12-8-1993

Methyl Anduanilate Formulations to Repel Birds from Water at Airports and Food at Landfills

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Bird strikes to aircraft are of increasing concern to the aviation community (BSCE 1990). One factor contributing to strikes is that gulls and other bird species often flock to temporary pools of fresh water at airports after heavy rains (Blokpoel 1976). Another factor is the location of waste disposal facilities near airports which gulls and other bird species use as a food source (Burger and Gochfeld 1983, Greig et al. 1986). The U.S. Federal Aviation Administration issued Order 5200.5 in 1974 to prohibit waste disposal sites within 10,000 ft (3,000 m) of runways used by turbine-powered aircraft. This order was revised in 1990 (Order 5200.SA) to include landfills from 10,000 feet to 5 miles (8 km) of runways "that attract or sustain hazardous bird movements from feeding, water or roosting areas into, or across the runways and/or the approach and departure patterns of aircraft". Thus, airport and landfill operators have incentives to eliminate standing water and putrescible waste on and near airports. If elimination is not possible, management actions should be taken to reduce the attractiveness of these sites to birds.

Development of an environmentally safe chemical formulation that would repel birds from water on airports and putrescible waste at landfills should have wide utility, providing an additional technique to enhance existing bird control and harassment activities. MA, a GRAS-listed human food flavoring (Jenner et al. 1964, Code of Federal Regulations 1988) may be a suitable repellent (Mason et al. 1989, 1991). Dolbeer et al. (1992) documented the effectiveness of experimental (RejeX-iTTM brand) formulations of MA in repelling ring-billed gulls and mallards from open water in cage studies.

One problem with using MA at landfills is developing a formulation or carrier that will allow the active chemical to cover the garbage at the landfill surface. A potential solution is to incorporate MA into new materials developed to cover garbage on a daily basis. One such product is ConCover 1808, a blend of polymers containing clays and recycled cellulose that, after mixing with water, can be sprayed as a slurry over exposed refuse in place of soil.

We present results from 2 sets of experiments. The first set (May-Aug 1991) evaluated 2 ReJeX-iTm formulations of MA applied to water at John F. Kennedy International Airport (JFKIA), New York. Our second set of experiments (Aug-Sep 1992) tested the hypothesis that a ReJeXiTTm formulation of MA mixed with ConCover 1808 would reduce consumption by birds when applied to food in a controlled environment (captive birds in cages).

Methods

Field Tests in Water at XA

Testing was limited to 14-19 May, 9-12 July and 28 July-2 August, the only times standing water was present from May-early August 1991.

14-19 May.–Testing was at 2 ponds 100-160 m southeast of taxiway H (Ponds HI and H2) and 2 ponds 100-200 m east of runway 22L at taxiway FA (Ponds FAI and FA2). These temporary ponds ranged in size from 150-4,000 m2 at the start of observations (Table 1). Ponds H1 and H2, in an area of grassy vegetation, were 60 m apart. Ponds FA I and FA2, in an area of low (0.5 m) shrubs and grass, were 100 m apart.

Ponds were observed for 5-min intervals throughout the day for 2 days pretreatment and for 2-3 days posttreatment (until the smallest pond of the pair had dried up). The number of birds, by species, in or entering the water during each 5-min period was recorded. A t-test was used to test for differences in the mean number of birds/5-min for pre- and posttreatment periods for each pon d.

The treatment consisted of applying 1 of 2 MA formulations (Table 1) to the water in 1 of the 2 ponds at each site. Immediately prior to treatment, surface area and volume of water were estimated for each pond by measuring the major and minor axes lengths and the depth at 3-5 locations along the major axis. ReJeX-iT'm TP250 was applied at the rate of 20 ml/m2 of water surface via a hand-held sprayer as the applicator waded through the pond. ReJeX-iT'm AP-75 was applied at the rate of 1 gAL of water by sprinkling the material from a bucket as the applicator waded through the pond. Control ponds were waded through in a similar fashion.

8-12 July.–Testing was at 4 temporary pools of water on taxiways. These pools ranged in size from 5-75 m' at the start of observations (Table 2) and were at least 200 m apart. These pools were selected for treatment because birds were observed in them after rainfall on 6-7 July. All 4 pools were treated with I g AP-75/1, of water. Bird observations and statistical tests were as described above for the May tests.

28 July-2 August.–Two taxiway-ramp areas, WA and B, were observed during a pretreatment period of 28-31 July. WA and B were about 0.5 km apart. WA had 8 pools of water covering 3,743 m2 (x _+ SD = 468 _+ 123) within a 2-ha area and B had 9 pools covering 4,026 m2 (x _+ SD = 447 _+ 143) within a 2-ha area. Pools in WA and B were treated with AP-75 as above from 0900-1000 on 1 August. Posttreatment observations were made at each area during the remainder of 1 August and on 2 August. At each area, a few minor pools on the peripheries (i.e., within 100 m of treated pools) were overlooked at the time of treatment (because we noted no birds in them during pretreatment observations) and left untreated. The dimensions of these pools were not measured but we estimate they comprised <10% of the surface area of treated pools.

Unlike the tests in May and early July, observations at each area were made continuously for approximately 2-hr periods 2-4 times daily. Total bird-minutes of pool use (e.g., 2 birds in a pool for 1 minute equals 2 bird-minutes) was recorded for each observation period for treated and untreated pools. There were 10 2-hr periods covering 1,240 observation minutes pretreatment and 10 2-hr periods covering 1,307 observation minutes posttreatment for the 2 areas combined. Observations were terminated on the afternoon of 2 August because most water had evaporated.

A I-test was used to test for differences in mean bird minutes of pool use during the 2hr observation periods pretreatment and posttreatment. A I-test was also used to test for differences in mean bird-minutes of pool use in the treated and untreated pools during the treatment period.

Cage Tests with ConCover 1808 over Food

Experiments were conducted in Erie County, Ohio. Birds were captured locally in decoy traps (cowbirds) or by rocket net (ring-billed gulls), July-September 1992. Water was provided ad libitum during all tests. Birds were released after completion of testing.

Test Materials.–We used a MA-based formulation (ReJeX-iTTM AP-50, 50% MA. AP-50 is a white, free-flowing, granular solid completely miscible in water.

Following manufacturers instructions, ConCover 1808 was blended using an electric mixer. With the mixer on low speed, we placed 417 ml of water into a mixing bowl and added 150 g of ConCover 1808 powder. We then added 35 g of paper mulch and mixed for 5 min. When required for a treatment, AP-50 and/or 100 g of white millet was then added and mixed. Next, 0.7 ml of a foaming agent was added and mixer

Millet/AP-50 Tests with Cowbirds.–Thirty cowbirds were placed in cages for >1 week to adapt to aviary conditions. Prior to testing, cowbirds were provided millet ad libitum. For testing, cowbirds were assigned randomly to 6 groups of 5 birds. Each group was placed in a 2.5- x 2.5- x 2.0-m outdoor cage, with a tarp covering 1/2 the top of the cage to provide shade.

To test the repellency of AP-50 with millet, we treated 4 1,000-g batches of millet with AP-50 at concentrations of 0.14%, 0.30%, 0.50%, or 1.00% (g/g; 1.40 g, 3.00 g, 5.00 g, or 10.00 g, respectively). Millet and AP-50 were mixed for 30 sec in a plastic 3.8 L container. Ten ml of corn oil were added and the mixture was shaken for an additional 30 sec. Four control batches were made by adding 10 ml of corn oil to 1,000 g of millet.

On test day 1 at 1400, food was removed from each cage. We then placed 2 food cups, each with 100 g of millet (1 treated, 1 untreated, randomly assigned positions 0.5 m apart) in each cage. Food cups were removed and weighed 24 hrs later and replaced with untreated millet for 24 hrs. We conducted 4 24-hr tests on alternate days using a different concentration of AP-50 during each test.

We used randomized block analysis of variance (ANOVA; SAS Inst., Inc. 1988) to assess whether the amount of treated and untreated millet consumed among tests differed and if any differences occurred in the total amount of food consumed in both cups among tests. If significant differences occurred, Turkey tests were performed to detect which treatments differed.

ConCover 1808/AP-50 Tests with Cowbirds.-We first conducted a 4-day, 2-choice test. On test day 1 at 1600, food was removed from the cages and each group of birds was presented 3 aluminum trays (39- x 26- x 2cm). Each tray in this 3-choice test contained 1 of 3 treatments; (1) 100 g of millet, (2) 100 g of millet evenly distributed within a 2-cm layer of ConCover 1808, or (3) 100 g of millet evenly distributed within a 2-cm layer of ConCover 1808 mixed with 1.00 g of AP-50 (0.14% g/g). For treatments 2 and 3, a piece of 4-mm thick cardboard was placed in the bottom of trays to absorb water from the mixture. We drilled 5 holes in the bottom of each tray to provide drainage. Each tray containing only millet was weighed before being presented to the birds. Trays were assigned a randomly selected position in a row with 0.5-m spacing between trays. At 1600 on day 2, 24 hrs after placement, trays were removed from the cages and those containing only millet were weighed to measure the amount of millet displaced by the birds during the previous 24 hrs. We also visually estimated the percent of surface area disturbed for each of the treatments containing ConCover 1808. This observation procedure was repeated on days 3, 4, and 5.

On day 5, a plastic sheet gridded with 4- x 4-cm cells was placed over each tray containing ConCover 1808. Ten cells (16% of total surface area) were selected randomly for each tray and the percent of surface area disturbed by birds in each cell was recorded. From the center of each tray we removed an 80-mm diameter circular sample (5% of total volume). These samples were separated by hand and the number of whole millet seeds was counted. Cowbirds were maintained using pre-test conditions during davs 5 and 6.

We then conducted 24-hr, 2-choice tests. Procedures were identical to day 5 of the 3-choice test except only trays containing ConCover 180' and millet or ConCover 180', AP-50, and millet were used. We conducted 3 24-hr, 2-choice tests using concentrations of AP-50 at 0.14%, 0.30%, and 0.50% (g/g; 1.00 g, 2.11 g, and 3.52 g, respectively). Untreated millet was provided ad libitum on days when tests were not conducted.

Randomized block ANOVA, with repeated measures (days), was used to compare changes in the amount of surface area disturbed between treatments with ConCover 180' during the 4-day, 3-choice test. We used t-tests to compare the number of seeds remaining and mean surface disturbance between treatments with ConCover 180'. Randomized block ANOVA was also used to determine whether differences occurred in the percent of surface area disturbed and the number of seeds remaining between treatments within and among the 3 24-hr tests. If significant differences occurred, Turkey tests were performed to determine which treatments differed.

ConCover 180'/AP-50 Tests with

billed gulls were placed in 2.5- x 2.5- x 2.0-m outdoor cages for 1 week to adapt to aviary conditions. Whole fish (gizzard shad [Dorosom g cepedianum]; mass [x _+ SD] = 9.6 _+ 0.4 g, length = 90.3 _+ 1.2 mm, n = 40) were provided daily in trays identical to those used during tests. For tests, 12 gulls were paired randomly, I pair in each of 6 cages.

Experimental design for tests involving ring-billed gulls was similar to that described for the 24-hr tests involving cowbirds except the 2 treatments were 10 whole ***fish*** placed within 2-cm layers of ConCover 1808 with or without AP-50. After pouring ConCover 180' into the trays, fish were aligned in 2 rows of 5 on the surface, then completely immersed. We conducted 1 1-hr test on each of 4 consecutive days using concentrations of 0.30%, 0.50%, 0.75%, and 1.00% (g/g) AP-50. We alternated pairs of gulls such that each gull was tested once every other day. Gulls were provided untreated fish on non-test days.

Randomized block ANOVA and Turkey tests were used to assess whether the number of fish consumed differed among tests and between treatments within a test. Means are reported with _+1 standard error. Differences were considered significant at

Results

Field Tests in Water at JFIdA

14-19 May.–The number of birds using the 2 ponds treated with TP250 or AP75 declined (P < 0.03) from pretreatment to posttreatment. In contrast, bird numbers at 1, of the untreated ponds remained constant (P = 0.80) while bird numbers at the other pond increased (P_ < 0.01) during posttreatment (Table 1). Overall, bird use of the 2 treated ponds declined from a mean of 2.7 birds/5-min during pretreatment to 0.3 birds/5-min during post-treatment.

Waterfowl, primarily mallards, were the most frequently observed birds.

8-12 July.–Bird use declined (P < 0.01) in the 4 pools posttreatment, averaging 0.1 bird/5-min compared to 4.6 birds/5-min pretreatment (Table 2). The pools attracted primarily laughing gulls.

30 July-2 August.–The pools averaged 15.7 bird-minutes/120 observation minutes during pretreatment at the 2 areas compared to 3.7 bird-minutes/120 observation minutes during posttreatment (Table 3). Although this was a 76% reduction in bird use posttreatment, the reduction was not significant (P = 0.12) because of high variability in bird numbers among observation periods. Birds using the pools primarily were rock doves (Columba livia) and gulls.

During posttreatment, bird use was noted in several previously overlooked, untreated pools on the periphery of the treated pools. We recorded 35.6 _+ 54.8 bird-minutes/120 observation minutes in these untreated pools compared to 3.7 _+ 7.0 bird-minutes/120

Cage Tests with ConCover 1808 over Food

The color of ConCover 1808 after complete mixing was light blue. Addition of AP-50 at any of the concentrations used changed the color to light green.

Millet/AP-50 Tests with Cowbirds.–Treated millet consumption by cowbirds decreased (F_ = 39.48; 3,20 df; P < 0.01) with increased levels of AP-50 up to 0.5% (Table 4). There was no difference (P < 0.05) in consumption of treated millet with 0.5% and 1.0% concentrations of AP-50. There was a treatment effect (F_ = 230.25; 1,40 df; P < 0.01) and day x treatment interaction (F = 16.83; 3,40 df; P < 0.01), with lower total millet consumption occurring during the 0.5% AP-50 test. Overallmillet consumption (treated and untreated seed) was similar (P > 0.05) among the remaining 3 tests.

ConCover 1808/AP-50 tests with Cowbirds, During the 4-day test using 0.14% concentration AP-50, cowbirds did not use either treatment containing ConCover 1808 until after day 2 when _>73% of the untreated millet had been consumed (F = 67.23; 3,30 df; P < 0.01; Fig. 1). The percent of surface area disturbed on both ConCover 1808 treatments then increased substantially. There was no difference (F = 90.75; 1,10 df; P = 0.69) in the percent of surface area disturbed between ConCover 1808 treatments with and without AP-50. The day x treatment interaction was not significant (F = 0.13; 3,30 df; P = 0.78).

After day 4, there was no difference (t = -0.78, 10 df, P = 0.45) in the mean number of millet seeds remaining in trays containing ConCover 1808 only (504 _+ 64) or ConCover 1808 with AP-50 (560 _+ 31). The percent of surface area disturbed was also similar (1= -0.61, 10 df, P_ = 0.56) between ConCover 1808 (95 _+ 3) and ConCover 1808 with AP-50 (98 _+ 2%). We noted that most millet seeds had sprouted by the end of the test in both the ConCover 1808 and ConCover 1808 with AP-50

Millet consumption differed (F = 34.60; 5,30 df; P < 0.01) during the 24-hr, 2-choice tests. There was also a treatment effect (F = 56.83; 1,30 df; P < 0.01) and test day x treatment interaction (F = 10.94; 2,30 df; P < 0.01). Cowbirds were repelled (F_ = 9.08; 2,15 df; P < 0.01) by ConCover 1808 treatments containing AP-50 at concentrations >0.30% (Table 5). There was no difference (P < 0.05) in percent of surface area disturbed and number of millet seeds remaining between trays with ConCover 1808 and 0.3% or 0.5% AP-50. There were 46% and 42% more millet seeds remaining in the 0.3% and 0.5% AP-50-treated trays.

respectively, than in trays with ConCover 1808 only.

ConCover 1808/AP-50 Tests with Ring-billed Gulls.–There was an overall difference ($F = 4.26$; 7,40 df; $P < 0.01$) in the number of gizzard shad consumed. Gulls consumed less total fish during the test with 0.3% AP50 than during the test with 0.5% AP-50 (Table 6). There was also a treatment effect ($F = 10.83$; 1,40 df; $P < 0.01$), with gulls consuming more gizzard shad overall from treatments without AP-50. Gulls consumed more (P_ < 0.05) gizzard shad from trays with ConCover 1808 only than from trays with ConCover 1808 containing 1.0% AP-50. There were no differences ($P > 0.05$) in the number of fish consumed between treatments within the other 3 tests. The test day x treatment interaction was not significant (F_ = 1.74, 3,40 df; $P = 0.17$).

Gulls easily located fish under ConCover 1808, perhaps detecting fish by odor. Three partially digested fish were found on the ground in 1 cage, apparently regurgitated during the test with 0.5% AP-50.

Discussion

Field Tests in Water at JFIGA

Rainfall was 22% below average and the mean temperature was 1.8° C above average during May-July 1991 (Unpubl. data, NOAH, JFKIA). The lack of standing water for sustained periods of time precluded longer-term 'evaluations with a suitable number of replications to thoroughly test the efficacy of TP250 and AP-75 in repelling birds from water. Nonetheless, the data obtained were supportive of results obtained in cage trials (Dolbeer et al. 1992).

TP250 did not disperse uniformly over the water surface but tended to coalesce in globules 1-5 cm in diameter that the wind blew to the leeward side of the pond. Perhaps the addition of a surfactant would disperse the material more uniformly over the surface. Similarly, AP-75 tended to form globules 2-10 mm in diameter on pool bottoms. The addition of a dispersing agent might result in a more uniform distribution of AP-75 throughout the pools.

Additional field tests should be conducted to more clearly evaluate the efficacy of MA formulations for repelling birds from water at airports. To circumvent the problems of unpredictable rainfall end insufficient experimental units (pools of water), we suggest the use of 1-m diameter plastic pools (50-L capacity) as used in previous cage trials (Dolbeer et al. 1992). These pools could be placed in locations away from air traffic with predictable bird activity such as at landfills. The pools could be filled with fresh water to conduct controlled, replicated experiments with free-ranging birds.

Cage Tests with ConCover 1808 over Food

AP-50 was repellent to cowbirds and ring-billed gulls at food sources, although a higher concentration (0.50% MA) was required to repel ring-billed gulls than cowbirds (0.15% MA). Cowbirds were repelled by similar concentrations of MA during tests using millet mixed with ConCover 1808 and those using millet only.

Cowbirds in this study were repelled at a MA level about 50% lower than that necessary to reduce food consumption by starlings (turnus nj&aris) and red-winged blackbirds (Agelaius phoeniceus) (Mason et al. 1991). Mallards and Canada geese ftWta canadensis) avoided shelled corn treated with 1.0% MA (Cummings et al. 1992).

Cowbirds displayed aversion to millet mixed with ConCover 1808 only during the 3-choice test when free, untreated millet was available. Thus, ConCover 1808 alone may reduce foraging by some bird species, provided alternate, more accessible food is available.

Repellency of gulls was not observed until AP-50 concentrations were at 1.0% (0.5% MA). This was 3-13 times greater than levels of AP-50 required to repel cowbirds during this study and to repel gulls (ring-billed and herring) from small pools of water during 2-choice tests (Belant et al. 1992). The difference in repellency between cowbirds and ring-billed gulls may be related to variation in taste perception (Espaillat and Mason 1990). Also, the effectiveness of repellents may depend upon the material being protected (e.g., water vs. food) (Rogers (1978).

Sprouting of millet did not appear to be hindered by ConCover 1808 or ConCover 1808 with AP-50. In fact, the moisture content and consistency of ConCover 1808 probably provides an excellent medium for millet seed germination. As ConCover 1808 can be sprayed as a slurry for distances to 50 m, applications such as seeding of highway right-of-ways, or aerial seeding of small grains warrant further investigation.

Testing of MA formulations and landfill cover materials as bird repellents at food sources under controlled conditions should be conducted with other bird species that frequent landfills (e.g., European starlings, herring gulls) to further evaluate repellency. Because other factors (e.g. social dominance, flock behavior) that could influence repellency were not addressed in this study, we also recommend field tests at landfills to examine repellency to free-ranging populations of birds

Acknowledgments

We thank J. K. Gartner and S. Chevalier, Port Authority of New York and New Jersey, for support at JFKIA. T. J. Nachtman and C. J. Smith, New Waste Concepts, Inc., Perrysburg, OH, and P. F. Vogt, PMC Specialties Group, Inc., Cincinnati, OH, shared their expertise and provided ConCover 1808 and MA formulations. We thank E. J. Bly, P. A. Bernhardt, E. C. Cleary, S. W. Gabrey, S. K. Ickes, T. W. Seamans, and P. P. Woronecki for assistance. Sponsorship and funds for this research were provided by the Federal Aviation Administration, Office of Airports Safety and Standards, Washington, D.C., and Airports Division, Airport Technology Branch, FAA Technical Center, Atlantic City

Iiterxture Cited

Belant, J. L., S. W. Gabrey, R A. Dolbeer, and T. W. Seamans. 1992. Methyl anthranilate repels gulls and mallards from water. U.S. Dep. Agric. Spec. Rep. for PMC Specialties Group, Cincinnati, Ohio. 20pp.

Bird Strike Committee Europe. 1990. Working papers of 20th meeting. Helsinki. 700pp.

Blokpoel, H. 1976. Bird hazards to aircraft. Can. Wildl. Serv., Ottawa, Canada. 236pp.

Burger, J., and M. Gochfeld. 1983. Behavior of nine avian species at a Florida garbage dump. Colonial Waterbirds 6:54-63.

Code of Federal Regulations. 1988. Food and drugs. Vol. 21, **Part 182.60, page** 391.

Cummings, J. L., D. L. Otis, and J. E. Davis, Jr. 1992. Dimethyl and methyl anthranilate and methiocarb deter feeding in captive Canada geese and mallards. J. Wildl. Manage. 56:349-3 55.

Dolbeer, R. A., L. Clark, P. P. Woronecki, and T. W. Seamans. 1992. Pen tests of methyl anthranilate as a bird repellent in water. Proc. East. Wildl. Damage Control Con£ 5:112-116.

Espaillat, J. E., and J. R. Mason. 1990. Differences in taste preference between red-winged blackbirds and European starlings. Wilson Bull. 102:292-299.

Greig, S. A., J. C. Coulson, and P. Monaghan. 1986. A comparison of foraging at refuse tips by three species of gull (Laridae). J. Zool. Lond. (A) 210:459472.

Jenner, P. M., E. C. Hagen, J. M. Taylor, E. L. Cook, and O. G. Fitzhugh. 1964. Food flavourings and compounds of related structures. I. Acute oral toxicity. Food Cosmet. Toxicol. 2:327-343.

Mason, J. R., M. A. Adams, end L. Clark. 1989. Anthranilate repellency to starlings: chemical correlates and sensory perception. J. Wild]. Manage. 53:55-64.

M. L. Avery, J. F. Glahn, D. L. Otis, R. E. Matteson, and C. O. Nelms. 1991. Evaluation of methyl anthranilate and starchplated dimethyl anthranilate as bird repellent feed additives. J. Wildl. Manage. 55:182187.

Rogers, J. G., Jr. 1978. Repellents to protect crops from vertebrate pests: some considerations for their use and development. Pages 150-165 in R. W. Bullard, ed. Flavor chemistry of animal foods. Am. Chem. Soc. Press, Wash., D.C.

SAS Inst, Inc. 1988. SAS/STAT user's guide, 6.03 ed. SAS Inst., Inc., Cary, N.C. 1028pp.

Table 1. Bind' numbers in 2 pails of 10- to 40-cm deep ponds of water in vegetated areas at John F. Kennedy International Airport, 14-19 May 1991. One pond of each pair was heated with a **Re*X-itrm** formulation of methyl anthrnnilate (MA).

Pond	Pond surface area (mZ)	MA formulation b	Pretreatment (14-17 May,) No. birds/ 5-min. N	x	SD	Posttreatment X16-19 Mgy) No. birds/ 5-min. N	x	SD
H1	150	Control	14	1.3`	1.6	22	1.4`	1.2
H2	1,300	TP250	21	4.1d	2.6	36	0.5d	1.0
FA1	4,000	Control	24	4.3`	2.7	4	9.0°	2.5
FA2	300	AP-75	10	1.2'	1.1	5	Or	0

'Ducks (76%), gulls (9%), other species (14%). bTP250 contained 25% MA in vegetable oil applied at rate of 20 ml/m' of water surface; AP-75 contained 75% MA in polymer matrix applied at rate of 1 g/L of water. ` Means are not different (t = 0.21, 34 df, P = 0.80). d Means are different (t = 7.45, 55 df, P_ < 0.01). ` Means are different (t = 3.25, 26 df, P < 0.01). Means are different (t = 2.40, 13 df, P = 0.03).

Table 2. Bird' numbers in 4 <4-cm deep pools of water on taxiways at John F. Kennedy International Airport pre- and posttreatment with ReJeX-iT"" AP-75 (75'/. methyl anthrunilate) at 1 g/L of water, 8-12 July 1991.

Pool	Pond surface area (m')	Pretreatment (8-9 July) No. birds/ 5-min. N	x	SD	Posttreatment (9-12 July No. birds/ 5-min. N	x	SD
V	75	2	6.0	0	13	0.1	0.3
ZG	5	1	4.0	0	4	0	0
WW13L	24	1	4.0	0	5	0	0
WA	39	1	3.0	0	7	0.1	0.4
Total		5	4.6b	1.4	29	0.11,	0.3

' Gulls (92%), other species (8%).,
b Means are different, t-test comparing all observations pre- and posttreatment (t = 16.67, 32 df, P < 0.01).

Table 3. Bird'-minutes of use in 3-cm deep pools of water on taziway-rump areas at John F. Kennedy International Airport pre- and posttreatment with RekX-iTrm AP-75 (75% methyl anthrunilate) at 1 g/L of water, 28 July-2 August 1991.

Area	No. of pools	Pool surface areas (m2)	Pretreatment x,28-31 July) Bird-minutes/ 120 observation minutes N			Posttreatment 1-2 August) Bird-minutes/ 120 observation minutes N		
			N	x	SD	N	x	SD
WA	8	3,743	5	12.8	19.8	5	0	0
B	9	4,026	5	18.6	28.3	5	7.5	8.7
Total	17	7,769	10	15.7b	23.2	10	3.7b	7.0

`Rock doves (34%), laughing gulls (31%), ring-billed gulls (23%), herring gulls (L. atgentatus) (9%), and American crows (orvus brachyrhynchos) (3%). b'Ivleans are not different, t-test comparing all observations pre- and posttreatment (t = 1.59, 18 df,P=0.12).

Table 4. Grams of untreated and ReJeX-itrm AP-50 (50°/. methyl anthrpnilate)-treated millet consumed by bmwn-headed cowbirds during 24-hr, 2-choice tests conducted on alternate days, 17-25 August 1992. Each cage held 5 cowbirds. Means within a column with different letters are significantly different `P < 0.05, Tukey tests).

Test no. (% AP-50 jg/g]).	Millet (g) consumed by cowbirds: Untreated x	Untreated SE	With AP-50 x	With AP-50 SE	Total x	Total SE
1 (0.14)	28.5	3.7 A	20.0	1.4 A	48.6	4.6 A B
2 (0.30)34.8` .		32$ . .	9.2	2.2 B	44.0	8.6 AB
3 (0.50)	33.8	3.5 B	1.2	0.8 C	35.0	10.4 A
4 (1.00)	46.8	3.1B	2.3	0.3C	49.2	13.8B

Table 5. Number of millet seeds remaining and percent of surface area disturbed by brownheaded cowbirds in ConCover 1808 and ConCover 1808 with ReJeX-iT"4 AP-50 (50% methyl anthranilate) treatments during 3 24-hr, 2-choice tests conducted 16 August-2 September 1992. Each cage held 5 cowbirds. Means within a column with different letters are significantly different (_P < 0.05, Tukey tests).

Test no	Concover 180/AP-50				ConCover 180			
(% AP-50	No. of seeds remaining		% surface area disturbed		No. of seeds remaining		% surface area disturbed	
19/911	x	SE	x	SE	x	SE x		SE
1 (0.14)	673	41 A	89	5 A	722	23 A 94		2 A
2 (0.30)	995	81 B	14	6 B	681	80 A 68		D A8
3 (0.50)	1173	32 B	2	1 B	825	102 A 64		10 B

Table 6. Number of gizzard shad in ConCover 1808 and ConCover 1808 with ReJeX-iT474 AP 50 (50°/.methyl anthmnilate) consumed by ring-billed gulls during 1-hr, 2-choice tests conducted 12-15 September 1992. Each cage held 2 gulls. Means within a column with different letters are significantly different (_P < 0.05, 7ukey tests).

Test no.	Number of fish consumed					
(% AP-50	With AP-50		Without AP-50		Total	
jg/gl)	x	SE	x	SE	x	SE
1 (0.30)	3.3	1.4 A	4.7	1.4 A	8.0	19 A
2 (0.50)	7.7	0.8 A	8.2	0.6 A	15.8	D *AB*
3 (0.75)	4.7	1.5 A	7.8	0.7 A	12.6	9 *AB*
4 (1.00)	3.0	1.0 A	8.0	0.8 A	11.0	19 B