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REPRODUCTION AND GROWTH IN AMERICAN ROBINS AT THE FEED MATERIALS PRODUCTION CENTER - (USED AS A REFERENCE IN OU5 RI REPORT)

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REPRODUCTION AND GROWTH IN AMERICAN ROBINS AT THE FEED MATERIALS PRODUCTION CENTER

by

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January 1991

Prepared for the
FEED MATERIALS PRODUCTION CENTER
Westinghouse Materials Company of Ohio
P. O. BOX 398704
CINCINNATI, OHIO 45239-8704

UNDER CONTRACT DE-AC05-860R21600
U.S. Department of Energy
OAK RIDGE OPERATIONS OFFICE

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REPRODUCTION AND GROWTH IN AMERICAN ROBINS AT THE FEED MATERIALS PRODUCTION CENTER

INTRODUCTION

Birds have been useful in environmental monitoring within forest ecosystems (Adams and Barrett 1976) and at a variety of industrial sites (Willard 1960; Brisbin et al. 1973; Levy et al. 1975).

Growth analyses have been shown to be a sensitive measure of environmental stress in gulls (Gilbertson and Fox 1977), eagles (Helander et al. 1982, and in passerine birds (Zach and Mayoh 1984).

As part of an intensive year-long baseline ecological study, we (Facemire, et al. 1990) initiated investigations in late spring 1987 in order to characterize growth and reproductive success in Mourning Doves (*Zenaida macroura*) and American Robins (*Turdus migratorius*) at the FMPC. We selected doves and robins for study because they were among the most abundant breeding and wintering species onsite and because they have similar hatching and fledging success (Young 1955). They differ in territorial behavior and diet. Doves defend only the immediate vicinity of the nest (type IV territory; Welty 1982) and only traces of insect or other animal foods are eaten; corn, wheat and grass seeds are the three top-ranked plant foods for Ohio dove populations (Martin et al. 1951:111). Young doves are not fed these foods directly, but are fed 'pigeon milk' which is produced by the mother's crop (Welty 1982).

Robins, on the other hand, defend relatively small territories (Wisconsin populations averaged 1200 m^2; Young 1955) for mating, nesting and feeding (type I territory; Welty 1982) and prefer clearings, lawns and orchards for foraging. Seventy-nine percent of their adult spring diet is earthworms; the food of nestling robins is mainly insect larvae and earthworms (Martin et al. 1951). Thus, robins, secondary consumers, are more likely to feed in or near their nesting sites than are granivorous doves.

We (Facemire, et al. 1990) monitored reproductive success and growth of Mourning Doves (*Zenaida macroura*) and American Robins (*Turdus migratorius*) from two onsite and two offsite locations during late spring, 1987). We found hatching and fledging success of doves significantly ($P<0.05$) lower in the northern pines as compared to the southern pines. Nestlings of onsite dove populations did not differ significantly from offsite nestlings in any of the five growth parameters measured. FMPC robin eggs from the northern pines weighed significantly less than robin eggs from the southern pines. FMPC robins showed significant suppressed growth in four of the five prefledging growth parameters measured as compared to offsite populations. We attributed species differences in suppressed growth to species specific differences in dietary stress. Because doves and robins occupy different trophic levels within the FMPC ecosystem, these species may be affected differently by any environmental stress which impacts food chains and diet quality as has been reported for these species at other nuclear facilities (Levy et al. 1982). We (Facemire et al. 1990) concluded that FMPC robins and doves were

not as healthy as has been previously reported for the site (WMCO 1987:60).

The current study was initiated in order to determine whether the pattern of suppressed growth and reproduction in FMPC birds still existed onsite. We selected only American robins (*Turdus migratorius*) for study because they appeared the most severely affected in 1987 (Facemire et al. 1990).

STUDY SITES AND METHODS

Previous baseline and ecological studies of the Feed Material Production Center (FMPC) have been conducted by Tarswell (1952), Pomeroy et al. (1977), Battelle (1981), and Facemire et al. (1990).

This study was conducted from May through July, 1990. Robin populations were sampled onsite within the 425 ha of the FMPC site excluding 55 ha covered by the FMPC operations complex, parking lots and associated construction facilities. Offsite stations within 40 Km of the FMPC (Fig. 1) used for statistical comparisons with FMPC robin populations included the Miami University Oxford Campus, and Nieman's Nursery, just north of the FMPC. Nieman's Nursery was selected because the coniferous habitat supported a moderate population of nesting robins. Other sites examined (Governor Bebbs County Park, Mount Airy Forest, Pater Park, Whitewater State Forest, Miami University Hamilton Campus, Champion Paper Park, Indian Creek County Park, Four Mile Creek Park, and a Park near Ross, OH) supported less than six active nests during the three month study period and were not included in the data analysis. Onsite sampling included those

landscaped habitats (particularly the northern and southern pine plantations, Fig. 2), known previously (Facemire, et al. 1990) to support high densities of robins.

All sites were intensely searched twice weekly during the study period. All active (those with eggs or young) robin nests were followed from the egg stage through fledging. Eggs were weighed to the nearest 0.1 g with Pescola scales. Maximum (greatest weight of the egg before predation or hatching) and average egg weights were used in the calculations. Hatchlings are defined as birds that have emerged from the egg, but have not yet left the nest. Fledglings are birds that have left the nest under their own power. Since it is difficult to determine precisely when the bird left the nest, nestling weights were monitored and young that were close to the maximum range of body weight for a hatchling and then not found in the nest the following sampling day were assumed to have fledged. We often observed fledglings being fed by the parents.

In order to determine robin productivity we monitored several reproductive parameters. Clutch size (number of eggs per nest), hatching success (number of eggs that hatched) and fledging success (number of young that left the nest) were calculated for each sampling site.

The standard growth parameters (N. A. Bird Banding Manual 1984) measured included egg and chick weights, the length of the wing (wing cord), last primary, bill (culmen) and middle toe. Measurements of each parameter were taken three times weekly until fledging. FMPC and offsite birds were measured at the same age.

Average asymptotic values (Rickleffs 1967; Springer and Osborne 1983) were used in the final computations of the growth data.

To determine if any differences existed between locations, data were treated statistically using the ANOVA program of StatView 512+ (1986). If significant results were found ($P<0.05$), Fisher's Protected Least Significant Difference (PLSD) comparison procedure was employed to detect the differences on a pairwise basis. Results are discussed and interpreted with respect to FMPC robin populations studied in 1987 (Facemire et al. 1990).

RESULTS

Although intense nest searches were conducted twice weekly in each habitat, only four of 14 stations studied exhibited nest densities adequate for statistical treatment (Fig. 1). FMPC nests were clumped along the berms of the northern and southern entrance roads (Fig. 2), and nests were essentially absent from the northern and southern pine plantations. Nests were uniformly spaced on the Miami University Campus (Fig. 3). Nieman's Nursery exhibited a uniform pattern of nest distribution and high nest densities similar to that of the Miami University Campus; nest densities were extremely low on the FMPC (Table 3). Evergreens were the preferred nesting substrate on the FMPC, Nieman's Nursery and the Miami Campus, followed by ornamental trees and low shrubs.

Ninety-nine young were measured for morphometric analysis (Table 1). Length of the toe and culmen did not differ significantly ($P>0.05$) between any of the populations.

Significant stunting ($P<0.05$) was found in three of the five prefledgling growth parameters. Wing chord, length of primaries and body weight of southern FMPC robins were significantly ($P<0.05$) smaller than those of offsite (Miami) robins. Robins from the northern FMPC showed no significant (ANOVA; $P>0.05$) reduced growth from offsite birds in any parameter. Northern and southern nestlings of the FMPC were statistically ($P>0.05$) similar to each other and to Nieman's Nursery birds in all five growth parameters measured. Thus stunting was more pronounced in southern than in northern FMPC robin populations. Robins from Niemans Nursery had significantly ($P<0.05$) shorter wings and weighed less than did nestlings from the Miami campus.

When we combined the northern and southern FMPC morphometric data (Table 1), FMPC robins showed suppressed growth as compared to Miami robins ($P<0.05$) in bill length, wing chord and length of the outermost primary, and body weight.

One hundred and ninety-one eggs were weighed during the incubation stage of the nesting cycle (Table 2). Average egg weights of northern FMPC robin eggs were found to be significantly greater ($P<0.05$) than Miami populations. Similar, but non-significant ($P>0.05$) trends existed for Nieman's and southern FMPC populations. Maximum egg weights did not differ significantly ($P>0.05$) across the four populations. When northern and southern FMPC egg data were lumped (Table 2), no significant ($P>0.05$) differences were found in egg weights between FMPC and Miami populations.

Reproductive success of 91 robin nests (Table 3) was examined during the study. No significant differences (P>0.05) were found with regard to average clutch size, number of hatchlings, and number of fledglings across sampling location. The northern FMPC had the highest percentage (55%) of young fledged followed by Nieman's Nursery (53%), Miami University Campus (47%), then the southern FMPC (42%); however, they were not significantly different (P>0.05) from each other (Table 3).

DISCUSSION

In this study FMPC robins did not nest, substantially, in either the northern or southern pine plantations. These habitats supported 310 and 274 breeding robins in 1987 (Facemire et al. 1990); only two active nests were recorded in the northern pine plantation in the current study.

Robins prefer lawns for foraging. The absence of adults and young foraging in the pine plantations suggest these habitats were not optimal for nesting during 1990. Under normal conditions the lanes in the pine plantations are frequently mowed. Because 1990 was an unseasonably wet year, these habitats were not mowed as frequently as in past years. During our field surveys there was often standing water in the lanes and vegetation was about 90 cm high. Similar characteristics were true for the pastures and portions of the woodlots. Thus, the only areas suitable for extensive nesting and foraging by robins at the FMPC during 1990 were the mowed berms of the northern and southern entrance roads having adequate drainage.

Nieman's Nursery and the Miami University Oxford Campus, which were mowed weekly, supported substantially higher densities of nests. Robins did not move back into the FMPC pine plantations even when the areas were mowed later in the reproductive season (mid July), suggesting strong site fidelity to the initial territory established for the rearing of additional broods. We made no attempt to document the number of broods raised on or off the FMPC, but seeing young foraging on the Miami University Oxford Campus lawns during our first foot surveys suggest the study should have been started earlier than in May, and that we may have missed the first clutches of some individuals. American robins typically begin nesting in March in Ohio (Trautman and Trautman 1968). Although five broods have been documented (Howe 1898), half of the robins usually stop breeding after the second successful brood, and most stop brooding young after the third nesting (Young 1955). These habitat and temporal factors in nesting may be important in accounting for low nest densities on the FMPC in 1990.

We found no significant differences in reproductive success across sampling site. Young (1955) reported average clutch size of 3.4 eggs/nest (N=273) in his Wisconsin birds. Clutch sizes in this study ranged from 2.9-3.4 for populations at Nieman's Nursery and the southern FMPC, respectively. Clutch sizes for offsite robins and FMPC robins were lower when compared to our findings in 1987 (range = 3.3-3.7; Facemire et al. 1990). Clutch sizes for FMPC 1990 robins were higher than for offsite populations. Thus, although nest densities were low, FMPC robins still produced

normal numbers of eggs per clutch.

We did not find any significant reduction in the average weights of FMPC robin eggs. Mean weights of robin eggs were similar regardless of sampling location. In fact, egg weights of onsite birds were often greater than those offsite suggesting that large embryos were possibly being produced onsite.

Hatching success in 1990 averaged from 1.8 (offsite) to 1.8-2.3 young per nest (onsite) as compared to 2.8 (offsite) to 2.3 (onsite) in 1987 (Facemire et al. 1990) showing a slight increase in embryonic mortality since 1987. Differences in embryonic mortality may be related to temporal differences in nesting (Young 1955), weather, or differential predation, rather than some contaminant stress affecting hatchability across sampling sites.

In 1987, we (Facemire et al. 1990) found that both the northern and southern FMPC pine plantation robin populations had significantly ($P<0.05$) lower average number of fledgings as compared to offsite populations. The percentage of robins which fledged the Miami Oxford Campus in 1990 was much lower (47% vs 87%) than that found in 1987 (Facemire 1990). FMPC fledgling success was similar across years. The percentage of FMPC robins which fledged in 1987 was 54% for the northern pines and 42% for southern pine populations versus 55% and 43% for the northern and southern 1990 robins, respectively. These values are lower than have been found elsewhere. Young (1955) reported a three year average of 78% for robins breeding in Wisconsin.

In 1987 we (Facemire et al. 1990) found FMPC robins showing suppressed growth in four of five of the growth parameters measured. We found a similar pattern of suppressed growth in 1990 except that the southern population of FMPC robins was more affected than the northern population. Both populations, when considered together, are statistically (ANOVA, $P<0.05$) different from the Miami offsite reference population. Nieman's Nursery, just north of the FMPC, differed from Miami birds in two of five growth parameters. Thus, although FMPC robins appear to produce normal sized clutches, relatively large embryos and fledge normal numbers of young, the young are stunted. Chronic and acute radiation are two factors documented to cause growth depression in nestling birds (Zach and Mayoh 1984,1986; Muller and Moreng 1966).

High radiation levels also reduces fertility (Muller and Moreng 1963; Mraz and Woody 1973), but appears not to be important in accounting for seasonal differences onsite. FMPC robins produced only slightly reduced numbers of nestlings between 1987 and 1990.

Other factors possibly affecting hatching success and growth include dietary stress, food quality and food type. For example, insectivorous robins have been found to have three times higher radiocesium body burdens than gramnivorous species (Levy et al. 1976) and species differences have been attributed to trophic levels each species occupied within the same habitat (Levy et al. 1982).

Clutch sizes did not differ significantly across habitats in 1987 and 1989 suggesting dietary stress prior to nesting was not an important factor affecting egg production.

Rickleffs (1973) showed that brood sizes affect growth in birds; one-young clutches tended to have slower growth rates than two or three-young clutches. Werschkul and Jackson (1979), and Ricklefs (1982) concluded that sibling competition on nestling development is a dominant force determining the evolution of growth rates. Brood sizes (Table 3; range = 1.8-2.3) in 1990 FMPC populations were not significantly different from offsite populations, and were similar to those found in 1987 (2.3 for both sites; Facemire et al. 1990). Thus, sibling competition does not appear to be affecting growth in FMPC robin populations.

The food of robins is chiefly insect larvae and earthworms (Martin et al. 1951). One source of chemical dietary stress is through earthworm-robin food chains. Earthworms have been shown to accumulate heavy metals (Helmke et al. 1979; Hughes et al. 1980; Beyer 1981) and to transport them to birds (Scanlon et al. 1979). Peredel'sky et al. (1957, 1960) showed that earthworms were important in dispersing radioisotopes through soil. Because undigested soil is a major constituent of the digestive tract of earthworms, any contaminated soil present in the gut may represent a potential impact on birds which feed on them. Martin and Coughtrey (1975) showed that thrushes (robins are members of the thrush family) accumulated heavy metals in kidney tissue. Pesticides and botanical poisons in the diets of birds have long been known to affect embryonic development and fledgling growth

(Welty and Baptista 1988). Hence, the reduced growth of FMPC robin populations in 1987 and 1990 could be due the bioaccumulation or chemo-toxicity of heavy metals or herbicides in the FMPC earthworm-robin food chain.

Another factor possibly affecting nestling growth in this study may have been food availability. In 1990 earthworms may have been equally abundant, but not readily accessible to foraging robins. The FMPC pine plantations were apparently not optimal breeding and feeding habitats as they were in 1987, resulting in the crowding and clumping of robin nests along roadside berms late in the breeding season. This could have led to intensive competition for a limited food supply, inadequate nestling diets, and eventually smaller young. Feeding frequencies of young birds have been recorded to be twice as great in early than in late broods of the same size (Royama 1966) and growth of individuals have been known to be affected by the temporal nature of food supply (Gill 1990) and food quality (Lack 1956; Bryant 1978).

Our findings agree with those of Young (1955) who found no relationship between crowding, i.e. population density, and reproductive success. FMPC robins fledged normal numbers of young per nest as compared to offsite populations; FMPC robins were just smaller.

SUMMARY AND CONCLUSIONS

FMPC robins showed high site fidelity, a clumped distribution along roadside berms, and did not nest in the pine plantations as they did in 1987. The clumping of nests along roadside berms is interpreted as a response to limited and restricted optimal

foraging habitat due to an unusually wet spring which resulted in high stands of vegetative cover and prevented the establishment of normal foraging territories.

Nesting success was similar for FMPC and for offsite robin populations. Clutch sizes did not differ significantly across sampling location, but were slightly lower when compared to 1987 populations. These data suggest that any stress prior to nesting was not an important factor affecting egg production. Egg weights were not significantly reduced.

Although FMPC robins (northern and southern populations combined) produce normal-sized clutches, normal-sized eggs and fledge normal percentage of young, FMPC robin nestlings are small. They showed suppressed growth in four of five prefledgling growth parameters, a pattern similar to that reported for FMPC robins in 1987. FMPC nestling robins have significantly shorter bills, shorter wings, shorter primaries and weigh less than do offsite members.

Neither direct acute or chronic radiation exposure, sibling competition, nor crowding appear to be suppressing FMPC nestling growth. Other factors associated with diet quality seem more important. They include the possibility of heavy metal or pesticide stress operating through earthworm-robin food chains, food abundance, and the availability of food to foraging adults for feeding the young.

RECOMMENDATIONS

We recommend further studies begin in March, 1991 on elucidating the pattern of suppressed growth and reproductive fitness in FMPC robins. Critical to the study would be determining robin and nest densities and the degree of clumping in additional comparable habitats off the FMPC (e.g. other pine habitats). Food quality needs to be examined in terms of earthworm abundance and levels of heavy metals and herbicides/pesticides in the soil and tissues. Herbicides and pesticides were used over a five year period when the pine plantations were planted on the FMPC. Growth parameters need to be measured in addition to screening of select tissues in nestling robins for the presence of herbicides/pesticides and uranium, and other heavy metals (e.g. lead). Such information is essential to clarify further the pattern of stunting in FMPC robins, possible dietary stress through earthworm-robin food chains, and current environmental quality of the FMPC since the termination of production.

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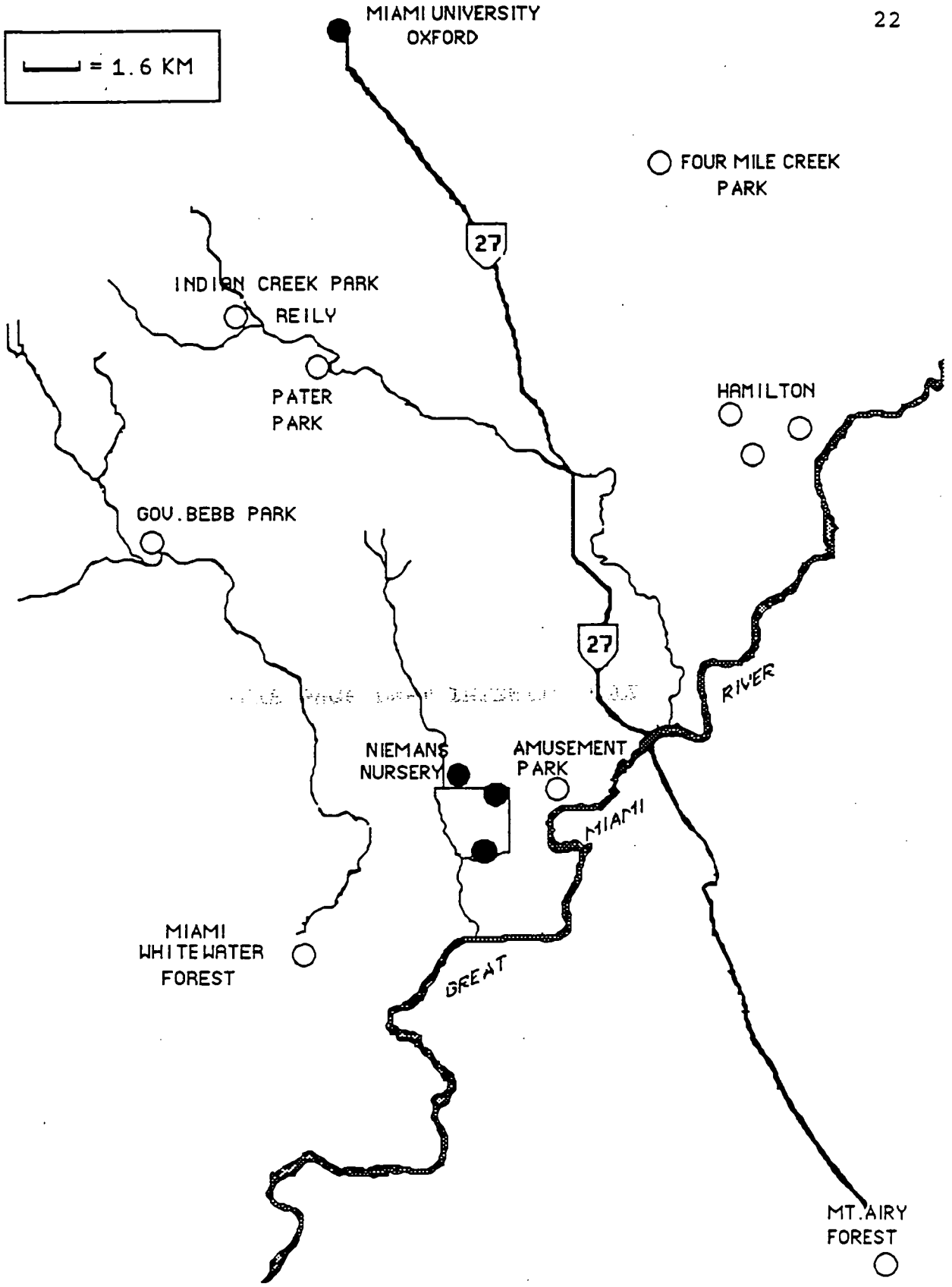

Figure 1. Location of sampling stations for American Robins in the vicinity of the FMPC, Spring, 1990. Open circles represent stations surveyed and where robins nested, but because of low population size were not included the the statistical analysis. Solid circles represent populations treated statistically in this study.

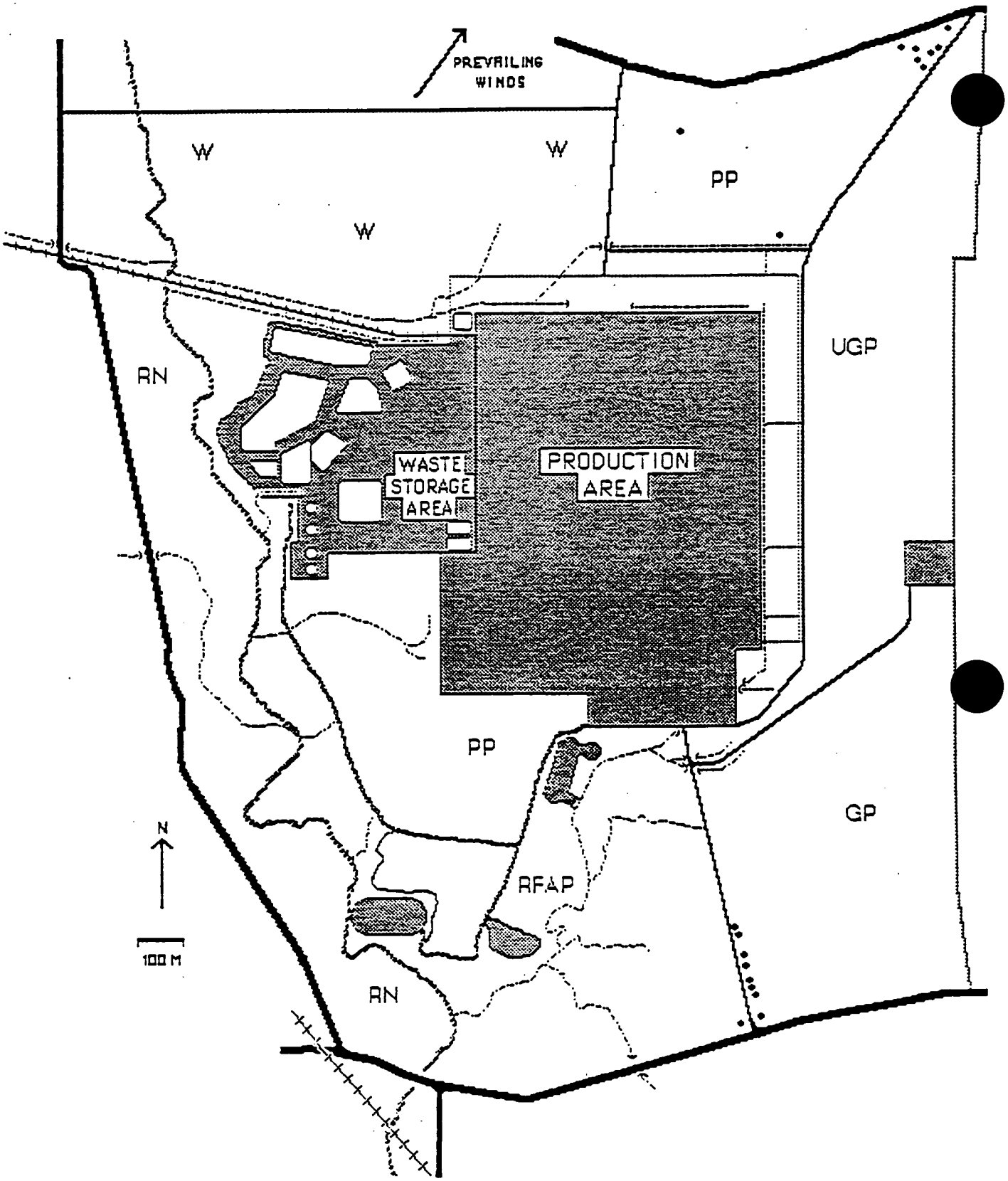

Figure 2. Distribution of American Robin nests on the FMPC, Spring/Summer, 1990. Habitats: UGP=ungrazed pasture; GP=grazed pasture; PP=pine plantation; RFAP=reclaimed flyash pile; W=woodlot; RN=riparian.

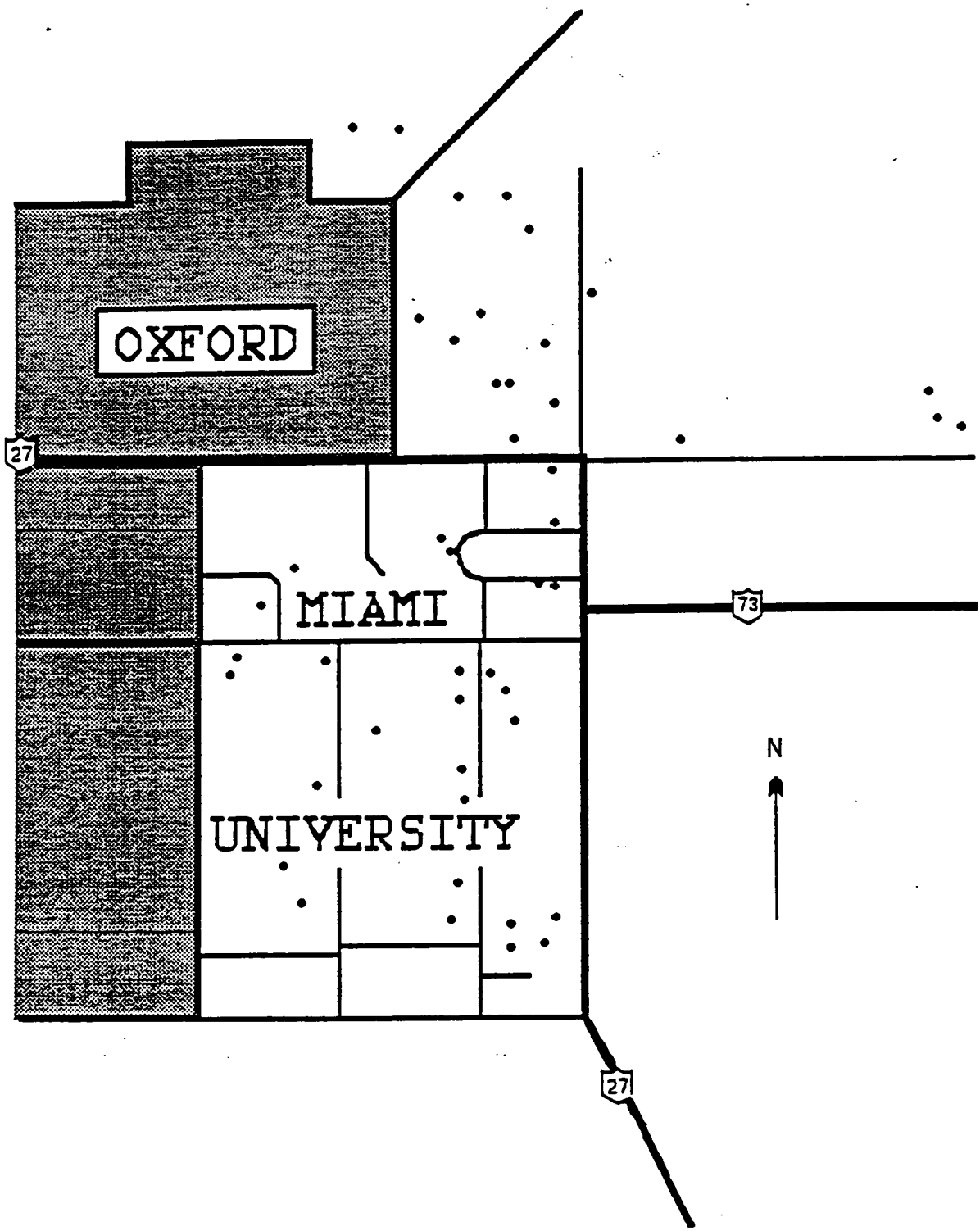

Figure 3. Distribution of American Robin nests, Miami University campus, Oxford, OH, Spring/Summer, 1990.

Table 1. Weights and morphometrics of prefledgling American Robins of the north FMPC, south FMPC, entire FMPC, Nieman's Nursery, and Miami University Campus (offsite). Spring, 1990. Values [means (SE)] represent asymptotic values before fledging.

PARAMETER	MIAMI	N FMPC	S FMPC	FMPC	NURSERY
Number of Fledglings	46	11	12	23	30
Culmen (mm)	14.293(0.216)	13.227(0.807)	13.292(0.264)	13.261(0.400)B	13.950(0.266)
Toe (mm)*	18.902(0.318)	18.364(0.704)	18.167(0.548)	18.261(0.432)	18.550(0.385)
Wing Chord (mm)	69.130(1.808)	61.636(5.838)	56.833(5.097)A	59.130(3.801)B	61.733(2.648)AB
Primary (mm)	33.022(1.745)	29.091(3.755)	22.000(3.492)A	25.391(2.611)B	29.383(1.922)
Weight (g)	57.511(1.064)	53.864(0.842)	50.000(2.493)A	51.848(1.395)B	53.783(1.283)AB

* ANOVA yielded $P > 0.05$
A $P < 0.05$ when comparing Miami to NFMPC, SFMPC, and Nursery using Fisher PLSD.
B $P < 0.05$ when comparing Miami to FMPC and Nursery using Fisher PLSD.

Table 2. Maximum egg weights and average egg weights [mean (SE)] for American Robins in the north FMPC, south FMPC, entire FMPC, Nieman's Nursery, and Miami University Campus.

	MIAMI	N FMPC	S FMPC	FMPC	NURSERY
Total Number of Eggs	86	14	29	43	62
Average Egg Weight (g)	6.103 (0.093)	6.564 (0.226)A	6.259 (0.534)	6.358 (0.100)	6.198 (0.09)
*Maximum Egg Weights (g)	6.319 (0.107)	6.764 (0.249)	6.417 (0.111)	6.530 (0.112)	6.329 (0.088)

* ANOVA yielded $P > 0.05$
A $P < 0.05$ when comparing Miami to NFMPC, SFMPC, and Nursery using Fisher PLSD.

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Table 3. Reproductive parameters *means (SE) for American robins in the northern FMPC, southern FMPC, Nieman's nursery, and offsite populations (Miami University Campus) Spring, 1990.

REPRODUCTIVE PARAMETER	MIAMI	N FMPC	S FMPC	NURSERY
Number of Clutches	42	10	9	30
*Clutch Size	3.024 (0.162)	3.400 (0.306)	3.111 (0.200)	2.867 (0.171)
*Number of Hatchlings	1.800 (0.264)	1.800 (0.521)	2.330 (0.471)	1.690 (0.263)
*Number of Fledglings	1.677 (0.266)	1.600 (0.499)	1.550 (0.503)	1.586 (0.256)
*Percent Fledged	46.67	54.62	42.50	52.90

*ANOVA yielded $P > 0.05$