

GAME MORTALITY RESULTING FROM A SEVERE SNOW AND ICE STORM IN TENNESSEE

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In general, only a small portion of the annual increment of game populations is harvested by the hunter. Wildlife technicians have often speculated as to the reasons why a part of the "unharvested" portion of the annual increment is not carried over into the breeding season. Such speculation often brings attention to the reduction of the potential spring breeding population by severe winter weather. It is a known fact that "winter-kill" does occur but it is apparently more common in the Northern than in the Southeastern States. Although numerous reports of "winter-kill" occur in the literature, it is seldom that these reports contain qualitative data collected from extensive areas. Following a period of exceptionally severe winter weather the planning, administrative, and time factors involved in an extensive study of "winter-kill" generally prohibit the organization of a study based on sound sampling procedures. It is an exceptional case when a study of the effects of a severe snow and ice storm on game populations can be integrated immediately with a current state-wide study. Such an instance occurred in Tennessee during the winter of 1950 - 51 with the advent of a destructive snow and sleet storm while a state-wide wildlife survey was in progress (Fig. 1, 2). The organization of this state-wide survey was conducive to the immediate integration of field work with a study on "winter-kill."

Although the project leader collected a limited amount of data, the main burden of interviewing was carried by the assistant project leaders: R. H. Anderson, Jack A. Fox, William H. Griffin, Eugene Legler, Jr., Walter M. Weaver, and Gerald A. Webb. Clerical assistance was received from M. J. Burrow, Pearl G. Lister, and Blanche G. Wheeler.

Mr. Al Marsh, Chief of the Game Management, furnished information collected by his section. His request for immediate information on "winter-kill" was the major influence on the establishment of this study.

Photographs are the courtesy of The Southern Bell Telephone and Telegraph Company.

METHOD OF STUDY

The design of the State-wide Wildlife Survey has been discussed by Schultz (1950). The method of sampling applied is known as "area sampling." In brief, the method consists of dividing the study area into many small areas of land which contain approximately equal numbers of the population to be interviewed. The total land area for this survey, the "Open Country Zone" of Tennessee, was divided into 50,914 small areas. These areas are called "sampling units" and contain an average of five indicated dwellings. A total of 1,000 of these sampling units was selected at random (a sampling ratio of approximately 1/51) and the heads of farm households and hunters, dwelling on these selected areas, were interviewed personally (Fig. 3).



Fig. 1. Scene in Davidson County, Tennessee.

As the wildlife survey had been in progress since September, 1950, only a portion of the 1,000 sampling units were involved in a study of "winter-kill" resulting from the snow and ice storm which occurred during late January and early February. As a result of various difficulties that arose, only 523 of the 1,000 sampling units were used on the game mortality study. As the primary sampling ratio was 1 to 51, the sampling ratio for this study on "winter-kill" is approximately 1 to 100. The 523 areas used were selected primarily by adhering to a strict system of random selection using a table of random sampling numbers, i.e., half the areas in each county were selected at random with the intention of contacting first in all counties respondents in this portion of the sample before attempting to complete all areas in a county. The few deviations resulted from the fact that the first one-half of the sampling was nearing completion and a few counties were in the process of completion at the initiation of the mortality study.

Immediately following the inclement weather resulting from the storm, Mr. Marsh, Chief of the Game Management Section, suggested that field men, in conjunction with their regular survey work, submit notes on observed mortality. Although such a method of obtaining data on "winter-kill" served the desired purpose, it did not take full advantage of the experimental design. In order to take full advantage of the design, it was necessary that all eligible respondents on the sampling areas be contacted and that negative as well as positive reports be tabulated.

After a few weeks of taking notes on "winter-kill" it became apparent that if a reminder or question was not attached directly to all questionnaires, interviewers



Fig. 2. Scene in Wilson County, Tennessee.

would often forget to inquire about mortality or neglect to record negative answers; therefore, during March an extra page containing a reminder was attached to all appropriate questionnaires. It was as follows: "MORTALITY AS A RESULT OF ICE STORM." Personnel were instructed when inquiring about observed mortality to mention "doves, quail, rabbits and other animals." Only actual observations of respondents were recorded. No hearsay information on mortality has been used in this paper. This paper is based only on data obtained after the above procedure was initiated (Appendix 1).

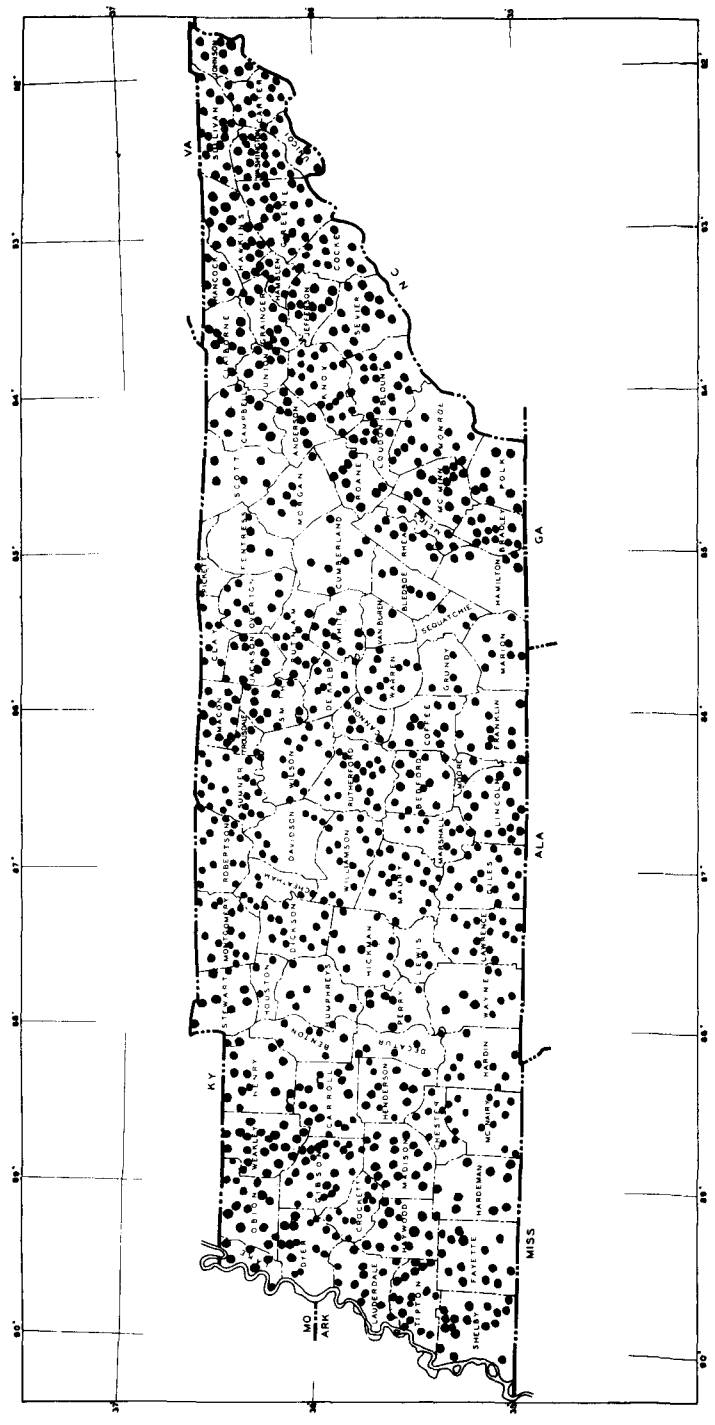


Fig. 3. Distribution of sample areas.

As a result of an oversight on the part of the project leader, who assumed mortality of songbirds would be recorded along with game species, two of the seven project personnel did not record "winter-kill" of songbirds for a period of about two months. Their work was primarily in Central West Tennessee. This undoubtedly accounts for the lack of reports on songbirds in Chester, Dacatur, McNairy and Madison counties. The wildlife survey in Dickson and Shelby counties was nearing completion when the mortality study was initiated; therefore, the complete lack of reports of game mortality in these counties is not unreasonable even though the counties lie in the storm area.

It is conceivable that mortality observed in East Tennessee during the 14th, 15th and 16th of January, a period of heavy snowfall in that region, might be reported as having occurred during the "Big Snow" of January 28 - February 1.

The sample size is not adequate for estimating parameters at a county level however, it is probably suitable for estimating observed "winter-kill" on a regional basis. The "sampling errors" in estimating observed mortality will be computed at a later date when this paper will be prepared for publication.

RESULTS

Climatological Data

Climatological data is derived primarily from Eklund et al. (1951), Anonymous (1951), and Weather Bureau (1951a,b). The period of severe winter weather referred to in this paper began on the 28th of January (1951) and was preceded by relatively mild weather. For Tennessee in general this warm period was from the 10th to the 20th with the highest temperatures for the month being recorded at most stations on the 19th and 20th. Severe weather was not restricted to Tennessee, but in the Southeast extended from the Gulf of Mexico through Kentucky (Fig. 4).

Most of the precipitation for January occurred during three storms. The most important period of precipitation occurred from the 28th of January until the 1st of February. This precipitation resulted from a cold arctic air mass, moving in a southeasterly direction, being overrun by moist tropical air. Thus occurred the most destructive "sleet, freezing rain and snow storm" on record for the western and central sections of Tennessee (Fig. 5). The weather was nearly as severe east of Chattanooga but in general the Eastern Tennessee River Valley did not have the ice and extreme depths of snow that occurred in West and Central Tennessee.

This period of inclement weather began with a heavy rain during January 28. Over West Tennessee the freezing rain and sleet fell during the night and by the morning of the 29th a thin layer of ice was on the ground. Freezing rain, sleet and light snow fell during the night of the 29th and by the morning of the 30th up to two inches of ice and snow covered the ground. In Henry County, Tennessee, sleet and snow were reported on January 30 and 31, continuing until the morning of February 1, at which time there was an eight-inch layer of snow and ice on the ground and a temperature of four degrees below zero was reported. This county is in the area of relatively light damage to telephone installations (Fig. 5). Very little ice formed on telephone lines in Henry County, however, in this county, as well as

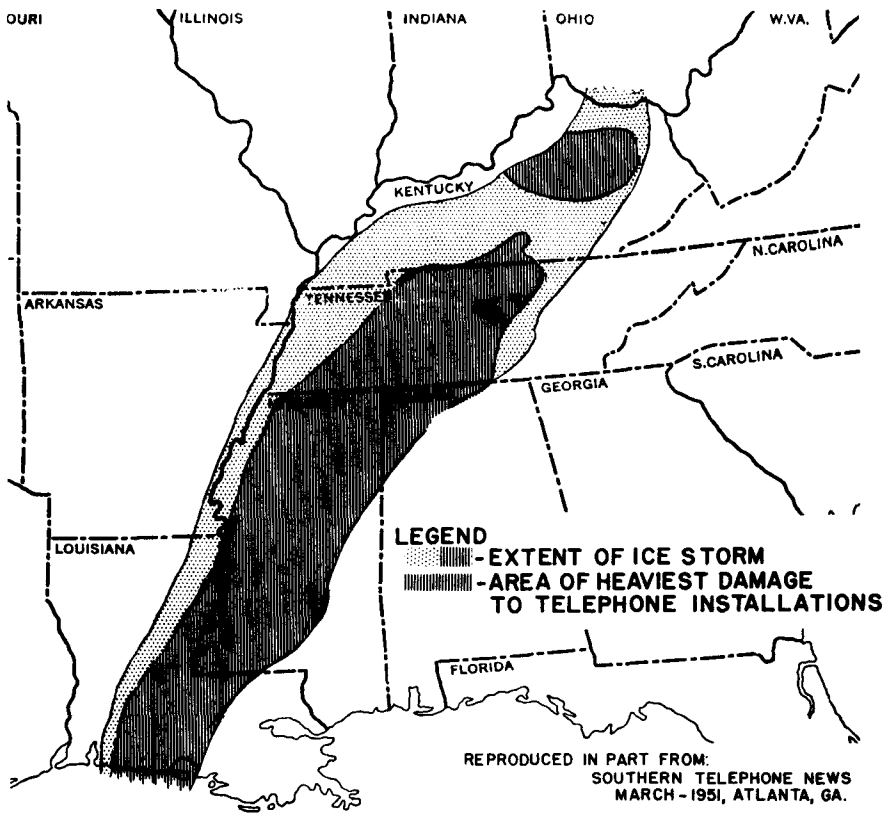
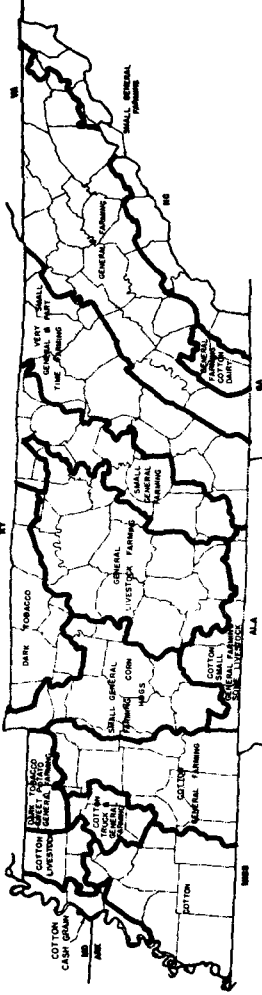


Fig. 4. Extent of ice storm in the Southeastern states January 28 - February 1, 1951.

others in West Tennessee, heavy ice did in general cover the ground. In Hardin County, Tennessee, shown as being in the area of severe damage to telephone installations (Fig. 5), the reported snow and ice layer ranged from 1 to 6.5 inches in depth. Layers of ice up to 2 inches thick covered trees, power lines and telephone lines. Trees and wires had fringes of icicles up to eight inches long. Although the reports are conflicting, it appears that in general the greatest snow fall and ice cover occurred in Central Tennessee. The lowest reported temperatures during this storm did not occur until the morning of February 2, when 21.5 degrees below zero occurred in Henry County, 23 below zero in Gibson County, 26 below zero in Carroll County and 13 below zero in Davidson County. The snow cover which ranged from 6 to 8 inches in depth had a water equivalent of almost 5 inches.

Throughout the State the temperature was below normal for the first ten days of February. The snow and ice melted slowly over the area of greatest snow depth and, with additional light snow flurries, traces remained on the ground until February 12. With a few exceptions the rest of the month was unseasonably warm.



TYPES OF FARMING IN TENNESSEE

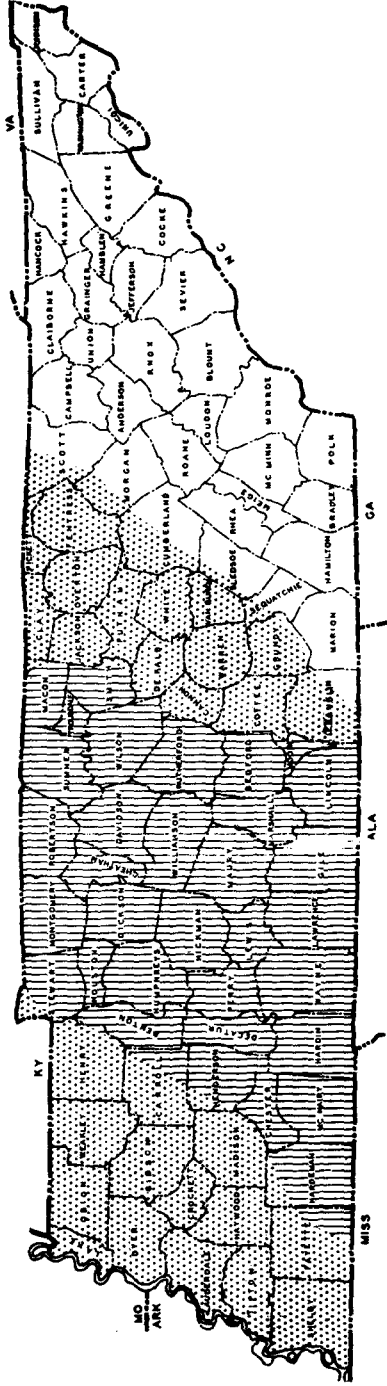


Fig. 5. Approximate extent of ice storm in Tennessee.

Winter-kill

The extreme severity of the storm that commenced the 28th of January caused wildlife technicians and administrators to speculate as to the effect of the storm on game populations. The data collected during this study of "winter-kill" should be a valuable indicator of population changes that occurred during the storm.

Although the data in Appendix 1 refers only to quail, rabbits, doves and songbirds, a few reports of "winter-kill" were obtained on other animals. Reports were received on "winter-kill" of 1 deer, Greene County; 1 opossum, Unicoi County; 4 opossum, Carter County; 4 muskrats, Obion County; 1 coot, Coffee County; and 4 ducks and 1 fox squirrel, Lauderdale County. The habits and numbers of various species, e.g., squirrel and deer, respectively, would undoubtedly have an effect on the number of dead animals observed. These even appear to affect the number of observations of quail, rabbits, doves, and songbirds (Tables 1, 2).

Of the 1,961 eligible respondents in Tennessee interviewed on winter-kill 421, of 21%, reported seeing animals dead as a result of the ice and snow storm. The counties in which mortality of quail, rabbits, doves and songbirds were reported are shown in Figure 6. It is obvious that it is incorrect to analyze the data strictly on the basis of these maps as there is no way to determine the intensity of the kill from the maps alone. From Table 1 it is seen that the percentage of persons observing mortality varies extremely between counties. In general, the large percentages are associated with counties in the ice storm area and a few of these counties are located in the region of relatively mild ice damage to telephone installations, a region which in general had a heavy ice cover on the ground (Fig. 5). The large percentage of persons reporting mortality in these areas of relatively little ice damage is possibly a result of: 1) the increased total kill due to relatively large numbers of quail, rabbits, doves, and songbirds and 2) inclement weather. Similarly the few reports from Bledsoe, Grundy, Marion, Sequatchie, and Van Buren counties, which are in the southern portion of the Cumberland Plateau, may be a result of the relatively poor populations of small game in this region or because these counties are on the edge of the storm area and only a small portion of each county suffered ice damage. The populations of small game of the Eastern Tennessee River Valley are generally smaller than those in West and Central Tennessee and this should be taken into consideration when inspecting the data. It is not the object of this paper to integrate the farming-types of Tennessee (Fig. 5) with "winter-kill"; however, there appears to be a definite association of "winter-kill" with them. When analyzed on a regional basis 28% of the respondents in the area of the ice storm (West and Central Tennessee) reported mortality while only 8% of the respondents in the area of "relatively mild" weather (East Tennessee) reported "winter-kill." The 8% is probably an overestimation as a result of including in this area counties such as Cumberland, Morgan and Scott in which the ice storm occurred over a fairly large portion of the county.

The sampling procedure applied on this study is compatible with the estimation of reliable population parameters. The estimations presented in Table 2 have been arrived at by using a conversion factor derived from the sampling ratios (Table 2). From a statistical standpoint this method of estimating the total observed kill from the sample leaves much to be desired, however, the estimations obtained should be valuable in assessing the "winter-kill" in Tennessee.

Table 1. Percentage of observed mortality. ^a

Area	Number of Counties	Total persons			%	Percent of persons interviewed reporting						Percent of observations		
		Interviewed	Report Mortality	Mortality		Quail	Rabbit	Dove	Songbird	Quail	Rabbit	Dove	Songbird	
														2
State of Tennessee West &	95	1961	421	21	2	3	8	13	10	14	36	61		
Central Tenn. ^b	61	1329	369	28	2	4	9	18	9	15	34	66		
East Tennessee	34	632	52	8	2	1	4	3	19	8	46	31		

^a Caution should be exercised when analyzing the data in this table. It should be realized that the variability in the observations was not taken into consideration when computing these percentages. As a result of the differential response in regard to songbird mortality between East Tennessee and West and Central Tennessee, the percentages listed under: "Percent of Observations Concerning" are not suitable for use in evaluating differential "winter-kill" in game species between the two regions.

^b West and Central Tennessee refers to the ice storm area while East Tennessee includes the remainder of the State (Fig. 5).

Table 2. Estimated observed mortality ^a.

Area	Total no. of sampling units	No. of sampling units used	Conversion factor	Estimated observed mortality		
				Quail	Dove	Total
State of Tennessee West &	1000	523	96.9	16,764	20,737	84,884
Central Tenn. ^b	659	347	96.9	14,438	19,380	73,450
East Tennessee	341	176	96.9	2,326	1,357	11,434
						122,385

^a Caution should be exercised when analyzing the data in this table. It should be realized that the variability in the observations was not taken into consideration when computing these estimates. The conversion factor was computed as follows:
 $51 \text{ (Primary Sampling Ratio, } 1/51) \times 1.9 \text{ (Sub-sampling Ratio, } 1/1.9) = 96.9 \text{ (Conversion Factor.)}$

A question mark in Appendix 1 was evaluated as being equal to the average observed mortality of the species.

Dove? = 5.8. Rabbit? = 3.5.

^b West and Central Tennessee refers to the ice storm area while East Tennessee includes the remainder of the state.

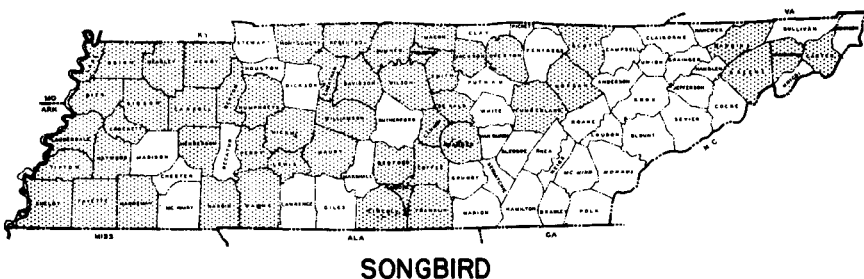
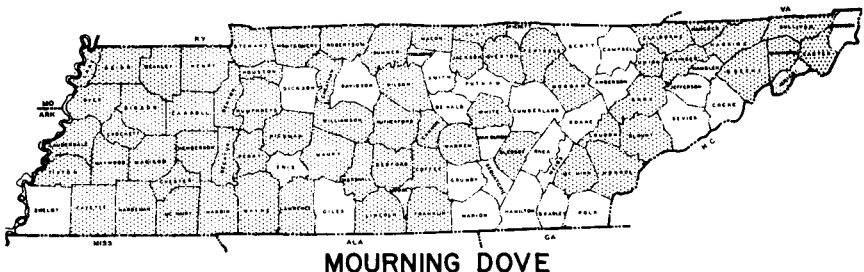
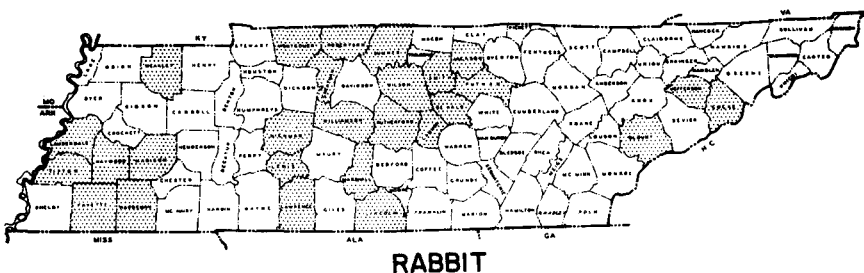
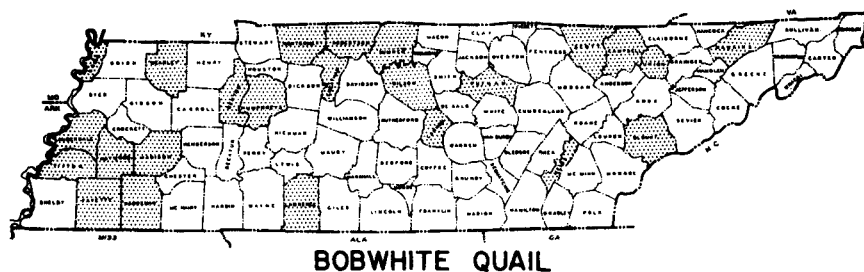


Fig. 6. Counties in which mortality was reported.

The estimations of observed mortality are: 16,764 quail; 20,737 rabbits and 84,884 doves (Table 2). It is difficult to speculate soundly concerning the number of these species that were not observed, however, it is not difficult to conceive of their numbers being many fold those actually observed.

Without a doubt it can be stated that during the "Big Snow" a large number of small game animals perished in Tennessee; however, the largest "winter-kill" occurred in the ice storm area (Tables 1, 2). It is difficult to ascertain what effect

this "winter-kill" will have on the 1951 hunter harvest as: 1) Tennessee was fortunate in having what appears to have been an above average breeding season and 2) the percentage "winter-kill" of the total population is not known.

The fall dove population was relatively poor from the standpoint of the hunter. What effect the "winter-kill" of doves had on the dove population in Tennessee is a moot point as it is not known whether or not the "winter-kill" was of resident or of wintering birds.

LITERATURE CITED

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APPENDIX

Appendix 1. Mortality data.

County	Total Persons Reporting			Total Persons Reporting				Number of Animals Observed		
	Interviewed	Mortality	%	Quail	Rabbit	Dove	Songbird	Quail	Rabbit	Dove
Anderson	17	0	0	0	0	0	0	0	0	0
Bedford	21	6	29	0	0	5	4	0	0	2-5-4-3-3
Benton	8	4	50	2	0	2	2	4-1	0	1-4
Bledsoe	10	1	10	0	0	1	0	0	0	3
Blount	36	2	6	1	1	1	0	2	2	1
Bradley	8	1	13	0	0	0	0	0	0	0
Campbell	10	10	100	1	0	0	0	3	0	0
Cannon	13	4	31	1	3	1	2	2	1-2-1	1
Carroll	26	11	42	0	0	3	10	0	0	? a-2-6
Carter	25	3	12	0	0	1	1	0	0	3
Cheatham	20	11	55	1	1	2	10	2	1	2-?
Chester	15	4	27	0	0	4	0	0	0	3-1-1-2
Claiborne	23	2	9	0	0	2	0	0	0	8-?
Clay	7	1	14	0	0	1	0	0	0	?
Cocke	15	1	7	0	1	0	0	0	1	0
Coffee	15	6	40	0	0	2	4	0	0	2-3
Crockett	28	6	21	0	0	4	2	0	0	2-5-3-1
Cumberland	16	3	19	0	0	0	3	0	0	0
Davidson	6	4	67	0	0	0	4	0	0	0
Decatur	4	1	25	0	0	1	0	0	0	12

Appendix 1. Continued.

Dekalb	16	3	19	0	1	0	2	0	2	0
Dickson	1	0	0	0	0	0	0	0	0	0
Dyer	17	6	35	0	0	2	6	0	0	2-2
Fayette	40	24	60	4	8	4	21	4-5-4 36	2-12-3- 2-2-3- 4-5	11-18 3-8
Fentress	10	1	10	0	0	1	0	0	0	2
Franklin	19	5	26	0	0	2	3	0	0	3-2
Gibson	30	3	10	0	0	2	2	0	0	12-2
Giles	23	0	0	0	0	0	0	0	0	0
Grainger	12	2	17	0	0	2	0	0	0	?-4
Greene	58	4	7	0	0	4	1	0	0	6-12- 1-1
Grundy	3	0	0	0	0	0	0	0	0	0
Hamblen	13	2	15	2	0	0	0	4-2	0	0
Hamilton	9	0	0	0	0	0	0	0	0	0
Hancock	10	2	20	0	0	2	0	0	0	3-1
Hardeman	31	15	48	2	1	6	11	12-4	3	2-4-? 1-4-3
Hardin	21	15	71	0	0	5	13	0	0	3-13-3 100-13
Hawkins	33	6	18	3	0	2	3	5-4-4	0	4-4
Haywood	35	17	49	3	3	4	13	2-6-3	2-2-2	6-2-2-2
Henderson	19	15	79	0	0	6	10	0	0	2-2-5 7-2-7
Henry	19	4	21	0	0	2	4	0	0	2-3
Hickman	17	9	53	0	2	3	6	0	1-1	2-7-?
Houston	5	1	20	0	0	1	0	0	0	3
Humphreys	19	7	37	1	0	3	5	0	0	2-2-4
Jackson	25	7	28	0	2	2	6	0	3-2	2-2
Jefferson	19	2	11	0	2	0	0	0	?-?	0
Johnson	20	0	0	0	0	0	0	0	0	0
Knox	22	1	5	0	0	1	0	0	0	17
Lake	18	4	22	1	0	1	3	0	0	1
Lauderdale	53	14	26	1	1	1	11	0	5	8
Lawrence	30	7	23	1	1	5	0	0	2	1-2-3 18-50
Lewis	2	2	100	0	1	0	1	0	?	0
Lincoln	24	4	17	0	1	2	3	0	3	2-6
Loudon	12	1	8	0	0	1	0	0	0	1
McMinn	24	1	4	0	0	1	0	0	0	4
McNairy	26	6	23	0	0	6	0	0	0	1-3-3 4-4-4
Macon	22	6	27	0	0	1	6	0	0	1
Madison	29	6	21	2	1	4	0	2-12	3	1-1-4-4
Marion	14	0	0	0	0	0	0	0	0	0
Marshall	19	2	11	0	1	2	0	0	6	2-5
Maury	32	2	6	0	0	2	1	0	0	4-?
Meigs	2	1	50	1	0	0	0	0	0	0
Monroe	25	1	4	0	0	1	0	0	0	?
Montgomery	33	6	18	1	1	1	5	0	3	1
Moore	6	2	33	0	0	0	2	0	0	0
Morgan	15	5	33	0	0	1	4	0	0	2
Obion	66	8	12	0	0	2	5	0	0	2-4
Overton	25	5	20	0	0	2	4	0	0	1-5
Perry	5	3	60	0	0	2	2	0	0	3-6
Pickett	5	0	0	0	0	0	0	0	0	0
Polk	12	0	0	0	0	0	0	0	0	0

Appendix 1. Continued.

Putnam	20	1	5	1	1	0	0	2	1	0
Rhea	11	0	0	0	0	0	0	0	0	0
Roane	13	0	0	0	0	0	0	0	0	0
Robertson	39	13	33	2	5	4	6	3-9	4-2-6	2-4-6-8
									3-1	
Rutherford	33	6	18	0	3	3	0	0	1-3-15	1-2-?
Scott	16	3	19	1	0	0	2	0	0	0
Sequatchie	8	0	0	0	0	0	0	0	0	0
Sevier	22	0	0	0	0	0	0	0	0	0
Shelby	12	1	8	0	0	0	1	0	0	0
Smith	23	7	30	0	1	0	6	0	2	0
Stewart	13	2	15	0	0	1	0	0	0	?
Sullivan	44	1	2	0	0	1	0	0	0	12
Sumner	45	12	27	2	8	1	1	4-1	3-2-3-2	3
									1-3-2-3	
Tipton	55	29	53	5	8	7	22	2-3-4	12-1-7	1-2-2
								2-5	3-6-5	3-5-6
									3-3	?
Trousdale	6	5	83	0	0	0	5	0	0	0
Unicoi	10	1	10	0	0	0	0	0	0	0
Union	11	1	9	1	0	1	0	0	0	?
Van Buren	34	0	0	0	0	0	0	0	0	0
Warren	14	2	14	0	0	1	1	0	0	5
Washington	37	4	11	0	0	2	2	0	0	3-5
Wayne	8	3	38	0	0	1	2	0	0	2
Weakley	44	6	14	1	1	2	4	0	17	4-24
White	15	2	13	0	0	2	0	0	0	3-6
Williamson	35	3	9	0	1	1	2	0	3	5
Wilson	25	10	40	2	1	4	9	3-12	5	1-2-10
										100
Total	1961	421		43	61	150	258	173	203	801
									3-?	13-?

*No information obtained on number observed.