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In the first article of this series, we described the complexity of the predator quail issue. We outlined some of the major historical perspectives that have shaped the dominant predation paradigm in today's biological circles. We described how, in theory, predator abundance may contribute to observed low quail densities on some localized areas managed for quail in the Southeast. We also presented that, while no definitive predator studies have been conducted on bobwhite, a preponderance of studies conducted on predation of game birds have documented that predators reduced reproductive output and limited fall population size. We introduced the concept of the predator context, that is the composition and abundance of predators in time and space, and how it likely interacts with habitat to affect the "quality" of an area for bobwhite. Quality can be defined demographically as the survival and reproductive success of quail on a given area.

Finally, we suggested that biologists, ourselves included, without methods to assess the predator context in relation to quail demographics may find themselves prescribing unnecessary habitat changes hoping to increase quail populations. We made these points to make clear the need for a sustained research effort to better understand how predation affects quail populations and how this is important to better management at the local scale - the scale of quail management in the Southeast. In this second article, we will describe current research activity with bobwhite and predators, including the cooperative project funded in part by Quail Unlimited.

A Cooperative Effort

In 1999, researcher members from the Southeast Quail Study Group met with Quail Unlimited to discuss the potential for predator and

habitat research. After lengthy debate on baseline information available, the kinds of research needed, and the costs and benefits of various research approaches, we decided to develop a cooperative research project between Quail Unlimited and members of the Southeast Quail Study Group who conduct research on quail demography and habitat. We determined that a study that manipulated predator density (predator removal) would be premature before we understood the nature of the relationship between relative abundance of predators and bobwhite productivity. Three scientists within the SEQSG already had ongoing radio-telemetry studies measuring bobwhite productivity and habitat use on 12 sites in Georgia, Florida, Mississippi and Tennessee. However, these studies had not been monitoring predator abundance because of funding constraints. Funds provided by QU would be used to measure the types and relative abundance of predators, that is the predator context, on these sites with active telemetry and habitat research to determine if reproductive success was correlated to predator abundance. This infusion of QU funds leveraged the half million dollars already being allocated to bobwhite research by state and private institutions and helped to facilitate cooperation among these research groups. This will allow us to accomplish far more than either QU or any of the individual researchers could alone. This cooperative project is unique in that it is the first time in the history of quail research that an effort has been made to establish a relationship between predator abundance and quail abundance and demography, ideas first advanced by Herb Stoddard and Aldo Leopold over 50 years ago. This is critical because the first step in the scientific process is to observe a phenomenon in question. If predators are not related to

quail demographics, the result of our research should be similar to Figure 1a, showing that reproductive performance, survival or density vary independently of low or high predator contexts when habitat is well-managed. This outcome would support the often-heard claim that quail populations are limited by habitat only. If the local predator context explains some of the variation in reproductive performance, survival or density, then the results

A

B

Figure 1. Hypothetical relationships between nest predator abundance and quail productivity on 17 areas with good habitat. The top graph (a) shows an example of what the cooperative research results might look like if there was no relationship found between nest predator abundance and quail reproductive success. The lower graph (b) shows what the research results might look like if nest predator abundance, across areas, was negatively related to quail reproductive success.

should mirror Figure 1b, showing that as the predator context increases or exceeds some threshold, quail survival and reproduction decline regardless of habitat. This result would support the idea that under certain conditions, predators reduce the “quality” of an area for quail. Notice in Figure 1b that even at low predator abundance, some populations of quail will show poor reproductive performance as well. We believe this is because factors other than habitat and predators, such as weather, can cause lower than expected reproduction in some years and there will always be some error in our measurements of predator abundance and quail demography.

We established rigid criterion as to which study sites would receive QU funding to support predator monitoring. The project study areas were limited to those with ongoing radio-telemetry research to measure quail nesting and survival parameters. These sites had to be at least 2000 acres in size with an active quail habitat management program, a GIS system that mapped available habitat, and annual estimates of quail population size. At appropriate times, relative abundance of predators is measured using a series of scent stations for mid-sized mammalian predators. A “scent station” is a circle of sand, one meter in diameter, with a special scent tablet placed in the center. The odor from the tablet attracts nest predators from the local vicinity to the sand ring, at which they leave a foot print signifying their presence. The proportion of scent stations visited by nest predators provides an index to the relative abundance of mammalian nest predators among the study areas.

We specifically chose to avoid areas with poor habitat, because we wanted to see if predator abundance explained much of the variation in production of young and spring and fall populations when habitat was presumably not limiting. We reasoned that if predators limit quail on areas of good to excellent habitat, then they are also likely to be limiting in areas of poor habitat (for quail not predators). Potential study sites include private quail lands, state-owned wildlife management areas and demonstration areas, such as Tall Timbers Research Station in Florida and Ames Plantation in Tennessee. Study areas are distributed across a broad range of southeastern physiographic regions from the Red Hills Region, to the Sandy Lower Coastal Plain, to

the Black Prairie, to the Upper Coastal Plain. Study sites vary in habitat composition from farmland mixed with cut-overs, to upland pinewoods managed using traditional techniques of prescribed-fire and discing.

The primary objective of this project is to determine the relationship between bobwhite productivity and relative abundance of all medium-sized mammalian predators. However, there are several other significant potential outcomes of this cooperative project. First, as we obtain more data over the course of the project, we will be capable of testing which predator populations in the Southeast appear to be the most responsible for reducing quail reproduction. For example, does one opossum = one raccoon = one armadillo = one snake in their relative propensities for depredating quail nests. Research centered at Tall Timbers is beginning to shed some new light on what predators are actually depredating quail nests (See side bar). Second, this research will provide clues to what types of landscapes tend to have high predator contexts and which have low predator contexts. Third, if the results of our research are similar to Figure 1b, then this information will be useful for researchers interested in selecting sites with high predator abundance for testing the effects of predation management on quail populations. Finally, the most exciting potential outcome of this research to quail managers may be the development of standardized methods for measuring predator abundance so that any quail manager can determine if the quail population on the land they are managing may be limited by high predator abundance. If predator numbers exceed some threshold beyond which quail production is suspect, investment in predator management may be cost-effective relative to other management practices. Otherwise, if predator numbers are naturally low, predator management may be a waste of time and money. The precedent for this is the highly successful Integrated Pest Management in agriculture (see side bar, page 10). Ultimately this type of information needs to be developed so that the professional wildlife management community can provide the knowledge and tools needed for developing integrated predation management.

First Year Results

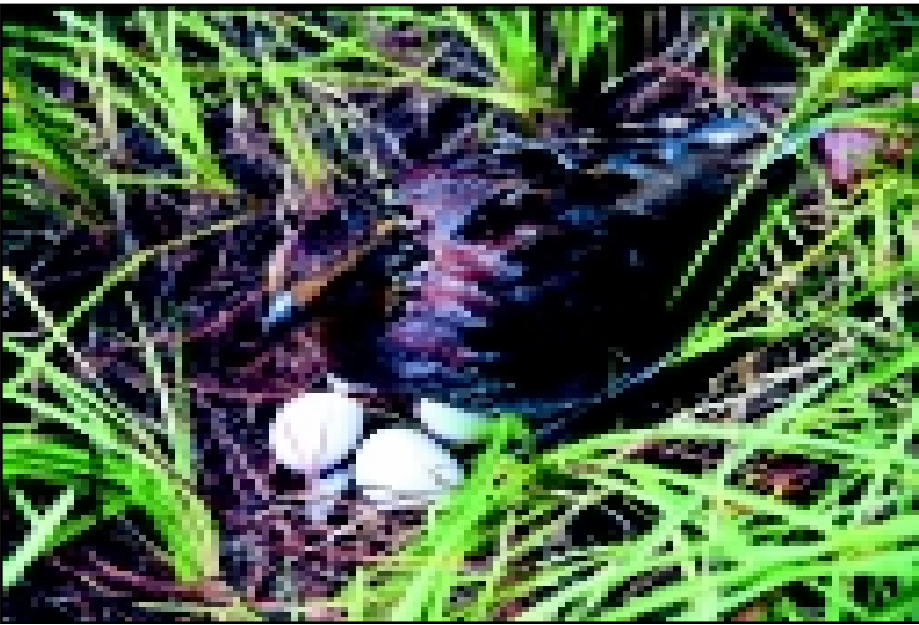
In 1999, nest predator abundance was measured in conjunction with quail demographics on 10 areas in Tennessee, Mississippi, Florida and Georgia. The survival and reproductive output of a total of 420 radio-tagged quail were determined on these sites from April through October. Results of this research are presented in Figures 2 and 3. Figure 2 shows the relationship found between relative abundance of mammalian predators and the number of hatched nests produced per hen over the entire breeding season. Figure 3 demonstrates

What Predators Eat Quail Nests?

Despite years of work, technology for identifying nest predators has limited our ability to actually be certain of which animals are significant nest predators. Cooperative research begun at Tall Timbers Research Station with the University of Georgia, and Auburn University has begun to monitor wild nests with small 24-hour micro-video cameras. The goal of this research has been to identify nest predators in relation to predator communities. The research has already identified some surprising results (Visit TTRS.ORG to view actual predations).

The first result was that certain common snakes were a far more important nest predator than previously documented, depredating more quail nests than any other predator. Second, raccoons have been our number two nest predator followed closely by armadillos (once considered not to be significant egg predators). But across all study sites, snakes, raccoons and armadillos are the top three nest predators. Third, we are learning that evidence at the nest site is usually a poor predictor of the actual predator of nests. Raccoons often leave little evidence of their presence, snakes often are partial egg predators, rodents and quail often ingest the remains at nest sites obliterating evidence and confusing signs. This means that inferences drawn from previous studies are mostly unreliable when it comes to identification of nest predators.

In conjunction with research on predators, this type of information will help us to document the vulnerability of quail nests to various predators and the role of compensatory predation of quail nests by lesser predators, such as owls, bobcats and squirrels. Finally, our results are further documenting the complexity of the predator community.



the relationship between the total population production of successful nests, including those incubated by males. The total population production index is a collective measure of survival, nesting and nesting success for an entire nest season for a cohort of radio-tagged bobwhite. This composite index provides important additional insights over “nests produced or female” because many “lost” nests are actually incubated by males and males often hatch a significant proportion of nests (30%). The x-axis on both graphs is a measure of scent station visitations by known nest predators, including armadillos, raccoons, skunks, foxes, opossum and bobcats.

These graphs illustrate that hatching of nests by hens and total population productiv-

ity were negatively related to predator abundance even in areas of good to excellent habitat. These relationships were statistically significant ($P < 0.05$). It is important to point out that nest predator abundance appeared to vary up to five-fold among the study areas in 1999, assuming our index of predators was linearly related to predator abundance. These data support our ideas that the predator context varies across time and space with apparent ramifications for quail production. While these findings are interesting, they are only a beginning to unraveling the mysteries of predation as a process. No single research project can answer all questions and this one is no different in that it has strengths and weaknesses. However, with the funding from quail enthusiasts and Quail Unlimited together, this research has already opened the eyes of those entrenched in the “predation has no effect” paradigm and has helped in garnering additional funding for more detailed research. It is worth noting that these findings are yet preliminary and simply represent the first step in the scientific process. Recall that earlier we said observing and characterizing a phenomenon or process is the first step in the scientific method. Relationships such as we have observed between predator abundance and quail productivity do not necessarily imply causal relationships because they may be false or actually caused by some other unmeasured but correlated factor. However, they provide the informed groundwork for the second part of the scientific method in which solid, testable hypotheses are formulated and then tested with controlled, manipulative experiments. Reliable

Figure 2. Number of hatched nests produced per radio-tagged female bobwhites over the entire breeding season in relation to scent station visitations of nest predators (raccoon, opossum, skunks, foxes, bobcat, and armadillo) on 10 study areas in 1999. As nest predator abundance increased across areas, the number of nests successfully hatched per radio-tagged hen declined. The lower number of hatched nests was a function of lower numbers of nests incubated, lower nesting success and to some degree lower survival rates of hens.

knowledge concerning ecological processes results from the completion of the scientific process through rigorous controlled and replicated experiments, something that has been lacking in the past. Our research lays the foundation for formulation and rigorous testing of hypotheses regarding effects of mammalian predators on bobwhite productivity.

To date, our research indicates that predator context appears to explain a significant amount of variance in the demographic success of quail populations in good habitat. Other key findings include large variations in the predator context across areas. This is not to minimize the importance of habitat — which remains the key to regional population declines and the key to local populations as well — but simply to act as a siren that we need a sustained research effort on habitat and predation to achieve an understanding of if, when and how predators limit quail populations. We need to provide tools to managers so they may measure the predator context and determine what actions, if any, are needed. We need to understand regional variations in the process of predation in quail populations and be able to predict what landscapes and habitat deficiencies predispose quail to predation. Ultimately, we need information to guide predation management systems that do not harm the image of our sport and profession and ultimately help people better manage for quail at the local scale.

Quail Unlimited, through contributions by individuals, chapters and national conservation programs with Budweiser and the National Fish and Wildlife Foundation, is participating in the largest, most comprehensive regional study of bobwhite and predation ever attempted. QU funds are being leveraged at a more than 10:1 ratio in a cooperative project that utilizes the expertise and infrastructure of four Universities, two private research foundations, four state wildlife agencies and numerous private landowners to answer questions at a scale and resolution not previously attempted. This research is contributing to a new understanding of the process of predation and the population consequences for quail. In the end, quail populations, quail managers and quail enthusiasts will be the ultimate beneficiaries of this investment.