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). The distinguishing white tail is raised and highly visible when the deer is running (Burt and Grossenheider 1980). The deer is most active in the morning, in evenings and on moonlit nights (Raycroft 1994).

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
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 1980:218). 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.

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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 Th Ruin Some Operations
- 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.
- Intrauterine 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

- Anti-fertility Action of Two Synthetic Progestins in Female White Tailed Deer
- Effectiveness, Reversibility, and Serum Antibody Titers Associated with Imunocontraception 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 Imunocontraception 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”.
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 Their 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 Quebec
- 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 Th Ruin Some Operations
- Reducing Deer Damage to Yews and Apple Trees: Testing Big Game Repellent™, Ropel™, 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 Their 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 Their 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 TAIRED DEER
Two synthetic progesterins, MGA (17α-acetoxy-6-methyl-16-methylene-4,6,regnadiene-3,20-dione) and DRC 6246 (11α-allyl-17β-hydroxy-3-oxostra-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 29032

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.
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%; Marten River -- beaver up from 37 to 74% and deer fell from 42 to 1% of scat.

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.

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.
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. Caeser 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 Adirondack 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
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 an 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 Off Limits™ claims; “Since 1990, Off limits 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.
Katherine L McArthur. College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow 83843

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 Melchioris 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 microspheres 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 REPELLANTS 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
François 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 REPELLANTS 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 REPELLANTS
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, MO 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 waterfowl, (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, racoons, 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 (diethylstibesol), 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 renumeration 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 (saslslq@unx.sas.com), Bruce Dodd (ag187@freeNet.Carleton.CA), Erik DjukaKastein (Erik@scatMat.com), Andy Wing (adwing@astro.ocii.tempo.edu), John Nedimyer (nedimyer@buffnet.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 DjukaKastein reports on a new scarecrow that is being developed by Contech 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 DjukaKastein 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 Hindriks 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-EFFECTIVITY 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, 1:8 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, Berkly, 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 YEWS AND APPLE TREES: TESTING BIG GAME REPELLENT™, ROPEL™, 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 Repellant™ (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 RoPel™ did not reduce deer damage. Manufacturers of RoPel™ claim the bitter tasting product (containing 0.065% benzyl diethyl {[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$1170 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 raccoon (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 2176 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-
minutes 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, Philippines

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 repellant 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 co-operator (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
R. K. Murton. Ministry of Agriculture, Fisheries and Food, Infestation Control Laboratory,
Worpleston, England

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 1/2 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 (Poplarus 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 coruina), strawberry (Fragaria virginiana), willow (Salix spp.), choke cherry (Prums 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)

Muskrat

Prepared For: The Bay of Quinte Wetlands/Woodlands/Wildlife Project
Prepared By: Rob Mound
Completed Fall 1996
Muskrat (Ondontra zibethica)

Results of the Grower Needs Assessment

The Muskrat (Ondontra 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 Ondontra 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 150 m 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 (Kurma 1995). The porcupine uses the same den site throughout its life and most often forages very close to home (Kurma 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 (Kurma 1995).

ENVIRONMENT/HABITAT
Porcupines are most often found in forested areas, especially ones with pine and hemlock (Kurma 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” (Kurma 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 (Kurma 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 (Kurma 1995, Burt and Grossenheider 1980). The porcupine stays with its mother until 6 months and is sexually mature at 3 years of age (Kurma 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 (Kurma 1995). Preferred trees include white pine, hemlock, sugar maple and birch, although basswood, aspen and elm are of importance in the summer.
months (Kurta 1995).

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 1997). 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 Eadie. 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)

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 Leporadai (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 180). 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 Leporadai 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
• Coyote Foods in the Black Hills, South Dakota
• The Ecology of Red Foxes, Gray Foxes and Rabies in the Eastern United States
• Foods of Adult Maine Coyotes and Their Known Age Pups
• Population Ecology of Coyotes During a Fluctuate of Snowshoe Hares
• Red Fox Feeding Habits in Relation to Fawn Mortality

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
AN ACOUSTIC SCARING DEVICE TESTED AGAINST EUROPEAN HARES
Charles J. Wilson and I. Gordon, McKillop. Ministry of Agriculture, Fisheries and Food, Worpplesdon Laboratory, Tangle 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, Tanglely 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).

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 (*Lepes 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)

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 streams 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 peak 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 be 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, racoons, 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 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 “Vole” Section
- Bait Acceptance by Rats of Microencapsulated Male Sterilant Alpha-chlorophydrin
- 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

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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 Townsendi)
- Cultural Practices Affecting Montane Voles in Washington Apple Orchards

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◆ Fish and Wildlife Habitat Management: Best Management Practices
◆ Habitat Selection by Small Mammals of Riparian Communities: Evaluating Effects of Habitat Alterations
◆ L-1351 Effective Rodent Control on Poultry Farms
◆ L-1905 Controlling Mole Damage
◆ L-1916 Control of Rats and Mice
◆ Protecting Trees from Vole Damage
◆ Rodent and Deer Control in Orchards
◆ Rodents and Rodent Control
◆ Small Mammals in Farmstead Shelter Belts: Habitat Correlations of Seasonal Abundance and Community Structure
◆ Vole (Mouse) Control

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.
- Microencapsulation 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-chlophorhrin
- Chloropicrin Tested as an Area Repellant 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
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- Hazards to Birds from Zinc Phosphide Rat Bait in a Macadamia Orchard
- L-1900 Controlling Rats and Mice with Anticoagulants
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- 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
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
Nest Box and Perch Installation for Raptors
• Progress in Rodent Control and Strategies for the Future
• Raptor Use of Artificial Perches
• Raptor Use of Nest Boxes and Platforms on Transmission Towers
• Red Fox Feeding Habits in Relation to Fawn Mortality
• Residues of the Rodenticide Brodifacoum in Voles and Raptors after Orchard Treatment
• Secondary Poisoning of Owls by Anticoagulant Rodenticides
• Wildlife & Agriculture (1): Trees and Shrubs for Erosion Control and Wildlife Habitat

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