# QUAIL NEWS

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The newsletter of game bird research and management from the Bollenbach Chair, Oklahoma State University.

## HEAT IS YOUR ENEMY

This special edition of *Quail News* addresses the problem of heat and its effects on the reproduction and survival of wild quail. Heat is a powerful yet poorly understood enemy of quail.

Heat, or high temperature, may lower production at one or more of several important stages from the nutritional preparation of a hen for laying through the survival of young chicks.

Although the outright death of wild quail because of hyperthermia (heat stroke) has not been reported, we shall see that temperatures hot enough to kill them commonly occur in their habitat. Young chicks are particularly vulnerable to heat, because they largely lack the ability to cool or warm their bodies.

Biologists have known of the problems associated with high temperatures for more than 60 years. Aldo Leopold reported on the heating of eggs during drought in his classic book (*Game Management*, 1933):

"It is ... well known that eggs lose moisture during incubation, and that the loss must not exceed a certain amount, lest the chick become too weak to accomplish his release. It is conceivable that when incubating hens are disturbed during intense heat the sun may 'cook'

*In this issue.....*

or weaken the eggs, in addition to drying them unduly."

Leopold and co-workers, in investigating the quail shortage coincident with the drought of 1930, "encountered frequent reports of 'addled [rotten] eggs' in the states whose weather records showed the most abnormal heat and dryness, but none elsewhere. This 'addling' may have been induced by hot dry air and soil. While the states that had suffered extreme drouth showed a 30-90 per cent shortage in the quail crop, the adjoining states to the northward showed a decided *increase* in quail in many localities. This seems to confirm [Herbert L.] Stoddard's conclusion that a moderately dry summer is the most favorable, whereas a very hot and dry one may be fatal."

Jack A Stanford, Missouri Department of Conservation, observed similar problems during the hot, dry years of 1952-57:

- Covey break-up (pairing) and nesting start later than normal.
- Some coveys do not break up for the entire breeding season.
- Nesting ends earlier than normal.
- Nests containing a full set of eggs are abandoned.
- Hens become emaciated and die on the nests.
- Clutch size is smaller.
- Chicks pip and partially ring their eggshells, but rapid drying traps them in partially opened eggs.
- High ground temperatures prematurely incubate eggs before the hen begins incubation, causing a few eggs to hatch earlier than the rest. Hens leave with the early-hatched chicks and eggs left in the nest perish.

Drought was occurring during Stanford's observations, so dryness and high temperatures *both* contributed to the effects he observed.

## RAIN AND HEAT

Thane Robinson, studying bobwhites in Kansas, was among the first biologists to recognize the interplay between the amount of rainfall, temperatures and bobwhite production.

Robinson speculated that if summer rainfall failed to reach a threshold level, that rainfall per se was largely responsible for reproduction failure. If rainfall reached the threshold, however, breeding season temperatures largely governed production. Production was strong with threshold rainfall and low to moderate summer temperatures. Conversely, production was weak with threshold (or more) rainfall and high temperatures.

Subsequently, Robinson's speculations have been supported by research results in Texas and Arizona. Analysis of Val Lehmann's data, presented in *Bobwhites*

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*in the Rio Grande Plain of Texas,* revealed that high temperatures during the breeding season could reduce or eliminate the benefits of rainfall. That is, a boom year for production required *both* high rainfall and cool temperatures.

Jim Heffelfinger and associates from the Arizona Department of Fish and Game have analyzed the response of breeding Gambel's quail to weather variables. They, too, found production depended on rainfall and temperature. Bust years occurred with low rainfall and high temperatures. Moderately good production was possible in dry years if temperatures remained cool during the breeding season. By the same token, high temperatures late in the breeding season could suppress production, despite above-average rainfall.

## HEAT AND CHICKS

Evidence of the effects of high temperatures on newly hatched chicks is anecdotal but disturbing. Chicks are not able to regulate their body temperature very well until 3-4 weeks of age. Moreover, being small, they may rapidly absorb lethal quantities of heat.

Concern about the effects of heat on the chicks of ring-necked pheasants arose in the 1930s. Ralph E. Yeatter, Illinois Natural History Survey, obtained field and laboratory evidence that exposure of eggs to high temperatures results in pheasant chicks prone to high mortality rates. Yeatter's research also showed a moderate decline in the hatchability of bobwhite eggs exposed to higher preincubation temperatures. Hatchability means the percentage of normally incubated eggs that hatches. Preincubation refers to the time required to lay a clutch, before a hen formally begins incubating it.

"While summer temperatures evidently reduce both the desire and the ability to breed," reports Val Lehmann, "effects on the young appear even more serious. Through the first week of life chicks seemingly are comfortable with temperatures as high as 98 °F. Soon thereafter high temperatures cause intense discomfort."

Death of wild chicks from heat overload has not been directly observed, but the loss of experimental chicks to heat has been observed. Heat was suspected of killing chicks maintained in wire pens in southern Texas. Masked bobwhites chicks released in southern Arizona have been found in a mummified condition within days after release. Heat could have killed these animals. Carol Evans, New Mexico State University, reported a total loss of wild scaled quail chicks in a year with an intense heat wave. Many drowned in livestock waterers. Production was normal in a year without a heat wave.

## HEAT AND GROWN BIRDS

The thermal biology of adult bobwhites and certain other quails is well understood because of past research. This biology reveals that adult quail are more sensitive to high temperatures than is generally realized.

The normal body temperature of quail ranges between 106.7 F and 108.5 F with a tendency towards the lower part of this range. Because of a higher body temperature than humans, quail "feel comfortable" at a higher ambient temperature than humans. The thermoneutral zone, or most comfortable range of ambient temperatures, is thought to lie between 86 F and 95 F.

When the ambient temperature exceeds 95 F, quail must begin to actively get rid of heat to maintain body temperature at a normal level. They do this by seeking shade, scooped out cups in the soil, or other cool spots in the environment. They also dissipate heat through the skin and by panting (gular flutter).

If the ambient temperature rises much above 102 F, bobwhites cannot get rid of heat as fast as they take it in. Hence, the body temperature rises above normal, leading to thermal stress.

What happens next depends on the amount of time quail are exposed to temperatures above about 102 F. Bobwhites can survive exposure to temperatures ranging from 111.4 F to 113.2 F for up to 100 minutes; their body temperature rises above normal.

Prolonged exposure to high temperature leads to death from heat overload. Some, but not all, scaled (blue) and Gambel's quail may succumb to temperatures of 113 F within 2 hours. A temperature of 104 F is lethal to bobwhites if exposure lasts for 24 hours or more. Of course, wild birds would not be exposed to these temperatures for more than a few hours.

Death occurs when the core body temperature reaches 114.8-115.7 F. Note that the body temperature causing death is only 7-8 F above normal body temperature.

## IT'S HOT ON THE BACK FORTY

David L. Goldstein, UCLA, has estimated that if an adult Gambel's quail left a shady covert and started walking on a hot summer day in Arizona, it could die of heat stroke in less than 1 minute.

"A [blue quail] left in the direct sunlight at air temperatures above 90 F can live less than half an hour," reported O. C. Wallmo.

The phrase, direct sunlight, used by Wallmo is important in understanding how quail respond to temperatures in the field. Sunlight usually adds to the heating effects air temperature. Thus, quail almost always experience temperatures that are slightly higher than the temperature one would record with a thermometer. These birds absorb heat from sunlight in a manner similar to greenhouses.

The temperature to which quail respond is called *operative temperature*. Wildlife biologists have measured operative temperatures near Laredo, Texas, that were high enough to kill bobwhites within a few minutes. Operative temperatures near the soil surface maximized at 140 F on a hot, June day.

Research at the Caesar Kleberg Wildlife Research Institute indicates high temperatures fragment usable space for bobwhites. Bobwhites avoided operative temperatures above 102 F, or approximately the temperature where thermal defense mechanisms break down and body temperature begins to rise.

## GLOBAL WARMING AND QUAIL POPULATIONS

Global warming has become a controversial issue. About all that can be predicted with some confidence is that greenhouse gases being added to the earth's atmosphere will cause the temperature of that atmosphere to increase. Based on what we know about the thermal biology of quail, global warming might damage populations in some regions.

How might global warming affect the population dynamics of quail in regions subject to warming temperature trends. The possible effects, though not explicitly stated, have already been addressed in this issue of *Quail News*. The main problems will be along these lines:

- The breeding effort will dwindle because hens do not enter laying condition or go out of laying condition more rapidly than normal.
- Higher temperatures will shorten the laying season, resulting in fewer opportunities for renesting and multiple-brooding.
- Killer heat waves will become more frequent and more severe, potentially exacerbating the effects listed above. These heat waves might also result in the death of young chicks.

The effects listed above might be expected to lead to a long-term decline in quail populations. The decline would not occur everywhere, because some portions of the earth are expected to become cooler and wetter, if the behavior of a warmed atmosphere follows current computer projections.

Some people wonder whether quail might be able to adapt to warmer climates. It is unlikely their thermal biology, as outlined in this issue of *Quail News*, will change. That is, key temperatures now will remain key temperatures in the future.

Quail populations might be able to shift to earlier breeding seasons to take advantage of cooler temperatures in late winter and early spring. Evidence from the United Kingdom indicates breeding birds are shifting to earlier nesting dates as global temperatures rise.

The full impact of global warming, whatever it might be, likely is at least a human generation away.

## QUAIL QUESTIONS

*I have a couple thousand acres of rough land west of Bristow that has no cattle on it, which I am developing for wildlife. It is pretty typical cross timbers country in that it is mostly wooded, but there are a number of open areas that have good stands of native grass and, in some of these areas, I have planted clover and Korean lespedeza. I also have some small cleared areas where I have planted rye for winter feed plots. I hope to plant some sunflowers in these areas next spring.*

*There ought to be a fair number of quail because there certainly is plenty of feed and cover to support them and there is no competition from domestic animals. We have a good deer population, some turkey, and a lot of predators. Unfortunately, our quail population has decreased to the point that it is rare to see or hear them. No one has hunted them in the last 2 years....*

*I do not believe that the avian predators are any problem, because the quail have access to so much cover. I do believe that the mammalian predators are a problem.... Other than what I am now doing, I cannot figure out anything else. Would you please make some suggestions?*--**Harry M. McMillan, Bristow, OK**

Based on data from the Breeding Bird Survey, bobwhites in central and eastern Oklahoma have been declining for the past 15-20 yers. Conversely, in western Oklahoma (excluding the panhandle), the birds have shown population stability or slow rates of increase.

The reasons for the decline in central and eastern Oklahoma are not well understood. Certainly, nest loss to predators is a viable hypothesis. Other hypotheses include the loss and splintering of habitat, trends in rainfall and temperatures, mystery diseases, chemicals, and others.

Sanford Schemnitz, New Mexico State University, analyzed the abundance of scaled (blue) quail in Cimarron County, Oklahoma, in 1954-56 and again in 1990-91. Populations declined 50% during this time span. Schemnitz did not know what caused the decline. He speculated it might be associated with abandonment of farms, conversion of farmland to the Conservation Reserve Program and climate change. Rainfall was high during 1981-90 in comparison with the 1950s.

Bobwhite populations in Oklahoma took a big jump between 1996 and 1997, according to counts done by the Oklahoma Department of Wildlife Conservation. Excellent hunting and high populations were found in northern Texas and western Oklahoma during the 1997-98 season. So, there is reason for hope.

Aldo Leopold, Herbert L. Stoddard and Valgene Lehmann all observed that the way to maximize quail populations is to make each and every square inch of a management area usable each and every day of the year. In modern parlance, this philosophy is called maximizing space-time. Usability depends on good interspersion of woody cover and herbaceous cover. The herbaceous cover

must be thick enough to conceal bobwhites but not so thick as to impede their movement. A bobwhite should never be more than about 50 yards from woody cover. If these conditions are met, the manager has done his job, and the ups and downs in populations will arise mainly from changes in the weather.

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*Is the nutritional value of pricklypear seed actually as dismal as reported in Lehmann's book [*Bobwhites in the Rio Grande Plain of Texas*]? If the crude protein is really 1%, is the energy value just as poor? Do quail peck at tunas for the moisture or the seed or what? Is tasajillo fruit or seed any better than pricklypear?*--**Steve Nelle, San Angelo, TX**

The *Handbook of Proximate Analysis Tables of Higher Plants* lists pricklypear seed as being 14.0% crude protein, 6.3% fat, 55.8% carbohydrates, 12.8% fiber and 24.1% ash (minerals).

The handbook says pricklypear fruits run 5-10% protein, 0.6-9.1% fat and 78-90% carbohydrates.

The metabolizability (digestibility) of cactus seeds is probably low. A guess would place the metabolizable energy value at less than 2 kcal/g. By comparison, corn and sorghum seeds metabolize at about 4 kcal/g and crickets at about 4.5 kcal/g.

Birds, in general, do not metabolize fruits or greens very well. Birds extract about 40% of gross energy, by dry mass, of these food items. If cactus tunas run 85-90% water, quail do not gain much energy from eating tuna flesh (on the order of 0.24 kcal/g wet mass or 1.6 kcal/g dry mass). Both estimates are quite low for quail foods; we seek foods that metabolize at more than 3 kcal/g.

Nutritionally, tasajillo fruit is probably similar to pricklypear fruit.

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*Could you enlighten us as to the minimum woody cover requirements for bobwhites?*--**Tim F. Ginnett, Uvalde, TX.**

Canopy coverage of 15% is reasonable. The brush contributing to the 15% coverage needs to be well dispersed so that a covey is never more than about 50 yards from woody cover. Twenty-five percent canopy coverage is acceptable if the brush is not too tall (most of it should be 1-3 feet tall). Bobwhites require fairly tall herbaceous cover if the canopy coverage of brush and trees reaches low values, e.g., 5%.

Support research on game birds. Send a tax-deductible contribution made payable to "OSU Foundation/Game Bird Research Fund" to the attention of Fred S. Guthery, Department of Forestry, 008C Ag Hall, Oklahoma State University, Stillwater, OK 74078. Contributors receive *Quail News* and *Quail Flashes*.