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NEST-MONITORING PLOTS: METHODS FOR LOCATING NESTS AND MONITORING SUCCESS

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Abstract.—Attention to long-term declines in populations of Neotropical migratory birds has generated increased interest in how to monitor and manage them. Measurement of nesting success provides information on trends in recruitment, and measurement of vegetation associated with nests may identify habitat influences on breeding productivity. Examination of nests also allows collection of life history data (e.g., clutch size, numbers of broods, numbers of nesting attempts, nesting success), which provide important insight into vulnerability of species to decimation or perturbations. Comparisons of nesting success and habitat use across the geographic range of a species can determine local habitat effects on population recruitment and historical constraints on habitat use and species distributions. In this paper, standardized methods and cues are described that aid in locating and monitoring nests to allow comparisons across studies in space and time.

MÉTODOS PARA LOCALIZAR NIDOS Y MONITOREAR EL ÉXITO DE ESTOS

Sinopsis.—El decrecimiento progresivo de las poblaciones de aves que migran al neotrópico ha generado gran interés en cómo monitorear y manejar a éstos. El medir el éxito de anidamiento provee información en relación a las tendencias en el reclutamiento poblacional y las medidas de la vegetación asociada a nidos puede ser importante en identificar aspectos de ésta que influyan en la productividad. El examen de nidos también permite recopilar datos sobre ciclos de vida (ej. tamaño de la camada, número de camadas por año, número de intentos de anidamiento, y éxito de anidamiento) el cual provee información importate en referencia a la vulnerabilidad de la especie a perturbaciones. La comparación del éxito de anidamiento de una especie en diferentes habitats a lo largo de extensiones geográficas puede determinar el efecto de habitats locales en el reclutamiento poblacional y restricciones históricas en el uso de habitat y la distribución de la especie. En este trabajo, se describen métodos estandarizados y pistas que pueden ayudar a localizar y monitorear nidos de tal manera que se puedan hacer comparaciones entre estudios y lapsos de espacio y/o tiempo.

Habitat features that influence breeding productivity of birds are poorly known (Martin 1992). Measurement of nesting success and associated vegetation allows identification of such habitat features and also provides greater insight into evolution of habitat requirements and species coexistence than traditional metrics such as presence or abundance (Martin 1986, 1988a, 1992). Data on nest sites and mortality also improve understanding of ecological and evolutionary influences on life history traits

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(Lack 1968; Martin 1988b, 1993a, b; Martin and Li 1992), which can give insight into the abundance and vulnerability of species to population decimation (Martin 1993a, Pimm et al. 1988). Knowledge of life history traits taken together with data on breeding productivity can also provide information on demographic trends and warn of population problems before declines in density actually occur (Martin 1992, 1993a; Pienkowski 1991; Temple and Wiens 1989). Many life history traits, however, are unknown or poorly known for many species in North America; breeding biology studies are poorly represented among species and geographic locations (Martin 1992, 1993a; Ricklefs 1969). The paucity of studies exists in part from a misconception that nests are too difficult to find. Yet, cues and techniques for finding nests can be learned, as we describe here, thereby providing the vital information needed to curb long-term population declines of many species (see Robbins et al. 1989).

Nest record programs, where volunteers turn in records of nest attempts, have been in existence for years in both the United Kingdom (Ballie 1990) and United States (Bart 1977). These programs obtain data for broad geographic regions from volunteers who often locate nests incidental to other activities. Sample sizes for many geographic regions and habitat types are minimal and consistency in monitoring nests once they are found is poor. Thus, these programs suffer from several potential biases and require careful interpretation (Ballie 1990). In contrast, studies that focus on nest monitoring on long-term plots can provide data on breeding productivity for entire collections of species to allow comparisons within and among species in space and time (e.g., Martin 1992, 1993a; Martin and Li 1992; Sherry and Holmes 1992). Moreover, broad-scale deterioration of environmental conditions from habitat degradation or global warming can be detected if such studies are distributed across local microclimatic gradients and broad geographic regions (Martin 1992, Temple and Wiens 1989). Additionally, if vegetation is measured, habitat features that influence nesting success can be compared across the geographic ranges of species to provide insight into habitat requirements and distribution of species (see James et al. 1984, Knopf et al. 1990). Effective comparisons among species and locations, however, depend on standardization of sampling protocols.

In this paper we describe aids and standardized techniques for locating and monitoring success of nests. These methods are provided to standardize data collection to allow comparisons across investigators and in the hope of increasing both sample sizes and numbers of studies of breeding biology.

NEST LOCATION

Nest finding is labor intensive (DeSante and Geupel 1987), but most observers can improve their ability to locate nests in a matter of days with training and practice. The behavioral observations and clues described below work effectively for a variety of species. Our experience includes only a small subset of species and habitats available in North America, however, and is largely restricted to wooded (scrub and forest) habitats. Other methods may be more effective in other habitats. For example, cable-dragging (Higgins et al. 1969) and rope-dragging (Labisky 1957) may be more effective methods for many grassland species. The patience and alertness of observers and their familiarity with the habitat and behavior of species are the most important influences on effectively locating nests.

We have successfully used these techniques to train individuals who even lack experience at bird identification. For example, a crew of four assistants initiated a study in Arkansas in 1991 where nesting behaviors of species were unstudied; this crew was provided only the general nest-finding guidelines given below. The crew included one experienced nest-finder, one person experienced at identifying birds and two people without experience at either. These workers found over 300 nests of open-nesting birds (Table 1). A crew of seven assistants that included two experienced nest-finders found more than 800 open-cup and cavity nests on Arizona sites in the same year (Table 1). In general, about 20 nests are needed for an adequate estimate of nesting success (Hensler and Nichols 1981), and such sample sizes were obtained for most species (Table 1). Moreover, species with small sample sizes can be compiled across years.

We recommend that two study plots be established for each person searching for nests and he or she should work on these two plots for the entire nesting season. Nest-searching should be alternated between plots between days. This schedule allows consistent monitoring and allows the person to become familiar with the plot and identify "hot spots." In general, eight plots, each 40 ha in size, should be established in forest habitat to find adequate numbers of nests for most species coexisting in any given forest, but smaller plots can be established if studying habitats with higher densities. This design fits in the national Breeding Biology Research and monitoring Database (BBIRD) administered by Martin.

Nest finding should begin early, as soon as territories are established. Non-migratory species generally are more variable than migrants and may initiate breeding considerably earlier in some years (e.g., Geupel and DeSante 1990). Visits prior to nesting are recommended to ensure early nests are not missed in 'unusual' years. Once general chronology of nest initiation is known (after the first year), a general description of this chronology helps assistants to know species on which to focus early in the season.

Nest location during nest construction.—Nests located during construction provide the best estimates of nest success. Permanent residents and many ground-nesting species often begin the earliest. Only the female constructs the nest and incubates for most small terrestrial bird species in North America (Kendeigh 1952, Silver et al. 1985). Exceptions include woodpeckers (Picidae), vireos (Vireonidae), and wrens (Troglodytidae). Thus, the most effective way of finding nests is by locating and following females, although males may provide some cues (see later), and some nests in the shrub layer can be found by random search. Ground nests

TABLE 1. List of species and numbers of nests found in a single field season in Arkansas and Arizona using teams of four and seven field assistants, respectively.

Arkansas		
Yellow-billed Cuckoo	*Coccyzus americanus*	13
Acadian Flycatcher	*Empidonax virescens*	51
Wood Thrush	*Hylocichla mustelina*	40
Red-eyed Vireo	*Vireo olivaceus*	51
Black-and-white Warbler	*Mniotilta varia*	19
Ovenbird	*Seiurus aurocapillus*	14
Worm-eating Warbler	*Helmitheros vermivorus*	16
Hooded Warbler	*Wilsonia citrina*	67
Indigo Bunting	*Passerina cyanea*	30
Arizona		
Acorn Woodpecker	*Melanerpes formicivorus*	8
Red-naped Sapsucker	*Sphyrapicus varius*	30
Williamson's Sapsucker	*Sphyrapicus thyroideus*	32
Hairy Woodpecker	*Dendrocopus villosus*	10
Downy Woodpecker	*Dendrocopos pubescens*	8
Northern Flicker	*Colaptes auratus*	26
Cordilleran Flycatcher	*Empidonax difficilis*	36
Mountain Chickadee	*Parus gambeli*	45
Pygmy Nuthatch	*Sitta pygmaea*	24
Red-breasted Nuthatch	*Sitta canadensis*	26
White-breasted Nuthatch	*Sitta carolinensis*	14
Brown Creeper	*Certhia familiaris*	22
House Wren	*Troglodytes aedon*	83
Hermit Thrush	*Catharus guttatus*	74
American Robin	*Turdus migratorius*	24
Ruby-crowned Kinglet	*Regulus calendula*	14
Warbling Vireo	*Vireo gilvus*	58
Orange-crowned Warbler	*Vermivora celata*	71
Virginia's Warbler	*Vermivora virginiae*	34
Yellow-rumped Warbler	*Dendroica coronata*	45
MacGillivray's Warbler	*Oporornis tolmiei*	9
Red-faced Warbler	*Cardellina rubrifrons*	21
Western Tanager	*Piranga ludoviciana*	39
Black-headed Grosbeak	*Pheucticus melanocephalus*	7
Green-tailed Towhee	*Pipilo chlorurus*	24
Dark-eyed Junco	*Junco hyemalis*	46

in forests are usually the most difficult to find and ground-nesting species are poorly studied (Martin 1992, 1993a). Yet, this group is thought to be particularly area-sensitive and good indicators of habitat disturbance (Martin 1993a, Whitcomb et al. 1981). Thus, special efforts should be made at locating and monitoring ground-nesting species.

Females tend to be extremely furtive during nest building. Mated females may be recognized by copulation events during latter stages of building or by observing that they move about the territory unharassed by the male. Any non-mated bird, especially an intruding male, is normally attacked immediately. Any female observed should be checked with binoculars, especially after long flights across the territory, to determine whether nesting material is being carried. Nest material may not be obvious. For example, species such as Yellow-rumped Warblers (*Dendroica coronata*) and Wrentits (*Chamaea fasciata*) collect spider webbing, which is only observable as a small white spot after careful examination of the bill (Martin and Geupel, pers. obs.). Similarly, many birds carry fine materials for lining nests, and these materials are not obvious upon casual inspection.

Sitting near sources of nesting material (i.e., failed nests, thistles) or open areas with a good view of the territory can help detection of nest-building females. Different paths across plots should be used on each visit to increase the probability of randomly encountering females near undiscovered nests. Follow a bird carrying nesting material from a distance to avoid disturbance. Do not interrupt a long flight. If the bird disappears, begin to scan for potential nest sites. Be patient and wait for another visit, being careful not to interfere with her behavior. If the female disappeared near the nest, she will spend time in the area. Remain aware, however, that she may also move out of the back side of the patch to a different patch that contains the nest.

Some birds tolerate nearby observers and behave normally, but most are very wary of observers. If the observer is too close to the nest, the bird often will sit on a perch and eventually drop the nesting material if the observer does not move away. The observer should move quickly and quietly in the opposite direction from which the bird came. Obtain a new hiding position at least 15 m away and watch the female take nesting material several times and leave without it. Stay alert to the possibility that the female may enter one patch and then surreptitiously move among patches only to return the same way to give the appearance of nesting in the first patch. Some species such as MacGillivray's Warblers (*Oporornis tolmiei*), Hooded Warblers (*Wilsonia citrina*) and Sage Sparrows (*Amphispiza belli*) will walk on the ground for several meters to approach the nest secretly. Species that nest off the ground can often be detected as they move through a thick patch of vegetation by watching the vegetation move. Verify the nest status and location a few hours later, being careful to make sure the female is not present. Later visitation is recommended because usually the female has become aware of observers during their nest-finding activities.

Nest location during egg-laying.—The most difficult stage for finding nests is during egg-laying because the female may visit the nest only when she lays an egg and most songbirds lay one egg per day. In cold climates, the female will sometimes sit on the nest during egg-laying when weather is particularly harsh. Also, nest visitation becomes more frequent with increases in numbers of eggs laid (Kendeigh 1952, Zerba and Morton 1983). One means of finding nests during egg-laying is by carefully observing female and male behavior. When either parent gets near the nest, it will look at the nest. If an egg-laying female detects a predator in the area, such as an observer following her, she will sometimes check the nest by looking down at it repeatedly. A good cue is a female staying in an area without actively feeding.

Finally, copulatory behavior can be used to detect nests during both nest-building and egg-laying. Copulation often occurs in the same tree above a nest, on the same branch, or in the next tree. Carefully examine the area immediately adjacent to any copulatory activity observed.

Nest location during incubation.—When females suddenly "vanish" and males increase the frequency of singing, females have probably initiated incubation. An increase in female foraging speed also indicates the onset of incubation. Females forage at slower speeds prior to incubation (during pre-construction, nest construction, and egg-laying) than during incubation and nestling stages. Females that are moving obviously fast (e.g., rapid hops, quick short flights, rapid wing flicks) should be carefully followed because they will return to the nest soon; on average, female passerines stay off the nest for 6–10 min and on for 20–30 min at a time across species (e.g., Nice 1937, Southern 1958, Zerba and Morton 1983).

Detection of incubating females can be accomplished in two ways. First, females can be encountered by constantly moving through the study plot, but constant alertness is imperative. Sometimes, sitting down in a spot for 20–30 min is useful because incubating females will leave the nest in that period. Second, females can be detected by call notes. Females of many taxa (e.g., Silviidae, Parulinae, Emberizinae) chip or call when they are off the nest. The female begins chipping just prior to leaving the nest or as soon as she is off it. Some taxa such as emberizid finches and icterines give a unique nest departure call when leaving the nest (McDonald and Greenberg 1991). If a vocalizing female is detected and then lost during the course of following her, immediately return to the point of original detection because it is often near the nest and the female can often be relocated before getting back on the nest.

Males can also be of some help. First, males often will respond to females when they leave the nest and either quietly guard the nest (e.g., Gray Catbird, *Dumetella carolinensis*; Slack 1976), or the female. Detection of a quiet male may indicate presence of a foraging female or a nest somewhere near him. Second, males will feed incubating females for a great array of species, particularly cavity-nesting birds, but for many open-nesting birds as well (Lyon and Montgomerie 1987, Silver et al. 1985, Martin and Geupel, unpubl. data). Any birds (male or female) observed should be checked for material in their bills because they potentially could be building nests, feeding females or feeding young. Finally, males of some species (e.g., Chestnut-sided Warbler, *Dendroica pensylvanica*) use favorite singing perches that are in direct view of the nest (Martin, pers. obs.). The nest can be located by following his line of sight.

Females are fairly tolerant of people following while they forage. The female is more cautious as she returns to the nest. A relatively long flight after foraging is probably a return to the nest and is often along the same route. Quickly running in her direction for about 25 m may often allow resighting because the disturbance will keep her from returning to the nest. If she is near the nest, but cautious about approaching, she will display nervous displacement behavior. This "nest dance" involves bouncing back and forth between a few trees or substrates, and in some cases also includes very rapid foraging. Eventually, she will start to move down toward the nest and then suddenly fly back up. This behavior will be repeated several times in the course of a few minutes. If the observer is too close to the nest, the bird will continue to bounce back and forth between substrates and will sometimes fly off for a short time, only to return within a few minutes. The observer should back off and watch her with binoculars and she will then return to the nest. If the work is being conducted in cold conditions, do not keep her off the nest for more than 15 min because the eggs can chill to lethal levels. If the female has been followed for more than 30 min and has not disappeared or exhibited displacement behavior, then she probably does not have a nest. Of course this "30-min rule" does not apply to species where both sexes incubate.

If a female disappears into a tree or shrub, memorize the area where the female disappeared and choose potential nesting sites before approaching. Moving quietly, begin tapping potential nest shrubs in this area with a stick. Listen for the flush of the female off the nest. Watch for the female or the "nest dance." Note that spotting the female will confirm that the nest is nearby. If the nest is not found and the female is not observed leaving, then there is no confirmation that a nest is in the area. Because the nest is in a fixed location, the site can be revisited for careful searches in the future.

In many species, nest site preference seems to be an evolutionarily conservative trait (Martin 1988a, 1992, 1993c). Many birds prefer to nest in or under certain plant species or patch types that differ among bird species (Geupel 1993, Martin 1993c, Martin and Roper 1988). Familiarity with nest substrate and patch preferences can help in finding nests. Describe and visit nest locations from previous years to aid new observers in finding nests.

Nest location during the nestling stage.—Finding nests during the nestling period is easiest because both males and females commonly bring food to the nestlings and remove fecal sacs. Males are normally the easiest to follow because they are generally less cautious than females in approaching nests. Nests can usually be found from a greater distance using binoculars because of the constant activity of the parents.

Knowledge of the nesting cycle allows an observer to anticipate when to start looking for a new nest. Most species will renest following a nesting failure, although the number of nesting attempts or renesting intensity varies within and among species (Geupel and Desante 1990, Martin and Li 1992). Reconstruction begins almost always at a new site within 10 d and the new nest is likely to be farther away from the previous nest the earlier in the nesting cycle that failure occurred (citations in Martin 1992). Multi-brooded species may begin another nest in as little as 8 d after fledging a prior nest. Sometimes the female will begin nesting while the male is still tending the fledglings of the previous brood (Burley 1980, Smith and Roff 1980).

Nest finding can be a difficult and frustrating task; patience is the most important asset. An observer should set a goal of trying to find at least one nest every day. More than one nest will be found on many days, but if at least one nest can be found each day the numbers of nests obtained over the season will accumulate and frustration will be minimized.

NEST MONITORING

Each nest found should be checked every 3–4 d to determine if it is still active (with eggs or young) or has failed. Except just after egg-laying and near hatching and fledging events, it is not necessary to check the nest contents. Instead, check the nest from a distance; if an adult is on the nest, do not flush it. Careful and highly conscientious attention to checking nests is critical for data quality because the number of days that nests are observed with eggs or young is used to calculate daily mortality rates, the most effective measure of nest success (Hensler and Nichols 1981; Mayfield 1961, 1975). Moreover, nesting outcome is difficult to determine with increasing length of time between nest checks and variation at this stage can bias estimates of nest success. The fledging date should be identified as the date of the last visit on which nestlings were observed in the nest. Do not extrapolate past the last date that young were observed except when the average nesting cycle duration is used to determine the fledging date from the known initiation date. Otherwise, an upward bias on Mayfield estimates occurs. Prior to the field season, a sheet of information that summarizes the general clutch size, length of the incubation period, and length of the nestling period for every species that occurs on the study sites should be prepared. This information aids anticipation of hatching and fledging events.

Flagging or other visible markers can increase risk of predation (Picozzi 1975) and, hence, should be used with caution. When possible, memorize the area and write a description of how to find the nest using compass bearings and distance estimates (paces) from obvious landmarks or flagging placed greater than 10 m from the nest. Another solution is to grid permanently all study plots with numbered stakes at 25 or 50 m intervals depending on the density of the vegetation; 25 m intervals are usually best (see Ralph et al. 1993 for information on establishing permanently marked plots). Nest location can be described from these permanent markers.

Nest cards are used to record data about the nest site and nest activity. The Cornell Laboratory of Ornithology (159 Sapsucker Woods Rd., Ithaca, New York 14850) maintains a national nest card database and, thus, their card or some similar variant should be used. All observations of nests should be recorded on the nest card, including visits when no activity was noted. Noting lack of adult activity is particularly critical for canopy or cavity-nests where nest contents cannot be checked. All this information is needed for calculating nesting success (see also Bart and Robson 1982). Recorded information should include date, time, presence of adults and activity of adults (e.g., incubating, feeding young, flushed from nest). Also, any time the nest is approached close enough to see the contents, they should be noted on the nest cards (number of eggs, or number and age of nestlings). Age of the nestlings helps determination of nest fate in some cases by providing information on length of time that nests were active. Also, data should be summarized by success at each nesting stage (egg-laying, incubation and nestling) and, thus, accurate records of these stages are needed. When possible, data should include date of first egg, clutch completion date, hatching date, day of banding (if banded) and fledging date. Careful and detailed observations should be recorded if a nest predation event is observed in action. If the nest appears inactive based on observations from a distance, it should be approached to verify mortality. In the case of canopy nests, mirrors attached to telescoping poles (we use window-washing poles) can be used to check nest contents of nests up to 10 m off ground. If the nest appears depredated (eggs or young removed) then check the nest structure and immediate area around and under the nest for evidence of predation. Look for holes in the bottom of the nest cup. Any evidence (e.g., shell fragments, hole in nest, nest torn up) should be fastidiously noted on the card. When the young fledge, they commonly perch on the side of the nest thereby flattening the nest and they leave fecal droppings in the nest or on the edge or ground and such should be noted as possible evidence of successful fledging. When a nest is thought to have fledged, however, observers should try to verify by watching for fledglings or parents feeding fledglings or by hearing parents giving alarm or distress calls or young begging. This activity usually occurs near the nest site because fledglings often do not move very far in the first couple of days. Some species such as Rufous-sided Towhees (*Pipilo erythrophthalmus*), however, may move as far as 100 m in less than a few hours. Care must be exercised in classifying nest fate because some species or individuals may carry food up to 24 h or longer after predation of their nest. This behavior may be exacerbated by unrelated fledgings from neighboring territories. Descriptive confirmatory evidence of fledging should be noted on the nest cards.

PRECAUTIONS FOR MINIMIZING HUMAN-INDUCED MORTALITY

Locating and monitoring nests have the potential to reduce nest success (Gotmark 1992) but with proper precautions such biases can be eliminated or minimized (Martin and Roper 1988, Nichols et al. 1984, Willis 1973). Some investigators use camouflage netting over their heads or attached to camouflaged hats to reduce disturbance to birds. Initial location of the nest normally creates the most distress to adult birds and disturbance to the nest site because subsequent visits are brief. Some evidence suggests that predation rates are higher on the first or early visits than subsequent visits (Bart 1977, Nolan 1978, but see Bart and Robson 1982), perhaps caused by the disturbance during locating the nest. Therefore the following guidelines are suggested when attempting to locate nests. (1) Distress calls by adults should be minimized and never allowed to continue for over 5 min. (2) Do not approach a nest when any potential nest predator, particularly a visually-oriented predator (e.g., corvid) is present. (3) Minimize disturbance to the area around the nest. (4) Do not get close to nests during nest building; birds will abandon if disturbed prior to egg-laying, particularly during the early part of a season.

To lower the probability of predation or brood parasitism during checks, we recommend the following precautions. (1) Check the nest from as great a distance as possible. Use binoculars to see the female or contents of the nest or get on logs and look from above into the nest when possible to minimize proximity and disturbance near the nest. (2) Disturb the birds and area as little as possible. Move to nests in different paths on subsequent visits and use a path that is quick, quiet and that minimizes disturbance to the vegetation; paths in the vegetation from broken stems or smashed grass/forbs can cue possible predators. Never leave a dead end trail to the nest. Do not return on the same path but continue walking in a different direction away from the nest. If avian predators are common, check other bushes without nests. Always assume a predator is watching. (3) Be quick and accurate during nest checks and nestling banding. If the nest must be approached, minimize the amount of time spent near the nest examining the contents because the more time spent at nest the more scent that is left for olfactory predators. (4) Minimize the number of observers visiting the nest (no photographers). (5) Use a pen or stick to check nests to prevent human scent from being left on or near a nest.

VEGETATION MEASUREMENT

As soon as a nesting attempt terminates (successful or unsuccessful), complete the nest card and then measure the vegetation associated with the nest. Be careful at the beginning of the season (May to early June), as an empty nest may not have had eggs laid yet; some species or individuals will delay as long as 8 d between completing nests and laying eggs. Do not bother nests at this stage, unless it is certain a nesting attempt was made and failed.

Vegetation should be measured for the nest substrate and surrounding patch. Vegetation in the patch surrounding the nest can provide information on microhabitat choices. Species that choose the same plant species as a nest substrate may choose different microhabitat types (Martin 1993c, unpubl. data). Moreover, vegetation in the habitat patch surrounding a nest may exert a strong influence on probability of mortality. For example, numbers of potential nest sites (stems of the same size and plant species as used for the nest) in the patch surrounding the nest may affect predation risk (Martin 1988c, 1992, 1993c; Martin and Roper 1988). Hence, determination of habitat patch preferences is important for developing land management guidelines and testing habitat selection theories. Comparisons of nest patch characteristics to unused patches or to patches used across the range of species may provide important insight into habitat preferences (e.g., see James et al. 1984; Knopf et al. 1990; Martin 1988c, 1992, 1993c; Martin and Roper 1988). Standardized vegetation sampling methods should be used to allow comparisons among locations and investigators. Details of the vegetation sampling protocols used by the national BBIRD program are available from Martin upon request.

In conclusion, nest-monitoring plots can provide valuable data on the habitat influences on nesting productivity and possible causes underlying population trends. Constant-effort mist-netting schemes can provide an index of annual productivity (Ballie et al. 1986, DeSante and Geupel 1987) and also some information on adult and juvenile survivorship. These methods, however, do not necessarily provide information on the types of habitat conditions that facilitate increased nesting productivity. Nest-monitoring is more labor-intensive but provides direct information on both productivity and habitat conditions that facilitate maintenance of viable populations, thereby providing direct land management information. Moreover, nest-monitoring is the only way to ascertain the rate and consequences of cowbird parasitism. Finally, nest-monitoring provides badly needed data on life history traits of species, which allows identification of bottlenecks in the demography of species and, also, when taken together with nesting success may provide important insight into vulnerability of populations to disturbance (see Martin 1993a).

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