ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

STATE OF ALASKA
William A. Egan, Governor

DEPARTMENT OF FISH AND GAME
Wallace H. Noerenberg, Commissioner

DIVISION OF GAME
Frank Jones, Acting Director
Donald McKnight, Research Chief

POPULATION CHARACTERISTICS OF ROCK PTARMIGAN.

By

Jerry D. McGowan

Final Report
Federal Aid in Wildlife Restoration
Projects W-6-R, W-13-R, W-17-1R, W-17-2, W-17-3, and W-17-4
Jobs 2, B-2, and 10.1R

(Printed June, 1972)

FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Jerry D. McGowan

Project No.: W-6-R 106
W-13-R 1-3
W-17-R 1-4

Project Title: Small Game Investigations

Job No.: 2, B-2, and 10.1R

Job Title: Population Characteristics of Rock Ptarmigan

Period Covered: July 20, 1959 to June 30, 1972

SUMMARY

Spring densities of rock ptarmigan at Eagle Creek fluctuated between 1959 and 1971, reaching peaks in 1962 and 1969. Major factors responsible for these changes were winter loss (primarily of juveniles), and changes in production of young. Variations in clutch size and nest failure (primarily due to predation by weasels) were the most important factors involved in productivity changes. Although nest predation by weasels varied in parallel to production losses, no single extrinsic factor was found to account for winter losses of juveniles or yearly variations in clutch size. Hence, an extrinsic mechanism of population control seems unlikely; possibly factors operating within the population govern abundance of ptarmigan.

Most ptarmigan shot at Eagle Creek are shot within 0.5 miles of the road, and hunters rarely take the legal limit. Annual harvests of 400-1,000 birds are normally taken from the upper Steese Highway area, however, hunting pressure in any year is to some extent related to availability of caribou. Early in the season juvenile ptarmigan are shot roughly in the proportion at which they exist in the population, however, as the season progresses the proportion of juveniles taken decreases. Sexes are harvested in about equal numbers, but among males, the adults are more commonly shot. Considering the entire season, the various age-sex groups are thought to be harvested roughly in the proportion in which they exist in the population. Throughout the season, most of the ptarmigan taken at Eagle Creek were transients having moved three or more miles before being shot. Fall hunting was found to have no numerical effect on breeding populations, however, this may not be the case with spring hunting. Fall hunting did alter age ratios by producing a higher proportion of yearlings among breeding males. Various methods of manipulating harvest are discussed.

CONTENTS

Background 1
Objectives 2
Procedures 2
Findings 2
Breeding Populations. 2
Losses Throughout the Year. 2
Winter Losses 3
Production Losses 3
Discussion of Population Data 4
Management Implications 6
Hunting Patterns and Methods 6
Hunter Success 7
Harvest Levels 7
Effects of Hunting 8
Manipulation of Harvest. 9
Acknowledgments. 11
Literature Cited 12
Appendix 14
Annotated List of Publications 15
Technical Publications. 15
Theses. 20
Popular Publications. 23
Federal Aid to Wildlife Restoration Progress Reports. . . . 25

BACKGROUND

Rock ptarmigan (Lagopus mutus) are the most heavily hunted upland game bird in interior Alaska and unlike other grouse they are easily taken during all seasons. Local populations are readily accessible, and we can detect effects of current harvest levels. At present large areas of inaccessible ptarmigan habitat serve to replenish more heavily hunted areas. Human populations are increasing in interior Alaska, thus greater hunting pressure on ptarmigan is expected in the near future.

Early studies raised many questions concerning the biology and life history of rock ptarmigan (De Leonardis, 1952). In 1959 Robert B. Weeden initiated an intensive study of rock ptarmigan population characteristics at Eagle Creek in interior Alaska, and the study was carried on through the summer of 1971. This research has provided the Department of Fish and Game with a sound basis for management. Normal patterns of population change, normal parameters of production and survival, the effects of fall hunting, methods for detecting symptoms of excessive harvests and techniques for reducing effects of hunting when needed have all been studied.

In this final report, the major findings of this 12-year study are discussed, and a listing of all publications with abstracts is presented. Basic data collected between 1960 and 1971 are presented in Appendix A. Much of these data are presented graphically in publication (Weeden and Theberge, 1972) and are not duplicated here. The bulk of this report is taken from Weeden and Theberge (1972) and Weeden (1969b).

OBJECTIVES

To record numerical changes of ptarmigan populations on selected study areas.

To determine mortality and reproductive rates among ptarmigan.

To evaluate roles of behavior, movements, and birth and death rates in determination of spring population levels.

PROCEDURES

Each May during the study counts of territorial males were made on the 15-square-mile Eagle Creek area. This area is considered typical interior Alaska rock ptarmigan breeding range, and is described by Weeden (1965). The spring counts of territorial males are estimated to be 95 percent accurate. The number of females was estimated yearly from both direct counts in May and subsequent observations during the nesting period. These count techniques along with other procedures used for population estimates are discussed by Weeden (1965). Ptarmigan were captured using long handled hoop nets, banded with metal leg bands, and color marked with felt tipped pens (Weeden, 1965). After 1963 age of ptarmigan up to 12-15 months was determined by coloration of the primaries as discussed by Weeden (1961) and Weeden and Watson (1967). This technique is considered 98 percent accurate for both sex groups. Most information concerning hunting pressure and success is based on checking station data collected during the falls of 1967 and 1968, and is discussed by Weeden (1969b).

FINDINGS

Breeding Populations

Early reports indicated that ptarmigan populations peaked about every 10 years, however, recent studies suggest that fluctuations are not rhythmic in nature. Breeding populations (males plus females) at Eagle Creek increased from 163 birds during the first two years of the study to a high of 325 birds in 1962, decreased for three years to 126 birds in 1965, increased again for three years to 223 in 1969, and then decreased to 180 in 1971.

Age ratios varied over the years, and the proportion of yearlings varied directly with breeding densities in all years. However, the correlation coefficient ($r=0.59$) was not quite significant at the 95 percent level (Weeden and Theberge, 1972). Sex ratios were fairly constant, varying only from 0.98 to 1.17 males per female during the period 1960-69.

Losses Throughout the Year

In order to more fully understand the major factors responsible for fluctuations, Weeden and Theberge (1972) assembled the following data for a "key loss factor" analysis (Varley and Gradwell, 1960; Southwood, 1966):

clutch size, hatchability, nest failure (nest predation and desertion), summer chick loss, summer yearling and adult loss, and winter loss of all age-sex groups. These data are presented graphically and discussed by Weeden and Theberge (1972) and the following discussions on winter and production losses are largely extracted from that paper.

Winter Losses

Both winter loss and production loss (clutch size loss, hatchability loss, and summer chick loss) closely paralleled total loss trends. Statistical comparisons showed highly significant correlation coefficients for winter loss correlated with total loss and production loss correlated with total loss. The magnitude of change between years in winter loss and production loss was very similar. In four years, change in winter loss exceeded change in production loss, and in five years the reverse was true. Thus, both winter loss and production loss were involved about equally in causing variations in total loss.

Considering mean loss over the 10-year period, winter loss was the most important factor and accounted for 59 percent of total loss for this period. Winter losses were divided into two components: juvenile loss, and adult and yearling loss. Variations in juvenile loss generally paralleled variations in total loss, and the magnitude of variation between years in juvenile loss was greater than that of yearlings and adults in all but one year. Hence, changes in winter loss resulted primarily from changes in juvenile loss. Losses in both sexes of juveniles were similar, but among yearlings and adults more variation in losses between sexes occurred. The mean level of winter loss was primarily determined by juvenile loss, which greatly exceeded yearling and adult loss in all years.

In summary juvenile winter loss was primarily responsible in both changes in winter loss between years, and the mean level of winter loss over the 10 years, with juveniles of both sexes contributing equally.

Production Losses

Two components of production loss, clutch size loss and nest failure, varied in parallel to total loss during most years. Furthermore, variations in magnitude of these two loss factors were similar, consequently losses in clutch size and nest failure were about equally responsible for variations in production loss. Changes in clutch sizes were not due to changing age ratio of hens. Production loss contributed to changing spring numbers as it was not found to be a density dependent factor. Hatchability loss and summer loss of chicks bore little or no relation to changes of total loss. Changes in total loss from year to year resulted from loss changes of similar proportions in winter loss and production loss. Winter losses were consistently greater than production losses, and therefore contributed more (59 percent) to the mean annual loss over a 10 year period. Juvenile loss during winter greatly exceeded yearling and adult loss in all years.

In summary, abundance of rock ptarmigan at Eagle Creek was the result of generally synchronous changes in winter and production losses, with each contributing about equally to variation in total loss. Variations in production loss were primarily caused by clutch size and nest losses. Mean loss of ptarmigan over 10 years resulted primarily from winter loss which was mainly determined by loss of juveniles.

Discussion Of Population Data

Research to date has served to point out three major situations which must be understood before a complete explanation of population fluctuations can be made:

1) The high and variable loss of juveniles in winter.

2) The similar loss in the sexes of juveniles in winter even though they spend most of their time in different habitats (see Weeden, 1964).

3) The parallel changes in clutch size, nest failure, and winter loss.

Various environmental factors which may act simply and directly to influence ptarmigan numbers are: food, weather, predators, parasites, and hunting. Food habits of rock and willow ptarmigan were reported by Weeden (1969a) but no data concerning nutrient quality were obtained. Various aspects of food as an important factor in population regulation of rock ptarmigan are discussed by Weeden and Theberge (1972). It appears that quantity of various seasonal foods does not operate to control populations but a direct study of nutritional quality is needed before this can be ruled out as a major population controlling factor.

The annual progression of flowering dates of certain plants at Eagle Creek correlated well with hatching dates of rock ptarmigan (Weeden, 1968). Other aspects of potential effect of weather on ptarmigan populations are discussed by Weeden and Theberge (1972). Weather conditions were not closely monitored during the study. Although no component of weather was found to be an important contributor to any loss type, data obtained were insufficient to eliminate weather as a potentially important population regulating mechanism.

Common rock ptarmigan predators are gyrfalcons (Falco rusticolus), red foxes (Vulpes fulva), martens (Martes americana), snowy owls (Nyctea scandiaca), and golden eagles (Aquila chrysaetos) (Weeden, 1965). No information was collected to determine the role predation played in regulating ptarmigan numbers in winter, however, other works dealing with winter predation on rock ptarmigan are discussed by Weeden and Theberge, (1972). The behavior of gyrfalcons and their prey is discussed by White and Weeden (1966). Nest predation by weasels (Mustela erminea) was the most important factor contributing to nest failures. Over the 10 years 81 percent of nests that failed to produce chicks contained removed or mutilated eggs assumed to be weasel predation. Little is known of weasel food habits

or fluctuation in weasel numbers. Consequently, it was not determined whether the observed high levels of nest predation associated with decreasing ptarmigan densities were causes or symptoms of ptarmigan in population declines.

Parasites found in Alaskan rock ptarmigan have been reported by Babero (1953), Jellison and Neiland (1965), and Stabler et al. (1967). No direct evidence was obtained to suggest that parasites were disabling birds. Until parasite levels are monitored during population fluctuations their influence on ptarmigan numbers will not be fully understood.

Experiments suggest fall hunting has no depressing effect on subsequent spring numbers (McGowan, 1971). However, spring hunting, at least in some years, may depress spring densities (McGowan, 1972). In most years during the 10-year study little or no spring hunting occurred at Eagle Creek. Fall hunting during the study resulted in the harvest of only 5 to 20 percent of the fall population in most years (Weeden, 1969b). Experimental evidence suggests that removal of 40 percent of the fall population for three consecutive years does not depress subsequent breeding stocks. In view of these and other findings discussed by Weeden and Theberge (1972) fall hunting is thought to have little effect on ptarmigan numbers.

No extrinsic factors other than nest predation by weasels were identified that could operate directly to control ptarmigan numbers. Food abundance and hunting were definitely not major factors, and superficial evidence suggests that weather and parasitism were unimportant. Predation and food quality were not studied in depth. It is possible that a number of environmental factors operate in combination to produce numerical changes, but any one factor is probably not responsible for population fluctuations.

It is also possible that intrinsic factors which operate to produce variations in type or quality of stock may be responsible for numerical fluctuations. Data from other studies discussed by Weeden and Theberge (1972) tend to strengthen this hypothesis. Controlled experiments with rock ptarmigan obtained near Eagle Creek showed that changes in chick aggression occurred during the period 1967 through 1969 (Theberge, 1971). The fact that the level of inherent aggression varies over the years may provide a key to population regulation. Another study will be completed shortly which should provide information on the physiological condition of rock ptarmigan hens prior to laying, and the relationship of this to clutch size and other factors. Hopefully, this will provide more insight into the probability of intrinsic factors governing population fluctuations.

In conclusion, declines in breeding density primarily resulted from parallel changes in loss of juveniles during winter, smaller clutch sizes, and nest failure, all acting together to produce fluctuation in numbers.

The synchrony in these parameters, and the inability to relate these fluctuations to direct extrinsic factors, leads to the supposition that the regulation mechanism is governed by unidentified changes in the type of birds composing successive populations (Weeden and Theberge, 1972).

Management Implications

Aside from giving insight into mechanisms of rock ptarmigan population regulation, this study has yielded a wealth of information of direct management significance. The purpose of the following discussion is to summarize information on: hunting patterns and methods, hunter success, harvest levels, visable effects of hunting, and techniques of manipulating the harvest. Much of the information presented appeared in an unpublished report by Weeden (1969b) and pertains specifically to the Eagle Creek population. Certain aspects are applicable to other ptarmigan populations in interior Alaska.

HUNTING PATTERNS AND METHODS

In general, the interest of Eagle Creek ptarmigan hunters is low at the opening of the season (August 10 in interior Alaska). Interest increases throughout September, remains fairly high during October, and then decreases with arrival of cold, snowy weather in November. Some ptarmigan hunting areas receive moderate spring pressure, and while this has not been true at Eagle Creek, interest in spring hunting can be expected to increase throughout the Interior in the future. About half of the hunters checked in 1967 and 1968 were in the field specifically to hunt ptarmigan, the remainder being big game hunters who had capitalized on the opportunity to take ptarmigan. At least half of the ptarmigan shot at Eagle Creek in 1967 and 1968 were taken on weekends.

In years when moderate numbers of caribou (Rangifer tarandus) are available in areas such as Eagle Summit, Mt. Fairplay, Poly Summit, or certain portions of the Denali Highway, relatively high ptarmigan harvests should be expected. This is especially true when caribou cross roadways early in the season (August through October).

Most ptarmigan hunters do not walk more than 0.5 miles from the highway to find birds. Between 1960 and 1968, of 2,719 ptarmigan banded, hunters returned 224. Sixty-seven percent of these returns were from birds banded within 0.5 miles of the highway and later shot in that zone. Hunting pressure is by far the greatest near access points, and banding records show that in most cases where ptarmigan were banded more than a mile from the highway and later shot, the birds had moved to within 0.5 miles of the highway. These basic findings probably apply to most popular ptarmigan hunting areas in interior Alaska.

Unlike other popular hunting locations, mechanized vehicles have not been used at Eagle Creek to any extent to hunt ptarmigan. Snow

machines are heavily used in most popular spring ptarmigan hunting areas, however, and their use can be expected to increase at Eagle Creek.

HUNTER SUCCESS

Ptarmigan hunters were considered to be those who actually had shot birds, and this admittedly overlooks unsuccessful hunters. However, on this basis the average number of birds taken by successful parties varied over the years, and there was little correlation between number of birds shot and fall abundance of ptarmigan. The average number of birds in possession by hunters in 1968 was only 10.6, and in that year only three of 80 parties took the legal limit. The current limit of ptarmigan (20 a day and 40 in possession) is generally a hypothetical restriction, even in years of high hunter success such as 1968.

HARVEST LEVELS

Information presented here is based on band return data from the period 1960-68, and data from the 1967 and 1968 check station operated during August through September near Eagle Creek. Age-sex information is based on 1968 check station data. Although this was a year of high breeding density and a moderately high rate of summer gain, findings are probably applicable to most years.

In most years an estimated 400 to 1,000 ptarmigan are taken by hunters from the upper Steese Highway (mainly Eagle Creek and Harrison Summit), and this suggests a harvest of 14 to 36 ptarmigan per square mile in these years. Early in the season hunters took juveniles in approximately the proportion in which they existed in the population. Later in the season the proportion of juveniles shot decreased markedly. This decline late in the season is probably a result of the following: 1) increasing vulnerability of adults stemming from fall behavioral changes; 2) relatively high natural mortality of juveniles; and 3) movement of adult hens, young females, and some young males away from breeding grounds to lower wintering habitat.

Males comprised 51 percent of the kill in 1968, fifty-five percent of the males taken were adults and 45 percent were juveniles. Possible explanations of relative high vulnerability of adult males to hunters are: 1) they are noisy; 2) they are not as wary early in the season as females; and 3) they are more often alone and easier to approach. The reason relatively few juvenile males are taken by hunters cannot be explained at this time.

To summarize, hunters show an involuntary bias in age and sex classes of birds taken during certain portions of the fall season. However, when considering the entire fall season, hunters generally take the various age and sex groups in about the same proportions as they exist in the

population. This conclusion is based on findings during a single fall hunting season at Eagle Creek, but is probably true in other years and at other areas.

It is of importance to game managers to know where birds taken in a particular harvest are hatched (juveniles) or breed (adults). As pointed out earlier, ptarmigan banded close to the highway are shot more often than those caught up to three miles away. These findings pertain only to ptarmigan residing on the Eagle Creek area. Definite movement data are scarce, but seasonal movements of considerable distances do occur (Weeden, 1964). Considering 1968 band returns and estimated proportions of banded residents, it appears that only 23 percent of the birds shot were summer residents at Eagle Creek. There was undoubtedly movement of summer residents off the study area, and movement onto the area of non-residents. While no definite conclusions are possible, evidence available suggests that early in the season (up to September 7) about half the ptarmigan shot were summer residents at Eagle Creek, and for the entire fall only about 25 percent of the harvest includes Eagle Creek residents. Hence, most ptarmigan that hunters shot in the fall at Eagle Creek were transients having moved three or more miles before nearing the highway.

It has been pointed out that fall harvests are comprised both of birds residing (during summer) at Eagle Creek and elsewhere. Further, age and sex classes of birds shot in the entire fall harvest are roughly in the proportion that they exist on the study area. However, for management purposes it is important to know what proportion of the resident, breeding population is harvested annually. Direct band returns suggest a disproportionately high harvest of resident adult cocks; 20 percent compared to 6 percent for both resident adult hens and juveniles. Annual harvests of 20 percent of the adult resident males could have noticeable effects on population composition, but there is little chance that observed fall harvest levels can seriously affect the abundance of any segment of the population.

EFFECTS OF HUNTING

One would expect excessive harvest to show up as a numerical decrease in breeding stocks. Since most hunting occurs along the highway, numerical changes in breeding stocks resulting from excessive harvest would be expected to be most apparent in this zone. However, breeding densities in the zone 0.5 miles from the road are not significantly different from those in zones of equal size further from the highway in most years. In the two years when this was not the case, spring hunting occurred along the highway. Only in years when spring hunting occurred were breeding numbers relatively low near the road. Apparently fall harvests at Eagle Creek have not numerically influenced breeding densities to any extent. Furthermore, experimental evidence shows

that removal of 40 percent of the fall population (a removal considerably higher than "normal" harvests at Eagle Creek) for three consecutive years does not depress breeding stocks (McGowan, 1971).

An experiment conducted in May 1971, further suggested that spring hunting can depress breeding numbers (McGowan, 1972). On the contrary, a spring removal experiment in 1966 indicated birds shot were replaced 12 days later (Weeden, 1967). Positive conclusions on the effects of spring hunting cannot be made at this time, but it is possible that the effect of spring hunting and the probability of occupation of vacated territories vary from year to year. Overharvest of a population could result when the population is accessible in late April and there is a liberal bag limit (Weeden, 1963).

While fall hunting was not known to effect numbers of breeding ptarmigan, it did influence composition of breeding populations. Two previously discussed findings must be kept in mind: 1) the bulk of the resident ptarmigan harvested at Eagle Creek reside in the zone 0.5 miles from the road, and 2) fewer resident adult females are shot than males. Consequently, if hunting influences age ratios a higher proportion of yearlings would be expected near the road than elsewhere, and there would be more juveniles among males than females. Age data from breeding ptarmigan handled between 1960 and 1968 showed that yearlings of both sexes were more common along the road than elsewhere, and in all zones there were more yearlings among males than females. Further evidence that fall hunting can alter age ratios was obtained in 1966 when over 50 percent of the adult males banded that year were shot by hunters; only 15 percent of the banded adult hens were reported to be shot. The following spring 82 percent of all cocks caught on the study area were yearlings, while only 60 percent of the breeding hens were yearlings.

Fall hunting clearly can influence spring age ratios, and this probably results from replacement by younger birds upon removal of dominant adult males. General observations suggest that "replacement" birds probably exist at Eagle Creek in some years but their age and whether or not they are present in all years are not known.

MANIPULATING HARVEST

Harvest levels at Eagle Creek have been low because of: 1) limited participation in bird hunting by Alaskans; 2) fall closure of Steese Highway; 3) limited use of snowmobiles; and 4) limited access to much of the area. These key factors should be watched closely by game managers both at Eagle Creek and elsewhere. Marked increase in any of these could lead to management problems. At Eagle Creek if spring counts close to the highway showed low densities, and especially if this were coupled with relatively high proportions of yearlings near the road, managers would be warned of excessive harvests the previous year.

To counter over-harvest, the season could be opened later, which would result in fewer resident birds being taken and possibly allow breeding stocks to increase. Another possibility would be earlier closure of the season in spring. An early March closure would remove most of the pressure from local breeding stock. A later March closure would allow some territorial males to be taken but with the possibility of replacement by yearlings. Females do not normally appear on breeding grounds until early April, consequently any closure prior to April would remove pressure from this segment of the population. Another possibility is to impose a closure along the road, but this is not recommended because: 1) it would be difficult to enforce, and 2) it would eliminate "road hunting" which is practiced by a significant number of bird hunters. Findings suggest that it is the male segment of the population that has greatest probability of over-harvest. In order to reduce the harvest of males, the bag limit could be reduced after October 1. This would allow liberal limits when all segments of the population are available, but reduce the limit at a time when mostly resident males are available. If this approach were used limits should be reduced to not more than 5 birds per day. Again, a March 1 closure would reduce males harvested, however, it would eliminate spring hunting. Finally, the present season could be altered by a closure of October only, allowing good harvests of both sexes in early fall and allowing winter and spring hunting from November through March.

ACKNOWLEDGMENTS

This study was initiated by Dr. Robert B. Weeden, and he directed field activities through 1969. Much of the information and interpretation of data in this report are taken from the numerous publications he has prepared over the years. Numerous other persons (listed below) aided in various aspects of this project, and their contributions are acknowledged and appreciated.

Terrence Bendock
Walter Brunner
M. Thomas Dean
James Erickson
Dale Haggstrom
David Hatler
Philip Headley
Rodney Herrick
Sandra Kogl
John Trent

LITERATURE CITED

Babero, B.B. 1953. Studies of helminth fauna of Alaska. XVI. A survey of helminth parasites of ptarmigan (Lagopus spp.). J. Parasit. 39:538-545.

DeLeonardis, S. 1952. A study of the rock and willow ptarmigan, Lagopus mutusL. and Lagopus lagopus L. Unpubl. MS. Thesis, Univ. of Alaska, College. 74p.

Jellison, W.L. and K.A. Neiland. 1965. Parasites of Alaskan vertebrates. Host-parasite index. Department Army and Univ. of Okla. Rept. 73p.

McGowan, J. 1971. Effects of controlled hunting on rock ptarmigan. Fed. Aid to Wildl. Rest. Final report. Projects W-13-R, W-17-1, W-17-2, and W-17-3. Jobs B-7 and 10.3R.

_____ 1972. Effects of controlled spring hunting on rock ptarmigan. Fed. Aid to Wildl. Rest. Progress Rept. Project W-17-4, Job 10.1.

Southwood, T.R.E. 1966. Ecological methods. Methuen and Co., London. 391 p.

Stabler, R.M., N.J. Kitzmiller, and R.B. Weeden. 1967. Blood parasites in rock ptarmigan from Eagle Summit, Alaska. J. Parasit. 53:1297.

Theberge, J. B. 1971. Population fluctuation and changes in the quality of rock ptarmigan in Alaska. Unpubl. Ph.D. thesis, Dept. Zool., Univ. of British Columbia, Vancouver, 186 p.

Varley, G.C., and G.R. Gradwell. 1960. Key factors in population studies. J. An. Ecol. 29:297-401.

Weeden, R.B. 1961. Outer primaries as indicators of age among rock ptarmigan. J. Wildl. Mgmt. 25:337-339.

_____ 1963. Management of ptarmigan in North America. J. Wildl. Mgmt. 27:673-683.

_____ 1964. Spatial separation of sexes in rock and willow ptarmigan in winter. The Auk 81:534-541.

_____ 1965. Breeding density, reproductive success, and mortality of rock ptarmigan at Eagle Creek, central Alaska, from 1960 to 1964. Trans. N. Am. Wildl. and Nat. Resources Conf. 30:336-348.

_____ 1967. Population characteristics of rock ptarmigan. Annual Fed. Aid to Wildl. Restoration Report. Project W-13-R-1 and 2, work plan B.

_____ 1968. Dates of first flowers of alpine plants at Eagle Creek, central Alaska. Can. Field-Nat. 82:24-31.

_____ 1969a. Foods of rock and willow ptarmigan in central Alaska with comments on interspecific competition. The Auk 86:271-281.

_____ 1969b. Effects of hunting on rock ptarmigan along the Steese Highway. Unpubl. Rept. to Alaska Dept. Fish and Game.

_____ and J. B. Theberge. 1972. The dynamics of a fluctuating population of rock ptarmigan in Alaska. Proc. of XIV Ornith. Congress. Rotterdam. In press.

_____ and A. Watson. 1967. Determining the age of rock ptarmigan in Alaska and Scotland. J. Wildl. Mgmt. 31:825-826.

White, C.M. and R. B. Weeden. 1966. Hunting methods of gyrfalcons and behavior of their prey (ptarmigan). The Condor 38:517-519.

PREPARED BY:

Jerry D. McGowan
Game Biologist

APPROVED BY:

Frank Jones
Acting Director, Division of Game

Donald E McKnight
Research Chief, Division of Game

Appendix A. Basic rock ptarmigan data collected at Eagle Creek between 1960 and 1971.

Year	No. Breeding Birds (♂ & ♀)	Mean Clutch Size (n)	% of Nests Lost To Predation	% Hatch-ability of Eggs in Successful Nests	Peak Hatching Date	Mean Brood Size-Aug.(n)	Estimated Fall Population	Summer Gain	Yearling To Adult Ratio For All Summer Trapped Birds ♂	♀
1960	163	8.2 (12)	17	98	June 19	5.4 (10)	470	2.9	0.8: 1.0	2.3: 1.0
1961	269	7.4 (17)	15	94	June 19	6.1 (38)	813-894	3.0-3.1	2.1: 1.0	4.0: 1.0
1962	325	7.0 (18)	45	91	June 23	5.5 (50)	735-790	2.2-2.4	-	-
1963	212	6.5 (34)	44	94	June 19	4.8 (75)	428	2.0	-	-
1964	209	6.6 (15)	40	-	July 1	5.1 (35)	459	2.2	0.7: 1.0	0.2: 1.0
1965	126	7.6 (7)	0	92	June 23	6.2 (49)	385±	3.0-3.1	0.5: 1.0	0.3: 1.0
1966	155	9.0 (18)	25	98	June 20	6.0 (20)	460±	3.0	1.5: 1.0	1.8: 1.0
1967	200	8.9 (16)	20	98	June 22	5.3 (17)	604	3.0	4.4: 1.0	1.6: 1.0
1968	205	7.5 (23)	32	86	June 23	4.8 (33)	510	2.5	6.3 1.0	1.4: 1.0
1969	223	6.5 (11)	29	85	June 17	3.9 (30)	462	2.1	-	1.0: 1.0
1970	204	7.5 (20)	33	93	June 21	5.2 (30)	496	2.4	-	1.2: 1.0
1971	180	6.3 (6)	-	-	-	3.9 (18)	-	-	-	-

ANNOTATED LIST OF PUBLICATIONS

Technical Publications

Stabler, R.M., N.F. Kitzmiller, and R.B. Weeden. 1967. Blood parasites in rock ptarmigan from Eagle Summit Alaska. J. Parasit. 53:1,297.

One hundred and nineteen rock ptarmigan (Lagopus mutus) taken along Eagle Creek in Alaska were examined for blood parasites. Ten were negative and 109 were positive. Of the positives: 108 had Leucocytozoon; 15 had Trypanosoma; 16 had microfilariae. Multiple infections were: Leucocytozoon and Trypanosoma - 12; Leucocytozoon and microfilariae - 12; Leucocytozoon, Trypanosoma, and microfilariae - 3.

Weeden, R.B. 1961. Outer primaries as indicators of age among rock ptarmigan. J. Wildl. Mgmt. 25:337-339.

Shape and pigmentation of the outer primaries of rock ptarmigan proved to be unsatisfactory as age criteria in a sample of 250 young and 39 adults collected in interior Alaska in autumn. Subjectively, tip shape showed too many intermediate individuals; when reduced to a series of measurements, the means were not significantly different and there was much overlap. Whereas 96 percent of the young-of-the-year showed pigmentation of the vane of the 9th primary, so did 33 percent of the adults. Fewer males than females had pigmentation on the 9th primary, and those that did have pigmentation frequently had less than most females.

_____ 1963. Management of ptarmigan in North America. J. Wildl. Mgmt. 27:673-683.

Ptarmigan are monogamous, territorial game birds of arctic and alpine tundras. They are gregarious and migratory or nomadic from late summer until spring. Sex-segregation occurs in winter. Populations of rock (Lagopus mutus) and willow ptarmigan (L. lagopus) fluctuate widely from year to year; whether the fluctuations are rhythmic is not known. Breeding densities commonly range from 1 to 10 pairs per square mile. Ptarmigan habitat is unusually free from human disturbance. Most ptarmigan harvested in North America now are killed primarily for food; the main harvest occurs in winter. Sport hunting exists on a small fraction of ptarmigan range. The only active management of ptarmigan is through regulation of harvest. Present regulations are set with no knowledge of ptarmigan numbers, the kill, or the effect of one on the other. Lack of access to

ptarmigan range restricts the harvest. Greater future demand for ptarmigan as a recreational resource is expected; research is needed to establish a basis for an intelligent management program.

_____ 1964. Spatial separation of sexes of rock and willow ptarmigan in winter. The Auk 81:534-541.

Among willow ptarmigan (Lagopus lagopus) and rock ptarmigan (Lagopus mutus), there was a partial separation of the sexes in October and November. Many of the females moved into boreal forests from their alpine nesting haunts; most males remained throughout the winter in the alpine area.

_____ 1965. Breeding density, reproductive success, and mortality of rock ptarmigan at Eagle Creek, central Alaska, from 1960 to 1964. Trans N. Am. Wildl. and Nat. Resources Conf. 30:336-348.

Initial breeding stocks of rock ptarmigan (Lagopus mutus) on a 15-square-mile area in east-central Alaska rose from 88 cocks in 1960 to a peak of 170 in 1962, then declined to 109 in 1964. Two years of good chick production were followed by three years of lower production. Clutch size decreased significantly from 1960 (av. clutch 8.2) to 1963 and 1964 (av. clutch 6.5, 6.6), but predation on nests by weasels (Mustela erminea) accounted for most of the decreased production in 1962-1964. Early survival of chicks did not vary greatly. Mortality from late summer to spring was only 40 to 46 percent for all ages in 1960-61, but death rates rose in 1961-62 and 1962-63 to 64 to 67 percent. Overall mortality was 53 to 57 percent in the winter of 1963-64, with a very high loss of young birds balanced by excellent survival of adults, especially hens.

_____ 1966. Molt of primaries of adult rock ptarmigan in central Alaska. The Auk 83:587-596.

The molt of primaries of adult male rock ptarmigan in central Alaska began in the period 5-20 June in 1961-65 and was completed 5-30 September. The molt began when territorial behavior was waning and when hens were incubating. Primaries were molted faster early in the molt period than later. A cold snowy spring in 1964 delayed the molt and breeding schedule of rock ptarmigan by about 12 days in comparison with 1963.

Adult hens with chicks began molting 4-12 days after their chicks hatched, rarely earlier. Hatching peaks varied from 19 June to 1 July; molting began latest in the year of latest hatchings. The molt proceeded faster among hens early in the molt period than later, as was the case among males. There was no close correlation between molt progress of hens and the age of their chicks.

Hens that lost nests began shedding primaries soon after the nests were destroyed. As a group, unproductive hens molted later than cocks but earlier than hens that nested successfully.

_____ 1968. Dates of first flowers of alpine plants at Eagle Creek, central Alaska. Can. Field - Nat. 82:24-31.

Among 84 species of conspicuous flowering plants at Eagle Creek, east-central Alaska, the earliest (Douglasia gormanii) showed its first blossoms about May 23, on the average. The latest species to flower, (Gentiana algida), began blooming July 23 most years. About 25 percent of the species studied achieved first anthesis between June 14-18. Site variation within species was not studied, but considerable variation in flowering dates among species on the same site was observed. The annual progression of flowering correlated well with hatching dates of rock ptarmigan. As far as the data allowed an examination of the subject, I found no evidence that year-to-year variations in flowering dates were greater among early than among late species.

_____ 1969. Foods of rock and willow ptarmigan in central Alaska with comments on interspecific competition. The Auk 86:271-281.

A collection of 743 rock ptarmigan crops from all of the year and 663 willow ptarmigan crops from August through April was analyzed for oven-dry weight of food items.

Throughout Alaska, rock ptarmigan eat mainly buds and catkins of dwarf birch in winter (11 October to 9 May). In spring (10 May to 5 June) the transition to the varied early summer (6 June to 31 July) diet of leaves and flowers is fairly quick. The late summer (1-31 August) diet is characterized by decreased consumption of leaves and flowers and increased consumption of berries and seeds. Animal matter is taken opportunistically, but rarely in large amounts.

The fall period is essentially a long transition from the seeds and fruits of August to the monotonous diet of buds and catkins of winter.

The pattern among willow ptarmigan seems similar to that of rock ptarmigan from August to early spring in central Alaska. In coastal areas where there is little snow, willow ptarmigan eat a wider variety of foods in winter, but still feed heavily on buds and twigs of deciduous shrubs. Throughout Alaska the main winter food of willow ptarmigan is (Salix spp.) buds and twigs.

Given the demonstrated heavy dependence of the rock and willow ptarmigan on a very few types of winter food, quantitative or qualitative shortages in winter foods could have serious direct and indirect population effects. The short period of dietary transition in spring could be critical also, as heavy energy demands for molting and breeding occur at that time.

Interspecific competition may have a bearing on winter foods selected by rock, willow, and white-tailed ptarmigans in areas of sympatry. Bill shape seems to be an adaptive feature correlated with the winter food specializations observed, and behavioral specializations such as perching or scratching for food may be important too.

_____ and J.B. Theberge. 1972. The dynamics of a fluctuating population of rock ptarmigan in Alaska. Proceedings of XIV International Ornith. Congress Rotterdam. In press.

This study decribes demographic changes in a population of rock ptarmigan at Eagle Creek, Alaska, from 1960 to 1969. By "key factor analysis", we attempt to identify the main causes of changes in spring breeding numbers.

Spring numbers fluctuated, rising to 325 birds on the 15 square mile study area in 1962, falling for 3 years to 126 birds, rising for 3 years to 235 birds, and falling again in 1969. This fluctuation was the result of an orderly and generally synchronous change in loss of juveniles in winter, clutch sizes, and failures, all acting together in most years to either increase or decrease numbers. When changes in clutch sizes and nest failures are considered together, their combined effect was approximately equal to loss of birds in winter in their influence on subsequent spring numbers.

Variations in the survival of adults and yearlings in summer and winter, chicks in summer, and hatchability were considered less important to changes in subsequent spring numbers.

An assessment was made of direct extrinsic control of ptarmigan numbers by environmental variables. Evidence was found that weasel predation on nests played a small role in influencing changes in spring numbers. Changes in winter loss of juveniles were not due to food shortage or hunting. Superficial evidence suggested that weather and parasitism were also unimportant. Predation and food quality were not assessed. Changes in clutch sizes were apparently not influenced by spring weather.

Although not complete, the assessment of extrinsic control failed to identify a direct environmental source of the changes in winter loss of juveniles, or clutch sizes, or their synchrony. This suggests a more basic underlying cause of fluctuations in the quality of the stock. We conclude that population regulation must come about through yet undefined changes in the type of birds that make up successive populations.

_____ and A. Watson. 1967. Determining the age of rock ptarmigan in Alaska and Scotland. J. Wildl. Mgmt. 31:825-826.

Up to the age of 12-15 months, when young rock ptarmigan (Lagopus mutus) shed their first set of white primaries, they can be distinguished from older birds by primary coloration. On old birds the second outermost primary has the same amount or less dark pigment than the third outermost primary; younger birds have more pigment on the second outermost. The method was tested with 607 banded or dissected birds in Alaska and Scotland, and was about 98 percent accurate for all sex and age groups combined.

West, George C., R.B. Weeden, L. Irving, and L.J. Peyton. 1970. Geographic variation in body size and weight of willow ptarmigan. Arctic 23:240-253.

Multiple range test comparisons of wing, tail, and net body weight measurements of 2,600 willow ptarmigan (Lagopus lagopus) specimens collected in Alaska and adjacent Yukon Territory showed statistically significant differences among populations from different geographic areas but also indicated surprising uniformity within populations designated as recognizable subspecies.

Previous range distributions based on summer plumage colour and size of bill separated L. I. alascensis from L. I. albus at the Alaska-Yukon border. On the basis of our measurements, it is believed that the population of the larger L. I. alascensis extends eastward into Yukon Territory at least to Old Crow whereas the smaller L. I. albus extends westward into Alaska in the upper Tanana River Valley and south of the Alaska Range to the Susitna River. It is suggested that the present distribution of the various subspecies of willow ptarmigan in Alaska may be explained in part by their distribution at the time of Wisconsin glaciation and their subsequent dispersal.

White, C.M. and R.B. Weeden. 1966. Hunting methods of gyrfalcons and behavior of their prey (ptarmigan). The Condor 68:517-519.

Observational information is presented on: 1) how gyrfalcons look for prey; 2) how gyrfalcons pursue ptarmigan; 3) how ptarmigan try to escape detection; and 4) how ptarmigan attempt to escape when chased.

Theses

Modaferri, R. Ph.D. thesis University of Alaska dealing with the nutritive condition of pre-laying female rock ptarmigan as correlated to clutch size.

Expected to be completed in 1973.

Theberge, John B. 1971. Population fluctuation and changes in the quality of rock ptarmigan in Alaska. Unpubl. Ph.D. thesis, Dept. Zool., Univ. of British Columbia, Vancouver, 186 p.

The molt of primaries of adult male rock ptarmigan in central Alaska began in the period 5-20 June in 1961-65 and was completed 5-30 September. The molt began when territorial behavior was waning and when hens were incubating. Primaries were molted faster early in the molt period than later. A cold and snowy spring in 1964 delayed the molt and breeding schedule of rock ptarmigan by about 12 days in comparison with 1963.

Adult hens with chicks began molting 4-12 days after their chicks hatched, rarely earlier. Hatching peaks varied from 19 June to 1 July; molting began latest

in the year of latest hatchings. The molt proceeded faster among hens early in the molt period than later, as was the case among males. There was no close correlation between molt progress of hens and the age of their chicks.

Hens that lost nests began shedding primaries soon after the nests were destroyed. As a group, unproductive hens molted later than cocks but earlier than hens that nested successfully.

This study attempts to explain changes in abundance of rock ptarmigan (Lagopus mutus) at Eagle Creek, Alaska. It includes an analysis of population data collected from 1960 to 1969, and a test of an hypothesis: that there were no differences in the quality (survival, growth, behaviour) of rock ptarmigan chicks between years that influenced spring densities.

Spring densities fluctuated between 1960 and 1969, reaching peaks in 1962 and 1968. This was the result of an orderly and generally synchronous change in the loss of birds (primarily juveniles) in winter, accompanied by changes in the production of young. Both acted together in most years to either increase or decrease numbers. Each contributed approximately equally to changes in total annual loss. Changes in the production of young were primarily caused by parallel changes in both clutch sizes and nest failures.

Population regulation by direct extrinsic control appeared unlikely. Other than weasel predation on nests, no environmental factor external to the population itself appeared sufficient to explain changes in winter loss of juveniles or clutch size loss, or their synchrony.

These results suggested that some internal process within the population must have been important in changing the abundance of ptarmigan. I tested the aforementioned hypothesis in 1967, 1968, and 1969 by examining chicks both in the wild, and in captivity. Survival, growth, and behaviour of chicks all varied between years. Changes in survival were apparently determined by unidentified parental influences (genetic or physiological) rather than by the direct influence of the environment. Growth rates were similar between years in captivity, but not in the wild, suggesting that environmental influences must have had some effect. However, neither the changes in survival of chicks in summer, nor in growth rates, could be implicated in altering subsequent spring breeding densities.

Levels of agonistic and aggressive behaviour in successive cohorts of aviary chicks differed. In the similar environment of the aviary each year, these behavioural changes were attributed to undetermined parental influences (genetic or physiological). These changes in aggressive-agonistic behaviour offer the best possible explanation of changes in the population parameters most important in altering spring breeding densities.

Weeden, R.B. 1959. The ecology and distribution of ptarmigan in western North America. Unpubl. Ph.D. Thesis Univ. of British Columbia. Vancouver. 247 p.

The three purposes of this study were to summarize the important features of the habits and life history of ptarmigan (Lagopus lagopus, L. mutus and L. leucurus), to describe and compare some places in which each species breeds in western North America and to propose some factors which may influence the distribution of the three species.

Ptarmigan are herbivores which show little evidence of important specific differences in diet. All known populations of leucurus and many populations of lagopus and mutus are non migratory, although seasonal vertical movements may occur. However, some northern populations of the latter two species show annual migratory movements presumably based on food scarcity. Male ptarmigan defend areas of ground in the breeding season. Ptarmigan are monogamous and produce only one brood each year. The onset of egg-laying seems to coincide with the initial disappearance of snow from potential nesting sites.

In spring each species selects areas in which to breed. Where three species are present on the same mountain, the ranges of lagopus, mutus and leucurus are progressively further above timberline. The segregation seems to be based primarily on features of vegetation form and terrain. Estimates of height and coverage were used to describe vegetation in places used by ptarmigan. L. lagopus established territories and nested where clusters of shrubs from 3-6 feet in height alternated with openings where plants were less than 1 foot tall (or, if taller, very sparse); the vegetation was relatively luxuriant, with a wide variety of species. L. mutus occupied a zone of tundra similar in vegetation structure but with lower shrubs and a

greater proportion of herbaceous vegetation. L. leucurus showed a preference for shrubless alpine areas where plants rarely exceeded 1 foot in height, and where ledges, boulder fields and coarse screes provided crevices for shelter.

The available evidence suggests that psychologic factors may control habitat selection. It is proposed that each ptarmigan responds to a set of visual cues which is peculiar to that species. As a result, the range boundaries of a particular population may be set by the occurrence of the features of the environment which are important visual cues. Through such habitat selection, each species of ptarmigan may choose automatically the environment to which it is best adapted.

Popular Publications

Weeden, R.B. Date unknown. The ptarmigan in Alaska. Alaska Dept. Fish and Game Wildlife Series, Birds: No. 1.

A brief presentation of life history, foods, population fluctuations, and hunting of Alaskan rock, willow, and white-tailed ptarmigan.

_____ 1969. Effects of hunting on rock ptarmigan along the Steese Highway. Unpubl. rept. to Alaska Dept. Fish and Game.

In 1927 the Steese Highway connected Fairbanks with Circle City, opening up several pieces of alpine country to hunters. The popularity of these areas reached a peak about 1950. Since Department studies began in 1959, ptarmigan country has been relatively uncrowded with hunters, although rumors of good caribou hunting have occasionally and temporarily increased bird-hunting pressure. Fall hunting has begun August 10 or 20 in the last decade, and has been brought to an early close by official highway closures or drifting snow in October. Only twice- in 1968 and 1969 - did the Highway open up in spring early enough to allow hunters to travel to Eagle Summit before the season closed April 30.

At least half of the ptarmigan shot are taken on weekends. Half of the hunters come up the Highway with plans to hunt birds, although the best way to identify a ptarmigan hunter is by looking in his game bag. Most hunters walk only a short distance to get ptarmigan, which means that a bird summering within one-half of the Steese Highway is about twice

as likely to be shot as one living farther back. Few snowmobiles are in use in the Eagle Summit area.

Most years about 400 to 1000 rock ptarmigan are shot along the upper Steese Highway, or about 14 to 36 birds per square mile of accessible habitat. Successful parties of hunters (mean of two hunters per party) get from 4 to 11 ptarmigan per trip. Very few people - about 5 percent in 1968 - shoot a bag limit of 20 ptarmigan per day. Ptarmigan are shot in nearly the same sex and age proportion in which they occur in the population, although an unconscious selection of adult males occurs. Most of the ptarmigan that hunters shoot in fall are transients, having moved three miles or more before getting close to the Steese Highway. In 1968 only 23 percent of the ptarmigan harvested up to October 13 had lived, that summer, within three miles of the road. Up to 50 percent of the birds shot in August are local residents, however.

Upwards of 20 percent of the old cocks living at Eagle Creek are shot each fall, although one year (1966) at least half were shot. Hunting pressure on adult hens and local chicks is lighter, averaging 6 percent. Analyses of spring distribution and densities of breeding pairs suggested that this hunting pressure has had little effect on subsequent breeding numbers, but that the removal of old males (and their replacement by surplus yearlings) often skews the age distribution among males. Only in two years, 1968 and 1969, did we have evidence that hunting reduced breeding densities along the road. This was probably due to spring hunting (April and May) rather than fall hunting.

By comparing spring populations in an unhunted area with those in an area from which 40 percent of the fall population was shot in 1967 and 1968, we learned that spring breeding stocks were unaffected by hunting pressure of that magnitude.

A variety of techniques are available to the game manager to manipulate harvest or maintain the quality of recreation derived from ptarmigan hunting at Eagle Summit. These are discussed in the text.

_____, and L. Ellison. 1968. Upland game birds of forest and tundra. Alaska Dept. Fish and Game Booklet Series No. 3. 44p.

A discussion of distribution, habitat, life history, food habits, and methods for determining age and sex of Alaskan rock ptarmigan, willow ptarmigan, white-

tailed ptarmigan, ruffed grouse, spruce grouse, sharp-tailed grouse, and blue grouse.

Federal Aid to Wildlife Restoration Progress Reports (listed chronologically).

Weeden R.B. (Printing date unknown). Population characteristics of rock and willow ptarmigan. (Vol I) Project W-6-R-1. Work Plan I. Job 2. Rept. I-2. p. 393-416. Covers July 20, 1959 - June 30, 1960.

The basic objectives of this study are to describe the rise and fall in numbers of ptarmigan within one year on a selected study area, to record any year-to-year changes in numbers and to determine from those data the harvestable portion of the fall population. Data obtained in 1959 show that the late summer and early fall proportion of immature birds to adult hens was about 7.5:1. An effort was made to discover a reliable indicator of age in rock ptarmigan after December, without success. Neither the "pointed primary" nor "speckled primary" methods, as described by others, appear satisfactory for the ptarmigan studied. Some information obtained in the study indicates that flock formation occurs early in September, and that extensive movements from one area to another may take place in September and October. The reproductive cycle probably begins in March, with testis enlargement and behavioral changes becoming evident early in April. Some data on weights of ptarmigan are given.

_____ (Printing date unknown). Population characteristics of rock and willow ptarmigan. Vol. 2. Project W-6-R-2. Work Plan I. Job 2. Rept I-2. p. 22-49. Covers July 1, 1960 - June 30, 1961.

Ptarmigan were slightly more numerous in Alaska in 1960 than in 1959, as shown by replies to letters mailed to 160 people throughout the State. Most of the 105 respondents thought that ptarmigan populations were at moderate levels. On the Eagle Creek study area in central Alaska, 88 male and 75 female rock ptarmigan (Lagopus mutus) were present in May. Twelve nests containing 98 eggs were found. The 75 pairs of rock ptarmigan produced about 325 chicks that survived into August (5.4 chicks per brood). Marked broods traveled variable distances, but usually did not exceed one-half mile of net movement from June to August. Eleven willow ptarmigan (Lagopus lagopus) and 158 rock

ptarmigan were banded, representing (of the latter species) about half of the adult females, 25-30 percent of the cocks and 15-20 percent of the young on the study area. Six band returns were obtained from the Eagle Summit area in August and September, 1960. In October, both species began to appear in non-breeding habitats in the Tanana Valley, remaining there in moderate numbers until early March.

_____ 1963. Population characteristics of rock and willow ptarmigan. Vol. III. Project p. 21-61 W-6-R-3. Work Plan I. Job 2. Covers July 1, 1961 - June 30, 1962.

Ptarmigan populations, as assessed by recipients of the statewide game-bird questionnaire, were slightly higher than in 1960, especially in northern and western sections of the state. At Eagle Creek in central Alaska, breeding populations of rock ptarmigan rose to 269 birds in 1961, an increase of 65 percent over 1960. Although the average clutch contained one less egg than in 1960, survival of young was better in 1961; the total population in August was 813-894 birds, or about three times as many as in May. Investigators captured 258 rock ptarmigan on the study area, including 28 birds banded in 1960 and 118 chicks. Analysis of band returns and other data suggest that adult cocks, young males and young females take part in a dispersal from the study area some time between September and May. Most of the young females that lived until the spring of 1961 moved off the study area and bred elsewhere. The survival rate among adult hens was about 70 percent, and nearly all surviving birds returned to breed a second time at Eagle Creek. The overall survival rate of males from August 1960 to May 1961 was 40 percent; the survival of females in a comparable period was 57 percent. Ptarmigan again appeared in low-altitude, non-breeding areas in October. Most of the birds (90 percent of the willow and rock ptarmigan collected) taking part in this movement were females.

_____ 1963. Upland game bird investigations. Vol. IV. p. 1-20. Covers July 1, 1962 - April 1, 1963.

Recipients of a questionnaire on game bird abundance were of the opinion that grouse were scarce throughout Alaska in 1962; ptarmigan were thought to be at moderate levels and slightly more numerous than in 1961. Increases in numbers of breeding pairs or broods of ptarmigan were noted during censuses of three small areas of Interior Alaska. Populations were apparently stabilized at high

levels at Chilkat Pass and on one Alaskan study area. Limited counts of sharp-tailed grouse along roads in May revealed little change in abundance from low densities in 1961. Only about 50-60 percent of 150 female rock ptarmigan nesting at Eagle Creek brought off broods. The average clutch contained 7.0 eggs; broods averaged 6.4 chicks at hatching and 5.5 chicks at the end of the first month. Mortality of ptarmigan on the study area was estimated at 60-65 percent from August 1961 to August 1962. Banding efforts yielded 68 adult male rock ptarmigan, 95 adult females and 141 young, all from the study area. Studies from October to May revealed that sex-segregation occurs in the fall, with male ptarmigan tending to stay near alpine habitats all winter while females move to forested areas at lower elevations. Hens did not return to Eagle Creek until late in March and early in April 1962.

_____ 1965. Grouse and ptarmigan in Alaska, their ecology and management. Vol. V. Project W-6-R-5. Work Plan I. Comprehensive report covering investigations completed by December 1, 1963. 110 p.

Knowledge about ptarmigan accumulated as of December 1963 is summarized. Discussions of current research, field techniques, distributions, life history, food habits, numbers of upland birds, patterns of utilization, hunting, and habitat considerations are presented.

_____ 1965. Game Bird Report. Vol. VI. Project W-6-5,6. Work Plan I. Job 1,2. p. 1-11. Covers January 1, 1964 - December 31, 1964.

A survey by mail of 302 Alaskans with an interest in game birds suggested that population levels of grouse and ptarmigan were lower throughout the State than in 1963, although moderate to high numbers of ptarmigan were reported from the Alaska Peninsula and the western coastal areas. Grouse were particularly scarce in the Interior. Counts on small areas showed similar trends, with declining breeding populations of ptarmigan at Eagle Creek and Chilkat Pass, low numbers of broods on three Interior check areas, and record low counts of sharp-tailed grouse in the Tok area.

Breeding began at Eagle Creek at the latest date in the 5-year study, with the hatching peak 7 to 11 days later than previously. Clutch sizes were low (6.6 av.). Predators destroyed nearly half of the nests started. Summer gain (2.2 birds alive August 1 for every bird alive June 1) was relatively low. Most breeding birds in 1964 were 2 or 3 years old, indicating poor breeding success in 1963 and high winter losses of young in 1963-64. Hunters reported 22 bands in 1964, probably representing

a kill of about 90 ptarmigan.

_____ 1966. Game Bird Report. Vol. XII. Projects W-6-R-6. Work Plan I and W-13-R-1 Work Plan B. Job 1,2 p. 1-12. Covers January 1, 1965 - December 31, 1965.

According to a questionnaire mailed to 301 cooperating Alaskans, grouse and ptarmigan continued at low levels of abundance (actually decreasing in some areas) throughout the State. Counts of ptarmigan and sharp-tailed grouse on selected, small areas also showed low population levels relative to recent years. At the Eagle Creek study area, rock ptarmigan breeding for the second or third time outnumbered yearlings by 2:1 for males, 3:1 for females. Nesting success was high (about 80 percent) and mortality of chicks from hatching to six weeks of age was low (12 percent). Just over three birds were present on the relatively high recruitment rate. Data were gathered from this population on live weights in summer, molt of primaries among adults, and rate of incidence of blood parasites.

_____ 1967. Game Bird Report. Vol. VIII. Project W-13-R-1 and 2, Work Plan B. Job 1 and 2 (both segments) 4 (last half of 13-R-1) p. 1-25. Covers January 1, 1966 - December 31, 1966.

Grouse and ptarmigan remained at low levels of abundance in 1966, but signs of increases among ruffed and spruce grouse in interior Alaska, and of ptarmigan in northern Alaska, were noted by respondents to the annual questionnaire. Snowshoe hares were scarce throughout the state, but with local increases recorded. Counts on small areas in interior Alaska showed low but increasing populations of rock ptarmigan, willow ptarmigan, and sharp-tailed grouse. At Eagle Creek yearlings dominated the breeding population for the first time since 1963. Clutch size was high (9.0 eggs) and predation losses moderate (25 percent). About 33 percent of the chicks died in the first 6 weeks after hatching. Fall populations were better than in the previous years, and hunters were quite successful. Analysis of band returns suggested that 47 percent of adult males banded in 1966, 15 percent of adult females, and 9 percent of chicks caught in 1966 were shot by hunters from August 20 to October 20. Other data gathered in 1966 included live weights of adult rock ptarmigan at Eagle Creek, nutrient analysis of foods taken by ptarmigan in winter, and occurrence of grit in ptarmigan gizzards.

_____ 1968. Game Bird Report. Vol. IX. Project W-13-R-2 and 3. Work Plan B. Job 1,2,6,7, and 8. p. 1-22. Covers January 1, 1967-December 31, 1967.

The annual small game questionnnaire suggested that most species of grouse and ptarmigan were stable at low to moderate levels, or rising from previous low population levels. Hares were thought to be low throughout the state, with some indication of local increases in the Interior. Counts on small areas suggested ptarmigan in the spring of 1967, lower fall populations of spruce grouse along the Steese Highway, sparse but increasing numbers of this species on the Taylor Highway, and stable populations of spruce grouse on the Kenai study area. Yearlings were twice as numerous among males, on the rock ptarmigan among hens, and four times as numerous as older ptarmigan among hens, and four times as numerous among males, on the rock ptarmigan study area in spring. Clutch sizes were as high as in 1966, predation on nests was relatively low, and chick survival to August was relatively poor. The combination of these factors resulted in production equalling 1966 rates per breeding adult. Banding and checking station data indicated a harvest of 17 percent of resident adult males, 6 percent of resident hens, and 9 percent of locally-reared chicks.

Forty percent of the rock ptarmigan on a five-square-mile area near Eagle Creek were shot in autumn, initiating a study of the effects of that level of exploitation on ptarmigan numbers. The Department cooperated closely with the University of British Columbia and University of Alaska in a study of the growth and behavior of young rock ptarmigan at Eagle Creek.

Courtright, A.M. 1968. Game Harvest in Alaska. Special Alaska Department Fish and Game Rept. 70 p. Ptarmigan harvest data p. 16 and 41.

A general summary of ptarmigan harvest between 1926 and 1965 obtained from numerous sources.

Weeden, R.B. 1969. Game Bird Report. Vol. X. Project W-13-R-3 and W-17-1 Work Plan B. Job 1. Abundance and distribution of upland game. Covers January 1, 1968 - December 31, 1968. 5 p.

The Eagle Creek study area as a whole contained seven percent more cocks in 1968 than 1967. Adjacent areas showed increases of 55 to 75 percent. The dampening of the population increase at Eagle Creek probably was due to hunting, especially in spring (April, May). There were about 1.35 yearling hens for every older female in the population, a slight decline in proportion of first-year birds from 1967. Of 51 males caught in 1968, only seven were two years old or older. This reflects the removal of old cocks by hunters in fall and spring, and their replacement by young birds.

Clutch sizes dropped sharply from 8.9 per nest in 1967 to 7.4 per nest in 1968. Nests hatched moderately late in 1968, the peak coming about June 23. Six of the 19 nests found on the study area were lost to predators, and hatchability in successful nests was relatively low (86 percent). The mean total loss of chicks was 26 percent from hatching to early August. August stocks were 2.5 times as high as breeding stocks. About 50 percent of the adult hens alive in August 1967 survived to June 1968, but only 15 percent of the adult cocks survived the same period.

Hunters shot about 27 percent of the resident adult cocks in 1968, 16 percent of the adult females, and 7 percent of resident chicks.

_____ 1969. Game Bird Report. Vol. X. Project W-13-R-3 and W-17-1. Work Plan B. Job 2. Population characteristics of ptarmigan. Covers January 1, 1968 - December 31, 1968. 16 p.

Hatchability of eggs was higher in the aviary (93 percent) than in the wild (86 percent) in 1968. Survival was also better in the aviary (84 percent to the end of August) than in the field (74 percent to early August). Chicks in the aviary appeared more aggressive this year than last. No strong differences in growth were noticed this season in comparison with 1967 either in the aviary or on the Eagle Summit study area.

_____ 1969. Game Bird Report. Vol. X. Project W-13-R-3 and W-17-1 Study Plan B. Job 8. Exploitability of small game populations. Covers January 1, 1968 - December 31, 1968. 3 p.

Between May 1967 and May 1968 spring breeding stocks rose 58 percent on the Golddust Creek unhunted area and 74 percent on the Ptarmigan Creek area, from which 136 ptarmigan had been removed in the fall of 1967. Two hundred ptarmigan, or about 40 percent of the calculated August population, were shot or trapped from the same experimental area in August and September 1968.

_____ 1970. Game Bird Report. Vol. XI. Project W-17-1 and W-17-2. Work Plan B and R Job B-2 and R-10.1. Population characteristics of ptarmigan. Covers January 1, 1969 - December 31, 1969. 16 p.

The Eagle Creek study area had 113 territorial males in 1969, a slight decline from 1968. Spring hunting occurred in 1969 which may have lowered the count, however, this depressing effect was not as great as that projected for 1968. An early spring snow melt got the breeding season underway at least one week earlier than most years, but an extremely cold, windy period in late May froze eggs in some nests. Consequently, renesting was rather common, and known hatching dates ranged from June 1 to July 1 (average June 17). Clutch size of 22 nests located on or near the study area averaged 6.4 eggs. Nest predation in 1969 was 29 percent, and hatchability of eggs in successful nests was 85 percent. An average of 5.3 chicks hatched from each successful nest, and by mid August chicks had sustained a 26 percent loss. Overall summer gain was 2.1, slightly lower than in 1968.

Adult to yearling ratios of trapped birds were 1.0:1.0 for females, and 1.6:1.0 for males. Over-winter mortality (fall of 1968 to spring 1969) was 55 and 39 percent for adult males and females, respectively. Estimated chick mortality (August 1968 - May 1969) was 57 percent for males and 66 percent for females. No checking station was operated in 1969, however, 49 bands were returned voluntarily by hunters. These returns indicate 31 percent of the adult males, 8 percent of the adult females, and 22 percent of the summer's chicks were shot. This is a 26 percent harvest of the estimated fall population at Eagle Creek.

_____ 1970. Game Bird Report. Vol. XI. Project W-17-1 and W-17-2. Work Plan B and R. Job. B-8 and R-10.3. Effects of controlled hunting on rock ptarmigan. Covers January 1, 1969 and December 31, 1969. 3 p.

The spring count of 81 territorial males on the control (Golddust) area indicated a 15 percent decline from the spring of 1968. Counts on the removal (Ptarmigan Creek) area revealed 98 males; this is little change from 1968. For the third consecutive fall, 40 percent of the estimated fall population of rock ptarmigan was shot on the 5 square-mile Ptarmigan Creek area. Shooters shot every bird they could, regardless of age or sex, simulating the non-selective shooting by sportsmen. A total of 187 birds were shot; 32 were adult males, 47 were adult females, and 108 were chicks. At present it appears that 40 percent removal of fall population has no influence on subsequent spring breeding stocks. The counts planned for the spring of 1970 will complete this three-year study.

McGowan, J.D. 1970. Report of Survey and Inventory Activities Part III waterfowl and small game Project W-17-2 Job no. 10 and 11. pp. 32-34. Covers 1969.

Findings of 1969 spring counts of rock ptarmigan at Eagle, Ptarmigan, and Golddust Creeks are summarized. A statewide summary of 1969 small game questionnaire responses is also presented for all upland game birds.

_____ 1971. Game Bird Report. Project W-17-2 and W-17-3. Job 10.1R. Population characteristics of rock ptarmigan. Covers January 1, 1970-December 31, 1970. 8 p.

Breeding density of male rock ptarmigan at Eagle Creek in 1970 (102) was slightly lower than in 1969 (113), and considerably lower than in 1968 (120). The Steese Highway was opened very early in 1970, and first flowering dates of alpine plants indicated an early spring. Males were on territories in mid-May, and subsequent cool weather did not seem to alter breeding or nesting activities.

Based on a small sample of females, the juvenile to adult ratio was 1.2:1.0; the true age ratio was probably lower than indicated. Average clutch size of thirteen nests at Eagle Creek was 7.2, an increase over 1969. The average hatching date of June 21 was normal for most years, while nest predation (33 percent) was higher than 1969 (29 percent). Hatchability was 93 percent, an increase over 1969.

Average brood size in early August was 5.2, indicating at least 22 percent chick mortality between hatching and start of hunting season. Summer gain (2.4) was low, but showed a slight increase over 1969. Early completion

of brood counts possibly resulted in a higher summer gain value than was actually the case. Little trapping was done in 1970 so overwinter mortality rates for age-sex groups could not be computed, but overwinter (1969-70) mortality for all age-sex groups was 56 percent. No checking station was operated; consequently very few band returns were received, and hunting pressure was not assessed. The parameters of clutch size, age ratio, and summer gain suggest that rock ptarmigan densities at Eagle Creek will continue to decrease in 1971.

_____ 1971. Effects of controlled hunting on rock ptarmigan. Final report Project W-13-R, W-17-1, W-17-2, W-17-3. Job 10.3R and B-7. 6 p.

An experiment was designed to test the effects of fall hunting of rock ptarmigan on subsequent spring densities. Two areas representing typical interior Alaska rock ptarmigan breeding range, where no hunting occurs, were selected.

A census of territorial males was made on both areas in May of 1967-70. On one area 40 percent of the estimated fall population was shot in the falls of 1967-69. After the first removal spring densities of males rose 42 percent on the removal area, but only 37 percent on the control area. After the second removal spring densities rose 1 percent, but decreased 15 percent on the control area. After the last removal breeding densities dropped only 4 percent on the removal areas and showed no change on the control area. Fall hunting at the 40 percent level for three consecutive years does not seem to depress spring breeding density. Data from the nearby Eagle Creek area where public hunting occurs also substantiate this finding. Spring hunting may have very different effects on breeding stocks than fall hunting.

_____ 1971. Report of survey and inventory activities. Part III-waterfowl and small game. Vol. 11. Project W-17-3. Job 10 and 11. p. 53 - 56. Covers 1970.

Findings of 1970 spring counts of rock ptarmigan at Eagle, Ptarmigan, and Golddust Creeks are summarized. A statewide summary of 1970 small game questionnaire responses is also presented for all upland game birds.