

NORTHERN BOBWHITE AND RED IMPORTED FIRE ANT INTERACTIONS IN THE TEXAS COASTAL PLAINS

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ABSTRACT

Observations of interactions between red imported fire ants (RIFA; *Solenopsis invicta* Buren) and wildlife, including Northern bobwhite (*Colinus virginianus*) have led to widely disparate views. We discuss the current experimental evidence that is available concerning the impacts of RIFA on northern bobwhite and suggest future directions for research.

INTRODUCTION

The introduction, life history, and spread of red imported fire ants (RIFA; *Solenopsis invicta* Buren) into North America has received significant attention (Vinson 1997), in part because of the significant damage this species can cause. RIFA can cause a multitude of problems including crop destruction (Brinkley 1989), damage to electrical transformers (Vinson and Sorenson 1986), and serious injury to humans (Lockey 1979). Observations of such damage have led to much speculation about the impacts of RIFA on wildlife. It is intuitive that ground-nesting animals, such as northern bobwhite (*Colinus virginianus*), must encounter RIFA. Some observers have concluded that immobile animals near RIFA colonies, such as hatching northern bobwhite chicks, are likely to be killed. Others have observed relatively dense northern bobwhite populations in areas occupied by RIFA and concluded that RIFA must not limit northern bobwhite populations. These observers concede that RIFA cause mortality of some chicks in the population, but this mortality rate is not sufficient to cause northern bobwhite populations to decline below limits set by other factors (e.g., predation by vertebrates, food limitation, drought). Are either of these explanations correct? We must use experimental evidence if we wish to understand how RIFA can impact northern bobwhite. We examine evidence available in the literature and that revealed by our research activities during participation in the Texas Imported Fire Ant Research and Management Plan.

EVIDENCE IN THE LITERATURE

Allen et al. (1995) detected a pattern between northern bobwhite declines in Texas and RIFA infestation. They found that initial northern bobwhite declines in Texas counties were correlated with the timing of each county's invasion by RIFA. RIFA could be causing northern bobwhite populations to decline. This explanation, however, could be misleading. If RIFA indeed cause northern bobwhite populations to decline, then removal of RIFA

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should halt the decline or cause an increase. Allen et al. (1995) performed an experiment to test this prediction in the Texas Coastal Plains. Northern bobwhite density more than doubled on areas treated with an insecticide designed to kill RIFA, as compared to nontreated areas. This experiment provided evidence that RIFA can limit northern bobwhite population size.

The experiment of Allen et al. (1995) provided evidence that RIFA can limit northern bobwhite populations. If this is the case, what is the mechanism? Several pieces of evidence suggest mechanisms by which RIFA limit the number of chicks that survive to become a member of the fall population. Northern bobwhite populations fluctuate primarily due to their differential success at reproducing each year (Roseberry and Klimstra 1984). Given the right conditions, northern bobwhite populations can grow quickly, because hens can lay an average of 14 eggs per nest and can renest following nest destruction or success when conditions are favorable during the reproductive season (Mueller et al. 1999). Artificial nest studies have demonstrated that foraging RIFA can recruit to northern bobwhite eggs and kill unhatched chicks (usually all chicks in the nest) by entering the egg through a cut made by the chick as they attempt to exit the egg (Allen 1993). Other studies have demonstrated that RIFA can sting hatched chicks a sufficient number of times to decrease foraging time, impair vision and locomotion because of swelling, and even directly kill them (Pedersen et al. 1996, Mueller et al. 1999). Chicks that have reduced vision and locomotion would be less able to escape predators and keep up with the rest of the brood and the hen. Chicks that cannot keep up with the rest of the brood the first few weeks of life will almost certainly die because they cannot regulate their own body heat and must be protected by the hen from cold temperatures (Blem and Zara 1980, Choi and Bakken 1991). Reduced chick foraging time could lead to reduced body growth and development (Schew and Ricklefs 1998). RIFA may also reduce growth and development of northern bobwhite chicks by directly competing with them for food. Chicks require a high protein diet early in life (Serafin 1982). This means chicks must eat insects, because they are one of the richest sources of protein available (Robel et al. 1995, Dabbert et al. 1996). Entomologists have found a reduced density and diversity of insects in areas inhabited by RIFA as compared to areas not inhabited by RIFA (Porter and Savignano 1990). This body of information provides evidence of possible mechanisms by which RIFA may reduce the number of northern bobwhite chicks that survive to enter the fall population.

A FIELD EXPERIMENT

Our research team initiated an experiment in 1997 to compare hatching success and survival rate between broods that hatched from nests protected from RIFA using an insecticide and controls (Mueller et al. 1999). We captured hens in early spring and fitted them with a radio transmitter. We then used telemetry to monitor hens and their nests. We protected half the nests by broadcasting an insecticide onto a 60- x 60-m area centered on the nests. Chicks hatching in non-treated nests were exposed to the naturally occurring density of RIFA in the area of the nest. We measured hatching success on the day of hatch by determining the proportion of eggs that hatched successfully. We measured brood survival when chicks were 21 days old by flushing the hen and chicks and determining the proportion of hatched chicks that were still alive. Hens led broods away from the nests a few hours after hatch; thus broods that hatched from protected and unprotected nests were subject to the same habitat conditions and RIFA densities after hatch. Broods only benefited from the insecticide treatment during hatch and a few hours posthatch. The entire experiment was repeated in 1998.

Our results were surprising. Unlike the artificial nest studies, only 2% of northern

bobwhite chicks in unprotected nests were killed by RIFA while hatching (Mueller et al. 1999). However, survival of chicks from nests treated with insecticide was more than twice that of chicks from unprotected nests (60% versus 22%) (Mueller et al. 1999).

Mortality caused by RIFA appears to be additive to other mortality factors that have historically caused northern bobwhite chick mortality before the appearance of RIFA. In our study, 38% of all chick mortality to 21 days of age was attributable to RIFA stings at hatching. Mortality caused by RIFA can only be compensatory (substituting for historical mortality factors) if subsequent chick survival is higher. This change in survival could result from the lower density of northern bobwhite chicks in areas with RIFA. For example, the surviving chicks may have more food to eat or be less susceptible to disease due to the lower density of chicks. We can use a simple mathematical model to examine the potential for RIFA mortality to be compensatory. If we compare the expected chick production from 1,000 nests protected from RIFA with that of 1,000 unprotected nests using the data of Mueller et al. (1999; assume a clutch size of 14, a nest success of 38%, and survival of chicks from protected and non-protected nests is 60 and 22%, respectively), we would expect 3,192 chicks from protected nests and 1,170 chicks from non-protected nests to survive to 21 days-of-age. If only 50% of chicks (1,596 chicks) from protected nests survive to 15 weeks-of-age (Fatora 1966), chicks from non-protected nests cannot match their number even if they experience 100% survival during this same time period. It seems very unlikely that chick mortality caused by RIFA is compensatory in the Texas Coastal Plains. Further, our data suggest that food limitation may not be a problem for northern bobwhite chicks that cohabit with RIFA areas in the Texas Coastal Plains. Northern bobwhite chicks from treated nests that ranged in areas inhabited by RIFA (mean of 290 mounds/ha) in our study attained 101% of a predicted 37.9 g body mass at 22 days of age (Mueller 1999).

We also detected another important relationship. Chick survival is related to the number of RIFA captured within a 30-minute period in a standardized bait cup placed in northern bobwhite nests on the day after hatch (Mueller et al. 1999). Our data indicate that when 300 or more RIFA recruit to the nest one day post-hatch, chick survival is essentially zero. If less than 300 RIFA recruit to the nest then survival of chicks is similar to that of chicks that hatched from nests protected from RIFA attack using insecticide. Thus, not all areas of the landscape harbor enough RIFA to kill northern bobwhite broods.

Differences in climate may cause differences in the way northern bobwhite populations from different regions of the southeastern United States respond to chick mortality caused by RIFA. Reproductive activities of northern bobwhite are sensitive to rainfall regimes. Drought causes fewer hens to nest and reduces the number of re-nesting attempts (Guthery et al. 1988). RIFA predation on chicks, however, does not appear to be impacted by rainfall (Mueller et al. 1999). We can examine this relationship using another simple mathematical model. We can use our previous arbitrary number of 1,000 nest attempts by hens in a population and as before estimate that a population protected from RIFA could expect 1,596 chicks to reach 15 weeks-of-age. Guthery et al. (1988) provided evidence that drought conditions could reduce the number of hens that are able to breed by 40%. This would reduce the number of nesting attempts in our hypothetical population to 600 and the number of chicks reaching 15 weeks-of-age to 798 (this assumes no drought impact on chick survival which is unlikely). If we now combine the negative impacts of drought on nest attempts and RIFA on chick survival to 21 days-of-age, the number of chicks that survive to 15 weeks-of-age falls to 293. A combination of drought and RIFA predation can have severe impacts on northern bobwhite population size. Droughts are a much more frequent feature of the climate of some regions of the southeast as compared to others (Diaz 1983, Soule 1992).

RIFA populations can be significantly reduced using broadcast applications of insecticide baits such as Amdro® (American Cyanamid, Wayne, NJ). However, this treatment is not economically feasible for many landowners, particularly those with larger tracts of land (Drees 1998). Until an economically feasible method to control RIFA over large areas is available, we must attempt to slow the invasion of RIFA and prevent increases in population densities on currently colonized areas. Therefore, it is important that we examine whether current land management practices are benefiting RIFA populations, and thus possibly degrading habitat for northern bobwhite and other wildlife species.

Disking and prescribed burning are often used to enhance habitat for early successional wildlife species such as northern bobwhite. Disking breaks up most dense grasses and, to a lesser extent, shrubs. Forb growth is stimulated, which provides food for northern bobwhite (Buckner and Landers 1979, Webb and Guthery 1983). Invertebrate biomass, an important protein source for northern bobwhite chicks, increases in response to disking (Robel et al. 1996). Additionally, disking creates travel lanes through thick cover and provides edge between grasses and bare ground, which is beneficial to nesting hens (Guthery 1986).

Prescribed burning is one of the least expensive habitat manipulation techniques used to manage habitat for northern bobwhite (Wright and Bailey 1982, Guthery 1986). Fire favors many species of forbs, which are preferred northern bobwhite foods (Hansmire et al. 1988, Masters et al. 1995). Burning also encourages the growth of grasses such as *Panicum* spp. and *Paspalum* spp. (Wright and Bailey 1982). These grasses provide winter food and to a lesser extent, cover, for northern bobwhite (Lehmann 1984). Formerly avoided as a management practice, prescribed burning is becoming an accepted and valuable tool for wildlife habitat enhancement.

While both disking and burning improve habitat quality for early successional wildlife species, they may also make habitat more suitable for RIFA. RIFA mound density has been positively correlated with habitats maintained via disturbance (Tschinkel 1988, Stiles and Jones 1998). Consequently, management practices used to benefit early successional species may increase RIFA and lessen or even negate the desired benefits of habitat manipulations. We tested the hypothesis that prescribed burning and disking would increase RIFA mound densities in the Texas Coastal Plains. Methods available to control RIFA on large areas of land using insecticides cost about \$20/ha/treatment (Drees et al. 1996) and treatments may last < 3 months (Apperson et al. 1984). Use of insecticides may also be ecologically undesirable because the insecticide also kills native ants reducing competition for recolonization by RIFA. Our research team has also examined possible methods to lessen the impacts of RIFA on northern bobwhite populations in Texas. Data from a study in Northern Florida suggests the density of RIFA mounds increases after soil disturbance (Tschinkel 1988). We experimentally tested the possibility that the benefits of burning and disking (soil disturbance) treatments for northern bobwhite habitat management could be outweighed by increased RIFA predation on chicks that results from greater densities of RIFA after soil disturbance. We compared RIFA mound densities on areas that had been prescribed burned or strip disked to non-disturbed controls. Mound densities were estimated using distance sampling (Forbes et al. 2000). Burning and disking had no impact on RIFA mound densities (Forbes 1999). Initially high RIFA mound densities in our study area coupled with the territoriality of predominantly monogyne (single-queen) colonies may have limited increases in RIFA mound density in response to treatments on these study sites.

We also plan to study methods to mitigate the impacts of RIFA on northern bobwhite populations by attempting to identify economically and ecologically desirable techniques to decrease other sources of chick mortality. We plan to develop management guidelines in the future to help landowners estimate and deal with the impacts of RIFA on their

properties.

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