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URBAN VERTEBRATE PEST MANAGEMENT: A PRACTICAL APPROACH

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ABSTRACT: Urban vertebrate pest management is influenced by a variety of factors. Public perceptions of wildlife limit control specialists in their methods of operation. Population density, costs of operation and timing of control are considered. Suggestions are made for operational mode, methods, baits, traps and disposal. Two new trapping concepts are described and experimental data on attractants are given. Computer-summarized data on urban wildlife conflicts from one state (Texas) show that most complaints can be handled by extension methods supplemented with direct control by the public and wildlife damage control specialists.

Urban wildlife damage control does not exist in a vacuum. It is influenced by attitudes of the public, costs of operation, and the availability of socially-acceptable and legal methodologies. W.E. Howard (1973) said, "Man has a moral responsibility to manage nature once he has disrupted it." And we would add, ". . .for the benefit of nature as well as man." The conflicts in society concerning nature generally stem from questions on how, when, where, and by whom management should ensue, and for what purpose (Smith 1973). The purpose of this paper is to address a small fraction of these questions and to offer suggestions that may guide others in the professional control field to solutions.

METHODS

Two studies have been utilized to supplement the text. The first is a computer-assisted summarization conducted by Chamberlain on Wildlife Complaint Logs containing all recorded requests for assistance from clients of the Urban Programs - Texas Rodent and Predatory Animal Control Service for the period of June 1980 to May 1981. These reports contained listings of complaints categorized by month, day, species, county, control request code, type of damage, location of damage, estimated dollar loss, and action taken.

The data were coded directly by assigning a number to each type of event. To facilitate the analysis only 19 species or animal groups were specifically coded; additional species not represented were lumped into "other." The "county" was interpreted as the county where the reporting office was located even though some complaints may have originated in bordering areas for which the specialist had responsibility. Twelve employee "locations" submitted reports during the period analyzed. Eleven monthly reports were unavailable because of (1) failure to report or (2) a staff vacancy. A code was devised

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THE OPINIONS EXPRESSED ARE THOSE OF THE AUTHORS AND IN NO WAY REPRESENT THE OPINIONS OF CURRENT OR PAST EMPLOYERS AND ASSOCIATIONS. USE OF COMMERCIAL NAMES OF PRODUCTS FOR THE PURPOSE OF CLARITY DOES NOT NECESSARILY CONSTITUTE ENDORSEMENT.

to join the data from the columns on "type of damage" and "location of damage." Since sufficient information had been included by the employees in the cases involving nuisance, damage prevention and potential rabies threat or exposure in addition to cases involving damage, all complaints were analyzed by the newly created category "type/location." Seven subcategories were defined. The estimated dollar loss was coded according to a loss range with 11 intervals. The amount of dollar loss should be interpreted only as a minimum estimate made by the control specialist based either on reliable reports of damage by the client, or by physical inspection of the damage by the specialist. No dollar value was recorded for nuisance or damage prevention, and only where an actual expenditure arose for veterinary or physicians' fees in the case of rabies threat or exposure was an amount coded in that category. The "action taken" data were coded into 9 alternative subcategories. In cases involving ambiguity, the control specialist was contacted by telephone for an interpretation. Computer assistance was essential because the records contained 53,767 coded elements.

The second data set was provided by Wright for food preferences of wild captured commensal rodents native to north and east Texas. The analysis was prepared from screening and comparison tests conducted over a two-year period by the B & G Chemical and Equipment Company, Dallas, Texas. Tests were conducted to find a blend of various grains and food additives that would be accepted by all species of commensal rodents. As a basis of comparison, the EPA challenge diet formula was used and the EPA recommended multiple-dose rodenticide protocol was followed to determine acceptance levels of the new food. The test foods were composed of the EPA basal diet with a food additive blended into it.

Initial screening tests using wild Norway rats (Rattus norvegicus) were used to isolate any candidate that could be considered as an additive to activate higher acceptance than the challenge diet. After the 13 screening tests, 33 comparison tests were run with wild Norway rats, and 19 followup comparison tests with wild roof rats (Rattus rattus). Sixteen comparison tests on wild house mice (Mus musculus) were completed using materials that had tested highly at each phase of the two prior series. An initial acceptance level of 40% or better was required of all materials for further testing in the series.

Other information presented on attractants, baits or new control methods was obtained from research and field personnel, experience of the authors, or from the literature.[1]

DISCUSSION AND RESULTS

Wildlife forms a very important and visible part of nature. In 1975, an estimated 96,000,000 persons participated in the United States in wildlife activities, and about 23,640,000 of those persons also hunted and fished (USDI 1977). About 22%, or roughly 1 person in every 5 participates in birdwatching and birdfeeding (DeGraaf and Payne 1975; Geis 1980; Kellert 1977). Seeds purchased for this leisure activity in 1974 cost in excess of $170,000,000. An additional $22,000,000 was spent for birdhouses and feeders, field guides, and wildlife gift books (DeGraaf and Payne 1975). More than $21,000,000,000

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[1]Scientific names of all other animals named in the text are contained in Table 5.

was spent for hunting and fishing alone and an additional $500,000,000 was spent for non-consumptive wildlife related recreation (USDI 1977; DeGraaf and Payne 1975). If the old saying is true that a man's heart is where his money is, then it can be said that the hearts of Americans are in wildlife.

A current interest exists in urban and suburban environmental enhancement for the purpose of retaining, and in some instances introducing, wildlife into an area offering closer relationships with man (Geis 1980; Howard 1973; More 1979; Thomas et al. 1977; Thomas and Dixon 1973). In addition to individual efforts, planners have developed a variety of land-use plans that further the existance of wildlife in cities (Allen 1974; Geis 1975; Leedy et al. 1978; Leedy 1980; Maestro 1974; Seater 1975). With the promulgation and development of urban green spans, planned unit development, and parkland concepts, there are now a number of spokes of green, along with water courses, that encourage access by wildlife of all kinds. One of the problems with the wide array of publications (Albrecht and Weicherding 1980) extolling the social benefits of wildlife in urban places is that, in many cases, authors inadequately assess the potential for attraction of undesirable species or the introduction of wildlife associated disease in a congested area. As only one example, the trend in rabies occurrence since 1955 has been toward a decrease in dogs and an increase in wildlife. In 1972, 78% of the 4,427 reported cases were in wildlife (Locke 1973) and by 1977, the figure had increased to more than 84% of laboratory-confirmed cases (Center for Disease Control 1978). Other diseases can simulate the symptoms of rabies and only laboratory diagnosis can establish its presence or absence (Locke 1973). In our analysis of complaints from Texas cities, we found fear of personal injury or actual attack caused 84 requests for assistance and 113 complaints involved a threat of injury or actual damage to pets or livestock in urban or suburban areas (Table 1). In spite of similar problems on a nationwide basis, people are generally opposed to destroying wild animals even when the guilty party is caught in the act (Smith 1973). Whether an animal is "desirable" or not is in the eye of the beholder. If all people felt animals in nuisance or damage situations were "undesirable" the job of a control specialist would be easy. However, wildlife preference studies have given conflicting reports on which types of animals are most liked or disliked by persons in the United States. Most people are reported to picture wildlife in a positive light (More 1979). The exact manner in which Americans perceive animals varies greatly. Kellert (1976) demonstrated that several demographic factors are important in determining perceptions. Age, sex, race, education, occupation, childhood residence and marital status are very significant. Persons reared in urban areas versus those from rural surroundings perceive animals differently. These perceptions then translate into differing animal-human relationships and affiliations. On the basis of Kellert's study (1976), it would be unreasonable to believe that today's urban residents will respond to animal damage control and control methodologies in the same fashion as their rural counterparts.

Wildlife damage control specialists accustomed to serving a farm clientele that scores high in the utilitarian group (where predator and general pest control is supported 100%) would find themselves in great difficulty by speaking, acting or using methods approved of by utilitarians when dealing with persons in urban areas rating high in the naturalistic, humanistic, and moralistic groups (Kellert 1976).

In rural areas, damage generally has already occurred prior to a request for assistance. In urban areas, assistance was requested in approximately 71%

Table 1. Type/Location of complaints from 12 cities in Texas served by the Urban Programs Staff, Texas Rodent & Predatory Animal Control Service.

Description[a]	Number of Complaints	Percent Composition
Structural	4953	65
Yard, Plants, Trees	1966	26
Personal Property	252	3
Garden (Veg/Fruits)	225	3
Pets/Livestock	113	1
Utilities (Elec./Heating ducts/Plumbing/Phone)	88	1
Personal Injury[c]	84	1
TOTAL	7681	100[b]

[a]Presence of animal in, doing damage to, or about to do damage to the indicated item.

[b]Rounded.

[c]Fear of threat from an animal or actual attack.

Table 2. Control Request Code given to each complaint received by a Wildlife Damage Control Specialist (Urban Program Staff).

Type of Complaint	Number of Complaints	Percent Composition
Nuisance	3729	49
Damage	2219	29
Damage Prevention	1711	22
Rabies Prevention or Threat of Exposure	22	.3
TOTAL	7681	100.3[a]

[a]Error due to rounding.

of the cases as a result of nuisance and damage prevention with 29% for damage (Table 2). In handling each request, the control specialist is, in a manner of speaking, an island by himself, subject to review by the general public and the employing agency. The urban specialist is constrained by factors that generally do not affect an operator in the rural environment. Restrictions exist on methods, timing and privacy, among other things.

Methods of control and prevention of damage for a wide variety of animals exist; however, because of restrictive ordinances many methods available in rural areas are unavailable in cities. Use of firearms, "steel" traps (sometimes including cage traps, conibear and leg-hold varieties) and even legally registered toxicants, such as avicides, are prohibited in some metropolitan areas. One example of timing problems exists with noise ordinances. If enforced, they can prohibit bird control methods utilizing loud speakers or fireworks during the very hours of the day needed to move roosts. As a result of city government accession to movements to designate a city as a bird sanctuary, sparrows, starlings, pigeons and other birds of pest or public health significance are given complete protection regardless of the consequences.

Privacy is non-existant in urban areas. When control activities take place in a neighborhood over a period of two or more days, neighbors generally express interest. In some instances persons other than the client interject themselves to the point of destroying control devices, releasing captured animals, and threatening the specialist or client.

Most effort in an urban area is generally placed in educational programs that teach people how to avoid problems or to help themselves when necessary. It is physically impossible to handle every complaint from the persons who request help. Scientifically and legally correct information should be made available to the people on proper ways to solve their problems with wildlife. Then, once informed, it becomes the responsibility of the client to make use of available resources. Every homeowner and business person is a potential client because of the problems from a conflict with an ever-increasing abundance of wildlife. The ratio of specialists to persons needing help is extremely small and can lead to a totally impossible situation of demand for services. Under such conditions, individual assistance can become a strain. Of course, there will always be cases where the only means of feasible assistance is by direct and personal control applied by the specialist with traps or baits. Examples are with the elderly, the disabled, and in many cases, with those in poverty.

Most persons, however, are capable physically and financially of helping themselves if given proper instructions. From June 1980 to May 1981, the Texas Urban Program staff handled 78.5% of all individual complaints by extension methods alone and another 11.2% by extension methods supplemented by temporary loan of an agency-owned trap. Only 8.9% required direct control action by the specialist. An additional 1.3% were referred to another agency or control specialist (Table 3). Commercial pest control operators in most areas are willing to accept complaints on certain species including squirrels and raccoons as well as rats. A listing of companies that will work on vertebrates can be maintained by the specialist at a government office, and 3 to 5 company names can be referred to each client who requests the information. By giving more than one company name, the specialist can avoid endorsement of any one company and rotate the listings with each call.

Table 3. Action Taken: The choice of mode for handling each complaint received by a Wildlife Damage Control Specialist (Urban Programs).

Action Mode	Number of Complaints	Percent Composition
Control Methods Instruction[a]		
Consultation Only	4998	65.07
Consultation + Literature	1034	13.46
Consultation + Issued Trap	838	10.91
Cons. + Lit. + Issued Trap	19	.25
SUBTOTAL	6889	89.69
Direct Control Operation and CMI[b]		
Cons. + Lit. + Rodenticide	404	5.26
Cons. + Lit. + Trapped	285	3.71
SUBTOTAL	689	8.97
Referral to another agency or TR & PACS Specialist[c]	103	1.34
TOTAL	7681	100.00

[a]CMI is another name for an extension type activity.

[b]Direct Control Operations and Control Methods Instruction used in conjunction.

[c]Referral to another governmental agency or another specialist within the same agency but located in another location. Texas Rodent & Predatory Animal Control Service.

The management method chosen by the specialist must be suited to the individual situation. No prescription remedy will work in all situations and no fixed formula should be relied upon. In each situation encountered, the specialist should first identify the damaging species and once identification is complete, work out a management option for the specific opportunities and constraints of the case. Several things should be kept in mind:

1. Human and non-target animal exposure and danger of injury from the pest and/or the control method.

2. Human opposition to specific methods or to control in toto.

3. Private or public property? And who gives consent?

4. Timing of control and method availability.

5. Legal restrictions on species to be controlled, means or methods (local ordinances, state game and humane treatment laws, and federal laws).

6. Labeling, if a pesticide product is being considered (avicides, rodenticides).

7. Economic threshold.

8. Likelihood of effectiveness of preferred or alternative measures, and species selectivity (Smith 1973).

9. New approaches.

10. Who will carry out the recommendation on the control? Client? Pest Control Operator? Specialist?

11. Proper disposal of live or dead animals.

If the problem can be alleviated by environmental manipulation rather than by direct control, it will likely result in a more permanent solution and should be tried first. Many booklets and leaflets are available on "rodent proofing" from the Center for Disease Control, County Agricultural Agents, and Fish and Wildlife Service offices. This information is equally applicable to keeping raccoons, squirrels, and other unwanted wildlife out of structures. The specialist should try non-contact, non-lethal control only until it has been given a reasonable time to be successful. Then, if damage continues, direct contact (live trapping and relocation) and/or lethal control (snares, conibear, chemicals, other kill-traps) should be used. Losses can be substantial in some cases and reasonably prompt action may minimize further loss (Table 4).

Urban areas are so open and populous that a specialist should expect questions from neighbors, the press and governing officials. New specialists should be impressed with the necessity of conducting all work in a professional and respectable fashion that can stand the light of public scrutiny. Trouble can result for the individual and the agency if short cuts are taken or laws are violated because of expediency.

Table 4. Loss: The estimated dollar loss attached to each complaint of damage sustained by a client or client's property and reported to a Wildlife Damage Control Specialist (Urban Programs).

Estimated Dollar Loss Range	Number of Complaints	Percent of Total
1 to 5	144	6.5
6 to 10	337	15.1
11 to 25	714	32.0
26 to 50	486	21.8
51 to 100	270	12.1
101 to 200	136	6.1
201 to 500	107	4.8
501 to 1,000	16	0.7
1,001 to 5,000	19	0.9
5,001 to 10,000	1	.448
10,001 and over	1	.448
TOTAL	2231[a]	100.8[b]

[a]2219 complaints were for damage and 12 were loss associated with doctor (MD) or veterinary (DVM) bills incurred as a consequence of a rabies threat or fear following an exposure or bite.

[b]Error due to rounding.

Operating strictly in a direct control mode in urban areas would require more than the total number of control specialists in the entire U.S. only to manage an area the size of Texas. The cost differences can be dramatic based solely on the general pattern of operation. In 1979, when 93,342 people were assisted individually or in groups by the Urban Programs staff in Texas, the cost per person served was $3.48. However, if city staff locations were analyzed separately, the costs ranged from $1.53 per person to $6.85 per person (Chamberlain, unpub. data). The difference was largely a matter of the program orientation. The lower figure was for a location operating by roughly a 20% direct control and 80% extension ratio; the higher figure was for a greater mix in the opposite direction.

The choice of approach ultimately may narrow to the type of animal involved. Most of the wild animals indigenous to an area prior to urbanization have the potential to cause problems. Planned re-introduction of mammalian wildlife to urban areas on a large scale is a recent phenomenon. However, a wide variety of species made urban areas their permanent homes years ago and we now face generations that are as much at home eating the fruits from trees and gardens as are the humans who planted them for their own consumption. The vast quantities of pet food available, and access to plastic garbage can liners filled with edible garbage, make easy pickings for raccoons, skunks and many other opportunists (Flyger 1973; Schinner and Cauley 1973; Thomas and Dixon 1973; Turkowski and Mech 1968). In a study of cemeteries in the Greater Boston metroplex, Thomas and Dixon (1973) found an amazing diversity in the wildlife present. They discovered 95 species of birds, 20 species of mammals, and a wide array of amphibians and reptiles. The most prominent among the mammals were raccoons, skunks, foxes, and squirrels. In Texas, we noted 20 different species or animal groups that could be classed as offending types (Table 5). The top eight were commensal rodents, raccoons, tree squirrels, skunks, gophers, opossums, armadillos and birds.

Many of the larger mammals can be lured into cage traps. These devices should be of sufficient size to comfortably accommodate the animal and be of sufficient strength to prevent escape. In continuous operation some traps fail to have a long life expectancy. The trap should fit the need. If used on a regular basis, it should not be of such light construction that an angry animal could bend or warp the wire or doors. A door closure may become a problem if bending occurs. We experienced great difficulty with the locking mechanisms and doors on one type of trap. It proved defective for use with raccoons and animals were able to escape. Two traps that have proven successful in repeated field use in Texas under difficult conditions are the Tomahawk and the Havahart Traps. If a trap is needed for only infrequent use or for weaker animals, the Tender Trap may prove useful. However, they have not withstood the same rigorous use to which the Tomahawk and Havahart respond (Caroline, unpub. data).

Manufacturers' instructions available to urban dwellers on trap use frequently omit three bits of information: how to make proper trigger adjustments, which baits or attractants to use, and how to dispose of the animal once caught. Proper trigger adjustment should be made so the trap can be easily sprung, but not at such a delicate point that it releases prematurely.

Handling, as well as disposal, of live-captured animals should be carried out with considerable care. Injury may occur to the trapper if care is not taken to keep fingers away from the angry caged occupant. The disposal of

Table 5. List of animals, or animal groups, that were involved in a human/wildlife conflict reported to the Urban Programs Specialist.

Common Name	Taxon	Complaints	Percent
Rats and Mice	Rodentia (Muridae 98%) (Cricetidae 2%)	3282	42.7
Raccoons	*Procyon lotor*	834	10.9
Squirrels	Sciuridae	753	9.8
Skunks	Mustelidae (3 species)	514	6.7
Pocket Gophers	Geomyidae	474	6.2
Opossums	*Didelphis virginiana*	367	4.8
Armadillo	*Dasypus novemcinctus*	356	4.6
Birds	Class: Aves	302	3.9
Moles	*Scalopus aquaticus*	193	2.5
Bats	Order: Chiroptera	189	2.5
Snakes	Colubridae, Elapidae or Viperidae	169	2.2
Beaver	*Castor canadensis*	50	.7
Coyote	*Canis latrans*	46	.6
Ground Squirrels	*Citellus*	43	.6
Rabbits/Hares	*Sylvilagus*/*Lepus*	39	.5
Other (animals appearing too infrequently to name)		35	.5
Deer	*Odocoileus virginianus*	13	.2
Nutria	*Myocastor coypu*	12	.2
Prairie Dogs	*Cynomys ludovicianus*	5	.1
Fox	*Urocyon*/*Vulpes*	5	.1
	TOTAL	7681	100.3[a]

[a]Rounding error.

most animals trapped in smaller urban areas generally poses no problem. In large urban centers, large distances, time, and energy restrictions may prove limiting in relocation efforts.

Trapped animals should be taken to previously arranged sites in appropriate habitat types for release. Care must be taken that the relocated animal is not simply moved to a new area where similar nuisance or damage problems may occur. This is especially true when the private individual (instead of the specialist) is arranging the relocation. The home range of raccoons in urban areas may extend from 11 to 24 acres (Schinner and Cauley 1973) and the distance traveled in one night may be as much as 3 miles (Turkowski and Mech 1966). They are not averse to regularly traveling any available route, including sewers, to desired locations (Schinner and Cauley 1973). Care should be taken not to leave behind young-of-the-year when an adult is trapped. As many as 23 raccoons have been reported living together in a cellar den in winter (Mech and Turkowski 1966). In some cities, wildlife rescue associations may prove helpful in capture and relocation efforts.

Suggestions for baits and attractants vary widely (Table 6). Baits should be fresh and properly attached to the trap. An old sock cut where the toe portion forms a sack can be filled with bait and attached so the animal will be well into the trap before the mechanism activates. Proper placement is essential for effective trapping. Experimentation on auditory, olfactory, visual, and gustatory attractants and baits has been productive in recent years. B & G Chemical and Equipment Company conducted extensive tests over a two year period on grains and feed products, oils and oil blends, flavors and food additives (Table 7). The result was identification of 9 food and flavor items that, when added to the EPA basal diet, appreciably altered acceptance levels for all three rodents tested. Percent acceptance ranged from 41% to 77% for differing concentrations of Merrick Dry Milk, whole wheat, corn chops, whole canary seed and imitation apple, fish, meat, and peanut flavors. The average acceptance for all species combined ranged from 44% to 68%. Individual species showed higher preferences for some items not listed which would be important if a species specific bait were used. Individually high species preferences were exhibited for ground pepper, cotton-seed meal, molasses, soybean meal, ground garlic, salt (non-iodized), and meat-scrap meal. In other tests, B & G noted different levels of acceptance of toxic baits based on color of the bait materials. Since those tests were being conducted to determine mortality factors based on percent active ingredient, they did not follow up on the color factor. However, they did note that the blue dyed baits seemed to induce mortality in a shorter time span than the green or red-dyed baits where the only difference in composition was the color additive. Since it is generally accepted that rats and mice lack color vision, the difference may be attributed to taste differences because of chemical composition (H. Tietjen, pers. comm.). This attraction lends credibility to the claims of at least one other rodenticide manufacturer (Central Soya 1978).

Howard Tietjen (pers. comm.) stated that no significant differences were noted in the attractiveness of baits with monastral green dye in tests on mammals. Denver Wildlife Research Center staff conducted tests on essential oils, extracts and essences used as masking agents for strychnine in gopher baits. Consumption of the bait doubled but there was no significant difference in mortality. Tietjen suggested that experiments might be appropriate on the chemistry of dyes where a color apparently contributes to attractiveness, and where tests show a significant relationship of the dye to differences in mortality.

Table 6. Baits and Attractants: Items noted are from a variety of sources.

Animal	Bait or Attractant
Armadillos	broken egg, fetid meats, meal worms, hamburger, over-ripe fruits, maggots, sardines (Chamberlain 1980; Sanderson 1945)
Fox	live chicken or rabbit, rotten fish, dead mouse, meat of any kind (Sanderson 1945; Eadie 1954)
Gophers	strychnine alkaloid treated grain baits placed in runways; sheet metal, concrete or wire fencing - fine mesh placed underground for better than 2 feet (Eadie 1954)
Nutria	muskmelon or cantelope rind, ripe bananas (Sanderson 1945), carrots and oil
Opossum	meat scraps, chicken head, dead mouse, vegetables, sweet apples, chicken entrails, sardines, canned cat food, bacon fried crisp (Eadie 1954; Sanderson 1945), half cooked bacon
Rabbits	fresh vegetables, lettuce, carrots, brussel sprouts or apple (Sanderson 1945), rabbit chow
Raccoons	fish, honey covered vegetables, smoked fish, watermelon, sweet corn, cooked fatty meat, crisp bacon (Sanderson 1945), sardines and dog food (Schinner and Cauley 1973), synthetic fermented egg product, Christmas ornament bird call, and mouse distress call (Turkowski et al. 1979; Turkowski, pers. comm.), prunes and vanilla wafers (Caroline, unpub. data)
Skunk	chicken entrails, canned or fresh fish, insect larvae, crisp bacon (Sanderson 1945), fruit, eggs and meat (Eadie 1954), half cooked bacon, cat food, dog food
Snake	whole bantam egg or live mice (Sanderson 1945)
Squirrel	cereals, grains, nuts, peanuts, sunflower seeds, anise oil (a few drops on bread), peanut butter and oatmeal, peanut butter and molasses (Sanderson 1945), dry prunes, nuts (Eadie 1954), pecans stuck to the trigger with peanut butter (Clay*), mushrooms, carrots, cedar nuts, hazel nuts (Raspopov and Isakov 1980)
Rats	meats, fish, cereals, milk products, fresh fruits and vegetables (melon, bananas, apples, sweet potatoes) (Eadie 1954), grapes smeared with peanut butter (Chamberlain, unpub. data), peanut butter and oatmeal, canned dog and cat food, dry dog and cat food, chicken mash, Thanksgiving stuffing

*Bill Clay, pers. comm. (Wildlife Damage Control Specialist, San Antonio, Texas)

Table 7. Food preferences of commensal rodents as determined by comparison tests. (B & G Company - Wright, unpub. data)

Food Product	Percent Acceptance			
	Norway Rat	Roof Rat	House Mouse	Total
Merrick Dry Milk (0.5% 20-40)	56	77	72	68
Whole Wheat (2%)	66	62	73	67
Merrick Dry Milk (0.5% 12-50)	52	68	66	62
Imitation Apple Flavor (9.3%)	47	65	54	55
Corn Chops (2%)	47	54	55	52
Imitation Meat Flavor (9.3%)	43	50	55	49
Imitation Fish Flavor (9.3%)	45	52	50	49
Whole Canary Seed (2%)	44	51	53	49
Imitation Peanut Flavor (9.3%)	41	47	44	44

Research by several authors has indicated a potential value for olfactory stimulants as both attractants and repellents (Bullard et al. 1978; Howard et al. 1969; Marsh et al. 1970; Turkowski et al. 1979). Ground squirrels and tree squirrels tested in the laboratory were able to discriminate for and against certain odors (Howard et al. 1969; Marsh et al. 1970). Raccoons were attracted to synthetic fermented egg formulations (SFE) enhanced with aldehydic, fishy and rancid fractions (Turkowski et al. 1979). Another SFE product has proven useful as a repellent for deer (Bullard et al. 1978). Electronically-powered audio attractants, which operate when odor attractants may not, might offer useful species-specific capabilities for capture techniques in urban centers (Turkowski, pers. comm.). A mouse-like distress squeak and a trilling bird song device made from converted Christmas ornaments were field tested by Denver Wildlife Research Center personnel. The audio devices were more attractive than the fermented egg products and the bird device was more attractive to raccoons and skunks than the mouse device.

Two new trapping ideas have been developed recently. The first is a modification of the typical box trap that allows entry from two directions, end and bottom. Because of a central narrowing of the trap width, the animal can be funneled into a position where a 110 Conibear can be used. The trap can be used for either live capture or instantaneous death, as appropriate. The Caroline-Whitten modification arose when a trap was needed to capture animals exiting from a roof or from under a foundation. The modification offers the potential of a kill technique with maximum non-target protection in urban areas. Milton Caroline and Sharon Whitten developed the trap and Whitten did preliminary field testing. A San Antonio specialist used it in an attic and captured two small raccoons simultaneously (Clay, pers. comm.). More field use is needed to make sure that the measurements are proper. (Rough plans are available on request from Chamberlain.)

The second trapping concept was developed by an engineer in Dallas, Mr. James E. McKee. Mr. McKee developed a pneumatically powered robot system that kills, releases, and resets itself for the next target animal. In laboratory tests, the model currently available can strike a 320 gm Norway rat, release, reset, and cause death within 15 seconds. The time from detection of the animal to reset is less than 3 seconds. The additional 12 seconds was required for death. The victims die within 3 feet. If the bar strikes a less vital area, death may occur in about 2 minutes. The non-sparking system is perfect for use in explosion-hazard areas. Exposure adaptations can also make it suitable for use underwater and in sewers. The striking force is 640 psi. The velocity of the strike bar is in excess of 100 feet/sec. The system was designed for use in a completely integrated pest management program. Field trials of the original model proved its effectiveness for both rat and mouse control (J.E. McKee, pers. comm.).

The development of such trap adaptations and/or new concepts in control methodology needs encouragement. There is a real scarcity of easy to use, effective, and low cost methods of mechanical control that are both legally and socially acceptable for use in urban areas. Even though advances have been made in development of new rodenticides such as Talon and Maki, no chemicals are currently registered for control of the minor predators. Reliance on mechanical and environmental control techniques is essential.

Euthanasia of target animals may be required for several reasons, including lack of appropriate relocation sites, overt illness or symptoms of an

infectious disease, and danger to the public or control specialist. An arrangement can sometimes be made with city or county animal control facilities to accept trapped wildlife for disposal. These sources may not be available if the facility's management perceives the situation as a political or legal liability. Some pounds will destroy the animals only if a fee is paid. None of the animal control facilities we dealt with would accept live skunks. Since almost 60% of the wildlife rabies cases in the U.S. occur in skunks, handling and relocation is a dangerous procedure for more reasons than their odoriferous personality (Center for Disease Control 1978). The odor potential from a trapped skunk largely can be overcome by covering the top and sides of the trap with canvas or draping a plastic trash can liner over 3 sides and one end before capture. So long as the animal cannot see out, the danger of spraying is reduced. Carbon monoxide can effectively kill the animal in a short time period.

Some animals, including skunks, that present a direct threat of potential personal injury to urban residents must be dealt with during daytime hours when nocturnal species are not normally present. At these times, the animal is generally not in a trap. A catch pole may be of use in some instances or thick welding gloves may be helpful if the animal can be caught by hand. Both of these approaches can be reasonably successful, but both place the specialist in a more difficult and dangerous position. Several years ago, we investigated the availability of capture drugs and devices that could be used in urban areas. We immediately encountered difficulty based on two factors: method of delivery and availability of the drugs. Local firearms ordinances in almost every city prohibit anyone except police officers from having a capture gun in possession, even if the power is CO_2 instead of an explosive cap or a .22 blank. In addition, the federal agency responsible for hazardous control substances refused to license our agency without a research scientist (Ph.D.) or physician on staff. Since a gun delivery system had been abandoned, we investigated a blow gun technique suggested by Mr. Rodney Marburger of Kerrville, Texas. He stated the method was reasonably accurate with practice and that euthanasia drugs and/or tranquilizers probably could be obtained by arrangement with local veterinarians. The project was not completed. Little work has been done to select proper drugs, dosages, or devices for use on free ranging small mammals. Only one recommended product and dosage is listed for raccoons in the latest edition of the Wildlife Management Techniques Manual (Day et al. 1980).

Currently, the Texas Cooperative Animal Damage Control staff under supervision of the U.S. Fish and Wildlife Service is experimenting with the Teleinject Blowpipe System. Their efforts are geared to develop a control tool that will tranquilize and immobilize target animals without destroying them. They also want to develop a system that will destroy an animal quickly and effectively when necessary. The delivery system is a blow tube made of lightweight alloy and the projectile has capacities ranging from 0.6 cc to 2 cc. Tranquilizers being tested are Ketalar (ketamine hydrochloride), Rompun (xylazine), Sucostrin (succinylcholine chloride), and a commercial Euthanasia Solution containing sodium pentobarbital. Ketalar and Rompun can be used separately or together for a tranquilizing effect. Sucostrin and Euthanasia Solution can be mixed to destroy the target animal. Experimentation is proceeding to determine the best mixes and dosages for each type of target animal (Donald Hawthorne, State Supervisor, pers. comm.). We hope that the results will be disseminated in a journal publication so this useful information will be widely available.

In the final analysis, most control techniques are only a treatment of symptoms and not the disease. Environmental manipulation to make areas attractive to desired species and unattractive to others is the real cure. As in some human diseases, we must treat the symptoms while seeking a permanent cure. With proper vegetation management, including density, height, and variety, many types of wildlife can be encouraged or discouraged selectively (Geis 1980; Hooper and Crawford 1969; Seater 1975; Thomas et al. 1977). Control of pet food availability and garbage will solve many of the remaining problems.

It seems hardly a thoughtful and humane practice, in light of the pain, suffering and bewilderment that many animals must bear when involved in man/wildlife conflicts, to introduce wildlife into the urban scene merely for the social benefits that might be generated for man. Do we not owe an obligation to the animals to think before we act? Shouldn't we plan more carefully first? Howard (1973) suggested that planners, architects, wildlife specialists, and local government officials sit down together to determine all the consequences of their plans before they leave the drawing board. We agree and applaud the items he listed for consideration in his article, "Why wildlife in an urban society?". Man's responsibility to manage must be for the wildlife as well as for man.

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