EFFECTS OF HUNTING ON QUAIL POPULATIONS

STEPHEN J. DeMASO, Upland Game Biologist, Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105

Abstract: The topic of quail (*Colinus virginianus* and *Callipepla squamata*) harvest and its effect on quail populations remains an emotional issue to many quail enthusiasts. An understanding of quail population dynamics is needed before examining the effect of hunting. Quail hunting is not totally interchangeable with natural mortality (compensatory), nor is it totally added to natural mortality (additive). The effect of hunting on quail populations falls between these 2 extremes. The management of quail harvest takes place at 2 levels. Most state wildlife agencies manage quail harvest by providing the maximum amount of recreational opportunity without harming the quail population. Individuals wishing to conduct more intensive quail harvest management on private property can make hunting parameters (no. of days hunted, no. of hunters, bag limit, method of hunting, etc.) more restrictive within the general framework set by the state wildlife agency. Collecting harvest data can give information on hunter success, hunting pressure, and the health of the quail population in the hunting area.

Introduction

The effect of harvest on quail populations is a topic of concern and controversy for wildlife managers and quail hunters. Much of what we believe about the effects of harvest on quail populations is false. Many of our beliefs about quail harvest are based on early research that had poor scientific study designs and some researchers misinterpreted results.

Research on quail harvest in Iowa (Errington and Hamerstrom 1935, 1936) and Wisconsin (Errington 1945) resulted in 2 concepts that have long-term implications on quail harvest management strategies. The first concept, the threshold of security, assumes that fall populations of quail have a surplus of animals (the "doomed surplus") and that harvest of this "doomed surplus" has no effect on the spring population (the threshold level). The doomed-surplus logic promotes that quail harvest is completely compensatory (natural mortality decreases to compensate for hunting mortality). The second concept, inversity, means that populations at low levels reproduce more vigorously. Inversity can lessen the effects of harvest, even if hunting mortality adds to natural mortality (Roseberry and Klimstra 1984:145).

The logic of the doomed-surplus and complete compensation are plausible because of early research conducted by Baumgartner (1944), Glading and Saarni (1944), Parmalee (1953), Vance and Ellis (1972), and Campbell et al. (1973). More recently, researchers have found that quail harvest adds to natural mortality at varying levels (Rosebery and Klimstra 1984, Pollock et al. 1989, Warner 1991, Robinette and Doerr 1993, Dixon et al. 1996). The above research and theoretical consideration have lead to phrases like "more additive then compensatory" and "partial compensation" which have more recently appeared in the quail literature (Caughley 1985, Roseberry and Klimstra 1984, Burger et al. 1994).

Understanding Quail Populations

A population is a group of the same species of animals that occupies a particular space at a particular time. Population parameters that affect changes in population are interrelated. Quail populations are very complex systems (Fig. 1). The primary population parameters that impact quail populations are reproduction, mortality, immigration, and emigration (Fig. 2).

Quail Density

Quail populations are estimated by measuring density. Density is the number of quail per unit area, for example the number of quail per acre. Bobwhite density varies depending on where you are located in the bobwhite's range. A density of 1 bird/acre is considered excellent. Quail density can be measured using a variety of techniques including direct counts (line-transect flush counts), banding (mark-recapture estimators), and call-counts (male whistle and morning covey call counts). Some techniques require a considerable amount of time and labor to get estimates.

Quail Reproduction

Populations increase because of reproduction.

Reproduction is the process of producing new individuals within a species. The number of quail produced each year varies with habitat conditions and weather. The length of the nesting season, the number of females entering the breeding season, the number of eggs laid, the fertility of eggs, the number of successfully hatched nests, and survival of quail chicks after they hatch are all important for quail production.

The length of nesting season for bobwhites in southern Illinois ranged from 78 to 128 days and averaged 112 days (Roseberry and Klimstra 1984:84).

The number of females that enter the spring population is not well known. However, it is estimated that 43% (Burger et al. 1995a) to 47% of the breeding population are females. It is assumed that nearly 100% of the hens in the breeding population lay eggs.

The number of eggs in incubated bobwhite nests ranged from 6 to 28 during a long-term study in southern Illinois (Roseberry and Klimstra 1984:72). The average number of eggs per nest for the entire bobwhite range is 12-14 eggs (Rosene 1969). Average clutch size decreases as the nesting season progresses and renesting occurs (Stoddard 1931, Lehmann 1984).

Nesting success reported by Roseberry and Klimstra (1984:76) ranged from 25 to 53% in southern Illinois. Predation, agricultural practices, and abandonment appear to be the largest causes of nest failure.

Chick survival is the least understood aspect of quail ecology. Chick survival is lowest during the first few weeks after hatching. Chick survival in western Oklahoma from hatching to 39 days old was estimated to be 37.0% (DeMaso et al. 1997).

Quail Mortality

The percentage of juveniles in the hunting bag has been taken as an estimate of the annual mortality rate. Differential vulnerability of juveniles and adults to harvest (Shupe et al. 1990, Roseberry and Klimstra 1992) may bias demographic inferences developed from age ratio data, depending on the intensity and duration of hunting (Shupe et al. 1990). Guthery (1997) developed a method of interpreting age ratio data in context meaningful for management theory. On average, bobwhites in warmer climates (low latitudes) sustain about 70% annual mortality with net production of 2.3 juveniles/adult, whereas bobwhites in colder climates (high latitudes) sustain ≥80% annual mortality with ≥4 juveniles/adult (Guthery 1997).

The annual mortality rate during a 5-year radio-telemetry study in western Oklahoma was estimated to be 80.2% (DeMaso et al. 1998). A telemetry study in North Carolina reported bobwhite annual survival of 6.1% and an annual mortality of 93.9% (Curtis et al 1988). Another bobwhite telemetry study in northern Missouri reported 94.7% annual mortality and 5.3% annual survival (Burger et al. 1995b).

Bobwhite populations cannot persist at annual survival rates of 5% and 6%. Based on age ratio information (Guthery 1997), the Missouri and North Carolina populations would require productivity of about 18 juveniles per surviving adult for population stability. This is doubtful since the average bobwhite nest only contains about 14 eggs!

Natural Mortality

Most mortality experienced by quail populations is natural. Predation is the largest cause of quail mortality (Burger et al. 1995b, DeMaso et al. 1998). Mortality observed during field studies tends to be highest during fall and winter. Avian predation is highest during the fall-spring and mammalian predation increases from spring to fall, coinciding with the nesting season (Curtis et al. 1988, Burger et al. 1995b, DeMaso et al. 1998). Annual mortality rates between females and males are similar (Curtis et al. 1988, Burger et al. 1995b).

Non-natural mortality

The largest form of non-natural mortality on quail populations is hunting. Hunting mortality (retrieved and unretrieved birds) was estimated to be 28.2% in northern Missouri (Burger et al. 1995b). Research in western Oklahoma estimated hunting mortality to be 22.8%, however, hunting was limited to 2 days/week (S. DeMaso, unpubl. data). Researchers in North Carolina estimated the bobwhite harvest rate (retrieved birds only) to be 14.0% in North Carolina (Curtis et al. 1988).

Immigration and Emigration

Immigration is the movement of individuals into a population and emigration is the movement of individuals out of a population. We know little about immigration and emigration and quail populations. Early research by Stoddard (1931) reported that "50% of the quail spend their lifespan within a quarter mile

of their birthplace while few ever wander more than mile." Band recoveries (Lehmann 1984:119) and recent radio-telemetry research in western Oklahoma (Scott Cox, Oklahoma Department of Wildlife Conservation, personal communication) document that bobwhites are capable of moving large distances (≥ 20 miles). We do know that movement does occur in bobwhite populations. However, knowledge about the amount, timing, and density levels at which ingress and egress from quail populations may occur is still unknown.

Density Dependence

Density dependence is the action of repressive factors that intensify as the population density increases or relax as the density decreases. Density-dependent processes do occur in bobwhite populations (Errington 1945). Two density-dependent processes in bobwhite populations are reproduction and mortality. Roseberry and Klimstra (1984) in a long-term bobwhite study in southern Illinois observed that low numbers of bobwhites had high reproductive success and high populations had greater mortality.

Hunting can be considered a density-dependent event. When quail populations are high, hunters make more hunting trips and harvest more birds, when populations are low hunters hunt less frequently and harvest fewer birds.

Is Hunting Mortality Compensatory or Additive?

Compensatory

The concept of completely compensatory natural mortality is based on the belief that limited hunting and non-hunting mortality are inversely related. It is believed by some that below a certain threshold level that non-hunting mortality rates decrease and compensate for increased hunting mortality. This concept on quail harvest management was introduced by Errington and Hamerstrom (1935). The idea of complete compensation is supported by field research conducted by Campbell et al. (1973).

Additive

The idea of additive hunting mortality is based on the thought that hunting mortality is added to the natural mortality that the population is experiencing. Under the additive theory, it is assumed that the number of harvested birds would have otherwise survived. Recent research has found that quail harvest adds to natural mortality at varying levels (Rosebery and Klimstra 1984, Pollock et al. 1989, Warner 1991, Robinette and Doerr 1993, Dixon et al. 1996). In quail populations it is doubtful that all hunting mortality is additive.

Which is Quail Hunting?

Quail hunting falls between the two extremes of completely additive and completely compensatory. Research and theoretical consideration have lead to phrases like "more additive than compensatory" and "partial compensation" which have begun to appear in recent quail literature (Caughley 1985, Roseberry and Klimstra 1984, Burger et al. 1994). Also, research indicates that hunting mortality may be more compensatory early in the hunting season and become additive later in the hunting season as breeding season approaches (Robinette and Doerr 1993).

Harvest Management

The Wildlife Agency Perspective

State wildlife agencies set the season dates, season lengths, bag limits, shooting hours, etc. for their states. The primary goals in setting state harvest regulations are to protect the species being managed, but provide ample recreational opportunity to the hunting public. Most license holders do not understand the process which hunting regulations must go through in order to be changed or modified.

Management on Private Land

Many private landowners wish to intensively manage the quail harvest on their property. Managers on private land can restrict harvest variables within the framework set by the state wildlife agency. Managers may stipulate which days can be hunted, hunting hours, the number of hunters, lower the bag limit, limit the method of hunting, etc., etc., to modify the harvest and hunting pressure on their property.

Scientific Harvest Management

Quail harvest can be scientifically managed. The idea behind scientific quail harvest management is to manage overwinter and hunting mortality to leave a desired number of quail in the spring breeding population.

Most managers want to maximize the fall quail population for recreational hunting. To maximize the

fall population, an adequate number of birds must enter the preceding breeding population to produce enough young birds to meet the fall population goal. When entering into hunting season the management goal is to leave the minimum spring population needed to produce the next years desired fall density.

Managers can determine the number of birds to be harvested by monitoring quail densities on their property and having an estimate of overwinter mortality.

A good estimate of overwinter mortality without hunting is about 50% (Roseberry and Klimstra 1984).

Knowing that harvest is neither completely additive nor completely compensatory, we can use the following relationship to estimate the harvest rate (F. S. Guthery, Oklahoma State University, person. commun.).

$$H = (T - N)/(1 - N)$$

where

H = Harvest rate

T = Total mortality over a given period (winter)

= (Fall density - Spring density goal)/Fall density

N = Natural mortality over a given period (winter)

Assume we have 10,000 acres of native rangeland. Our estimated fall quail density is 0.75 birds/acre. Our estimated population is 7,500 quail. Our spring management goal is have at least 0.30 birds/acre (spring population 3,000 birds). Using the equations above we can determine the appropriate harvest rate for the area.

$$T = (0.75 - 0.30)/0.75 = 0.6$$

$$N = 0.5$$

$$H = (0.6 - 0.5)/(1 - 0.5) = 0.2$$

The harvest rate is .2 or 20%. We can now multiply the harvest rate and our fall population estimate (7,500 birds) to determine the number of birds that can be harvested . We can harvest 1,500 quail and still achieve our management goal.

Does it Matter????

It depends! Generally, on a statewide basis or very large areas harvest management has little impact on quail populations. However, on smaller areas where specific harvest management goals are a priority then harvest management has to be a vital part of the management program. Fortunately, quail hunting and populations are somewhat self regulating. Previously in this paper we discussed some of the population processes that protect quail populations from overharvest. However, it is important for hunters and wildlife professionals to understand and appreciate the biological principles and concepts underlying harvest management, both for the sake of the resource and their own credibility.

Keeping Harvest Records

Keeping records is a vital part of any sound management program. Harvest records can be used to measure the progress and success of a management program. Quail harvest records are fairly easy to keep and can give insight to management priorities for the next year.

First, the hunt area should be divided into management units. Each management unit should range from 200 to 1,000 acres (Guthery 1986). Each unit should be identified by either a unique name or number.

Each time a unit is hunted, record the time, date, number of hunters, number of hours hunted, number of coveys moved, number of birds harvested, the number of birds shot, but not retrieved, and the age of the birds harvested (adult or junvenile). The age of bobwhites can be determined by the molt pattern and coloration of the primary flight and covert wing feathers (Rosene 1969).

Harvest data compiled at the end of the season can give information about the hunting area and the quail population on the area. First, suppose you have 3 management units and all units received the same amount of hunting pressure. Area 1 had a season harvest of 400 birds, area 2 had a harvest of 250 birds, and area 3 had a harvest of 125 birds.

The following year you have some extra money or there is a new farm bill program for wildlife habitat improvement. Which area should you work with?

Area 3 produced the least number of birds last season and could probably benefit from additional habitat improvement. If hunting pressure was not equal on all 3 areas, some type of rate measure, coveys moved per hour would need to be used to compare the areas.

A harvest age ratio for a healthy quail population is about 20% adults and 80% juveniles. Suppose you have a management unit and the harvest age ratio is 40% adults and 60% juveniles. This harvest data indicates poor recruitment. To improve this property the manager should work on improving nesting habitat and/or brood-rearing areas.

Conclusion

Quail population processes involve several safeguards from overharvest. Quail hunting is neither completely compensatory nor completely additive, but does fall between the 2 extremes. Private landowners and managers have the liberty to further restrict the state's existing framework of hunting regulations to meet management goals. Harvest records can provide useful information on which to base future management decisions.

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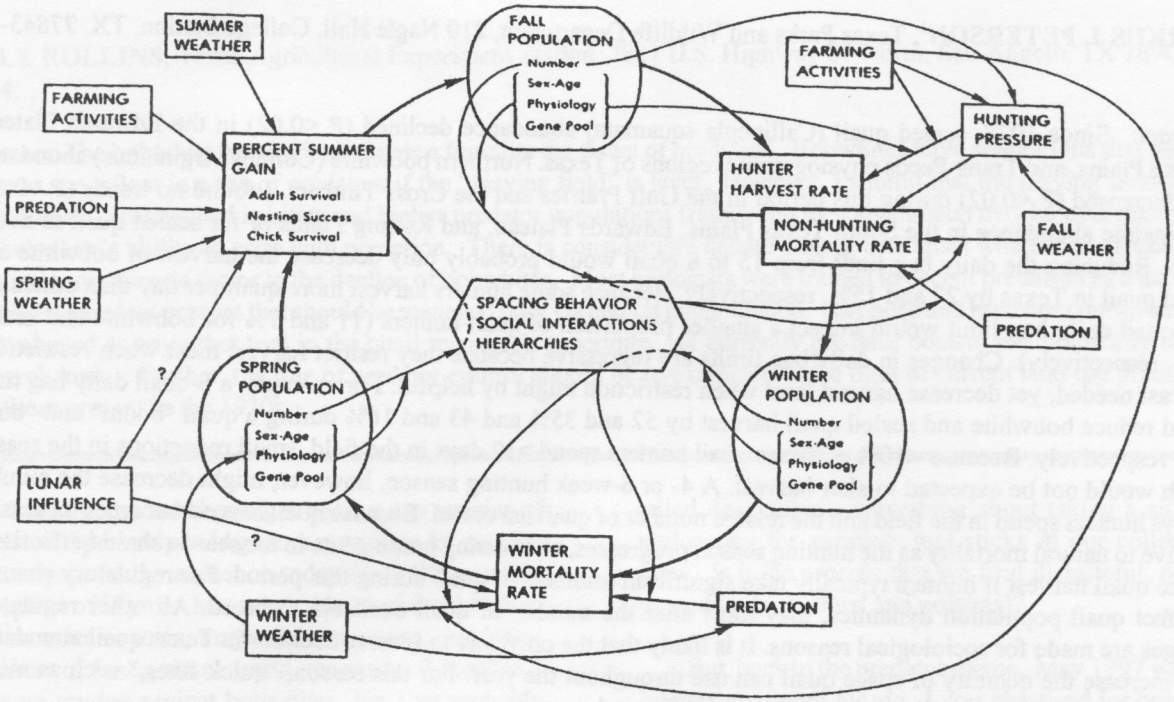

Figure 1. A model of northern bobwhite population dynamics (Roseberry and Klimstra 1984).

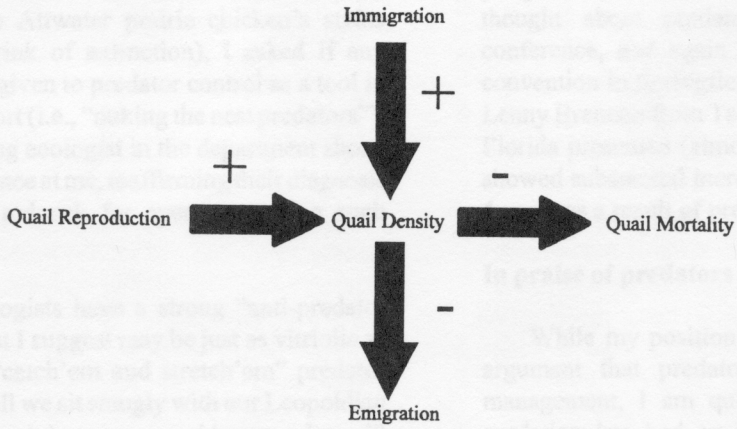

Figure 2. Population parameters that affect northern bobwhite populations.