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AN ECONOMIC STUDY OF RATS (GENUS RATTUS)

IN CACHE COUNTY, UTAH

by

John Vincent Bruce

U. S. A. O.
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A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

ZOOLOGY

UTAH STATE AGRICULTURAL COLLEGE
Logan, Utah

1951

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I am deeply grateful to Owen W. Morris, district agent, Predator and Rodent Control, U. S. Fish and Wildlife Service; and Dr. Jessop B. Low, professor and leader of the Wildlife Research Unit at Utah State Agricultural College, for their guidance and assistance.

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INTRODUCTION

Time and Place of Study

The work upon which this study is based was done from November 1950, through March of 1951. The writer also worked on the control of rats during the summer of 1950. The control of rats conducted in Cache County for the United States Fish and Wildlife Service was under the supervision of Owen W. Morris, district agent of the Predator and Rodent Control Division.

Importance of the Problem

The most destructive animals in the world are rats (Rattus sp.). The annual destruction caused by rats in the United States is not known, but it has been estimated to be \$189,000,000, according to Silver (1942) of the United States Fish and Wildlife Service. Silver states that our nation's farmers lose approximately \$63,000,000 annually. Rats not only eat vast amounts of food meant for human and livestock consumption, but they contaminate and waste as much or more than they eat. Rats are able to gnaw into buildings, grain bins, and other places where food and shelter are available to them. Other feeding habits may be more destructive, such as the killing of baby chicks, baby pigs, lambs, and at times, full-grown hens and ducks. Several hundred baby chicks have been known to be killed in a single night. With today's need for increased human and livestock food throughout the world, we cannot afford to feed millions of rats.

In addition to their destructive habits, rats are a definite health menace. Hamilton (1947) states that rats have been the cause of more deaths than all the wars in history. During the fourteenth century bubonic

plague (carried by rats and their fleas) took the lives of 25,000,000 people, or one-fourth of the total population of Europe. Hubbard (1947) states that there have been 506 cases of bubonic plague in America since 1900; 1 case occurred in Beaver County, Utah.

Need of the Study

United States Fish and Wildlife Service and United States Public Health Service representatives have expressed a desire to assist in a rat control program for Cache County. In order to organize a sound program there is a definite need for information concerning the rat problem in Cache County. There has been very little study of a local nature concerning the economic losses caused by rats, and the relationship of such losses to the sanitary conditions. Lantz (1910) did a rat-loss survey of Washington, D. C. and Baltimore, Maryland, and since that time the results of his study have been used in making estimates concerning the damage caused by rats. There is a need for knowledge concerning the history of rat infestation and control in the county, the present distribution of rats, type of species present, degree of rat infestation, amount of damages caused by rats, amount being spent for control, and percentage of premises infested with rats.

Delimitation

In limiting this problem the writer tried to study the most important agricultural group in the county and one class of commercial establishments. Since dairying is the most important enterprise in the county, dairy farms formed the major portion of the study. A sample of poultry farms, turkey farms, and fish and fur farms was studied. One group of commercial establishments was included, the feed mills, flour mills, and grain elevators.

REVIEW OF LITERATURE

Lantz (1910) stated that he believed the losses caused by rats in the United States were much higher than in the European countries. Losses in Great Britain and Ireland were estimated to be \$73,000,000. This estimate was made by assuming three propositions: first, that in cities and villages the number of rats equals the human population; second, that in the country there is at least 1 rat for every acre of cultivated land; third, that each rat in the kingdom inflicts a damage of a farthing per day. From circulars sent throughout the country asking if the above assumptions were excessive, 90 to 99 percent of the replies indorsed each assumption. The annual loss in Great Britain was estimated to be \$1.27 per person. Denmark's annual loss per person was estimated at \$1.20, a total of \$3,000,000 per year. Germany's annual loss per person was estimated at 85 cents, a total of \$47,640,000 per year. France's annual loss per person was set at a little over \$1.00, a total of \$38,500,000 per year.

Lantz concluded from the above estimates of losses in the European countries that no common basis could be set for all countries.

Hobdy (1910) reported that rats may cause considerable damage aboard ships. On a ship carrying 46,000 bags of wheat, rats damaged 44,000 of them in 29 days at sea.

Silver (1942) reported that as a result of rat-loss surveys conducted in Winston Salem, N. C., in 1928, and in Dallas, Texas, in 1931, the losses were fixed by a biological survey representative at \$100,000 for Winston Salem and \$356,000 for Dallas. This was approximately \$1.50 per person in Winston Salem and \$1.35 in Dallas. Silver also stated that authorities

of the health service had placed the annual loss in United States at one-half billion dollars, or \$4.00 for each resident of the country. Silver summarized the total losses caused by rats on our nation's farms at \$63,000,000, in small towns and non-farm residences at \$68,000,000, and in cities at \$58,000,000, which made an estimated annual total loss of \$189,000,000 for the United States.

Silver reported that questionnaires were mailed out by district agents of the biological survey and 14,650 replies were received, reporting annual losses averaging \$35.00 per farm.

Gunderson (1944) reported that farms may be heavily infested without the owner knowing the extent of infestation or damages. In studying a heavily infested farm to estimate the rat population, Gunderson found approximately 4,000 rats within 3 acres. The rats were extremely abundant in a corn crib where 600 to 1,000 bushels of grain had been eaten and the remainder of 3,000 bushels rendered unfit for general use as stock feed.

Hamilton (1947) stated that he received 300 replies from people to whom he had mailed questionnaires. These questionnaires were mailed to people who requested rat control information, and the returns indicated an average loss per farm of \$80.00. He further stated that \$50.00 per farm in New York State is a conservative figure for yearly rat damages. Hamilton's estimate for the United States' yearly losses was \$260,000,000.

No one knows how many rats there are in the United States, nor how much damage rats are doing annually. Rats have plagued man for centuries and many times men have tried to estimate the damage they do. There have been relatively recent estimates concerning the yearly loss caused by rats from \$50,000,000 to \$500,000,000. Other than estimates from small samples or just guesses, very little information is available.

D. E. Lantz has been quoted most frequently when estimates of rat damages are made. Lantz (1910) stated that he could conservatively place the yearly rat loss for Washington, D. C., at \$400,000 and for Baltimore at \$700,000. Lantz had made a careful rat-loss survey of the 2 cities. This total of each city was slightly more than \$1.00 a year for each human inhabitant. With 10 years' experience, and because of advancing prices, Lantz saw fit to raise this figure in 1917 to \$2.00 per year for each human (estimating equal numbers of rats and people), and since 1917 this figure has been generally accepted by workers in this field.

DESCRIPTION OF STUDY AREA

Geography and Climate

Cache County, Utah, is primarily an agricultural county of 752,000 acres, of which 386,000 acres are farm lands. Cache County is located 36 miles north of Ogden (Figure 1). The United States Weather Bureau reports an average annual temperature of 47.2 degrees F. for Logan, the county seat. The average annual precipitation for Logan is 19.77 inches. The elevation of Logan is 4,535 feet above sea level. There are 19 communities in the county, with populations ranging from 250 to 16,802, a total of 33,496.

Economics

According to the United States Census of Agriculture of 1945, there were 2,227 farms in Cache County. The value of these farms was \$26,539,632

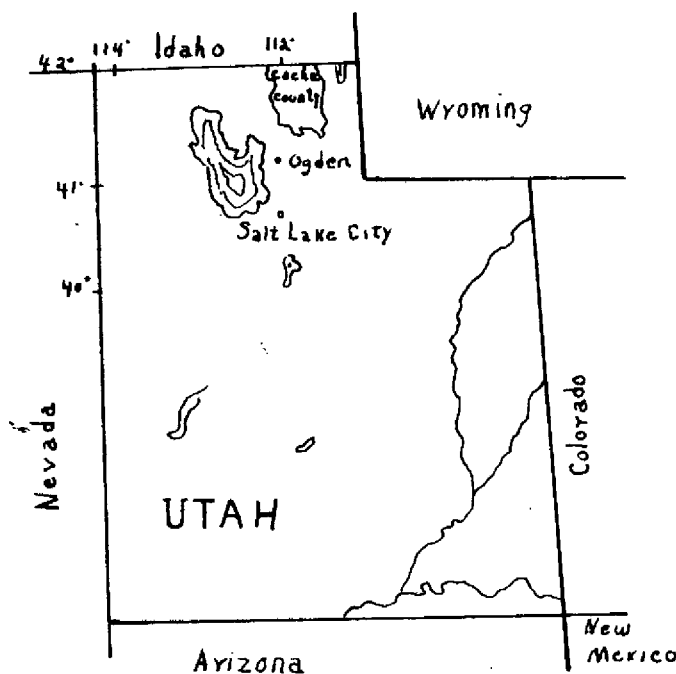


Figure 1. Location of Cache County, Utah.

(value of land and buildings). Dairying provides the major source of income to the farmers. In 1945 there were 15,732 cows being milked and the value of all dairy products sold was \$2,756,529. Poultry products were valued at \$1,436,464. The Cache Chamber of Commerce, in their Logan-Cache Statistical Review of 1951, indicates that the above figures have increased considerably since 1945. The Cache Chamber of Commerce estimates the agricultural income of Cache County for 1950 at approximately \$11,000,000.

Many of the communities in Cache County were planned so the farm yards were close together and the croplands were outside of town. It is possible that this condition tends to favor rats because the farm buildings and livestock are congested, and whenever rats become heavily infested on 1 premise, the near-by premises may also become infested. Many of the communities permit open, uncontrolled dumping grounds on the edge of town. These dumps may be a source of reinfestation to the near-by farms and business establishments.

Two types of farms in Cache County are the dry farms and irrigated farms. The majority of the farms are irrigated, and numerous waterways and canals are dispersed throughout the cultivated land of the county.

METHODS OF PROCEDURE

Dairy farms formed the major basis for this study, because dairying is 1 of the major sources of income to the farmers in Cache County. A list of dairymen was obtained from the County Agricultural Office and samples were selected at random from this list. Dairymen having 4 or fewer cows were omitted, because the majority of this group worked at occupations other than farming. The remaining 1,220 dairymen were divided into 3 groups according to the number of cows each dairyman had. This was done so that some small as well as large dairymen would be included in the samples. The first group included dairymen having 5 to 10 cows. An 8 percent sample was drawn, which was a total of 32 farms to investigate in this group. The second group included dairymen having 10 to 20 cows. An 8 percent sample was drawn, which was 41 farms. The third group included dairymen having 20 or more cows. A 10 percent sample was drawn, which was 33 farms. A total of 106 dairy farms was investigated.

A list of 35 poultrymen was obtained from the County Agricultural Office. This list was composed of poultrymen who made approximately 50 percent or more of their income from poultry. The list was made up by Reuben Hansen, assistant County Agricultural Agent. A sample of 23 poultrymen was investigated by the writer. The list of turkey growers was obtained in the same manner as the poultry list, and it included turkey growers who produced from 2,500 to 10,000 turkeys per year.

The feed mills, flour mills, and grain elevators were grouped into 1 list of 16, and 13 of these were investigated. Five of this group

were studied in detail during the summer of 1950 and revisited frequently until November 1950. In an attempt to control rats in these 5 establishments, sodium fluoroacetate (1080) was used. A visit was made every 10 days or 2 weeks by the writer to check the results of the poisoning and to service the poison containers.

Five fish and fur farms were investigated several times to try and determine the extent of damages and to assist the managers in controlling rats. Sodium fluoroacetate was used on 1 of these premises during July, August, and September of 1950. More than 700 rats were picked up and burned as a result of this poisoning campaign.

In order to get uniform answers when making interviews, a form was designed so the same questions would be asked of each cooperator (p. 12). In addition to the personal interview form an inspection form (p. 13) was attached, and immediately after interviewing the owner and investigating the premise, these forms were filled out in detail. An attempt was made to fill these forms out while interviewing the owners, but less information was obtained in this manner than when filling out the forms after the interview. A government truck was used while making these surveys and the writer believes this assisted in gaining the confidence of the cooperators.

On Form 1 the degree of infestation (heavy, medium, light) was decided from the following factors: (1) the number of rats seen at night and during the day; (2) the number of rats killed during the year; (3) extent of damages caused by rats; (4) amount of rat evidence seen; (5) the writer's inspection of the premise concerning the amount of food and harborage available to rats. Taking into consideration the above factors, an estimate was made as to the approximate number of rats on the premise. If it were estimated that there were probably fewer than 20 rats on the premise,

the infestation was considered light. If the number of rats was estimated to be from 20 to 75, the infestation was considered medium. Above 75, the infestation was considered heavy.

The writer's estimate of the damages was made after considering the following: (1) all statements made by the owner concerning the damages suffered; (2) number of rats killed; (3) location of the rat infestation; (4) amount and type of food available; (5) amount of rat evidence seen; (6) degree of infestation.

At the beginning of the study an attempt was made to evaluate the total amount spent for rat control. This included money spent for rat poisons, poison bait boxes, rat-proofing buildings, and repairing buildings that had been damaged by rats. The latter 2 items, rat-proofing and repair of buildings, had to be abandoned because of the inability of the writer to evaluate these costs with any degree of accuracy.

The number of dogs and cats on a premise was not considered at the beginning of the study. Several farmers insisted that cats and dogs were an important factor in controlling rats, so these questions were added.

On Form 2 the condition of the buildings and premise was decided from several factors. Whether the buildings were rat-proofed, partially rat-proofed, or not rat-proofed was considered. The amount of food and harborage inside and outside the buildings was considered. If the buildings were rat-proofed, or partially rat-proofed by having cement foundations and cement floors, and there was not an accumulation of feed, trash, lumber, and other debris scattered about the premise, the place was considered good. If the buildings were not rat-proofed, and there was a minimum of feed and harborage available to rats, the place was considered fair. If the buildings were not rat-proofed and there was abundant feed

and harborage inside and outside the buildings the premise was considered poor.

A questionnaire was designed by the writer to try to evaluate the usefulness of such a method in a study of this kind (p. 14). Fifteen poultrymen and 85 dairymen were sent questionnaires in official government envelopes with an enclosed stamped envelope for return to the writer.

During July 1950 the Utah State Agricultural College initiated a rat-control program. The writer, as an employee of the United States Fish and Wildlife Service, made a rat survey of the college buildings and attempted to control the rats. The writer worked part-time on the poisoning campaign from July 1950, through March of 1951. Sodium fluoroacetate (1080), Red Squill, and Warfarin were used in an attempt to control the rats on the college property.

PERSONAL INTERVIEW - FORM 1

Code _____

Date _____

1. When did rats first appear in your community?
Exact year _____. Approximate year _____.
2. What is the extent of rat infestation in your community?
(Heavy, medium, light).
3. What is the extent of rat infestation on your premise?
(Heavy, medium, light).
4. Investigator's estimate of rat infestation. (Heavy, medium, light).
5. What was the extent of damages, due to rats, on your premise during 1950? Total \$ _____.

Damage to:

Buildings _____	Poultry _____
Human food _____	Turkeys _____
Livestock feed _____	Other animals _____
Feed containers _____	Other damages _____
(sacks, boxes)	

Remarks:

6. Estimate your total losses for 1950. \$ _____.
- A. Investigator's estimate of losses. \$ _____.
7. Estimate total spent for control of rats. Total \$ _____.
- | | |
|------------------|--------------------|
| Poison _____ | Bat-proofing _____ |
| Bait boxes _____ | Repairs _____ |
8. Estimate the number of rats killed during 1950 _____.
- How killed? _____.
9. Number of cats _____, dogs _____ on premise.
10. Additional data:

PERSONAL INSPECTION OF SANITARY CONDITIONS

AND RAT HARBORAGE AVAILABLE - FORM 2

LIBRARY Code _____
Date _____

Specific type of farm or business _____.

Location _____.

Buildings:

Number _____; number rat-proofed _____; partially rat-proofed _____; not rat-proofed _____.

Remarks:

Interior of buildings:

Food available to rats _____ a. abundant
Harborage available _____ b. moderate
c. scarce
d. none

Remarks:

Outside of buildings:

Food available _____ (livestock feed) a. abundant
(haystacks) b. moderate
Harborage available _____ (lumber piles) c. scarce
(old sheds) d. none
(garbage)
(trash)

Remarks:

General condition of buildings and premise _____ a. good
b. fair
c. poor

Remarks:

145588

QUESTIONNAIRE - FORM 3

United States Department of Interior
 Fish and Wildlife Service
 Predator and Rodent Control
 Box 14, USAC Campus
 Logan, Utah

March 27, 1951

Dear Sir:

The United States Government is planning to assist in the organization of a rat control program for Cache County, Utah. In order to organize a sound program information concerning the rat problem is urgently needed. Any of the following information you may be able to supply will be greatly appreciated. Please return this form immediately.

1. When were you first aware of rats being present in your community?
 Name exact year _____ or approximate year _____.
2. What was the extent of damages you suffered due to rats during 1950?

Damage to livestock food	\$ _____.
" " sacks, boxes, etc.	\$ _____.
" " baby chicks, poults	\$ _____.
" " buildings	\$ _____.
" " other ()	\$ _____.
3. Estimate amount spent to control rats.

Amount spent for poison	\$ _____.
" " " traps and bait boxes	\$ _____.
" " " rat-proofing	\$ _____.
" " " repair	\$ _____.
4. Estimate number of rats killed on your farm during 1950 _____.
 How killed? _____.
5. Number of cats _____ and dogs _____ on farm.
6. Add additional information. (Your ideas on rat control methods welcome.)

(Name and address not necessary)

RAT HISTORY AND DISTRIBUTION

Species of Rats in Cache County

There is no evidence that any species of "alien" rat, except the Norway Rat, exists in Cache County.

An attempt was made to determine whether there were other species present but after examining more than 1,000 rats taken from several parts of the country, the writer tentatively classified them all as the Norway Rat. Representatives of the United States Public Health Service and United States Fish and Wildlife Service examined several rats and classified them as the Norway Rat. Dr. J. S. Stanford, professor of Zoology at the Utah State Agricultural College, has examined several rats taken in Cache County and has found all of them to be the Norway Rat.

During the semi-annual rat campaign of 1949 the writer worked for the Logan City Health Department to study the distribution and the possibility of the presence of the Roof Rat in Logan. No evidence was found that indicated the presence of any rat except the Norway Rat.

The Roof Rat, Rattus rattus alexandrinus, has been reported from Salt Lake City, 85 miles south of Logan. The infestation of the Roof Rat is limited to the business district of Salt Lake City. There is no evidence of its presence elsewhere in Utah.

The Black Rat, Rattus rattus rattus, has not been found in Utah to date according to the United States Public Health Service.

History of Rat Infestation and Control in Cache County

Zinsser (1944) states that the Norway or Brown Rat originated in Asia. In 1727 hordes of rats swam the Volga River and within one year had swept over Europe and reached England. A mistaken notion of its

Description and Taxonomy of the Norway Rat



Figure 2. Norway Rat Rattus norvegicus

Names: Norway Rat; Brown Rat; Domestic Rat; Barn Rat; Common Rat; House Rat; and Wharf Rat.

Description: A large robust rat, nearly naked ears, semi-naked tail with conspicuous annulations; pelage coarse; brown or grayish brown, fading to dirty silver-gray or pale yellowish white on the belly. Individuals may vary considerably from almost pure gray to reddish brown, or nearly black, and partial albinos are not rare.

Measurements: Sexes of equal size; total length, 15 to 16 inches; tail vertebrae 7 to 8 inches; hind foot 1.6 to 1.7 inches. Weight 10 to 17 ounces.

Dentition: Incisors, $\frac{1}{1}$; canines, $\frac{0}{0}$; premolars, $\frac{0}{0}$; molars, $\frac{3}{3} = 16$.

Habits: Lives mainly on or below ground level, seldom going above the first floor like the Roof Rat. Found along ditch banks, in garbage dumps, and where man provides food and shelter for them.

Description and Taxonomy of the Roof Rat



Figure 3. Roof Rat Rattus rattus alexandrinus (Geoffroy)

Names: Roof Rat; Alexandrine Rat; Gray Rat.

Description: The Roof Rat is a subspecies of the Black Rat, Rattus rattus rattus. Except for lighter color, the Roof Rat resembles the Black Rat in size and physical features. The upper parts of the Roof Rat are reddish brown; underparts are white, strongly suffused with yellowish; tail very long and finely annulated, color above like back, lighter below.

Measurements: Total length, 17 inches; tail vertebrae, 9.5 inches; hind foot, 1.6 inches. Height at shoulders, 2 inches. Weight, 8 to 10 ounces.

Habits: Roof Rats climb readily and travel on the exterior of rough-surfaced buildings, on electric wires and cables, and in trees. It is more common on ships than the Norway Rat.

origin gave it the name norvegicus. It did not reach Norway until 1762. The Black Rat, Rattus rattus, had arrived in Europe sometime between the fourth and eleventh centuries. The Black Rat reached America during the sixteenth century. The Norway Rat killed or drove out the Black Rat whenever the 2 met. The Norway Rat appeared in America in 1775 and spread slowly across the continent. It did not reach California until 1851.

Harmston (1951) reports that rats appeared in Utah in approximately 1900. They appeared first in Salt Lake City. Harmston further states that Dr. E. G. Titus, former head of the Zoology Department of the Utah State Agricultural College, collected the first rats in Cache County in 1911. These first rats were found in Cache Junction, and were relatively few in number. Harmston also states that Dr. Titus reported rats being present in Mendon and in Benson in 1914, and by 1925 they were in Logan and several other parts of the south end of Cache County. Zimmerman (1950) states that he saw a rat on a farm between Logan and Mendon in 1915. In 1927 Mr. Zimmerman was called to Hyrum and Wellsville concerning a complaint of rats being in 2 feed mills.

According to the Cache County Agricultural Yearly Reports, the first appearance of rats in Cache County was in 1932. Two farmers came in to request assistance in controlling rats. Table 1 indicates the rat control programs in Cache County from 1932 through 1950.

From interviews with several hundred people the majority reported that rats appeared from 1935 to 1940. The writer believes that they remained relatively few in number until 1936-37, then rapidly increased and spread throughout the populated area. Figure 4 indicates when rats appeared in the different communities. Many of the dates may be much later than the actual appearance of rats, but no evidence was found to

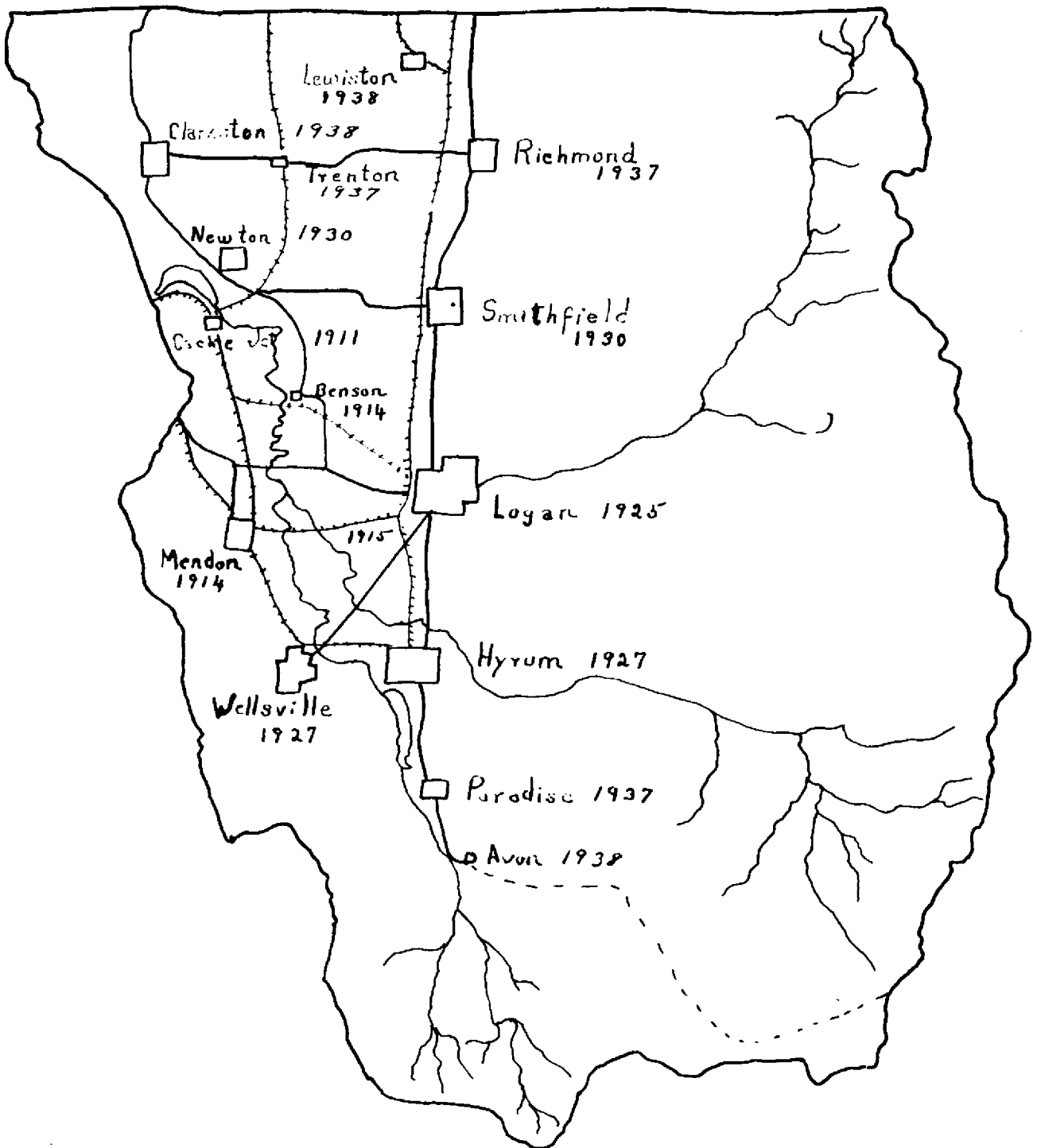


Figure 4. History of rats in Cache County, Utah.

indicate an earlier appearance.

During the past 4 years the United States Fish and Wildlife Service has attempted to control rats in a few of the business establishments by the use of sodium fluoroacetate (1080) treated water. They have also used (1080) treated grain on several public dumping grounds. The writer, using (1080), picked up more than 1,365 poisoned rats from 11 premises during July, August, and September 1950.

Poison bait boxes have been manufactured in Cache County by the Janson farm shop in Trenton during the past 2 years. These boxes are made of aluminum approximately 6 inches by 6 inches, and 20 inches long. They are designed to keep animals, other than mice and rats, from eating the poison placed inside the box. More than 400 boxes, at \$5.00 per box, have been sold in Cache County.

Distribution of Rats in Cache County

The distribution of the Norway Rat, Rattus norvegicus, was found to extend through the populated area of the county. Rats, or recent evidence of rats, were found in every community in the county, and on many of the isolated farms along the mountains. One rat was killed by the writer along the Bear River 2 miles from the nearest farm. Two trappers reported to the writer that they often caught Norway Rats in their muskrat traps 1 and 2 miles from their farm. Many of the public dumping grounds on the outskirts of the communities were found to be infested with rats. The distribution of rats is shown in the shaded area of Figure 5.

In November 1950 Fred Harmston, United States Public Health Service; Reed Roberts, Logan City Health Department; Willard West, State Health Department; and the writer worked on the distribution of rats in Logan

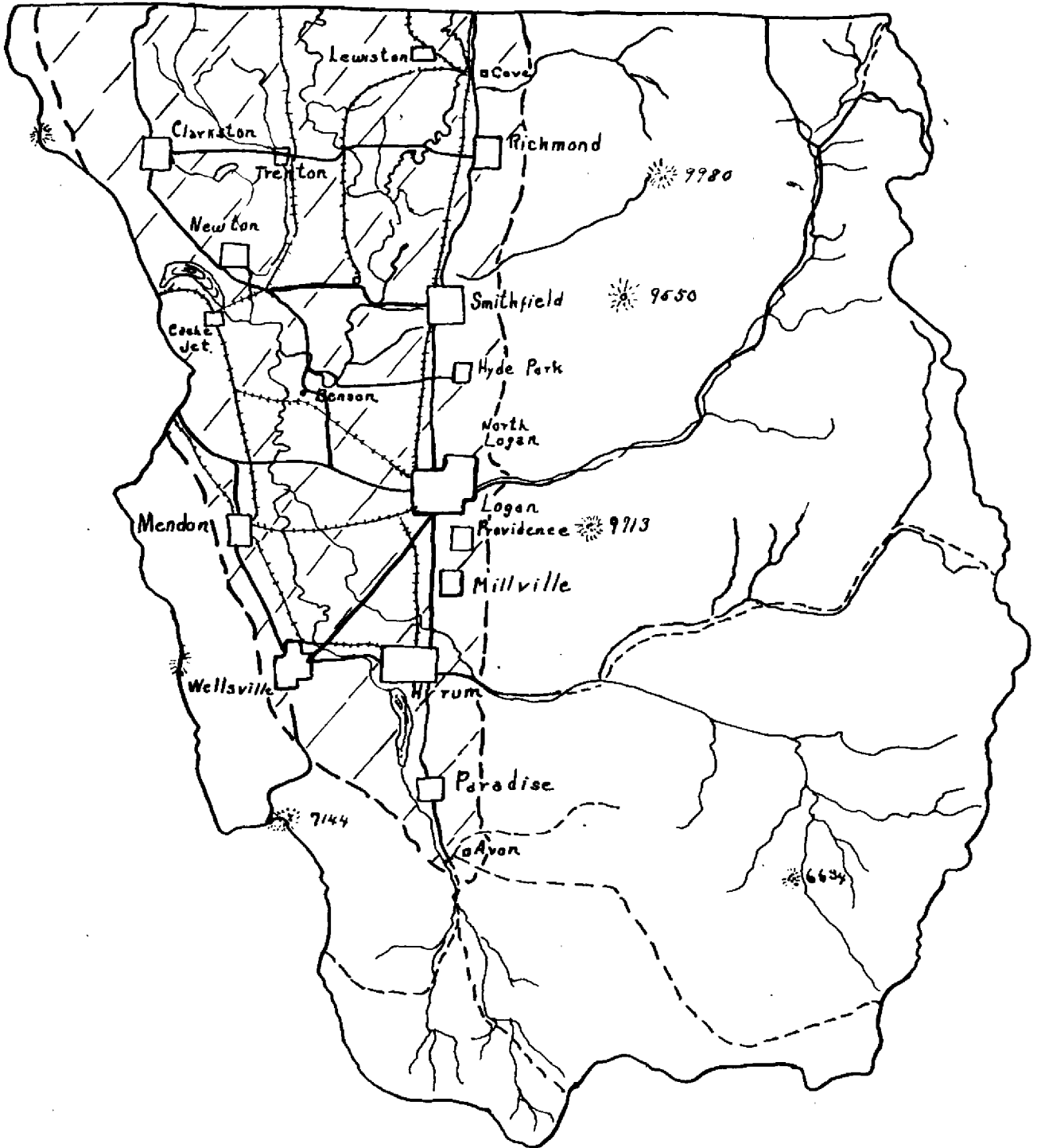


Figure 5. Distribution of rats in Cache County, Utah.

Table 1. Records of rat control programs in Cache County, Utah, from 1932 to 1950 (taken from County Agricultural Office Yearly Reports)

Year	Amount and kind of poison	Cooperators	Communities
1932	2 packages of Red Squill concentrate	2	?
1933	None	-	-
1934	None	-	-
1935	None	-	-
1936	4 packages of Red Squill concentrate	?	?
1937	794 pounds of prepared Red Squill	227	?
	70 packages of Red Squill concentrate	?	?
1938	1100 pounds of prepared Red Squill	?	?
	211 packages of Red Squill concentrate	?	?
1939	645 pounds of prepared Red Squill	209	4
1940	1203 pounds of prepared Red Squill	534	?
1941	1378 pounds of prepared Red Squill	505	20
	160 packages of Red Squill concentrate	139	?
1942	946 pounds of prepared Red Squill	424	19
	155 packages of Red Squill concentrate	118	19
1943	109 cartons of Barium Carbonate	82	15
1944	333 pounds of Barium Carbonate	82	16
	47 packages of Red Squill concentrate	?	?
1945	1st campaign		
	350 pounds of prepared Red Squill	165	14
	2nd campaign		
	770 pounds of prepared Red Squill	267	19
1946	1st campaign		
	452 pounds of prepared Red Squill	169	19
	2nd campaign		
	376 pounds of prepared Red Squill	179	19
1947	1st campaign		
	678 pounds of prepared Red Squill	234	20
	2nd campaign		
	500 pounds of prepared Red Squill	180	17
1948	1st campaign		
	603 pounds of prepared Red Squill	349	23
	2nd campaign		
	259 pounds of prepared Red Squill	500	21
	86 packages of Red Squill concentrate	80	16
1949	1st campaign		
	399 pounds of prepared Red Squill	110	19
	2nd campaign		
	230 pounds of prepared Red Squill	93	21
1950	1st campaign		
	861 pounds of prepared Red Squill	383	21
	2nd campaign		
	400 pounds of prepared Red Squill	245	23

City. Rats, or rat evidence, were found in several places in the business district from the city limits south of town to the city limits north of town. Rats were found in all sections of the city, and were especially numerous in the western section and in the eastern section of the city.

ANALYSIS OF RAT SURVEYS IN CACHE COUNTY, UTAH, 1950

Analysis of the Survey of Small Dairy Farms

The data in Table 2 indicate that from the sample of 32 small dairymen, 24 or 75 percent were found to have rats or rat evidence on their premises. Five of these farms were found heavily infested, 7 had a medium infestation, 12 had a light infestation, and 8 were found free of rats or rat evidence.

The minimum total annual loss estimated by the writer was \$269.00; with individual losses of \$2.00 to \$50.00. The average minimum loss per farm was \$8.40. The losses estimated by the owners were vague; only 7 dairymen had a definite idea as to the amount of damages caused by rats.

The total amount spent for poison and bait boxes was \$51.75; with individual expenditures of \$1.00 to \$10.00. The average expenditure per farm was \$1.61 for 1950.

Fourteen farmers, who indicated a definite number of rats killed, reported a total of 238 killed during 1950. Eight other dairymen reported killing "some" rats.

It is noted in Column 7, Table 2, that 18 farms were judged to be in poor condition. Five of the 18 farms in poor condition were found to be heavily infested, and 12 of the 18 were found to be suffering losses from rat damages. None of the 4 farms judged to be in good condition were heavily infested, and only 2 of the 4 good farms were suffering losses from rat damages.

Table 2. Results of the rat survey of small dairy farms

Sample No. (1)	Degree of Infestation (2)	Amount of 1950 Damages		Amount Spent for Control-1950 (5)	No. Rats Killed 1950 (6)	Condition of Bldgs. & Premise (7)
		Investigator's Estimate (3)	Owner's Estimate (4)			
189	None	None	None	None	None	Good
211	None	None	None	None	None	Good
96	None	None	None	None	None	Fair
139	None	None	None	None	None	Fair
502	None	None	None	None	None	Fair
297	Light	None	None	None	Some	Fair
169	Light	None	None	None	Some	Fair
401	None	None	None	None	None	Poor
265	None	None	None	None	None	Poor
103	None?	None	None	None	None	Poor
500	Light	None?	None	None	Some	Poor
246	Light	None?	None	\$1.00	5	Fair
176	Light	None?	None	\$2.00	2	Poor
267	Light	None?	No idea	None	4	Poor
349	Light	\$2.00	No idea	\$2.00	5	Fair
133	Light	\$3.00	No idea	\$5.00	3	Poor
236	Light	\$4.00	Few \$	\$1.00	Some	Poor
173	Light	\$5.00	No idea	\$2.00	6	Fair
51	Light	\$5.00	No idea	\$2.00	6	Fair
334	Medium	\$5.00	Few \$	\$6.00	10	Fair
80	Medium	\$5.00	Few \$	None	10	Good
217	Heavy	\$5.00	Few \$	\$6.00	30	Poor
140	Light	\$5.00	Few \$	None	Some	Poor
34	Medium	\$10.00	\$10.00	\$1.00	25	Good
395	Medium	\$15.00	\$10.00	\$1.50	Some	Poor
59	Medium	\$20.00	Few \$	\$5.00	10	Poor
49	Medium	\$20.00	\$15.00+	\$5.00	Some	Poor
203	Medium	\$25.00	\$10.00	\$1.25	Some	Poor
501	Heavy	\$25.00	\$20.00	\$1.00	12	Poor
321	Heavy	\$25.00	No idea	None	10	Poor
240	Heavy	\$40.00	\$40.00	\$10.00	Some	Poor
315	Heavy	\$50.00	\$50.00	None	100+	Poor
Total		\$269.00		\$51.75	238	
Average		\$ 8.40		\$ 1.61		

Analysis of the Rat Survey of Medium Dairy Farms

The data in Table 3 indicate that from the sample of 41 medium dairy-men, 31 or 75.6 percent were found to have rats or rat evidence on their premises. Six of the 41 were found to be heavily infested, 9 were found

Table 3. Results of the rat survey of the medium dairy farms

Sample No. (1)	Degree of Infestation (2)	Amount of 1950 Damages		Amount Spent for Control-1950 (5)	No. Rats Killed 1950 (6)	Condition of Bldgs. & Premise (7)
		Investigator's Estimate (3)	Owner's Estimate (4)			
39	None	None	None	None	None	Good
28	None	None	None	None	None	Good
95	Light	None?	None	None	1	Good
46	None	None	None	None	None	Fair
314	None	None	None	None	None	Fair
278	Light	None?	No idea	None	Some	Good
299	None	None	None	None	None	Fair
420	None	None	None	None	None	Fair
442	Light	None?	None	\$.80	Some	Fair
184	None	None	None	None	None	Poor
340	None	None	None	None	None	Poor
321	None	None	None	None	None	Poor
309	None?	None	None	None	None	Poor
425	Light	None	None	None	Some	Poor
236	Light	None?	No idea	None	Some	Poor
96	Light	None	None	None	Some	Fair
491	Light	\$3.00	Few \$	\$1.00	Some	Fair
197	Light	\$5.00	Few \$	\$5.00	Some	Good
40	Light	\$5.00	Few \$	\$1.00	10	Fair
29	Light	\$5.00	No idea	\$2.00	5	Fair
467	Light	\$5.00	Few \$	None	None	Fair
253	Light	\$5.00	Few \$	\$3.00	Some	Fair
232	Light	\$5.00	No idea	\$1.00	Some	Poor
284	Light	\$5.00	Few \$	\$.80	Some	Poor
191	Medium	\$10.00	\$5.00	\$2.00	15	Fair
12	Medium	\$10.00	\$10.00	\$2.00	15	Fair
281	Medium	\$10.00	Few \$	\$6.00	15	Poor
286	Light	\$10.00	\$10.00	\$2.00	10	Poor
296	Light	\$15.00	\$10.00	\$7.00	Some	Poor
368	Medium	\$15.00	Few \$	None	15	Poor
86	Medium	\$15.00	Few \$	\$17.00	10	Poor
267	Medium	\$20.00	No idea	\$2.00	Some	Poor
20	Heavy	\$20.00	No idea	\$7.00	50	Poor
75	Medium	\$25.00	\$10.00	\$5.00	Some	Fair
351	Medium	\$25.00	\$20.00	\$2.00	Some	Poor
387	Medium	\$25.00	\$20.00	\$2.00	25	Poor
261	Heavy	\$25.00	\$10.00	\$6.00	20	Poor
464	Heavy	\$75.00	\$50.00	None	Some	Poor
165	Heavy	\$100.00	\$100.00	\$3.00	50	Poor
438	Heavy	\$125.00	\$125.00	\$2.00	50	Poor
500	Heavy	\$150.00	\$100.00+	\$2.00	85	Poor
Total		\$713.00		\$80.80	376	
Average		\$ 17.39		\$ 1.97		

to have a medium infestation, 16 had a light infestation, and 10 were found free of rats or rat evidence.

The minimum total annual loss estimated by the writer was \$713.00, with individual losses of \$3.00 to \$150.00. The average minimum loss per farm was \$17.39. The losses estimated by the owners were vague; only 12 had a definite idea as to the amount of damages caused by rats.

The total amount spent for poison and bait boxes was \$80.80; with individual expenditures of \$0.80 to \$17.00. The average expenditure per farm was \$1.97 for 1950.

Fifteen dairymen who indicated a definite number of rats killed reported a total of 376 killed during 1950. Fifteen other dairymen reported killing "some" rats.

It is noted in Column 7, Table 3, that 22 farms were judged to be in poor condition. Six of the 22 were found to be heavily infested, and 16 of the 22 farms in poor condition were suffering losses from rat damages. None of the 5 farms judged to be in good condition were heavily infested, and only 1 of the 5 good farms was suffering losses from rat damages.

Analysis of the Rat Survey of Large Dairy Farms

The data in Table 4 indicate that from the sample of 33 large dairymen, 24 or 75.8 percent were found to have rats or rat evidence on their premises. Eight of the 33 were found to be heavily infested, 5 had a medium infestation, 12 had a light infestation, and 8 were found free of rats or rat evidence.

The minimum total annual loss estimated by the writer was \$765.00; with individual losses of \$2.00 to \$250.00. The average minimum loss

Table 4. Results of the rat survey of large dairy farms

Sample No.	Degree of Infestation	Amount of 1950 Investigator's Estimate	Amount of 1950 Damages Owner's Estimate	Amount Spent for Control-1950	No. Rats Killed 1950	Condition of Bldgs. & Premise
(1)	(2)	(3)	(4)	(5)	(6)	(7)
257	None	None	None	None	None	Good
296	None	None	None	None	None	Good
261	None	None	None	None	None	Good
94	None	None	None	None	None	Good
86	None	None	None	None	None	Good
149	Light	None?	None	None	None	Good
26	Light	None?	None	None	Some	Good
140	Light	None?	None	None	2	Good
87	Light	None?	None	None	1	Good
258	None	None	None	None	None	Fair
109	None	None	None	None	None	Fair
190	None	None	None	None	None	Fair
309	Light	None?	None	None	None	Fair
132	Light	None?	None	None	Some	Fair
269	Light	\$2.00	Few \$	\$.80	Some	Fair
189	Light	\$3.00	Few \$	\$5.00	8	Poor
134	Light	\$5.00	No idea	\$1.00	Some	Poor
113	Light	\$5.00	Few \$	None	None	Fair
235	Medium	\$5.00	Few \$	\$5.00	8	Fair
239	Light	\$10.00	Few \$	None	7	Fair
67	Light	\$10.00	No idea	\$2.00	Some	Poor
185	Medium	\$10.00	Few \$	None	None	Poor
15	Medium	\$10.00	Few \$	\$1.00	Some	Fair
28	Medium	\$10.00	Few \$	\$1.00	25	Poor
292	Medium	\$10.00	No idea	\$10.00	6	Poor
58	Heavy	\$15.00	No idea	\$6.00	50	Poor
234	Heavy	\$20.00	\$10.00	\$2.00	100+	Poor
301	Heavy	\$50.00	\$50.00	\$2.00	20+	Poor
119	Heavy	\$75.00	\$50.00+	\$6.00	75	Good
306	Heavy	\$75.00	\$50.00+	\$5.00	100	Poor
215	Heavy	\$100.00	\$100.00	\$10.00	20	Poor
56	Heavy	\$100.00	\$75.00+	\$2.00	50+	Poor
122	Heavy	\$250.00	\$250.00	\$6.00	100+	Poor
Total		\$765.00		\$64.80	572	
Average		\$ 23.18		\$ 1.96		

per farm was \$23.18. The losses estimated by the owners were vague; only 7 had a definite idea as to the amount of damages caused by rats.

The total amount spent for poison and bait boxes was \$64.00; with

individual expenditures of \$.80 to \$10.00. The average expenditure per farm was \$1.96 for 1950.

Fifteen dairymen who indicated a definite number of rats killed reported a total of 572 killed during 1950. Six other dairymen reported killing "some" rats.

It is noted in Column 7, Table 4, that 13 of the 33 dairy farms were judged to be in a poor condition. Seven of the 13 were found to be heavily infested, and all 13 farms in poor condition were suffering losses from rat damages. The 10 farms judged to be in good condition had only 1 that was heavily infested, and this was the only 1 that was suffering losses from rat damages.

Analysis of the Rat Survey of Poultry Farms

The data in Table 5 indicate that from the sample of 23 poultrymen, 17 or 73.9 percent were found to have rats or rat evidence on their premises. Nine of the 23 were heavily infested, 7 had a medium infestation, 1 had a light infestation, and 6 were found free of rats or rat evidence.

The minimum total annual loss estimated by the writer was \$1,890.00; with individual losses of \$5.00 to \$700.00. The average minimum loss per farm was \$82.17. Fourteen poultrymen reported a definite amount lost, \$1,592.

The total amount spent for poison and bait boxes was \$139.00; with individual expenditures of \$2.00 to \$50.00. The average expenditure per farm was \$6.04 for 1950.

The number of chicks reported lost by 7 poultrymen was 878.

Thirteen poultrymen who indicated a definite number of rats killed reported a total of 898 killed during 1950. Four other poultrymen reported

Table 5. Result of the rat survey of poultry farms

Sample No.	Degree of Infestation	Amount of 1950 Investigator's Estimate	Damages Owner's Estimate	Amt. Spent for Control-1950	No. Chicks Killed 1950	No. Rats Killed 1950	Cond. of Bldgs. & Premise
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
105	None	None	None	None	None	None	Good
1	None	None	None	None	None	None	Good
3	None	None	None	None	None	None	Good
101	None	None	None	None	None	None	Good
2	None	None	None	None	None	None	Good
37	None	None	None	None	None	None	Fair
30	Medium	\$5.00	\$5.00	None	None	Some	Fair
25	Light	\$10.00	\$10.00	\$10.00	None	10	Fair
103	Medium	\$10.00	Few \$	\$12.00	None	20	Fair
24	Medium	\$20.00	\$20.00	\$ 6.00	None	8	Fair
100	Medium	\$20.00	\$12.00+	\$ 5.00	12	Some	Poor
19	Heavy	\$20.00	\$20.00	\$ 2.00	None	100	Poor
53	Medium	\$25.00	\$20.00	\$ 7.00	30	25	Fair
15	Medium	\$25.00	\$15.00+	\$ 3.00	None	20	Poor
11	Medium	\$30.00	\$30.00	None	None	Some	Fair
8	Heavy	\$35.00	\$20.00	None	None	100	Poor
60	Heavy	\$90.00	\$90.00	None	164	10	Poor
104	Heavy	\$100.00	\$100.00	\$ 3.00	47	50	Fair
102	Heavy	\$100.00	Many \$	\$ 5.00	None	125	Poor
7	Heavy	\$200.00	\$200.00	\$ 4.00	None	75	Fair
12	Heavy	\$250.00	Several hundred \$	\$12.00	175	200	Fair
29	Heavy	\$250.00	\$150.00	\$20.00	300	Some	Poor
52	Heavy	\$700.00	\$900.00	\$50.00	150	155	Poor
Total		\$1890.00	\$1592.00	\$139.00	878	898	
Average		\$ 82.17		\$ 6.94			

killing "some" rats.

It is noted in Column 8, Table 5, that 8 of the 23 poultry farms were judged to be in poor condition. Six of the 8 were heavily infested, and all 8 farms in poor condition were suffering losses from rat damages. The 5 farms judged to be in good condition were not infested, nor were any suffering losses from rat damages.

Analysis of the Rat Survey of Turkey Farms

The data in Table 6 indicate that from the sample of 23 turkey growers,

Table 6. Results of the rat survey of turkey farms

Sample No. (1)	Degree of Infestation (2)	Amount of Investigator's Estimate (3)	Damages Owner's Estimate (4)	Amt. Spent for Control-1950 (5)	No. Poults Killed 1950 (6)	No. Rats Killed 1950 (7)	Cond. of Bldgs. & Premise (8)
5	None	None	None	None	None	None	Good
21	None	None	None	None	None	None	Good
22	None	None	None	None	None	None	Good
32	None	None	None	None	None	None	Good
25	Light	None?	No idea	Some	None	10	Fair
2	Light	\$2.00	Few \$	None	12	5	Good
3	Light	\$3.00	Few \$	\$1.00	None	10	Good
13	Light	\$5.00	Few \$	\$5.00	None	Some	Good
10	Light	\$5.00	Few \$	\$10.00	None	Some	Fair
28	Light	\$5.00	No idea	\$2.00	None	10	Fair
8	Light	\$10.00	Few \$	None	None	Some	Good
9	Light	\$10.00	Few \$	\$7.00	None	Some	Poor
18	Medium	\$10.00	Few \$	None	None	30	Poor
11	Medium	\$15.00	No idea	\$5.00	None	Some	Fair
7	Medium	\$20.00	Few \$	\$11.00	None	50	Good
12	Medium	\$20.00	No idea	\$.70	None	Some	Poor
1	Medium	\$20.00	Few \$	None	None	25	Poor
20	Medium	\$25.00	\$25.00	\$7.00	None	12	Fair
15	?	\$25.00	\$4.00	Some	None	Some	?
17	?	\$75.00	\$75.00	None	30	Some	?
4	Heavy	\$100.00	\$100.00	\$10.00	None	Some	Good
30	?	\$100.00	\$100.00	\$6.00	None	Some	?
31	Heavy	\$700.00	\$1000.00	\$75.00	200 chicks	Hundreds	Poor
Total		\$1150.00		\$139.70+	42 poults	200 chicks	152+
Average		\$ 50.00		\$ 6.07			

18 or 82.6 percent were found to have rats or rat evidence on their premise. Two of the 23 were found to be heavily infested, 6 had a medium infestation, 8 had a light infestation, and 4 were found free of rats or rat evidence. Three turkey farms were not classified, except for damages suffered.

The minimum total annual loss estimated by the writer was \$1,150.00; with individual losses of \$2.00 to \$700.00. The average minimum loss per farm was \$50.00. The losses estimated by the owners were vague; only 6

turkey growers had a definite idea as to the amount of damages caused by rats.

The total amount spent for poison and bait boxes was \$139.70+; with individual expenditures of \$.70 to \$75.00. The average expenditure per farm was \$6.07 for 1950.

Two turkey growers reported a total of 42 poults killed. One turkey grower, who also raises poultry, lost 200 chicks to rats during 1950.

It is noted in Column 8, Table 6, that 5 of the 23 turkey farms were judged to be in poor condition. One of the 5 was heavily infested and all 5 poor farms were suffering losses from rat damages. Of the 10 farms judged to be in good condition, 1 was heavily infested and 6 of the good farms were suffering losses from rat damages. Three of the turkey farms were not classified, but the owners were interviewed and they reported a total loss of \$200.00 during 1950.

Analysis of the Rat Surveys of Feed Mills, Flour Mills, and Grain Elevators

The data in Table 7 indicate that from the sample of 13 establishments, 9 or 69.2 percent were found to have rats or rat evidence on their premises. Six were found heavily infested, 2 had a medium infestation, 1 had a light infestation, and 3 were found free of rats or rat evidence. One owner would not cooperate with the writer.

The minimum total annual loss estimated by the writer was \$1,400.00. The average minimum loss per establishment was \$107.69. The writer was unable to make an estimate of damages for 3 firms. Only 3 owners reported a definite amount of damage caused by rats. Six other owners admitted suffering losses, but were unable to state a definite amount.

The total amount spent for poison and bait boxes by 4 firms was \$145.00 for 1950. Four firms were assisted in controlling rats by the

Table 7. Results of the rat survey of feed mills, flour mills, and grain elevators

Type of Business	Sample No. (1)	Degree of Infestation (2)	Amount of Investigator's Estimate (3)	1950 Damages Owner's Estimate (4)	Amt. Spent for Control-1950 (5)	No. Rats Killed 1950 (6)	Cond. of Bldgs. & Premise (7)
Feed mill and flour mill	13	None	None	None	None	None	Good
Feed mill	8	None	None	None	None	None	Good
Feed mill	10	None	None	None	None	None	Fair
Feed mill and flour mill	9	Light	\$50.00	\$50.00	Some	Some	Good
Grain elevator	6	Medium	?	Many \$	None	30	Fair
Grain elevator	7	Medium	?	Many \$	\$15.00	Some	Fair
Feed mill	4	Heavy	\$50.00	Many \$	None	100	Poor
Feed mill	11	Heavy	\$200.00	Sev. hundred \$	\$15.00	100	Poor
Feed mill	12	Heavy	\$200.00	Sev. hundred \$	(1080) used by Gov. free	200	Poor
Feed mill and grain elevator	5	Heavy	\$300.00	\$300.00	\$80.00	Some (1080) used by Gov. free	Fair
Feed mill	2	Heavy	\$300.00	Sev. hundred \$	\$35.00	Sev. (1080) hundred used by Gov. free	Poor
Feed mill	1	Heavy	\$300.00	\$200.00-	None	Some (1080) used by Gov. free	Poor
Feed mill	3	?	?	No cooperation	?	Some	?
Totals			\$1400.00		\$145.00	430	
Average			\$ 107.69				

United States Fish and Wildlife Service.

Four firms reported a definite number of rats killed, a total of 430 for 1950. Five other owners reported killing "some" rats.

It is noted in Column 7, Table 7, that 5 firms were judged to be in poor condition. All 5 of the poor firms were heavily infested and all were suffering losses from rat damages. None of the 3 firms judged to be in good condition were heavily infested, and only 1 was suffering losses from rat damages.

Analysis of the Rat Survey of Fish and Fur Farms

The data in Table 8 indicate that 100 percent of the sample of 5 fish and fur farms were found to have rats or rat evidence on their premises. Four of the 5 were found heavily infested and in poor condition.

The minimum total annual loss estimated by the writer was \$1850.00; with individual losses of \$100.00 to \$1000.00. The average minimum loss per farm was \$370.00. The losses estimated by the owners and employees were \$1550.00.

The total amount spent for poison and bait boxes during 1950 was \$175.00. The average expenditure per farm was \$35.00.

The number of rats killed in sample No. 1 was estimated by the writer. More than 750 poisoned rats were picked up by the writer and employees during July, August, and September of 1950. The employees of this particular farm reported that rats were frequently shot during several months previous to the poisoning campaign. Flooding the burrows also killed numerous rats. Sodium fluoroacetate (1080) was used to poison the rats during the summer months. The poison was used in water, and placed in locked boxes designed so only rats or mice could enter to obtain the treated water. In November 1950, the owner of this farm began using

"Warfarin," a new rodenticide, and has had very good success keeping the rats under control with this new rodenticide.

Table 8. Results of the rat survey of fish and fur farms

Sample No. (1)	Degree of Infestation (2)	Amount of 1950 Damage		Amount Spent for Control-1950 (5)	No. Rats Killed 1950 (6)	Condition of Bldgs. & Premise (7)
		Investigator's Estimate (3)	Owner's Estimate (4)			
1	Heavy	\$1000	\$700+	\$25.00 (1080) used by Gov. free	1000+	Poor
2	Heavy	\$ 100	\$100	\$50	200	Poor
3	Heavy	\$ 250	\$250	\$50	Some	Poor
4	Heavy	\$ 500	\$500	\$50	Some	Poor
5	Light	Some	Some	None	Some	Good
Total		\$1850+	\$1550	\$175		
Average		\$ 370		\$ 35		

Results of Questionnaire Survey

Eighty-five questionnaires were mailed to dairymen, and 15 to poultrymen, with stamped addressed envelopes enclosed. Twenty-five replies were received, 18 from dairymen and 7 from poultrymen. Nineteen reported rats being present on their premise, and 14 stated that they were losing money as a result of rat damages. The majority of questions were not answered. From the questions that were answered, very little definite information could be obtained except that 76 percent reported the presence of rats on their premises.

Table 9 indicates the relationships between the different types of farms studied. The totals indicate that the annual loss for the 149 farms surveyed was \$4587.00. The average loss per farm was \$30.79. The amount

Table 9. Analysis of rat surveys of dairy, poultry, and turkey farms in Cache County, Utah, 1950

Type and number of farms surveyed	% of premises having rats or rat evidence	Degrees of infestation (heavy, medium, light, none)	Investigator's estimates of total losses for 1950	Average loss per premise 1950	Amt. spent for control 1950	No. rats killed 1950	Cond. of bldgs. & premise (poor, fair, good)
32 Small dairy farms	75%	5 - H 7 - M 12 - L 8 - N	\$269.00	\$8.40	\$ 51.75	238+	18 - P 10 - F 4 - G
41 Medium dairy farms	75.6%	6 - H 9 - M 16 - L 10 - N	\$713.00	\$17.39	\$ 80.80	375+	22 - P 14 - F 5 - G
33 Large dairy farms	75.8%	8 - H 5 - M 12 - L 8 - N	\$765.00	\$23.18	\$ 64.80	569+	13 - P 10 - F 10 - G
23 Poultry farms	73.9%	9 - H 7 - M 1 - L 6 - N	\$1890.00	\$82.17	\$139.00	898+	8 - P 10 - F 5 - G
23 Turkey farms	82.6%	2 - H 6 - M 8 - L 4 - N 3 - not classified	\$950.00 3 farms not classified \$200.00	\$50.00	\$139.70+	152+	5 - P 5 - F 10 - G 3 - not classified
Totals		30 - H 34 - M 49 - L 36 - N 149 total 3 not classified 152 total	\$4587.00 plus 3 farms	\$30.79 \$31.49	\$476.05+ ave. \$3.13 per farm	2232+	66 - P 49 - F 34 - G 149 total 3 not classified 152 total

spent for poison and bait boxes was \$476.05+. The average expenditure per farm was \$3.13. It is noted that 66 farms were judged to be in poor condition

and 30 farms were found heavily infested.

Table 10. Analysis of commercial establishments and fish and fur farms in Cache County, Utah, 1950

Type and number of farms surveyed	% of premises having rats or rat evidence	Degrees of infestation (heavy, med., light, none)	Investigator's estimates of total losses 1950	Average loss per premise 1950	Amt. spent for control 1950	No. rats killed 1950	Cond. of bldgs. & premise (poor, fair, good) 1950
13 feed mills, flour mills, and grain elevators	76.9%	6 - H 2 - M 1 - L 3 - N 1 - not classified	\$1400	\$107.69	\$145	430-	5 - P 4 - F 3 - G 1 - not classified
5 fish and fur farms	100%	4 - H 0 - M 1 - L 0 - N	\$1850-	\$370.00-	\$175	1200-	4 - P 0 - F 1 - G

Table 10 is an analysis of 13 commercial establishments and 5 fish and fur farms. These 2 groups were selected for study because of their known rat infestation. No valid conclusions can be drawn from these groups except the relationship between the different phases of the study.

Table 11. Relationship between the condition of the premises, degree of rat infestation, and amount of damages on the dairy, poultry, and turkey farms surveyed in Cache County, Utah, 1950

Dairy Poultry Turkey farms	Degrees of Infestation					Percentage of farms	Losses due to rat damage	
	No. Heavy	No. Medium	No. Light	None	Total		Total	Average
Poor	25	18	16	7	66	44.3%	\$3525.00	\$53.41
Fair	3	13	22	11	49	32.9%	817.00	16.67
Good	2	3	11	18	34	22.8%	245.00	7.21
Total	30	34	49	36	149		\$4587.00	\$30.79
		(Farms not classified)	3		3		200.00	
					152		\$4787.00	\$31.49

Table 11 indicates the relationship between the condition of the premises, the degree of rat infestation, and the amount of damages on dairy, poultry, and turkey farms surveyed.

A total of 44.3 percent of the farms surveyed were found in poor condition, and these farms suffered \$3525.00 damages due to rats during 1950. The average individual loss per farm in poor condition was \$53.41. The average individual loss per farm in good condition was \$7.21.

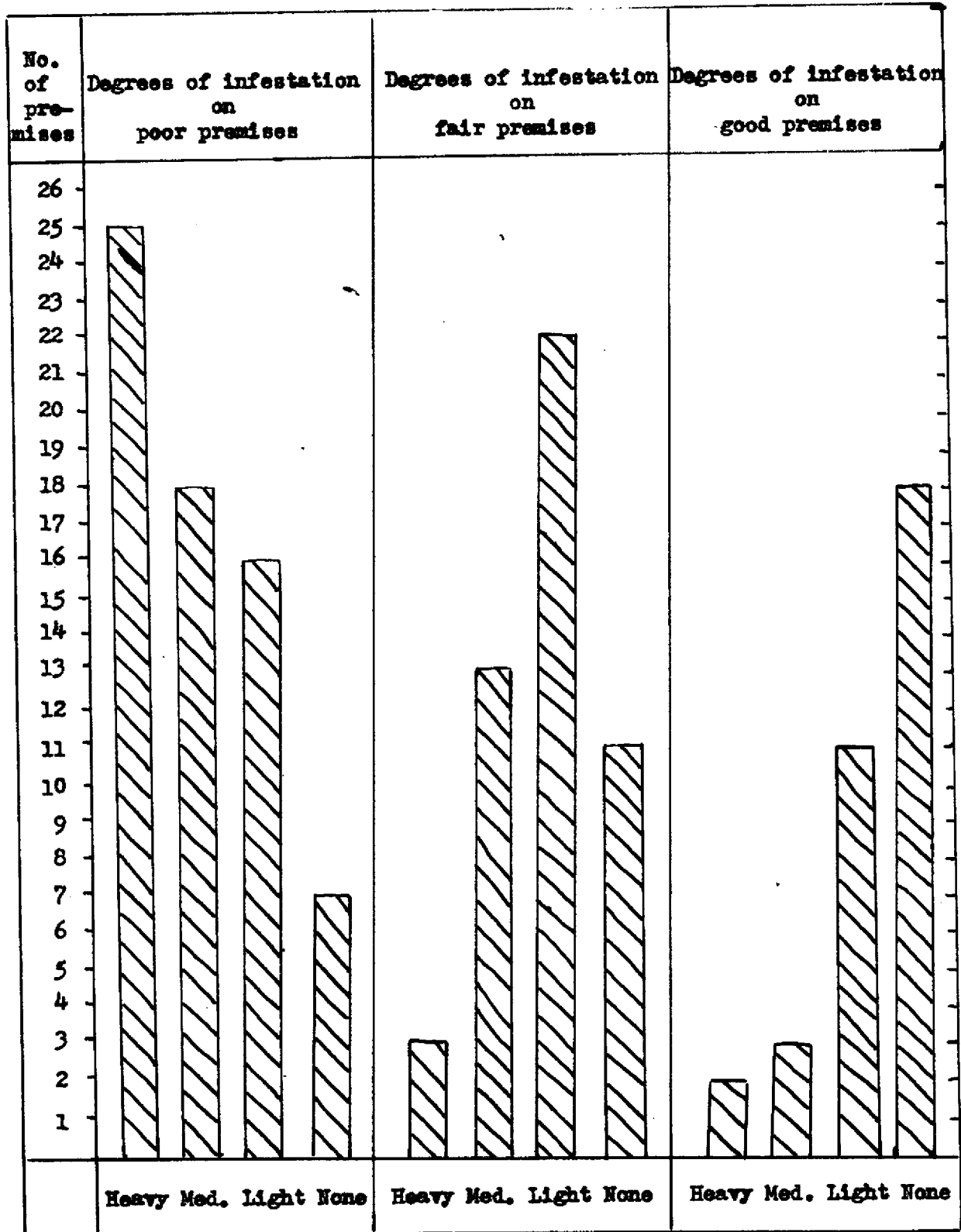
Table 12. Relationship between the degrees of rat infestation, condition of premises, and amount of damages on the dairy, poultry, and turkey farms surveyed in Cache County, Utah, 1950

Degree of infestation	No. infest.	Premises in poor condition	Premises in fair condition	Premises in good condition	Amount of losses	
					Total	Average
Heavy	30	\$3145.00	\$550.00	\$175.00	\$3870.00	\$129.00
Medium	34	315.00	195.00	35.00	545.00	16.03
Light	49	65.00	72.00	35.00	172.00	3.51
None	36	None	None	None	None	None
Total	149	\$3525.00	\$817.00	\$245.00	\$4587.00	\$30.79
	<u>3</u> not classified				<u>200.00</u>	
	152				\$4787.00	\$31.49

Table 12 indicates the relationship between the degree of rat infestation, condition of the premises, and amount of damages on the dairy, poultry, and turkey farms surveyed.

It may be noticed that the 30 farms found heavily infested suffered \$3870.00 damages during 1950. The average individual loss per heavily infested farm was \$129.00.

Graph 1 indicates the correlation between the conditions of the premises and the degree of rat infestation on the dairy, poultry, and turkey farms surveyed.

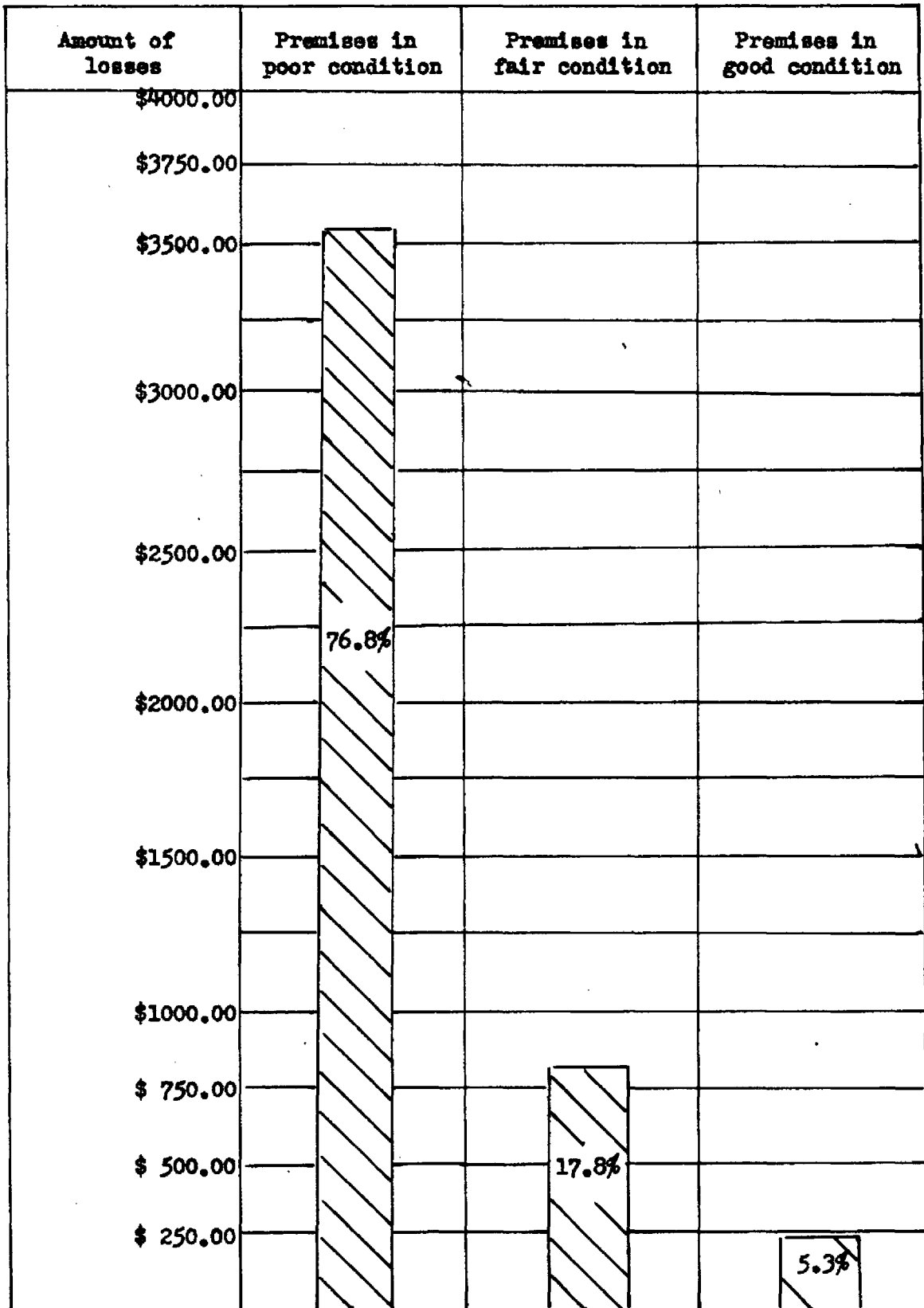


Graph 1. Relationship between the condition of premises and degrees of rat infestation on dairy, poultry, and turkey farms in Cache County, Utah, 1950.

It may be noticed that 25 of the farms rated as poor were heavily infested, while only 2 of the farms rated as good were heavily infested.

Graph 2 indicates the coorelation between the amount of damages due to rats and the condition of the premises on the dairy, poultry, and turkey farms surveyed.

It may be noticed that the farms judged to be in poor condition suffered 76.8 percent of the losses, a total of \$3525.00, while the farms judged to be in good condition suffered only 5.3 percent of the losses, a total of \$245.00 for 1950.



Graph 2. Relationship between the amount of rat damage and condition of the premises on dairy, poultry, and turkey farms in Cache County, Utah, 1950.

RESULTS OF THE RAT PROGRAM AT UTAH STATE AGRICULTURAL COLLEGE

In July 1950, the writer made a survey of the livestock buildings at the Utah State Agricultural College to determine the extent of rat infestation at the college. Rats or rat evidence was found in every building that contained livestock feed and rat harborage on and near the campus, with 1 exception—the new poultry plant north of the campus. In several buildings on and near the campus heavy infestations of rats were found.

The School of Agriculture, under Dr. R. H. Walker, initiated a rat control program for the college to be directed by Dr. Wayne Binns, head of the Veterinary Science Department.

The writer, as an employee of the United States Fish and Wildlife Service, used sodium fluoroacetate (1080) in an attempt to control the rats. Within 90 days an estimated 250 rats were killed by using 1080 treated water and Red Squill poison in meat.

In November 1950, a change in control methods was made. Dr. Binns had 12 poison bait boxes built in addition to 19 (1080) bait boxes supplied by the United States Fish and Wildlife Service. Warfarin, a new rodenticide, was used in these boxes. Several different types of bait were tried with cornmeal and chicken mash being accepted the best. In addition to the poisoning campaign many of the conditions that favored rats were eliminated. The writer, assisted by college employees, killed 58 rats in 2 days by turning over the mangers in the barns and using gas cartridges in rat burrows to drive out the rats. From the middle of November 1950 until the first of February 1951, more than 50 pounds of Warfarin bait was consumed by rats and mice. During the latter part of

January very little bait was being eaten, and very few rats were seen in and about the livestock building. During February and March no noticeable amount of bait was taken by rats, nor were very many rats seen, except in 1 building where there was an abundance of food and harborage available to the rats.

Dr. Wayne Binns and the writer estimated the losses and costs of controlling the rats at more than \$1,000 for 1950. The losses of chicks, poults, feed, sacks, and damages to buildings would vary from \$5.00 to \$300.00 per department that has buildings on or near the campus containing livestock food and harborage available to the rats.

At the present time it is the writer's opinion that rats can be controlled at the Utah State Agricultural College if the program initiated by the School of Agriculture is continued. The program has indicated that rats can be controlled by the proper use of poisons, and by eliminating the conditions that favor rats. At the present time (1951) there are very few rats on college property. Rats have been completely eliminated from the majority of the livestock and poultry buildings.

DISCUSSION

The history of rats in Cache County indicates that the presence of rats in relatively few numbers causes little or no concern among the general public. The majority of people interviewed reported that rats first appeared from 1935 to 1940. From the first appearance of rats in Cache County in approximately 1911 to 1937 little control work was carried on. Rats in other areas have been known to increase in vast numbers within 1 or 2 years, but for some unknown reason rats remained few in number for more than 25 years in Cache County.

The present distribution of the Norway Rat in Cache County, Utah, was found throughout the populated area of the county. Rats were found in every community, and on many isolated farms along the mountains; also along rivers 1 and 2 miles from human habitation. It is the writer's opinion that rats use these natural waterways and irrigation canals to travel from 1 area to another.

This study has shown that there exists a definite relationship between the sanitary condition of a farm or business establishment and the degree of infestation and amount of damage caused by rats. There were many exceptions to the hypothesis, but generally the results show that when the writer's estimate of the damages increased the following tended to occur: (1) the degree of infestation had increased; (2) the condition of the buildings and premise was rated from good and fair to poor; (3) the owner's estimate of damage became more definite; and (4) the amount spent for control increased. The writer found little concern or interest among the people who were suffering losses that were difficult to measure.

such as when rats were eating with the livestock or eating from a large amount of loose grain. Some of these people had a medium or heavy infestation of rats on their premises, but did not realize the extent of damage being done. When the losses became extensive and immediately evident, such as the loss of baby chicks or expensive feed and sacks, the owners were not only aware of their losses, but became interested in trying to control the rats. The results from the sample of poultrymen indicate that the losses were high and that the owners realized the extent of the losses by stating a definite amount of damages and increasing their control measures (Table 5).

In some samples the farms and business establishments in good or fair condition were having trouble with rats. This situation may be caused by several factors, but it is the writer's opinion that carelessness on the part of the management is important. Many farms and business firms in good condition allowed rats to enter their buildings through doors or windows and find food and shelter inside. Rats were found inside of rat-proof buildings living within double walls, behind equipment, and other places that provided shelter.

Generally the premises in poor condition had heavier infestations and greater losses than the ones in fair or good condition.

Many farmers stated that their cats and dogs assisted them in controlling rats. Some farmers stated that their cats and dogs were wholly responsible for keeping rats under control. Eighteen farmers who had no rats or rat evidence on their premises stated that their cats and dogs assisted them in keeping their farms free of rats. Twenty-two other farmers reported that although rats were present on their farms, they believed their cats and dogs tended to keep the rats under control. The

losses on these 22 farms were less than \$25.00 per farm. The writer believes cats and dogs are of value in keeping rats under control.

There were more than 700 buildings on the 170 premises surveyed. Approximately 70 percent were not rat-proofed, 20 percent were partially rat-proofed, and the remaining 10 percent were rat-proofed. The majority of the rat-proofed buildings were steel granaries.

The major problem in Cache County is to get the citizens to realize they have a rat problem. The writer found that the majority of people who had a few rats, or no rats, were not interested and were unconcerned over small losses. People failed to realize the potential danger of a light infestation of rats on their premises. The average citizen lacked knowledge of the seriousness of the rat problem.

RECOMMENDATIONS

The following suggestions are recommended for a rat control program for Cache County, Utah:

1. A full-time, county-wide, permanent rat control program should be initiated for Cache County. Funds for such a program should come from each community, the county, and federal government. Additional funds could be contributed by civic organizations or by the sale of rat poison, poison bait boxes, and small fees for special assistance.

2. The leaders for such a program should organize a county rat control organization made up of representatives of the Boy Scouts, Rotary, Lions, Chamber of Commerce, church groups, and health departments. Sub-committees based on the same plan should be organized for each community of the county.

3. The county committee and all sub-committees should sponsor an educational program by using the newspapers, radio, films, and lectures. Technicians from the United States Fish and Wildlife Service, United States Public Health Service, State Health Department, and Utah State Agricultural College should be requested to assist in carrying out the educational program.

The following points should be emphasized in such a program:

- a. Get all citizens behind the program.
- b. Clean-up campaigns to eliminate all rat harborage and food for rats on every premise in the county.
- c. Instructions for rat-proofing all types of farm buildings and commercial establishments.
- d. Improved methods for handling garbage and trash emphasized.

e. Methods of rat eradication.

- (1) Instructions for using poison, fumigation, and traps.
- (2) Encouragement of natural enemies of rats, such as cats, dogs, hawks, and owls. The keeping of cats and dogs under control should be stressed.

f. Encourage citizens to assist in getting a "Rat Control Ordinance," and "Garbage Disposal Ordinance" for all communities in the county.

- (1) The "Rat Control Ordinance" should require the rat-proofing of all commercial buildings.
- (2) The "Garbage Disposal Ordinance" should give the communities control and supervision over all garbage and dump grounds.

SUMMARY

1. This study was done during the period from November 1950 through March of 1951, in Cache County, Utah, to determine economic factors concerning rats (Genus Rattus). Some background work in rat control was completed during the summer of 1950.

2. Surveys consisting of personal interviews and inspections were made of 171 premises. Dairy farms formed the major basis of the study with 106 farms surveyed. The study also included 23 poultry farms, 23 turkey farms, 13 feed mills, flour mills, and grain elevators, and 5 fish and fur farms. A study of the rat problem at Utah State Agricultural College was also made.

3. The factors undertaken in this study were:

- a. Species of rats in Cache County.
- b. History of rat infestation and control in Cache County.
- c. Distribution of rats in Cache County.
- d. The percentage of farms surveyed that had rats or rat evidence.
- e. The percentage of premises surveyed that were suffering losses due to rat damages; total minimum annual losses estimated by the writer; average annual loss per premise.
- f. Amount spent for poison and bait boxes; average spent for poison and bait boxes.
- g. Sanitary conditions in relation to the damages and degree of rat infestation.
- h. An evaluation of the value of dogs and cats as an aid in controlling rats.
- i. An evaluation of the use of questionnaires.

4. The species of rats present in Cache County was found to be the

Norway Rat, Rattus norvegicus. No evidence was found of another species of "alien" rat.

5. The history of rat infestation in Cache County began approximately 1911 in Cache Junction. From 1911 until 1937 little control work was carried on. The general public was unaware of the presence of rats until 1936-37 when they increased rapidly and spread throughout the populated area of the county.

6. The distribution of rats was throughout the populated area of the county. Rats or rat evidence was found in every community, and on many of the isolated farms along the mountains. Rats were also found along the waterways and irrigation canals.

7. The number of dairy, poultry, and turkey farms having rats or rat evidence was 113, or 75.8 percent of the total 149 farms surveyed. (Three turkey farms were not classified except for damages suffered.)

8. The total annual amount of damages suffered by the 149 dairy, poultry, and turkey farms was \$4587 (estimated by the writer). The average loss per farm was \$30.79 for 1950. The estimate of losses by the owners was vague when the damage was light and difficult to measure. When the damages were high and measurable the owner's estimate became more definite.

9. The total annual amount spent for poison and bait boxes by the 152 farms was \$476.05. The average expenditure was \$3.13 per farm.

10. The conditions of the buildings were rated poor, fair, or good. Sixty-six of the 149 farms were rated poor, 49 were rated fair, and 34 were rated good. The writer found that these conditions were related to the amount of damages and the degree of rat infestation. The 66 farms rated as poor had 25 that were heavily infested and these 66

farms in poor condition lost a total of \$3525.00 during 1950, an average annual loss of \$53.41 per farm rated poor. The 34 farms rated as good had only 2 that were heavily infested with rats and these 34 farms lost a total of \$245.00 during 1950, an average annual loss of \$7.21 per farmer rated good.

11. Three special groups were studied: 13 commercial establishments consisting of feed mills, flour mills, and grain elevators; 5 fish and fur farms; and 1 educational institution, the Utah State Agricultural College.

- a. The total annual loss suffered by the commercial establishments was \$1400.00 during 1950, an average annual loss of \$107.69.
- b. The total annual loss suffered by the 5 fish and fur farms was \$1850.00 during 1950, an average annual loss of \$175.00.
- c. The total annual loss suffered by the Utah State Agricultural College was probably in excess of \$1000.00. This amount also included the cost of controlling the rats. The rats at the college were controlled by the use of sodium fluoroacetate (1080), Red Squill, and Warfarin, a new rodenticide. The elimination of rat shelter and food also helped to control the rats.

12. More than 700 buildings were on the 167 premises surveyed. Approximately 70 percent were not rat-proofed, 20 percent were partially rat-proofed, and 10 percent rat-proofed.

13. Dogs and cats were considered to be of value in assisting to control rats on the farms.

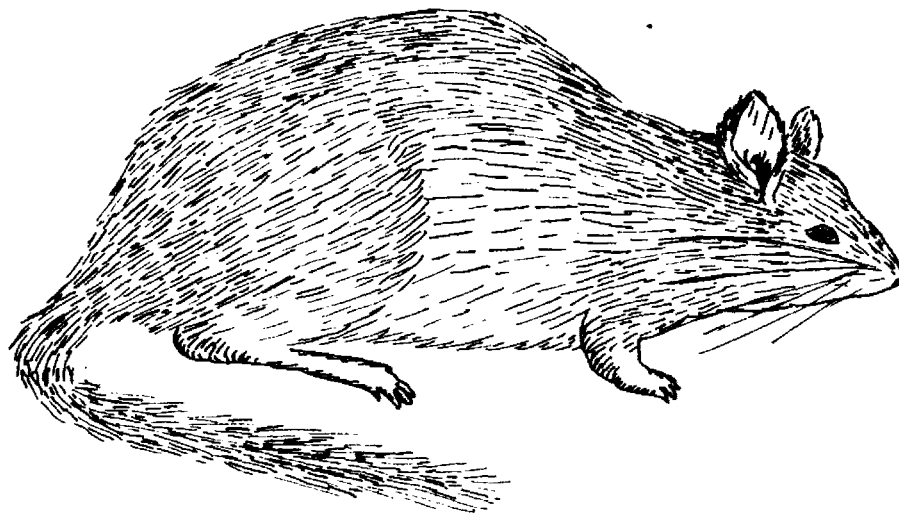
14. In addition to the personal interviews and inspection surveys, 100 questionnaires were mailed to 85 dairymen and 15 poultrymen. Twenty-five replies were received that contained little information of value. The answers were vague in most cases; however, 76 percent reported the presence of rats on their premises.

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APPENDIX



Wood Rat, Neotoma cinerea

Names: Wood Rat; Pack Rat; Trade Rat; Mountain Rat; Brush Rat.

Description: Superficially resembles the "alien" rats. Size large; ears large; tail less than half of total length, bushy; hind foot densely furred on sole; pelage long and thick, upper parts grayish buff to ochraceous buff, thickly sprinkled with dusky hairs on back; fore and hind feet white; ears edged faintly with whitish, clothed with brownish and grayish hairs. Tail bushy but flattened, above brownish gray, below white, banded with pale buffy at base; underparts white.

Measurements: Total length, 15.5 inches; tail vertebrae 6.5 inches; hind foot 1.7 inches.

The Wood Rat usually lives in the mountains, but occasionally wanders into farms along the foothills in Cache County. The Wood Rat is not destructive like the "alien" rats.

(In questioning many of the older people in Cache County concerning the history of rats, the writer found many that confused the Wood Rat with the Norway Rat. The Wood Rat is a native American rat.)

Map of Cache County study area,
with the location of
dairy, poultry and turkey farms
investigated in rat survey, 1950

dairy x
poultry ▲
turkey ■

LEGEND:
 DASHED LINE SURFACE ROAD
 SOLID LINE GRAVELLED ROAD
 DOTTED LINE GRADE/UNGRAVELLED ROAD

