Survival and Nesting Success of Late Winter Wild Turkey Introductions

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Abstract: During late winter 1988 and 1989, 18 radio-marked eastern wild turkey (*Meleagris gallopavo sylvestris*) hens released into Natchez Trace State Park, Forest and Wildlife Management Area (Natchez Trace), and 20 radio-marked Natchez Trace (resident) hens released at the capture site were monitored continuously throughout the nesting and brooding season. Introduced turkeys experienced greater mortality than residents, especially during the 30-day period following release ($P < 0.05$). Introduced birds displayed more frequent and greater daily movements than resident hens. Spring home ranges of introduced hens were larger ($P = 0.02$) than residents. During the initial nesting season, released birds had fewer nesting attempts, renesting attempts, nests to completion, and lower recruitment rates than resident hens ($P < 0.05$). In their second post-introductory season, introduced hens had a higher nesting success rate than in the previous year and higher recruitment rates than second-year residents ($P < 0.05$). Our data suggest that habitat unfamiliarity contributes to mortality and lower reproductive rates in late-winter transplanted turkeys.

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In recent years, many state and other conservation agencies have undertaken efforts to restore eastern wild turkey throughout its historical range (Gilpin 1959, Johnson 1959, Lewis 1959, Preston 1959, Dickneite 1973, Wise 1973, Boyd and

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Ogelsby 1975, Little 1980, McMahon and Johnson 1980, Carroll and Thompson 1986, Miller 1990). Releasing wild birds into suitable habitat appears the most efficient and effective means of establishing or supplementing turkey populations (Wunz 1973). Most facets of wild turkey restoration have been investigated, particularly the mechanics of trapping and releasing turkeys (Bailey et al. 1980). More recently, criteria and guidelines for release priorities were established (Backs and Eisfelder 1990). Still, many wild turkey restoration endeavors are unsuccessful (Prestwich 1977, Mayer 1982).

Few studies have evaluated the behavior and activities of transplanted wild turkey in new habitat (Bowman et al. 1979, Little 1980, Little and Varland 1981, Carroll and Thompson 1986), including factors affecting their survival (Miller et al. 1985, Miller 1990). Clearly, mortality of transplanted wild turkey and restoration success are closely linked to single and cumulative effects of various stress factors (Miller 1990).

We examined the effectiveness of late-winter introductions by comparing behavior, survival and reproductive success of introduced hens to resident hens. Specifically, we tested the following hypotheses: introduced and resident hens behave similarly following capture and release; introduced and resident hens experience similar survival; nesting success and recruitment of introduced and resident hens are similar.

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Methods

Natchez Trace consists of 17,574 ha of oak-hickory (*Quercus-Carya*) and upland pine (*Pinus* spp.) forests located within portions of Carroll, Henderson and Benton counties in western Tennessee. The topography is rolling hills interrupted by abrupt ravines and other large drainages. Elevation ranges from 127 to 216 m above mean sea level. The soil is highly erodable, especially in the absence of ground cover vegetation.

Annual precipitation varies considerably and averages 128 cm (NOAA 1988). In 1988, monthly precipitation ranged from 28.1 cm in November to 0.1 cm in June, totalling 144.5 cm for the entire year. During 1988, the average annual temperature was 15.6 C. Monthly mean temperatures ranged from 1.8 C in January to 27.4 C in August.

Forest communities represent a mix of upland hardwoods and pine and bottomland hardwoods. Dominant overstory species include southern red oak (*Quercus falcata*), scarlet oak (*Q. coccinea*), hickory and pecan (*Carya* spp.), American beech (*Fagus grandifolia*) and loblolly pine (*Pinus taeda*). Tulip-poplar (*Liriodendron*

tulipifera) and sweetgum (*Liquidambar*) styraciflua) occur at lower elevation along wetter sites. A more detailed description of the study area is presented by McGuiness (1989).

Capture, Handling, and Marking Birds

Hens were captured with a 12.2 × 18.2 m cannon net as described by Bailey et al. (1980), Austin (1965), and Austin et al. (1972). Introduced and resident hens were similarly handled except for transport of introduced birds to the release site. Each bird's age and sex were determined (Williams 1961, 1981), and each were weighed, banded with a numbered, aluminum leg band (National Band and Tag Company, Newport, KY), and marked with numbered ALLFLEX button tags (Vet Brand, Inc., Torrance, Calif.) in the patagium of both wings. Also, turkeys were fitted with a motion-sensitive, ≤100-g radio-transmitter using a backpack configuration and were released. Following a 2-week period of habituation, turkeys were located at least 3 times/week (except during nesting when birds were located daily). Each turkey was located in 1 of 5 defined daily activity periods (Smith and Teitelbaum 1986). The rotation was repeated whereby all hens were located ≥5 times within all possible activity periods throughout each season. A minimum of 25 locations was used to compute seasonal home range. For ≥75% of turkey locations, the hen was approached until signal quality and intensity indicated the bird was within about 100 m. Locations were obtained by visual verification or triangulation and plotted on individual U.S.G.S. topographic maps (scale = 1:15,580). Observations were digitized with a Calcomp 9100 into ARC/INFO (Environ. Systems Res. Inst., Inc., Redlands, Calif.), a mapping-database (GIS) management system installed on a MicroVAX II computer. Date, time, habitat type, group composition (number of birds, sex, and age), and activity also were recorded. ARC/INFO was used to generate state plane coordinates to compute smallest convex polygon home range estimates (Harestad 1981) and centers of activity (Smith and Teitelbaum 1986) for birds with ≥25 locations (Jennrich and Turner 1969). Clutch size was determined from nest inspection; poults produced and recruitment were determined from number of eggs hatched and from field observations, respectively.

Telemetry error was determined by calculating 95% confidence arcs (Lee et al. 1985) from 14 randomly selected transmitters placed at known locations. Chi-square analysis was used to determine if each of the nesting parameters contributing to reproductive success (e.g., hatching rate, recruitment) were different between introduced and resident hens. The Mann-Whitney 2-sample test (Zar 1984) was used to compare home ranges of introduced and resident hens. The Lifetest Procedure (SAS 1985:529) was used to analyze post-release survival of resident and introduced hens. This procedure computed nonparametric estimates of the survival distribution and a ranks test for association from right-censored data, i.e., observations of individuals whose future are undetermined (e.g., transmitter failure), or from a study that was terminated before all test animals died (Kalbfleisch and Prentice 1980).

Although these data represent a relatively small sample of wild turkey, this study examines the dynamics of a typical eastern wild turkey introduction in the

southeast (Natl. Wild Turkey Fed. 1986). We attempted to obtain a replicate sample in 1989, but were unsuccessful because of a poor trapping season. We used nonparametric, or "distribution-free" statistics (Steel and Torrie 1980), to analyze data. These tests require only that data represent independent observations and generally result in more conservative conclusions, i.e., Type I error occurs less frequently (Steel and Torrie 1980). A probability of <0.05 was accepted as indicating statistical significance.

Results

On 28 January 1988, 15 hens (13 adults and 2 subadults) from Natchez Trace were captured, instrumented, and released at the capture site. Between 3 February and 10 February 1988, 14 hens (9 adults and 5 subadults) captured at Land Between-the Lakes (LBL), Tennessee, were released onto Natchez Trace.

In 1989, 5 resident (4 adults and 1 subadult) and 4 subadult LBL hens were released onto the study area 10 February and 20 February, respectively. All surviving birds were monitored continuously through August 1989 or until transmitter failure.

Post-Release Behavior and Survival

Movement and activity patterns of resident and introduced turkeys differed following release. Natchez Trace birds reestablished social groups within about 2 weeks following release and remained in winter flocks until nesting activities ensued (late March-early April). All residents remained within a 2-ks^2 winter range except for a single, 1-week foray (1.9 km).

In contrast, LBL birds remained solitary or in small groups, not exceeding 4 hens. Long-distance forays (1.4–4.8 km) were frequent and continued into the summer (July), long after the resident birds segregated and began nesting. One LBL hen wandered continuously, making daily movements of $\geq$2 km. One 2-week foray extended a straight-line distance of 12.4 km from the release site.

Sixty locations from 14 transmitters yielded a 95% confidence arc of $\pm 5.48°$ (Lee et al. 1985). At a distance of 0.5 km (i.e., typical greatest distance at which locations were obtained), this represents an area polygon of 0.82 ha/location, or $<0.2\%$ of 1988 average spring home range of resident hens.

Average spring home range of 1988 resident hens (467 ha) and introduced hens (2,004 ha) were different ($U^{4, 12} = 45$, $P = 0.02$). With 1 exception, introduced spring home ranges (526–5,072 ha) were twice that of residents (174–1,434 ha). Spring movements of resident hens were generally characterized by 1 long distance movement followed by the establishment of relatively small, well-defined spring and summer home ranges. Introduced hens shortened their daily movements during spring, but typically did not establish well-defined home ranges until summer. Data were insufficient to compute seasonal ranges of birds released in 1989.

Two resident adult hens died prior to nesting in 1988; 1 apparently died from cold stress (12 February) because of feather loss during capture and handling, and the second was illegally harvested (23 March). Thirteen (86.7%) resident hens

survived into the nesting period. A transmitter failed in April, and 2 hens were taken by canid predators in June leaving 10 resident hens to complete the 1988 nesting and brooding season.

Only 50% (7/14) of the introduced hens survived into the nesting period; 5 known mortalities occurred within 1 month following release. Between 3 February and 2 March 1988, 2 hens were taken by canid predators, 1 was illegally harvested, and 2 others were taken by avian predators (probably *Bubo virginianus* or *Strix varia*). We knew of 7 LBL hens that completed the nesting and brooding season (1 lost its transmitter and 1 transmitter failed).

Mortality rates of resident and introduced hens following release appeared to differ (Fig. 1) Clearly, within the first 2 weeks following release the survival rate of introduced birds (72%) was lower ($x^2 = 16.9$, d.f. = 1, $P < 0.005$) than resident hens (94%). Overall survival of introduced hens ($\bar{x} = 242$ days) may have differed (Lifetest Procedure, Wilcoxon Test, $P = 0.09$) from resident hens ($\bar{x} = 390$). Although median age at death was not different ($\bar{x}^2 = 1.69$, $P > 0.10$), median ecological longevity (Dapson 1971, Smith 1982) of resident hens was 464 days (Fig. 2) as compared to 191 days for introduced hens.

Reproductive Success

1988 Releases.—Ten of 13 resident and 3 of 7 introduced hens attempted to nest in 1988 (Table 1). Initially, 5 resident hens were successful; 3 of 5 remaining hens attempted a second nest and were successful. Eight hens produced 71 poults, of which 11 were recruited into the fall population. Only 1 introduced hen was

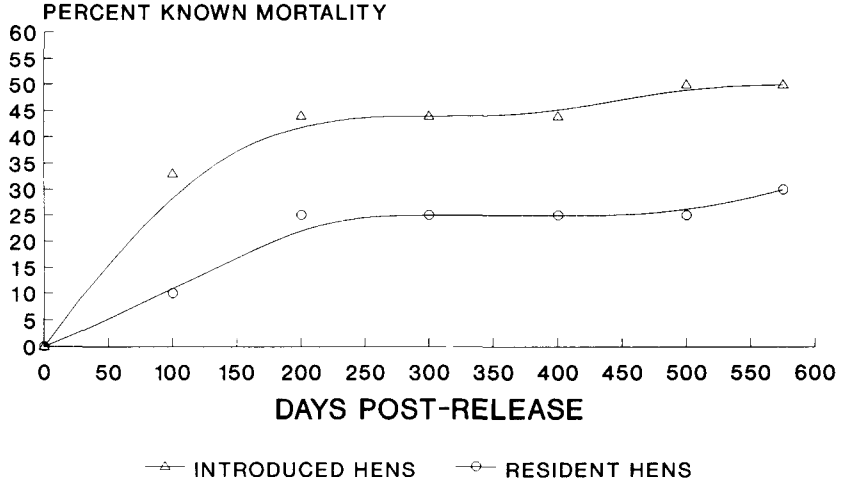

Figure 1. Cumulative known mortality of resident and introduced eastern wild turkey over 100-day intervals post-release, February 1988–August 1989, Natchez Trace State Park, Forest and Wildlife Management Area, Tennessee.

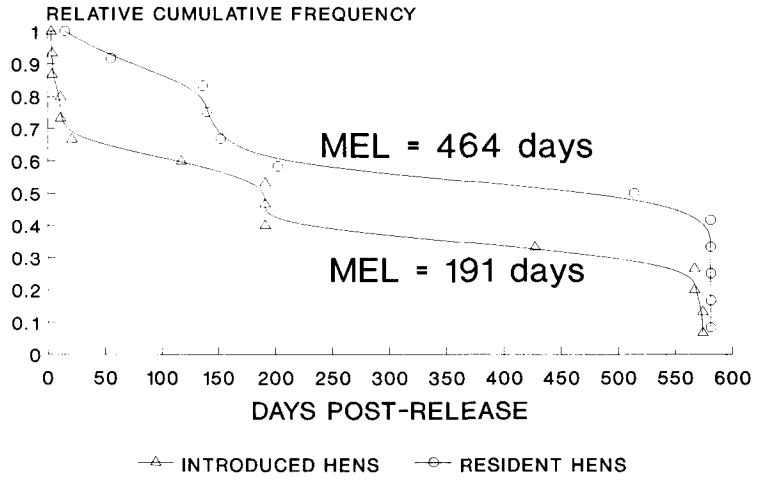

Figure 2. Relative cumulative frequency of mortality and corresponding Median Ecological Longevity (MEL) of resident and introduced eastern wild turkey following release onto Natchez Trace State Park, Forest and Wildlife Management Area, Tennessee, February 1988–August 1989.

successful initially. She produced 9 poults, of which 2 survived into the fall population. The other 2 introduced hens did not attempt to renest.

In their second year (1989), 3 of 5 known resident hens and 3 of 4 known introduced hens attempted to nest (Table 1). All initial nests were successful. One resident hen lost her initial brood and renested successfully. Five of 36 poults produced by resident hens survived into the fall population. Two introduced hens recruited 12 of 23 poults; a third recruited 7 poults (clutch size was undetermined).

In 1988, resident hen recruitment was responsible for a 20% net increase over

Table 1. Nesting success and poult recruitment for 1988 radio-marked resident and introduced eastern wild turkey, Natchez Trace State Park, Forest and Wildlife Management Area, Tennessee. (N = number of radio-collared hens; percentages are given in parentheses.)

Parameters	Resident hens				Introduced hens			
	1988, N = 15		1989, N = 10		1988, N = 14		1989, N = 5	
Initial nesting attempts	10	(77)	3	(60)	3	(43)	3	(75)
Successful nests	5	(50)	3	(100)	1	(33)	3	(100)
Renesting attempts	3	(60)	1		0	(0)	0	(0)
Successful renests	3	(100)	1	(100)	0	(0)	0	(0)
Poults produced	71		36		9		≥3[a]	
Poults recruited	11	(15)	5	(14)	2	(22)	19	(≤63)[a]

[a]Clutch size was undetermined for 1 hen that recruited 7 poults.

the initial captive sample; in 1989 recruitment essentially replaced losses. At the same time, introduced hens experienced a net 50% loss, as relatively poor recruitment did not compensate for heavy mortality in 1988. In contrast, only 1 mortality was documented for introduced turkeys in 1989 and recruitment averaged 6.3 poults/hen. This represents a 4.6-fold population increase (from 5 to 23 birds) by introduced turkeys in 1 reproductive season.

1989 Releases.—Three of 5 resident hens were known to survive into the nesting season. Only 1 hen attempted to nest; her 2 nest attempts were both unsuccessful. Three of the 4 introduced turkeys survived the nesting season. Two of the hens were unsuccessful in an initial nest attempt; 1 attempted to renest but was unsuccessful.

Discussion

High mortality (>50%) among transplanted wild turkeys frequently has been reported in the literature (Prestwich 1977, McMahon and Johnson 1980, Clark 1985, Carroll and Thompson 1986, Miller 1990). Most of this mortality occurs within the first month following release (Prestwich 1977, McMahon and Johnson 1980, Mayer 1982, Carroll and Thompson 1986, Miller 1990), even when annual mortality rates are relatively low (Hopkins 1981). First month mortality ranged from 72% of annual mortality (i.e., 22%) in Texas (Hopkins 1981) to 100% of known mortalities (50%) in Kentucky (Carroll and Thompson 1986). The greatest overall mortality occurred with late winter releases (Prestwich 1977, McMahon and Johnson 1980, Mayer 1982) and among birds carrying radio-transmitters (Carroll and Thompson 1986, Miller 1990).

Several factors have been identified as contributing significantly to the apparent higher mortality of translocated turkeys (Miller et al. 1985, Miller 1990). Little, if any, information exists regarding what portion of this mortality is related directly to stresses associated with capture and handling (Miller 1990), as compared to the role that habitat imprinting (*sensu* Thorpe 1945) or experience (Klopfer 1963) might play in influencing the behavior and fate of turkeys in an unfamiliar habitat. Ecological implications of disrupting imprinting and habitat recognition include energetic costs and efficiency (Miller et al 1985), reproductive and other physiological processes cued by the physical and social environment (Ketterson 1979), mate selection (Bateson 1979), genetic structure and diversity (Backs and Eisfelder 1990), and increased risk to predation (Carroll and Thompson 1986).

In our study, resident hens were used as a comparison group to control for capture, handling, and radio-marking. We examined movements, survival, and reproductive success of introduced birds to assess the relative influence of habitat unfamiliarity on the expected success of turkey introductions. During the first month post-release, introduced hen mortality was 33%, but only 5% for resident hens. Given that resident and introduced birds experienced almost similar circumstances (resident hens were not transported) prior to release, one can surmise that significant difference in mortality between the 2 groups was associated with behavioral changes or stress due to habitat familiarity or transport and not to capture or handling.

This conclusion is supported further by the more frequent and greater long-distance movements and home range of introduced hens as compared to residents. We believe, as did Miller et al. (1985), that increased movements were a direct result of habitat unfamiliarity, which in turn contributed further to higher predation rates during the initial period of the study. Also, added energetic costs of these movements, at a time when resources were scarce and weather more severe, probably reduced energy available for reproduction (Miller 1990). This may be evident in our study as only 1 introduced bird nested successfully during their first year (Table 1). As time progressed, habitat familiarity increased and predation decreased to levels similar to resident hens (Fig. 1). Moreover, once introduced birds became habituated to the new environment (over the period of a year) movements decreased and reproductive success increased significantly (Table 1).

In addition, we propose that moving turkeys out of their familiar environment during late winter may disrupt normal social behaviors (e.g., flocking) and physiological processes associated with reproduction. Even if energy is not limiting, nesting and brooding may be seriously compromised by inappropriate cues, timing, and other behaviors (Bateson 1979). Many introduced birds in this study continued to display extended movements long after most resident hens began nesting. Indeed, some introduced birds did not even attempt to nest.

Several environmental conditions coupled with the physiological responses of transplanted turkeys make it difficult for late winter releases to survive. Weight loss from stress (Miller 1990) and the added expenditure of energy associated with extensive movements following release occur during a period of high energy demand, low food availability, and little cover (Miller et al. 1985, Miller 1990). Combined with an apparent increased predation associated with post release and increasing energetic demands of nesting, the outlook for a successful introduction during late winter appears uncertain.

At a time when resource agencies are attempting to provide the maximum benefit from each management dollar, we need to increase efficiency and success of turkey introductions. One obvious solution to the problem is stress reduction. Miller (1990) reported that stress factors associated with transplanting turkeys affected survival and that reducing stress can enhance success of restoration efforts. Moreover, McFarlane and Curtis (1986) and McFarlane et al. (1989) found in laboratory studies that effects of simultaneous stressors are additive.

Even under the best circumstances, a minimum amount of stress will be associated with translocating turkeys. However, the added stress placed on introduced turkeys by the environment in late winter could probably be reduced in fall. Hens in the fall are presumably in better physical condition, and food, escape cover, and thermal cover are more readily available. In addition, the weather is milder and the released birds are afforded a longer period to habituate prior to the nesting season (Benner 1989). Finally, movements from summer to winter range typically occur during fall (David 1976) in response to changes in diet and food availability, and normally result in winter flock establishment.

Fall trapping turkeys is not without drawbacks. Foremost among these is

presumably high mortality related to capturing and handling young of the year, which make up a substantial portion of the flock. Also, fall trapping requires prebaiting during periods of increased hunter activity and probably subjects turkeys to increased risk to poaching. Finally, many state biologists and conservation officers are unavailable for trapping in fall because of other commitments.

We recommend that studies be conducted comparing the survival, movements, and reproductive success of fall and late winter introductions. Results from these studies should provide insight in determining how to increase the success rate of wild turkey introductions and supplemental stockings, thus maximizing the efficiency of wild turkey restoration efforts.

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