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SNOWSHOE HARE REPORT

By
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Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-4, Jobs 10.7R and 10.8R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Jeannette Ernest

Project No.: W-17-4 Project Title: Small Game Investigations

Job No.: 10.7R Job Title: Snowshoe Hare Population Enumeration

Period Covered: July 1, 1971 to June 30, 1972

SUMMARY

Snowshoe hare populations were studied in the Central and Fairbanks areas from June, 1970 to the present time. Two study areas were set up for live trapping and populations estimated from recapture results.

In August, 1970, hares at the Central study area were live trapped and the hare population was estimated at 407 animals in .57 square miles. The adult/juvenile ratio was 27:63, and the ratio of juvenile hares to adult females was calculated to be 3.9:1. Juvenile survival from birth to August was calculated to be 33.3 percent.

The Central area was trapped again in May, 1971, with a population estimate of 157 hares calculated from live trapping data. Over-winter survival was calculated to be 39 percent of the population of the previous August.

The August, 1971, live trapping of the Central area yielded an estimate of 967 hares. Adult/juvenile ratio was 19:105 and juvenile survival was calculated to be 61.1 percent.

Road counts were conducted extensively in Central during the summer of 1970, with an overall average of 1.8 hares counted per mile. Road counts were conducted to a lesser extent in 1971, and were discontinued due to poor road conditions.

A Fairbanks study area was established in the summer of 1971 on state land near Fairbanks and live trapped in August of 1971 and in April of 1972.

The August live trapping gave a population estimate of 782 hares in .5 square miles. The adult/juvenile ratio was approximately 20:80, and the juvenile survival was estimated to be 74 percent from birth to mid-August.

The April live trapping period on the Fairbanks area was the most successful of the trapping periods with an average trapping success of 81 percent. The population was estimated at 249 hares in .5 square miles. Survival from the previous August was calculated to be 31.9 percent.

Reliability and confidence limits of population estimates derived from the Schnabel formula are discussed. Juvenile mortality was considered as a factor in population declines.

CONTENTS

BACKGROUND

In May, 1970, a study of snowshoe hare (*Lepus Americanus*) populations in and around the Central area was begun to help furnish information on prey available to lynx, which were being studied extensively in this area, and to also provide some basic information on hare populations and reproduction in the Interior. The study was initiated June 1, 1970 (Ernest, 1971).

Ecological investigations of snowshoe hare populations in the Interior were originated in 1955 by the Cooperative Wildlife Management Unit at the University of Alaska. Paul Tovey, a student at the University, conducted a study of physiological effects of population trends on hares. Tovey's study (Tovey and Bishop, 1962) consisted of roadside counts and collections with comparison of the effects of population densities on the endocrine glands and reproductive organs. After Tovey's death in a plane crash the data from his collections were compiled by Richard Bishop.

O'Farrell (1960) studied the home range and ecology of a hare population on a 160-acre plot near the University of Alaska, from June, 1958 through April, 1960. He derived several estimates of population on this area using the Lincoln index and Schnabel method and the Calendar graph. Trapp (1962) continued the study of the same population, concentrating on the relationships of population density to home range, and studying reproduction, behavior and ecology. O'Farrell's population estimates had quite broad confidence limits; Trapp felt that his own attempts at measuring the population were unsuccessful due to differential trap response of the hares.

An extensive study of snowshoe hare populations was conducted near Rochester, Alberta, beginning in 1961 by Meslow and Keith (1968). They studied snowshoe hare populations during a peak, decline to a low, and the initial stages of population recovery. They concluded that the decline in the hare population resulted from a decrease in adult survival, an extremely low juvenile survival and a halving of the reproductive rate. They felt that recovery from the low was due to increased adult survival, a marked increase in juvenile survival, and a doubled reproductive rate.

Various records and observations have recorded the history of snowshoe hare population fluctuations around the Fairbanks area and the interior of Alaska. Gasser (1935) indicated there was a high hare population in the Fairbanks area in 1903-1905 and again in 1913. A general population high was reported by both Gasser (1935) and Buckley (1954) in 1924-1926 and a low in 1928, followed by a high in 1935-1936. Records indicate highs in 1947, 1954, 1961-1962, and the present year, 1971-1972. Lows were mentioned in 1938-1940, 1943-1945, 1948-1950, 1955 and 1965-1966 (Trapp, 1962).

From June, 1970, until June, 1971, the present study, originally under S&I Job 10, concentrated on the hare populations around Central, with the live trapping studies restricted to the Central study area. In the spring of 1971 the study was expanded to include the Fairbanks area and a study area was set up near Fairbanks in the summer of 1971. Most of the population estimation work is now being concentrated in the Fairbanks area.

OBJECTIVES

To determine the density of snowshoe hares on selected study areas during the spring and fall of 1971, and to correlate the estimated density with other indices of abundance.

PROCEDURES

Two study areas were live trapped in this study. The study area near Central (Fig. 1) is approximately .57 square miles in extent and was set up in July of 1970 and trapped in August 1970, May 1971, and August 1971. The Fairbanks study area (Fig. 2), of 0.5 square miles, was set up in July 1971 and trapped in August 1971 and April 1972.

Hares were live trapped on these areas using Tomahawk collapsible wire live traps size 9" x 9" x 26". Traps were set in well-used runways at the intersections of transects running north-south and east-west every one-eighth mile through the areas. In the spring trapping, compressed alfalfa cubes were used as bait. No bait was used in the August trapping.

Traps were checked daily over the trapping period and hares were removed from the traps by picking up the trap and inverting it into a burlap sack. All hares were handled in the sack which facilitated the procedures and prevented injury to the animals. All hares were weighed with a Chatillon spring balance. Measurements were taken of the right hind foot, and right ear, notch to tip. The sex and approximate age of the animals were then determined, and they were examined for signs of pregnancy if the trapping period was in the breeding season (May). The hares were marked with a #3 fingerling tag placed in the lower anterior portion of the ear. At Central, colored saflag was fastened to the ear with the tag in the first two trapping periods, but was not used for the August, 1971 period. Records of trap site, date captured and other information were kept daily.

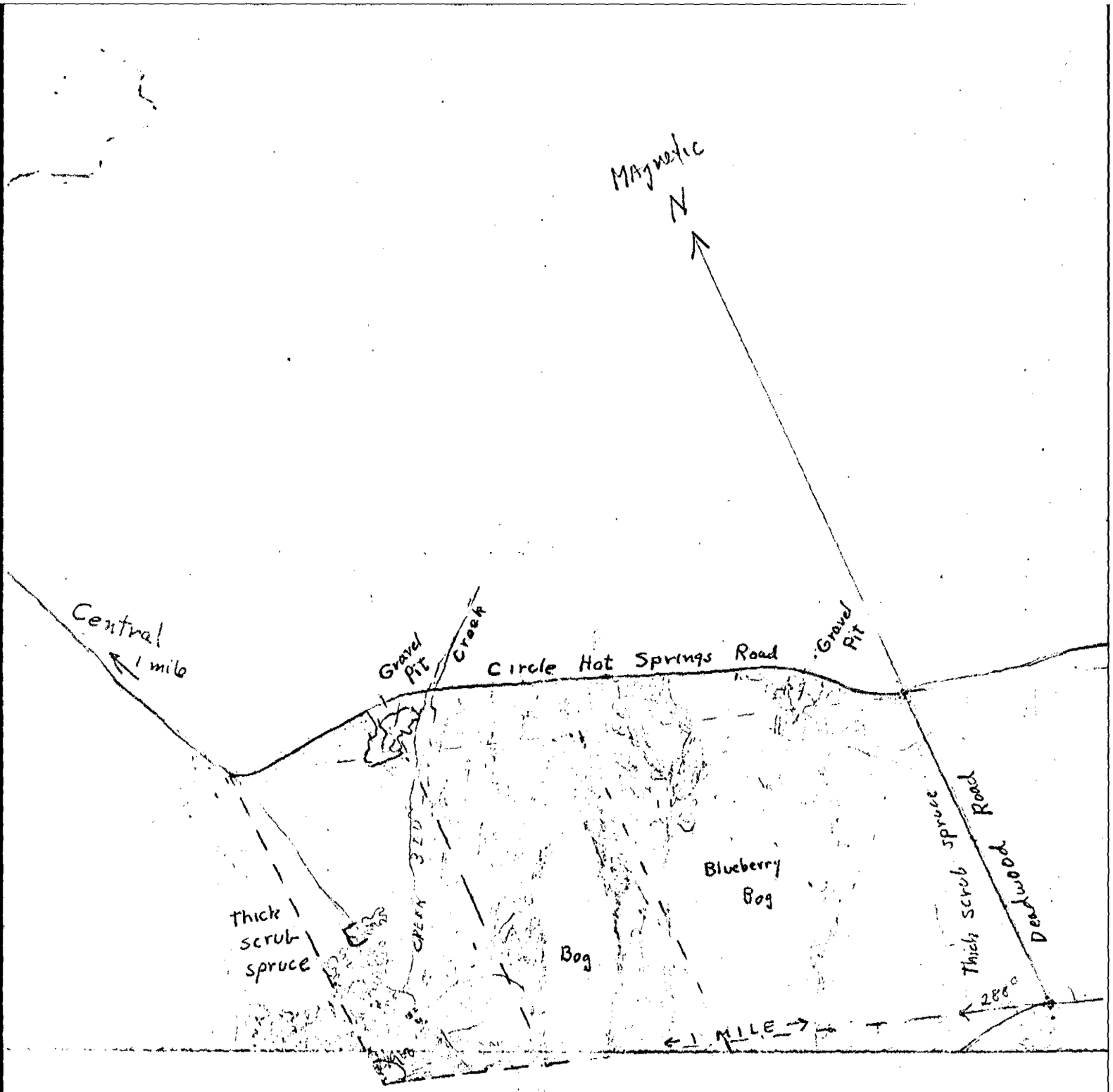

Figure 1: Central Study Area

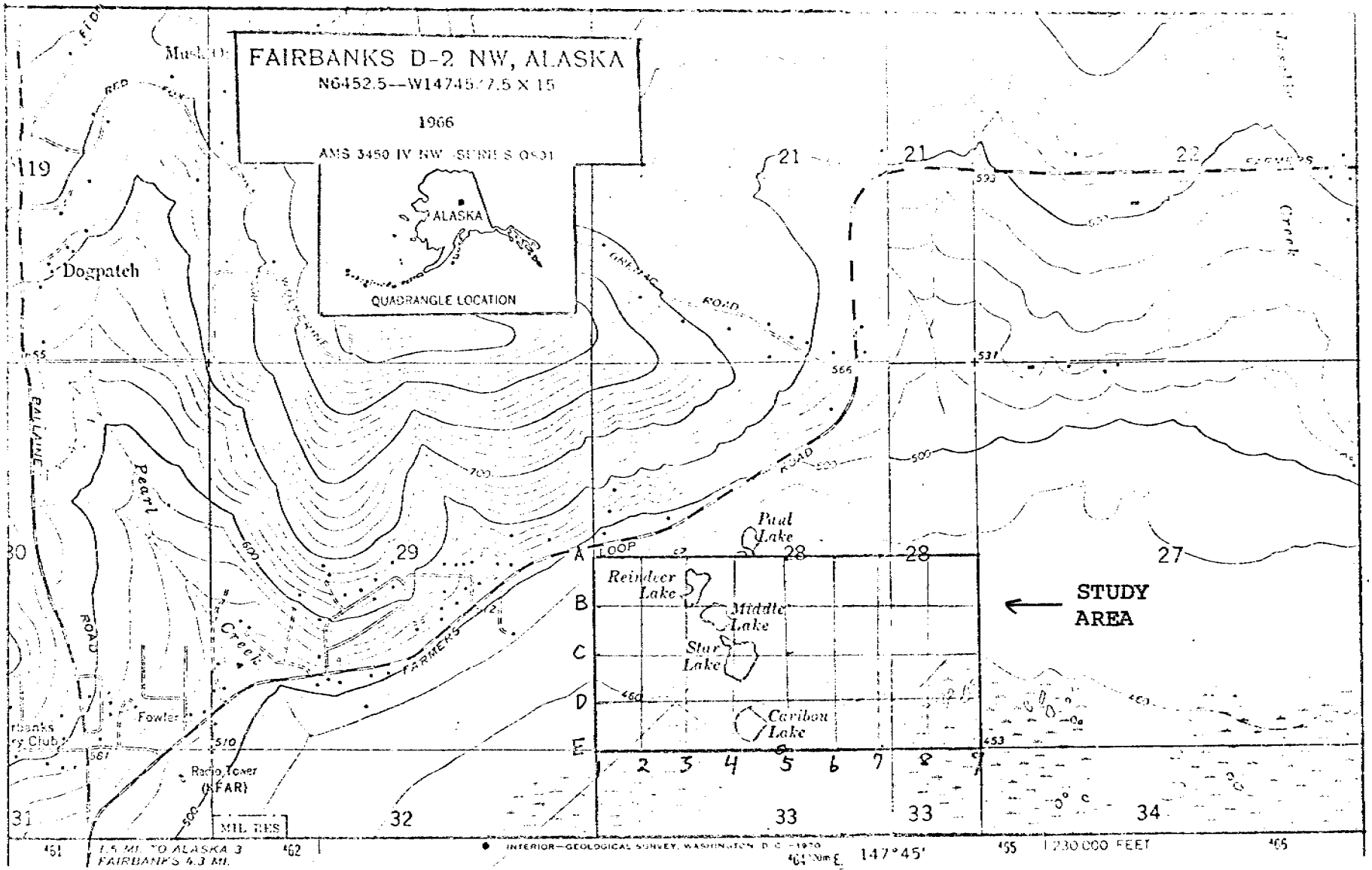

Fig. 2. Fairbanks study area located on the Fairbanks Wildlife Management Area.

Population estimates were based on the Schnabel method (Schnabel, 1938) or the Peterson or Lincoln index. Adult-juvenile ratios were used to give a rough index of population size based on the population of the previous spring.

Road counts were conducted throughout the summer of 1970 and during several periods in the summer of 1971 in the lynx study area near Central. Hares per mile were recorded on the Circle Hot Springs Road, Deadwood Road, and Ketchem Creek Road. Counts were conducted at all hours, but only those between the hours of 6:00 p.m. and 6:00 a.m. have been considered in this report. Counts were considered invalid on days with rain or wind during the count periods.

FINDINGS

Central Study Area

The study area at Central is located one mile from the town of Central (65°54' N Lat., 144°50' W Long.) on the Circle Hot Springs Road. It is .57 square miles in area, of a somewhat irregular parallelogram shape and bordered on two sides by roads; the Circle Hot Springs Road and Deadwood Road (see Fig. 1). The terrain is essentially flat, with a small rise in the southwestern corner. The vegetation consists largely of scrub black spruce (*Picea mariana*), willow (*Salix* sp.), aspen (*Populus tremuloides*) and large boggy areas covered with blueberry (*Vaccinium uliginosum*).

The Central study area was inactivated, as far as the live trapping program was concerned, after the August 1971 trapping. It was determined that, because of logistical problems of working in the area and the plans of the Bureau of Land Management to open up part of the area to homesite selection, another study area should be selected near Fairbanks and operations moved to the new site. The Central area will continue to be monitored as to hare reproduction and habitat conditions.

August, 1970 live trapping

The August, 1970 live trapping period was reported in detail earlier (Ernest, 1971). However, it will be briefly summarized here as the data are useful in evaluating later trapping data.

Live trapping was conducted for three weeks beginning August 15, 1970 for a total of 1002 trap nights. There were 105 captures, for a trapping success of 10.4 percent. There were ten recaptures, and the population was estimated at 407 animals in .57 square miles (190-759 at the 95 percent confidence level) (Table 1).

Ninety individual hares were captured and examined. Of these, 30 percent (27) were adults and 70 percent (63) were juveniles born in the 1971 breeding season (Table 2). The sex ratio was calculated as 59 percent females and 41 percent males in both adult and juvenile groups which would indicate that there were approximately 18 adult females per 100

Table 1. Central Study Area, August, 1970. Estimates of a snowshoe hare population calculated from live trapping results, using a Schnabel Index. (Estimates were calculated daily from the 14th day to the end of the trapping period).

Day	Total Captures	Total Marked	Recaptures To Date	Schnabel Estimate
14	84	63	7	373
15	86	63	7	380
16	86	65	7	390
17	88	65	7	409
18	91	67	8	384
19	97	68	10	348
20	101	72	10	376
21	101	76	10	376
22	105	76	10	407

The final population estimate was 407 (190-759 at the 95 percent confidence level).

Table 2. Adult-Juvenile ratios found in live trapped samples in August trapping periods.

Location	Date	Adults	%	Juveniles	%	Total
Central	August 1970	27	30	63	70	90
Central	August 1971	19	15	105	85	124
Fairbanks	August 1971*	20	20	80	80	100

*Ages difficult to determine in several hares of sample. Ratio only approximate.

hares. The ratio of juveniles to adult female hares was estimated to be 3.9 per female. The reproductive rate calculated from data gathered from collections of females during the breeding season was an average of 11.7 young per female. Calculated survival of young was about 33.3 percent from birth until the latter part of August (Table 3).

May, 1971 live trapping

Trapping was initiated on May 18, 1971 and continued for two weeks. During this period, 133 individual hares were captured a total of 262 times. Two were marked from the previous August. Trapping success was excellent during the period, with 25-50 percent success on most nights, and an overall average of 37.4 percent as compared to 10.5 percent the previous August. Population estimates were calculated each day from day 8 to the end of the trapping period, and the population was estimated at 157 (130-188 at the 95 percent confidence level) hares on the last day of trapping (Table 4). All animals were considered adults, with a sex ratio of 50 males (39 percent) to 77 females (61 percent) (Table 5). Sex ratios the previous August had been 41 percent males and 59 percent females. The May population estimate suggested a survival rate of 39 percent from the previous August.

August, 1971 live trapping

Trapping was started on August 15, 1971, and continued for two weeks. During this time 126 individual hares were captured a total of 133 times, with seven recaptures. This gave a population estimate of 967 hares (380-2092 at the 95 percent confidence level) (Table 6). This would have been an increase of 809 hares, or a little over 500 percent since the spring census. Trapping success averaged 17.7 percent.

The adult/juvenile ratio was 19 adults to 105 juveniles (Table 2), and of the 19 hares classified as adults, eight were first tagged in May, 1971. If the population estimate for May is assumed to indicate the number of adults in the August population, this ratio would give an approximation to the estimate of population derived by applying the Schnabel formula to the retrap data. For example, if zero mortality and no migration in or out of the area were assumed, we would obtain a figure of 1040 hares in August from the adult/juvenile ratio. If 10 percent mortality and no migration were assumed, the figure would be around 940 animals. These figures are well within the range of the population estimate derived from the recapture data.

The sex ratios of animals captured in this trapping period were 60 males (57 percent) to 44 females (43 percent) in the juvenile group, but only two males (11 percent) to 16 females (89 percent) in the adult group (Table 5). The ratio of juveniles of both sexes to adult females averaged 6.6 juveniles per adult female for a survival rate of 61.1 percent of the calculated average number of young (10.8) produced by Central hares in the 1971 breeding season (Table 3).

Table 3. Juvenile survival rate - birth to August 15.

Location	Year	Average No Young Produced/female	Ratio of Juveniles to Adult Female	Juvenile Survival Rate
Central	1970	11.7	3.9:1	33%
Central	1971	10.8	6.6:1	61%
Fairbanks	1971	9.9	7.3:1	74%

Table 4. Central Study Area, May, 1971. Estimates of a snowshoe hare population calculated from live trapping results using a Schnabel Index. (Calculated daily from day 8 - 14).

Day	Daily Captures	Daily Recapture	Total Captures	Total Recaptures	Marked Hares in Population	Schnabel Estimate
8	17	11	171	63	91	171
9	16	12	187	75	97	164
10	20	14	207	89	100	161
11	11	10	218	99	105	156
12	15	8	233	107	103	159
13	8	6	241	113	110	159
14	21	16	262	129	112	157

The final population estimate was 157 (130-188 at 95 percent confidence level).

Total area: .57 square miles.

Table 5. Sex ratios of hares in live trapped samples.

Location	Date	Age Group	Females	%	Males	%	Total
Central	August 1970	Adult	14	59	11	41	25
		Juv.	36	59	24	41	60
Central	May 1971	Adult	77	61	50	39	127
		Juv.	-	-	-	-	-
Central	August 1971	Adult	16	89	2	11	18
		Juv.	44	43	60	57	104
Fairbanks	August 1971	Adult	11	54	10	46	21
		Juv.	46	45	52	55	98
Fairbanks	April 1972	Adult	82	45	100	55	182
		Juv.	-	-	-	-	-

Table 6. Central Study Area, August, 1971. Estimates of a snowshoe hare population calculated from live trapping results using a Schnabel Index. (Calculated daily from day 12-15.)

Day	Daily Captures	Total Captures	Total Recaptures	Marked Hares in Population	Schnabel Estimate
12	6	102	3	80	1275
13	10	112	4	86	1172
14	10	122	6	95	939
15	11	133	7	103	967

The final population estimate was 967 (380-2092 at 95% confidence level).

Total Area: .57 square miles.

Fairbanks Study Area

The Fairbanks study area is located just outside of the Fairbanks city limits (64°50' N Lat., 147°50' W Long.) on land belonging to the Department of Fish and Game which is part of the Fairbanks Wildlife Management Area. It occupies the south 1/2 of Section 28, T1N, R1W of the Fairbanks Meridian (Fig. 2). Section lines were already marked on the area, which is 1/2 mile by 1 mile in size. North-south and east-west lines were established every one-eighth mile through the area, and trap sites were located at the intersections of these lines and numbered 1 through 9 from east to west, and A through E from north to south. This gave each trap site a binomial designation, e.g. A-1, B-4, etc. There were 45 trap sites.

The terrain is flat, with several small lakes totaling 27 acres in area (.0425 square mile). Vegetation consists of stands of black spruce (*Picea mariana*), bog blueberry (*Vaccinium uliginosum*), alder (*Alnus fruticosa*) and willow (*Salix* sp.), with patches of birch (*Betula papyrifera*) and aspen (*Populus tremuloides*). The southeastern corner tends to be marshy and the whole area was very wet after continuous heavy rains in the latter part of August. The area is heavily used by moose, especially in the eastern half. Several old dogsled trails winding through the area provide additional access.

August, 1971 trapping period

Forty-five traps were set on August 22, and were checked each day for a total of 15 trap nights, from August 22 to September 11. Traps were closed during periods of extremely heavy rainfall. During this time 106 individual hares were captured, with a total of 112 captures. There were six recaptures, from which a population estimate of 782 (282-1821 at 95 percent confidence level) animals was derived (Table 7). Trapping success in the Fairbanks study area was 16.6 percent which was almost the same as that in the Central area in the August, 1971 trapping. Poor weather conditions contributed to a very low trapping success on about half the days. Rain was very heavy, with water standing in all low areas and often in the runways where traps were set.

The adult/juvenile ratio was approximately 20:80. There was some question as to age of eight of the hares. The sex ratio was 11 (54 percent) females to 10 (46 percent) males for the adults and 46 (45 percent) females to 52 (55 percent) males for the juveniles. Apparently, either males are more vulnerable to mortality or sex ratios vary between years. Fetal sex ratios for the 1971 season were 52 percent females to 48 percent males which was not significantly different from a 50-50 ratio.

The ratio of juveniles of both sexes to adult females was 7:1, indicating a survival rate of 74 percent of the total number of young produced by Fairbanks hares in the 1971 breeding season (Table 3).

Table 7. Fairbanks Study Area, August, 1971. Estimates of a snowshoe hare population calculated from live trapping results using a Schnabel Index. (Estimates calculated daily from the 12th day to the end of period).

Day	Total Captures	Total Marked	Recaptures To Date	Schnabel Estimate
12	92	70	3	1046
13	100	73	5	744
14	106	78	5	838
15	112	84	6	782

Final Population Estimate: 782 (282-1821 at 95 percent confidence level).

Total Area: .5 square miles.

Table 8. Fairbanks Study Area, April, 1972. Estimates of a snowshoe hare population calculated from live trapping results using a Schnabel Index. (Calculated daily from day 2 - 8).

Day	Daily Captures	Daily Recaptures	Total Captures	Total Recaptures	Marked Hares in Population	Schnabel Estimate
1	21	0	21	0	0	-
2	38	1	59	1	20	760
3	39	4	98	5	49	534
4	37	9	135	14	76	392
5	40	17	175	31	98	302
6	39	18	214	49	119	287
7	42	29	256	78	135	253
8	37	23	293	101	147	249

Final Population Estimate: 249 (204-304 at 95 percent confidence level).

Total Area: .5 square miles.

April, 1972 trapping period

Plans to live trap the Fairbanks area in May were altered when it appeared that trapping would be more easily carried out with better results if the area were trapped in April, just before the snow melted. Trails were broken with a snow machine. Skis were used after trails were broken. Traps were baited with compressed alfalfa cubes, which strongly attracted hares at this time of year.

Traps were set on the 5th of April, and closed on the 13th, for a total of eight days of trapping. In this period, 192 individual hares were captured a total of 293 times for a average trapping success of 81 percent. There were 101 recaptures from which a population estimate of 249 hares was derived (204-304 at the 95 percent confidence level) (Table 8).

All hares captured were considered adults, as they would have had to be born the preceding summer. There were several very small (2 lbs.) hares, one of which would have been classified as juvenile by a "stubby penis." The sex ratio was 55.5 percent males to 44.5 percent females (Table 5). Survival from the previous August was estimated at 31.9 percent.

Movements

There were nine hares captured in the spring trapping that had been tagged the previous August. All of these hares were captured at the same trap site at which they had been originally captured the previous August, indicating very little movement over the winter. Recapture data from both trapping periods indicate that hares rarely moved over one-fourth mile from their place of original capture.

Road Counts

Road counts in the Central area during 1970 were sorted out to a one month period (June 15 - July 15) and standardized as to time of day (6:00 p.m. - 6:00 a.m.). The counts for 1970 indicated an overall average of 1.8 hares per mile on the roads covered. Count figures are broken down into days, etc. in Table 9.

During the summer of 1971 road counts were attempted in the Central area, but were considered of little value as road conditions obstructed a complete count. Deadwood Road was impassable a great part of the time and road graders working along the Circle Hot Springs Road interfered with counting activities.

DISCUSSION

Population estimates were derived using the Schnabel formula (Schnabel, 1938) which is a multiple census based on tagging, releasing and recapturing animals. Several conditions must be met when methods

Table 9. Snowshoe hares sighted in road counts, Central, Alaska. June 16 - July 15, 1970.

Date	Hares Seen	Miles Driven	Hares/ Mile
June 16	17	14	1.2
17	24	15	1.6
18	33	38	.9
19	45	33	1.4
20	54	24	2.3
21	72	31	2.3
25	37	45	.8
26	25	23	1.1
27	44	23	1.9
28	19	9	2.1
29	77	48	1.6
July 1	63	41	1.5
2	30	21	1.4
3	59	35	1.7
4	13	15	.9
6	147	29	5.1
8	40	24	1.7
9	76	27	2.8
10	63	30	2.1
12	67	26	2.6
13	41	31	1.3
14	46	24	1.9

Average number of hares per mile: 1.8

based on recapture are used to measure populations (Trapp, 1962). Marked individuals must remain identifiable, natural mortality among marked and unmarked must be the same, there must be no births, emigration or immigration, and there should be the same susceptibility to capture in marked and unmarked individuals. The first condition was met in this study. Ear tags with the identifying number were rarely missing from recaptured hares, and never were both tags. Trapping was conducted just before and at the end of the breeding season to avoid adding any animals through births. The trapping periods were short, reducing emigration and immigration, and trapping and tagging didn't appear to adversely affect the survival of the animal during the census period, although the colored flagging used on some of the animals in the Central study area may have attracted raptors and made the hares more susceptible to predation. No flagging was used on hares in the Fairbanks area. The question of "trap prone" hares is more difficult to answer. Some hares returned to the trap time after time for the bait in the trapping periods before the snow was gone. However, the several hares that showed this tendency were taken into account in estimation of population and it was felt that the majority did not. In the August trapping, no bait was used, and it is doubtful that hares developed a trap habit or shyness. Keith and Meslow (1968) believed that captures tended to occur at random in their trapping studies.

The confidence limits for the spring trapping periods are fairly narrow, but the estimate may be biased by the trap habit of some hares attracted to the bait. In the fall trapping period, hares were not influenced by bait in the traps, but recaptures were fewer, resulting in much broader confidence limits (380-2092 at the 95 percent confidence level).

Ideally, there should have been a much greater density of traps to provide a more accurate census and more details of movement. Trapping success cannot be used as an index to population levels unless conditions are the same in the trapping periods compared. If we were to consider only the trapping success attained in the spring trapping periods without consideration of other factors, we would have to conclude that populations were higher in the spring. (Trapping success averaged 81 percent in the April, 1972 period in Fairbanks compared to 17 percent in the August, 1971 trapping periods in both Fairbanks and Central). Obviously the populations in both places would have to be higher in the fall just after the breeding season than in the spring, after a winter mortality had occurred. If traps had been set in the spring with no bait, the trapping success, when compared with the August figures, would have more significant. However, the comparison between the August, 1970 trapping success on the Central area, and the trapping success in August of 1971 on the same area suggests that these data may provide some index to population levels if all factors were equal.

Juvenile Survival and Recruitment into the Population

The mean number of young produced per adult female surviving the breeding season can be determined from the adult/juvenile ratio. Juvenile

survival rates from birth to the middle of August are given in Table 3. Monthly survival rates given by Meslow and Keith (1968) in their Alberta study and figures from Minnesota (Green and Evans, 1940 a, b, c) and Montana (Adams 1959) indicate that in years of population increase the juvenile survival rate tends to be higher than in years of population decrease. The monthly survival rate for juveniles in Alberta increased from .69 to .87 from 1962-1967. The mean juvenile survival rate in the Minnesota study was .85, .87, .79, and .75 monthly in years of population decline. The declining Montana population had an average monthly survival rate of .76. Green and Evans' data indicate juvenile survival was .92 and .99 in years of population increase.

The data from the present study are expressed in terms of survival from birth until the middle of August, rather than a monthly rate. If the figures are valid, they indicate that the juvenile survival rate was almost twice as high in 1971 as in 1970 at Central. The population was higher in 1971 than in 1970, and increasing both years. The juvenile survival rate was 74 percent in Fairbanks in 1971, even higher than in Central that same year. Population estimations for Fairbanks were lower than for Central in 1971.

No conclusions can be drawn from these limited data, but a greatly decreased juvenile survival rate should foretell a population decline.

Keith and Meslow (1968) found that by early fall, young snowshoes have the same mortality rate as older hares. The ratio of juvenile to adults becomes stabilized as early as October in Alberta, and it is likely that this is the case in Alaska as well. Over winter mortality in the two populations studied was estimated from the differences in the population estimates of an area.

The population of the Central study area in May, 1971 was apparently only 39 percent of the population of the previous August. The population of the Fairbanks study area in April, 1972 decreased to 32 percent of the population of August, 1971.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Jeannette Ernest

Project No.: W-17-4 Project Title: Small Game Investigations

Job No.: 10.8R Job Title: Productivity of Snowshoe Hares

Period Covered: July 1, 1971 to June 30, 1972

SUMMARY

Female showshoe hares were collected during the three months of the breeding season from the Central, Fairbanks and Delta areas of Interior Alaska. Reproductive tracts were removed and examined for placental scars, number of embryos and fetuses, and resorbed embryos. Embryos and fetuses were measured and their ages determined to calculate conception and parturition dates for the three collection areas.

Sixty-nine adult female hares were collected from Central; 28 in the first breeding period, 20 in the second, and 21 in the last. The pregnancy rate was 100 percent for the first two groups and 10 percent for the third. Litter sizes averaged 4.7, 5.7 and 4.0, respectively, for the three groups, with a calculated average production of 10.8 young during the 1971 season. The onset of breeding in Central was calculated to be about April 24, and the first litters were born around May 30.

Sixty-six adult female hares were collected from the Fairbanks area; 30 in the first period, 15 in the second, 17 in the last and four between periods. The pregnancy rate was 100 percent for the first two periods, and 6 percent for the third. Litter sizes averaged 4.1, 5.6, and 3.0, respectively. The calculated average productivity was 10.4. Onset of breeding occurred about April 15, and the first litters were born as early as May 20.

Forty-seven adult female hares were collected from Delta in two collection periods, covering the second and third litters. First litter sizes were estimated from placental scars. Pregnancy rate in the June group was 100 percent. The average litter sizes were 3.2, 4.9 and 4.0, respectively, for the three periods. Only 4.2 percent were pregnant with a third litter. Onset of breeding occurred about April 15 with the first litters born about May 20. The average productivity was calculated at 8.3 young per female.

Data from the present study are compared with snowshoe hare studies in various parts of the country and during previous years in Alaska.

The average litter size in Alaska seems considerably higher than in Alberta, Michigan or Newfoundland. The mean for the 1971 breeding season over the three areas is not significantly different from the mean calculated for Interior Alaska hares in 1960 by Trapp of 4.6 young per litter.

CONTENTS

BACKGROUND

The present study on snowshoe hares (*Lepus americanus*) was initiated under the small game survey and inventories job in June, 1970, when it appeared that the hare population in the Central area was approaching a high. Previously Paul Tovey, a student at the University of Alaska, conducted a study of physiological effects of population trends on hares. Tovey's study (Tovey and Bishop, 1962) consisted of roadside counts and collection with comparison of the effects of population densities on the endocrine glands and reproductive organs. After Tovey's death in a plane crash, his data were compiled by Richard Bishop. Tovey's work included considerable reproductive information from the Delta area, with somewhat less from the Fairbanks and Central areas. This information was indicative of conditions in the years of 1955 and 1956 and Tovey's data will be discussed in relation to the data gathered in the present study.

O'Farrell (1960) studied the home range and ecology of a hare population on a 160-acre plot near the University of Alaska from June 1958 through April 1960. He derived several estimates of population size on this area using the Lincoln index, and the Schnabel and Calendar graph methods. Trapp (1962) continued the study of the same population, concentrating on the relationships of population density to home range and studying reproduction, behavior and ecology. O'Farrell's population estimates had quite broad confidence limits; Trapp felt that his own attempts at measuring the population were unsuccessful due to differential trap response of the hares. Their trapping methods and results will be discussed more fully in the report on Population Enumeration, Job 10.7R of this study. Trapp and O'Farrell contributed a great deal of knowledge concerning reproductive data and certain techniques which were very useful in the present study.

Several studies on snowshoe hare reproduction were being conducted in various areas of their range from 1954 through 1968. Dodds (1965) studied reproduction and productivity of a hare population in Newfoundland from 1954 to 1962 with reference to population increase. Bookhout (1965) studied snowshoe hare reproduction in Michigan from June 1957 through April 1962. Bookhout (1964) also studied prenatal development of the snowshoe hare using known-age embryos and fetuses from wild-caught hares

bred in captivity. He was able to estimate the age of wild-collected prenatal hares to within one day of true age using growth curves for weight and length and morphological characteristics. His scale of development has been used to determine the ages of embryos in this study.

An extensive study of snowshoe hare populations has been conducted near Rochester, Alberta since 1961 by Meslow and Keith (1968). These workers studied a snowshoe hare population cycle during a peak, the decline to a low, and the initial stages of population recovery. They concluded that the decline in the hare population resulted from a decrease in adult survival, an extremely low juvenile survival, and a halving of the reproductive rate. They felt that recovery from the low was due to doubled adult survival, marked increase in juvenile survival, and a doubled reproductive rate.

From June, 1970 to September, 1970 the present study concentrated on the hare populations near Central. After January 1, 1971 it was expanded to include the Fairbanks area, with collections throughout Interior Alaska, especially near Delta and Tok. This report covers mainly the period from May 1971 to April 30, 1972, with some discussion of work conducted from May, 1970 through April, 1971 which was reported on in a special Survey and Inventory report (Ernest, 1971).

OBJECTIVES

To determine the annual productivity of snowshoe hares as the population approaches a high in the cycle, and to relate the annual productivity to population trends.

PROCEDURES

Adult female hares were collected from the Central, Fairbanks and Delta areas in samples of at least 20 from each area each month in May, June, and July. There are two to three periods of peak breeding activity spaced about 36 days apart (the length of the gestation period) according to Bookhout (1964) as hares generally breed immediately post-partum. When possible, collections were timed to correspond with the period when most pregnancies would be easily detectible by enlargements of the uterus at the implantation site, but before they were so far advanced as to make detection of placental scars difficult. Evidence of embryos in the uterus becomes discernible on the seventh day of gestation (Bookhout, 1964).

All female hares were weighed with a Chatillon spring balance, measurements were taken of hindfoot and ear lengths, and the reproductive tract was removed. Hares were examined briefly for signs of disease, parasites or abnormalities, and a note was made of the general physical condition. Embryos and fetuses were counted and measured, and placental scars were counted. Ovaries and uteri were preserved in 10 percent formalin.

Ages of embryos and fetuses were calculated from measurements and morphological characteristics using a scale developed by Bookhout (1964). Probable conception and paturition dates were calculated using these ages and counting back from the date of collection. Incidence of pregnancy and average litter size were calculated from the embryo and placental scar counts.

Males shot during these collections were also weighed, measured and examined. Testes were removed and preserved in 10 percent formalin prior to weighing. It is interesting to note that most adult hares shot on roadsides were females. In the Central area this ratio was as high as 95 percent females to 5 percent males.

FINDINGS

Central

Sixty-nine adult female hares were collected from the Central area in the 1971 breeding season over three collecting periods. In Central, collection periods were May 15-20, June 23-28, and August 1-6. Twenty-eight were collected in the first breeding period, (eight of these from live trapping mortality around June 1), 20 in the second breeding period, and 21 in the last. Reproductive data are summarized in Table 1.

Pregnancy rate of the first group was 100 percent and the first litter parturition dates calculated from ages of embryos varied from May 30 to June 15 (Fig. 1). Most were in the period June 3-9, or about two weeks later than in 1970, when first litter dates were mainly from May 19 to 27 (Fig. 3). Litter size averaged 4.7 young per female, with a resorption rate of 1.5 percent of the total count.

The second group of female hares also had a pregnancy rate of 100 percent and the projected second litter parturition dates ranged from July 2 to July 20, with most falling between July 10 and July 15 (Fig. 2). These females averaged 5.7 young, with a resorption rate of 7.3 percent of the total count. Placental scars were visible and averaged 4.4 per female, a close correlation with the average embryo count for the previous group (Table 4).

In the third group only 10 percent (2 out of 20) of the females were pregnant, with four fetuses each. One female would have had her litter on August 5, and might be considered as being in the "2nd litter" group, while the other would have had hers about September 2, which would definitely be considered a "third litter." The average number of placental scars was 5.7, the same as the average embryo count of the second group (Table 4).

The calculated average number of young produced by Central area hares during the 1971 breeding season was 10.8 (Table 2).

Table 1. Reproductive data from adult female hares collected in 1971 breeding season.

Area	Month	Sample Size	Average No. of Embryos	Average No. Placental scars	Percent Pregnant
Central					
	May	28	4.7	0	100
	June	20	5.7	4.4	100
	July	20	4.0*	5.7	10
Fairbanks					
	April-May	30	4.1	0	100
	June	15	5.6	4.7	100
	July	17	3.0**	5.9	6
Delta					
	June	23	4.9	3.2	100
	July	24	4.0**	5.0	4

* Only two females with embryos.
** Only one female with embryos.

Table 2. Calculated average reproductive potential* and mean litter size of female snowshoe hares collected in the 1971 breeding season.

Area	Sample Size	Mean Litter Size	Calculated Average Reproductive Potential*
Central	68	4.9	10.8
Fairbanks	62	4.5	9.9
Delta	47	4.0	8.3

*The average number of young that would have been produced per female during the breeding season calculated from placental scars and embryos and fetuses.

Table 3. Comparison of 1971 snowshoe hare reproductive data from Central, Fairbanks and Delta, and 1970 reproductive data from Central.

Area Collected	1st Litter	2nd Litter	3rd Litter	Percent Pregnant with 3rd Litter	Average* total of young per female 1st & 2nd Litters
Central, 1971	4.7	5.2	4.0	10	10.3
Fairbanks, 1971	4.1	5.6	3.0	6	10.2
Delta, 1971	3.2**	4.9	4.0	4	8.1
Central, 1970	4.2	6.3	4.0	30	10.4

* Placental scar counts as well as embryo counts were used to calculate this figure.
** No collection was made in May, thus this figure was derived from placental scar counts.

Table 4. Comparison of placental scar and embryo counts.

		Average Embryo Count	Sample Size		Average Placental Scar Count	Sample Size
Central						
1970	May	4.2	46	June	4.1	26
	June	6.3	26	July	6.1	27
1971	May	4.7	28	June	4.3	20
	June	5.7	20	July	5.7	20
Fairbanks						
1971	May	4.1	30	June	4.7	15
	June	5.6	15	July	5.9	17
Delta						
1971	May**	-		June	3.2	23
	June	4.9	24	July	5.0	24

* Placental scar count of group representing following pregnancy.
** No collections made in May in Delta.

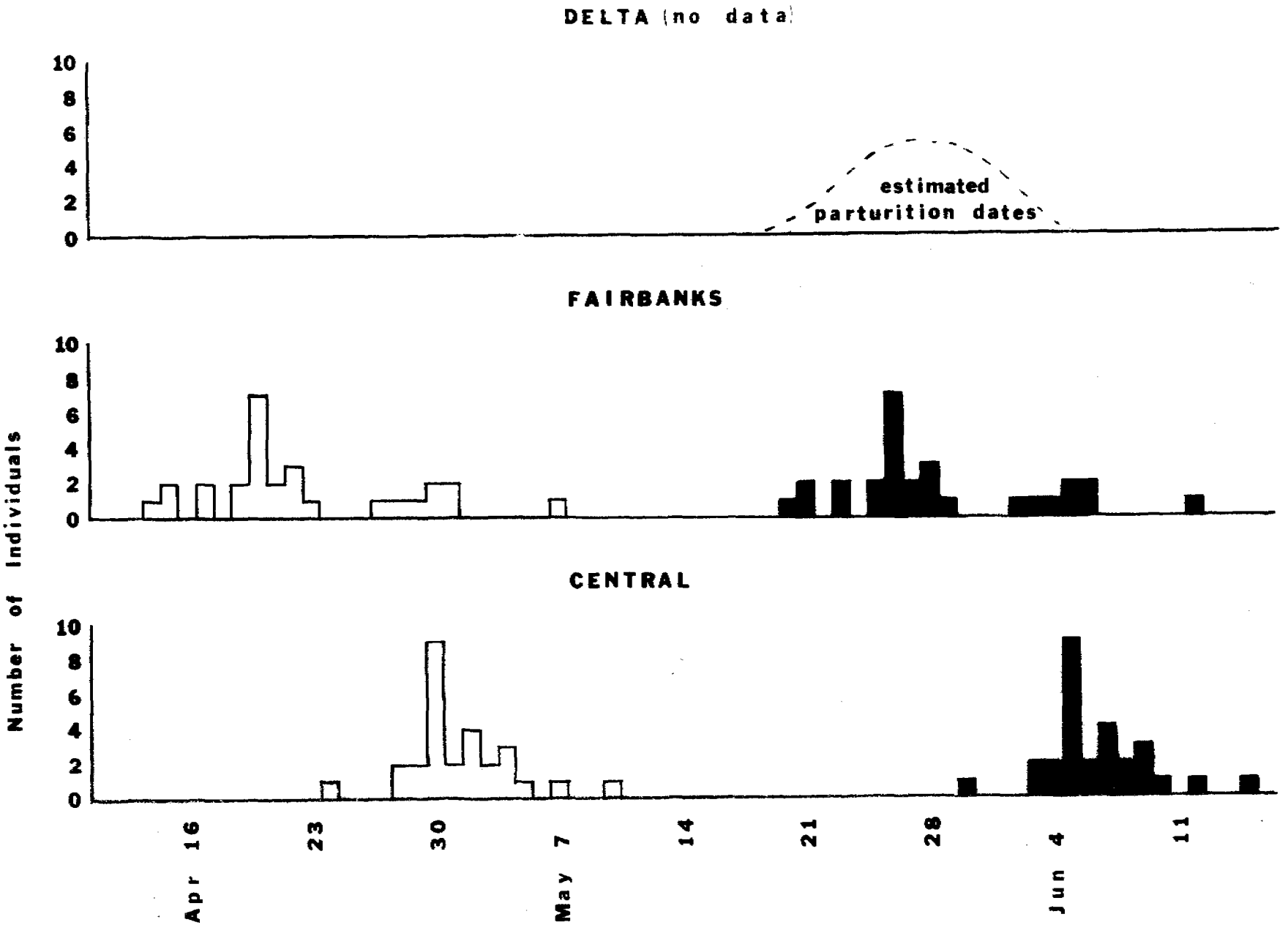


Figure 1. First litter conception dates (white) and parturition dates (black) for snowshoe hares collected in interior Alaska in 1971.

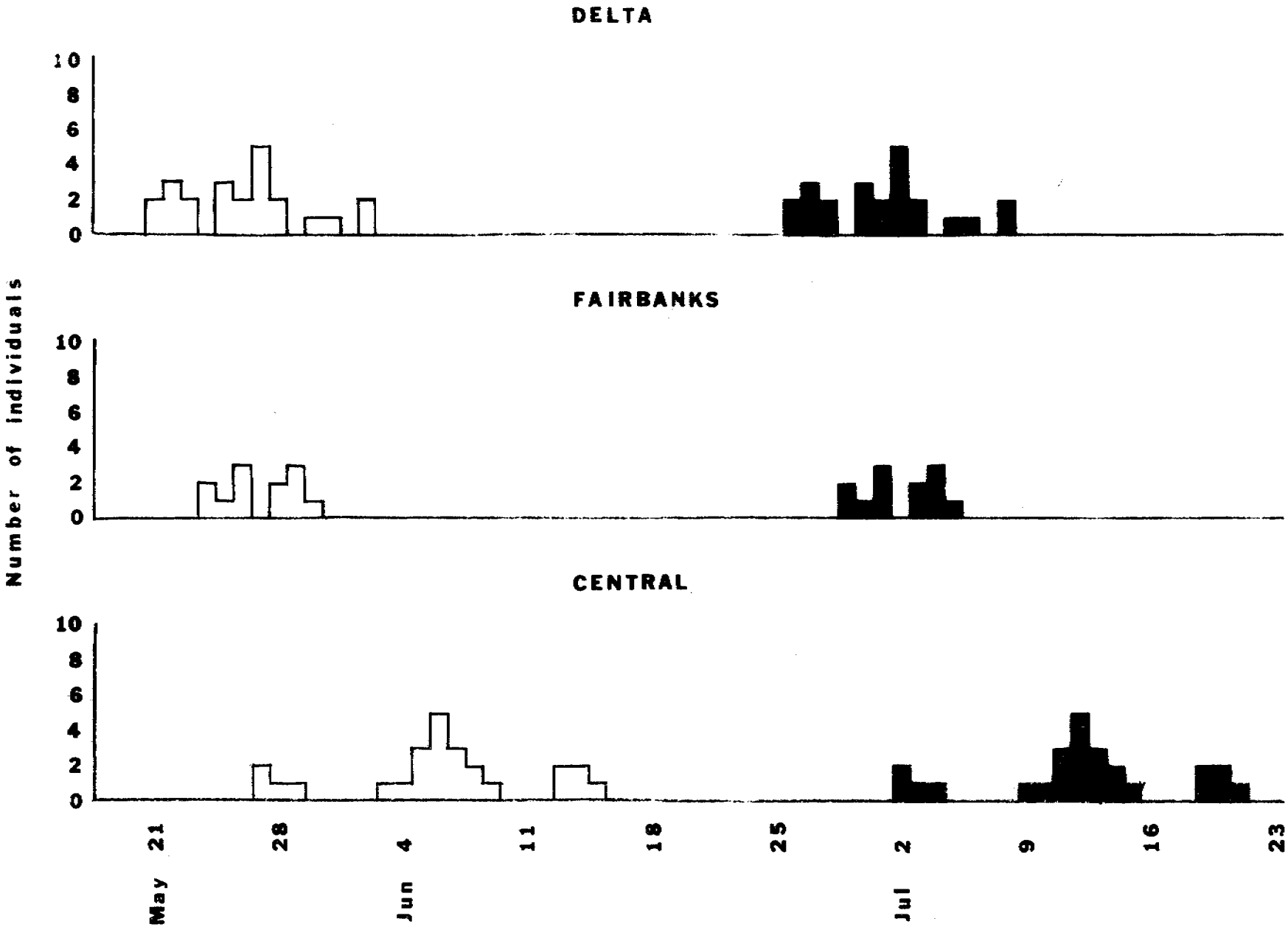
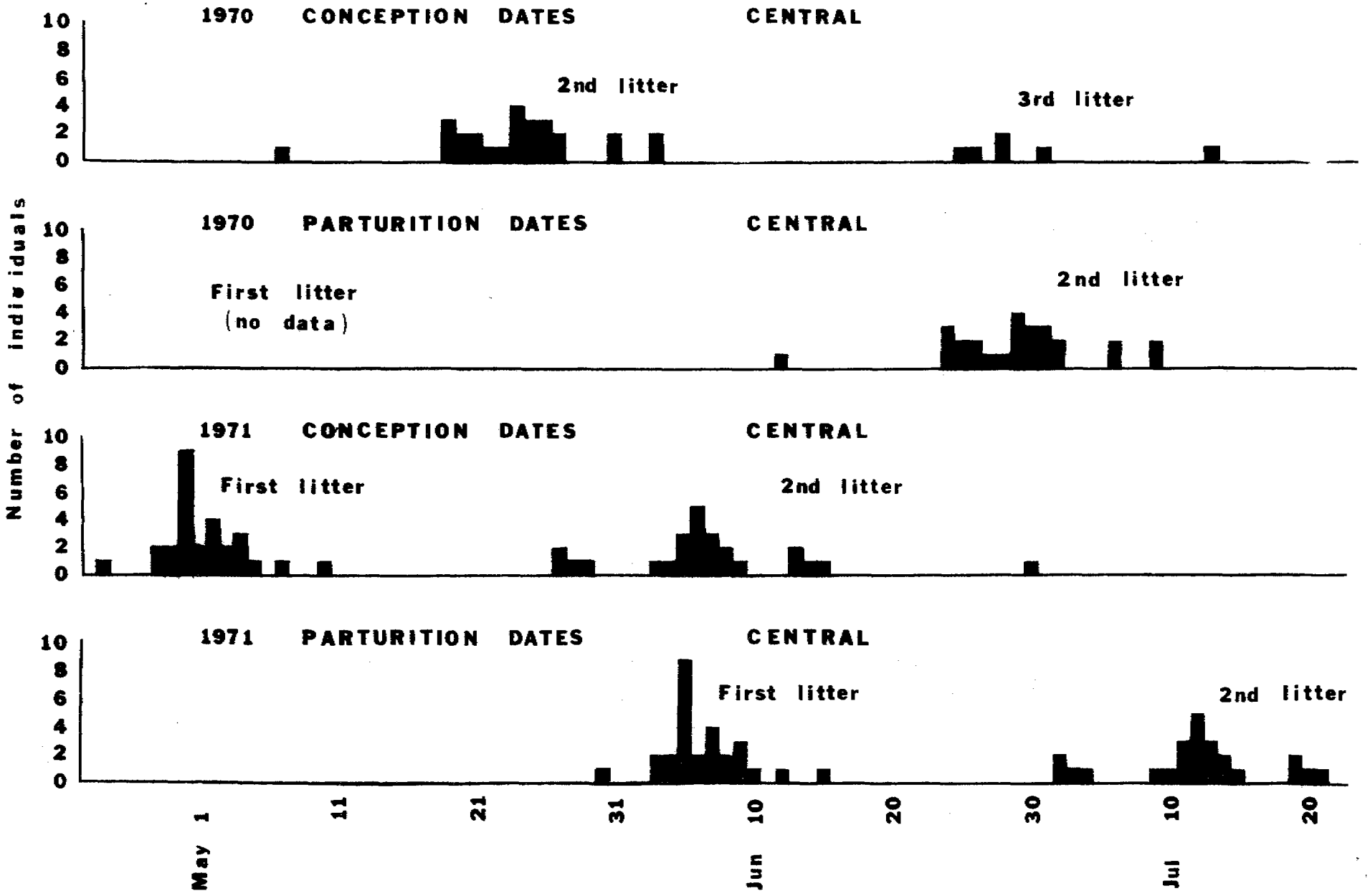


Figure 2. Second litter conception dates (white) and parturition dates (black) for snowshoe hares collected in interior Alaska in 1971.

Figure 3. Litter conception and parturition dates for hares collected in Central Alaska, in 1970 and 1971.



Most fetuses were too small to allow determination of sex, but of those two litter groups which were old enough, there were five females and four males. Sex ratios of adults and juveniles trapped in the Central area are given in the report on population enumeration (Job 10.7R).

Fairbanks

Sixty-six adult hares were collected from the Fairbanks area during the 1971 breeding season. Collecting was concentrated in the periods May 1-15, June 6-20 and July 12-30. Thirty specimens were collected in the first period, 15 in the second and 17 in the last. The rest were collected as opportunity arose at various times between these specific periods. Reproductive rates are given in Table 1.

The pregnancy rate of the first Fairbanks group was 100 percent. First litter parturition dates (Fig. 1) projected from fetal ages, ranged from May 20 to June 6, with most between May 20 and 29. Average litter size was 4.1. There were no placental scars detectable, and the embryo resorption rate was zero.

The pregnancy rate of the second group was also 100 percent and second litter parturition dates ranged from June 29 to July 5. The average number of embryos or fetuses was 5.6 per female, and the placental scar count was 5.9 per female. The rate of resorption of embryos was 2.4 percent of the total count.

The third Fairbanks collection yielded only one pregnant female out of 17, and she would have had her litter of three on August 1. This represents a pregnancy rate of 6 percent. The average placental scar count was 5.9 per female, compared to the average litter size of 5.6 for the second group. The calculated average productivity for Fairbanks hares during the 1971 season was 9.9 per female (Table 2).

Delta

Forty-seven adult female hares were collected from the Delta area, near Donnelly Dome, in two collections. The two collection periods, June 9-11, and July 30-31, covered the second and third gestation periods. The first breeding period was not monitored, except by placental scars found in the June collection. Reproductive data are shown in Table 1.

The pregnancy rate in the June group was 100 percent. Projected parturition dates ranged from June 26 to July 8 (Fig. 1) and the average litter size, as determined from embryos and fetuses, was 4.9 young per litter. Placental scar counts in this group averaged 3.2 per female, indicating that these females had all carried a previous litter.

The group of female hares collected on July 31 represented the third breeding period. One adult female (4.2 percent) was pregnant of the 24 collected. This one female would have borne her litter on August 29. This group of hares had an average of 4.9 placental scars

per female, which corresponds closely with the average embryo count of the June group. The calculated average productivity for Delta hares was 8.3 young per female for the 1971 season (Table 2).

DISCUSSION

There has been a great deal of speculation as to the factors involved in showshoe hare population fluctuations. In microtine populations, an inverse relationship between reproductive rates and increasing population density has led some researchers to postulate that reproduction is a major causative factor in these fluctuations. Among snowshoe hare studies, the data from Rochester, Alberta (Meslow and Keith, 1968) support the idea of reproductive involvement in population changes. However, earlier work by Green and Evans (1940 a, b, c,) at Lake Alexander, Minnesota showed no significant variation in reproductive rate, but found that juvenile mortality increased greatly during the decline. Severeid (1942) also reported there was no correlation between litter size and cyclic fluctuations in populations, but Macfarlane (1905), Preble (1908), Elton (1924) and Maclulich (1937) suggested that litter size varied from year to year, with large litters during years of population increase and smaller litters during years of decline.

Variations in reproductive rate between populations in different regions and latitudes may give some clues as to the factors affecting population levels. Rowan and Keith (1956) suggested that the fecundity of hares of northern latitudes may be greater than that of more southern latitudes.

The date of onset of breeding in an area can be determined from the first litter conception and parturition dates. Comparing the first litter parturition dates for Fairbanks, Central and Delta for 1971 (Fig. 1), it is apparent that onset of breeding was about two weeks later in Central than in Fairbanks and Delta. A comparison of the 1970 parturition dates for Central with the dates from 1971 shows that the onset of breeding in Central was ten days to two weeks later in 1971 than in 1970 (Fig. 3).

Meslow and Keith (1971), in their studies in Alberta, found that the intensity of illumination in midwinter, as measured by cloud cover, was significantly correlated with the date of onset of breeding the following spring. There was a much greater snowfall in Fairbanks in the winter of 1970-71 than in 1969-70 and a later spring. Comparison of conditions in Central and Fairbanks in the spring of 1971 indicates that there was still snow on the ground in the Central area around May 15, when the Tanana Valley was beginning to show green in some places.

If breeding begins relatively early, there seemingly would be more chance to have three litters and the breeding season might be extended if dates of testicular regression remained relatively the same. This is not always the case, of course, as Meslow and Keith (1971) found the mean date of testes regression varied 39 days between years. It is interesting

to note, however, that the percentage of females from the Central area having third litters was higher (33 percent compared to 10 percent) in the year that onset of breeding was earliest.

There is a very close correlation between placental scar count and the litter size of the previous pregnancy in showshoe hares, as placental scars will persist through the following pregnancy. However, they do not persist much beyond the breeding season, as the uterus atrophies considerably. During the first pregnancy of the breeding season, in late April or May, no placental scars are visible. In the second pregnancy, placental scars from the first are visible until the uterus becomes greatly enlarged and stretched from the fetuses, at about 28 days and beyond. Placental scars from the second pregnancy are detectable during the third pregnancy, or if the animal has no third litter, will persist until late August or early September. They do not seem to last through the winter as none are detectable in early spring.

Changes in litter size would be a prime factor in changing birth rates, which would undoubtedly affect the population level (Meslow and Keith, 1968). Litter sizes from the three areas of collections during the 1971 breeding season are compared in Table 4.

Litter size of hares in Interior Alaska seems considerably larger, both first and second litter, than the mean litter size recorded for hares in Alberta, Michigan or Newfoundland. Alaskan hares had fewer litters per season, on the average, but first litters averaged around four, while the mean of first litter sizes over six years in Alberta was only three (Meslow and Keith, 1968). Second litters were also larger in Alaska than those seen in the Alberta studies.

First litters were smaller on the average than second litters (Table 4). The same situation has been found in Michigan (Bookhout, 1965) and Alberta (Rowan and Keith, 1956) and Newfoundland (Dodds, 1965). The significance of this phenomenon is not clear. That it may be a factor of nutrition is suggested by Meslow and Keith (1971). These workers found, when weather factors were correlated with snowshoe hare population parameters, the colder the temperatures in the 250 days preceding mid-February and the deeper the winter's accumulation of snow the larger the litters the next spring. This was possibly due to the fact that as snow depth increases, the height above ground level at which a hare feeds also increases. They postulated that the hares were able to reach more nutritious browse with the help of the increased snow depth and that this influenced the size of their first litter. Perhaps the nutritive value of this food is such that it promotes a greater ovulation rate. Later, in the spring, green plants are available to the hares and may provide more nutrition which could stimulate a higher ovulation rate.

The data from this present study cover only two years at Central and one year in the Fairbanks area. Therefore, trends for these areas are not yet discernible. A comparison of these reproductive data with data from other studies from the Fairbanks area may give some better idea of what is happening.

Previous researchers averaged the several litters of the breeding season together to get a mean annual litter size. Two biologists in Alaska, Philip (1939) and Hensel (1960, notes on file at Cooperative Wildlife Research Unit, College, Alaska), each obtained a mean litter size of 4.9 young per litter. Tovey (Tovey and Bishop, 1962) collected 114 hares from several areas in Interior Alaska in June and July of 1955 and 1956 and obtained a mean of 4.2 young per litter. Trapp (1962), in the summers of 1960 and 1961, found a mean of 4.6 fetuses in 12 pregnant hares. The figures obtained when the data from this study were averaged out over the breeding season, were a mean of 4.9 young per litter for Central (50 females), 4.5 young for Fairbanks (46 females) and 4.0 for Delta (47 females). I think it is more meaningful to give a mean litter size for each breeding period as in Table 1. The most important data are the size of the first and second litters. So few hares have a third litter that is difficult to get a meaningful average size for the third litter.

Another year's data from the three collection areas should give a clearer picture of just what is happening in these populations as far as reproduction at this stage of the hare cycle. Productivity also must take into account the survival of the young produced during the breeding season. Discussion of sex and age composition is included in the report for Job 10.7 on population enumeration.

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