

SURVIVAL AND MORTALITY IN EUROPEAN WILD HOGS

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Abstract: European wild hogs (*Sus scrota*) were trapped, marked for identification and released. Recoveries by trapping and hunter kills provided data on survival, mortality, and longevity. Average annual survival was 49 percent and did not vary by age. Hunting mortality does vary with tagging age, season of birth and time of tagging. However, hunting mortality replaces natural mortality and does not increase total mortality. Most non-hunting mortality occurs between winter and spring. A mean life expectancy of 1.5 years, slightly higher for females; a population turnover period and ecological longevity of 7+ years for females and 5 years for males; and a maximum life span of 10 years were estimated.

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The purposes of this study were to determine (1) age specific survival and mortality rates and, (2) longevity, and (3) to construct life tables for the species.

The European wild hog was introduced into the Southern Appalachians in 1912 (Jones 1959). Life history and management information were totally lacking on the species in its new habitat. Thus, trapping and marking hogs began on a limited basis in 1956 and a long-term investigation to obtain needed information was started in Tennessee in 1959. This study is part of that investigation.

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METHODS AND PROCEDURE

The study was conducted from 1956 through 1971 on the Tellico Wildlife Management Area (now the Tellico Unit of the Cherokee Wildlife Management Area), located in the Appalachian mountains of southeastern Tennessee. The hog population on the 31,792 ha study area during the time of this study varied from 200 in 1959 to 797 in 1968, as estimated by the Lincoln Index. Trapping of wild hogs using a box-type portable trap (Matschke 1962) was conducted throughout the year except during the annual hunts (October-December). Traps were located near feeding or wallowing sites or in areas proven to be good trapping sites in the past. Trapped hogs were eartagged and earnotched (Winters 1952). Harvested hogs were examined for eartags, earnotches, age and sex at 1 of 3 checking stations. Data were analyzed by sex, age, season of birth and time prior to the hunting season when marked.

Although hogs were marked in different years, composite tabulations were made of the data for construction of life tables by considering the year marked as the base year. Survival was estimated by dividing the number of marked hogs killed during a year by the number of marked hogs killed the previous years ($S = \frac{N_2}{N_1}$) (Eberhardt 1969). Survival of

hogs from tagging until the first hunting season was estimated by dividing the proportion of marked hogs killed that were tagged during a specified time period prior to the hunting season by the proportion of marked hogs killed that were tagged immediately prior to the

hunting season ($S = \frac{P_2}{P_1}$). Life tables (Deevey 1947, Allee *et al.* 1949) were utilized to present concise summaries of survival and mortality.

RESULTS

From 1956 through 1971, 502 hogs were tagged on the study area. Forty-two percent of these animals were harvested on the area, with the majority of recoveries occurring the hunting season following tagging and the rate of recovery decreasing in subsequent years (Table 1). The time period elapsing between marking and the hunting season was a major determinant of recovery rate. Those tagged within 3 months of the hunting season were harvested at the highest rate and the percentage killed decreased in direct proportion to the time elapsed from tagging to the start of the hunting season.

Table 1. Number of European wild hogs marked, recoveries, and time prior to the hunting season when marked, Tellico Wildlife Management Area, Tennessee, 1957 through 1971.

Days prior to hunting when marked	No. mkd.	Recoveries by hunting (number of years following marking)										Total	
		Same year		1		2		3		4'			
		no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
0-90	166	43	25.9	20	12.0	10	6.0	4	2.4	3	1.8	79	50.0
91-180	172	38	22.1	21	12.2	13	7.6	2	1.2	1	0.6	75	43.6
181-270	121	26	21.5	7	5.8	2	1.7	6	5.0	2	1.7	43	35.5
271-360	43	6	14.0	5	11.6	1	2.3	1	2.3	2	4.7	15	34.9
Totals	502	113	22.5	53	10.6	26	5.2	13	2.6	8	1.6	213	42.4

Table 2 presents only data for hogs trapped during their first year of existence and separates data for animals born during different farrowing seasons. Henry (1966) presented evidence of 2 major breeding seasons in European wild hogs and discussed the relative significance of the different breeding seasons. A comparison with Table 1 shows similar hunting recovery rates for young-of-the-year and all hogs. Therefore, total annual mortality does not vary with age. A difference does exist, however, between hogs born during different farrowing seasons, with a greater percentage of hogs born in April-July being harvested.

Although hunting mortality of young-of-the-year hogs is similar to hunting mortality of all hogs, further breakdown of age classes (Matschke 1967) to separate hogs captured before normal weaning age (3-4 months) and before sexual maturity (7-8 months) does show some differences (Table 3). The recovery of marked hogs by hunting increases in direct proportion to the age of the animal when initially captured and tagged.

Survival and mortality rates based upon data presented in Tables 1 and 2 are shown in Table 4. Survival of hogs from the end of one hunting season to the beginning of the next hunting season was estimated at 54.1%. Most of the non-hunting mortality occurs between winter and spring (34.9%) and coincides with the birth peak. Mortality decreases between spring and summer to negligible amounts and then increases slightly between summer and fall. Average annual survival was 48%.

Table 2. Number of hogs marked and recoveries by season of birth for trapped young-of-the-year European wild hogs, Tellico Wildlife Management Area, Tennessee, 1959 through 1971.

Season of birth	No. mkd.	Recoveries by hunting (number of years following marking)											
		Same year		1		2		3		4+		Total	
		no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Dec-Mar	122	29	23.8	8	6.6	2	1.6	3	2.5	3	2.5	45	36.9
Apr-July	99	17	17.2	13	13.1	9	9.1	2	2.0	1	1.0	42	42.4
Totals	221	46	20.8	21	9.5	11	5.0	5	2.3	4	1.8	87	39.4

Table 3. Number of European wild hogs marked and recoveries by age, Tellico Wildlife Management Area, Tennessee, 1961 through 1971.

Age	marked	Recoveries by hunting					
		Same year		Subsequent years		Total	
		number	%	number	%	number	%
0-19 weeks (pre-weaned)	155	18	11.6	34	21.9	52	33.5
0-33 weeks (juvenile)	202	33	16.3	43	21.3	76	37.6
0-1 years	225	43	19.1	47	20.9	90	40.0
1+ years	109	30	27.5	16	14.7	46	42.2
Total ^a	334	73	21.9	63	18.9	136	40.7

^aTotal of last 2 lines, first 2 lines are not additive.

Trapping and subsequent recoveries have yielded data on longevity. Records of the oldest hogs recovered by each sex are presented in Table 5, showing ages of at least 5-9 years, with twice as many records for females 5 years old or older.

Two composite dynamic life tables were constructed for European wild hogs (Tables 6 and 7) based upon 2 different sets of data. Table 6 is constructed from animals marked in their first year of life and subsequently recovered and is similar to that constructed for wild turkeys by Mosby (1967). If assumptions inherent in this type of life table are valid (Deevey 1947, Allee *et al.* 1949, Eberhardt 1969), the following results are obtained.

Average annual mortality ($m_a = \frac{\sum dx}{\sum l_x}$) is 50.8% for the total population, 52.9% for males and 49.5% for females. The turnover period (time required for a cohort of 1,000 to be reduced to 5 or less) is 5.78 years. However, there is one year difference in the turnover period for males, 4.82, as compared to females, 5.87. Mean life expectancy ($e_x = \frac{\sum Lx}{\sum l_x}$) is

1.46 years, and is slightly less (1.38) for males than for females (1.52). The maximum length of life is 5 years for males and 6 years for females, which is the same as the turnover period when rounded to whole numbers.

Table 4. Survival and mortality rates for European wild hogs, Tellico Wildlife Management Area, Tennessee.

<i>Time period</i>	<i>Survival rate (S)</i>	<i>Mortality rate (1-S)</i>
<u>Between hunting seasons:</u>		
Winter - Spring	.651	.349
Spring - Summer	.973	.027
Summer - Fall	.853	.147
Winter - Fall	.541	.459
<u>Young-of-the-year</u>		
0-1 years	.457	.543
1-2 years	.524	.476
2-3 years	.455	.545
Avg.	.479	.521
<u>All hogs:</u>		
0-1 years	.469	.531
1-2 years	.491	.509
2-3 years	.500	.500
Avg.	.487	.513

Table 5. Longevity of marked European wild hogs, Tellico Wildlife Management Area, Tennessee.

<i>Sex</i>	<i>Original Capture</i>		<i>Method</i>	<i>Final Recovery</i>	
	<i>Date</i>	<i>Age</i>		<i>Date</i>	<i>Age (longevity)</i>
Female	6-14-65	7-19 weeks	Killed	11-4-72	7 years, 7 months (min.) ^a
Female	8-1-62	2 months (est.) ^b	Trapped	5-28-69	7 years (est.)
Female	2-5-63	8 months (est.)	Killed	10-25-68	6 years, 4 months (est.)
Female	3-28-58	15 months (est.)	Killed	11-19-62	6 years (est.)
Female	1-5-62	9-13 months	Killed	11-12-66	5 years, 7 months (min.)
Female	8-22-68	7-19 weeks	Killed	12-22-73	5 years, 6 months (min.)
Female	7-27-62	26+ months	Killed	11-9-65	5 years, 4 months (min.)
Female	2-1-63	20-33 weeks	Killed	10-27-67	5 years, 1 month (min.)
Male	3-10-66	7-19 weeks	Killed	11-23-74	8 years, 10 months (min.)
Male	8-17-67	20-33 weeks	Killed	11-10-72	5 years, 8 months (min.)
Male	8-10-65	7-12 months	Killed	10-18-69	4 years, 9 months (min.)
Male	9-?-56	21+ months	Killed	10-?-59	4 years, 10 months (min.)

^amin. - minimum age

^best. - estimated age

Table 6. Composite dynamic life table, by sex, of 89 European wild hogs tagged under one year of age and recovered by hunting.

<i>x</i>	d_x^1	d_x	l_x	$1000q_x$	kL_x	e_x
<i>Age at recovery</i>	<i>No. deaths in age class</i>	<i>No. dying in age/1000</i>	<i>No. surv. beginning age interv. per 1000</i>	<i>Mortality rate per 1000 at beginn. age interv.</i>	<i>Average between 2 age intervals:</i>	<i>Mean expectation of life remaining</i>
1	17	472	1000	472	764.0	1.39
2	11	306	528	580	375.0	1.18
3	4	111	222	500	166.5	1.12
4	3	28	28	1000	14.0	0.50
Females						
1	22	415	1000	415	792.5	1.52
2	18	339	585	579	415.5	1.24
3	8	151	246	614	170.5	1.27
4	2	38	95	400	76.0	1.50
5	1	19	57	33	47.5	1.16
6	2	38	38	1000	19.0	0.50
Totals:						
1	39	438	1000	438	781.0	1.46
2	29	326	562	580	394.5	1.21
3	12	135	236	572	168.5	1.21
4	5	56	101	554	73.0	1.17
5	2	22	45	489	34.0	1.01
6	2	23	23	1000	11.5	0.50

Table 7. Composite dynamic life table of European wild hogs, Tellico Wildlife Management Area, Tennessee, with 51.3% mortality rate.

<i>x</i>	d_x	l_x	L_x	e_x
<i>Age at recovery</i>	<i>No. dying in age/1000</i>	<i>No. surv. beginning age interval/1000</i>	<i>Average no. living between two age intervals</i>	<i>Mean expectation of life remaining</i>
1	513	1000	743.5	1.44
2	250	487	362.0	1.44
3	122	237	176.0	1.43
4	59	115	85.5	1.42
5	29	56	41.5	1.39
6	14	27	20.0	1.35
7	7	13	9.5	1.27
8	3	6	4.5	1.17
9	2	3	2.0	0.83
10	1	1	0.5	0.50

A life table based on the mortality rates in Table 4 was also prepared. The average annual mortality rate for all hogs (51.3%) was utilized for all age classes because mortality rates by age classes were only available for the first 4 years. This rate was used in preference to the average rate for young-of-the-year hogs because rates were similar but sample size was larger for all hogs.

The average annual mortality of 51.3% and the mean life expectancy of 1.44 years are basically the same as those determined from Table 6. However, the turnover period of 7.33 years is 1.5 years longer and the maximum length of life is 10 years, or 4 years longer.

DISCUSSION AND CONCLUSIONS

Total annual survival averages 49% (Table 4) and does not differ significantly by age. However, hunting mortality does vary with the age at time of tagging, season of birth and days prior to the hunting season when tagged. Natural mortality apparently takes a greater toll of younger hogs, hogs born in the winter and hogs tagged a long time prior to the hunting season. Peak mortality during the year coincides with the post-farrowing periods. Therefore, hunting mortality replaces natural mortality and does not increase total mortality.

Piglet mortality of pen-reared European wild hogs from birth until weaning was 38.3%. Add this to the hunting mortality of hogs tagged before weaning (11.5%, Table 3) and annual mortality is estimated at 59.9%. This further supports results regarding average survival and mortality and the consistency of these rates between age classes. It may be argued that natural mortality of wild piglets would be higher because of additional mortality factors such as predation, starvation, and climate. However, piglet mortality in pen-reared hogs included factors related to crowding that would not be as prevalent in wild populations. Based upon the mortality rates in Table 4 for the winter-spring and spring-summer period, which are attributed to piglet mortality, these differing factors cancel each other.

Experimentation with increasing hunter-take to see how much natural mortality can be replaced by hunting mortality without increasing total mortality would be desirable. The objective would be to increase recreation opportunity, participation, and satisfaction without reducing hog populations below the desired level. At present, total hunting mortality of tagged hogs is about 40%, which is 20% lower than the annual total mortality rate of 50%. This indicates a possibility of a considerable increase in hunting pressure. A 20% increase would be a logical first attempt.

The number and percent harvest of hogs born in the 2 major breeding seasons support prior conclusions. Henry (1966) concluded that more hogs are born during the winter farrowing period but the April-July farrowing period contributes more to the population in terms of returns to the hunting public.

Although annual survival is 49%, there is an indication of a gradual increase in annual survival rates through the fourth year of life. Unfortunately, data are not available for the older ages to determine when survival peaks and then decreases, which it must, based on overall mortality rates. This is the reason that average mortality was used in constructing Table 7. Construction of a similar table using mortality rates in Table 4 for the first 4 years and the average mortality rate thereafter did not alter results.

Life tables are useful, especially when better analytical methods are lacking, if one is cognizant of the shortcomings and involved assumptions (Eberhardt 1969). When constructing life tables, one assumes sample populations are randomly drawn and thus representative of the population from which they were drawn. These tables tell only half the story, that of losses, and apply only at a given point in time or to stationary populations where births equal deaths.

The life tables constructed are based upon 2 different sets of data and serve as comparisons in evaluating the validity of assumptions and shortcomings involved. A

comparison of the 2 tables leads one to conclude that an average annual mortality of 51% and a mean life expectancy of 1.5 years are reliable estimates.

Higher mortality of males (Table 6) is supported by other data, including longevity information (Table 5). Sex ratios also indicate differential mortality with ratios of 1:1 at birth and ratios increasingly favoring females in subsequent older age classes. Behavior of captive animals and observations of injuries to wild hogs also lend support to higher mortality of males because of aggressive competition between males for mates and/or territory. Fights have been interrupted in captivity that resulted in serious injury and would have resulted in death except for human intervention. Many injuries believed to be a result of these male encounters have been observed in wild animals.

An additional problem with Table 6 is that data were almost totally from hunter-killed hogs because knowledge of other mortality was limited to animals found accidentally by personnel working on the area. Therefore, it is not a good estimate of mortality from other causes.

The estimate of turnover period and maximum life span based on Table 7 are regarded as more reliable because of the additional shortcomings involved in Table 6 and the similarity of data in Table 7 to other data. Longevity records in Table 5 are similar to the turnover period derived from Table 7, with the exception of the 9-year-old male. The maximum life span of 10 years based on Table 7 is also comparable to the 10-12 years life span reported by local residents who rear European hogs in captivity. Lack of longevity records suggesting similar age in wild hogs is attributed to a lack of an aging technique for hogs older than 26 months. Hogs older than 5-9 years have probably been trapped and killed but could not accurately be aged.

Our results on mean life expectancy and longevity are supported by Henson (1975). He determined average ages of 1.37 for the hog population on the Tellico Wildlife Management Area and 1.47 for the Great Smoky Mountain National Park population. He also found longevity in the 5-7 year range with the oldest hog 7 years, 7 months of age.

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