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A Study of Fluctuations In Coyote Numbers and Possible Causes

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A STUDY
OF FLUCTUATIONS IN COYOTE NUMBERS AND POSSIBLE CAUSES

being

A thesis presented to the Graduate Faculty
of the Fort Hays Kansas State College in
partial fulfillment of the requirements for
the Degree of Master of Science

by

Sherwin B. Griswold, B. S.
Fort Hays Kansas State College

Date

July 23 1942

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The study for this thesis was done at the suggestion and under the guidance of Doctor L. D. Wooster, Fort Hays Kansas State College.

I wish to express my thanks to him particularly for his assistance and criticism during the advancement of this work, and for the use of published material relating to the study.

I wish to express my thanks to the Kansas State Forestry, Fish and Game Department at Pratt, Kansas, for the reports of the fur dealers of the state; to the county clerks of the counties in which bounty records were studied, for granting permission to gather information from these records, and for additional information they were able to give; to the United States Weather Bureau at Topeka, Kansas, for the weather records of the state; to the Kansas State Auditor's office for information regarding the bounty payments made by the state to the complying counties of the state; and to the following: Doctor George M. Robertson for criticism and suggestions; Doctor F. B. Streeter, Librarian, Fort Hays Kansas State College; Miss Helen T. Fisher, Assistant Librarian, Fort Hays Kansas State College; the T. J. Brown Fur Company, Topeka, Kansas, for information as to fur prices and the number of pelts purchased; and the Friend Fur Company, Wichita, Kansas, for fur prices.

I am indebted to my wife for the invaluable aid she has given me in securing bounty records and in aiding in the progress of this study.

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A STUDY
OF FLUCTUATIONS IN COYOTE NUMBERS AND POSSIBLE CAUSES

INTRODUCTION

This paper reports the findings of a study of coyote numbers, with particular reference to fluctuations, their periodicity, if any, and their possible causes.

The writer has for some time been desirous of obtaining information as to whether or not there has been a periodic fluctuation in coyote numbers, and if so, whether factors producing such fluctuations can be discovered.

Do coyote numbers fluctuate in a given region from year to year? If there are such fluctuations, are they periodic? If so, what is the period? Do the fluctuations in different counties coincide?

What are the possible factors producing such fluctuations? Do precipitation and temperature cause fluctuations in coyote numbers? Do fur prices cause fluctuations in coyote numbers? Do food conditions cause fluctuations in coyote numbers? Do general economic conditions cause fluctuations in coyote numbers?

Methods

In order to answer these questions studies of bounty payments

were made in four centrally located counties of Kansas. The counties selected for this study were Ellis, Russell, Edwards, and Harvey. The location of these counties is shown in figure I on page 5. A record of these bounty payments was secured by checking through the records in the office of the county clerk of these counties for all years in which records were on file.

All state bounty payments available were secured from the state auditor's office at Topeka, Kansas.

All available numbers of coyote pelts purchased each year were obtained from one of the leading fur companies of the state.

Reports of fur sales by dealers in the state to the Kansas Fish and Game Commission were obtained for all years in which these were available.

Weather records of the state were obtained for use as a key to climatic conditions for periods covered in the study.

A graph of general economic conditions of the United States was used as a guide to determine economic fluctuations.

The highest price paid for coyote pelts, per year, was secured for all years in which this information was available.

Studies in which the food of the coyote was determined were used as a guide to determine the influence of food on the fluctuation of coyote numbers.

This information was compared in tables and graphs to ascertain if there were fluctuations in numbers, and to determine if there was any periodicity in the fluctuations, and if so, to determine

the period. A comparison of causal factors with numbers was made to determine, if possible, the presence of any correlations.

Records of original research by the writer are in his personal files. The information herein used was secured in the years 1941 and 1942.

Related Studies

Papers dealing with the number of coyotes in this area are few, studies of factors which may have affected the numbers and caused fluctuations are still fewer.

The reports of the Chief of the Bureau of Biological Survey (1933)^{14*} gives the results of studies of the natural drift of the coyote, based on animals which were tagged, released, and later captured.

Lantz (1905)¹⁰ lists the number of coyote bounty payments by counties in the state of Kansas.

Wooster (1931)¹⁵ lists the number of coyotes in western Kansas based on bounty records.

Wooster (1933)¹⁶ lists the number of coyotes per square mile in Ellis County, Kansas, based on bounty records.

Carter (1939)⁴ gives a checklist of certain mammals including the coyote, in western Kansas, based on the accounts of old settlers and on bounty records.

* The raised number refers to the corresponding number of the reference in the bibliography.

Kansas Fish and Game Commission Fur Sales Reports (1927-28, 1937-38, 1939-40, 1940-41)^{6,7,8,9} list coyote pelt sales by licensed buyers in Kansas.

Sperry (1932)¹² lists the food of coyotes in the autumn season.

Sperry (1933)¹³ lists the food of coyotes in the winter season.

Murie (1935)¹¹ lists the food of coyotes.

Bond (1939)² lists the food of coyotes.

Hewitt (1921)⁵ lists the periodicity of numbers of wolves and coyotes as shown by the records of the Hudson Bay Fur Company.

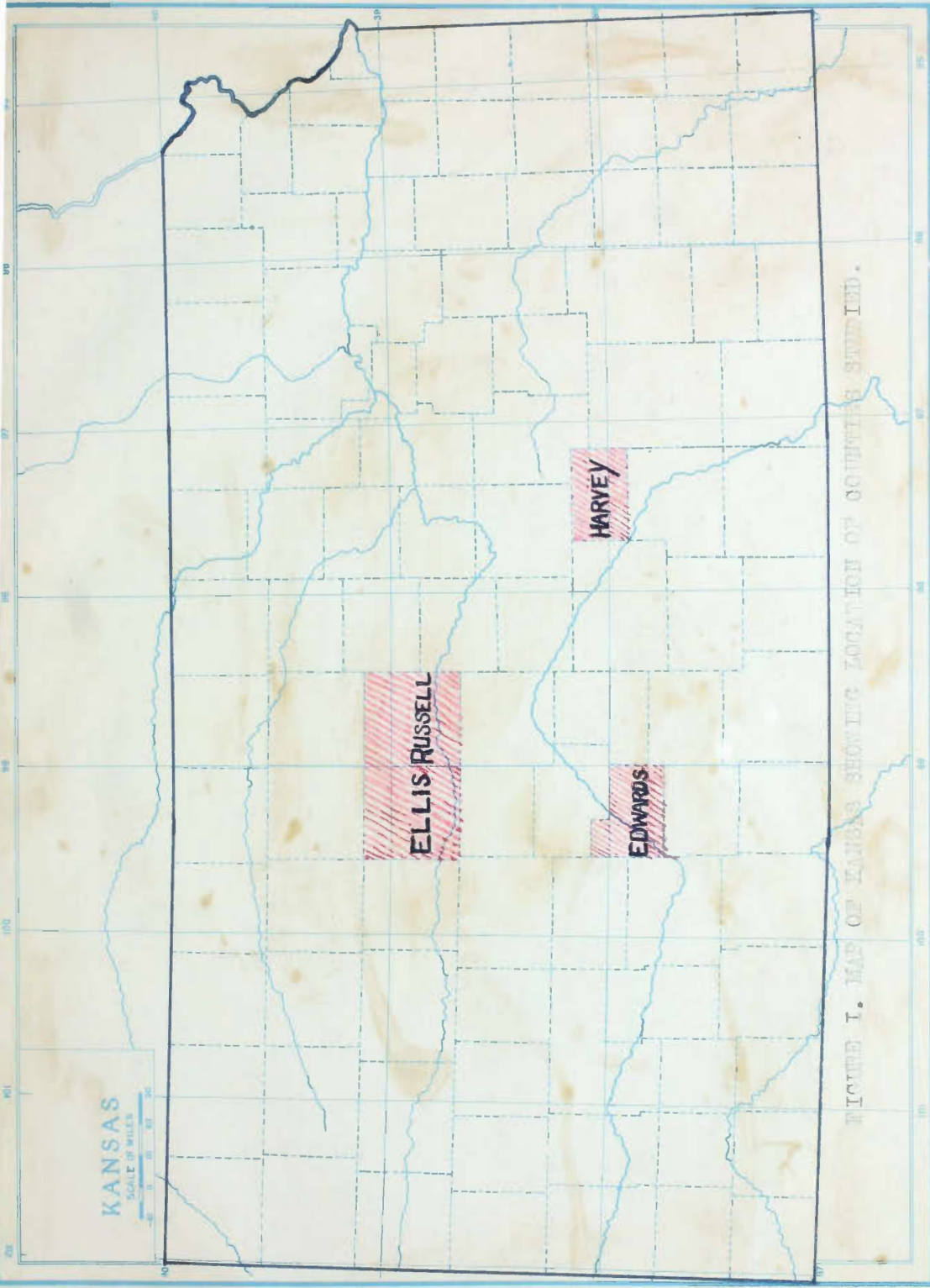


FIGURE 1. MAP OF KANSAS SHOWING LOCATION OF COUNTIES STUDIED.

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NUMBERS AND FLUCTUATIONS

The following records of bounty payments and coyote pelt sales were studied to determine coyote numbers and fluctuations.

Ellis County Bounty Records

The bounty records of Ellis County were tabulated from 1881 to June 1, 1942 inclusive. This represents all the years in which bounties were paid for coyotes. No bounties were paid from 1876 to 1880 inclusive. In years when payments were made the rate was \$1.00 per scalp, with the following exceptions: 1881 to 1890 inclusive, during which time the rate was \$1.00 for wolves and 50¢ for coyotes. During the early years the bounties were listed as wolf. In later years they were listed as coyote but the rate paid remained the same. This somewhat confuses the early record, and in order to remain as nearly consistent as possible all wolf and coyote bounties were listed together. In 1891 the rate paid for coyotes was \$1.00. In 1893 the rate was reduced to 50¢. During the latter part of 1931 and 1932 and 1933 the rate was \$2.00. No bounties were paid in 1887, 1892, 1895, 1896, 1897, 1898, and 1935.

In the years 1936, 1937, 1938, 1939 and 1940 apparently the bounty was \$1.00 for old coyotes and 50¢ for pups.

There is evidence which tends to show that the general funds were not sufficient to pay for all bounties in some of the years.

The greatest number of coyote scalps 723, was received in the year 1900. The rainfall this year was well above normal. Fur prices for this year were not available. The next greatest number of coyotes was brought in for the year 1907, when bounties were paid on 600. The rainfall for the year was slightly below normal. Fur prices were not available for this year.

The economic conditions in 1900 were above average. The economic conditions for 1907 were also above the average.

The temperature for 1900 was above average, and for 1907 was very slightly above the average.

The bounty payments by ten year periods for the county showed a slight increase in the period 1892 to 1901 over the period 1832 to 1891. The number of payments made during the period 1902 to 1911 was much greater than for the previous period. The period 1912 to 1921 dropped somewhat in comparison with the previous period. The period 1922 to 1931 increased again and the last ten year period, 1932 to 1941, dropped decidedly but still was above the first two periods.

The precipitation by ten year periods correlated with the ten year periods of bounty payments with the exception of the first period, precipitation dropped lower than the earliest period recorded, but bounty records remained above the first period.

The temperature by ten year periods showed an increase from the period 1892 to 1901 to the period 1902 to 1911. The next period remained at the same level. The period 1922 to 1931 showed an increase, as did the last period, which was decidedly the highest period. This is largely in contrast with bounty records and precipitation records.

Year	Temperature	Bounty	Precipitation
1892-1901
1902-1911
1912-1921
1922-1931
1932-1941
1942-1951
1952-1961
1962-1971
1972-1981
1982-1991
1992-2001
2002-2011
2012-2021
2022-2031
2032-2041
2042-2051
2052-2061
2062-2071
2072-2081
2082-2091
2092-2101

...

Number Of Coyote Bounties Paid In Ellis County

1881-- 33-?*	1902-- 79	1923--335
1882-- 47-?	1903--261	1924--300
1883--190	1904--268	1925--315
1884--157-?	1905--337	1926--293
1885--175-?	1906--368	1927--286
1886-- 22	1907--600	1928--278
1887--...	1908--517	1929--245
1888--187	1909--419	1930--474
1889--385	1910--400	1931--417
1890--196	1911--465	1932--356
1891--219	1912--317	1933--134
1892--...	1913--243	1934--158
1893--166	1914--213	1935--...
1894-- 3-?	1915--340	1936--198
1895--...	1916--358	1937--138
1896--...	1917--496	1938-- 51
1897--...	1918--447	1939--251
1898--...	1919--423	1940--164
1899--481	1920--161	1941--341
1900--723	1921--237	1942--to 6/1-107
1901--332	1922--446	

* This indicates years in which the accuracy of the records is questionable.

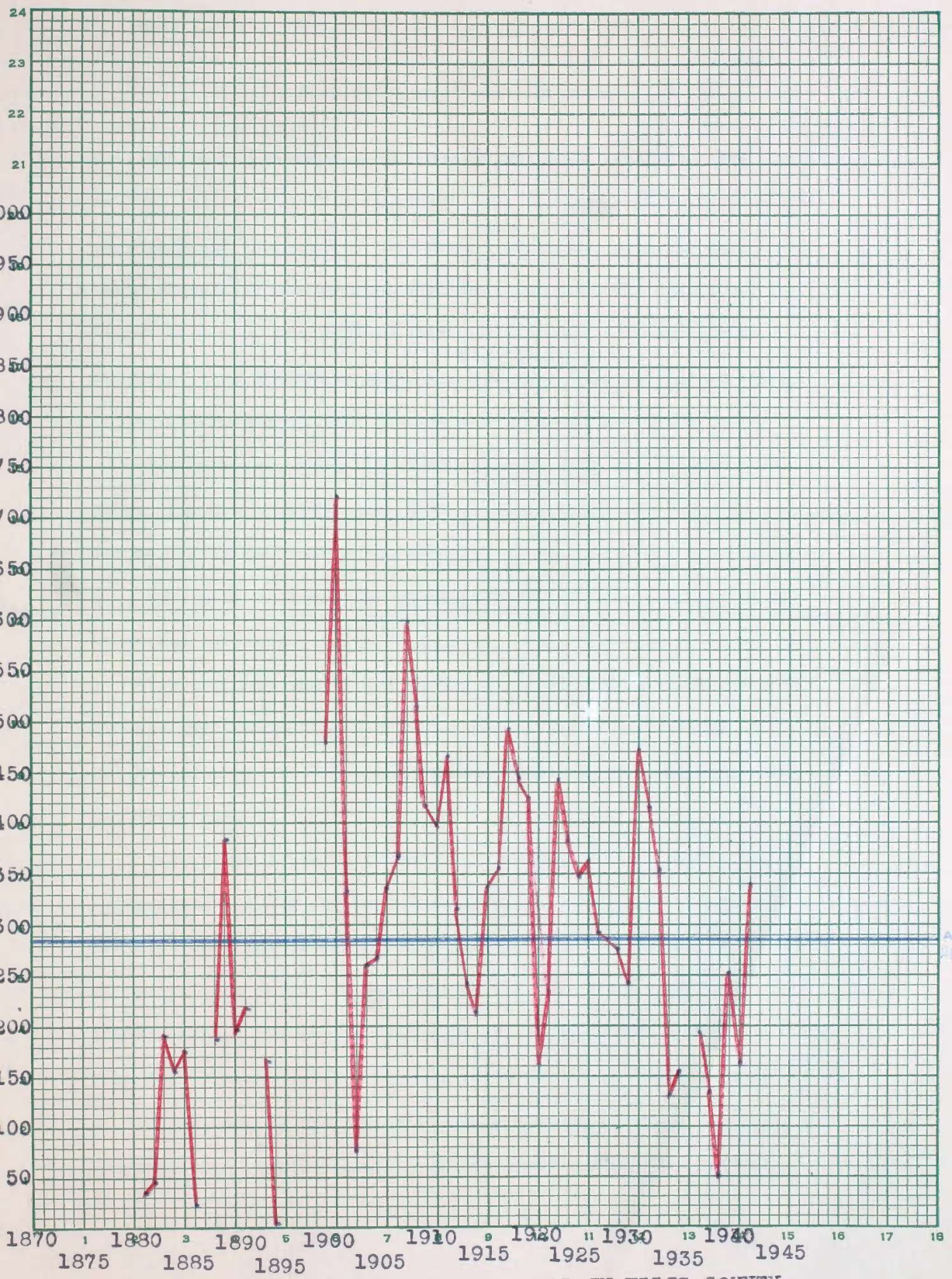


FIGURE II. NUMBER OF BOUNTIES PER YEAR IN ELLIS COUNTY.

Russell County Bounty Records

The bounty records of Russell County were tabulated from 1889 to 1941 inclusive. This represents all the years in which bounties were paid for the coyote. The amount of bounty paid was \$1.00 per scalp except for the years 1889, 1931, and 1932 when \$2.00 was paid. No bounty was paid in 1914 and the previous year shows evidence which indicates there may not have been sufficient funds to pay all bounty claims. Bounty was paid on the coyote only.

The greatest number of coyote scalps, 959, was received in 1925. The precipitation for this year was below the average. The next greatest number was received in the year 1941 when bounties were paid on 899. The precipitation for this year was much above the average.

The economic conditions in the first case were above the average and information for the latter case was not available, but it probably would be safe to consider it approximately normal for that year.

The bounty payments by ten year periods for the county showed an increase for 1902 to 1911 in comparison with the previous ten year period. In the period 1912 to 1921 bounty payments decreased slightly. The period of greatest numbers was the next period of 1922 to 1931. The last period, 1932 to 1941, showed a decrease from the preceding period but was still above the other periods.

Comparison of the ten year bounty records with the ten year precipitation records showed a fairly close correlation for this

county. The years of greater rainfall were years of greater bounty payments and conversely those of less rainfall were years of fewer bounty payments. This was not the case for individual years but only for the ten year periods.

The ten year temperature records correlated fairly well with the exception of the last period, in which the temperature reached its highest average and the number of bounties paid decreased.

Number Of Coyote Bounties Paid In Russell County

1889----155	1907----429	1925----959
1890----247	1908----373	1926----240
1891----193	1909----405	1927----301
1892----271	1910----398	1928----284
1893----268	1911----404	1929----327
1894----372	1912----409	1930----617
1895----319	1913----234-?	1931----387
1896----344	1914----326	1932----133
1897----379	1915----401	1933----...
1898----338	1916----338	1934----430
1899----408	1917----548	1935----350
1900----303	1918----269	1936----219
1901----270	1919----425	1937----397
1902----330	1920----224	1938----455
1903----244	1921----310	1939----474
1904----286	1922----351	1940----554
1905----315	1923----499	1941----899
1906----328	1924----628	



FIGURE III. NUMBER OF BOUNTIES PER YEAR IN RUSSELL COUNTY.

Edwards County Bounty Records

The bounty records of Edwards County were tabulated from 1882 to March 31, 1942. There were no bounties paid from 1874 to 1881 inclusive. The bounty rate was \$1.00 per scalp except for 1881, when \$3.00 was paid, and 1933, when \$2.00 was paid. There were three periods when bounty payments were suspended, one during the years 1885 and 1886, another during the years 1895, 1896 and 1897, and the third from 1934 to 1940 inclusive. Bounties were paid on gophers, crows, crow eggs, rabbits, and coyotes. However, the various bounties were listed separately.

The greatest number of bounty payments, 823, was recorded in 1899. The precipitation during this year was slightly below normal. The next greatest number of payments, 680, was recorded in 1900. The precipitation during this year was a little above the normal.

The temperature for 1899 was nearly normal and for 1900 it was below normal.

The economic conditions for the year 1899 were above normal and the forepart of 1900 was above normal but dropped below normal the latter part of the year.

Fur prices were not available for either of the two high years.

The ten year averages of bounty payments for this county showed a steady increase from the period 1882 to 1891 through the period 1892 to 1901 and into the period 1902 to 1911, which

was the high point. The succeeding periods all declined, terminating at about the same point as the first period.

The first period on a ten year average for precipitation was not available but the next period 1892 to 1901, showed a corresponding increase in precipitation; the next period both bounty payments and precipitation reached the high point; the following period 1912 to 1921 both decreased. In the next period the bounty payments decreased and the precipitation increased. The last periods both showed a somewhat similar decrease.

The temperature and bounty payments by ten year periods increased correspondingly for the period 1892 to 1901. The temperature remained constant for the next period and the bounty payments increased to the highest point. The remaining periods were contrasting, in that bounty payments decreased and temperature increased.

Number Of Coyote Bounties Paid in Edwards County

1882----- 1-?	1903-----315	1924-----106
1883----- 91	1904-----227	1925-----297
1884-----103	1905-----261	1926-----191
1885-----...	1906-----403	1927-----157
1886-----...	1907-----506	1928-----102
1887----- 47	1908-----412	1929-----125
1888-----351	1909-----400	1930-----208
1889-----184	1910-----297	1931-----163
1890----- 67	1911-----322	1932-----270
1891-----263	1912-----381	1933-----539
1892-----134	1913-----389	1934-----...
1893-----288	1914-----293	1935-----...
1894----- 66	1915-----292	1936-----...
1895-----...	1916-----255	1937-----...
1896-----...	1917-----471	1938-----...
1897-----...	1918-----322	1939-----...
1898-----327	1919-----161	1940-----...
1899-----828	1920-----257	1941-----239
1900-----680	1921-----203	1942-up to 3/31-93
1901-----553	1922-----179	
1902-----499	1923-----149	

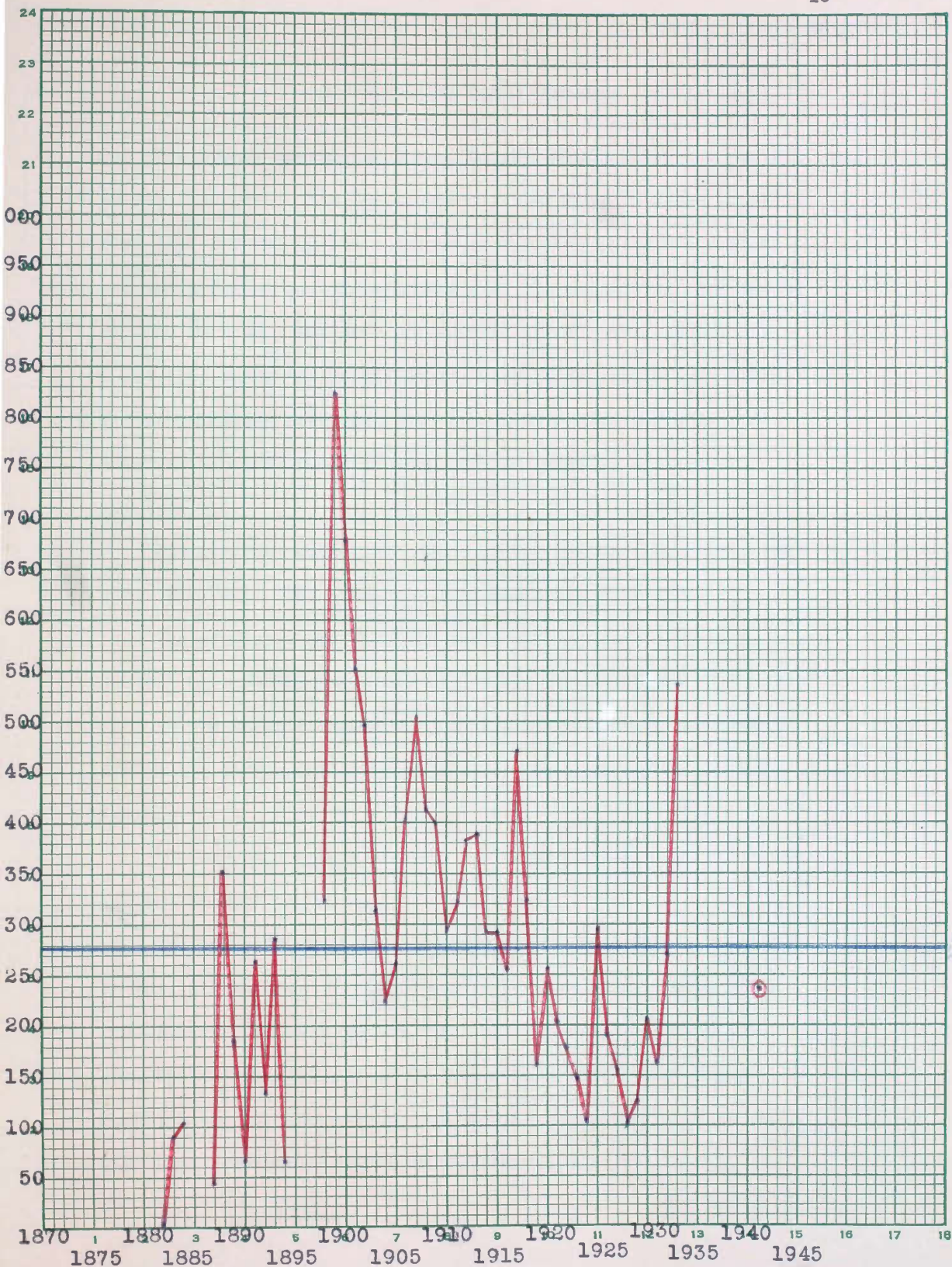


FIGURE IV. NUMBER OF BOUNTIES PER YEAR IN EDWARDS COUNTY.

Harvey County Bounty Records

The bounty records of Harvey County were tabulated from 1899 to May 25, 1942. This represents all the years in which bounties were paid for the coyote. The rate of bounty payment was \$1.00 per scalp except in 1932 and 1933 when the amount paid was \$2.00. In 1914 no bounty was paid and several other years showed evidence that there was insufficient money to pay all bounty claims. In 1928 bounties were also paid for jackrabbits, gophers, and coyotes. In 1931 bounties were paid on gophers, crows and coyotes.

The greatest number of coyote scalps was brought in for the year 1918, with 198. The next high was 1923, with 178.

The precipitation for 1913 was a little above the average. In 1923 the precipitation was well above the average.

In the first instance the fur prices were below the average and in the latter case they were about the same amount above the average.

The economic conditions for the United States were above the average in both instances.

The ten year averages for precipitation and bounty payments in this county start with the period 1902 to 1911. There was a decrease in both from this period to the next. For the period 1922 to 1931 both showed an increase, with the bounty payments reaching the high point. In the last period both decreased and the bounty payments dropped to the low for all periods.

The temperature for ten year periods showed no change for the first comparable periods as against a slight increase for bounty payments. The next period, 1912 to 1921, both increased, in comparison with the following period. During the last period, there was an increase in temperature and a decrease in bounty payments.

Number Of Coyote Bounties Paid In Harvey County

1899----- 5	1914-----...	1929----- 37
1900-----142	1915----- 33	1930----- 64
1901----- 73	1916-----100	1931----- 67
1902----- 91	1917-----117	1932-----149
1903-----107	1918-----198	1933----- 84
1904-----107	1919-----100	1934----- 88
1905----- 83	1920----- 77	1935----- 68
1906----- 4	1921-----101	1936----- 5
1907----- 42	1922-----133	1937----- 2
1908-----115	1923-----173	1938----- 4
1909-----126	1924----- 86	1939----- 2
1910----- 92	1925-----170	1940----- 6
1911----- 69	1926----- 93	1941----- 23
1912----- 51-?	1927----- 33	1942-up to 5/25-67
1913----- 1	1928----- 40	

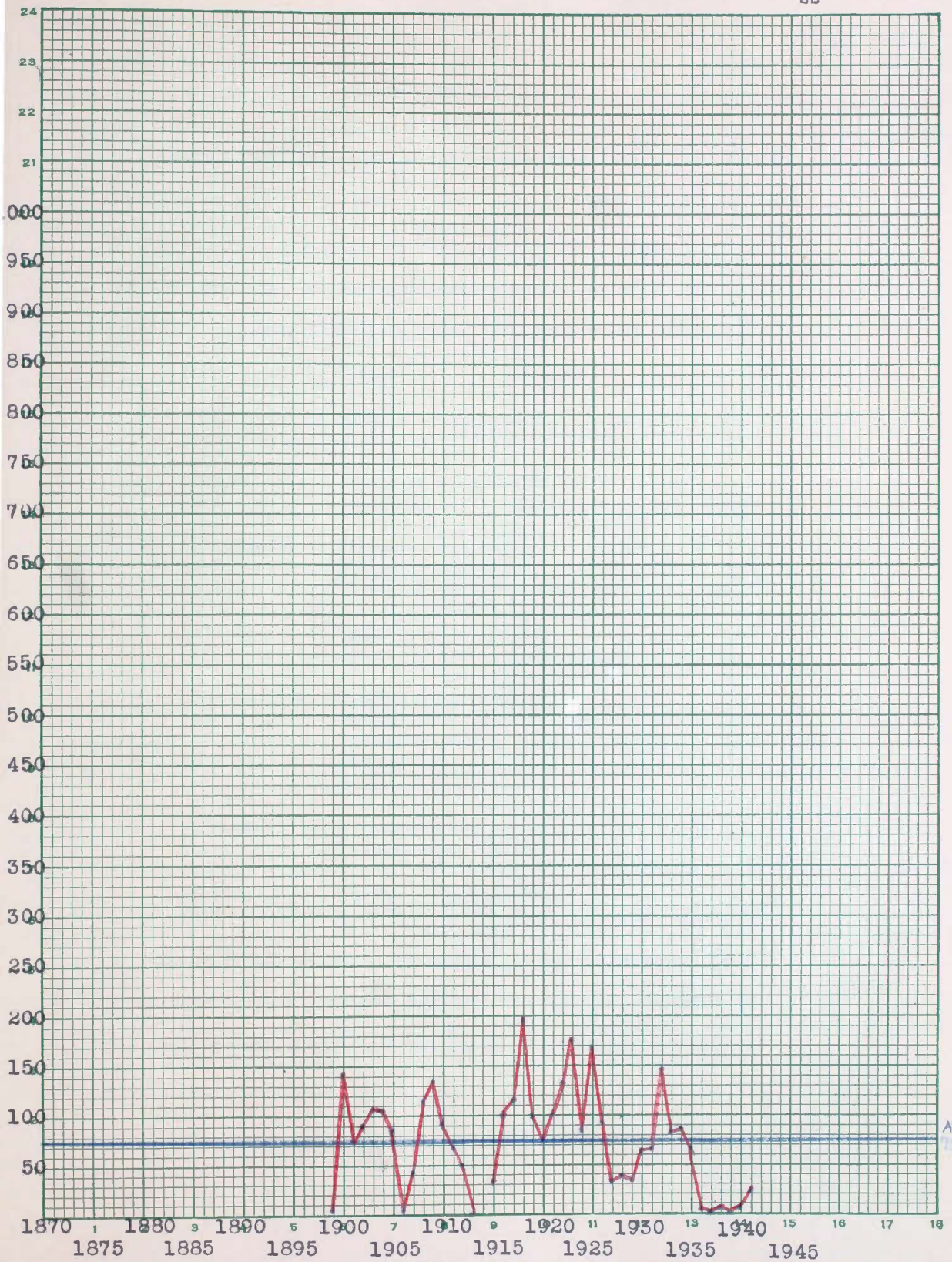


FIGURE V. NUMBER OF BOUNTIES PER YEAR IN HARVEY COUNTY.

State Bounty Payments

Lantz (1905) published a fairly complete list of the bounty payments in Kansas by counties from July 1, 1903 to June 30, 1904. This dating did not coincide with the available state records for 1941 and 1942 but for portions of these years which were in excess of payments listed by Lantz,¹⁰ a comparison was made.

Year	County	Bounties
1903-04-----	Barton-----	109
1942-----	Barton-----	111-approved but unpaid.
1903-04-----	Hamilton-----	275
1942-----	Hamilton-----	291-approved but unpaid.
1903-04-----	Harper-----	44
1941-----	Harper-----	56
1942-----	Harper-----	46-approved but unpaid.
1903-04-----	Lane-----	164
1942-----	Lane-----	163-paid first quarter.
1903-04-----	Meade-----	224
1942-----	Meade-----	334-approved but unpaid.
1905-04-----	Ottawa-----	61
1941-----	Ottawa-----	81
1903-04-----	Rice-----	90
1941-----	Rice-----	162
1903-04-----	Scott-----	193
1942-----	Scott-----	212-paid first quarter.

These county payments either for an entire year or for portions of a year exceeded payments for the same counties in the earlier period with the exception of Lane county which was one below.

This indicates an increase in coyote bounty payments, at least in the above named counties of the state, since 1903-04.

Records for other counties either were not complete or were below the earlier number and due to the fact that the periods did not coincide only the above seemed suitable for use.

Carter⁴ reports a decrease in coyotes since 1894, from abundant to common.

An interesting observation was made on bounty records by Lantz¹⁰ for Ellis County. He reports 248 bounty payments from July 1, 1903, to June 30, 1904. In the studies by the writer for the same period only 237 payments were recorded.

Wooster¹⁶ reports bounty payments from 1914 to 1932 inclusive and there are several variations from those of the writer. Records studied by Wooster were taken from receipt books and those of the writer from the commissioners journals.

Wooster¹⁵ reports the coyote has held its own for fifteen or twenty years but previous to that they were found in greater numbers.

In general, records of bounty payments to determine numbers are subject to correction in such instances as: years in which no bounty was paid; years in which funds were insufficient to pay bounty the entire year; illegal collection of bounty on dogs, or on coyotes captured outside the particular county; disagreement of bounty receipt books and commissioner journals in recording the number of bounties paid. Possibly there are other

factors which might enter in and further reduce the value of these records for use in determining numbers.

In view of possible corrections, the records used for determination of numbers show quite clear fluctuations and correlations and thus render their degree of accuracy suitable for use in this study.

Coyote Pelt Sales

Information for coyote pelt purchases of the T. J. Brown Fur Company of Topeka, Kansas, was secured for the following fur purchasing seasons: 1934-35 to 1939-40 inclusive. This information shows 11,145 coyote pelts were purchased the first season on a \$4.00-5.00 basis. The following season the number purchased dropped to 6,794 with the price increased to \$5.00-9.00. The next year showed an advance in purchases to 9,321 on a price basis of \$6.00-9.00. The following year purchases increased to 15,169 with a price of \$6.00-6.00. The next year the purchases continued to increase with a price of \$6.00-6.00. The last year purchases dropped to 15,000 with a price of \$5.00-6.00. These purchases were from Kansas, Oklahoma, Colorado and Texas.

The bounty records showed a slump during this period, 1934-35 to 1939-40, in general but some of the individual years were well above the average during this period. This indicates fluctuations with an apparent tendency for an increase in the number of coyote pelts, which would naturally indicate either better methods of capture or the presence of more coyotes.

In the Fur Sales Reports of the Kansas Fish and Game Commission⁶ for 1927-28, there was reported a total sale of 6,169 coyotes and 1,416 wolves or a total of 7,585. The next season⁷ 1937-38, there was reported a total of 10,957 coyotes and 2,492 wolves or a total of 13,449. During the season⁸ of 1939-40,

the total coyotes reported was 14,022 and 1,047 wolves or a total of 15,069. The last season⁹ there was reported a total of 14,295 coyotes and 1,748 wolves or a total of 16,043. This showed a steady increase of both coyotes and wolves but for the wolves alone the third season slumped decidedly, and the last season was below the second season. The number of sales in these records that were made from outside the state was not determined.

An apparent tendency toward a gradual increase in coyotes is indicated by these reports. There is also evidence of it being a fluctuating increase.

Coyote Pelt Purchases By The T. J. Brown Fur Company

Season	Number	Price
1934-35-----	11,145-----	4 4.00-5.00
1935-36-----	6,794-----	5.00-9.00
1936-37-----	9,821-----	6.00-9.00
1937-38-----	15,169-----	6.00-6.00
1938-39-----	17,636-----	6.00-6.00
1939-40-----	15,880-----	5.00-6.00

These purchases are from Kansas, Oklahoma,
Colorado, and Texas.

Kansas Fish And Game Commission Fur Sales Reports

Season	Coyotes	Wolves	Rabbits
1927-28-----	6,169-----	1,416-----	...
1937-38-----	10,957-----	2,492-----	49,319
1939-40-----	14,022-----	1,047-----	347,850
1940-41-----	14,295-----	1,748-----	...

FACTORS STUDIED AND CORRELATIONS

The factors discussed in the following paragraphs, were studied to determine if there were any correlations between numbers and factors which might indicate possible causes of fluctuations.

Prices Paid For Coyote Pelts By Years

This information was tabulated from 1912 to 1941 inclusive, with the exception of the years 1913, 1914, 1915, 1929, 1932, and 1933. These dates, obtained from the T. J. Brown Fur Company, Topeka, Kansas, and the Friend Fur Company, Wichita, Kansas, show the top prices paid during the years listed.

Prices above the average were paid in the years 1919, 1920, 1923, 1924, 1925, 1926, 1927, 1928, and 1936. The years of highest prices did not correlate in general with the years of greatest bounty payments. The majority of years of high prices, however, did correlate with years which had above normal precipitation. They also correlated in general with the years with above normal temperature.

Annual Coyote Pelt Prices

Year	Price	Year	Price
1912-----	\$ 5.00	1927-----	\$10.00
1913-----	...	1928-----	15.00
1914-----	...	1929-----	...
1915-----	...	1930-----	6.00
1916-----	3.00	1931-----	6.00
1917-----	5.00	1932-----	...
1918-----	5.00	1933-----	...
1919-----	10.00	1934-----	4.00
1920-----	15.00	1935-----	5.00
1921-----	3.50	1936-----	9.00
1922-----	6.00	1937-----	6.00
1923-----	8.00	1938-----	6.00
1924-----	8.00	1939-----	6.00
1925-----	10.00	1940-----	5.00
1926-----	12.00	1941-----	5.00

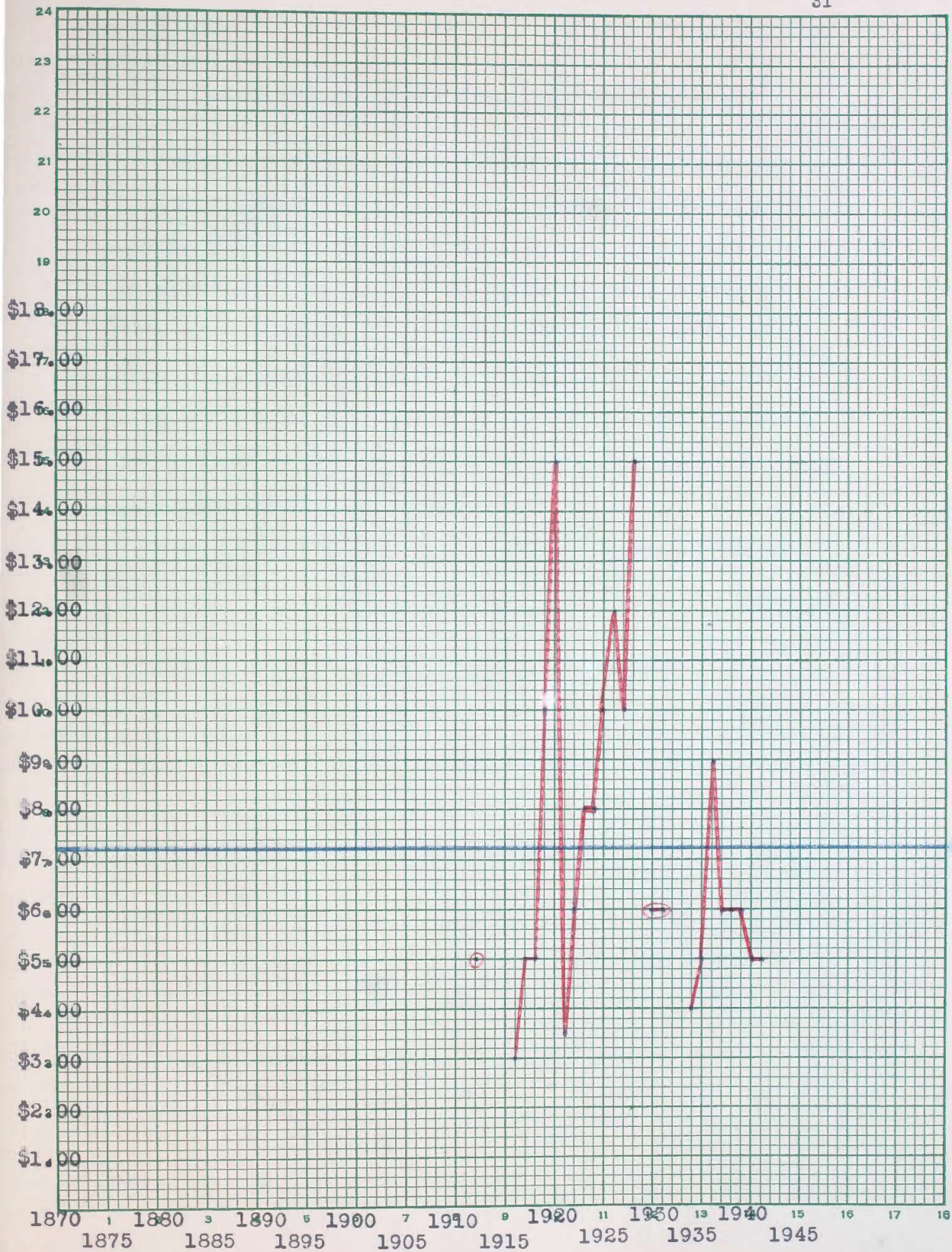


FIGURE VI. GRAPH OF ANNUAL COYOTE PELT PRICES.

Annual Precipitation Records For The State Of Kansas

This information was tabulated from 1881 to 1941 inclusive.

Taking ten year periods there was evidence of a period from 1902 to 1911 of above normal rainfall, a period from 1912 to 1921 of below normal rainfall, the next period from 1922 to 1931 of above normal rainfall and the last period from 1932 to 1941 of below normal rainfall. The first period from 1892 to 1901 was one of low rainfall but the lowest period was the last one from 1932 to 1941. Information for 1941 and 1942 indicates an increase the latter part of this period.

The all time high was in 1915, and the all time low was in 1936.

Annual Precipitation For The State Of Kansas

Year	Inches	Year	Inches	Year	Inches
1887	23.37	1906	28.58	1925	25.08
1888	23.43	1907	26.46	1926	24.80
1889	29.44	1908	32.30	1927	32.40
1890	21.16	1909	31.15	1928	33.40
1891	31.14	1910	19.67	1929	27.96
1892	29.02	1911	24.53	1930	26.87
1893	20.25	1912	26.69	1931	25.90
1894	20.72	1913	23.02	1932	23.76
1895	28.08	1914	23.08	1933	22.18
1896	28.72	1915	40.77	1934	20.02
1897	24.45	1916	23.84	1935	28.47
1898	31.79	1917	19.60	1936	18.31
1899	26.26	1918	27.60	1937	20.88
1900	27.96	1919	25.65	1938	27.27
1901	21.35	1920	26.65	1939	20.08
1902	34.43	1921	24.19	1940	25.67
1903	31.35	1922	29.01	1941	36.92
1904	31.01	1923	31.88		
1905	30.77	1924	24.23		

Average--26.61

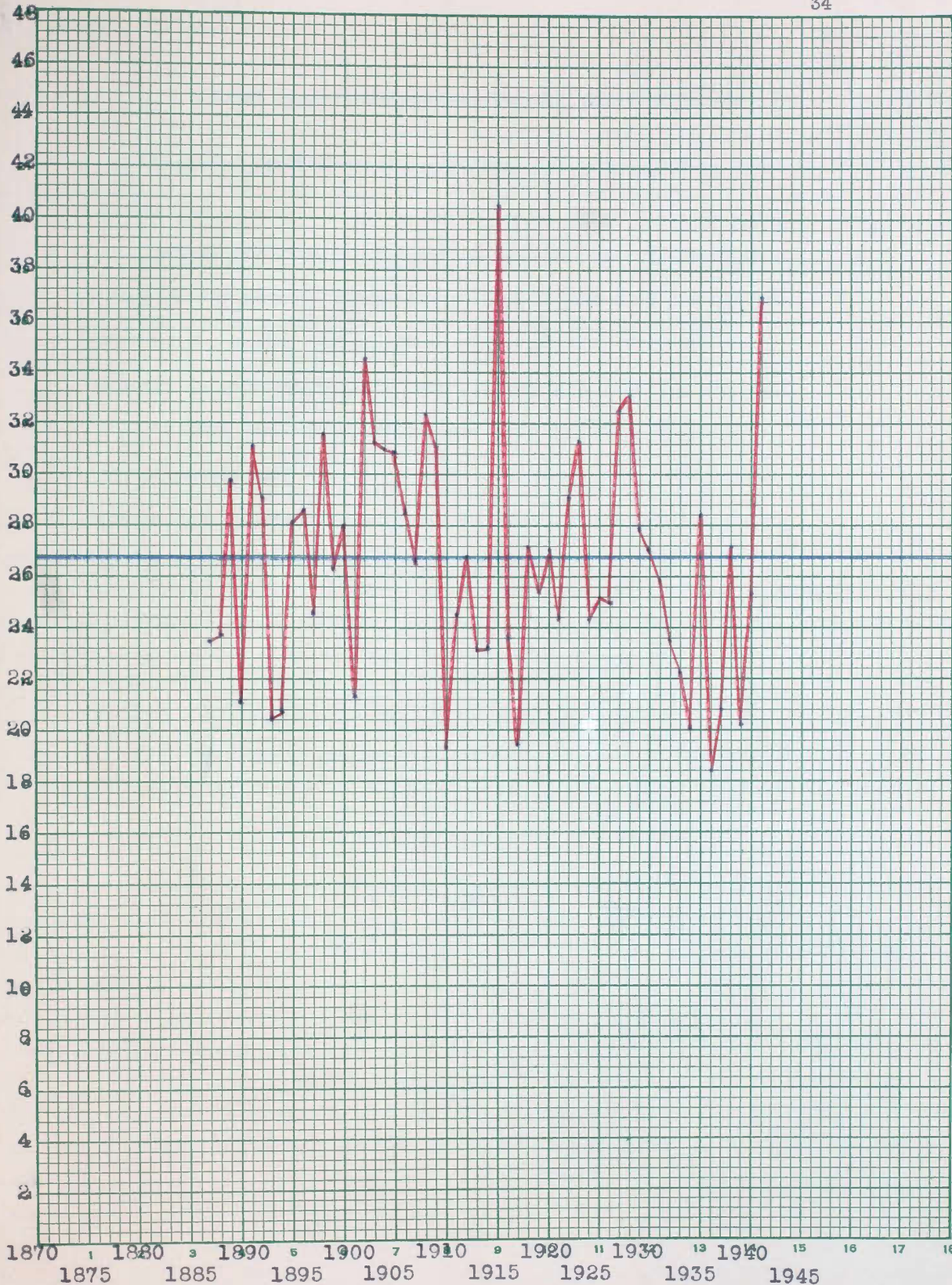


FIGURE VII. GRAPH OF ANNUAL PRECIPITATION IN KANSAS.

Annual Temperature Records For The State Of Kansas

This information was tabulated for the years 1887 to 1941 inclusive.

Bounty payments for the period 1902 to 1912 increased over the previous period. Temperature for the same period likewise, increased. During the following period, bounty payments decreased and the temperature remained constant. In the period 1922 to 1932, bounty payments increased, with the exception of one county, and the temperature also increased. The last period bounty payments decreased and the temperature increased to the highest point for periods studied.

Annual Temperature Records For The State Of Kansas

1887----54.4	1906----54.4	1925----55.6
1888----53.6	1907----54.9	1926----55.2
1889----53.6	1908----55.8	1927----55.0
1890----54.8	1909----54.4	1928----55.2
1891----53.0	1910----55.7	1929----53.2
1892----52.6	1911----56.1	1930----55.5
1893----53.7	1912----52.9	1931----57.4
1894----54.7	1913----55.5	1932----54.7
1895----53.2	1914----55.8	1933----57.8
1896----55.8	1915----53.7	1934----58.5
1897----55.1	1916----54.1	1935----55.9
1898----54.2	1917----53.2	1936----56.3
1899----54.1	1918----55.2	1937----54.6
1900----55.8	1919----53.9	1938----57.9
1901----55.4	1920----54.5	1939----57.8
1902----54.1	1921----57.6	1940----54.6
1903----53.4	1922----55.8	1941----56.2
1904----54.2	1923----54.9	
1905----53.5	1924----53.0	

Average--54.9

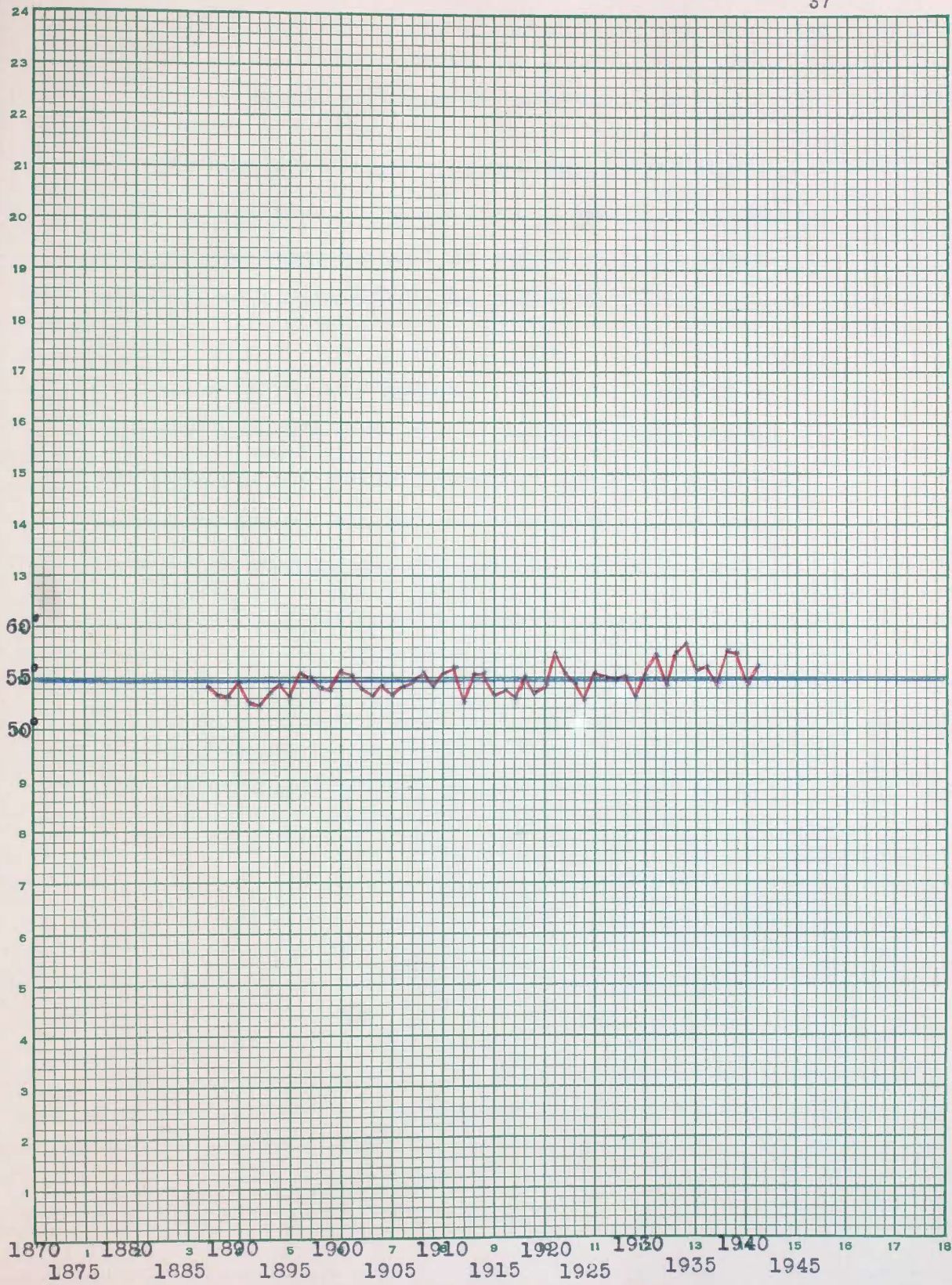


FIGURE VIII. GRAPH OF ANNUAL TEMPERATURE IN KANSAS.

Economic Conditions Of The United States

This information covered the years 1874 to 1937 inclusive, as taken from Century of Business Progress, charted by the National Association of Purchasing Agents and Other Statistical History, published by The Century Press, West Toledo Station, Box 61, Toledo, Ohio.

Periods of economic depression and economic prosperity apparently had slight correlation as far as the bounty payments were concerned. The weather periods gave slight correlation; low rainfall and economic lows were concurrent; and high temperature periods coincided in a few instances with the economic periods.

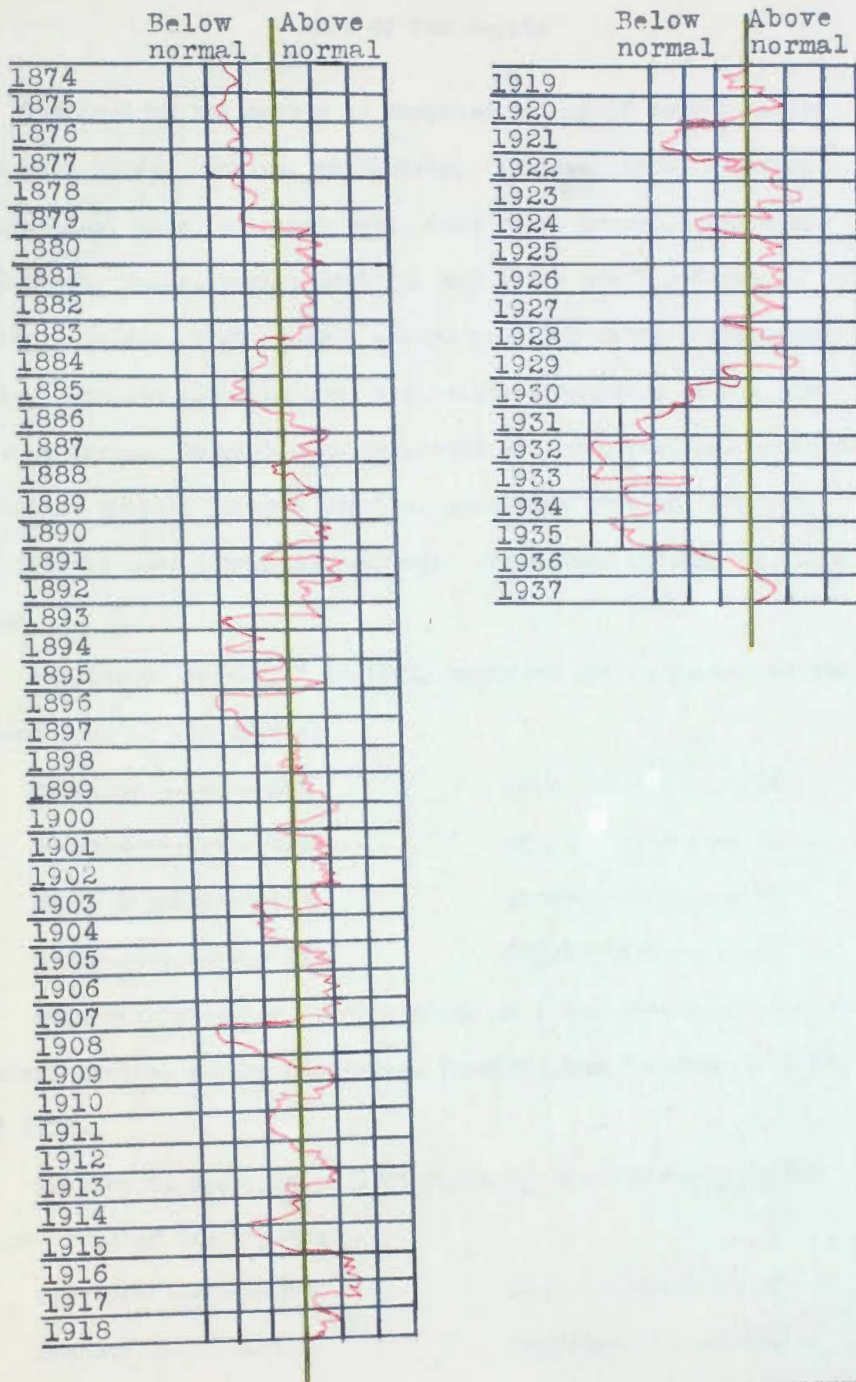


FIGURE IX. GRAPH OF ECONOMIC CONDITIONS OF THE UNITED STATES.

Food Of The Coyote

The food of the coyote is composed mainly of animal matter such as: birds, rabbits, amphibians, reptiles, fish, insects, crustaceans, mice, kangaroo rats, wood rats, ground squirrels, woodchucks, voles, pocket gophers, and other small rodents, poultry, calves, pigs, lambs, goats, yearling cattle, sheep and colts. Carrion also composes a sizeable proportion of the diet in some areas. Vegetable matter, such as: watermelons, peaches, apricots, grapes, juniper berries, manzanita berries, fruit of the prickly pear (*Opuntia*), garbage, grass, and sticks, is also eaten.

Charles C. Sperry,¹² in 1933, reported the following as the Autumn food of the coyote:

Carrion-----29%	Deer----- 2%
Rodents-----17%	Skunk & badger--- 2%
Sheep & goats----14%	Insects----- 1%
Birds----- 3%	Vegetable----- 3%

This was determined from a study of 3,042 stomachs, from 12 western states, during September, October, and November in 1931 and 1932.

Charles C. Sperry¹³ in 1934 reported the following as the Winter food of the coyote:

Carrion-----36%	Deer----- 3%
Rodents-----15%	Rabbits-----34%

Sheep----- 8%

Vegetable----- 1%

Birds----- 3%

This was determined from a study of 1,692 well-filled stomachs during the winter months of 1931, 1932, 1933, and 1934 from 10 western states.

Olaus J. Murie,¹¹ Biologist, Bureau of Wildlife Research, Bureau of Biological Survey reported in 1935 the following as food of the coyote:

Mammals--(non-carrion)--64.43%	(Carrion):
Birds----(non-carrion)-- 3.02%	Mammals----6.05%
Fishes---(non-carrion)-- none	Birds----- .54%
Invertebrates-----23.97%	Fishes----- .70%
Vegetable matter----- 1.29%	(Trout)
<hr/>	
Total---(non-carrion)---92.71%	(Carrion)--7.29%

Richard M. Bond² reported the following as the food of the coyote based on 273 droppings and nine stomachs, of which 706 items probably non-carrion were identified:

Mammals-----65.18%-----481 items
Birds or bird eggs----- 3.67%----- 26 items
Reptiles----- 1.08%----- 8 items
Vegetable items----- 6.23%----- 46 items
Insects-----19.65%-----145 items

Ellis County paid a bounty on rabbits in 1909. In that year there were payments on 419 coyotes. The average annual payment

was 287.04. Possibly this indicated that coyotes were also quite numerous that year.

Russell County paid no bounties on rabbits.

Edwards County paid bounties on rabbits in 1891 and coyote bounty payments were below the average. In 1893 bounties were paid on rabbits, and coyote bounty payments were above the average. Bounties were paid on rabbits in the years 1930, 1931, and 1932, and in all these years coyote payments were below the average. In 1933, bounties were paid on rabbits, and coyote payments were much above the average. This year the bounty rate was raised from \$1.00 to \$2.00.

In Harvey county, bounties were paid on rabbits in 1923, and coyote payments were above the average. In 1928 bounties were paid on rabbits, and coyote payments were below the average.

Assuming rabbits to have been plentiful when bounties were paid on them, then there was no indication that they affected coyote numbers.

GENERALIZATIONS

This study of fluctuations in coyote numbers and possible causes gives the following results:

Coyote numbers were determined best by means of the county bounty records. The coyote pelt sales records gave supporting evidence, as shown by comparison of figures II, III, IV, and V, with date shown on page 28. The Pelt sales records were not used to determine correlations, due to insufficient data.

The coyote bounty records show a periodic fluctuation of numbers. C. Gordon Hewitt⁵ studied the records of the Hudson Bay Fur Company for periodicity by using the average number of years between peak years of fur purchases as the period of fluctuation. By this method he determined the periodicity to be 10 years for wolves and coyotes. The method used by Hewitt did not give the same periodicity when used in this study, but gave the following results for numbers based on bounty payments:

Ellis County - - - - -	6.0 year periodicity
Russell County - - - - -	6.1
Edwards County - - - - -	8.2
Harvey County - - - - -	6.4
<hr/>	
Average - - - - -	6.7 year periodicity

A comparison of the above periods is shown in figure XI.

By using Hewitt's method the periodicity for precipitation was found to be 4.9 years; for temperature 4.2 years; and for

economic conditions 3.8 years. These periods possibly are multiples of larger periods, but since correlation was not evident, no further study of these periods was made.

In studying numbers it became evident that a 10 year period was the best to use for correlations, since a number of peak payments were 10 years apart in most of the counties.

By comparing the 10 year periods of bounty payments with 10 year periods of precipitation, correlation was noted in all instances for all the counties, except the one period 1912 to 1922 for Edwards county. No attempt was made to explain this variation. These correlations are shown by a comparison of figure X and figure XII.

By comparison of figures IX and X there is noted slight correlation between the 10 year periods of economic conditions and the bounty numbers for the same periods.

In comparing figures X and XIII there is noted no particular correlation between temperature by 10 year periods and bounty numbers for the same periods.

Food data taken from the result of studies in this field could not be used in a correlation study, due to insufficient data regarding the food supply within the area of this study.

Records of fur prices were too incomplete to attempt their use in correlations.

Data were not available to attempt to ascertain whether precipitation and economic conditions were causes of fluctuations or if there might be a common cause

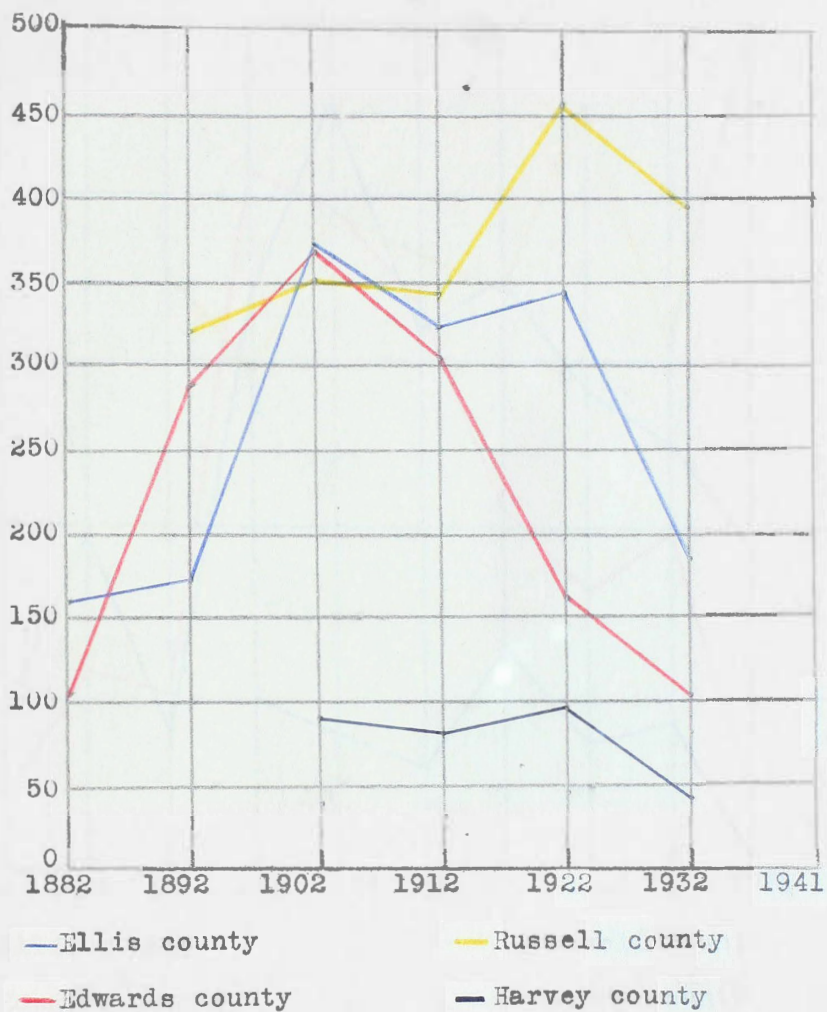


FIGURE X. COUNTY BOUNTY PAYMENTS BY 10 YEAR AVERAGES.

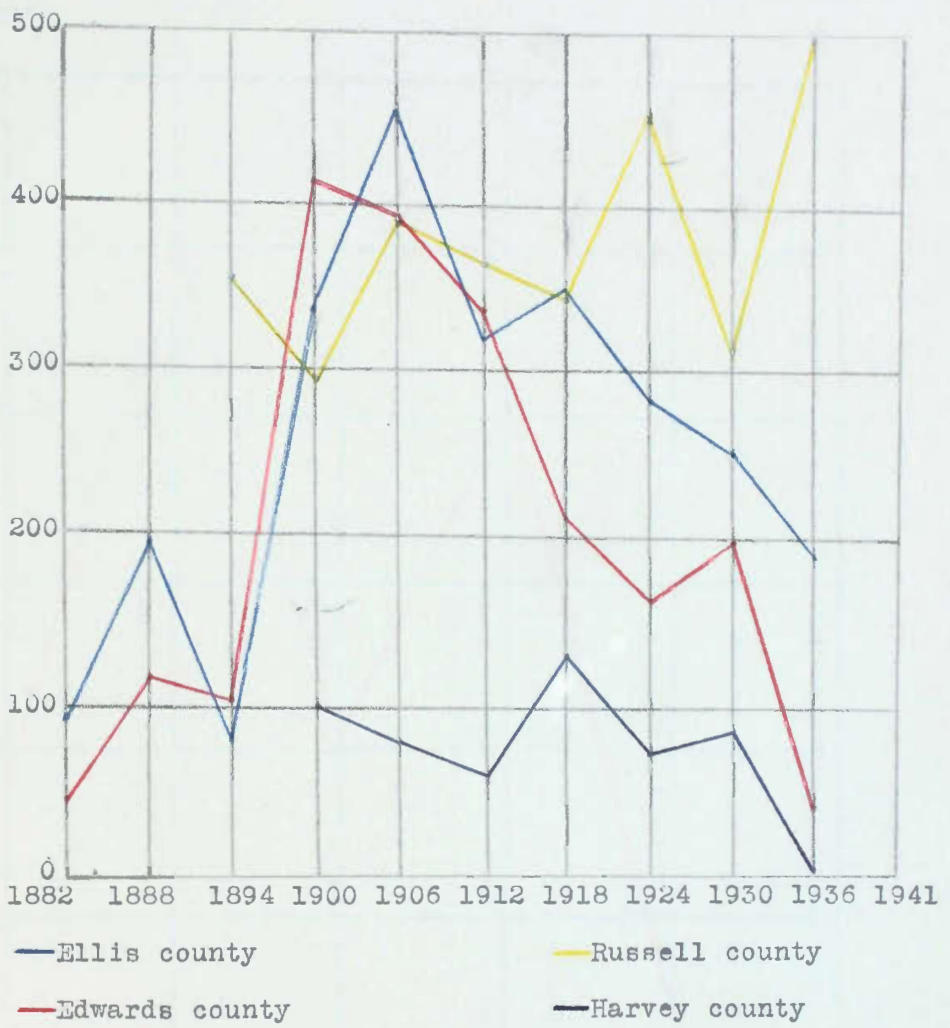


FIGURE XI. COUNTY BOUNTY PAYMENTS BY 6 YEAR AVERAGES.

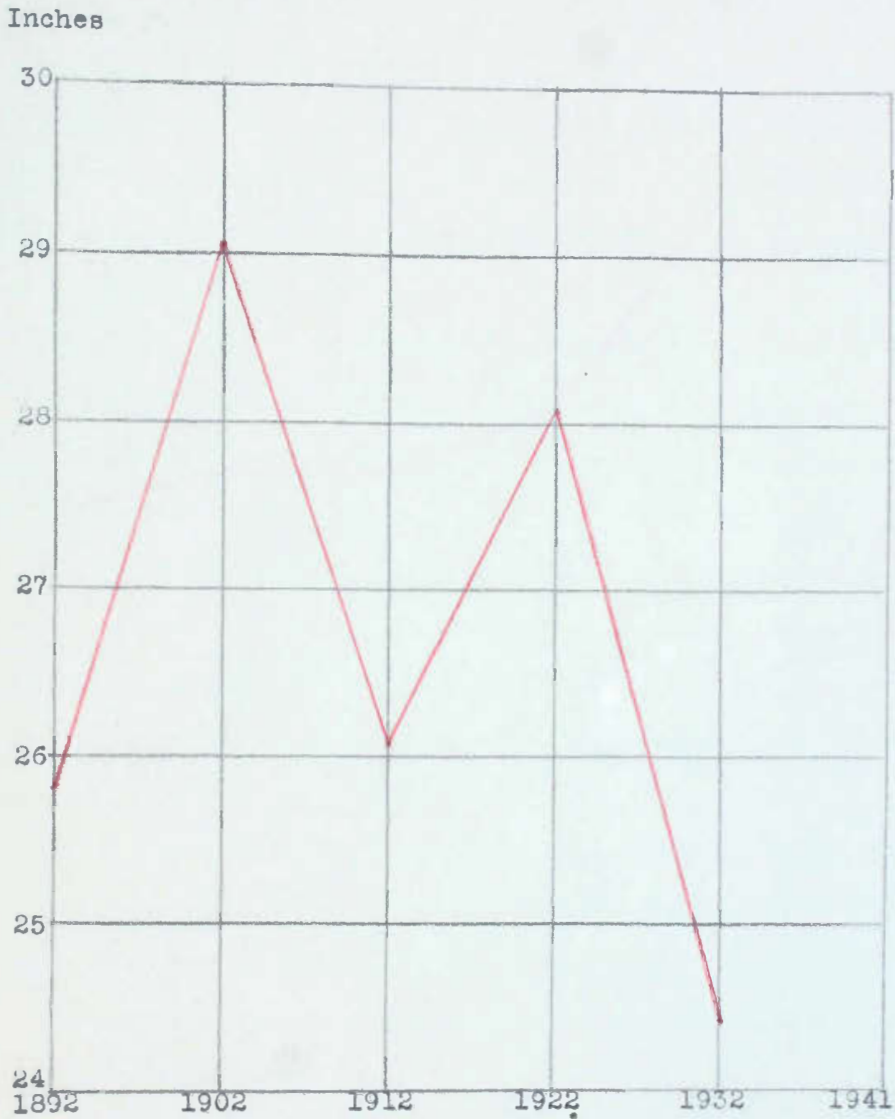


FIGURE XII. PRECIPITATION FOR KANSAS BY 10 YEAR AVERAGES.

Degrees F.

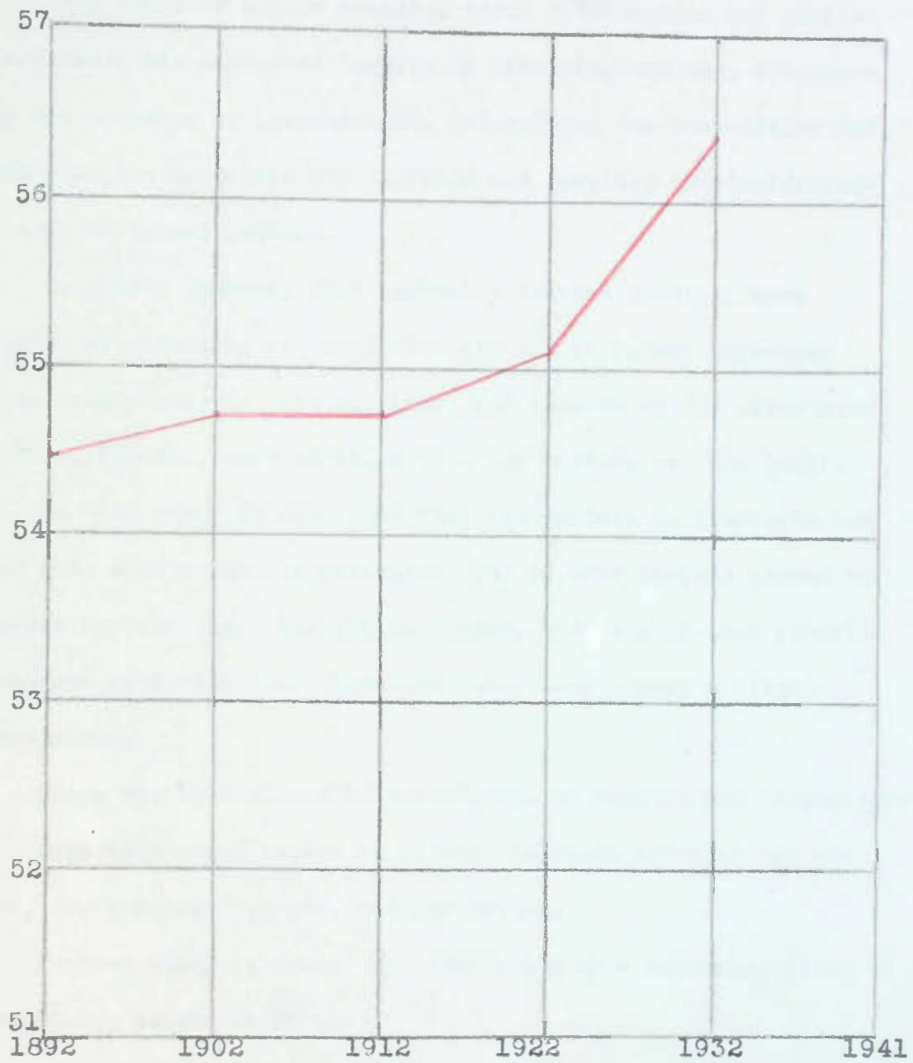


FIGURE XIII. TEMPERATURE FOR KANSAS BY 10 YEAR AVERAGES.

SUMMARY

This study of coyote numbers, their fluctuations and possible causes, was conducted largely by obtaining numbers, determining the presence of fluctuations, determining the periodicity and attempting to correlate the findings and possibly obtain information as to causal factors.

To obtain numbers, four centrally located counties were studied by obtaining all available records of bounty payments; state bounty records were obtained; and records of fur sales were obtained for all years in which this information was available.

In this study it was found that the numbers do fluctuate and that this fluctuation is periodic. The 10 year periods showed the closest correlation. The single factor, with the closest correlation, was precipitation. Economic conditions showed a slight correlation.

There was no evidence of correlation of numbers and temperature.

Data were insufficient to attempt to reach correlations for food, fur purchase records, and fur prices.

Further study is needed to establish a more accurate method of determining coyote numbers.

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