EFFICACY OF ODOR LURES AND BAITS FOR COYOTES

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Although attractants are used to draw predators to control devices such as traps, M-44 cyanide guns, and placed baits, few have been evaluated statistically. Precise data on the relative effectiveness of lures are limited. Decomposed animal or plant matter is used in many lures, which can produce variable results. The availability of attractive synthetic lures with consistent chemical and odor properties would insure reproducibility. Because of its consistency, an attractive synthetic lure could be used as a base or standard against which to compare other candidate attractants.

Some control techniques require attractants that elicit specific behavior such as biting and pulling. Thus, lures that increase such behavior are needed. Many lures used to control coyote depredations also attract nontarget species including carnivores that are valuable aesthetically and as furbearers. Lures should be evaluated to determine their selectivity.

This study was undertaken primarily to obtain information on coyote (*Canis latrans*) responses to lures and baits to benefit the U.S. Fish and Wildlife Service's (USFWS) Animal Damage Control Program (ADC) in controlling predatory animal damage to livestock. The objectives were to: (1) develop methods for comparing predator lures; (2) evaluate several synthetic lures to select a base or "standard attractant" against which other lures could be compared; (3) determine whether specific coyote behavior responses could be elicited by certain odor fractions; (4) determine how varying concentrations might affect the efficacy of a lure, and (5) evaluate some potentially superior commercial, synthetic, and ADC-formulated M-44 and trap lures.

STUDY AREAS AND METHODS

Tests in Texas were conducted on several cattle ranches with high coyote populations as determined by USFWS scent-station survey indices (Roughton 1976). Zapata, Jim Hogg, Dimmit, Maverick, Zavala, and Kinney counties are all within the Rio Grande Plain. Replicate tests with the best lures were conducted in Custer State Park, South Dakota, and the Malheur National Wildlife Refuge, Oregon.

A scent-station survey technique (Linhart and Knowlton 1975, Linhart et al. 1977) was modified (Turkowski et al. 1979) to evaluate lures according to their ability to attract predator species or elicit behavior in relation to other lures and a base attractant.

In the first 3 tests comparing synthetic mixtures, lures were added to polyamide resin particles which were placed in plastic tissue capsules with perforated tops (designed for imbedding tissue in wax). In the other tests lures were absorbed in small synthetic sponges which were also placed in capsules. The capsules were located in the center of a 0.91-m cleared circle of sifted or raked soil. Stations were positioned at 0.48-km intervals within 1.5 m of the edge of ranch roads. In addition to coyote visits as indicated by tracks, data were accumulated on other carnivores. Other signs imprinted in soil on the scent stations and animal influences on the capsules, such as teeth marks, were recorded. These behavior categories included pulling, carrying the capsule from the station, biting the capsule, digging and scratching, rolling, urinating, and defecating on the station.

Lures were evaluated in a series of tests. Each lure was first compared with others in the same category (synthetic, commercial, and ADC-formulated trap and M-44 lures). Each attractant was ranked against others in the same test according to the relative number of visits and specific behavior responses it elicited from each predator species. Daily visit rates for each lure were tabulated by species. Testing continued until each lure received at least 80 coyote visits (many lures re-

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ceived over 100 visits in some tests). The number of visits each lure received in 24 hours was divided by the number of operable stations (stations where sign would be detectable from a visiting animal) for that lure. The daily visit rates were averaged for each lure in the final analysis for each test. To illustrate how visit rates were calculated, if a lure was exposed at a total of 200 stations during a test and 40 of the stations were visited by coyotes, the coyote visit rate was 20%.

Responses in the 8 behavior categories (pulling, etc.) were converted to rates for each lure by dividing the number of responses in each behavior category by the operable stations for that lure. Arc sine square root transformations of visit and behavior data (Steel and Torie 1960) and visit behavior means were separated into homogeneous groups by the Scott-Knott multiple comparisons procedure (Scott and Knott 1974). Lures that ranked highest in visit rates (for trap lures) or pulls (for M-44 baits) and whose means were statistically separable ($P < 0.05$) from others in the same test were considered "superior."

Prior to the field tests several synthetic predator lures were developed. To replace an air inoculated fermented egg product used to obtain predator population indices in the western U.S., Bullard et al. (1978*a*) identified and isolated 76 active components by a gas displacement technique. A refined synthetic fermented egg blend was labeled DRC-6500 (Bullard et al. 1978*b*). This lure was among those tested for efficacy. A similar process was used to develop a synthetic blend of fatty acids that are common to the vaginal secretions of primates and canines (DRC-6502).

Field Tests

The objective of the first field test was to compare DRC-6500 with several other potentially attractive odors to select a synthetic formulation to be used as a base lure against which all the other lures could be compared.

The components of DRC-6500 had individual odors themselves varying from sweaty to that of fruit and feces (skatole). In Test 2 the 7 samples of DRC-6500, each with a specific odor fraction enhanced, were compared to determine relative attraction and behavior they elicited. Another objective of Test 2 was to determine if some odors selectively attracted predator species. The specific odor fractions absorbed in resin particles were: fruity, sulfurous, sweaty, fishy, rancid, aldehydic, and skatologic. The objective of Test 3 was to determine how varying concentrations influenced the appeal of a lure. DRC-6500 was absorbed in polyamide resin particles in the following concentrations by volume: 4, 6, 8, 10, and 12%.

Test 4 was designed to evaluate commercial coyote and general canine lures including those used by ADC personnel. It was not feasible to test all commercial lures, so samples were acquired from companies that had supplied ADC personnel. These lures were sorted into 8 major odor categories such as musky, fishy, and urinous. Twenty-three percent of these samples were selected at random for testing. Five of the 8 lures selected had been used or were in use in at least 1 western state to capture coyotes.

Samples of trap lures formulated and used by ADC personnel in 9 states were compared in the fifth test. Persons considered to be knowledgeable about lures in each state provided at least 1 trap lure they had formulated. In most states, coyote urine was also used as a trap lure. Urine samples obtained from captive coyotes were used. A total of 13 lures were compared in Test 5. Methods for acquiring samples from ADC personnel for the M-44 bait evaluations (Test 6) were similar to that for the trap lure tests except that 18 lures were compared.

After initial comparisons, the most effective attractants in the first 6 tests were selected. These were compared in replicate tests in South Dakota (Test 7) and Oregon (Test 8) to determine if they also would be attractive in other geographic locations and habitats. Attractant samples compared in Tests 7 and 8 included at least 1 candidate among the synthetic, commercial, and ADC-formulated trap and M-44 lures. Lures used by ADC personnel located near the test areas were also included.

Lure Evaluations Under Operational Use

Before lure-use recommendations were made, the superior lures from scent-station tests and some other innovations were also evaluated by ADC personnel under actual depredation-control activities. Sixty-nine kits, each containing 12 odor lure samples identified by number only, were sent to selected individuals in 14 western states. Questionnaires were included to obtain information and opinions regarding lure efficacy and improvement suggestions.

While the scent-station tests were in progress, fur trappers, ADC personnel, and others requested DRC-6500 samples. Some of its 70 ingredients were expensive, difficult to obtain, and formulating the mixture was a complex process. Therefore, Bullard and others conducted laboratory tests to simplify the mixture but retain odor properties and its appeal to coyotes. The simplified formulation, labeled DRC-6503, contains only 7 chemicals. DRC-6503 is a liquid mixture of the following by percent of the total volume: 41.8 caprioc acid, 35.1 butyric acid, 7.1 hexyl amine, 7.2 trimethyl amine (25% aqueous), 0.6 dimethyl disulfide, 0.2% 2-mercaptoethanol, and 8.0 ethyl caproate. Because the ingredients could irritate the skin and respiratory tract, rubber gloves and protective eyewear were worn in a well-ventilated space while formulating the lure. According to a field test using the scent-station method, it is about 90% as effective in eliciting coyote visits as the original formulation. DRC-6503 was included in the kits.

Table 1. Coyote visit and behavior response rates and lure attraction indexes of some superior lures in the commercial, ADC-formulated, and synthetic categories evaluated in Test 8 in Oregon. Values within a column with unlike superscript letters are significantly different ($P < 0.05$).

Lures	Visit	Lure index	Pull	Carry	Bite	Dig	Scratch	Roll	Urine	Defec.
Synthetic (DRC-6500)	41.8[a]	100.00	14.8[a]	12.0[a]	2.5	0.3	0.8[a]	0.0[b]	2.2[a]	0.8
Oregon ADC Trap	37.3[a]	89.2	14.2[a]	9.5[a]	5.3	0.0	0.6[a]	1.1[a]	1.7[a]	0.3
Carman's Distant Call	33.7[a]	80.6	14.2[a]	11.3[a]	3.4	0.0	0.0[b]	0.3[b]	0.8[b]	0.0
Mast's No. 6	27.8[b]	66.5	9.9[a]	8.3[a]	2.7	0.6	0.0[b]	0.0[b]	0.7[b]	0.0
Arizona ADC Trap	26.7[b]	63.9	9.9[a]	8.1[a]	1.8	0.0	0.8[a]	0.0[b]	0.3[b]	0.8
Nevada ADC Trap	22.1[b]	52.9	3.5[b]	2.3[b]	0.3	0.3	0.0[b]	0.0[b]	0.6[b]	0.6
N.D. ADC M-44	21.7[b]	51.9	10.2[a]	9.4[a]	1.1	0.0	0.0[b]	0.0[b]	0.3[b]	0.0
Blank Controls	14.1[c]	33.7	2.6[b]	1.8[b]	0.0	0.0	0.0[b]	0.0[b]	0.0[b]	0.3

Two superior lures, DRC-6503 and Carman's Distant Call Lures,[a] were combined with a paste which prolonged odor release and protected them from weather and insects. This paste could be used to bait traps or M-44s. The ingredients by weight were 42% plaster of Paris, 42% vaseline petroleum jelly, and 16% lure (percentages can be adjusted according to lure consistency if other lures are used with the matrix). These 2 attractants also were combined within a self-hardening matrix in which M-44 capsule holders were dipped. The matrix included by weight: 20% household wax (paraffin), 20% white beeswax, and 60% plaster of Paris (calcium sulfate). The lures were added so the ratio was 80% matrix and 20% bait. DRC-6503 also was contained with a liquid resin under pressure in an aerosol spray can with a propellent.

Data and opinions from ADC personnel that received these lures in the kits were summarized and evaluated along with scent-station data. This information was provided to the ADC supervisors including the Supply Depot Manager.

RESULTS AND DISCUSSION

Fifty-eight lures were compared in 8 tests; station exposure days totaled 47,255. Coyote visits to all attractant stations combined totaled 8,091 and there were 9,474 coyote behavior responses recorded. Eleven other carnivore species, 8 hoofed species, armadillos (*Dasypus novemcinctus*), and opossums (*Didelphis virginianus*) also were attracted to the lures. Visit and behavior responses for carnivores other than coyotes totaled 919 and 265, respectively. The accumulated data on other animals included 4,703 visits and 1,238 behavioral responses.

The Scott-Knott test provided a statistical basis for evaluating lures. Including the 8 tests, attractants and controls were ranked and separated either singly or homogeneously into 3 or 4 groups ($P < 0.05$) based on their mean coyote visitation rates. The coyote behavioral response means for pull, carry, bite, and roll categories were separable, with significant differences, into 2–4 groups. Among the 8 tests the dig, scratch, urination, and defecation categories were usually separable into only 2 statistical categories or in some tests were inseparable.

Table 1 lists information from 1 of the replicate tests (8) which was conducted in Oregon with superior lures and exemplifies statistical treatment of visit and behavior data for all the field tests. As indicated by superscript letters, the visitation rates in this test were separable into 3 categories that included the first 3 lures listed, the second 4, and the blank control capsules. Among the 8 behavioral responses, the number of statistical category groupings varied from 0–2. The lure index column will be discussed later. Superior lures that were ranked statistically in the top group in each field test because of high visit, pull, or bite rates are

[a] Reference to trade names does not imply government endorsement of commercial products.

listed in Table 2. The latter 2 behavior responses are important for coyote depredation control methods (traps, M-44s, and placed baits).

Tests on Synthetic Lures and Fractions

In Test 1 the coyote visit rate to the synthetic fermented egg formulation (DRC-6500) was greater and statistically separable from the other lures. Therefore, DRC-6500 was selected as the standard lure and was included in the tests comparing commercial and ADC-formulated lures.

Changes in the concentration of a lure apparently influence coyote responses. In Test 2 the coyote visit rate for the 8% DRC-6500 samples was greatest and separable from the 10 to 12% samples, which were intermediate, the 4–6% samples were lowest. However, in the pull category, concentrations above 4% ranked highest. These results suggest that a lure can have an optimum concentration and minute changes in lure concentrations that result from additives, evaporation, storage, or exposure could alter its effectiveness.

There were predator behavior response variations to fractions of DRC-6500 in Test 3. This variation indicated a potential to elicit desired coyote responses by addition or deletion of specific compounds or fractions. Pull and bite behaviors were especially of interest because of their application to control techniques. Coyote pull rates were greatest for skatologic, aldehydic, and fishy fractions. These results confirm the usual practice of using decomposed animal matter including fish and scent glands to make M-44 baits. Coyotes readily mouthed the skatologic samples and a few of the effective M-44 lures formulated by ADC personnel contained coyote feces or urine that are sometimes considered distasteful to coyotes. Fruity, sulfurous, and sweaty fractions ranked lower in all other categories.

Tests on Commercial Lures

The results of Test 4, comparing commercial lures, indicated that those purchased by the ADC program were among the most attractive to coyotes. Apparently when lures are used throughout large areas by many ADC personnel, recommendations regarding their efficacy are highly reliable. For example, 5 of the 8 commercial attractants tested were used by ADC personnel in several states as trap lures, M-44 baits, or as lure additives. These lures were recommended by 1 or more ADC supervisors because they were successful in their districts. The synthetic formulation (DRC-6500) ranked first in visit and pull rates in this test. However, the 4 ADC recommended lures ranked second, third, fourth, and fifth (Carman's Distant Call, Mast's No. 6, Mast's No. 1, Mast's No. 5). There were 3 statistical groupings based on the Scott-Knott test. The prementioned lures, except for Mast's No. 5, were ranked in the first group because visit rates to them were significantly greater ($P < 0.05$) than the second grouping that included the other lures. The control was ranked separately. The 3 commercial lures then ranked highest according to coyote pulls were also those that were recommended (Carman's, Mast's No. 1, and Mast's No. 6).

ADC-Formulated Lures and Replicate Tests

In Test 5 comparing ADC-formulated trap lures, the first ranked category included 4 attractants: a lure from Montana, DRC-6500, and samples supplied by Arizona and Oregon personnel. Two lures were placed in the second category based on coyote visit rates, and 7 other lures ranked in the third category along with the controls.

In Test 6 comparing the ADC-formulated M-44 baits, the Scott-Knott procedure placed the baits into 2 categories based on coyote pull rates. The first category included samples la-

Table 2. Lures, listed according to test number and objective, with greatest coyote response rates in categories[a] considered important for depredation control methods (traps, M-44s, placed baits).

Test no. & objective	Lure(s) with highest visit rates	Lure(s) with highest pull rates	Lure(s) with highest bite rates[b]
1. Select effective standard attractant	DRC-6500	DRC-6500	—
2. Determine if DRC-6500 odor fractions elicit varied coyote responses	Fruity, fishy, aldehydic, scatologic, sulfurous, sweaty, rancid	Scatologic, aldehydic, fishy	—
3. Determine if DRC-6500 concentrations elicit varied coyote respones	8% concentration	8, 6, 10, and 12% concentrations	—
4. Compare some potentially superior commercial trap and M-44 lures	DRC-6500, Carman's Distant Call, Mast's No. 6, Mast's No. 1	Carman's Distant Call, Mast's No. 1, DRC-6500, Mast's No. 6	Carman's Distant Call, DRC-6500, Mast's No. 6, Mast's No. 1
5. Compare some potentially superior ADC-formulated trap lures	Montana, DRC-6500, Arizona, Oregon	DRC-6500, Oregon, Montana, Arizona, Idaho	DRC-6500, Oregon, Montana
6. Compare some potentially superior ADC-formulated M-44 baits	DRC-6500, Montana, N. Dakota	N. Dakota, DRC-6500, S. Dakota, Montana, Idaho (A), Nevada (A) Idaho (B), Oregon, Nevada (B)	Nevada (A), DRC-6500, Idaho (A), N. Dakota, S. Dakota, Utah, Texas, California
7. Compare some superior lures from tests 4–6 (conducted in Texas) in another area (S. Dakota).	Carman's Distant Call	Carman's Distant Call, Arizona ADC trap, Montana ADC trap, N. Dakota ADC M-44, S. Dakota M-44 (local ADC), DRC-6500	—
8. Compare some superior lures from tests 4–6 (conducted in Texas) in another area (Oregon)	DRC-6500, Oregon (local), Carman's Distant Call	DRC-6500, Oregon Trap (local ADC), Carman's Distant Call, N. Dakota ADC M-44, Mast's No. 6, Arizona ADC trap	—

[a] Lures in each category are those that ranked highest and whose means were statistically separable from other lures or the control capsules in the same test ($P < 0.05$).
[b] In some tests lures were not statistically separable from other lures or control capsules on the basis of coyote bite rates and therefore are not listed.

beled North Dakota, DRC-6500, South Dakota, Montana, Idaho (A), Nevada (A), Idaho (B), Oregon, and Nevada (B). Nine other baits and the controls ranked in the second category. The trap and M-44 lures formulated by ADC personnel compared in tests 5 and 6 had greater differences in coyote visit rates than the commercial lures. Some of these lures did not meet expectations regarding their efficacy. A few of them elicited 25% fewer visits or pulls than the best attractants they were compared with, which possibly could have been due to regional coyote preferences for particular odors. However, in a few instances, the lures provided by local control agents (operating in the district where the test was conducted) were among the least attractive.

It appears that many factors can cause variation in predator responses to attractants. Included are the influences of geography, season, climate, property changes of lures, individual behavior, and many population density-dependent factors. Though there were some differences in the ranking of the best lures compared in the replicate tests (7 and 8) in relation to geographic location, generally they were attractive in all areas. For example, among all the trap lures tested, the synthetic formulation DRC-6500, Carman's Distant Call lure, and a Montana ADC trap lure were ranked at the top according to visit rates wherever they were tested.

DRC-6500 was compared with 3 to 17 other lures in 6 field tests. In 5 out of 6 of the tests DRC-6500 was ranked statistically in the highest visit rate category. Among the commercial lures, Carman's Distant Call Lure was in the top ranking visit rate category each time it was compared. This included Test 4 in Texas and the replicate tests (7 and 8) in South Dakota and Oregon. This lure and DRC-6500 also ranked high in pull rates in every instance. Some ADC-formulated trap lures that had the highest visit rates were from the Montana and Arizona districts. Mast's No. 6 and Mast's No. 1 were commercial lures with both high visit and pull rates in all areas where they were tested. These results support the practice of using these lures for both traps and M-44s followed in some ADC state districts. In Test 6, the North Dakota bait had the highest pull rate and it ranked in the top pull rate category in the replicate tests (7 and 8).

We can only speculate as to why some lures were more attractive to coyotes. It appears that the most attractive lures compel coyotes to visit because they appeal to a variety of urges. For example, in Test 5 comparing ADC-formulated trap lures, it is evident in Table 2 that the 4 lures that were ranked in the highest statistical category based on visit rates were also ranked first in the pulling behavior responses. In addition, these 4 lures also ranked at the top in carry and scratch responses. Also, in Test 5, the Montana lure also ranked in the highest categories based on bite, urine, and defecation rates and DRC-6500 ranked high in bite, roll, urine, and defecation categories. The Oregon ADC trap lure, another one of the best 4 lures, also ranked in the highest bite, scratch, and urine categories. There were similar relationships in the other field tests between the coyote visit rates of high ranking lures and their behavior responses.

All of the lures mentioned above were composed of decaying animal matter with animal scent glands or their secretions added. The objectives of the tests were to benefit the ADC program and therefore complete recipes of the superior ADC lures are not given here. Among these superior ADC attractants there was no single ingredient that was common to all the lures. The best ADC trap lures included fetid animal matter and a variety of other additives. Included in the list of ingredients were: horse meat, bobcat, beef brains, beef liver, limberger cheese, eggs, sardines, coyote anal and foot glands, seal oil, and mullet and beaver castors. M-44 lure ingredients included: chicken grease, trout, beaver oil, mink musk,

tonquin, asafoetida, zinc valerate, sheep tallow, phenyl acetic crystals, and skunk musk.

DRC-6500 is partially composed of volatile short-chain fatty acids that also are found in a variety of decaying animal tissues and scent gland secretions. Coyotes may be attracted to it and the other superior lures out of curiosity or because the odors resemble prey. Also, because coyotes scavenge for food, they could be attracted to the short-chain fatty acid odor due to its resemblance to carrion. Like many of the other superior lures, DRC-6500 probably relates to both hunger and mating drives as they have both food and scent gland odors. Most of the superior ADC lures had musky odors, Carman's lure has an intense skunk musk odor. In addition to their basic appeal, the volatile molecules of such intense lures are diffused over great distances probably increasing the chances of detection and response.

Attempts at applying predator lure response data to make control methods more species-selective were not productive. Coyotes were the most common predator in the test areas, and raccoons (*Procyon lotor*) were the only other carnivore for which data were abundant enough to indicate lure preferences statistically.

ADC Evaluations of Superior Lures

Information obtained from ADC personnel receiving sample attractant kits is shown in Table 3. Generally, favorable opinions of field personnel were proportional to the success rate of the lure taking coyotes. The simplified synthetic egg formulation (DRC-6503) was among the most effective lures for coyotes. Although this mixture and the other synthetic attractants were useful, the numbers of favorable opinions for them were not in as great a proportion as their coyote capture success rates. Possibly this was because they were novel or their permeating odors contaminated equipment and were disagreeable to the field personnel.

The commercial lures, Carman's Distant Call Lure and Mast's No. 6, were requested more often than the synthetic attractants, but lures formulated by Montana and North Dakota ADC Program personnel were the most popular. Their odor and texture are generally characteristic of frequently used fetid lures. Skatologic-enhanced DRC-6503 had high coyote visit and pull rates in scent-station tests but was not as successful for some kit recipients. Its odor, which is disagreeable to most persons, may have accounted for the limited use.

The lures discussed thus far were evaluated by the scent-station method and with control devices and therefore were thought to be effective before they were evaluated by the field personnel. The remaining samples in the kits showed promise but were not tested extensively prior to distribution in the kits. The aerosol spray can concept was well received by some of the field personnel, but the enclosed DRC-6503 with propylene glycol and the propellent corroded the valves and the samples were discarded. This concept may have useful application with less corrosive substances. The predipped M-44 capsule holders with DRC-6503 and Carman's Distant Call Lure in matrix were requested by many field personnel who used M-44s. DRC-6503 and Carman's in paste were requested less frequently, though they were successful for baiting M-44s.

In addition to indicating lure desirability, kit recipients commented on the samples and about predator attractants in general. Most statements by kit recipients supported the results of the scent-station tests conducted earlier. Many individuals indicated that there were seasonal and other influences on predator lure responses, and that changing lures correspondingly enhanced control device efficacy.

One kit recipient stated that a useful trap lure should appeal to 4 basic urges: curiosity,

Table 3. Summary of questionnaire information from ADC program personnel that received predator attractant samples.

Attractant	Persons using lure	Persons with favorable opinion	No. traps baited[a]	No. coyotes trapped	No. others[b] trapped	No. M-44s baited	Coyotes taken—M-44s	Others taken—M-44s
Synthetic egg DRC-6503	36	9	255	77	14	1	0	0
Synthetic pheromone	33	9	282	38	10	3	0	0
Carman's Distant Call	36	18	254	89	23	12	1	0
Mast's No. 6	29	7	201	30	16	7	0	0
Montana trap	38	22	213	93	34	67	22	1
North Dakota M-44	24	7	73	12	1	102	19	1
DRC-6503 & scatol	20	3	87	7	4	79	16	3
DRC-6503 in spray can	22	7	164	19	10	6	0	0
DRC-6503 in paste	25	5	153	20	7	79	13	0
M-44 heads & DRC-6503	24	11	20[c]	5	0	130	54	10
Carman's in paste	20	8	79	21	2	72	8	1
M-44 heads & Carman's	24	7	21[c]	4	0	125	47	8

[a] Not to be considered precisely as "trap exposure nights."
[b] Carnivores other than coyotes (bobcats, foxes, raccoons, badgers, skunks).
[c] Sometimes used to bait traps where M-44s not permitted.

sex, hunger, and urination. This theory was substantiated, at least partially, by the field test results. Lures with the greatest visit rates, a requirement for good trap lure, also had high response rates in a variety of behavior categories including biting, pulling, and urination.

The failure of coyotes to approach lures closely, though apparently interested in them, was evidenced by tracks near, but not on, scent stations and by observations of captive animals. Such responses also were observed by kit recipients. Though some of this behavior could have been due to fear, it may have been because some synthetic lure samples were too intense. Some control personnel thought that coyotes were repelled by intense odors, or that these canines often satisfy their curiosity without approaching closely to such lures. In some areas this prevented the lures from being effective for traps. Therefore, some of the kit recipients diluted the synthetic lure samples or used them as additives to their own lures, including coyote urine.

MANAGEMENT RECOMMENDATIONS

Synthetic attractants, such as DRC-6500 and DRC-6503, appear to be advantageous because they can be consistently formulated, have a variety of uses, and are as attractive as natural-ingredient lures. Tests of the ADC-formulated trap and M-44 lures indicated variability in how attractive they were to predators. This denotes the need to test lures before they are used widely, especially those produced by decomposition. The tests also showed that even during the mating season several lures were more attractive to coyotes than coyote urine, a frequently used trap lure.

Odor attractants considered for control or research purposes can be evaluated in areas where they are to be used by comparing them in a simple test against a standard lure. Synthetic lures such as DRC-6500 and DRC-6503 could be used as a standard lure because they apparently attract a variety of predators during all seasons and in most geographic areas. The modified scent-station method or a similar technique can be used for such comparisons. A "lure index" can be calculated for each candidate lure by comparing its efficacy in relation to a standard attractant. This is done by dividing the candidate lure's visit rate (or pull rate for M-44s) by the rate of the standard attractant in that test. For example, if the standard attractant has an average visit

rate of 24 and that of a candidate lure in the same trap lure test is 12, the candidate lure attraction index is 50. Table 1 illustrates how lure indexes can be listed. Thus, new lures cannot only be compared from year to year against a synthetic standard, but also against other superior lures if lure index records are available. Reference data or tables could be maintained by individuals or in district or state ADC offices. The formula for DRC-6500 is given by Bullard et al. (1978*b*) and that for DRC-6503 is reported here.

Because most of the superior lures tested were attractive to predators in several areas of the West, a method of dispersing lure formulas to ADC Program personnel throughout the United States would probably also enhance the efficacy of the agency's overall depredation control activities. For example, one of the most effective M-44 lures tested in Texas and other states was originally developed in North Dakota. A report of our field evaluations, which included recipes of the best lures, was provided to ADC supervisors in each of the western states.

Although the evaluations of some innovations related to lure use were not extensive, it appears that some methods show promise. Prebaited M-44 capsule holders and slow release matrixes are useful in dry climates where insects consume baits, or wind-blown sand or dessication adversely affects lures applied by conventional methods.

Information on seasonal responses to test lures indicate that lures used for control methods should reflect the biological needs of the predators. Presently it appears that the best method for increasing the species selectivity of attractants is to relate stimuli to the variations in sense organ systems of target species. The principle of providing visual clues to selectively attract certain carnivores is used by trappers. Feathers or other objects are sometimes placed to move in the wind to decoy bobcats to traps and shiny objects are used to attract raccoons. Based on limited data from our ongoing experiments, it appears that electronic sound generators are better for selectively attracting some species such as bobcats, coyotes, and raccoons. Variations in visits according to habitats support the practice of selective placement to increase efficacy and selectivity of control devices. Attractive but nonselective lures can be used with greater efficacy if modifications are made to exclude nontarget animals or minimize undesirable behavior. For example, placing rocks beside M-44s often prevents coyotes from rolling on the devices; and nontarget animal captures can be minimized by use of trap-pan tension devices (Linhart et al. 1980).

Many of the 58 lures evaluated in this study were known or suspected of being superior predator lures. There are hundreds of additional commercial and ADC-formulated lures and it is likely that some superior lures were not evaluated. Therefore, the results of this report should not be considered definitive. Predators and furbearers are an important wildlife entity because of aesthetic values and their depredations to crops, domestic animals, and wildlife. Ongoing research on lures is needed to improve the efficacy and selectivity of traps, M-44s, placed baits, and other predator control and research methods.

SUMMARY

The responses of coyotes to 58 commercial, synthetic, and U.S. Fish and Wildlife Service Animal Damage Control Program-formulated lures were statistically compared using a scent-station technique. The attractants were evaluated to increase the efficacy and selectivity of traps, M-44 cyanide guns, and other depredation control methods.

Exposure in 3 states of 47,255 capsules containing candidate attractants yielded 8,091 coyote visits and 9,474 behavioral responses during a 28-month period. Coyote visit and

behavior rate variations indicated that some lures were more effective than others. Additional evaluations of the most attractive lures by ADC personnel verified results of the scent-station tests.

Lures determined to be superior are listed. A synthetic formulation that can be produced with consistent properties was among the most attractive lures in most tests. The relative appeal of candidate lures and baits can be determined by comparing them to a synthetic base attractant using the scent-station technique.

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