64).

FOOD
The meadow vole feeds primarily on local vegetation including clover, plantain, dandelion, goldenrod, yarrow, seeds, grain, bark, roots, bulbs, fungi, insects and invertebrates (especially caterpillars)(Kurta 1995, Carpentier 1987, Burt and Grossenheider 1980). Adults will often be cannibalistic towards young voles, especially in high stress periods (Carpentier 1987).

Meadow vole feeding habits vary with environmental conditions. In the spring, voles feed
primarily on fresh new growth; in the summer and fall, they feed on the growing portions and seeds. It is only in the winter that voles resort to roots and bark and usually only during high population periods that significant damage is done to trees (Kurta 1995, Carpentier 1987).

PREDATORS/LIMITING FACTORS
The reasons for the 3-4 year population explosion are unclear. The Meadow vole is a primary prey species to many bird and mammal predators (Carpentier 1987). Some of the many predators include snakes, owls, shrikes, hawks, cranes, gulls, foxes, coyotes, raccoons, weasels, shrews, and chipmunks (Kurta 1995).
**Results of Literature Survey**

The information available suggests many options for reducing conflicts between meadow voles and orchards in the Bay of Quinte watershed. General conclusions can be drawn from available information about alternative food sources, beneficial aspects of rodent populations, chemosterilization, cultivar selection, general biology and life history, habitat management/cultural methods, physical barriers, poison, predators, repellents, scaring devices and trapping.

**ALTERNATIVE FOOD SOURCES**
- An alternative food source, such as sunflower seeds, may be used to reduce damage by voles.
- Alternative sources of food are best distributed in winter and early spring, when other sources of food are scarce but this may increase rodent populations in the long run.

**References**
- Protecting Trees from Vole Damage

**BENEFICIAL ASPECTS OF RODENT POPULATIONS**
- Rodents destroy weed seeds.

**References.**
- Weed Seed Destruction by Arthropods and Rodents in Low-input Soybean Agroecosystems
- Protecting Trees from Vole Damage

**CHEMOSTERILIZATION**
- Microencapsulation of chemosterilants improves bait acceptance.
- Diethylstilbersol, mestranol, alpha-chlorohydrin, Quinestrol, onion, pokeweed, rauwolfian, chamomile and hop have been demonstrated to reduce fertility in rodent populations.
- Mestranol in mothers' milk inhibits sexual development of young rodents feeding on the milk.
- All vertebrate reproductive systems (including human systems) are very similar. Chemosterilants therefore have a high inherent potential to effect non-target organisms.
- Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

**References in “Vole” Section**
- Bait Acceptance by Rats of Microencapsulated Male Sterilant Alpha-chlopohydrin
- Effects of Mestranol and Diethylstilbestrol on Captive Voles
- Mestranol as a Reproductive Inhibitor in Rats and Voles
- The Nature, Modes of Action, and Toxicity of Rodenticides
- Progress in Rodent Control and Strategies for the Future
- Prospects for the Use of Some Plant Substances for Rodent Control

207
References in “General” Section

- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant™ Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immunocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

CULTIVAR SELECTION

- Novole rootstock shows resistance to pine and meadow vole damage.

References

- Novole: a Crabapple Selected for Resistance to Pine Voles and Meadow Voles
- Novole, an Apple Stock Resistant to Voles and Other Environmental Hazards
- Novole Apple

HABITAT MANAGEMENT/CULTURAL METHODS

- The most important cultural practice is to mechanically or chemically remove grasses within 60 cm of the base of trees and to keep orchard turf cut. Other cultural methods include removing prunings, brush piles and other cover from orchards and borders.
- Cultural methods are the most effective way to limit vole populations in orchards.
- Cultural techniques will not eliminate rodents, but will reduce rodent damage and the necessity of other control and crop protection practices.
- Rodents prefer to feed in areas with cover.
- In buildings, when it is possible, the removal of food, water, shelter and entrances are the best rodent management practices.

References

- Attracting Birds of Prey Can Improve Rodent Control
- Control of Rats and Mice
- Cover and Efficacy of Predator Based Repellents for Townsend’s Vole (Microtus Townsendii)
- Cultural Practices Affecting Montane Voles in Washington Apple Orchards
GENERAL BIOLOGY, LIFE HISTORY AND FOOD PREFERENCES

- Vole populations fluctuate dramatically for unknown reasons.
- Apple bark is not a preferred food for voles and is eaten only in the absence of alternative foods.

References
- A Method for Describing Former Fluctuations of Voles
- Pine Vole Diet Quality in Relation to Apple Tree Root Damage
- Response of Rodent Populations to Controls

PHYSICAL BARRIERS

- Guards can be effectively used to protect trees.
- Lethal and non-lethal electric fences can be used to protect crops, but these are generally considered to be impractical and sometimes unsafe.

References
- Evaluation of Nonlethal Electrical Barriers for Crop Protection Against Rodent Damage
- Fish and Wildlife Habitat Management: Best Management Practices
- Protecting Trees from Vole Damage
- Rodent and Deer Control in Orchards
- Vole (Mouse) Control

POISONS

- Many different chemicals have been used to poison rodents. These includes acute rodenticides, anticoagulants and fumigants.
- Rodenticides present a risk to the applicator and primary and secondary hazards to wildlife. The threats to wildlife from first and second generation anticoagulants and acute rodenticides
have been documented.

- Broadcast application of rodenticides presents a greater risk to nontarget organisms and is inefficient for long term control.
- The use of bait stations increases the life expectancy and effectiveness of rodenticides while reducing chances of primary poisoning to non-target organisms.
- Single-dose, non-anticoagulant rodenticides are less selective, rapidly acting and generally the most hazardous of rodenticides.
- Anticoagulant rodenticides are safer for the applicator but may pose greater risks to wildlife.
- Rodent populations can rebound quickly from poisoning.
- Repeated use of the same rodenticide or bait selects for neophobia and resistance to the rodenticide, the bait or both. Varying rodenticides and baits will slow this process.
- Microencapsulated can improve bait acceptance.
- Prebaiting can improve bait acceptance and decrease resistance.
- Zinc phosphide has an odor which is attractive to rodents but repulsive to other animals.

References.

- An Antibiotic Rodenticide for Pine Voles in Orchards
- Anticoagulant Rodenticide in Paper Tubes for Control of Meadow Mice
- An Assessment of the Secondary Poisoning Hazard of Warfarin to Tawny Owls
- Bait Acceptance by Rats of Microencapsulated Male Sterilant Alpha-chlopophydrin
- Chloropicrin Tested as an Area Repellent for House Mice
- Control of Rats and Mice
- The Cost and Effectiveness of Controlling Microtus by Zinc Phosphide
- Design and Evaluation Criteria for Development of Toxic Wicks for Rodent Control
- Effects of Hand Baits and Ground Sprays on Pine Vole Activity
- Evaluation of Rodent Bait Station Use under Controlled Conditions
- Exploitable Characteristics of Neophobia and Food Aversions for
- Improvements in Rodent and Bird Control
- Hazards to Birds from Zinc Phosphide Rat Bait in a Macadamia Orchard
- L-1900 Controlling Rats and Mice with Anticoagulants
- L-1905 Controlling Mole Damage
- L-1916 Control of Rats and Mice
- Laboratory Tests on the Effectiveness of Prolin Mouse Tubes
- The Nature, Modes of Action, and Toxicity of Rodenticides
- New Compound (Rh 787) for Use in Control of Orchard Voles
- Progress in Rodent Control and Strategies for the Future
- Protecting Trees from Vole Damage
- Rationale for Testing Vertebrate Pesticides and Devices in Actual Field Situations
- Residues of the Rodenticide Brodifacoum in Voles and Raptors after Orchard Treatment
- Response of Rodent Populations to Controls
- Responses of Siberian Ferrets to Secondary Zinc Phosphide Poisoning
- Rodent Free Using Permanent Bait Stations
- Rodent and Deer Control in Orchards

210
Rodents and Rodent Control
- The Safety and Efficacy of Brodifacoum (Klerat) Wax Blocks and Zinc Phosphide for Rodent Control in Thailand
- Secondary Poisoning of Owls by Anticoagulant Rodenticides
- Vole (Mouse) Control
- Wildlife Damage in Orchards--a Need for Better Management

PREDATORS
- Rodents are an important part of the food chain and are the primary food source for many birds, snakes and mammals.
- Mouse species are the primary food for red foxes in the United States.
- Predators increase or decrease their consumption of voles depending on relative abundance of prey species.
- In South Dakota, 12.2% of a coyote’s diet is made up of mouse species.
- In Maine, small mammals make up 21% of coyote diet from May to October.
- Meadow voles and deer mice are a staple in red fox diets.
- Small areas may be protected from rodent infestations by dogs and cats.
- It has not been demonstrated that raptor populations can be manipulated to reduce damage to crops.
- Mice are the primary food source for many birds of prey.
- Raptors may be poisoned by eating rodents that have ingested anticoagulant rodenticides.
- Tall weeds and grasses reduce raptor hunting success.
- Raptors will use artificial perches.
- One perch per acre will maximize hunting opportunities for raptors.
- Artificial perches should have cross bars so that raptors can perch against the prevailing wind.
- Artificial perches 5 meters high are preferred to 2.5 meter perches.
- Raptors will use nest boxes.
- Kestrels will be attracted to nest boxes only in open areas.
- One nest box per 20 acres will maximize nesting opportunities for raptors.
- Nest boxes should face south.
- Nest boxes should not be placed in areas where they may be sprayed.

References
- Attracting Birds of Prey Can Improve Rodent Control
- Control of Rats and Mice
- Coyote Foods in the Black Hills, South Dakota
- The Ecology of Red Foxes, Gray Foxes and Rabies in the Eastern United States
- Evaluation of Nonlethal Electrical Barriers for Crop Protection Against Rodent Damage
- Fish and Wildlife Habitat Management: Best Management Practices
- Foods of Adult Main Coyotes and Their Known Age Pups
- Kestrels-friends for Farmers
- A Mechanical Recorder for Measuring Raptor Perching Activity
REPELLENTS

- Chloropicrin, thiram, TMTD, TBTC, R-55, endrin and quebracho have been used as repellents.
- Predator based repellents are variably effective.
- Repellents will be most effective as a supplement to other controls.
- When there is no alternate food source, repellents will not always be effective.

References

- Chloropicrin Tested as an Area Repellant for House Mice
- Cover and Efficacy of Predator Based Repellents for Townsend’s Vole (Microtus Townsendii)
- Fish and Wildlife Habitat Management: Best Management Practices
- The Nature, Modes of Action, and Toxicity of Rodenticides
- Protecting Trees from Vole Damage
- Quebracho, Thiram, and Methiocarb Reduce Consumption of Apple Twigs by Meadow Voles
- Sonic Deterrents in Animal Damage Control: a Review of Device Tests and Efficiency

SCARING

- In laboratory situations, sound has been used to repel or even kill rodents.
- Sounds capable of repelling or killing rodents are difficult to create and may pose risks to the applicator.
- Scaring devices, including ultrasound, electromagnets and ultraviolet lamps, have been ineffective at reducing rodent populations in the field.

References

- Control of Rats and Mice
- Progress in Rodent Control and Strategies for the Future
- Rationale for Testing Vertebrate Pesticides and Devices in Actual Field Situations
- Responses of Confined Rodent Populations to an Ultrasound Generator
- Rodents and Rodent Control
- Sonic Deterrents in Animal Damage Control: a Review of Device Tests and Efficiency
TRAPPING
- Trapping is practical only indoors.
- Trapping is labor intensive.
- Trapping is most useful as a supplement to other control measures.

References
- Control of Rats and Mice
- L-1905 Controlling Mole Damage
- L-1916 Control of Rats and Mice
- Progress in Rodent Control and Strategies for the Future
- Rodents and Rodent Control
Summary of Selected References

AN ANTIBIOTIC RODENTICIDE FOR PINE VOLES IN ORCHARDS
Robert A. Stehn, Elizabeth A. Johnson and Milo E. Richmond. New York Cooperative Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY 14853

This paper describes the effects of DMCT (a fluorescent tooth marking agent, previously considered to be non-toxic to pine voles) on pine voles. Field tests demonstrate toxicity, and the authors suggest that the chemical could be used as a vole control in commercial orchards. The authors note that the chemical is not persistent in the environment and would not likely present secondary poisoning hazards to predators and scavengers. The paper recommends permanent bait stations to "facilitate bait placement and bait acceptance by orchard pine voles" (p.275).

ANTICOAGULANT RODENTICIDE IN PAPER TUBES FOR CONTROL OF MEADOW MICE
John L. Libby. Department of Entomology, University of Wisconsin, Madison
Joe I. Abrams. Wisconsin Alumni Research Foundation, Madison

The Prolin™ tube is a weather resistant cardboard bait station, the inside of which is coated in edible glue and approximately 1 oz (28 g) of grain coated with equal parts Warfarin (3[α-acetonyl-benzyl]-4-hydroxycoumarin) and sulfaquinoxaline (N'-2-quinoxalylsulfanilamide). This tube was tested against meadow voles (Microtus pennsylvanicus) in a laboratory situation. When mice were placed in a baited caged area with apple trees, they were dead within five days. Orchard test plots with prolin mouse tubes were protected from vole depredation for 2 months.

The tubes protected bait from rain and mold and were found to be more effective than zinc phosphide or strychnine baits in Wisconsin. The authors conclude, "The meadow mice, dead and dying from the action of Prolin, seem unlikely to cause a secondary poisoning to predatory wildlife based on results obtained with dogs" (p.518).

AN ASSESSMENT OF THE SECONDARY POISONING HAZARD OF WARFARIN TO TAWNY OWLS
Michael G. Townsend, Edward M. Odam, Peter I. Stanley and Mark R. Fletcher. Tolworth Laboratory, Ministry of Agriculture, Fisheries and Food, Tolworth, Surrey KT6 7NF, United Kingdom
The experiment studied the secondary poisoning hazard to tawny owls fed warfarin contaminated mice for 3 months. Food consumption, wing molt, body weight, pellet production and residues in owl tissues were measured. The authors conclude, "It is unlikely that tawny owls in commercial woodlands treated with warfarin bait for gray squirrel control will obtain a lethal dose from consuming warfarin contaminated mice...[but] the significance of sublethal effect in wild tawny owls is not known" (p.247).

ATTRACTING BIRDS OF PREY CAN IMPROVE RODENT CONTROL
Geraldine Warner. Editor, Wenatchee, Washington

Leonard Askham, a retired vertebrate pest management expert from Washington state university says birds of prey can be attracted to orchards with high densities of rodents by building perches and nest boxes. He says, "Keeping orchard grass mowed is the best rodent management strategy, but attracting predators can enhance vole control" (p.23). Voles are more likely to do damage in orchards with a lot of weeds and grass around the base of trees. These weeds and grass also reduce hunting success of raptors.

Askham suggests open areas for kestrel nesting boxes and more sheltered areas (such as in barns) for owl nest boxes. He recommends one box per 20 acres. He says owl boxes should be put out by January and kestrel boxes by April. The boxes should face south and be placed where they will not be sprayed with pesticides. Several inches of wood chips should be placed in the bottom of each box and replaced yearly.

Since birds use less energy when hunting from perches, Askham recommends erecting perches. Perches should have a crossbar. "The crossbar should be oriented so that birds can land on it against the prevailing wind. Where wind directions vary, two crossbars should be used. One perching pole per acre should provide the birds with enough perches for optimal hunting" (p.23).

The article includes diagrams for constructing owl and kestrel nest boxes.

BAIT ACCEPTANCE BY RATS OF MICROENCAPSULATED MALE STERILANT ALPHA-CHLOPOHYDRIN
R.J. Ericson. Fertility Research, The Upjohn Company, Kalamazoo, Michigan
H. E. Downing. Agricultural and Veterinary Activities, Upjohn International, Kalamazoo, Michigan
R. E. Marsh and W. E. Howard. Department of Animal Physiology, University of California, Davis

215
The study found that the chemosterilant Alpha-chlorohydrin (U-5897) at 1% concentrations resulted in sterility or death in wild and domestic rats. Microencapsulation of U-5897 significantly improved bait acceptance.

CHLOROPICRIN TESTED AS AN AREA REPELLENT FOR HOUSE MICE

Chloropicrin was evaluated for effectiveness against house mice (Mus musculus) in granaries. Mouse activity was reduced 23-83% in the granaries treated. The agent acts as a repellent and as a toxicant and “will remove house mice from confined spaces if correct concentrations are chosen” (p.748).

CONTROL OF RATS AND MICE
Agriculture Canada. Publication 1370
Information Services, Agriculture Canada, Ottawa K1A OCA

The publication includes descriptions of common rodent species and gives recommendations for rodent proofing buildings, eliminating shelter, food, water and nesting sites, poisoning, fumigating and baiting. Trapping, ultrasonic and natural predators are also discussed. Different types of poisons are described.

THE COST AND EFFECTIVENESS OF CONTROLLING MICROTUS BY ZINC PHOSPHIDE
E. W. Jamerson, Jr. Department of Zoology, University of California, Davis, California

The author concludes that despite its widespread use, zinc phosphide is not very effective on wild mice. Four trials were conducted and the average reduction in mouse populations was 95.5 ± 1.3 percent immediately after treatment, but 10 days later the average population reduction was only 82.4 ± 2.2 percent. The author attributes this change to the migration of wild mice into the field.

Note: these results were obtained for broadcast application, not application in bait station.
Cover and Efficacy of Predator Based Repellents for Townsend's Vole (Microtus Townsendii)
M. Merkens, A. S. Harestad and T. P. Sullivan. Department of Biological Science, Simon Frazer University, Burnaby, British Columbia, V5A 1S6

The paper states that predator based repellents have not always been effective wildlife management tools. The study looked at the relationship between cover, predator odors and feeding behavior of the Townsend's vole. By comparing "cover", "no cover plus repellent" and "cover plus repellent" to "no cover no repellent", the study found that voles preferred to feed in covered areas regardless of whether repellents were present or not. Predator odors were considered to be effective, but somewhat dependent on surrounding cover conditions.

Coyote Foods in the Black Hills, South Dakota
James G. MacCracken. Agricultural Experiment Station, University of Alaska, Palmer Research Center, P. O. Box AE Palmer, AK 99645
Daniel W. Uresk. USDA, Forest Service, Rocky Mountain Forest Service, Rocky Mountain Forest and Range Experiment Station, Rapid City, SD 57701

Prey remains (expressed as % dry matter) in coyote scat are broken down by season and species. Overall 43.5% of coyote food was white-tailed deer, 16.2% was mountain cottontail and 12.2% was various mouse species.

Cultural Practices Affecting Montane Voles in Washington Apple Orchards
M. E. R. Godfrey. Washington State University, Tree Fruit Research Center, Wenatchee, Washington 98801

The article stresses the importance of cultural methods in reducing the need for rodenticides. Cultural practices include, closely mowed turf, herbicide strips, clean borders and removal of prunings, bins and rubbish from the orchard. "Although cultural practices alone will not eliminate all voles and prevent damage, particularly in years of high population density, their effect is substantial and the need for rodenticides is reduced" (p.127).
DESIGN AND EVALUATION CRITERIA FOR DEVELOPMENT OF TOXIC WICKS FOR RODENT CONTROL
Karl D. Morris. Field Biologist, ICI Americas Inc., Goldsboro, NC 27530
Robert D. Proctor. Formulation Chemist, ICI Americas Inc., Goldsboro, NC 27530
Dale E. Kaukeinen. Technical Representative, ICI Americas Inc., Goldsboro, NC 27530

The paper examines the use of a brodifacoum wick as a commercial product for house mouse control. The wicks are placed so that the poison gets on the mouse and is then consumed through grooming. Device construction, composition, concentration of toxicant, placement, longevity, safety and rodent susceptibility and behavior are discussed. The device seems to have worked on poultry farms and in a flour mill and the authors conclude that, “These devices have great potential for mouse control under certain circumstances, including within stacked or pelletized commodities, where conventional control techniques and measures are inappropriate, or in areas with large amounts of competitive foodstuffs, where baits may not be readily accepted” (p.180).

THE ECOLOGY OF RED FOXES, GRAY FOXES AND RABIES IN THE EASTERN UNITED STATES
Andrew B. Carey. USDA Forest Service, 180 Canford Street, Morganstown, WV 26505

The paper identifies the most important food items for foxes to be rodents (*Microtus* and *Peromyscus*), lagomorphs (rabbits, hares and picas), vegetation (including fruit) and insects in that order. Other foods of less importance include fish, carrion, reptiles and amphibians. The paper’s primary focus is rabies ecology and what causes its localization. The paper finds rabies distribution is not directly related to landscape features or food preferences. The paper goes on to discuss possible mechanisms maintaining the virus in nature and suggests future study.

EFFECTS OF HAND BAITS AND GROUND SPRAYS ON PINE VOLE ACTIVITY
R. E. Beyers. Virginia Polytechnic Institute and State University, Winchester Fruit Research Laboratory, Winchester, Virginia

“Pine vole, (*Microtus pinetorum*) activity was reduced to very low levels with [(chloro-4-phenyl)-1-phenyl-1] acetyl-2-dioxo-1-3 indane (Chlorophacinone, CPN) ground cover spray at .2 kg/ha (.2lb/acre) and a CPN wax grain pellet applied in two applications of 11.2 kg/ha (10 lb. per acre) each. Inadequate control of voles was obtained with traditional zinc phosphide (ZnP2) treated apple and oat hand baits, CPN treated cracked corn, CPN wax blocks, CPN apple baits, and 2-diphenylacetyl-1,3-indandon (Diphacinone, DPN) meal pellets.
Ground cover sprays of ethyl 4-(methio)-m-tolyl isopropyl phosphor-amidate (Nemacur) or methyl N',N'-dimethyl-N-[(methylcarbamoyl)oxy]-1-thioxamimidate (Vydate) also did not give adequate vole control” (p.122).

EFFECTS OF MESTRANOL AND DIETHYLBESTROL ON CAPTIVE VOLES
G. L. Storm. Department of Ecology and Behavioral Biology, University of Minnesota, Minneapolis
Glen C. Sanderson. Illinois Natural History Survey, Urbana

The physiological effects of DES (diethylstilbestrol) and mestranol (17-ethynyl-3-methoxyestra-1,3,5(10)-trien-17-01), fed directly or through mother’s milk, on male and female vole’s reproductive organs, adrenals, kidneys and spleen were measured. At various treatment levels, ovary and testes weights were reduced, where as uteri, kidneys and adrenals weights were increased by the agents.

EVALUATION OF NONLETHAL ELECTRICAL BARRIERS FOR CROP PROTECTION AGAINST RODENT DAMAGE
M. W. Fall. Research Biologist, Denver Research Center, U. S. Fish and Wildlife Service, Denver, Colorado 80225

The non lethal barrier was found to have several advantages over lethal barriers now used in the Phillippines to protect rice fields from rats. These advantages include safety, lower labor costs and longer battery life.

EVALUATION OF RODENT BAIT STATION USE UNDER CONTROLLED CONDITIONS
Dale E. Kaukeinen. Senior Research Biologist, Biological Research Center, ICI Americans, Goldsboro, NC 27530

Eight “tamper proof” bait stations for Norway rats and other rodents were compared in
replicated controlled experiments. There was significant variation in complexity of devices. It was found that, “In general, simpler designs showed more rapid and greater utilization and bait consumption” (p.103).

EXPLOITABLE CHARACTERISTICS OF NEOPHOBIA AND FOOD AVERSIONS FOR IMPROVEMENTS IN RODENT AND BIRD CONTROL

J. Russell Mason. Assistant member, Monell Chemical Senses Center, Philadelphia, Pa. 19104

The paper reviews important behavioral defenses against dietary poisoning in birds and rodents including neophobia (avoidance of new foods and flavors), primary food aversion (avoidance of bad or bitter tastes) and learned food aversion (avoidance of foods which have caused illness in the past). Taste cues are an important part of a rodent’s defense system. The paper then discusses animal behaviors (rodent grooming in the presence of poisons), masking agents, microencapsulation and prebaits as possibilities for overcoming these defenses.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES

Agriculture and Agri-Food Canada, 1996.

This document offers “Best Management Practices” determined by a team of “farmers, researchers, resource managers, extension staff, and agribusiness professionals” to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, racoons, deer and birds are also included.

Suggested options for rodent control include tree guards, repellents, cats, removing ground cover and other rodent shelter, preventing access to buildings and installing hawk and owl perches.

FOODS OF ADULT MAIN COYOTES AND THEIR KNOWN AGE PUPS

Daniel J. Harrison and Joyce A. Harrison. Main Cooperative Wildlife research Unit, 240 Nutting Hall, Orono, ME 04469
The paper documents percent occurrence of food items in adult and pup coyote scats from May to October. White-tailed deer was detected in 43%, snowshoe hare in 30% and small mammals in 21% of all coyote scats.

HABITAT SELECTION BY SMALL MAMMALS OF RIPARIAN COMMUNITIES: EVALUATING EFFECTS OF HABITAT ALTERATIONS
Anthony R. Greier and Louis B. Best. Department of Animal ecology, Iowa State University, Ames, IA 50011

Riparian communities were classified into 6 general habitat types in Iowa (channelized, wet floodplain, dry floodplain, heavily grazed upland, lightly grazed upland and ungrazed upland). The abundance of 9 small mammals (mice, voles, shrews, chipmunks and squirrels) was related to 12 variables of those 6 general habitat types. Small mammal diversity was greatest in channelized habitats and lowest in dry floodplains. The likely effects of habitat alterations on small mammals are described.

Of interest to Bay of Quinte growers, the meadow vole (Microtus pennsylvanicus) was the species most intolerant of loss of preferred habitat (channelized). Meadow voles were correlated with microhabitat variables and were found to be negatively correlated with plant species richness and positively correlated with forbs. Of the 9 small mammals in the study, 7 were negatively correlated with plant species richness.

The paper concludes with habitat alterations likely to affect the 9 small mammal species. Based on their data set, thinning and/or removal of deciduous trees would likely increase meadow vole populations and the reduction of forb and/or grass cover would decrease vole populations.

HAZARDS TO BIRDS FROM ZINC PHOSPHIDE RAT BAIT IN A MACADAMIA ORCHARD
David P. Fellows. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, P.O. Box 2096, Jamestown, ND 58402
Larry F. Panko. U.S. Fish and Wildlife Service, Alaska Office of Fish and Wildlife Research, 1011 East Tudor Road, Anchorage, AK 99503
Richard M. Engeman. Animal and Plant Health Inspection Service, Animal Damage Control, Denver Wildlife Research Center, Balding 16, Denver Federal Center, P.O. Box 25266, Denver, CO 80225-0266

This paper examines the effects on bird populations of oat rat baits treated with 1.88% zinc phosphide poison, broadcast into sugarcane fields in Hawaii. The paper concludes,
“widespread acceptance of bait and limited mortality documented in this study indicate that orchards should not be [broadcast] baited if indigenous seed eating birds are present” (p.416).

KESTRELS-FRIENDS FOR FARMERS
Contact: Agricultural Habitat Specialist, OFAH, P.O. Box 2800, Peterborough, Ontario, K9J 8L5

The kestrel eats mice, voles, small birds, grasshoppers and other insects which may damage crops. The bird’s natural nesting site is a tree cavity but it can be attracted to nesting boxes in open areas or along fencerows. The paper lists materials and tools needed, as well as building and placement instructions.

L-1351 EFFECTIVE RODENT CONTROL ON POULTRY FARMS
1981 Texas Agricultural Extension Service WWW / Gopher Server Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Fred D. Thornberry, William O. Cawley & Danny M. Hooge

“Rodents consume and contaminate poultry feed and spread diseases and mites. They also damage insulation, curtains, equipment and electrical wiring. Rats may even harm chicks, poult's and eggs. This leaflet discusses the rodent life cycle, as well as how to prevent and control infestations. This 4-page publication contains 2 illustrations and 2 photographs.”

L-1900 CONTROLLING RATS AND MICE WITH ANTICOAGULANTS
1992 Texas Agricultural Extension Service WWW / Gopher Server Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
John Hobbs

This 2-page publication gives information about use of anticoagulants for rat and mouse control, and exposing and handling the baits for the best results.

L-1905 CONTROLLING MOLE DAMAGE
1992 Texas Agricultural Extension Service WWW / Gopher Server Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Virgil V. Parsons

“Like prairie dogs and gophers, moles can cause a considerable amount of damage to crops
and livestock. This leaflet explains the proper way to set choker loop traps and harpoon traps. Cultural controls and habitat modifications such as packing the soil with rollers or reducing soil moisture are discussed. Moles also can be controlled with toxicants and fumigants. This 4-page publication contains 5 illustrations.

**L-1916 CONTROL OF RATS AND MICE**
1992 Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
Theresa Stean

"House rats and mice eat and contaminate human and animal food and they damage and destroy property. This leaflet explains how to identify rats and mice by their droppings, runways, food crumbs and noises. Control methods such as habitat manipulation and the use of traps and rodenticides are discussed. Suggestions for rat prevention are also given. Illustrations show how to seal openings around pipes and foundations with concrete or sheet metal. Another drawing demonstrates how a trap trigger can be extended with a piece of cardboard. This 3-page publication has 4 illustrations."

**LABORATORY TESTS ON THE EFFECTIVENESS OF PROLIN MOUSE TUBES**
Rex E. Marsh. Department of Animal Physiology, University of California, Davis.

The experiment assessed the lethality and acceptability of prolin mouse tubes to 8 types of mice (*Microtus*) in laboratory situations. The Prolin tube is a weather resistant cardboard bait station whose inside is coated in edible glue and approximately 1 oz (28 g) of grain coated with equal parts Warfarin (3(α-acetyl-benzyl)-4-hydroxycoumarin) and sulfáquinoxaline (N'-2-quinoxalylsulfanilamide). The tube was tested against the western harvest mouse (*Reithrodontomys megalotis*), Montane meadow mouse (*Microtus montanus*), California meadow mouse (*Microtus californicus*), house mouse (*Mus musculus*), yellow pine chipmunk (*Eutamias amoenus*), deer mouse (*Peromyscus maniculatus gambelii*), deer mouse (*Peromyscus maniculatus rubidus*) and pinyon mouse (*Peromyscus truei*). The study measured the average bait consumption per rodent, deaths per animal, range of days to death and average number of days to death for each species. The experiment also found that the rodents were more accepting of oats and wheat than of corn.

**A MECHANICAL RECORDER FOR MEASURING RAPTOR PERCHING ACTIVITY**
John D. Forren and David E. Samuel. Department of Wildlife Biology, West Virginia University, Morgantown, WV 26506
Russell R. Haynes. Department of Engineering, West Virginia University, Morgantown, MV
The study examined raptor use of perches and the paper describes a mechanical device which can record raptor perching. A perch mechanism capable of recording perching activity was used to monitor raptor activity and was checked by personal observation. The paper names and describes the parts necessary to build the devices. Diagrams and descriptions of how to build the recorder are given. The total cost of materials for one recorder was 12 dollars.

In the study, the recorders produced 13,158 hours of usable data. American kestrels perched 5,933 times, red-tailed hawks 33 times and great-horned owls 22 times (owls were identified by weights and time but were not confirmed visually). Perching times varied from 1 to 75 minutes.

Problems with the original design and necessary modifications are noted.

**MESTRANOL AS A REPRODUCTIVE INHIBITOR IN RATS AND VOLES**
Walter E. Howard and Rex E. Marsh. Department of Animal Physiology, University of California, Davis

The study was conducted on Norway rats and two species of vole, (*Microtus californicus* and *M. Monanum*) but not the meadow vole (*M. Pennsylvanicus*). The animals were free-fed a synthesized estrogen called mestranol (17-ethynyl-1-3-methoxyestra-1,3,5 (10)-trien-17-ol) known to prevent normal sexual development when force fed to rats. In the study, the hormone was ineffective on rats as they developed a food aversion to treated food. The voles, however, repeatedly accepted foods with mestranol concentrations of 0.0005%. The chemical was concentrated in mothers' milk and passed on to young who then failed to develop sexually later in life.

**A METHOD FOR DESCRIBING FORMER FLUCTUATIONS OF VOLES**
Lars Ericson and Krister Jakobson. Department of Ecological Botany, University of Umeå, S-901 87 Umeå, Sweden

The paper estimates fluctuations in vole population density in a specific location during the previous 7-15 years by examining the amount of bark gnawing. By assuming that bark gnawing is a function of population, an index of historic vole densities can then be derived by examining gnawed bark on annual rings.
THE NATURE, MODES OF ACTION, AND TOXICITY OF RODENTICIDES
Peter J. Savarie

The paper is a technical review of major chemicals and groups of chemicals used to kill or control rodent populations. How the chemicals are applied, how widespread their use has been historically, chemical composition, active ingredients, antidotes, and known effects on organisms are detailed. Unknowns are also identified. Chemicals discussed are acute rodenticides, chronic rodenticides, fumigants, repellents and chemosterilants.

Acute rodenticides included are: inorganics (zinc phosphide, arsenic trioxide, thallium sulfate, phosphorous and barium carbonate), red squill, strychnine, aliphatic florines (sodium fluoroacetate 1080, fluoroanetamide 1081 and gliftor), ANTU, crimidine, phosacetim (gophacide), norbormide, central nervous system depressants (alphachloralose and reserpine), calciferol, pyrinuron (RH-787) and chlorinated hydrocarbons (DDT, lindane and endrin).

Chronic rodenticides included are: coumarins (warfarin, difenacoum, brodifacoum and bromadiolone) and indandiones (pindone, diphacinone, chlorophacinone and calcium salt).

Fumigants included are: calcium cyanide, sodium cyanide, carbon bisulfate, carbon disulfate, methyl bromide, aluminum phosphide and chloropicrin.

Repellents included are: thiram, TMTD, TBTC, R-55 and endrin.

Chemosterilants included are: mestranol, BDH-10131, U-5897, and butandiol-bis-methane sulfonic acid ester.

NEST BOX AND PERCH INSTALLATION FOR RAPTORS
Article: 4588 of the news group: alt.sustainable.agriculture, posted by caingels@ucdavis.edu
Chuck Ingels. Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616. Voice: (916) 757-3276, Fax: (916) 757-3281, E-mail: caingels@ucdavis.edu

The author has done research in enhancing rodent control with raptors. His posting included a questionnaire for people who have used nesting boxes and perches. He asked for additional information on the effects of installing boxes and perches and any academic references related to this subject. He included 22 selected references, some of which included nest box and/or hawk perch designs. They were:

NEW COMPOUND (RH 787) FOR USE IN CONTROL OF ORCHARD VOLEs
Ross E. Byers. Virginia Polytechnic Institute and State University, Winchester Fruit Research Laboratory, Winchester 22601

The study examines the laboratory effects of a possible niacin antimetabolite (1-{3 pyridylmethyl}-3-{4-nitrophenyl} urea, RH 787 on adult pine voles (Microtus pinetorum) and meadow voles (M. Pennsylvanicus) trapped in orchards in Virginia. The paper gives Ld50 values, pre treatment and post treatment population levels, etc. The chemical was very
effective at reducing vole populations in the laboratory. The paper concludes, "hand placement of zinc phosphide and chloroprophacinone apple baits has not provided adequate control of pine voles in experimental plots...the results herein suggest the ineffectiveness of apple baits has been due to the nature of the toxicant used, not the apple bait as a carrier" (p.171).

"NOVOLE": A CRABAPPLE SELECTED FOR RESISTANCE TO PINE VOLES AND MEADOW VOLES
J. N. Cummins, H.S. Aldwinckle and R. E. Byers. New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456

The paper describes the results of a five year project examining the inherent resistance to the pine vole (Microtus pinitorum) of 300 clones of Malas species and interspecific hybrids. The studies found that a Japanese crabapple, "Novole", and many of its hybrids had inherent resistance to the pine vole. Novole is resistant to fire blight but susceptible to stem pitting virus and stem grooving virus.

NOVOLE, AN APPLE STOCK RESISTANT TO VOLES AND OTHER ENVIRONMENTAL HAZARDS
J. N. Cummins, H.S. Aldwinckle and R. E. Byers. New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456

The authors claim Novole has "inherent host resistance" to pine vole (Microtus pinitorum) and meadow vole (Microtus pennsylvanicus).

"NOVOLE" APPLE
Hortscience. 18:772-774, 1983.
J. N. Cummins, H.S. Aldwinckle and R. E. Byers. New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456

The article reports on the trial use of "Novole" as vole-resistant root and trunk stock for commercial apple orchards. Novole has a number of resistances including resistances to pine and meadow voles.
PINE VOLE DIET QUALITY IN RELATION TO APPLE TREE ROOT DAMAGE
Frederick A. Servello, Roy L. Kirkpatrick, Kenneth E. Webb, Jr. and Alan R. Tipton.
Department of Fisheries and Wildlife Services, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

An analysis of the percent of digestible dry matter and digestible energy in the seasonal diets of pine voles found that apple tree bark is not a preferred food for pine voles and that the consumption of bark in the winter is a result of decreased availability of food, not change in diet preferences.

PROGRESS IN RODENT CONTROL AND STRATEGIES FOR THE FUTURE
A. B. Lazarus

The author argues that it is necessary to develop new rodent control strategies since anticoagulant resistance has led to the use of more toxic anticoagulants, and greater risks to non target organisms and the environment. The author reviews methods of control and estimates future aspects of rodent control. Control options discussed include exclusion, trapping, biological control, single dose and multi dose rodenticides. He refers to ultrasonic generators, ultraviolet lamps, magnetic devices, chemical repellents and electric fences for exclusion as being of little practical value. Trapping is criticized as being too labor intensive, and use of dogs cats, mongoose and weasel have been useful only in small areas.

Single dose non-anticoagulant rodenticides including zinc phosphorous, floracetamide, alpha-chloralose and norbormide are described generally as being non-selective, rapidly acting and therefore “extremely hazardous”. Multi dose anticoagulant rodenticides such as warfarin, hydroxycoumarin and indandione “revolutionized rodent control.... The relative safety of these anticoagulants to non-targets, together with the increased efficacy and ready availability of an antidote of vitamin K, resulted in almost universal reliance on them for tackling pest problems” (p.57). By 1960 resistance began to be documented.

Future approaches will include, according to the author, chemosterilization, second generation anticoagulants, new bait formulations, modified baiting techniques, selective rodenticides and the development of integrated rodent management.

Rat populations in a dump in England have been effectively sterilized for 6 months with synthetic oestrogenic steroids at 0.05% concentration in bait. Alpha-chlorohydrin has been marketed as a “male-rat-specific chemosterilant and as a lethal rodenticide- a ‘toxicant-sterilant’. However, alpha-chlorohydrin is not palatable to rats and it is not a species-specific poison” (p.58)
Second generation anticoagulants including difenacoum, bromadiolone, brodifacoum and flocoumafen are more expensive, more effective and of much greater toxicity. Some wild rat populations have already developed resistance to both difenacoum and bromadiolone.

Norbomide and alpha-chlorohydrin both show “selective toxicity to rats” (p.60).

The integrated management system envisioned by the author includes prebaiting, “prebaiting for two weeks can markedly improve anticoagulant rodenticide bait intake” (p.61). He also recommends practices to reduce resistance of rodents such as using a variety of control techniques.

PROSPECTS FOR THE USE OF SOME PLANT SUBSTANCES FOR RODENT CONTROL
V. Nardi, S. de Santos and M. Cristaldi. Laboratorio di Recerche Fitobiologiche, Via Varrone 9, 00192 Rome, Italy.

The paper lists plants with chemosterilant and abortive properties which may be of use in rodent control in the future. Onion (Allium cepa L.), and pokeweed (Phytolacca americana L.) contain female chemosterilants and Rauwolfia extracted from Rauwolfia serpentina Benta inhibits both male and female fertility. Wild chamomile (Matricaria chamomilla L.) and hop (Humulus lupulus L.) both contain abortive agents.

PROTECTING TREES FROM VOLE DAMAGE
Ontario Ministry of Natural Resources. Agdex 681, Queens Printer, 1995.

This 4 page document describes the appearance, habitat and diet of the redback, pine and meadow vole. Viable options for protecting trees and shrubs include removing vole habitat, providing alternative food sources, shelters and guards, repellents and poisons.

QUEBRACHO, THIRAM, AND METHIOCARB REDUCE CONSUMPTION OF APPLE TWIGS BY MEADOW VOLES
Robert K. Swihart. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

While anticoagulant toxicants employed in orchards are usually effective at reducing vole populations, the meadow vole’s (Microtus pennsylvanicus) adaptability to a wide variety of habitats and prolific breeding make it the hardest of all voles to control. Further, toxic baits are hazardous to nontarget species feeding on poisoned voles. This experiment examined the
efficiency of three compounds at reducing consumption of apple twigs through repellency in a laboratory situation.

The three chemicals, quebracho (a condensed tannin), thiram and methiocarb (3,5-dimethyl-4-{methylthio}-phenyl methylcarbamate) reduced average consumption of twigs 92, 78 and 68 percent respectively when alternative foods were available. Consumption of twigs treated with quebracho and thiram were constant when the alternate food was removed. The consumption of twigs treated with methiocarb, however, increased significantly when alternate foods were not available.

**RAPTOR USE OF ARTIFICIAL PERCHES**
Timothy R. Hall, Walter E. Howard and Rex E. Marsh. Wildlife and Fisheries Biology, University of California, Davis, CA 95616

This study examined whether raptors used perches for hunting as well as roosting, raptor preference for perch heights (2.5 vs. 5m), and raptor acceptance of lower perches in the absence of taller ones. The study did not evaluate the effects on rodent populations or crop losses. 36 perches were placed in freshly mowed alfalfa fields. All 36 perches were used by barn owls, great-horned owls and American kestrels during the 8-day study period. Red-tailed hawks and marsh hawks were also observed using the perches during the study. Red-tailed hawks, American kestrels and great-horned owls were observed capturing rodents from the perches. In the study, American Kestrels and great-horned owls showed a preference for the 5-m perches, but accepted the 2.5m perch in their absence. The barn owls showed no preference and the marsh and red-tailed hawks were too infrequent to assess perch preferences.

**RAPTOR USE OF NEST BOXES AND PLATFORMS ON TRANSMISSION TOWERS**

The paper documents the use of nesting boxes and platforms and makes recommendations for their placement on H-frame towers. Raptors did not nest on platforms in areas where natural nesting sites were abundant (primarily old dead trees), and starlings were found to occupy nest boxes in farmlands. Nest boxes moved to treeless grasslands were then occupied by kestrels.
RATIONALE FOR TESTING VERTEBRATE PESTICIDES AND DEVICES IN ACTUAL FIELD SITUATIONS
J. R. Beck. Biological Environmental Consultant Services, Birmingham, Michigan. 48008
H. S. Stein, Jr. President, Crane Pest Control, San Francisco, California. 94118

The paper discusses problems, limitations and failures resulting from the extrapolation of laboratory and limited field test results to actual field situations. 9 cases in the last 25 years are described. They include: (1) Quality control problems in large scale manufacture of “Checkmate” rodenticide leading to poor taste and therefore unreliable results for an otherwise effective rodenticide; (2) Certain rodent bait formulations are effective only in specific macro-climates; (3),(5),(7) Using carriers for toxicants that are not recognized as food by the target species; (6) “Furthermore” Colored Rat Pellets “come in beautiful, colored packages with impressive laboratory tests and credentials. Rats are color-blind and of discriminating and varying tastes. We have found that rats threatened with starvation may choose to eat it” (p.292); (8) Ultrasonic devices have been marketed despite a lack of supporting data, “The dozens of ultrasonic devices tested and observed by the authors have never accomplished the claims made for them” (p.292). The limitations of ultrasonic devices include rapid habituation by rodents and the creation of strong sound shadows. “There have also been incidents of sensitive tissue damage (torn retina) by installers, possibly caused by strong ultrasonic emissions. The efficiency and safety unknowns of these devices are so pronounced that they are an example...of insufficient testing -- laboratory as well as field” (p293).

General conclusions are that one should ask for tests by unbiased and qualified final applicators under market conditions.

RED FOX FEEDING HABITS IN RELATION TO FAWN MORTALITY
John J. Ozoga, Craig S. Bienz and Louis J. Verme. Michigan Department of Natural Resources, Shingleton, MI 49884

Red fox (Vulpes vulpes) is reported to prey on white-tailed deer fawns, based on scat samples with fawn remains. Foxes are also scavengers. The study examined the diet of foxes in Michigan’s Upper Peninsula. Snowshoe hare were a dominant food during early May, insects were dominant from mid-May to June and fruit was dominant during July and August. Meadow voles (Microtus pennsylvanicus) and deer mice (Peromyscus maniculatus) were well represented in scat counts throughout the year and may be considered a staple in fox diets.
RESIDUES OF THE RODENTICIDE BRODIFACOUM IN VOLES AND RAPTORS AFTER ORCHARD TREATMENT
M. H. Merson and R. E. Byers. Department of Horticulture Winchester Fruit Research Laboratory, Virginia Polytechnic Institute and State University, Winchester, VA 22601
D. E. Kaukeinen. ICI Americas Inc., Biological Research Center, Goldsboro, NC 27530

The study assessed the secondary poisoning hazard of the anticoagulant rodenticide, brodifacoum on screech-owls, barn-owls and American kestrel. The paper examines the effects on local raptors after an application of the poison in an orchard. The paper relies on a very small sample size (3 screech owls, 1 barn owl and 1 American kestrel). Two weeks after the application of Brodifacoum, no residues were found in the barn owl or kestrel pellets. Brodifacoum residues were found in screech owl pellets. One of the screech owls died and was consumed by scavengers before tissue tests could be performed. Brodifacoum residues were found in the other two screech owls and 1 was found to have large blood clots in its system attributed to brodifacoum.

The paper concludes that it is “highly probable that a raptor capturing a meadow vole in the orchard 24 hours to 2 weeks after treatment would be exposed to brodifacoum.... Maintenance of low vole numbers on a sustained basis could reduce secondary poisoning hazards to raptors when rodenticides are used, by reducing the probability of raptor hunting success.... the significance of contamination to individual survival and population trends needs to be determined” (p. 215-216).

RESPONSE OF RODENT POPULATIONS TO CONTROLS
John E. Wood. New Mexico State University, University Park

Many studies of rodenticides examine the toxicity and immediate effects on rodent populations, but few study the recovery of the rodent population. Strychnine and 1080-treated grain was used to poison rodents in desert grasslands in New Mexico and rodent population response was measured. In the control field, the species composition of the rodent population changed but rodent biomass remained constant. The 1080 poison was cheaper and gave better control after 1 month and 1 year. At 1 month after treatment rodent populations were reduced, on average, to 6.2% of their original biomass; after 1 year, the population had recovered to 23.9% of its original biomass; and after two years, the rodent biomass in the poisoned fields reached 69% of the original rodent biomass.

The paper lists the 12 rodents, 4 predatory mammals, 6 predatory birds and 4 snake species that live in the test area.

In the study the rodent populations fluctuated independently of each other. With the
introduction of poison into the environment, some rodent populations fell dramatically, others rose and others stayed constant. Generally, the poisons had a destabilizing effect on species composition while reducing overall density significantly. The author therefore concludes that “it seems unwise to refer to a group of species of rodents simply as the rodent population or range of rodent population, particularly when dealing with densities, changing characteristics or controls. Such reference ignores the complex interspecific population dynamics that can be, and in this study apparently were, dominant influencing factors” (p.437).

RESPONSES OF CONFINED RODENT POPULATIONS TO AN ULTRASOUND GENERATOR
J. H. Greaves and F. P. Rowe. Infestation Control Laboratory, M.A.F.F., Tolworth, Surry, United Kingdom

Wild rats (Rattus norvegicus) and wild house mice (Mus musculus) showed continued aversion to high intensity pulsing ultrasound although “rather than starve or go thirsty, both rats and mice would venture into the room with ultrasound to reach known sources of food and water” (p.409).

The authors suggest that the device may be useful in certain situations at reducing entry to rodent free areas or at diverting rodents from a food source to poisoned food.

RESPONSES OF SIBERIAN FERRETS TO SECONDARY ZINC PHOSPHIDE POISONING
Elwood F. Hill and James W. Carpenter. U. S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20811

Sixteen Siberian ferrets were fed rats poisoned with 2% zinc phosphide treatments. Black footed ferrets are now nearly extinct; their decline is associated with control measures directed at the ferret’s primary food, prairie dogs. Since the Siberian ferret is closely related to the black footed ferret, they were used as a laboratory surrogate. The study demonstrated that the Siberian ferret and likely its relative the black ferret, learned to avoid the gastrointestinal tracts of poisoned rats. Zinc phosphide is not considered to be an acute poisoning threat to the endangered ferret, but chronic exposure leading to respiratory, liver and kidney damage may exist.

RODENT FREE USING PERMANENT BAIT STATIONS
W. E. Howard. Wildlife and Fisheries Biology, University of California, Davis, California 95616
The author describes a program for “permanent preventative control” of rodents with permanent bait stations. “The bait boxes must be kept permanently active, i.e. should always contain either (1) a spoonful of non toxic rice, wheat, maize or other whole grain, or a non-toxic wax-grain block to indicate that no rodents are present, or (2) 25-100 g of a safe anticoagulant treated bait” (p.147).

RODENT AND DEER CONTROL IN ORCHARDS
Kevin W. Ker and Ken Wilson. Plant Industries Branch

Vole identification, biology and control are described. Herbicide strips, or otherwise removing grasses and weeds within 60-cm of tree trunks, encouraging domestic cats, foxes and birds of prey, using plastic or metal tree guards and poison baits in bait stations are recommended.

RODENTS AND RODENT CONTROL

With 23 pictures and diagrams and a list of “references for further study”, this book describes the basics for rodent control indoors. Recommended practices include the elimination of food and shelter, rodent proofing buildings, trapping and use of rodenticides (a chart comparing rodenticide characteristics is provided). Scare devices are suggested as a possible supplement. Scare devices are described as having “promise as a supplement”, but are expensive and “ineffective, or at least substantially less effective than advertising would have you believe”(p.37). For expensive new products the company recommends leasing with the option to buy if the device or product proves to be effective.

THE SAFETY AND EFFICACY OF BRODIFACOUM (KLERAT) WAX BLOCKS AND ZINC PHOSPHIDE FOR RODENT CONTROL IN THAILAND
K. Tongtavee and S. Hongnark and T. Artchawakom. Department of Entomology and Zoology, Department of Agriculture, Banghen, Bangkok 10900, Thailand
N. Hongsbhanich. IAAC, 53-55 Oriental Avenue, Bangkok 10500, Thailand
R. A. Brown. ICI Plant Protection Division, Jealotts Hill Research Station, Bracknell, Berks RG12 6EY, U.K.
C. G. J. Richards. ICI Plant Protection Division, Fernhurst, Haslemere, Surry GU27 3JE, U.K.

According to the authors, “at a village level” 5g wax blocks containing 5 or 500 ppm brodifacoum (it is unclear which application was used) gave better control of rodent pests than rice treated with 8000 ppm zinc phosphate. The brodifacoum treatment resulted in the
confirmed poisoning of 5.9% (4/68) of the village dogs and the death of at least one raptor (black-shouldered kite); and the chemical was shown to bio-accumulate in tissues of scavenger and predator populations (bird and snake). There was also an unexplained decrease in barn owl populations correlated with the brodifacoum treatment. The use of zinc phosphide resulted in the death of 3.4% (3/77) of the village dogs, 3.8% (9/234) of the village chickens, and 2.5% (3/119) of the village ducks.

SECONDARY POISONING OF OWLS BY ANTICOAGULANT RODENTICIDES
V. W. Mendenhall. U. S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20811
L. F. Pank. U. S. Fish and Wildlife Service, Denver Wildlife Research Center, Hilo, HI 96720

Six anticoagulant rodenticides (bromadiolone, brodifacoum, diphacinone, difenacoum, fumarin and chlorophacinone) were examined in a lab situation for secondary poisoning hazard to great-homed and saw-whet owls. Owls eating rats killed with bromadiolone, brodifacoum and diphacinone died of hemorrhaging. Owls feeding on rats killed with difenacoum suffered from sublethal hemorrhaging. Owls feeding on rats poisoned with fumarin and chlorophacinone did not suffer from detectable levels of hemorrhaging.

SMALL MAMMALS IN FARMSTEAD SHELTER BELTS: HABITAT CORRELATIONS OF SEASONAL ABUNDANCE AND COMMUNITY STRUCTURE
Richard H Yahner. Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108

The paper finds that species richness is greatest in larger shelterbelts with "complex vegetative structure". The great plains ecosystem has been almost completely appropriated for human use, leaving animals dependent on fencerows and shelterbelts. The majority of mammal species found in these shelterbelts were not those typically considered pests in that region. The paper lists species dependent on these areas and includes management recommendations and maintenance techniques which will protect ecosystem diversity. These recommendations include maintaining vegetative stratification, maximizing shelterbelt size, and leaving woody and people-made debris in shelterbelts. The opposite of these practices could be used as a wildlife management technique, but it is important to recognize that intentionally degrading habitats for one pest species will likely negatively impact on many non-target species, including beneficial ones.
SONIC DETERRENTS IN ANIMAL DAMAGE CONTROL: A REVIEW OF DEVICE TESTS AND EFFICIENCY
Mary Bomford, CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, ACT, 2602, Australia
Peter H. O’Brien, Bureau of Rural Resources, G.P.O. Box 858, Canberra, ACT, 2601, Australia

This paper is an extensive review of studies about the effectiveness of sonic scaring devices for wildlife management and animal damage control purposes. It reviews the different mechanisms by which these devices work, evaluates published studies, critiques bias in experiment designs and describes devices and mechanisms which are most effective. The paper recognizes that not all audible devices work the same way and categorizes repellency effectiveness according to mechanisms of pain, fear, communication disruption, disorientation, audiogenic seizure, internal thermal effects, alarm and distress mimics and ultrasound.

General descriptions and conclusions grouped by mode of action of acoustic devices.

Devices designed to cause pain. Noises of 130 dB, as well as infrasonic and ultrasonic sound greater than 140 dB, can cause pain or sickness in vertebrates, but these noises are technically difficult to create and radiate, can be a nuisance and are objectionable in terms of animal welfare. There is evidence that European starlings as well as other animals will habituate to these noises. The authors conclude that devices which operate by this mechanism are not currently practical for wildlife management.

Ultrasound devices. It is also not demonstrated that high frequency sounds have especially annoying properties for animals which can hear them. Furthermore these sounds require more energy to generate, dissipate more rapidly and travel inefficiently around barriers. Ultrasound was found to be impractical for rodent control, having only temporary repelling value and is considered to have little practical value in wildlife management.

Disorientation devices. The paper suggests that there is no evidence to support claims that any device will produce a sound to disorient animals and therefore be useful for wildlife management.

Devices which cause audiogenic seizures. Seizures resulting in rodent death have been created by high frequency, high intensity sound occurring in particular patterns in a laboratory setting. These audiogenic seizures have not been created in the field and it is unlikely that it is possible to do so because of problems with signal strength and sound shadows.

Devices which have audio-thermal effects. Insects and rodents have had their body temperatures raised by loud audible and ultrasonic sounds resulting in their death. These effects are difficult, expensive and dangerous to produce and therefore have little value in wildlife management.
VOLE (MOUSE) CONTROL

The publication gives precautions for handling poison baits, control options and an outline of the characteristics of available rodenticides. Crop protection and rodent management options include elimination of weeds (manually or with herbicide strip) within 60 cm of tree trunks; use of tree guards (anchored 8 cm below ground and protecting at least 45 cm of trunk above ground); encouraging foxes, snakes, owls, dogs and cats; and use of rodenticides. The publication further recommends alternating between zinc phosphide and anticoagulant baits to reduce chances of resistance or bait aversion developing.

WEED SEED DESTRUCTION BY ARTHROPODS AND RODENTS IN LOW-INPUT SOYBEAN AGROECOSYSTEMS
American Journal of Alternative Agriculture. 3:19-25, 1986
Gerald E. Burst. Graduate Program, Department of Entomology, Box 7634, North Carolina State University, Raleigh, NC 27695
Garfield J. House. Assistant Professor, Department of Entomology, Box 7634, North Carolina State University, Raleigh, NC 27695

In a five week study, the amount of weed seed consumption was measured in low input (no-insecticide and low herbicide) conventional and no-till soybean fields. The seeds used were ragweed (Ambrosia artemisiifolia L.), pigweed (Amaranthus retroflexus L.), sicklepod (Cassia obtusifolia L.), jimsonweed (Datura stramonium L.) and wheat (Triticum aestivum L.). The study found that “approximately 2.3 times more seeds overall and 1.4 times more large seeds as a group were consumed in no-tillage systems than in conventional tillage systems” (p.19). Different species were responsible for weed seed destruction in different tillage systems. Altering arthropod and rodent populations will also alter species composition and abundance of weeds in agricultural ecosystems.

WILDLIFE & AGRICULTURE (1): TREES AND SHRUBS FOR EROSION CONTROL AND WILDLIFE HABITAT
Ontario Federation of Anglers and Hunters
Wildlife Habitat Facilitator, OFAH, P.O. Box 28, Peterborough Ontario, K9J 6Y5 (705-708-6324)

The pamphlet suggests that it is possible to reduce crop loss by planting specific trees and shrubs. “Rodent and blackbird damage may be discouraged by establishing roosts for raptors such as hawks and owls.”

The facilitator can provide site-specific planting recommendations, recommendations for
nuisance animal control and information regarding both habitat enhancement and the availability and cost of certain trees and shrubs.

WILDLIFE DAMAGE IN ORCHARDS--A NEED FOR BETTER MANAGEMENT
Robert G Anthony and Alan R Fisher. School of Forest Resources, The Pennsylvania State University, University Park 16802.

This paper includes the results of a survey on animal damage to crops in Pennsylvania and expenditures by orchardists to control damage-causing species. Birds and deer were of importance in some areas in the state but not all. Pine voles (Microtus pinetorum) and meadow voles (M. Pennsylvanicus) were of most concern state wide. The study, using population estimates, found endrin, strychnine and zinc phosphide bates to give "inconsistent and often ineffective control" (p.107). The paper points out environmental and ecological problems associated with use of toxics in wildlife management and calls for research into more efficient and ecologically friendly wildlife management techniques in orchards.

WILDLIFE USE OF NO-TILL AND CONVENTIONALLY TILLED CORN FIELDS
D. R. Warburton and W. D. Klimstra. Cooperative Wildlife Research Lab, Southern Illinois University, Carbondale, IL 62901

The study found that no-till fields provided better wildlife habitat than conventionally tilled fields. There were more invertebrates, birds and small mammals in no-till fields than in conventionally tilled corn fields. This included a greater abundance and diversity of predators. Deer mouse and other small mammal populations were more stable than in conventionally managed fields. Differences in avian and mammalian populations are documented and discussed.
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Raccoon

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed: Fall 1996
Racoon (*Procyon lotor*)

Results of the Grower Needs Assessment

The racoon (*Procyon lotor*) was repeatedly identified as having significant or very significant impacts on overall farm productivity. The conflicts were between racoons and corn producers. Shooting racoons is the traditional control measure but has limitations and interest in alternative crop protection options was expressed.

Species Biology and Life History

The Procyonidae Family is a group of medium sized animals, related to bears, having five well developed toes with non retractable claws and naked soles on each foot. Their step is plantigrade. Their nose and ears are long and pointed and they have a long ringed bushy tail (Seton 1909b).

In addition to these family characteristics *Procyon lotor* has the following characteristics:

Total length: 660-1010 mm, (18-28 in.); tail length: 200-300 mm, (8-12 in.); weight: 5.5-16 kg (12-35 lb.) (Kurta 1995). Sexes look alike, grey, white and black with a black mask and alternating bands of yellow and black on the tail. Racoons are mostly nocturnal although are occasionally seen abroad during the day. They have 6 mammae and 40 teeth and live to a maximum of about 14 years (Burt and Grossenheider 1980 Seton 1909b).

RANGE

The racoon is found throughout the Bay of Quinte watershed. Seton writes, “Coons have increased in recent years because of the abundant food supply provided by settler’s crops and the destruction of animals which prey upon coons....[The] racoon increases in the northern region as the fisher is exterminated by the trapper.” (1909b:1028)

HOME RANGE

The home range of a racoon can be surprisingly large, up to 9 km² (4 mi²) but is usually less than 2 km² (1 mi²) (Burt and Grossenheider 1980). The young have been known to disperse up to 265 km (165 mi.) from their birth place, but usually less than 50 km, (30 mi.) (Burt and Grossenheider 1980). Within their home range, populations have been recorded as high as 1 racoon per 0.4 hectares (1 acre) although 1 racoon per 6 ha (15 acres) is generally considered high (Burt and Grossenheider 1980).

ENVIRONMENT/HABITAT

The racoon prefers hardwood edges. Conifers are not as attractive since the racoon most often dens in hollow trees. Racoons always have streams or lakes in their home range and have the
habit of washing food before eating it (Seton 1909b).

Racoons prefer to den in a hollow branch high in a large tree exposed to the sun, although hollow trunks are acceptable as well, even if the trunk has fallen (Seton 1909b). If such a space is not available, a racoon will den in caves, rocky crannies, hollow logs, abandoned burrows, culverts and houses (Carpentier 1987). Within its home range, the racoon “maintains a central home den and several hunting lodges scattered in convenient proximity to favorite and remote hunting grounds” (Seton 1909:1018).

SENSES
Racoons are well known for their well developed tactile abilities. Racoons have incredibly dexterous hands, and are quite clever, which allows them to get just about anywhere they want to. Racoons are capable of climbing fences, opening doors and have even mastered simple locks (Cameron 1964). Racoons have excellent night vision and primarily forage at night (Carpentier 1987).

COMMUNICATION
Racoons have limited verbal communications, the female makes a low twittering sound to reassure her young and adults growl and snarl when threatened (Burt and Grossenheider 1980).

REPRODUCTION
Mating occurs in late February or March in the Bay of Quinte watershed. Gestation lasts 63 days and on average 4 young are born in April or May but 2 to 7 is a normal range (Burt and Grossenheider 1980). Eyes open at 3 weeks and the young can be seen abroad with the mother in June. By July, young are weaned and begin to hunt with parents but leave before the next spring when room is needed for the next litter (Seton 1909). Some females mate in their first year of life (Burt and Grossenheider 1980).

MOVEMENT
Racoons can swim but are generally found out of water (Seton 1909). Racoons are excellent climbers but are not particularly fast on the ground; they will climb a tree if threatened (Carpentier 1987).

FOOD
Racoons do not store food, but rely on fat reserves to get them through the winter (Burt and Grossenheider 1980, Seton 1909). Primarily nocturnal and completely omnivorous, a racoon can and does eat most everything. In the wild, a racoon’s summer diet consists primarily of frogs and mice but they also eat crayfish, slugs, insects, fish, fowl, bird and turtle eggs, reptiles, shellfish, fruit, nuts, grain, vegetables and anything else available (Burt and Grossenheider 1980, Carpentier 1987, Seton 1909). Racoons often wash, or dunk food in water before eating it and therefore prefer to feed near water (Seton 1909).
PREDATORS/LIMITING FACTORS

Besides people and available food supply, the racoon has few limiting factors. Historically the main predator was the fisher. According to Seton, "[The] racoon increases in the northern region as the fisher is exterminated by the trapper" (1909b:1028). The fisher is a forest predator which prefers to live near wetlands, and has a home range of approximately 2600 ha (10 square miles) (Burt and Grossenheider 1980).

In 1877 Dr. Coves wrote, "It may not be generally known that the Pekan [also known as fisher, blackcat, pennant martin] successfully assault animals as large as a racoon, Indeed that the abundance of the latter depends in a measure, upon the rarity of the former" (Coves 1877:73-74).

In 1857 Peter Ried wrote, "Racoons are now more numerous than they were at the first settlement of the county [Washington County N.Y.] or for some time subsequent. Thirty years ago [1827] they were so seldom found that many boys age 15 to 18 had scarcely seen one.... The fisher has been nearly extinct from these parts for about 25 years and that to my mind accounts for the great increase in the numbers of the racoon" (Ried 1857).

With the scarcity of large predators in the southern Bay of Quinte watershed, people have become the main factor limiting racoon populations; they are often seen dead along roads or are shot by farmers.
Results of Literature Survey

The information available suggests several options for reducing conflicts between racoons and corn producers in the Bay of Quinte watershed. General conclusions can be drawn from available information about chemosterilization, conditioned food aversions, physical barriers, repellents, reproduction, scaring and trapping.

CHEMOSTERILIZATION
- It is possible to reduce raccoon reproduction with chemosterilants.
- Current baits are not selective and will reach many non-target organisms.
- All vertebrate reproductive systems (including human systems) are very similar. Chemosterilants therefore have an high inherent potential to effect non-target organisms.
- Secondary sterilization and reproductive abnormalities in non-target organisms associated with chemosterilants have been documented.

References in “Raccoon” Section
- Efficacy and Selectivity of Eggs and Tallow Baits for Skunk Control
- Percentage of Racoons and Skunks Reached by Egg Baits

References in “General” Section
- Chemical Fertility Control and Wildlife Management
- Contraception in Striped Skunks with Norplant™ Implants
- Hormone Sabotage: Synthetic Chemicals in the Environment May Be Wreaking Havoc with the Endocrine Systems of Humans and Animals
- Investigation of the Secondary Sterilizing Effect of Diethylstilbestrol (Des) on Predators
- New Developments in Feral Horse Contraception and Their Potential Applications to Wildlife
- Feral Horse Fertility Control: Potential and Limitations
- No Conception; Masquerading as Sex Hormones, Chemicals Ubiquitous in the Environment Could Threaten Our Children’s Ability to Reproduce
- Remotely Delivered Immunocontraception in Feral Horses
- Statement from the Work Session on Chemically-induced Alterations in Sexual Development: the Wildlife/human Connection
- Statement from the Work Session on Environmentally-induced Alterations in Sexual Development: a Focus on Wildlife

CONDITIONED FOOD AVERSION
- Emettine dithydrochloride can create conditioned food aversions in racoons.
- Emettine dithydrochloride is highly toxic to humans.

References
- Potential Compounds for Establishing Conditioned Food Aversions in Racoons
PHYSICAL BARRIERS
◆ 5-6 foot metal barriers can stop raccoons from climbing trees.
◆ A single electric wire 6-8 inches high has been used to protect small areas from raccoons.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Racoons

REPELLENTS
◆ Repellents may be used to protect an container or expel a racoon from a building.
◆ There are no repellents which can be used on agricultural crops.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ L-1902 Controlling Racoon Damage
◆ Racoons

REPRODUCTION
◆ A racoon’s reproductive potential peaks at about age four.
◆ Raccoon populations have been increasing and expanding their range with continuing settlement.

References
◆ Age Related Reproductive Success of Female Racoons
◆ Comments on Racoon Population Eruptions

SCARING
◆ Racoons may avoid brightly lit areas.

References
◆ Facts about Pesticides: Racoons
◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Reflecting Tapes Repel Blackbirds from Millet, Sunflowers, and Sweet Corn
TRAPPING

• Non-target organisms can be released from live traps.
• Young corn, melon, prunes, peanut butter, bread soaked in syrup or honey, fish, bacon, and eggs can be used as baits.

References

• Facts about Pesticides: Raccoons
• Fish and Wildlife Habitat Management: Best Management Practices
• L-1902 Controlling Raccoon Damage
• Percentage of Raccoons and Skunks Reached by Egg Baits
Summary of Selected References

AGE RELATED REPRODUCTIVE SUCCESS OF FEMALE RACOONS
Randall E. Junge. University of Illinois, Urbana, IL 61820
Glen C. Sanderson. Illinois Natural History Survey, Champaign, IL 61820

The paper found that reproductive success increased slightly for the first four years of life and then fell as racoons aged further.

COMMENTS ON RACOON POPULATION ERUPTIONS
Erik K. Fritzell. Department of Forestry, Fisheries and Wildlife, University of Missouri, Columbia, MO 65211

“Eruptive” populations are those which have sudden severe increases (>50%) in density and then, after a variable length of time, quickly decrease to their previous population density. The author argues that the racoon population has been increasing and expanding its range but has not, and never has, been an eruptive population, despite the fact that it is often characterized as such. The mistaken characterization of racoon population as eruptive is a result of improper interpretation of trapping records.

EFFICACY AND SELECTIVITY OF EGGS AND TALLOW BAITS FOR SKUNK CONTROL
Laurence D. Roy. Alberta Environmental Center, Postal Bag 4000, Vegreville, Alberta T9C 1T4
Michael J. Dorrance. Alberta Agriculture, 7000-113 Street, Edmonton, Alberta, T6H 5T6

This paper describes the selectivity and efficiency of egg and tallow baits for striped skunks (Mephitis mephitis) but is relevant to those who attempt to use similar baits for racoons. The study found that skunks do not always recognize eggs as food, especially clean and sanitized eggs which are less attractive than ones associated with poultry smells.

In the study area (Saskatchewan-Alberta border) non target organisms which were observed to feed on chicken egg and tallow baits include the coyote, red fox, domestic dog, weasel and black-billed magpie. Nontarget organisms observed to feed on tallow baits included ground squirrels, red squirrels, rats, cats, snowshoe hares and porcupines. The authors recommend placing traps in sites with evidence of skunks to increase efficiency and selectivity.
FACTS ABOUT PESTICIDES: RACOONS
Anon.

The fact sheet lists bobcat, fox and coyote as natural enemies. For excluding raccoons from a garbage can the sheet recommends using sealable metal containers. Use of 5-6 foot metal barriers around trees and T.V. towers are suggested to limit racoon access to nearby buildings. The sheet lists lights, oil of mustard and cayenne pepper as possible repellents.

Live traps recommended include Tomahawk (#108, 109, 207, 608 or 609.5) and Havahart (#3 or 3A) or other similar traps. The sheet recommends young corn, melon, prunes, peanut butter, syrup or honey soaked bread, fish and bacon as good baits.

FISH AND WILDLIFE HABITAT MANAGEMENT: BEST MANAGEMENT PRACTICES
Agriculture and Agri-Food Canada, 1996.

This document offers “Best Management Practices” determined by a team of “farmers, researchers, resource managers, extension staff, and agribusiness professionals” to improve wildlife habitat quality and ecological viability of Ontario farmlands (croplands, pastures, abandoned areas, farmsteads, windbreaks, shelterbelts and treed fence rows), woodlands (woodlots and plantations), transitional (wetlands, streambanks and shorelines) and Aquatic areas (watercourses, lakes and ponds). Wildlife management and crop protection options for rodents, racoons, deer and birds are also included.

For reducing raccoon damage the authors suggest making chicken wire fences around crops, shining bright lights, planting pumpkin vines among sweet corn, dogs and encouraging hunting and trapping.

L-1902 CONTROLLING RACOON DAMAGE
1992 Texas Agricultural Extension Service WWW / Gopher Server
Computer Technology Group / Texas Agricultural Extension Service /The Texas A&M University System / College Station, Texas 77843-2468.
William H. Clay

“Raccoons can cause a great deal of damage to attics, roofs, hen houses, gardens, orchards, lawns, pets and people. This leaflet describes methods of control, including traps and repellents. It also tells how to prevent racoon infestation by removing their food and water supplies and destroying their shelters. This is a 2-page publication.”
PERCENTAGE OF RACOONS AND SKUNKS REACHED BY EGG BAITS
Richard L. Nelson and Raymond L. Linder. South Dakota Cooperative Wildlife Research Unit, Brookings

Chicken eggs containing DMCT (a physiological marker) were distributed in a 25-mi² study area to assess the efficiency of these bait at reaching target organisms. 99.5% of baits were consumed within 6 days. The study found that 87% of racoons, 31% of coyotes And 29% of skunks had eaten the treated eggs. Six wild cats and 2 badgers were checked but did not have traces of DMCT in their system. The paper concludes that since egg baits reached 87% of racoons, they may be an effective way to deploy chemosterilants in the future. The paper suggests that the effects of a chemosterilant on skunk populations is difficult to evaluate and makes no mention of possible effects on non-target organisms.

POTENTIAL COMPOUNDS FOR ESTABLISHING CONDITIONED FOOD AVERSIONS IN RACOONS
Michael R. Conover. Department of Plant Pathology and Ecology, The Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504

A conditioned food aversion is a learned avoidance of a specific food by animals. It has been used as a successful wildlife management tool for birds and coyotes. This experiment tested 17 chemical compounds used previously to form conditioned food aversions in other animals or known to produce illness in racoons. The test examined the tendency of racoons to generalize aversion from treated foods to untreated foods. A conditioned food aversion was created for eggs in the racoons tested when food was treated with 0.02-0.05 g of emettine dithdrochloride. The animals continued to avoid eating the previously treated food when other food was available, but were found to slowly start eating the previously treated food if there was no alternative provided.

Emettine dithdrochloride is highly toxic to humans, may persist in tissues, and should not be used in situations where food could be consumed by humans. The author recommends further testing to study the likelihood of chronic, non target and secondary poisonings.

RACOONS
Animal Control in Field, Farm and Forest. p.20-26, 1954.
W. Robert Eadie. Cornell University

The author describes identifying features and biology and then gives management recommendations. Raccoons can be trapped or hunted with dogs and lights, although electric fencing may also be used. "Electric fences of various types have been used to effectively
exclude racoons from game farms or poultry yards. Generally, a single wire strung six- to eight-inches above the ground on the outside of an ordinary wire fence, as for foxes, will be effective. An additional electrified wire at the top of the fence is sometimes used... No successful repellents against racoons are known that can be used on corn or other vegetables.

REFLECTING TAPES REPEL BLACKBIRDS FROM MILLET, SUNFLOWERS, AND SWEET CORN
Richard A. Dolbeer and Paul P Woronecki. Department of Agriculture, Denver Wildlife Research Center, 6100 Columbus Avenue, Sandusky, OH 44870
Richard L. Bruggers. Us Department of Agriculture, Denver Wildlife Research Center, Building 16, Federal Center, Denver, CO 80225

The study evaluated the performance and cost of Bird Scaring Reflective Tape\textsuperscript{TM} at different spacing intervals (3, 5 and 7 meters) in millet, sunflowers and sweet corn. The tapes are 11 mm wide, 0.025 mm thick, metallic red on one side and metallic silver on the other. The tapes were suspended 1.5 meters above the ground on poles and can make a roaring sound under certain wind conditions.

Mammal damage evaluated included that done by white-tailed deer (\textit{Odocoileus virginianus}) and racoon (\textit{Pyrcojen lotor}). The report finds “There were no differences (P > 0.10) among the 3 treatments in damage caused by mammals at 25 or 35 days after silking”(p.421).
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Coyote

Prepared By: Rob Mound
Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project (1996)
Completed: Fall 1996
Appendix 1

Coyote (*Canis latrans*)

**Results of the Grower Needs Assessment**

Coyote (*Canis latrans*) populations were identified as benefitting agricultural production in the Bay of Quinte watershed. It was suggested that coyotes either control raccoons or limit their range and therefore reduce conflicts between raccoons and corn production. Coyotes were identified as the main factor reducing conflicts between orchards and cottontail rabbits. The rabies bait program was identified as a major positive influence.

**Species Biology and Life History**

The Canidae Family are doglike mammals with long pointed muzzles, long and slender legs, 5 toes on each front foot and 4 toes on each hind foot (some domestic dogs have 5 toes on all feet), with blunt, non-retractable claws (Kurta 1995, Burt and Grossenheider 1980, Seton 1909). All members of this family have a scent gland at the base of the tail and can run or walk on their toes for speed (Kurta 1995, Burt and Grossenheider 1980).

In addition to these family characteristics *Canis latrans* has the following characteristics:
Total length: 1100-1300 mm (43-51 in.); tail length 290-390 mm (11-15 in.); weight: 9-22 kg (20-50 lb.); 42 teeth and 8 mammae (Kurta 1995, Burt and Grossenheider 1980). This carnivore has a grey or rusty coat, is primarily nocturnal, but is sometimes abroad during the day (Kurta 1995, Burt and Grossenheider 1980). The coyote’s tail is bushier than others in the Canidae family, and is kept down when it runs (Burt and Grossenheider 1980). Coyotes may live 18 years in captivity or a maximum of 15 years in the wild but 6-8 years is average (Kurta 1995).

**RANGE**

The coyote is one of the mammals which has expanded its range the most with settlement. This animal’s range now includes almost all of North America including the Bay of Quinte watershed, but was previously restricted to the plains and desert. “Coyotes everywhere are sons of the desert”, writes Seton (1909:792). Unlike the grey wolf and other large predators which have abandoned the southern portions of the Bay of Quinte watershed, the coyote thrives in the patchwork environment created by agriculture and woodlots (Kurta 1995). The coyote was first recorded in southern Ontario in 1919 and was first recorded in Peterborough county in 1936 (Carpentier 1987). See the following page for past range map.

**HOME RANGE**

The home range for a coyote is typically 10-40 km² (4-15mi.²), larger for males than females and
MAP 43—RANGE OF THE COYOTES.

This chart is purely diagrammatic: many of the forms undoubtedly overlap or intergrade. It is drawn chiefly from Dr. C. Hart Merriam's Revision of the Coyotes, 1897; the Biological Survey map (Doc. 157, Senate 1907), also D. G. Elliot, Vernon Bailey, E. A. Preble, H. A. Allen, and from my own notes in many parts of the West. Full investigation must greatly change the boundaries between the many forms and all the boundaries in Mexico.

The following are recognized:

- Canis latrans Say. Common, with 4 races,
- Canis frustror Woodhouse. Woodland Coyote,
- Canis capitis (H. Smith). Red Coyote,
- Canis peninsulce Merriam. South California Coyote,
- Canis microdon Merriam. Rio Grande Coyote,
- Canis mearns Merriam. Mearns's Coyote,
- Canis estor Merriam. Desert Coyote,
- Canis ochropus Eschholtz. California Coyote,
- Canis aquila Merriam. Colima Coyote,
- Canis goldmani Merriam,
- Canis cleplicus Elliot,
- Canis impavidus Allen.

larger in the summer than winter (Kurta 1995). The hunting route can be between 16 and 160 km (10-100 mi.) in length (Burt and Grossenheider 1980). Ranges can overlap with those of other coyotes without conflict (Seton 1909).

ENVIRONMENT/HABITAT
Prairies, open woodlands, wooded edges, and bushy and rocky areas are preferred habitats; unbroken forest and coniferous forests do not usually support coyote populations (Kurta 1995, Burt and Grossenheider 1980, Seton 1909). Coyotes often have more than one den. They usually dig their own dens in the side of well drained sunny banks, but will also enlarge burrows abandoned by other animals (Seton 1909).

SENSES
"The senses of sight and smell are superb" (Kurta 1995:202).

COMMUNICATION
The coyote has highly developed communication abilities; it can communicate vocally and has a "well developed" scent gland located at the base of the tail (Kurta 1995, Seton 1909). Coyotes are a highly sociable animal and during the winter neighboring packs sometimes work together to bring down large prey (Carpentier 1987).

REPRODUCTION
Coyotes come into heat once a year for 4-5 days in late winter (Kurta 1995). 5-10 young are born in April-May after a 60-63 day gestation period (Burt and Grossenheider 1980). The pups open their eyes at 14 days, begin eating regurgitated food at 3 weeks and start to hunt at 2 months (Kurta 1995). Coyotes are monogamous and the males help raise the young (Seton 1909). These family units sometimes stay together and hunt as a pack (Kurta 1995).

Females are sexually mature at one year, although most do not breed until they are two (Carpentier 1987, Burt and Grossenheider 1980). The coyote will breed with domestic dogs and sometimes with the grey wolf (Kurta 1995).

MOVEMENT
Coyotes can run at up to 64 kph (40 mph) for short distances and are capable of swimming (Burt and Grossenheider 1980).

FOOD
The coyote is a well known scavenger, willing to eat almost anything, and will cache larger kills for later (Burt and Grossenheider 1980). Coyotes main summer diet includes squirrels, mice, rabbits, frogs, snakes, eggs, shrews, voles, hares, muskrats, fledgling birds and insects, but they are also known to eat porcupine, deer, elk and moose (Kurta 1995, Carpentier 1987, Seton 1909). The coyote kills larger animals by attacking the throat (Burt and Grossenheider 1980). It is usually only in the winter, when snow gives coyotes an advantage, that coyotes will attempt to prey on larger animals (Raycroft 1994). In these situations one or two coyote packs will work
together to bring down the animal, using a tag team approach to wear the animal down (Carpentier 1987, Seton 1909).

Burt and Grossenheider note that most damage done to livestock is done by wild dogs, not coyotes, and that the animal provides great service to farmers by preying so heavily on rabbits and rodents (1980).

PREDATORS/LIMITING FACTORS
Within the Bay of Quinte watershed, the coyote has few natural predators. Black bear, timber wolf and mountain lions are capable of preying on coyotes, but rarely do, and none of these predators is commonly present in the southern, agricultural portion of the watershed (Kurta 1995, Carpenter 1987). Rabies sometimes occur in coyotes (Burt and Grossenheider 1980). The main threat to coyote populations, however, is hunting, poisoning and trapping by people (Kurta 1995).
Wildlife Management and Crop Protection Options for High Value Crops in the Bay of Quinte Watershed

(An Annotated Literature Survey)

Red Fox

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed: Fall 1996
Appendix 2

Red fox (*Vulpes fulva* or *Vulpes vulpes*)

Results of the Grower Needs Assessment

Red Fox (*Vulpes fulva*) was identified as reducing conflicts between agriculture and rabbits and mice. Foxes were identified as a major factor limiting rabbit populations and conflicts between rabbits and orchardists. The rabies bait program was identified as a major positive influence.

Species Biology and Life History

The canidae family are doglike mammals with long pointed muzzles, long and slender legs, 5 toes on each front foot and 4 toes on each hind foot (some domestic dogs have 5 toes on all feet), all with blunt non retractable claws (Kurta 1995, Burt and Grossenheider 1980, Seton 1909b). All members of this family have a scent gland at the base of the tail and can run or walk on their toes for speed (Kurta 1995, Burt and Grossenheider 1980).

Many people consider *Vulpes fulva* and the old world fox, *Vulpes vulpes*, to be the same species (Burt and Grossenheider 1980). In addition to canidae family characteristics *Vulpes fulva* has the following characteristics:

- **Total length:** 950-1050 mm (37-41 in); tail length 325-400 mm (12-26 in); weight 3.5-7 kg (7.7-15.4 lb) (Kurta 1995). The red fox is well known for its striking red coat, white tipped, bushy tail and intelligent facial expressions (Carpentier 1987). Red black and silver color variations can occur (Cameron 1964). The red fox is most active at night, although it is often seen abroad during the day (Burt and Grossenheider 1980). It has 42 teeth and 8 mammae; it has an average life expectancy of only 1 year but may sometimes live to age 5 or 6 (Kurta 1995).

**RANGE**

Red foxes are found throughout the Bay of Quinte watershed and the majority of North America, but are scarce in the south western states (Kurta 1995). In fact, red fox are found throughout the world, with close relatives in Asia and Europe (Cameron 1964).

**HOME RANGE**

The red fox typically has a home range of 100-500 ha (250-1200 acres) and will travel 8 km (5 mi) with each night’s hunting (Kurta 1995). In the winter, the fox will often travel greater distances and is known to have moved up to 202 km, (126 mi) from its birth den (Burt and Grossenheider 1980).
The fox is more likely to enlarge an existing groundhog hole into a den then to dig its own (Kurta 1995). The den is typically positioned in well drained soil on a hill or stream bank (Burt and Grossenheider 1980). The fox maintains several dens so it can move its young if one den is threatened, but will often use the same den year after year (Burt and Grossenheider 1980, Carpentier 1964).

ENVIRONMENT/HABITAT
The red fox prefers a mixture of open and wooded land such as forest clear cuts, woodlots surrounded by farmland, fence rows, roads, railways, or wooded lake or stream banks; and it is often found near people, in suburban areas, cemeteries, golf courses and even large urban parks (Kurta 1995, Burt and Grossenheider 1980). The fox is not usually found in unbroken forest (Kurta 1995).

SENSES
The red fox has good vision, “acute hearing and a keen sense of smell” (Kurta 1995:210).

COMMUNICATION
Red foxes mark their territory by repeatedly urinating on specific sites within their home range (Kurta 1995). The female may make sharp barks to call her young or snarl when threatened (Vergara 1994).

REPRODUCTION
Foxes mate in February-March and 4-9 young are born in April-May after a 61 day gestation period (Burt and Grossenheider 1980, Cameron 1964). The young stay in the den for about one month before coming out to “play” (Burt and Grossenheider 1980). The parents remain together until fall when the young leave to fend for themselves (Burt and Grossenheider 1980, Cameron 1964). Both adults “share in feeding and training their young and are among the most devoted parents in the animal world” (Cameron 1964:49).

MOVEMENT
According to Seton, a fox can run 50 kph (27 mph) for short distances and is capable of swimming (1909b).

FOOD
Foxes occasionally search for food in pairs but are primarily solitary hunters (Kurta 1995). The fox is an omnivorous predator and scavenger but prefers flesh to vegetable matter (Carpentier 1987). Mice, particularly the meadow vole, make up the largest part of its diet, but fox will eat any mammal smaller than a rabbit, as well as turkeys and smaller birds, snakes, frogs, fish and vegetables, berries and other fruits (Burt and Grossenheider 1980, Carpentier 1987, Cameron 1964, Seton 1909b). Foxes will store mice, rabbits and birds, especially in the winter, for later use (Burt and Grossenheider 1980).
PREDATORS/LIMITING FACTORS
A fox may die from porcupine quills and owls and eagles occasionally catch the young (Kurta 1995). Fisher, bobcat, coyote and lynx sometimes prey on foxes, but there are no predators other than people which significantly affect fox populations (Kurta 1995). Burt and Grossenheider write that, “Foxes do more harm than good, as shown by many food studies. All bounties should be removed.” (1980:72)

Besides humans, the biggest threat to fox populations is disease. Red fox often suffer from sarcoptic mange and are sometimes victim of rabies outbreaks (Kurta 1995).
Appendix 3

Survey Questions
The following questions were used to structure the grower needs assessment completed in the spring of 1996.

Location of farm
1 You grow .......... , is there anything else you grow? (how many acres?)

2 In terms of overall farm productivity, how significant do you feel wildlife damage is? (Which animals? Which crops?)

3 If not, have you ever had problems with wildlife? (which ones?)
Could you express that in terms of % loss, bushels/acre or value/acre?

4 What management practices (control strategies) do you use?

5 Are you happy with the results? How would you rate the effectiveness of those management practices?

6 Are there other practices you used in the past which you no longer use? (why not?)

7 Are there other practices which you are seriously considering? (If no: Have you heard anything else interesting, which may be of interest or benefit to your neighbors?)

8 If yes:
Which ones?

9 What is the desired effectiveness of those practices?

10 What is the desired cost effectiveness/pay back time for those solutions?
Appendix 4: General Results of the Grower Needs Assessment

Introduction
A grower needs assessment was conducted during the month of April 1996, regarding conflict between agriculture and wildlife in the Bay of Quinte watershed. The purpose of the assessment is to help tailor the literature/information survey to the needs and concerns of growers working toward sustainable agriculture and reducing conflicts between agriculture and the natural world which supports it.

Twelve growers were contacted. The survey was discontinued when there seemed to be no new responses and major problems had been identified repeatedly by growers. While other responses are possible, the most important conflicts as well as the majority of minor conflicts between agriculture and wildlife seem to have been identified.

Grower Demographics
While statistics were gathered for individual farms, they have been summarized to protect grower identity. Further, rare crops which only a few growers produce are identified as "other crops" since identifying the crop could identify growers who participated and compromise confidentiality. Crops included under “other” are of minor importance in the study area and have not been identified by individual growers as having significant conflicts with wildlife and will, therefore, not be part of the literature survey.

The size of farms surveyed ranged from approximately 25 to 800 acres with an average of 150 acres and a median of 50 acres. The number of crops produced per farm ranged from 1 to 8 with an average of just over 3 crops* per farm.

Of growers surveyed:
66% of farms had orchard
42% of farms produced raspberries
42% of farms produced strawberries
42% of farms produced corn
33% of farms produced soybeans
33% of farms produced winter wheat
25% of farms produced mixed vegetables*
17% of farms produced straw or hay
17% of farms produced chickens
17% of farms produced other crops**

(*Mixed vegetables were considered 1 crop in these calculations)
(** Other crops were considered to be one crop in these calculations)

Grower Identified Productivity Impacts
Growers were asked to identify the significance of the impact of wildlife on their farms. The question, "In terms of overall farm productivity, how important do you feel wildlife damage is?" Growers were asked to estimate these impacts in terms of percent loss, bushels per acre or dollars per year loss.

Only one grower, a new producer, reported no impact. All other producers noted some degree of impact. Fully 50% of growers reported significant or very significant impacts on farm productivity. The results are summarized below.

The responses in Chart 1 are direct quotes or summaries of conversations with growers. Responses are grouped according to the severity of impact on farm productivity described by the grower. There are cases where one grower referred to damage as significant while other growers referred to similar levels or degrees of damage as not significant or very significant. This variation is assumed to reflect different tolerance levels of growers and no attempts to rearrange responses according to similar types or value of impact has been made.

See ‘Notes’ at the end of this appendix for a summary of results of similar but more extensive surveys.
Chart 1: Grower Identified productivity impacts

<table>
<thead>
<tr>
<th>Class</th>
<th>Response %</th>
<th>Effects on Farm Productivity</th>
<th>Species, Crop and Description of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8%</td>
<td>none, no problem</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>42%</td>
<td>not significant</td>
<td>rabbits, orchard, delayed productivity up to 20% in some areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>not major</td>
<td>none identified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>not very</td>
<td>deer, orchard, caused a lot of damage in new plantings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>small</td>
<td>deer, orchard, nibble buds on large trees, quite destructive in young plantings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>not significant</td>
<td>robins, raspberries, cat fruit and hard to scare</td>
</tr>
<tr>
<td>3</td>
<td>25%</td>
<td>significant</td>
<td>deer, orchard, caused a lot of damage in new plantings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>crows apples, lost up to ½ bushel per tree one year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>turkeys, apples, turkeys peck lower apples on dwarf trees, lost 20% of late apples and 1-2% of early apples.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>corn, racoons. 4-5% loss</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>quite important</td>
<td>racoons, corn. $1000's of dollars damage, less than half a crop in some plantings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>extreme impact</td>
<td>porcupine significant. added to problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>big problem</td>
<td>deer, orchard, damage equal to revenues, $10's of thousands in damage including replanting and lost potential productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>deer, orchard, stripping young trees, $1000's in replanting costs and delayed production.</td>
</tr>
</tbody>
</table>

1.4.1 Conflicts Identified in Chart 1

Conflicts repeatedly identified as having significant or very significant impacts on overall farm productivity

- Deer and orchard.
- Raccoons and corn

Conflicts identified at least once as having significant or very significant impacts on overall farm productivity

- Porcupine and corn
- Turkeys and apples
- Crows and apples

Conflicts identified as having little impact on overall farm productivity

- Robins and raspberries
- Rabbits and orchards

Other Wildlife/Agriculture Conflicts

Growers were asked if they were experiencing other conflicts with wildlife and to describe the impact, management approach and effectiveness of those management practices. This question was designed to pinpoint more specific problems and concerns of area growers. Surprisingly, some of the growers who identified wildlife as generally having little impact on farm productivity listed as many as six different conflicts with wildlife and described significant impacts.
on specific crops. These results are still assumed to represent different tolerance levels of growers to damage done by wildlife, however, they also suggest that conflicts between agriculture and wildlife are more common and widespread than section 1.4 (Grower Identified Productivity Impacts) suggested.

### Chart 2: Other Conflicts

<table>
<thead>
<tr>
<th>Crop</th>
<th>Wildlife</th>
<th>Significance of impact/control strategies/notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orchard</td>
<td>rabbits</td>
<td>Lost lower scaffolds, delayed productivity. Used Thiram(TM) paint - fairly effective until late March when rain and weathering reduced effectiveness. Believes the rabies bait program has led to a healthy red fox population eliminating the problem. Had some damage, used tree guards, shotgun and paint, but believes wolves and foxes have done the most to reduce the problem.</td>
</tr>
<tr>
<td>Orchard*</td>
<td>deer</td>
<td>Trees still suffering. Hung bars of soap on branches which helped a little. A lot of damage to young trees, used a shot gun for control and found it quite effective.</td>
</tr>
<tr>
<td>Orchard*</td>
<td>deer</td>
<td>Extreme damage. Uses partial fence plus soap and describes control as fairly effective.</td>
</tr>
<tr>
<td>Orchard*</td>
<td>deer</td>
<td>Very destructive. Has Native person shoot deer - works well but wants to get the right deer.</td>
</tr>
<tr>
<td>Orchard*</td>
<td>deer</td>
<td>Very destructive to new plantings. Used Hinder(TM) but found it not that effective. Weathering and timing with fungicide means quite a lot of damage can be done.</td>
</tr>
<tr>
<td>Orchard*</td>
<td>deer</td>
<td>Some damage, but soap really helps.</td>
</tr>
<tr>
<td>Apples*</td>
<td>crows</td>
<td>A lot of damage in the past. Bird banger quite effective.</td>
</tr>
<tr>
<td>Apples*</td>
<td>turkeys</td>
<td>20% damage to late varieties. Not aware of or practicing any control.</td>
</tr>
<tr>
<td>Apples*</td>
<td>‘blackbirds’</td>
<td>Bird banger is effective.</td>
</tr>
<tr>
<td>Corn</td>
<td>porcupine</td>
<td>Not as important as raccoons; more easily controlled by shooting.</td>
</tr>
<tr>
<td>Corn</td>
<td>crows</td>
<td>Especially in sweet corn: not very significant damage. Bird banger with shotgun are effective if used together.</td>
</tr>
<tr>
<td>Corn</td>
<td>raccoons</td>
<td>Noticeable damage. Shooting is effective. Minor damage. Coyotes live in area and seem to control or scare the raccoons away.</td>
</tr>
<tr>
<td>Corn</td>
<td>raccoons</td>
<td>Very significant damage. Shooting and trapping has limited effectiveness. Very interested in other alternatives. Interested in range of raccoons 5-10% damage. Interested in alternatives to shooting.</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>turkeys</td>
<td>Lost several acres. Moved plantings nearer to house and eliminated the problem.</td>
</tr>
<tr>
<td>Strawberries</td>
<td>turkeys</td>
<td>Significant damage. Used scarecrow which seems to be effective. Slight damage. No control being used.</td>
</tr>
<tr>
<td>Strawberry</td>
<td>'gulls'</td>
<td>Never a problem in the past but absolutely necessary to control now. Uses shotgun which works well. Important damage, uses 12 gauge to scare, which works well but requires a permit.</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Raspberries</td>
<td>'birds'</td>
<td>Bird banger is used with limited effectiveness. Bird banger, the birds get used to it. Upick customers and neighbors don’t like it, and it scared away a pair of bird hawks that used to nest nearby. Uses plastic owl, moving it every day so birds don’t get used to it, hoping to discourage birds from nesting nearby. Interested in range of robins. The big problem with robins is that they are used to people and therefore very hard to scare.</td>
</tr>
<tr>
<td>Land</td>
<td>beaver</td>
<td>Good and bad, floods land but provides irrigation pond too.</td>
</tr>
<tr>
<td>Land</td>
<td>muskrat</td>
<td>Causes erosion in drainage ditch.</td>
</tr>
<tr>
<td>Chickens</td>
<td>'gulls'</td>
<td>Concerned about alien influenza. Uses “everything and anything” if they are near chickens, works well.</td>
</tr>
</tbody>
</table>

*Where “Apples” are listed under “Crop” the wildlife species is damaging fruit and reducing harvest or value of harvest that year. Where “Orchard” is listed, the wildlife species is damaging the trees reducing future production potential of the orchard in addition to any loss at harvest.

**Conflicts Identified in Chart 2**

**Deer/orchard** was repeatedly identified as a significant conflict especially in young orchards. Limitations of past management options were noted and drastic measures are being considered and implemented.

**Raccoons/orchard** was repeatedly identified as an important conflict. Traditional control (shooting) has limitations and there is interest in alternatives. Of specific interest was the range of racoons. One grower suggested that coyotes either control racoons or limit their range.

**Rabbits/orchard** conflicts were mentioned and in both cases natural predators (foxes and coyotes) were identified as the main controlling factor. The rabies bait program was identified as a major positive influence.

**Porcupine/orchard** conflicts were identified only once and described as minor, the animal being easily controlled by shooting.

**Beaver/Land** was identified as a potential conflict but also as a benefit to the grower.

**Muskrat/Land.** The grower blames erosion in drainage ditches on muskrat, options to control erosion without disturbing muskrat are of interest.

**Conflicts between a variety of birds in a variety of situations have been identified:**

**Crows:** Apples and Sweet corn.

**Turkeys:** Apples, Tomatoes and Strawberries.

**‘Birds’**; Raspberries and Apples.

**‘Gulls’**; Strawberries and Chickens. Specific concerns about permits to scare and legalities of shooting birds were identified by growers.
Abandoned Practices

Growers were asked “Are there management practices you used in the past that you no longer use? (why not?)”

Some growers gave up practices as the problem went away and those practices were no longer necessary. In two cases red fox and coyote populations eliminated the need to control rabbits. One grower with a small orchard has quit all standard management practices for mice in orchards. The practices abandoned include tree guards, tree paint, scalping turf or using herbicide around tree base and poison mouse bait. The grower believes that the farm’s cats control the mouse population.

All other growers abandoned practices they found ineffective as problems escalated not because they were unnecessary.

Escalating Problems

Birds/Raspberries

Three growers have quit using bird bangers and one grower quit shooting birds in raspberry fields. All of the growers said that shooting is ineffective. Also the practice is not very compatible with Pick Your Own operations and unpopular with neighbors. One grower noted that the bird banger scared away a pair of bird hawks that nested nearby while the birds damaging the crops got used to it. New practices include nets, and moving a plastic owl around to discourage nesting.

Deer/Orchard

Practices abandoned include scarecrows, dogs, soap, bloodmeal, all of which are considered to be both expensive and/or time consuming with varying effectiveness. Alternatives which have been implemented include partial fencing and shooting deer. Shooting deer is of limited effectiveness since damage is often already done and there is concern that deer not causing damage could be shot. The grower was concerned that they only shoot the deer causing damage.

High, Medium and Low Priority Conflicts Identified

High Priority Conflicts:

White Tail Deer/Orchard Conflicts:
*Were repeatedly identified as having significant and very significant impacts on overall farm productivity.
*Were repeatedly identified as requiring control.
*Practices used in the past are not providing adequate control for young high density plantings
*Species are, in some cases, being controlled by shooting.

Raccoon/Corn Conflicts:
*Were repeatedly identified as having significant and very significant impacts on overall farm productivity.
*Were repeatedly identified as requiring control.
*The primary methods of control are trapping and shooting.
*Were identified once as being controlled by coyotes

Conflicts between Agriculture and Birds:
*Turkeys and Crows were each identified as having significant impacts on farm productivity.
*Crows, “birds”, Turkeys, Seagulls, and Robins were all identified as requiring some kind of control.
*Conflicts with robins and seagulls are escalating for some growers and traditional management practices are no longer effective.
*Seagulls are in some cases being controlled by shooting.
Medium Priority Conflicts:
Porcupine/Corn Conflict:
*Porcupines were identified once as causing significant impact on overall farm productivity.
*Species are controlled primarily by shooting.

Red Fox, Coyote and Wolf:
*Were identified twice as benefiting agriculture.

Eastern Cottontail Rabbit/Orchard Conflicts:
*Were identified twice as requiring control
*Were identified twice as being controlled by natural predators (fox and coyote).
*Were identified as declining in importance and no longer requiring management efforts.
*Are sometimes controlled by shooting.

Canadian Beaver/Land Conflicts:
*Was identified as having a potential conflict but also as being of benefit to the grower who used the water for irrigation.
*Beavers are often controlled by shooting and trapping
*Beavers create valuable wetland habitat important to rural biodiversity.

Meadow Vole/Orchard Conflicts:
*Were identified as declining in importance and no longer requiring control in one instance.
*Poison is a method often used to control mice (Meadow Vole) populations.

Low Priority Conflicts:
Muskrat/Land Conflict:
*Was identified as causing erosion in drainage ditches.

NOTES
The following is a summary of a booklet prepared by H. McCrimmon for the Ontario Agricultural College in 1958 found in Dagg, Anne Canadian Wildlife and Man

“The farmers that complain of wildlife pests are numerous although the damage may be slight. In a survey of 380 southern Ontario farmers in 1958, 41 percent reported that they had suffered some damage from wildlife within the last five years. Of these, 55 percent complained of raccoon eating corn mostly, 38 percent of fox killing poultry, 33 percent of deer eating cash crops such as fruit, cabbage, and lettuce from areas such as the Holland Marsh truck farms, 13 percent of rabbits damaging fruit trees and 2 percent of pheasants eating crops in market gardens or in suburban gardens.” (Dagg p. 53)

The following is a summary of results from a survey of 238 farmers during December 1991 in Cache and Rich Counties in Utah and Lincoln County in Wyoming found in McIvor, Donald E. and Michael R. Conover. “Perceptions of Farmers and Non-farmers Toward Management of Problem Wildlife” Wildlife Society Bulletin. Of the farmers that responded 92.8% were male, between 46 and 55 years old. On average, the farmers had a high school education and had been resident in their county for 46.2 years. “During 1991, 57.9% of agricultural producers in our survey experienced some level of damage from wildlife, while 66.4% experienced damage in prior years. When asked to estimate the most recent years loss, 15.6% reported losses < US$100, 56.5% reported losses from US$100-1000, 23.1% between US$1000-5000, and 4.8% estimated losses > US$5000.” (McIvor, p 212-213)
Figure A1: Bay of Quinte - Major Watersheds, Zones, and Counties
Appendix 6: Crude Population and Crop Land Statistics

Chart 1: Decreases in Cropland by County (1981-1991)

<table>
<thead>
<tr>
<th>County</th>
<th>Acres of Cropland 1981</th>
<th>Acres of Cropland 1991</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haliburton</td>
<td>1933</td>
<td>3177</td>
<td>+39.2</td>
</tr>
<tr>
<td>Hastings</td>
<td>139 534</td>
<td>125 243</td>
<td>-11.4</td>
</tr>
<tr>
<td>Northumberland</td>
<td>177 454</td>
<td>164 001</td>
<td>-8.2</td>
</tr>
<tr>
<td>Peterborough</td>
<td>127 428</td>
<td>117 739</td>
<td>-8.2</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>102 741</td>
<td>83 774</td>
<td>-22.6</td>
</tr>
<tr>
<td>Victoria</td>
<td>149 739</td>
<td>143 992</td>
<td>-4.0</td>
</tr>
<tr>
<td>Frontenac</td>
<td>82 513</td>
<td>72 302</td>
<td>-14.1</td>
</tr>
<tr>
<td>Lennox &amp; Addington</td>
<td>91 086</td>
<td>84 178</td>
<td>-8.2</td>
</tr>
</tbody>
</table>


Percent of Wetlands Drained by County.

<table>
<thead>
<tr>
<th>County</th>
<th>Percent of Wetlands Drained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haliburton</td>
<td>3-19%</td>
</tr>
<tr>
<td>Hastings</td>
<td>3-19%</td>
</tr>
<tr>
<td>Northumberland</td>
<td>3-19%</td>
</tr>
<tr>
<td>Peterborough</td>
<td>3-19%</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>19-35%</td>
</tr>
<tr>
<td>Victoria</td>
<td>3-19%</td>
</tr>
<tr>
<td>Frontenac</td>
<td>3-19%</td>
</tr>
<tr>
<td>Lennox &amp; Addington</td>
<td>3-19%</td>
</tr>
</tbody>
</table>

Salping 1995a, Salping 1995b
### Percent Change in Total Population by County from 1986 to 1991

<table>
<thead>
<tr>
<th>County</th>
<th>Total Population 1986</th>
<th>Total Population 1991</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haliburton</td>
<td>11 965</td>
<td>14 421</td>
<td>+20.5</td>
</tr>
<tr>
<td>Hastings</td>
<td>109 352</td>
<td>116 434</td>
<td>+6.4</td>
</tr>
<tr>
<td>Northumberland</td>
<td>67 704</td>
<td>78 224</td>
<td>+15.5</td>
</tr>
<tr>
<td>Peterborough</td>
<td>105 056</td>
<td>119 992</td>
<td>+14.2</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>22 427</td>
<td>23 763</td>
<td>+6.0</td>
</tr>
<tr>
<td>Victoria</td>
<td>52 599</td>
<td>63 332</td>
<td>+20.4</td>
</tr>
<tr>
<td>Frontenac</td>
<td>115 221</td>
<td>129 089</td>
<td>+12.0</td>
</tr>
<tr>
<td>Lennox &amp; Addington</td>
<td>34 354</td>
<td>37 243</td>
<td>+8.4</td>
</tr>
</tbody>
</table>

Ontario Ministry of Agriculture, Food and Rural Affairs. 1995

### Percent Change in Rural Population by County from 1986 to 1991

<table>
<thead>
<tr>
<th>County</th>
<th>Rural Population 1986</th>
<th>Rural Population 1991</th>
<th>Percent Change</th>
<th>Percent of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haliburton</td>
<td>11 965</td>
<td>14 421</td>
<td>+20.5</td>
<td>100</td>
</tr>
<tr>
<td>Hastings</td>
<td>37 295</td>
<td>43 070</td>
<td>+15.5</td>
<td>37.0</td>
</tr>
<tr>
<td>Northumberland</td>
<td>35 290</td>
<td>40 597</td>
<td>+15.0</td>
<td>51.9</td>
</tr>
<tr>
<td>Peterborough</td>
<td>36 350</td>
<td>43 464</td>
<td>19.6</td>
<td>36.2</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>16 985</td>
<td>17 964</td>
<td>+5.8</td>
<td>75.6</td>
</tr>
<tr>
<td>Victoria</td>
<td>34 560</td>
<td>42 186</td>
<td>+22.1</td>
<td>66.6</td>
</tr>
<tr>
<td>Frontenac</td>
<td>31 845</td>
<td>40 484</td>
<td>+27.1</td>
<td>31.4</td>
</tr>
<tr>
<td>Lennox &amp; Addington</td>
<td>23 155</td>
<td>25 959</td>
<td>+12.1</td>
<td>69.7</td>
</tr>
</tbody>
</table>

Ontario Ministry of Agriculture, Food and Rural Affairs. 1995

256
Percent Change in Rural Farm Population by County from 1986 to 1991

<table>
<thead>
<tr>
<th>County</th>
<th>Rural Farm Population 1986</th>
<th>Rural Farm Population 1991</th>
<th>Percent Change</th>
<th>Percent of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haliburton</td>
<td>250</td>
<td>275</td>
<td>+10.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Hastings</td>
<td>4,310</td>
<td>3,980</td>
<td>-7.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Northumberland</td>
<td>4,835</td>
<td>4,785</td>
<td>-1.0</td>
<td>6.1</td>
</tr>
<tr>
<td>Peterborough</td>
<td>4,605</td>
<td>4,590</td>
<td>-0.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>1,940</td>
<td>1,855</td>
<td>-4.4</td>
<td>7.8</td>
</tr>
<tr>
<td>Victoria</td>
<td>5,215</td>
<td>5,050</td>
<td>-3.1</td>
<td>8.0</td>
</tr>
<tr>
<td>Frontenac</td>
<td>2,715</td>
<td>2,330</td>
<td>-14.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Lennox &amp; Addington</td>
<td>2,400</td>
<td>2,340</td>
<td>-2.5</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Ontario Ministry of Agriculture, Food and Rural Affairs. 1995
Bibliography


Cameron, Auston W. 1964. “Canadian Mammals”, Department of Northern Affairs and Natural Resources, Ottawa.


Tromley, et.al. 1986. “Notes on the Preparation of Essays in the Arts and Sciences”, Academic Skills Center, Trent University, Peterborough Ontario.