Merriam's Turkey Winter Survival on the North Kaibab Ranger District Following the Bridger Knoll Complex Wildfires

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Abstract. During the winter of 1996-1997, we studied the survival of 34 radio-marked Merriam's turkeys (*Meleagris gallopavo merriami*) on the North Kaibab Ranger District (NKRD) of the Kaibab National Forest following the Bridger Knoll complex wildfires. We studied these turkeys because food availability seemed limited and the fires had substantially altered part of the traditional turkey winter range. During winter 1996-97, adult female turkeys from NKRD had lower ($P < 0.001$) body weights at capture than those from other Arizona habitats. Adult female over-winter survival was greater ($Z = 3.901$, $P < 0.001$) than survival of subadult turkeys, but did not differ from mean adult female turkey over-winter survival in north-central Arizona ($Z = 0.861$, $P > 0.195$). On the NKRD, subadult turkeys experienced 10.4% over-winter survival while adult females experienced 66.2% over-winter survival. Turkeys experienced the greatest mortality during late January and throughout March, generally in conjunction with adverse weather conditions and increased snowfall. Limited food availability and deep snow negatively influenced turkey survival. Although this study was prompted by concerns about the wildfire effects on the NKRD, we believe that limited winter food availability would have resulted in depressed survival rates even if the wildfires had not occurred. Our study supports the contention that winter food availability is closely tied with turkey over-winter survival.

Key words: Arizona, food, *Meleagris gallopavo merriami*, Merriam's turkey, mortality, survival, winter

During late June 1996, several lightning-ignited wildfires merged and burned 217 km^2 on the Kaibab National Forest North Kaibab Ranger District (NKRD) (Fig. 1). These fires, known as the Bridger Knoll complex, burned across a substantial portion of traditional turkey winter range. Because turkeys select specific winter habitat characteristics (Rumble and Anderson 1993, Rumble and Anderson 1996a, Wakeling and Rogers 1996), have selective diets (Rumble and Anderson 1996b, Wakeling and Rogers 1996), and respond differently to various habitat changes (Scott and Boeker 1977, Wakeling et al. 1997), this large-scale alteration could affect the quality of the turkey winter range in two ways by: (1) changing physical habitat attributes, and (2) removing winter food sources.

During late fall 1996, observations on the unburned portion of the traditional winter range disclosed limited mast production and availability. Mast items are a critical component of turkey winter diet (Wakeling and Rogers 1996). The lack of available mast on NKRD suggested that turkeys using this range during the winter of 1996-97 might be nutritionally stressed.

We studied turkey survival on the NKRD during the winter of 1996-1997 to determine if seasonal survival would correlate with relative seasonal habitat quality. Eastern turkey (*M. g. silvestris*) populations in northern habitats where food is seasonally limited experience lowest survival rates during winter (Austin and DeGraff 1975, Wunz and Hayden 1975, Porter et al. 1980). Wakeling (1991) speculated that winter food availability might have the greatest influence on over-winter survival in the Southwest as well.

Our objective was to ascertain winter survival rates of turkeys among age and gender classes on the west side of the NKRD and relate those rates to nutritional status. Specifically, we tested hypotheses that body weights did not differ during winter capture efforts on the NKRD from turkey body weights during winter in other Arizona habitats, and that winter survival did not differ among age and gender classes on the NKRD and adult females studied by Wakeling (1991).

Study Area

Our study was conducted on 1,511 km^2 of the western portion of the NKRD of the Kaibab National Forest in northern Arizona (Fig. 1). Elevations ranged from 914 to 2,838 m. Great basin conifer woodland (45.8%), petran montane conifer forest (26.7%), petran subalpine conifer forest (13.8%), great basin desertscrub (12.4%), and subalpine grassland

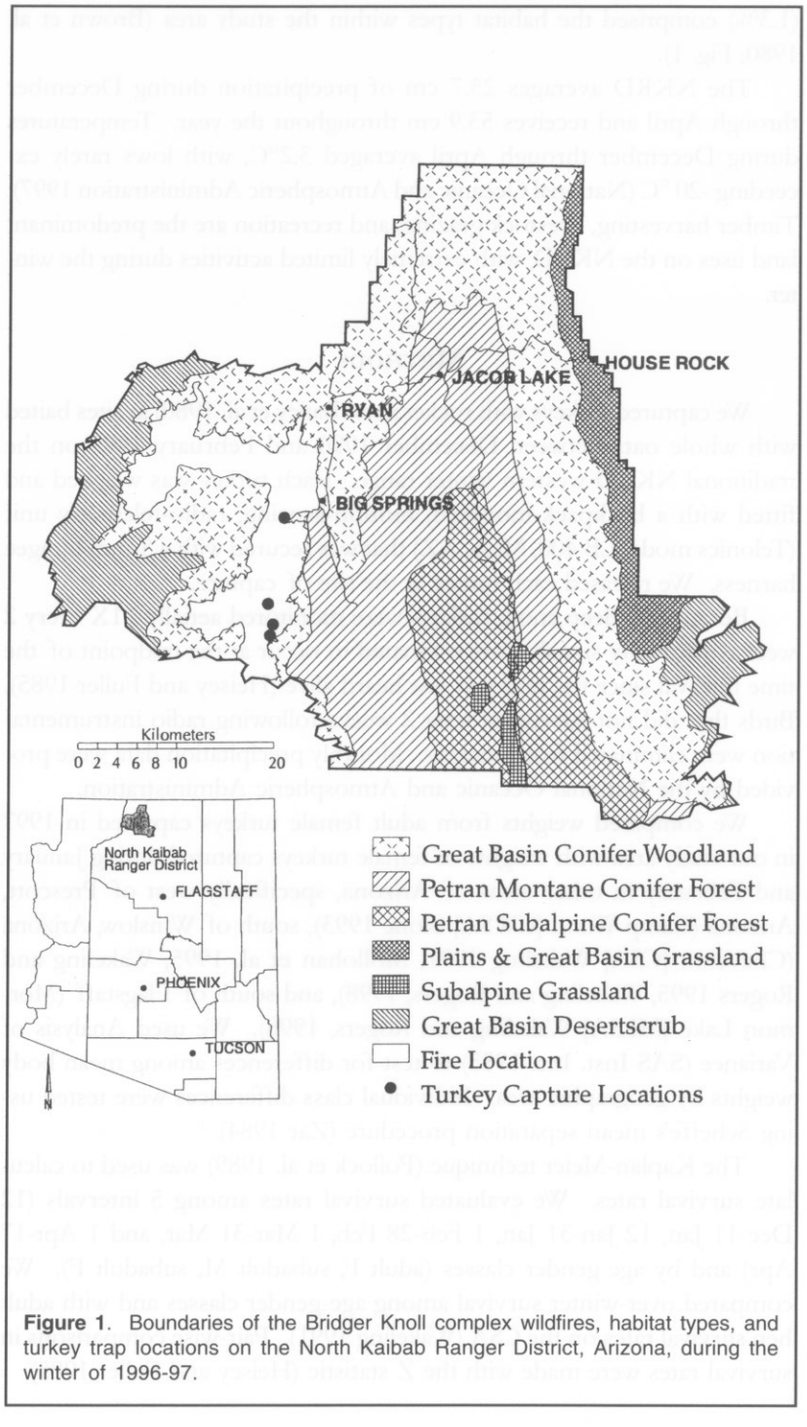

Figure 1. Boundaries of the Bridger Knoll complex wildfires, habitat types, and turkey trap locations on the North Kaibab Ranger District, Arizona, during the winter of 1996-97.

(1.3%) comprised the habitat types within the study area (Brown et al. 1980; Fig. 1).

The NKRD averages 25.7 cm of precipitation during December through April and receives 53.9 cm throughout the year. Temperatures during December through April averaged 3.2°C, with lows rarely exceeding -20 °C (National Oceanic and Atmospheric Administration 1997). Timber harvesting, livestock grazing, and recreation are the predominant land uses on the NKRD, with extremely limited activities during the winter.

METHODS

We captured turkeys with rocket nets (Bailey et al. 1980) at sites baited with whole oats between December 1996 and February 1997 on the traditional NKRD western winter range. Each turkey was weighed and fitted with a backpack-mounted, motion-sensing, radio-telemetry unit (Telonics model LB 400, Mesa, AZ) that was secured with a 5-mm bungee harness. We released each turkey at the site of capture.

Because of deep snow, turkeys were monitored aerially ≥1X every 2 weeks. Mortality signals were estimated to occur at the midpoint of the time interval since the bird was last heard alive (Heisey and Fuller 1985). Birds that did not survive at least 2 weeks following radio instrumentation were eliminated from analysis. Monthly precipitation data were provided by the National Oceanic and Atmospheric Administration.

We compared weights from adult female turkeys captured in 1997 in our study area with weights of female turkeys captured during January and February in other areas of Arizona, specifically west of Prescott, Arizona (Camp Wood [CWSA] Stone 1993), south of Winslow, Arizona (Chevelon [CSA] Wakeling 1991, Mollohan et al. 1995, Wakeling and Rogers 1995, Wakeling and Rogers, 1998), and south of Flagstaff (Mormon Lake [MLSA] Wakeling and Rogers, 1998). We used Analysis of Variance (SAS Inst. Inc. 1985) to test for differences among mean body weights by geographic area. Individual class differences were tested using Scheffe's mean separation procedure (Zar 1984).

The Kaplan-Meier technique (Pollock et al. 1989) was used to calculate survival rates. We evaluated survival rates among 5 intervals (12 Dec-11 Jan, 12 Jan-31 Jan, 1 Feb-28 Feb, 1 Mar-31 Mar, and 1 Apr-17 Apr) and by age-gender classes (adult F, subadult M, subadult F). We compared over-winter survival among age-gender classes and with adult hen survival rates on the CSA (Wakeling 1991). Pair-wise comparisons in survival rates were made with the Z statistic (Heisey and Fuller 1985).

RESULTS

We captured turkeys on 12 December 1996 (3 subadult M, 6 subadult F, 2 adult F), 12 January 1997 (9 subadult M), and 31 January 1997 (29 adult F). Fifteen birds died within 2 weeks of capture and were eliminated from analysis. Survival rates of subadult male and subadult female turkeys did not differ and were pooled for further analysis.

Turkey weights from birds captured on NKRD differed from those captured elsewhere. Specifically, adult female turkeys captured during January 1997 on the NKRD weighed less than female mean weights from elsewhere in Arizona ($F = 12.302$, $P < 0.001$; Table 1). No differences were detected among January and February weights from adult females captured in other Arizona habitats.

Survival of subadult turkeys on the NKRD decreased in conjunction with increased precipitation (Fig. 2). During the interval in which survival was lowest for both subadults and adults (1 Mar-31 Mar), the NKRD received a large amount of snowfall (which made the weather station inaccessible). During the interval in which subadults experienced the second lowest survival (12 Jan-31 Jan), several deep snowfalls also occurred. Six adult female, 10 subadult male, and 3 subadult female turkeys died during the study period.

Over-winter survival rates for adult females were higher than for subadult turkeys ($Z = 3.901$, $P < 0.001$; Table 2). Although substantially lower, over-winter survival rates for adult females on the NKRD did not differ significantly from those observed for adult females in north-central Arizona ($Z = 0.861$, $P > 0.195$; Fig. 3).

Table 1. Body weights, standard errors, and sample sizes of female turkeys captured during January and February on the North Kaibab Ranger District (NKRD), the Camp Wood study area (CWSA), the Chevelon study area (CSA), and the Mormon Lake study area (MLSA), Arizona.

Study Area	Weight (kg)[a]	SE	n
NKRD	4.04*	0.045	29
CWSA	4.50	0.103	19
CSA	4.51	0.039	119
MLSA	4.52	0.053	47

[a] Overall F ratio = 12.302, 210 df, $P < 0.001$, * denotes weight that differs from all others based on Scheffe's mean separation procedure.

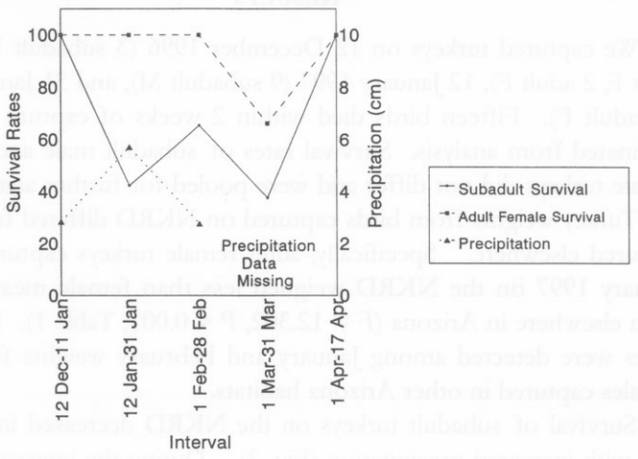

Figure 2. Monthly survival rates of adult female and subadult turkeys and precipitation on the North Kaibab Ranger District, Arizona, during the winter of 1996-97.

DISCUSSION

Over-winter survival influences population size. Turkeys suffered lower than average survival rates on the NKRD during the winter of 1996-97. The greatest mortality occurred in the subadult segment of the population, virtually eliminating an entire age cohort. Because yearling females in the Southwest rarely nest (Wakeling 1991), the removal of the yearling cohort will necessitate a two-year lag in the recruitment of addi-

Table 2. Merriam's turkey survival rates (95% confidence intervals) among age and interval classes on the North Kaibab Ranger District during the winter of 1996-97.

Class	12 Dec-11 Jan	12 Jan-31 Jan	1 Feb-28 Feb	1 Mar-31 Mar	1 Apr-17 Apr	Over Winter
Subadult (all)	100.0	42.4 (25.3-74.6)	65.5 (39.6-100.0)	37.7 (14.3-100.0)	100.0	10.4 (3.5-51.4)
Adult F	100.0	100.0	100.0	66.2 (48.7-92.2)	100.0	66.2 (48.7-92.3)

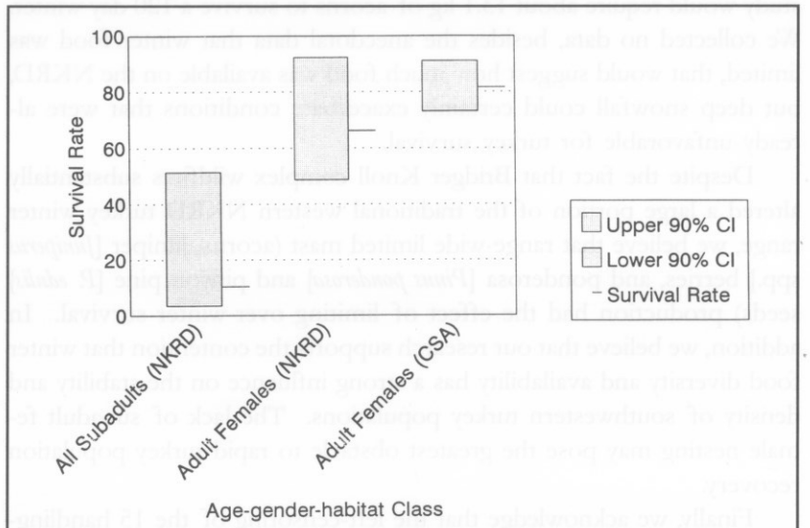

Figure 3. Over-winter survival of subadult turkeys and adult female turkeys on the North Kaibab Ranger District, Arizona (NKRD), during the winter of 1996-1997 and mean over-winter survival of adult female turkeys on the Chevelon study area, Arizona (CSA, Wakeling 1991).

tional breeding females into the population and will result in a substantial population fluctuation. Among-year fluctuations in turkey survival and populations are common (Wakeling 1991, Vangilder 1996), and depressed subadult survival may be common and responsible for observed fluctuations in turkey populations and recruitment.

Weight and survival appear to be influenced by food availability. Based on mid-winter body weights, adult female turkeys on the NKRD seemed to be nutritionally stressed. Hoffman et al. (1996) noted that subadult females with low body weights were less likely to nest and renest, demonstrating that weight affected productivity. Vangilder (1996) was only able to find a weak relationship between acorn production and fall survival on one of his study areas, but Wakeling (1991) suggested a stronger relationship between total mast production and subadult winter survival. Wakeling and Rogers (1996) speculated that winter food availability and diversity directly influenced the stability of turkey use of winter ranges.

Weather seems to have influenced food availability in our study area. Most mortality occurred in association with inclement weather, which may have covered meager food resources or driven turkeys into less suitable habitats. According to Haroldson (1996), an adult female in our

study would require about 13.1 kg of acorns to survive a 120 day winter. We collected no data, besides the anecdotal data that winter food was limited, that would suggest how much food was available on the NKRD, but deep snowfall could certainly exacerbate conditions that were already unfavorable for turkey survival.

Despite the fact that Bridger Knoll complex wildfires substantially altered a large portion of the traditional western NKRD turkey winter range, we believe that range-wide limited mast (acorns, juniper [*Juniperus* spp.] berries, and ponderosa [*Pinus ponderosa*] and pinyon pine [*P. edulis*] seeds) production had the effect of limiting over-winter survival. In addition, we believe that our research supports the contention that winter food diversity and availability has a strong influence on the stability and density of southwestern turkey populations. The lack of subadult female nesting may pose the greatest obstacle to rapid turkey population recovery.

Finally, we acknowledge that the left-censoring of the 15 handling-related mortalities, while prudent to control α and Type I errors, may have been unnecessarily restrictive. The proportion of handling-related mortalities in our study was greater than we have encountered in similar studies (Wakeling 1991, Mollohan et al. 1995, Wakeling and Rogers 1995) and may reflect unfavorable environmental conditions rather than handling-related mortality. This conservative approach may have artificially inflated survival rates. Had censoring not been necessary, more and larger differences in survival rates might have been observed. Resource managers should recognize the trade-off between Type I and Type II errors in our study and expect the possibility of greater mortality rates than we reported during winters of poor food availability.

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