CONTROLLING SHINY COWBIRDS IN PUERTO RICO

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ABSTRACT: A program to trap and remove shiny cowbirds (Molothrus bonariensis) was conducted during two successive passerine nesting seasons at Roosevelt Roads Naval Station in eastern Puerto Rico. It sought to improve existing trapping techniques and to determine the effect cowbird removal has on the reproductive success of the endangered yellow-shouldered blackbird (Agelaius xanthomus). Decoy traps of two basic designs were used to capture 2449 cowbirds in 1162 trap-days (average 2.1/trap-day) in June-September 1985 and 850 cowbirds in 1571 trap-days (average 0.5/trap-day) in March-August 1986. The lower capture rate in 1986 suggests that cowbirds removed in 1985 were not being replaced during the non-trapping period. Trapping data from yellow-shouldered nesting areas in mangrove swamps indicated that cowbird capture rates were significantly higher (P=0.02) for large (14.2-14.8 m^3) traps than for smaller (4.2 m^3) ones. The effect of cowbird removal on the nesting success of the yellow-shouldered blackbird could not be directly determined because only one nest could be found. Cowbird removal, however, greatly reduced parasitism rates of another parasitized species, the yellow warbler (Dendroica petechia).

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INTRODUCTION

The shiny cowbird, a brood parasite, lays its eggs in the nests of other birds that incubate and rear its young as their own. Consequently, productivity of host birds is sometimes reduced. Since the arrival of cowbirds in Puerto Rico in the late 1940's or early 1950's (Post and Wiley 1977a), the negative impact of cowbirds on the reproductive success of several native passerines has been substantial (Wiley 1982). The yellow-shouldered blackbird (YSB), endemic to Puerto Rico, has been particularly affected. From 1975 to 1981 Cruz et al. (1985) found 152 of 164 (93%) YSB nests examined to be parasitized by shiny cowbirds. Further, all 44 YSB nests investigated by Cruz et al. in 1982 were parasitized. They concluded that cowbird parasitism reduced YSB productivity.

Post and Wiley (1976, 1977b) and Wiley et al. (1983) report that cowbird parasitism has been the leading cause of the precipitous decline in the two major populations of YSB's in Puerto Rico from an estimated 2200 birds in 1975 to 500 in 1982. In 1976, the YSB was declared an endangered species, and a recovery plan outlining specific measures that should be undertaken to aid their recovery was written (U.S. Fish & Wildlife Service 1983). It assigned top priority to improving YSB nesting success by trapping and removing shiny cowbirds from YSB nesting areas. It also identified the need for both an evaluation of existing cowbird decoy trapping techniques and an evaluation of the effect of cowbird removal on the reproductive success of the YSB.

Experimenting with cowbird control techniques in a major YSB breeding area at Boqueron Forest in southwestern Puerto Rico, Wiley and Litovich (1984) found that cowbirds could be captured using 1.5 x 1.5 x 1.8 m high (4.2 m^3) portable decoy traps. Although they trapped and removed cowbirds for only 15 days in July 1980, they showed an immediate decline in the parasitism rate of YSB nests with a resultant productivity increase. These promising results led the U.S. Fish and Wildlife Service (USFWS) to contract with the Puerto Rico Department of Natural Resources (DNR) in 1983 to trap and remove cowbirds year-round in southwest Puerto Rico. Trapping success the first 2 years of this program was lower than anticipated, and its effect on the reproductive success of the YSB was not thoroughly evaluated (P. Gertler, pers. comm.). This led the USFWS to contact the Section of Bird Damage Control, Denver Wildlife Research Center, U.S. Department of Agriculture (formerly USFWS) for assistance.

The two objectives of our project were: 1) to evaluate and improve upon existing cowbird capture techniques using larger decoy traps; and 2) to determine the effects of a long-term cowbird removal program on the parasitism rates of YSB nests and subsequent YSB productivity. Work was conducted at Roosevelt Roads Naval Station in eastern Puerto Rico, one of the two largest breeding areas of the YSB remaining in Puerto Rico (Post and Wiley 1976). This area was chosen for the study because no cowbird control work was being done there and the YSB population was thought to be in immediate danger of extirpation, having declined from about 200 birds in 1975 to 75 in 1982 (J. Wiley, pers. comm.).

Work was conducted during two consecutive passerine nesting seasons, June-September 1985 and March-August 1986. During the first season we compared and evaluated the capture effectiveness of two different sizes of cowbird decoy

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traps. In 1986, we expanded our trapping areas and concentrated on determining the effects of cowbird removal on YSB reproductive success.

STUDY AREA AND METHODS

Roosevelt Roads Naval Station is located in eastern Puerto Rico near the town of Ceiba, about 60 km east of San Juan (Fig. 1). The Naval Station comprises 3,260 ha of which 25 percent (814 ha) is mangrove forest. Further description of the area is given by Wiley (1985).

In the mangroves, cowbird trapping and removal efforts in 1985 and 1986 were concentrated in the three main YSB nesting areas (Main Swamp [MS], Officer's Club [OC], and Airfield [AF]) (Fig. 1). A fourth mangrove area (LT) (Fig. 1), where YSB's were occasionally observed, was used as a cowbird non-removal "reference" area in 1986. These four areas are characterized by relatively old, undisturbed black mangrove (Avicennia germinans) -dominated forest. The MS and OC areas were previously used for cowbird removal experiments (Wiley 1982, Wiley et al. 1983). During both

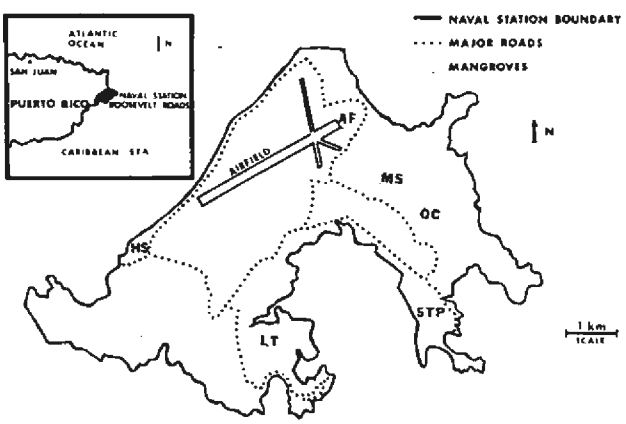

Fig. 1. Location of shiny cowbird decoy trap sites (MS, OC, AF, LT, MS, STP) at Roosevelt Roads Naval Station, Puerto Rico.

nesting seasons we also used two upland trap sites identified as the horse stable (HS) and the industrial area sewage treatment plant (STP) (Fig. 1). The HS and STP areas have been highly disturbed and are dominated by grass, shrubs, and buildings.

Decoy Trap Placement and Efficacy

Eighteen decoy traps of two designs were constructed of 2.5 x 2.5 cm galvanized welded wire mesh supported by 4.4 x 4.4 cm wooden frames. Nine traps were the same size (1.5 x 1.5 x 1.8 m high) (4.2 m^3) and design as those used by Wiley and Litovich (1984), Wiley et al. (1983), and the Puerto Rico DNR to trap cowbirds in previous years. The other nine traps (3.0 x 3.0 x 1.5 m high and 2.1 x 4.6 x 1.5 m high) (14.2-14.8 m^3) were patterned after the large decoy traps used to capture brown-headed cowbirds (Molothrus ater) in Michigan (Shake and Mattsson 1975). See Wiley (unpubl. rep., Yellow-shouldered Blackbird Manage. Coord. Doc. 1, Patuxent Wildl. Res. Ctr., USFWS, 1983) and Heisterberg et al. (unpubl. rep., Evaluating Shiny Cowbird Control Techniques in Eastern Puerto Rico: A Progress Report on Work Conducted June-Sept. 1985, Denver Wildl. Res. Ctr., USDA, 1985) for details on trap construction. The 4.2 m^3 traps (small traps) had a funnel entrance covering the top with a 5-10 cm x 1.5 m entrance slot. The 14.2-14.8 m^3 traps (large traps) had a 0.6 x 1.2 m inward hanging entryway (made of 2.5 x 5.1 cm wire mesh) in the top of the trap and birds entered the trap through 5.1 x 5.1 cm holes cut in the 2.5 x 5.1 cm wire mesh. For test purposes, we considered the 14.2 m^3 and 14.8 m^3 large traps to be the same because they covered about the same area (9.2 m^2 versus 9.7 m^2) and had the same size and type of bird entryways.

In 1985, 12 trap sites were chosen in the MS and OC mangrove areas; in 1986, 14 trap sites were chosen in the MS, OC, and AF mangrove areas. Sites for individual traps were chosen on the basis of proximity to YSB nesting areas, openness of surrounding habitat, and cowbird trapping success the previous year. In 1985, six large and six small traps were randomly assigned to the 12 sites. Six traps (three large and three small) were placed on platforms above water, whereas the other six traps were on dry ground. In 1986, seven large and seven small traps were randomly assigned to the 14 sites. Seven sites were at the same locations as the previous year whereas seven were new locations. Five traps were placed on platforms above water and nine were on dry ground. Traps at each mangrove area were in triangular patterns encompassing about 12 ha in 1985 and 29 ha in 1986. In 1985, the distance between adjacent trap sites averaged 168 m $\pm$ 48 m (SD) at the MS and 165 m $\pm$ 36 m (SD) at the OC. The distance between traps was increased in 1986, averaging 286 m $\pm$ 140 m (SD) at the MS, 394 m $\pm$ 100 m (SD) at the OC, and 692 m $\pm$ 516 m (SD) at the AF. In 1985, trap success for large and small traps in the mangrove swamps was compared using t-test statistics. The large and small traps were considered treatments, while the average number of cowbirds captured per trap-day (one trap open for 1 day) over the length of the trapping period was considered the response. After the 1985 trapping season, we felt that trapping success was being influenced more by trap location than trap size, so we switched to an analysis of variance changeover test design (Federer 1955) to eliminate trap location as a variable. This was accomplished by operating the 14 traps for a 1-month period (29 March-29 April 1986) and then moving the large traps to the small trap sites and vice versa for a second month operating period (10 May-11 June 1986). Significance levels for all statistics were set at 0.05.

In 1985, we also operated a small platform-supported trap in the AF mangrove area to determine trapping success at a lone trap located outside the two intensively trapped areas. In July and August 1986 we also operated a 14.2 m^3 large trap on a dry site in the LT mangrove reference area. This trap (LTL-1) was used to capture, band, and release cowbirds in preparation for another study in 1987.

Besides the traps in the mangroves, we placed an extra-

large trap (3.0 x 6.1 x 1.5 m high) (28.2 m^3) and a small trap at each of two upland areas (HS and STP) where cowbirds were observed feeding and congregating (Fig. 1). These were used to supply decoys for the mangrove traps when the latter were inactive. During the first 1 1/2 months of trapping in 1985, cowbirds captured in these traps were banded and released to determine their subsequent use of the mangrove trapping areas.

Decoy Trap Maintenance and Schedule

All traps were baited with a mixture of millet, cracked corn, barley, and molasses and were provided with fresh water, perches, and a 0.6 x 0.9 m feeding platform (which also served as shade); coconut palm leaves were placed on top the trap for additional shade. Five to 10 cowbird decoys were put in each trap. Traps were visited daily to supply food and water as needed and to record numbers and species of captured birds; species other than cowbirds were released. Any YSB's captured were immediately banded and released.

At least once a week captured cowbirds were removed in a non-selective fashion, leaving 5-10 decoys in each trap. Removed cowbirds were sexed and aged as either juveniles (hatching-year), intermediates (second-year), or adults (after-second-year) following techniques described by J. Wiley (pers. comm.). Removed cowbirds, except for those banded and released at the HS, STP, and LT areas, were sacrificed and frozen for later use in other studies.

In 1985, nearly all decoy traps were operated from late June and early July through mid-September. One small trap (HSS-1) was closed in early August because of few captures. In 1986, most traps were opened mid- to late-March and operated until mid-June. After mid-June the AFL-2 and AFS-2 traps and the six MS traps were closed because of few captures, vandalism, and security problems. Trapping at the other OC and AF mangrove locations continued into late August.

Evaluation of Cowbird Removal on YSB Reproductive Success

In 1986, we attempted to measure the effect of cowbird removal on the reproductive success of the YSB. We collected data on the parasitism rates of YSB and yellow warbler nests; warbler nests are common in the mangrove areas and are heavily parasitized by cowbirds (Wiley 1985). Parasitism rates for nests in the LT mangrove area, where cowbirds were not removed, were compared with those for nests in the three other mangrove areas where cowbirds were removed. Searches for YSB and yellow warbler nests in the four mangrove areas were made at least twice weekly from April-July. Nest sites were marked with flagging tape and revisited once or twice weekly until young fledged or the nest became inactive. At each visit, nests were inspected to determine the number of host and/or parasite eggs and chicks present. Attempts were made to determine causes of nest failure following criteria outlined by Wiley (1985). Active nests were defined as those having at least one host egg, or if parasitized and no host egg was present, the host was incubating the cowbird egg(s). Nests fledging at least one chick, either host or parasite, were considered successful.

In addition to using nesting success to measure the effect that cowbird removal had on the reproductive success of the YSB, in June and July 1986 we also searched all mangrove areas for individual or family groups of YSBs. When possible, YSBs were identified as juveniles (hatching-year) or adults (after-hatching-year). Areas were searched by walking through mangrove and nearby upland areas where YSBs were encountered during our 1985 work and on previous YSB surveys (J. Wiley, pers. comm.).

RESULTS

Decoy Trapping 1985

In 1985, 17 decoy traps caught 2449 cowbirds (including 45 recaptures) in 1162 trap-days, a capture rate of 2.1/trap-day (Table 1). The average capture rate for the six large traps in the MS and OC mangrove areas was 1.6/trap-day (659 cowbirds captured in 423 trap-days), significantly higher ($t_{10d.f.}$=2.79, P=0.02) than the average 0.7/trap-day (259 cowbirds captured in 389 trap-days) captured in the six small traps. There was no difference in capture rates between platform and non-platform large traps ($t_{4d.f.}$=0.47, P>0.50) nor between platform and non-platform small traps ($t_{4d.f.}$=1.11, P>0.30). Weekly capture rates for the 12 MS and OC traps fluctuated over a relatively wide range during the entire trapping period (Fig. 2). Increases or decreases in trapping success for the large and small traps often occurred during the same weekly intervals. Overall, the 13 MS, OC, and AF mangrove traps captured 1028 cowbirds in 879 trap-days (1.2/trap-day). Capture rates for the two upland extra-large traps were much higher than those for the mangrove traps, averaging 12.3/trap-day for HSEL-1 and 2.9/trap-day for STPEL-1 (Table 1).

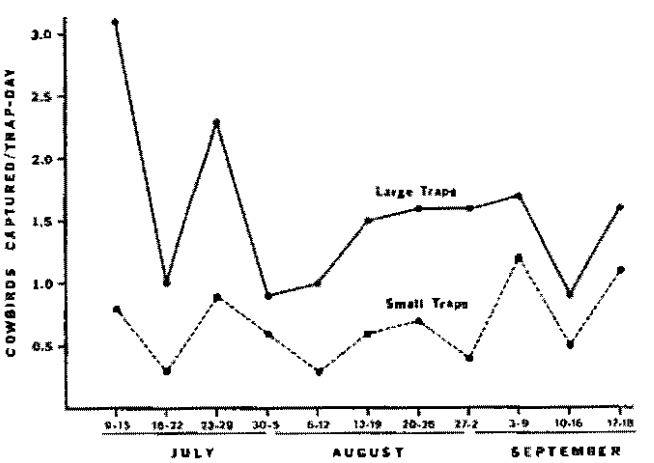

Fig. 2. Weekly shiny cowbird capture rates for six large (14.2-14.8 m^3) and six small (4.2 m^3) decoy traps in MS and OC mangrove areas, July-September 1985, Roosevelt Roads Naval Station, Puerto Rico.

Of the 2404 individual cowbirds captured in decoy traps in 1985, 48% were males, 42% females, and 10% unknown. By age class, 26% were adults, 16% intermediates, 51% juveniles, and 7% unknown. The proportion of adults and intermediates among aged birds captured (recaptures not

included) in all decoy traps steadily decreased during the trapping period from 63% in July (526 of 832 captures) to 21% in September (80 of 388 captures).

Table 1. Shiny cowbird capture rates for all decoy traps, June-September 1985 and March-August 1986, Roosevelt Roads Naval Station, Puerto Rico.

Trap[a]	No. Captured[b]		Trap-days		Birds/Trap-day	
	1985	1986	1985	1986	1985	1986
Mangroves						
MSS-1	24	--	67	--	0.4	--
MSS-2	28	--	71	--	0.4	--
MSS-3	94	16	71	58	1.3	0.3
MSS-4	--	1	--	51	--	0.02
MSS-5	--	7	--	64	--	0.01
OSC-1	54	--	72	--	0.8	--
OSC-2	39	--	63	--	0.6	--
OSC-3	20	--	45	--	0.4	--
OSC-4	--	21	--	120	--	0.2
OSC-5	--	40	--	120	--	0.3
AFS-1	110	37	67	120	1.6	0.3
AFS-2	--	3	--	60	--	0.1
MSL-1	197	25	71	78	2.8	0.3
MSL-2	112	23	68	64	1.6	0.4
MSL-3	89	19	71	56	1.3	0.3
OCL-1	92	75	71	138	1.3	0.5
OCL-2	43	--	71	--	0.6	--
OCL-3	126	99	71	135	1.8	0.7
AFL-1	--	123	--	120	--	0.1
AFL-2	--	21	--	58	--	0.4
LTL-1	--	157	--	30	--	5.2
Upland						
HSEL-1	1074	124	87	141	12.3	0.9
HSS-1	80	15	75	81	1.1	0.2
STPEL-1	264	44	91	77	2.9	0.6
STPS-1	3	--	30	--	0.1	--
Total	2449	850	1162	1571		
Mean					2.1	0.5

[a]S, L, and EL before numerals indicate small (4.2 m³) large (14.2-14.8 m³) and extra-large (28.2 m³) traps, respectively. [b]Includes 45 cowbirds originally captured, banded, and released in HSEL-1, HSS-1, and STPEL-1 in 1985 and 5 cowbirds originally captured, banded, and released in LTL-1 in 1986 and recaptured the same year of banding in the MS, OC, or AF mangrove areas. Other totals do not include recaptures.

Between 20 June and 12 August, 526 cowbirds captured in the four upland traps at the HS and STP were banded and released; 45 of these were recaptured in 12 of the 13 mangrove traps between 18 July and 17 September. In addition to the 45 recaptures in mangrove traps, 150 birds were recaptured in the same trap where banded and two were retrapped in a different upland trap.

Some cowbirds captured in decoy traps were lost to vandalism, predation, inclement weather, and stress of captivity. Of the 2404 cowbirds captured, 112 (5%) were found dead in the traps. Predators, mongooses (Herpestes auropunctatus) and black rats (Rattus rattus), killed 63 of these; the cause of death could not be determined for the other 49. At least 62 birds escaped from the traps because of tampering by vandals.

Four species other than cowbirds were also captured in decoy traps, including 202 Greater Antillean grackles (Quiscalus niger), 4 YSBs, 1 nutmeg mannikin (Lonchura punctulata), and 1 budgerigar (Melopsittacus undulatus). Of the four YSBs captured, three were juveniles and one was an adult; one of the juvenile YSBs was found dead in the trap, apparently a victim of stress.

Decoy Trapping 1986

In 1986, 18 decoy traps caught 850 cowbirds (includes five recaptures) in 1571 trap-days, a capture rate of 0.5/trap-day (Table 1). During the 2 1/2-month (29 March-11 June) comparison of cowbird capture rates for large and small traps, the capture rate for the seven large traps in the MS, OC, and AF mangrove areas was 0.6/trap-day, which was significantly higher ($F_{1,12d.f.}$=7.93, P=0.02) than the 0.2/trap-day captured for the seven small traps. Trap location, as a confounding source of variation in the comparison of large and small trap capture rates, was not significant ($F_{13,12d.f.}$=1.33, P=0.31). Overall, the 14 MS, OC, and AF mangrove traps captured 510 cowbirds in 1242 trap-days (0.4/trap-day). Capture rates for the two extra-large traps in the uplands were slightly higher than that for the MS, OC, and AF mangrove traps, averaging 0.9 and 0.6/trap-day (Table 1). Cowbird captures/trap-day for the MS, OC, and AF mangrove traps remained low throughout the trapping season, averaging 0.9 in March, 0.6 in April, 0.2 in May, 0.1 in June, 0.5 in July, and 0.7 in August.

The capture rate (not including recaptures) in the cowbird non-removal mangrove area was much greater than for other decoy traps. Catches in this area in a large trap averaged 5.2/trap-day in July and August (157 captured in 30 trap-days. In comparison, the other three large mangrove traps open at these same times averaged only 0.7/trap-day (92 captured in 123 trap-days).

Of the 845 individual cowbirds captured in decoy traps, 47% were males, 46% females, and 7% unknown. By age class, 18% were adults, 35% intermediates, 38% juveniles, and 9% unknown. As in 1985, the proportion of adults and intermediates among aged birds captured (recaptures not included) in all decoy traps steadily decreased during the trapping period from 100% in March (59 of 59 captures) to 14% in August (35 of 246 captures).

The 157 cowbirds captured in July and August in the LT mangrove large trap were banded and released. Of these 157, 26 were subsequently recaptured in this same trap, and 5 others in traps at the OC, AF, and HS.

We recaptured 39 of 526 (7%) cowbirds banded at the HS and STP sites in 1985. One or more recaptures were made at all six areas trapped in 1986. An additional 24 cowbirds banded at the HS site and nearby areas by J. Wiley from 1978 to 1983 were recaptured in 1986 at all six trapping areas. The two oldest banded birds recaptured were both originally banded at the HS on 18 August 1978 and were both recaptured in one trap (MSS-3) on 25 April 1986, 5 km from where they were originally trapped. They were originally aged and sexed as an after-second-year male and an unknown age female, making the male at least 11 years old when retaken. That both cowbirds were originally banded at the same location the same day and recaptured together 8 years later suggests that they were a mated pair.

Again in 1986 some cowbirds captured in decoy traps were lost to the same causes as in 1985. Of 845 cowbirds captured, 42 (5%) were found dead. Domestic cats, black rats, and mongooses killed 31 (74%) of these and the cause of death could not be determined for the other 11. At least 38 birds escaped from the traps because of tampering by vandals. An additional 71 birds were missing from traps; these may have escaped through cracks between trap panels or through the entryways.

Six species other than cowbirds were also captured in the decoy traps, including 124 Greater Antillean grackles, 84 nutmeg mannikins, 9 pearly-eyed thrashers (Margarops fuscatus), 3 YSBs, 2 Northern mockingbirds (Mimus polyglottos), and 1 smooth-billed ani (Crotophaga ani). Of the three YSBs, two were juveniles and one was a second-year bird that had been previously captured as a juvenile on 12 September 1985.

YSB Surveys and Nesting Success

The June 1986 YSB survey of the Naval Station's mangrove and nearby upland areas produced only 15 YSBs. However, on 9 July, we located 21 YSBs in three separate groups in the MS trapping area. Based on the location of these groups and other birds observed at different locations, the Naval Station YSB population was estimated to be at least 31 birds. Of those observed, 16 were adults, 8 were fledglings, and 7 were of unknown age.

We were able to locate only one active YSB nest in the cowbird removal areas and none in the non-removal area. This nest, found on 31 May, contained two YSB eggs and no cowbird eggs; on 12 June, it was empty and the eggs were assumed to have been lost to a predator. On 17 June, we observed three newly fledged YSB's perched near a YSB nest in the AF area. The chicks were still begging for food, and no cowbird fledglings were observed.

We located and followed the fate of 36 yellow warbler nests during the April-July nest searches. Of these, 12 were deserted, with 10 of the 12 containing only cowbird eggs and the other two containing no eggs. The success of the other 24 active warbler nests was much greater for non-parasitized than parasitized nests. Young fledged from 6 of 13 non-parasitized nests compared with no young fledging from 11 parasitized nests. In the cowbird removal areas, only 2 of 14 (14%) active warbler nests were parasitized, whereas 9 of 10 (90%) active nests in the cowbird non-removal area were parasitized. Warbler young fledged from 5 of the 14 (36%) active nests in the cowbird removal area, but young fledged from only 1 of 10 (10%) active nests in the cowbird non-removal area. Of the 24 active nests in both areas, 18 failed due to predation or exposure.

DISCUSSION

Approximately 71% fewer cowbirds (2404 versus 688) were captured from the same mangrove and upland trapping areas in 1986 than in 1985, despite more intensified trapping efforts in 1986 (1541 versus 1162 trap-days) over a longer period of time (6 versus 4 months) and over a larger trapping area (29 ha versus 12 ha). The greatly reduced capture rates the second season were likely a carry-over effect of bird removals made from June to September 1985. This suggests that birds removed from the trapping areas were not readily replaced by birds from outside the trapping area, at least from September 1985 to September 1986. The decrease in numbers of adults and intermediates captured during the course of both trapping seasons also suggests that during the trapping seasons few adult and intermediate birds from outside the trapping area moved into the trapping areas.

Cowbirds apparently did not develop trap-wariness. This is exemplified by the recapture of 37% (197 of 526) of the birds banded in 1985 within 3 months of their release. We found similar recapture rates in 1986 with 20% (31 of 157) of banded birds being recaptured within 45 days of release. In southwestern Puerto Rico, Wiley and Litovich (1984) recaptured 77% of banded cowbirds (n = 931) within 17 days of release. Cowbird capture rates were significantly higher for large traps than for small traps in both trapping seasons. This is not surprising, since large traps had nearly four times the flight area for decoy birds and 5-10 times the entryway area. Cowbirds attracted to larger traps may be less hesitant to enter because of the less restrictive entryways, and the less restricted movements of decoy birds.

In comparing large and small trap capture rates in 1986, we found trap location not to be a factor. We emphasize, however, that this should only be considered in the context of our comparisons of large and small trap capture rates. Trap location is perhaps the most important factor in successfully trapping cowbirds. For example, in 1985 more cowbirds were captured in the two extra-large decoy traps at upland sites than in the other 15 decoy traps combined (Table 1).

Large and small decoy traps have both advantages and disadvantages. The main advantages of the large traps (14.2 m^3 or larger) over the small 4.2 m^3 traps are that they capture more cowbirds, are easier to work in, and are less stressful to captives. This may be especially important if YSBs are apt to be trapped. The main drawbacks of large traps are their initial expense and time-consuming installation. Although installation is not much of a problem on upland or dry

mangrove sites, it is in wet mangrove areas that require platform support for the trap. Small traps are much easier to transport and set up in a flooded mangrove area and can be moved to new locations with considerably less effort. If large traps are to be used, however, sites should be chosen with the belief that they will be used for several seasons.

Recapture locations of banded cowbirds released at the HS and STP upland areas in 1985 and the LT mangrove area in 1986 indicate that many cowbirds range over the entire YSB breeding area at the Naval Station. However, intensive cowbird removals at five of the trapping areas in 1985 and 1986 apparently had little effect on reducing cowbird numbers or parasitism rates at a sixth trapping area 3-5 km away. We concur with Wiley (unpubl. rep., Yellow-shouldered Blackbird Manage. Coord. Doc. 1, Patuxent Wildl. Res. Ctr., U.S. Fish and Wildl. Serv. 1983) that to effectively reduce parasitism rates of susceptible species, traps must be located in the immediate nesting areas.

Decoy traps in three mangrove areas (MS, OC, and AF) were located relatively close to one another in both 1985 ($\bar{x}$=167 m) and 1986 ($\bar{x}$=457 m). This represents an intensive trapping effort in a relatively small area and raises the question whether fewer traps in the same area would result in nearly as many cowbird captures. No doubt the daily movements of cowbirds using these areas exposes them to more than one trap. There is some indication that individual trap success might improve if traps were located farther apart. The solitary mangrove trap (AFS-1) operated in 1985 had a cowbird capture rate of 1.6/trap-day compared to only 0.7/trap-day for the six other small mangrove traps (Table 1).

Because we were able to locate only one active YSB nest, our conclusions regarding the effects of cowbird removal on YSB reproduction must be based on indirect evidence, such as provided by the yellow warbler nesting study. The parasitism rate on active yellow warbler nests in the cowbird removal area was only about one-sixth of that in the non-removal area. In both cowbird removal and non-removal areas, 6 of the 13 non-parasitized active nests (46%) fledged young, whereas 0 of the 11 parasitized active nests fledged young. However, all 11 parasitized nests and 7 of the 13 non-parasitized nests eventually failed due to predators or exposure, indicating that parasitism is not the sole factor adversely affecting the reproductive success of hosts.

Direct evidence of the beneficial effects of cowbird removal on YSB reproduction comes from Wiley and Litovich (1984). They found that YSB clutch size, brood size, and fledgling success were greater in areas where cowbirds were removed than in non-removal areas.

Although cowbird populations at Roosevelt Roads Naval Station have been reduced, the YSB population remains at a critically low level. Of the 31 YSBs observed at Roosevelt Roads, 16 were identified as adults. Post and Wiley (1977b) believe that a YSB post-breeding season fledgling to adult ratio of two to one is necessary to maintain a population. Considering that the fledgling to adult ratio for the Roosevelt Roads population is considerably less than two to one, the YSB population continues to be perilously close to extirpation.

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