

**Research Summary:  
Quail Population and Nesting Characteristics  
in Western Oklahoma**



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**Oklahoma Agricultural Experiment Station  
Division of Agricultural Sciences and Natural Resources  
Oklahoma State University**



# **Research Summary: Quail Population and Nesting Characteristics in Western Oklahoma**

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Quail tracks, western Oklahoma

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# Introduction

The purpose of this summary is to present biometric (body measurement) and demographic (population) data of northern bobwhite (*Colinus virginianus*) and scaled quail (*Callipepla squamata*) in western Oklahoma. In particular, this summary reports characteristics of quail reproduction. A summary of adult survival data can be found in publication P-1054, *Research Summary: Evaluation of Northern Bobwhite and Scaled Quail in Western Oklahoma*. As we strived to make data easy to use and accessible, we allowed for a certain amount of redundancy in the following tables. All data presented in this summary were collected at Beaver River and Packsaddle Wildlife Management Areas (WMAs) in western Oklahoma during

2012–2017 as part of the research study titled Evaluation of Northern Bobwhite in Western Oklahoma. This study was funded by Oklahoma Department of Wildlife Conservation, project number: F11AF00069. Nearly all data pertaining to nesting were collected from radio-marked quail as part of the research. Comparisons among data groups were considered significantly different only if  $p < 0.05$ . Weights are recorded in grams and lengths in millimeters. Means (means) and standard deviations (a measure of variation, SD) also are provided where appropriate. All data pertaining to scaled quail were collected at Beaver River WMA, as scaled quail were rarely observed at Packsaddle WMA.

## Biometrics

Biometric measurements were collected from captured quail at Beaver River and Packsaddle WMAs. Wing chord length (measured from wrist joint to tip of longest primary feather) and tarsus length were collected at Beaver River WMA, while weights were collected at both WMAs. The tarsus is the section of a quail's foot above the toes and below the feathered leg. It appears to be part of the leg, but is actually part of the foot. Only measurements from fully grown quail were included. All quail exhibiting adult body plumage were considered fully grown unless aged as juveniles by buff-coloration on tips of primary covert feathers during July to December for northern bobwhite and July to November for scaled quail. Any repeat measurements for recaptured quail were averaged prior to

inclusion. Northern bobwhite weights differed marginally between WMAs for both males and females ( $p < 0.001$ ; Tables 1 and 2), with birds at Packsaddle WMA being slightly heavier. At Packsaddle WMA, female northern bobwhites were slightly heavier than males on average ( $p < 0.006$ ; Table 1), while at Beaver River WMA, northern bobwhites showed no signifi-

**Table 1. Body weight measurements (g) for northern bobwhites collected from fully grown live quail at Packsaddle Wildlife Management Area, OK, 2012–2017. Sample size, mean, standard deviation (SD) and range of measurements are given.**

<i>Northern Bobwhite – Packsaddle</i>				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Weight</b>				
Female	527	182	17.0	130 to 230
Male	600	180	15.2	131 to 230
All	1,128	181	16.1	130 to 230

**Table 2. Biometric measurements for northern bobwhites collected from fully grown live quail at Beaver River Wildlife Management Area, OK, 2012–2017. Sample size, mean, standard deviation (SD) and range of measurements are given for body weight (g), wing chord (mm) and tarsus length (mm).**

<i>Northern Bobwhite – Beaver River</i>				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Weight</b>				
Female	542	178	17.9	123 to 227
Male	705	176	15.8	115 to 240
All	1,247	177	16.8	115 to 240
<b>Wing chord</b>				
Female	299	113	3.30	103 to 125
Male	411	113	3.24	103 to 123
All	710	113	3.26	103 to 125
<b>Tarsus</b>				
Female	297	31.0	1.53	27.0 to 34.9
Male	403	31.2	1.51	27.1 to 35.1
All	700	31.1	1.52	27.0 to 35.1

cant differences between sexes in weight, wing cord length, or tarsus length ( $p>0.1$ ; Table 2). Scaled quail males had slightly longer tarsi and wing cords on average than females ( $p<0.001$ ), while weights did not differ significantly ( $p=0.3$ ; Table 3).

**Table 3. Biometric measurements for scaled quail collected from fully grown live quail at Beaver River Wildlife Management Area, OK, 2012–2017. Sample size, mean, standard deviation (SD) and range of measurements are given for body weight (g), wing chord (mm) and tarsus length (mm).**

<i>Scaled Quail</i>				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Weight</b>				
Female	192	202	17.8	149 to 264
Male	190	204	15.7	160 to 255
All	385	203	16.7	149 to 264
<b>Wing chord</b>				
Female	123	121	3.42	110 to 128
Male	116	123	3.55	115 to 133
All	239	122	3.59	110 to 133
<b>Tarsus</b>				
Female	126	31.5	1.62	26.4 to 35.8
Male	114	32.6	1.76	28.7 to 38.0
All	240	32.0	1.77	26.4 to 38.0

## Population Sex Ratios

The reliability of the population sex ratio data is dependent on the assumption that males and females have an equal probability of being captured during trapping. Given that all the quail were trapped using walk-in funnel traps baited with cracked corn and milo, this is a reasonable assumption. Therefore, data suggest the population sex ratio was slightly skewed towards a greater number of males compared to females for northern bobwhite at both WMAs ( $p<0.02$ ; Table 4), while for scaled quail the population sex ratio appeared even ( $p=0.9$ ; Table 4).

## Nesting – Northern Bobwhite

### *Sex of incubating adult*

Monitored northern bobwhite nests were three to four times more likely to be incubated by females compared to males both within and across WMAs ( $p<0.001$ ; Table 5). Shared incubation between male and female

**Table 4. Apparent population sex ratios (%) of northern bobwhite and scaled quail from trapping at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2017. Only quail of known sex were included.**

	<i>Sample size</i>	<i>Proportion females</i>	<i>Proportion males</i>
<b>Northern bobwhite</b>			
Beaver River	1,551	45	55
Packsaddle	1,554	47	53
All	3,105	46	54
<b>Scaled quail</b>			
Beaver River	459	51	49

**Table 5. Proportions (%) of nests incubated by females and males, respectively, for monitored northern bobwhite nests at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2016. Note: One nest at Packsaddle for which incubation was shared between the male and female was excluded.**

<b>Northern Bobwhite</b>		
	<i>Proportion female-incubated</i>	<i>Proportion male-incubated</i>
Beaver River	80	20
Packsaddle	76	24
All	78	22



**This hen bobwhite is incubating her well hidden nest.**



was observed during the study, but the data did not allow us to quantify how frequently it occurred.

### Nesting chronology

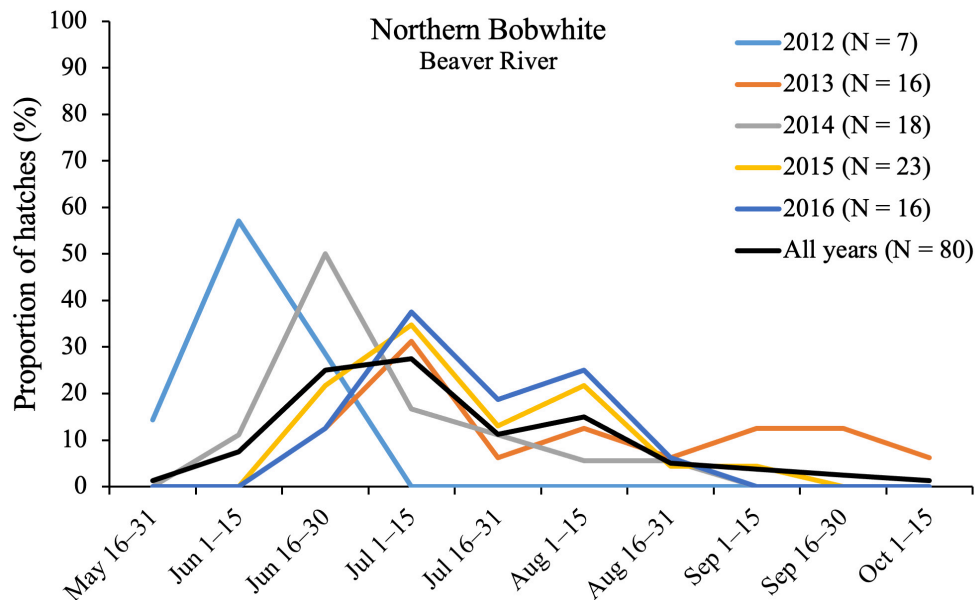
The timing of clutch (i.e., group of eggs) initiation (i.e., when the first egg was laid) and incubation initiation (i.e., the first day of incubation) was determined based on radio telemetry data or calculated from observed or estimated hatch dates, assuming a 23-day incubation period and an egg-laying frequency of one egg per day. Hatch dates were determined based on radio telemetry of the incubating adult and nest visits when the adult was no longer at the nest site. Unlike Packsaddle, all initiation dates were calculated from observed hatch dates at Beaver River WMA. Dates of clutch initiation, incubation initiation and hatch did not differ between WMAs for northern bobwhites ( $p > 0.08$ ). In general, nesting activity peaked in June and July, but there was considerable variability among years and WMAs (Table 6; Figures 1 through 3).

### Nest success

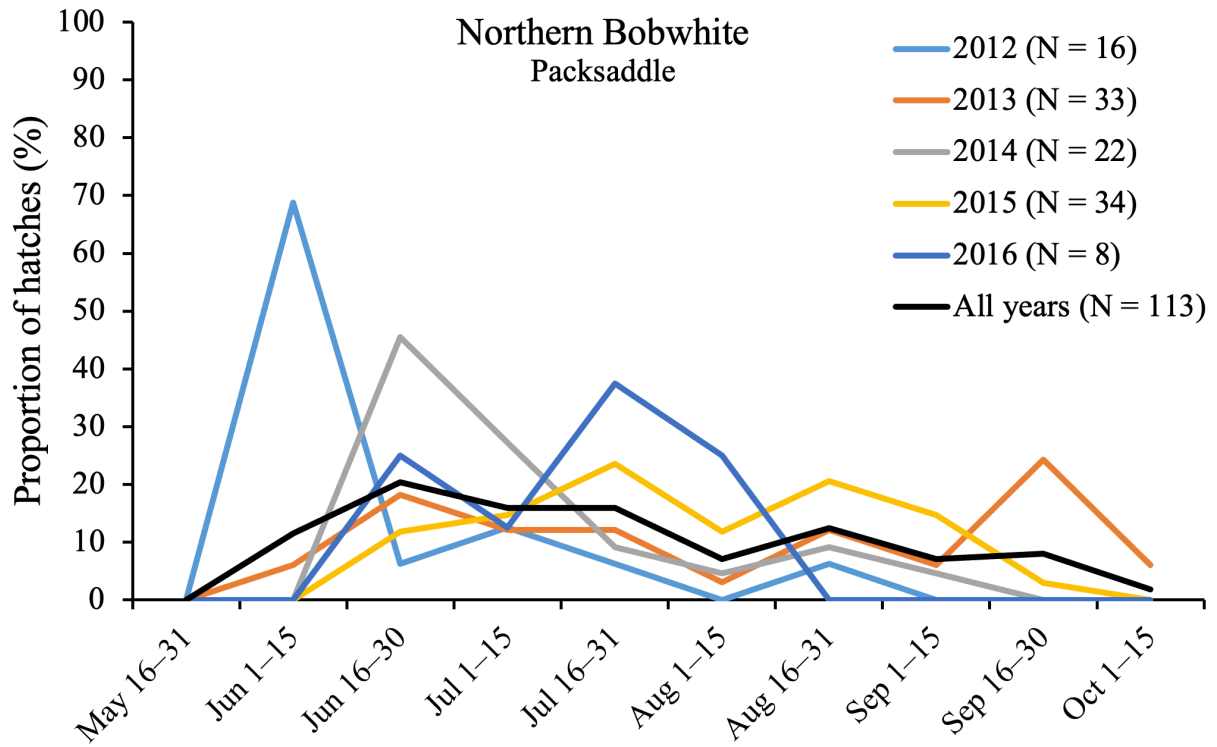
During the five years of nest monitoring, 55% of all monitored northern bobwhite nests successfully hatched at least one egg (Table 7). Nest success did not differ between WMAs ( $p = 0.4$ ) and there were no significant differences in nest success due to the sex of the incubating adult ( $p > 0.3$ ) or nesting attempt ( $p > 0.1$ ; Table 7).

**Table 6. Estimated dates (month/day) of clutch initiation, incubation initiation and hatch for monitored northern bobwhite nests at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2016. At Beaver River, all initiation dates were calculated from observed hatch dates. Data include all recorded nesting attempts for each bird (i.e., multiple nesting attempts by the same bird were included). For hatch date, only nests that successfully hatched  $\geq 1$  egg were included. Sample size, mean date, standard deviation (SD; days) and range (dates) are given for each variable.**

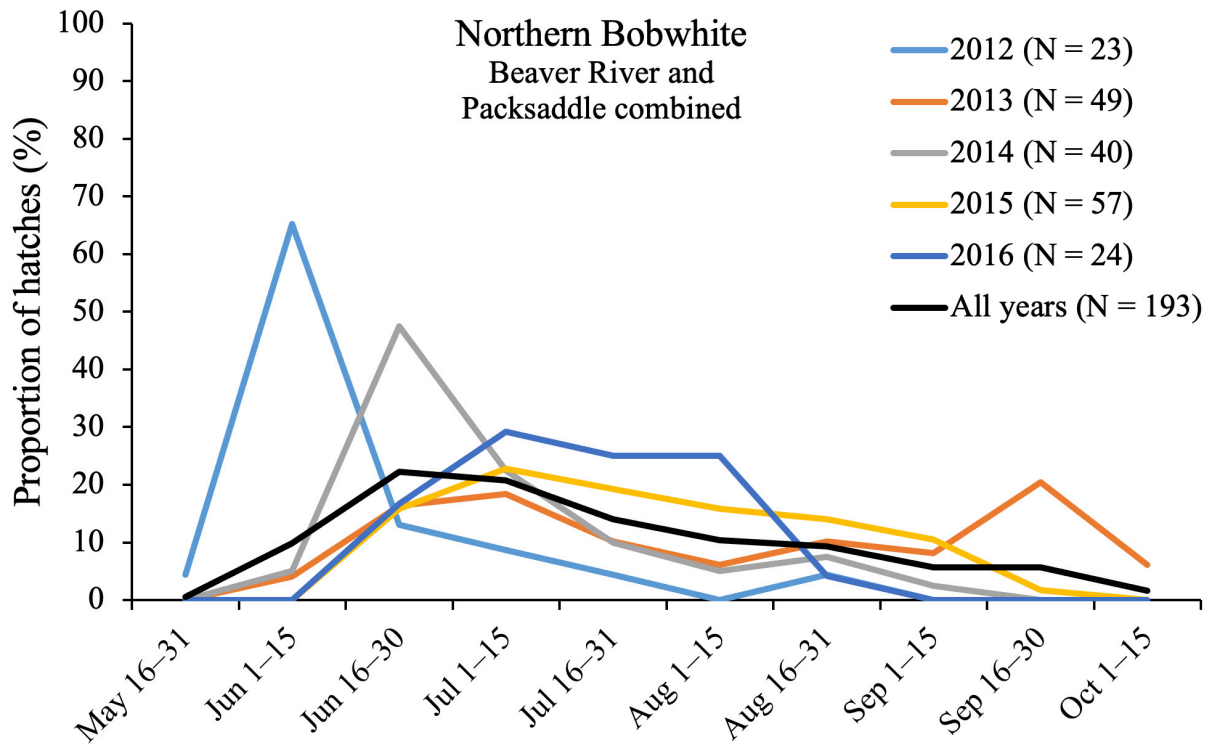
Northern Bobwhite				
	Sample size	Mean	SD	Range
<b>Clutch initiation</b>				
Beaver River	79	6/9	28	4/20 to 9/1
Packsaddle	191	6/14	33	4/19 to 9/4
All	270	6/12	32	4/19 to 9/4
<b>Incubation initiation</b>				
Beaver River	80	6/22	27	5/6 to 9/10
Packsaddle	195	6/27	31	5/9 to 9/14
All	275	6/26	30	5/6 to 9/14
<b>Hatch</b>				
Beaver River	80	7/15	27	5/29 to 10/3
Packsaddle	113	7/23	34	6/1 to 10/7
All	193	7/19	31	5/29 to 10/7



**Figure 1. Proportion of confirmed hatches (%) by time period (half-month) and year for monitored northern bobwhite nests at Beaver River Wildlife Management Area, OK, 2012–2016.**



**Figure 2. Proportion of confirmed hatches (%) by time period (half-month) and year for monitored northern bobwhite nests at Packsaddle Wildlife Management Area, OK, 2012–2016.**



**Figure 3. Proportion of confirmed hatches (%) by time period (half-month) and year for monitored northern bobwhite nests at Beaver River and Packsaddle Wildlife Management Areas combined, OK, 2012–2016.**

**Table 7. Overall nest success (%) for all nests combined, by sex of the incubating adult and by successive nesting attempt for monitored northern bobwhite nests at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2016. Nests success was defined as the proportion of all nests with known outcomes that successfully hatched  $\geq 1$  egg.**

	Northern Bobwhite					
	<i>Beaver River</i>		<i>Packsaddle</i>		<i>All</i>	
	<i>Sample size</i>	<i>Nest success</i>	<i>Sample size</i>	<i>Nest success</i>	<i>Sample size</i>	<i>Nest success</i>
All	152	53	196	58	348	55
Female-incubated	121	55	149	58	270	57
Male-incubated	31	45	45	58	76	53
First attempt	56	54	105	58	161	57
Second attempt	7	43	20	75	27	67
Third attempt	3	100	1	100	4	100

***Nest productivity***

Across all monitored northern bobwhite nests, clutch size averaged 13 eggs and hatching success (i.e., the proportion of eggs that hatched from a nest) averaged 44% (Table 8). Most of the egg loss during incubation was due to whole clutches being predated, destroyed or abandoned; and if only nests that successfully hatched at least one egg were considered, hatching success averaged 82%. Clutch size, number of eggs hatched and hatching success for all nests and successful nests only did not differ between WMAs ( $p > 0.6$ ; Table 8).



**A newly hatched brood of quail is ready to leave the nest.**



**A completed clutch of eggs will be incubated about 24 days.**

***Renesting and double-brooding***

Multiple nesting attempts during the same breeding season were common among monitored northern bobwhite hens. Renesting was documented in approximately half (53%; Table 9) of the instances where the hen was monitored and survived an entire breeding season, and there was no significant difference in the proportion of hens that renested based on whether the first nesting attempt failed or succeeded (59%,  $N=22$  and 42%,  $N=12$ , respectively;  $p > 0.4$ ). However, a substantial number of northern bobwhites normally perish during the almost six-month breeding season (late April to early October). Therefore, not all birds have an



**Table 8. Clutch size, number of eggs that hatched and hatching success (i.e., the proportion of eggs that hatched from a nest; %) for all nests and successful nests only for monitored northern bobwhite nests at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2016. A nest was considered successful when it hatched  $\geq 1$  egg. Sample size, mean, standard deviation (SD) and range are given for each variable.**

Northern Bobwhite				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Clutch size</b>				
Beaver River	148	13.0	3.2	1 to 20
Packsaddle	191	12.9	3.3	1 to 25
All	339	13.0	3.2	1 to 25
<b>Number of eggs hatched</b>				
Beaver River	152	5.6	5.9	0 to 17
Packsaddle	190	5.9	6.2	0 to 19
All	342	5.7	6.1	0 to 19
<b>Proportion of eggs hatched</b>				
Beaver River	148	43	44	0 to 100
Packsaddle	189	45	45	0 to 100
All	337	44	44	0 to 100
<b>Proportion of eggs hatched for successful nests</b>				
Beaver River	79	81	23	17 to 100
Packsaddle	103	82	25	5 to 100
All	182	82	24	5 to 100

**Table 9. Proportion of monitored northern bobwhite hens that renested and produced a second brood at Beaver River and Packsaddle Wildlife Management Areas, OK, 2012–2016. Renesting data are given for all breeding hens monitored throughout the entire breeding season or until they perished (all hens) and for breeding hens that survived the entire breeding season only (surviving hens). If a hen was followed for more than one breeding season, each breeding season was included as a separate data point.**

Northern Bobwhite			
	<i>Sample size</i>	<i>Proportion that renested</i>	<i>Proportion that double-brooded</i>
<b>All hens</b>			
Beaver River	14	29	7
Packsaddle	48	33	10
All	62	32	10
<b>Surviving hens</b>			
Beaver River	8	50	13
Packsaddle	26	53	15
All	34	53	15

opportunity to renest. When instances where the hen perished before the end of the breeding season was included, the overall renesting frequency decreased to 32% (Table 9). Of the 62 monitored breeding hens, only six (10%) successfully produced a second brood in the same breeding season (Table 9). This indicates that while renesting is relatively common among northern bobwhite in western Oklahoma regardless of the outcome of the first nesting attempt, successful double-brooding is not. Chicks observed in late season are typically from the first successful attempt from that particular hen. There were no differences in the proportions of renesting or double-brooding hens between WMAs ( $p=1.0$ ).

## Nesting – Scaled Quail

### *Sex of incubating adult*

Monitored scaled quail nests were nearly seven times as likely to be incubated by females compared to males ( $p<0.001$ ; Table 10). There were no observations of any case of shared incubation in scaled quail during the study.



**This nesting scaled quail choose a poorly concealed nest site and it subsequently failed.**

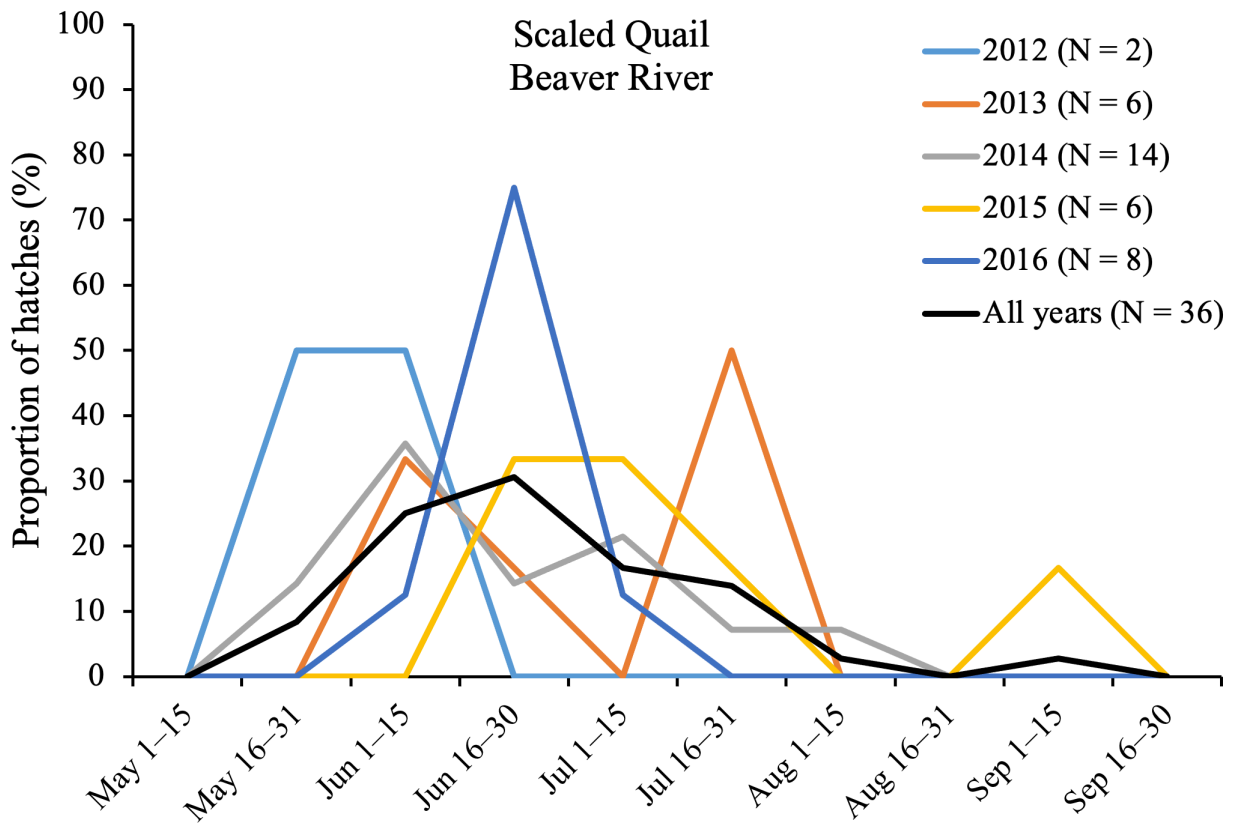


**Table 10. Proportion (%) of nests incubated by females and males, respectively, for monitored scaled quail nests at Beaver River Wildlife Management Area, OK, 2012–2016.**

Scaled Quail			
	Sample size	Proportion female-incubated	Proportion male-incubated
Beaver River	85	87	13

**Nesting chronology**

The timing of clutch (i.e., group of eggs) initiation (i.e., when the first egg was laid) and incubation initiation (i.e., the first day of incubation) was calculated from observed hatch dates, assuming a 23-day incubation period and an egg-laying frequency of one egg per day. Hatch dates were determined based on radio telemetry of the incubating adult and nest visits when the adult was no longer at the nest site. Unlike Packsaddle, all initiation dates were calculated from observed hatch dates at Beaver River WMA. In general, scaled quail nesting activity peaked in May and June, but there was considerable variability among years (Table 11; Figure 4).



**Figure 4. Proportion (%) of confirmed hatches by time period (half-month) and year for monitored scaled quail nests at Beaver River Wildlife Management Area, OK, 2012–2016.**

**Table 11. Dates (month/day) of estimated clutch and incubation initiation, and observed hatch for monitored scaled quail nests at Beaver River Wildlife Management Area, OK, 2012–2016. Data include all recorded nesting attempts for each bird (i.e., multiple nesting attempts by the same bird were included). Only nests that successfully hatched  $\geq 1$  egg were included. Sample size, mean (date), standard deviation (SD; days) and range (dates) are given for each variable.**

Scaled Quail				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Clutch initiation</b>				
Beaver River	36	5/22	24	4/11 to 8/8
<b>Incubation initiation</b>				
Beaver River	36	6/3	23	4/26 to 8/13
<b>Hatch</b>				
Beaver River	36	6/26	23	5/19 to 9/5

**Table 12. Overall nest success (%) for all nests combined, by sex of the incubating adult and by successive nesting attempt for monitored scaled quail nests at Beaver River Wildlife Management Area, OK, 2012–2016. Nests success was defined as the proportion of all nests with known outcomes that successfully hatched  $\geq 1$  egg.**

Scaled Quail		
	<i>Sample size</i>	<i>Nest success</i>
All	85	42
Female-incubated	74	43
Male-incubated	11	36
First attempt	51	49
Second attempt	14	36
Third attempt	2	0

### **Nest success**

During the five years of nest monitoring, 42% of monitored scaled quail nests successfully hatched at least one egg (Table 12). There were no significant differences in nest success due to the sex of the incubat-

ing adult ( $p=0.8$ ) or successive nesting attempt ( $p>0.4$ ; Table 12).

### **Nest productivity**

Across all monitored scaled quail nests, clutch size averaged 12 eggs and hatching success (i.e., the proportion of eggs that hatched from a nest) averaged 39% (Table 13). Most of the egg loss during incubation was due to whole clutches being predated, destroyed or abandoned; and if only nests that successfully hatched at least one egg was considered, hatching success averaged 90%.

**Table 13. Clutch size, number of eggs that hatched and hatching success (i.e., the proportion of eggs that hatched from a nest; %) for all nests and successful nests only for monitored scaled quail nests at Beaver River Wildlife Management Area, OK, 2012–2016. A nest was considered successful when it hatched  $\geq 1$  egg. Sample size, mean, standard deviation (SD) and range are given for each variable.**

Scaled Quail				
	<i>Sample size</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
<b>Clutch size</b>				
Beaver River	84	11.7	3.2	3 to 21
<b>Number of eggs hatched</b>				
Beaver River	85	4.8	6.1	0 to 18
<b>Proportion of eggs hatched</b>				
Beaver River	84	39	46	0 to 100
<b>Proportion of eggs hatched for successful nests</b>				
Beaver River	36	90	14	33 to 100

### **Renesting and double-brooding**

Only 20% of monitored scaled quail hens that survived the entire breeding season renested (Table 14), and there was no significant difference in the proportion of hens that renested based on whether the first attempt failed or succeeded (33%,  $N=6$  and 11%,  $N=9$ , respectively,  $p>0.5$ ). The overall renesting frequency did not change markedly when nesting hens that perished before the end of the breeding season was included (Table 14). Of the 27 monitored breeding hens, only three renested following a successful first attempt but none were successful at producing a second brood (Table 14). This indicates renesting is not very common

among scaled quail in western Oklahoma and double-brooding even less so. Chicks observed in late season are typically from the first successful attempt from that particular hen and are not likely a second brood produced.

**Table 14. Proportion (%) of monitored scaled quail hens that renested and produced a second brood at Beaver River Wildlife Management Area, OK, 2012–2016. Renesting data are given for all breeding hens monitored throughout the entire breeding season or until they perished (all hens) and for breeding hens that survived the entire breeding season only (surviving hens). No scaled quail was followed for more than one breeding season.**

Scaled Quail			
	Sample size	Proportion that renested	Proportion that double-brooded
<b>All hens</b>			
Beaver River	27	26	0
<b>Surviving hens</b>			
Beaver River	15	20	0

### Acknowledgements

We would like to recognize the dedication and hard work during countless hours in the field by the 57 technicians who made this report possible. We also would like to thank Oklahoma Department of Wildlife Conservation personnel at Packsaddle WMA (Marcus Thibodeau, Scott Parry, Zachary Handke, Jeremiah Zurenda, and Todd Atha) and Beaver River WMA (Weston Storer and Cody Crisswell). This research was funded by Oklahoma Department of Wildlife Conservation and administered by the Oklahoma Cooperative Fish and Wildlife Research Unit. Additional funding was provided through the Bollenbach Endowed Chair for Wildlife Management and the Groendyke Endowed Chair for Wildlife Conservation. Further support was provided by the Oklahoma Agricultural Experiment Station and Hatch research project OKLO2838.

## Summary Points

### Northern bobwhite

- The breeding season for northern bobwhites in western Oklahoma occurred from late April through early October.
- The timing of northern bobwhite nesting activity varied greatly among years and also between WMAs, suggesting that timing is highly dependent on local weather and habitat conditions.
- About one in five northern bobwhite nests were incubated by males.
- Northern bobwhite nest success was good, with 55% of nests hatching at least one egg.
- Successful northern bobwhite nests hatched 10.7 chicks on average.
- Renesting was common among northern bobwhite hens, regardless of the outcome of the first nesting attempt. But double-brooding was rare, with only one in 10 hens managing to produce a second brood the same season.
- Chicks observed in late season are typically from the first successful attempt from that particular hen.

### Scaled quail

- The breeding season for scaled quail in western Oklahoma occurred from mid-April through early September.
- The timing of scaled quail nesting activity varied greatly among years, suggesting that timing is highly dependent on local weather and habitat conditions.
- About one in eight scaled quail nests were incubated by males.
- Scaled quail nest success was good, with 42% of nests hatching at least one egg.
- Successful scaled quail nests hatched 11.3 chicks on average.
- Renesting was not common among scaled quail hens, regardless of the outcome of the first nesting attempt, and none of the monitored hens managed to produce a second brood the same season.
- Chicks observed in late season are typically from the first successful attempt from that particular hen.

For additional information about the results of this research and to download research and Extension publications, visit: <http://wildlifechairs.okstate.edu/>. Also, please contact Dwayne Elmore at [dwayne.elmore@okstate.edu](mailto:dwayne.elmore@okstate.edu) for specific quail management recommendations for your property.



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**EXTENSION**