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GAME BIRD REPORT

By

Jerry D. McGowan

Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-3, Jobs 10.5R and 10.6R (2nd half) and
Project W-17-4, Jobs 10.5R and 10.6R (1st half)

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Jerry D. McGowan

Project No.: W-17-3 W-17-4 Project Title: Small Game Investigations

Job No.: 10.5R Job Title: Effects of Controlled, Spring Hunting on Rock Ptarmigan

Period Covered: January 1, 1971 - December 31, 1971

SUMMARY

An experiment was designed to test the effects of spring hunting of rock ptarmigan. Two study areas representing typical interior Alaska rock ptarmigan breeding range, where no hunting occurs, were selected. Censuses of territorial males were made on both areas in mid-May. On the experimental area, 43 percent of the estimated spring population was shot. A count 7 days later showed the number of territorial males to be 43 percent below the original level, suggesting that little or no replacement of vacated territories occurred. Comparison of territories plotted during pre- and post-removal counts further suggests that little replacement occurred. After a 1-week interval a second count on the control area revealed a 17 percent decrease in number of territorial males. Avian predation probably accounted for the major portion of this decrease. The first year's findings of the 3-year study suggest that, in years of low density, replacement of territorial males removed from the population during spring does not occur to a great extent.

CONTENTS

BACKGROUND

Rock ptarmigan (Lagopus mutus) are heavily hunted in certain portions of interior Alaska during fall and spring. Fall checking station operations at Eagle Creek (Mile 101 Steese Highway) in past years have yielded useful information on hunting pressure, hunting success, number of birds taken, and age-sex composition of the harvest. Ptarmigan hunting at Eagle Creek currently results in annual harvests of 5 to 20 percent of the fall population (Weeden, 1969a). In the same area, recently completed studies indicate that repeated shooting of 40 percent of the fall population of rock ptarmigan does not depress subsequent spring breeding stocks (McGowan, 1971).

It appears that annual fall harvests in most popular ptarmigan hunting areas in the Interior have little effect on yearly population fluctuations; however, little is known concerning the impact of spring hunting on breeding stocks. A single experiment in 1966 suggested that territorial males shot in May are replaced by other males within 12 days after removal (Weeden, 1967, p. 6). This experiment was conducted at a time when the population was increasing in number, and results may have been quite different had removals occurred during a population decline. Further work at Eagle Creek suggests that spring hunting along the Steese Highway may greatly reduce breeding densities (Weeden, 1969b, p. 3).

Territoriality of male rock ptarmigan normally starts in late March or early April, and by late April territories are well established. Currently, the hunting season is open until April 30; hence, hunting actually occurs to some extent during the breeding season. Now that major highways are being opened early in the spring, certain ptarmigan breeding grounds will receive a significant increase in spring hunting pressure.

This is a report of the first year's findings of a 3-year study designed to test the effects of spring hunting on breeding densities of rock ptarmigan.

OBJECTIVES

To determine the effects of repeated shooting of 40 percent of the spring population of rock ptarmigan on subsequent fall and spring population levels.

PROCEDURES

Two study areas, an experimental removal area (Ptarmigan Creek) and a control area (Golddust Creek), were selected which represent typical interior Alaska rock ptarmigan breeding range. Both areas are about 100 miles northeast of Fairbanks in the Tanana Hills near Eagle Creek, where intensive productivity studies of rock ptarmigan have been conducted since 1959. The experimental areas are essentially the same physically and vegetatively as the Eagle Creek area described by Weeden (1968). Both the Ptarmigan Creek area (approximately 2.9 square miles) and Golddust Creek area (approximately 2.3 square miles) are situated about 6 miles from the Steese Highway and normally receive no ptarmigan hunting from the public.

On May 19, 1971 a direct count of territorial males was conducted at Ptarmigan Creek, and approximatley 40 percent of the total population (males plus females) removed. Although counting and shooting activities were completed during the same day, removals were spaced more or less uniformly over the entire study area. Territories of all males observed were plotted on a map for future comparisons. The number of birds to be removed was based on the estimated total population computed from direct count data for males plus an assumed equal number of females. Removal activities were conducted in a manner which simulated hunting as it would occur by sportsmen. In most cases males were spotted before females, and when a male was to be removed it would be approached and shot using a .22 caliber rifle. If, in this process, females were observed, they were also taken. In this manner approximately 40 percent of the estimated population was removed; however, no specific attempt was made to take 40 percent of each sex. Blood smears were made from each bird collected for future parasite studies. A direct count of territorial males was made at Golddust Creek (control area) on May 21, 1971 and territory locations plotted. In order to determine numerical effects of the experimental hunting on the breeding population, counts were again made and territories plotted at Ptarmigan and Golddust creeks on May 26 and 28, respectively. All counts were conducted as described by Weeden (1961, p. 24) and are considered to be at least 95 percent accurate for determining the actual number of territorial males on a given area.

FINDINGS

Removals

Twenty-eight males were observed at Ptarmigan Creek during the first census. Assuming an equal sex ratio the total population was estimated at 56; consequently, 22 birds should have been shot in order to remove 40 percent of the estimated population. However, a total of 24 ptarmigan were removed which is about 43 percent of the estimated spring population. The age-sex composition of the birds shot is shown in Table 1. Based on spring counts, the spring density of rock ptarmigan was significantly lower in 1971 than in 1970 and this fact is also reflected in low proportion of yearlings to adults (0.6:1.0) of the birds shot. Whether one or both members of a mated pair are removed may have a bearing on the probability of replacement in a breeding territory. With respect to mated pairs the birds shot fall into the following categories: 8 pairs, 4 single males (no female observed in territory), 1 single female (no male observed), and 1 male with two females.

Pre- and Post-Removal Counts

Results of counts of territorial males conducted before and after removal are shown in Table 2. Both study areas showed a decrease in number of males between pre-and post-removal counts. At Ptarmigan Creek, where 43 percent of the estimated population, including 46 percent of the actual breeding male population, was shot, a count 7 days later showed that the number of males was still 43 percent below the original level. At Golddust Creek where no shooting occurred, the male population decreased 17 percent during the time between counts.

It appears that little or no replacement of cocks removed at Ptarmigan Creek had occurred 7 days after shooting. The territorial urge among males was high during this time, and the week interval between counts should have been ample to allow new birds to become established in vacated areas had replacement birds been present. When locations of territories noted in both counts at Ptarmigan Creek were compared in view of removal locations, the fact that little or no replacement occurred was further substantiated. The reason for the 17 percent decrease in males on the control area cannot be definitely explained. The second count at Golddust Creek was started about 1.5 hours later than the first, and some males could have gone undetected because of decreased intensity of courtship displays later in the morning. It is not likely that this alone could account for the 17 percent decrease. No assessment of predation during the spring was made for either area, but gyrfalcons (Falco rusticolus) and golden eagles (Aquila chrysaetos) have commonly been observed at Golddust Creek since 1968. These species have been observed only rarely at Ptarmigan Creek. Two golden eagle nesting sites are located in the general vicinity of the Golddust area, and it is suspected that at least one pair of gyrfalcons nests nearby. Three pairs of raptors efficient at taking ptarmigan could definitely account for a 17 percent reduction in breeding males on the small study area.

Table 1. Age and sex of rock ptarmigan removed from Ptarmigan Creek area, May 1971.*

	Adult	Yearlings	Total
Males	10	3	13
Females	5	6	11
Total	15	9	24

* Age determined as described by Weeden, 1961. Sex determined by external plumage characteristics.

Table 2. Number of territorial males observed at Ptarmigan Creek (removal area) and Golddust Creek (control area), May 1971.

	Pre-Removal Count	Post-Removal Count	Percent Decrease
Ptarmigan Creek	28	16	43
Golddust Creek	35	29	17

DISCUSSION

Additional work will be required to fully assess the effect of spring hunting on rock ptarmigan population density. Removals may have to be done both during years of high and low density in order to determine if surplus (nonterritorial) males exist within the population in all years or just during population highs.

The concept of surplus males within a population of red grouse (Lagopus lagopus scoticus) is discussed by Jenkins et al. (1967), but no mention is made concerning their role in replacing territorial males which die during the courtship period. Weeden (1967) concluded, after a spring removal experiment, that non-territorial males existed in the population and were physiologically and behaviorally ready to occupy territories upon removal of the established cock; however, the significance of surplus males in the population is not clear since breeding male rock ptarmigan frequently mate with more than one female.

Due to their white plumage and noisy courtship displays, spring hunting would result in more males than females being taken by sportsmen during this season; however, some hens would be taken during a spring hunt. It is assumed that all females breed and attempt to nest, so any shooting of this sex would depress subsequent fall densities. The effect on productivity resulting from spring removal of males is more difficult to assess. If copulation had occurred before the male was removed, nesting activities would probably proceed normally. If copulation had not occurred by the time of removal, successful nesting could result only: 1) if the female moved and paired with another male, or 2) if another male moved into the vacated territory and mated with the female. Nothing is known concerning the time of copulation or activities of females upon death of their mates; consequently, noting replacement by males is the best method available for determining the effect of spring hunting on potential productivity. Based on findings in 1971, it appears that little such replacement occurs after spring shooting during years of low density. Removals planned for the springs of 1972 and 1973 should give further insight into the effects of spring hunting.

ACKNOWLEDGMENTS

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Jerry D. McGowan

Project No.: W-17-3 W-17-4 Project Title: Small Game Investigations

Job No.: 10.6R Job Title: Distribution, Density, and Productivity trends of Goshawks in Interior Alaska

Period Covered: January 1, 1971 to December 31, 1971

SUMMARY

Aerial surveys using a Supercub proved effective in locating active goshawk nests. Nine active nests were located in an area of 169.5 square miles in interior Alaska. Ninty percent of the nests were in birch or aspen trees, and physical characteristics of the nest and nest sites are presented. Eleven active nests were monitored throughout the summer, and the following information obtained: 1) egg laying was completed by May 5; 2) incubation time was about 29 days with hatching occurring between May 30 to June 5; 3) chicks spent about 37 days in the nest and fledged between July 5 and 28. The average clutch size was 3.1, and of 11 nests started, 9 were successful. In successful nests, egg hatching success was 96 percent and all young hatched survived to fledging age. Thirty-six percent of the nesting females had juvenile plumage, while all males observed at nest sites were in adult plumage. A general description of growth and development of chicks is presented. Between August and November 486 trap days yielded one capture per 8.2 trap days. Trapping success was highest in September and lowest in November. The sex ratio of 56 captures was 50:50 for all age groups combined, while the juvenile to adult ratio was 4.2:1, reflecting high summer productivity and relatively high mobility of juveniles. The average movements from banding to recovery sites were greater for juveniles (13.1 miles) than adults (3.2 miles). All nesting goshawks were molting primaries, and observations of trapped hawks indicate this molt is not complete until late fall. Comparisons of various measurements suggest that males are significantly smaller than females and that the length of first, fourth or fifth primary, or the central rectrix may be good sex indicators. The main food item during the summer of 1971 was snowshoe hares; however, red squirrels were taken to some extent.

CONTENTS

BACKGROUND

The goshawk (Accipiter gentilis) is an important predator throughout the year in wooded regions of Alaska. Goshawks are known to prey on snowshoe hares (Lepus americanus) and upland game birds in Alaska, and studies from Finland indicate that grouse are preferred for food by goshawks even when other birds are available (Sulkova, 1964). Presently there is serious concern for many raptors because of decreased productivity resulting from contamination by chlorinated hydrocarbons, and declines of peregrine falcons (Falco peregrinus) have been discussed by Hickey, (1969), Cade et al. (1968), and others. Because goshawks, as well as gyrfalcons (Falco rusticolus), are permanent residents of Alaska, pesticide contaminations are probably not reducing productivity of these species to the extent recorded for migratory raptors. Goshawks have long been recognized as excellent birds for falconry, and the demand for raptors to be used for this purpose is increasing. In view of the recent decrease in productivity of peregrine falcons and other birds of prey, goshawks and gyrfalcons may be the only species we are justified in using to satisfy this increasing demand. We have good general knowledge of gyrfalcon populations on the Seward Peninsula (Roseneau 1969, 1970, and 1971); however, little information on Alaskan goshawks has been reported. A literature review revealed few references to this species from elsewhere in North America, and no information concerning population densities or productivity was found. Initial studies on Alaskan goshawks were reported by McGowan (1971). This report summarizes findings of goshawk studies conducted during 1971.

OBJECTIVES

To develop techniques for determining distribution and productivity of goshawks in interior Alaska.

PROCEDURES

Nest Surveys

Aerial nest surveys of most birch (Betula papyrifera) and aspen (Populus tremuloides) stands within approximately 20 miles of Fairbanks were conducted using a Supercub during late April and early May 1971. This amounted to about 11 hours of actual survey time. Particular attention was given to hardwood stands which generally occur on south and west facing slopes north of Fairbanks. Little survey time was spent in coniferous stands on north and east facing slopes and on the Tanana River flats (south of Fairbanks). Consequently, spring nesting surveys were not conducted at random, but were based on geographic and vegetative conditions, and certain inherent biases must be considered when preferred habitat and nesting densities are discussed.

Stick nests are easily observed from the air in the spring when snow is on the ground but before the trees develop leaves, and in several cases goshawks were identified as they sat on the nest. As soon as possible after aerial surveys, all nests located were visited on the ground to confirm activity. This aerial survey technique proved to be very useful in locating nests and resulted in location of seven active goshawk nests and one of a great horned owl (Bubo virginianus).

Nests located long distances from the nearest road and situated in homogeneous stands were difficult to locate from the ground, and in these cases a Supercub was used successfully to direct ground observers to the nest site. While attempts were made to locate all active goshawk nests in the area surveyed, it is probable that active nests were overlooked; however, it is not known to what extent this occurred.

Nesting Studies

Once active nests were located, visits were scheduled in order to determine the following: laying dates, clutch size, incubation time, hatching dates, hatching success, period of time spent in nest by chicks, fledging date, and fledging success. In most cases about eight visits were necessary in order to obtain this information, and during visits to the nests, attempts were made to minimize disturbance. Pole climbing irons and a lineman's belt were used for climbing, and whenever possible a tree other than the actual nest tree was selected for climbing when making observations. At each nest site the following physical and biological data were collected: nest size, height of nest above ground, position of nest in tree, position of nest tree on slope, aspect of slope, altitude, presence of other stick nests nearby, species of nest tree, and general description of stand in which nest is located. Note was also made concerning plumage (including wing and tail molt) and behavior of adults.

Trapping and Banding

During the period of late August through November, seven Swedish goshawk traps baited with three or more feral pigeons (Columbia liva) were operated. The traps are similar to those described by Beebe and Webster (1964, p. 301) and Meng (1971). The general area covered (Fairbanks vicinity) in fall trapping operations coincides with that where summer nesting studies were conducted. Areas near deciduous woodlands and having an abundance of large openings in the forest cover were selected as trapping sites, and since attempts were made to capture as many goshawks as possible, unproductive traps were frequently moved.

Trapped hawks were transported to the Fairbanks Fish and Game office where they were banded with both plastic, color bands and size 7B Fish and Wildlife Service bands. Color banding corresponded to plumage. Chicks in nests were banded red (right leg) and trapped juveniles red (left leg). With few exceptions birds with a mixture of adult and juvenile plumage were banded yellow (right leg), and those in full adult plumage banded green (right leg). All hawks were transported in a specifically designed wooden box which prevented struggling and breaking of feathers. Special care was taken to avoid subjecting birds to drastic temperature changes, though birds were normally in captivity for about 7 hours.

It is generally felt that male goshawks are approximately one-third smaller than females (Mueller and Berger, 1968; Storer, 1966). Sex of trapped hawks was originally judged by general body and foot size; however, all hawks captured were weighed and subjected to the following measurements as described by Pettingill (1939, pp. 323-325): length, extent, wing chord length, length of the first, fourth, and fifth primary (numbering 1-10 proximately), length of center rectrix, and bill length. The measurements of primaries were the flattened lengths of the feathers. Trapped hawks were placed in three age categories as described by Mueller and Berger (1968). Juveniles (birds less than 1 year of age) are typified by brownish streaked breast, while adults I (birds 1 but less than 2 years of age) display a mixture of gray adult and some brownish juvenile plumage. Adult II (birds 2 or more years of age) have grey, adult plumage with no brown. Similar measurements were taken on dead goshawks obtained from various sources; however, in these cases it was possible to confirm sex by internal examination. General observations on eye color, condition, molted feathers and presence of shock marks were also made. All trapped birds were released at the same location as trapped with a few exceptions when birds were released up to 3 miles from the trapping location in order to discourage depredations on domestic fowl.

Food Habits

After the young had fledged, castings and skeletal remains were collected both from the nest and the base of the nest tree. Castings were dried and later analyzed to investigate food habits. Erington (1932) and Glading et al. (1943) concluded that casting analysis reflects food habits of hawks qualitatively and not quantitatively. It is not possible to differentiate between castings deposited by nesting

females and chicks; consequently, food habits information presented is intended merely as a qualitative listing of summer prey species and their relative frequency of occurrence.

FINDINGS

Breeding Density

Nine active goshawk nests were located during 11 hours of aerial survey time in the Fairbanks vicinity. These nests were distributed over an 169.5 square mile area for a minimal breeding density of one nesting pair per 18.8 square miles (Fig. 1). It is not known that all active nests within the area surveyed were located; hence, nesting densities could have been greater than suggested by this information. In one case two active nests were situtated 1.5 miles apart, further evidence that under certain conditions relatively high nesting densities can be attained. In Finland one pair of goshawks was recorded per 10.1 square miles (Hakala, 1969). Two additional nests were located in the Birch Creek drainage approximately 100 miles north of Fairbanks and monitored throughout the summer to augment productivity studies.

Description of Nests and Nesting Sites

Specific physical and biological data for each of the 11 active nests studied in 1971 are presented in Appendix A. The summary of information presented here is not intended to describe preferred goshawk nesting habitat due to bias in survey techniques which led to location of nests originally.

The number of active nests located in various timber types is shown in Table 1. In all nesting areas the understory was low to moderate in density and composed of alder (Alnus sp.), willow (Salix sp.), and saplings of dominant overstory species. Of 11 nests, six (55 percent) were in paper birch, three (36 percent) in aspen, and one (9 percent) in cottonwood (Populus balsamifera). No active nests were located in spruce, but in one case an inactive stick nest was found in a white spruce (Picea glauca) near an active nest. It is probable that in the past goshawks used this nest suggesting that spruce are selected for nesting in some instances. The diameter (DBH) of nest trees varied between 7.3" and 13.7", averaging 10.2". Birch nest trees were larger in diameter (mean 11.4") than aspen and cottonwood (means of 8.9" and 9.2", respectively). Nests were situated in the tree where relatively large branches joined the trunk, which normally occurs in the middle to upper portions of the tree. Of 11 nests, 73 and 27 percent of the nests were located in the upper and middle portions of trees, respectively. Hardwood stands in interior Alaska are not tall, and the height of nests above the ground ranged between 15' and 37' (mean 29'). Nests were situated higher above the ground in aspen (mean 31') than in birch (mean 26'). Nests were round to oblong in shape which made exact measuring difficult. Approximate dimensions of 11 nests averaged 36" x 30" x 23". In all cases eggs were laid in a cup-shaped depression; however, no measurement of cup depth was obtained until chicks were about 20 days old.

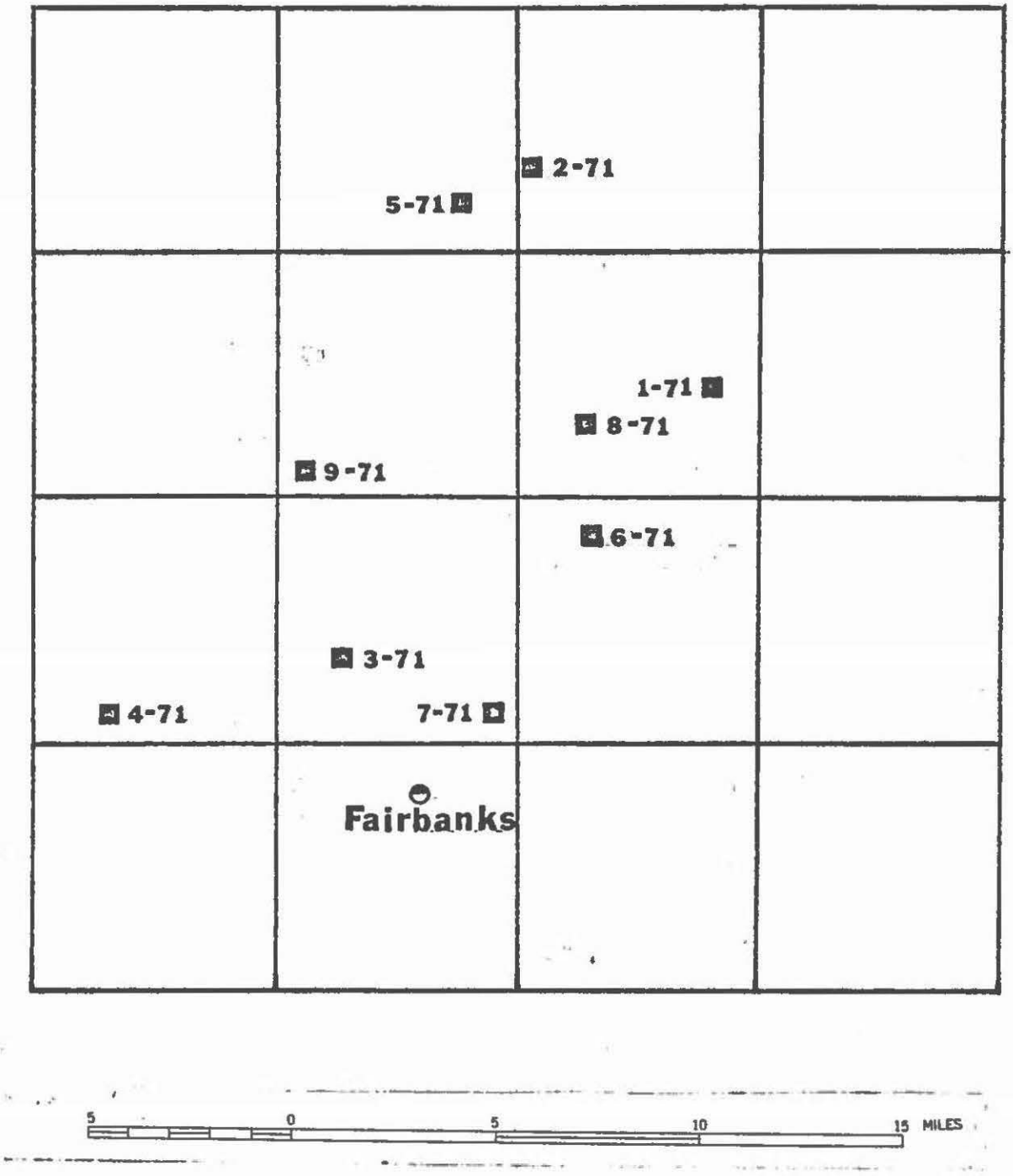

Fig. 1. Distribution of active goshawk nests located in Fairbanks vicinity, 1971.

Table 1. Number of active goshawk nests in various timber types, 1971.

Timber Stand Type	No. of Nests
Aspen	4
Birch	4
Birch-Aspen	1
Birch-Spruce	1
Cottonwood-Spruce	1
TOTAL	11

Table 2. Hatching date, fledging date and number of days chicks occupied nest for eight goshawk nests, 1971.

Nest No.	Hatching Date	Fledging Date	No. of Days Chicks Were in Nest
1-71	May 30	July 5 est.	36
2-71	June 1	July 7	36
3-71	May 31	July 6	36
4-71	May 29 est.	July 7	39
5-71	June 7	July 14 est.	37
6-71	June 3	July 12	39
7-71	June 23 est.	July 28	35
10-71	June 5 est.	July 12	37
Mean	June 5	July 12	37

By this time trampling by the chicks had reduced cup depth to a point where nests resembled a platform more than a cup-shaped structure.

All but two nests were situated in hillside situations. The two nests located on flat terrain were within a band of relatively large timber along stream courses. In hillside situations 44 percent of the nests occupied the lower portion of the slope, 44 percent the middle portion, and 12 percent the upper portion. The percentage of nests occupying various aspects of slope are as follows: south 33 percent, southwest 22 percent, northeast 22 percent, southeast 11 percent, and northwest 11 percent. The elevation of nest sites ranged from 650 to 1,800 feet.

All but two of the nests were lined. Lining materials consisted of deciduous twigs and green leaves, coniferous twigs with live needles, and bark. Sometimes only one type of lining material was used, while in other cases several types were used. Lining material was added as the nesting season progressed.

Searches of nesting areas were conducted to determine the presence of additional stick nests. Seventy-three percent of the active nest sites had other stick nests of similar size nearby (within 500 yards). In one case six such nests were located, and one of these was known to have been occupied by goshawks in 1970. At present, such nests located near active nests are considered to be sites used by goshawks in the past. It is not certain whether these "traditional" areas are occupied yearly by either or both members of a pair during the nesting season throughout their lives, or whether such areas are highly preferred nest sites and yearly attract breeding birds at random. Knowledge of all nests within any area is important in order to facilitate location of active sites in future years.

Nesting

Times of territory establishment, nest site selection, breeding, and egg laying were not determined. First visits to most nests were made during the period May 2-5 at which time eggs were counted. Subsequent visits revealed no increase in number of eggs indicating that clutches were complete and incubation underway by May 5. Craighead and Craighead (1956, p. 205) found that in Wyoming selection of nesting territories occurs in early April and the egg laying can start as early as May 6. Nesting activities appear to be initiated earlier in Alaska than in more southern latitudes, and are more in phase with nesting in northern Norway (69°10'N lat.) (Myrberget, 1970).

Hatching and fledging dates and number of days chicks spent in nest are presented in Table 2. Hatching dates ranged from May 30 to June 23 (mean June 5), and fledging dates ranged from July 5 to July 28 (mean July 12). Consequently, chicks spent an average of 37 days in the nest. One nest (no. 7-71) which was not located until June 3, hatched about June 23 indicating that egg laying and commencement of incubation can occur later than suggested by the majority of data.

It is not known if nest 7-71 was a case of renesting. The estimated incubation time for five nests where hatching dates were known ranged from 26 to 33 days (mean 29), however, these figures are considered minimal because the exact time incubation commenced was not determined. Craighead and Craighead (1956, p. 205) and Bent (1937, p. 128) indicate that the incubation period is 28 days which is roughly in agreement with data collected in this study. On the average chicks remained in the nests about 9 days longer than reported by Craighead and Craighead (1956, p. 205).

The age of breeding adults based on plumage is given per nest in Appendix A. Of 11 nesting females, four (36 percent) had juvenile plumage. Males were not seen at all nests; however, all paired males observed had adult plumage. In nesting areas occupied by females in juvenile plumage, males were never observed. This supports the findings in Finland where year-old females are known to breed, but the breeding of year-old males is quite exceptional (Hoglund, 1964a and 1964b).

During visits to nests females openly attacked and often struck observers, however, adult females were more aggressive than juveniles. In some cases males joined in defense displays but they usually stayed further away, never actually striking the observers. Defense displays consisted of loud calling and numerous low "passes" at intruders.

Productivity

Clutch size, hatching success and fledging success are summarized in Table 3. Clutches for 11 nests averaged 3.1, and the average clutch size for juvenile females was not significantly different at the 95 percent level from adults. In two instances (8-71 and 9-71) nests failed to produce young; both nests were occupied by juvenile females. No evidence of renesting was noted, and it is not known if nesting failure resulted from death or desertion by the female. The eggs from both nests were collected and all but one found to be fertile. Pesticide analyses are being carried out on all unhatched eggs.

From the 11 nests studied, 27 young (mean 2.4 per nest) fledged. Exclusive of the two unproductive nests, 27 of 28 eggs hatched, and all eggs hatched resulted in fledged young. Thus, 96 percent of the eggs layed in successful nests hatched; and of the eggs hatched, 100 percent of the young survived through fledging age.

It should be noted that in all three cases where some reproductive failure occurred (7,8,9-71) the nesting female was in juvenile plumage. However, at nest 5-71 occupied by a juvenile female, four chicks were successfully raised to fledging age. It is not known if juvenile birds have a lower reproductive rate than adults.

Hakala (1969) found an average of 3.4 eggs per nest (n=22) in Finland, and indicated a yearly reproductive rate of 1.5 fledged

Table 3. Clutch size, hatching success and fledging success for 11 goshawk nests, 1971.

Nest No.	Clutch Size	No. Eggs Hatched	No. Chicks Fledged*
1-71	3	3	3
2-71	1	1	1
3-71	3	3	3
4-71	4	4	4
5-71	4	4	4
6-71	3	3	3
7-71	3	2	2
8-71	3	0	0
9-71	3	0	0
10-71	4	4	4
11-71	3	3	3
Total	34	27	27
Mean	3.1	2.5	2.5

*Absence of dead chicks in nest or general nest vicinity was assumed to indicate absence of pre-fledging mortality.

juveniles per nesting pair. In the same country earlier findings by Hoglund (1964a) showed clutches to average 3.4, and 2.7 young were fledged per nest. Apparently, nestling survival varies yearly and the 1971 Alaskan data suggest that survival of chicks was responsible for the relatively high reproductive success in 1971. Hare (Lepus americanus) populations were high throughout interior Alaska in 1971. This abundant food supply probably contributed significantly to the high reproductive success of Alaskan goshawks in 1971.

Growth and Development of Chicks

Twenty-seven goshawk chicks at 11 nests were observed periodically after hatching in order to determine the preferred age for banding. Through these observations, plus weights and measurements taken at the time of banding, a general impression of nestling development was obtained. The weekly description presented below summarizes findings of all observations at nests with both known and estimated hatching dates. The post fledging (after 5 weeks of age) description is based on weekly observations and measurements of a captive male goshawk held for this purpose. The hawk was taken at about 28 days of age from nest #10-71 and held in captivity by Terrence Bendock under Scientific Collecting Permit #417-14. Snowshoe hare comprised the main diet of this bird during the observation period. The fact that captivity as well as an "artificial" diet may affect development must be kept in mind. This summary is presented as a general description of development from the time of hatching until full juvenile development is attained, and may be changed to some extent as more information is obtained.

One week - Chicks are medium sized and covered with gray down. Body feather growth is not apparent, the egg tooth prominent, and the eye light blue-gray in color. Chicks will hold their head upright but little other movement occurs.

Two weeks - Chicks are about two-thirds their adult weight but still down-covered. All primaries and secondaries are visible. The egg tooth is still visible, and body feathers appear through the down in the scapular region. Chicks are unstable on their feet; however, the feet have developed some gripping power and chicks cling to nest material when disturbed.

Three weeks - Chicks have reached their full weight (approximately 900 to 1,200 gms). All primaries and rectrices are visible and sheathed. Primaries 4 and 5 are 6-8 cm long. Body feathers appear on back, but head and breast are down covered.

Four weeks - Brown juvenile plumage appears on all portions of the body except the forehead, upper legs, lower back, and mid-breast. Down is localized and appears patchy. Chicks stand for short periods and begin to show aggression. This is the ideal age for banding.

Five weeks - Chicks generally appear fully plumed with brown juvenile feathers. Small patches of down are still present on the forehead and thighs. The feet are strong and well developed; however the eye is still blue-gray in color. Fledging occurs shortly hereafter despite the fact that primaries and rectrices have not completed their growth.

Six weeks - Juvenile plumage covers entire body with very little if any down visible. Eye color is gray-yellow, primaries and rectrices sheathed. Primaries 1, 4, and 5 are approximately 14, 21, and 23 cm. in length, respectively. Central rectrices about 19 cm long.

Seven weeks - Juvenile in appearance. No down visible at this time. Sheathing is present on primaries and rectrices. Primaries 1, 4, and 5 approximately 14, 23, and 25 cm. in length, respectively. Central rectrices are about 21 cm long.

Older than 7 weeks - Sheathing on primaries and rectrices disappears shortly after 6 weeks of age. Primaries and rectrices continue to grow at a relatively slow rate until their full length is obtained at about 14 weeks of age (See Table 4 for feather lengths for full-grown juveniles).

Like most raptors, goshawks develop rapidly during early stages of life, their full body weight being attained by the age of 3 weeks. Based on weekly measurements of a single individual, approximately 61 percent of the feather growth is completed by 28 days of age; however, fledging occurs long before feather growth is complete (Table 4). The rate of primary and rectrix growth appears to be inversely proportional to age until about 14 weeks of age when plumage development is completed.

Fall density

All goshawks handled in 1971 are listed in Appendix B. With the exception of 26 chicks banded as nestlings, all hawks were captured in Swedish goshawk traps. Intensive trapping occurred between late August and the end of November, and during this period 486 trap days yielded 59 captures or one capture per 8.2 trap days. Trapping success was highest in September (one capture/6.8 trap days) and lowest in November (one capture/10.2 trap days). The most productive trap site yielded one capture per 3.0 trap days during the period September

Table 4. Percent of total growth in length of selected feathers of a captive male goshawk between 28 and 103 days of age.

Feather Measured	Percent Total Growth				
	28 days	35 days	42 days	49 days	103 days
Primary 1	64.2	81.1	91.9	97.3	100
Primary 4	62.2	71.5	85.4	95.1	100
Primary 5	65.1	78.3	90.8	98.8	100
Center rectrix	51.9	64.1	78.9	89.5	100
Mean	60.8	73.8	86.8	95.0	100

Table 5. Age and sex of goshawks live-trapped in 1971.

Age	Males	Females	Total
Juvenile	20	23	43
Adult I	7	2	9
Adult II	1	3	4
Total	28	28	56

through November. On numerous occasions goshawks attempted to take the bait pigeons but failed to become captured. This inherent inefficiency of the Swedish goshawk trap poses problems in using captures per unit of trapping effort as an index of abundance. Nevertheless, the high trapping success suggests that populations were high during the fall of 1971.

Of 56 captures in 1971 the sex ratio was 50:50 for all age groups combined (Table 5). Percentages of males to females captured during September, October, and November were 58:42, 48:52, and 25:75 respectively. Of the 56 captures, 77 percent were juveniles, 16 percent Adult I, and 7 percent Adult II. The juvenile to adult (Ad I and Ad II combined) ratio between August and December was 4.2:1 probably reflecting both high productivity and relatively high juvenile mobility. During each of the three months of intensive fall trapping, juveniles comprised 83 percent of all hawks captured, further evidence of high productivity and juvenile mobility.

Movements

Six recaptures or recoveries of banded goshawks suggest that juveniles are more mobile, at least during autumn, than adults. Four recoveries of juveniles showed an average movement of 13.1 miles, while four adult recoveries revealed an average movement of only 3.2 miles. One adult male, banded on April 11, 1971 was recaptured on August 7, 1971 1.5 miles to the northeast, and again on November 20, 1971 approximately 0.75 miles north of the banding site. These findings are generally in agreement with those of Haukioja and Haukioja (1970) who found juvenile goshawks to be the most mobile age group in Finland. In Wisconsin Mueller and Berger (1967) further suggest that juveniles are apt to be more mobile than adults during periodic southern invasions.

Molting of adults

All nesting goshawks observed were molting the more proximal primaries in late April, and observation throughout the summer suggested that dropping of these feathers proceeds distally as described by Beebe and Webster (1964, p. 265) and Stabler (1943). Fall trapped hawks in Adult I and II plumage had the first (outermost) primary sheathed as late as September 20 indicating that wing molt is not complete and new feathers fully grown until late September. Molt of tail feathers was first noted while visiting active nests in mid-June. This molt could have commenced earlier and gone undetected because no hawks were trapped and examined closely in early summer. Fall trapped Adult I and II hawks had sheathed tail feathers as late as October 13. Apparently the tail molt commences later and is completed later than that of the primaries. This is in agreement with Stabler (1943).

Fall-trapped goshawks designated as Adult I had mostly adult (blue-gray) feathers with the exception of a few juvenile (brownish)

ones in the scapular and lower back regions. The eyes of Adult I birds were yellowish-orange, while in Adult II hawks eye color was rust to red.

A summary of all molt data collected in 1970 and 1971 from wild hawks and one bird being held in captivity since it was taken as a juvenile in 1970 leads to the following speculations. The typical juvenile plumage and yellow eye are retained throughout the first winter. In late April goshawks start to molt into adult plumage; however, contrary to Bent (1937, p. 130), this molt is not complete, and a few juvenile feathers are retained in the scapular and lower back regions. In April, when the bird is about 11 months of age, the eye color starts to change from yellow to orange. This intermediate plumage is worn throughout the second winter, and the following April when the bird is about 22 months of age, another molt commences. Completion of this molt the following October results in a bird displaying full adult plumage. At this age (28 months) the eye is rust in color but further information on eye color change is not available. At this point the foregoing statements are largely speculation and do not take into account individual variation nor variations between sexes.

Morphology

It is generally agreed that male goshawks are approximately one-third smaller than females; however, there are few references to actual measurements in the literature. Sexual dimorphism of goshawks has been discussed by Mueller and Berger (1968) and Storer (1966) and these authors agree that by using body weight plus a combination of measurements, sex can be determined accurately in most instances.

Measurement data for hawks where sex was confirmed by internal examination are summarized in Appendix C. Live-trapped hawks were placed in categories of assumed sex according to general body size, and data from these birds are summarized in Appendix D. In all cases only fully grown feather measurements were included in compilations. Absence of sheathing on primaries and rectrices was assumed to indicate that feather growth was complete. Sample size for adults was small; consequently, information from Adult I and II was combined. Birds of known sex were desiccated when examined preventing comparison of body weights. In order to develop an accurate (at least to the 98 percent level) and simple field technique for sex determination the means of all measurements were statistically compared using the "student t" test. Tests to determine statistical differences between means were conducted comparing various age and sex (both known and assumed) groups.

In the case of most measurements there was no sound statistical difference between means for males of known and assumed sex as well as between females of known and assumed sex (Table 6). This leads to the tentative conclusion that with some experience the sex of live-trapped goshawks can be accurately determined by general observation of body size. Of 56 live-trapped goshawks there were only two instances

Table 6. Results of t tests comparing means of various measurements for juvenile goshawks of known and assumed sex.

Measurements	Males: Known sex compared to assumed sex			Females: Known sex compared to assumed sex		
	D.F.	t	P	D.F.	t	P
Length P1 (cm)	27	0.473	.65	5	0.366	.75
Length P4 (cm)	26	0.784	.55	28	0.646	.50
Length Center Rectrix (cm)	26	0.088	.90	28	0.711	.50
Body Length (cm)	25	1.064	.30	28	3.039	.01
Wing Chord (cm)	24	1.612	.13	26	0.632	.50
Extent (cm)	23	2.234	.05	25	2.079	.05
Bill Length (cm)	24	0.026	.80	28	1.271	.22

where difficulty was encountered in placing hawks into sex catagories based on general body and foot size. At this time, however, the sample size of known-sex hawks is small.

None of the measurements comparing juvenile to adult females were significantly different at a level greater than 76 percent; however, five of the measurements comparing juvenile to adult males differed at the 98 percent level (Table 7). Mueller and Berger (1968) found adult goshawks to be longer winged and heavier than juveniles, and the tails of adult males to be shorter than those of juvenile males. While on the average juvenile males handled in 1971 had longer tails than adults, the difference was not highly significant.

Comparisons of the means of various measurements suggest significant differences between males and females both of known and assumed sex in most cases (Tables 8 and 9). Morphological data collected to date suggest that there is little difference in size between fully developed juveniles and adults of the same sex, with a few exceptions in the case of males. Females are larger than males, and the length of the first, fourth, or fifth primary as well as the length of the central rectrix are probably the best measurements for sex determination. Body weight and wing chord length may also be of some value as sex indicators. It is difficult to maintain consistency when taking extent and body length measurements; consequently, these along with bill length will be deleted from banding procedures in the future.

Food habits

Castings (regurgitated pellets) were collected from nine successful nests. The number of castings obtained at individual nests varied from 12 to 42, and all collections from each nest were considered as a single sampling unit. Frequencies of various food items are presented in Table 10. Snowshoe hare remains were present in all samples; in addition, observations of prey remains in the general nesting area further suggest hares as the major food source in 1971. While red squirrel (Tamiasciurus hudsonicus) occurred with lower frequency, this species may be a very important food source in some years. In the eastern United States, Meng (1959) found red squirrels to be a very important food source for nesting goshawks. Grouse numbers were low throughout interior Alaska in 1971, and grouse may assume higher importance as prey species in years of higher abundance. In Finland the food habits of goshawks vary with the abundance of prey species. This has been shown and discussed by Sulkova (1964).

Miscellaneous activities

Approximately one week was spent with photographers of Bill Burrid Productions of Los Angeles, California filming various aspects of the study.

Table 7. Results of t tests comparing means of various measurements for juvenile and adult goshawks of assumed sex.

Measurements	Juvenile males compared to adult males			Juvenile females compared to adult females		
	D.F.	t	P	D.F.	t	P
Body Weight (gm)	31	5.104	.01	28	1.116	.30
Length P1 (cm)	25	1.044	.30	24	0.998	.32
Length P4 (cm)	27	2.454	.02	26	1.171	.25
Length P5 (cm)	23	3.246	.01	25	0.200	.85
Length Center Rectrix (cm)	24	1.217	.23	26	1.004	.30
Body Length (cm)	27	1.012	.30	26	0.461	.65
Wing Chord (cm)	26	3.984	.01	25	0.391	.70
Extent (cm)	26	2.943	.01	24	0.503	.60
Bill Length (cm)	26	2.011	.05	26	0.683	.50

Table 8. Results of t tests comparing various measurements for juvenile males and juvenile females (known sex).

Measurements	D.F.	t	P
Length P1 (cm)	10	4.246	.01
Length P4 (cm)	10	6.324	.01
Length Center Rectrix (cm)	10	6.822	.01
Body Length (cm)	9	7.455	.01
Wing Chord (cm)	8	7.101	.01
Extent (cm)	7	1.127	.30
Bill (cm)	10	11.377	.01

Table 9. Results of t tests comparing means of various measurements for goshawks of known age and assumed sex.

	Juvenile males compared to juvenile females			Adult males compared to adult females		
Measurements	D.F.	t	P	D.F.	t	P
Body Weight (gm)	47	10.699	.01	12	2.885	.02
Length P1 (cm)	44	12.332	.01	5	4.323	.01
Length P4 (cm)	44	11.932	.01	9	8.093	.01
Length P5 (cm)	40	12.504	.01	8	6.380	.01
Length Center Rectrix (cm)	44	12.925	.01	6	4.561	.01
Body Length (cm)	44	10.834	.01	9	5.301	.01
Wing Chord	42	8.994	.01	9	2.996	.02
Extent (cm)	41	12.858	.01	9	2.562	.04
Bill Length (cm)	42	1.650	.10	10	2.663	.02

Table 10. Food item frequencies for castings analyzed from nine goshawk nests, 1971.

Food Items	Frequency
Hare (*Lepus americanus*)	100
Unidentified feathers	100
Unidentified hair	100
Red Squirrel (*Tamiasciurus hudsonicus*)	67
Unidentified Passerine feet	44
Unidentified grouse feet	33

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Appendix A. Data collected at 11 goshawk nest sites, 1971.

Nest No.	Nest Size	Height of Nest Above Ground	Nest Lining	Species of Nest Tree	DBH of Nest Tree	Timber Type	Position on Slope	Aspect of Slope	Altitude of Nest Site	No. of Other Stick Nests Nearby	Plumage of Adults*
1-71	32"x21"x12"	25'	Green Leaves	Aspen	9.2"	Aspen	Lower 1/3	S	1,000'	1	♂ Ad. ♀ Ad.
2-71	36"x36"x36"	25'	None	Aspen	8.9"	Aspen	Lower 1/3	SW	1,000'	1	♂ Ad. ♀ Ad.
3-71	45"x42"x24"	30'	Spruce Twigs	Birch	11.5"	Birch	Middle 1/3	NE	850'	2	♂ Ad. ♀ Ad.
4-71	45"x35"x20"	30'	Birch Bark	Birch	13.7"	Birch	Middle 1/3	NE	1,000'	6	♂ ? ♀ Ad. ?
5-71	33"x26"x32"	37'	Bark	Aspen	8.9"	Aspen	Middle 1/3	SW	1,000'	0	♂ ? ♀ Juv.
6-71	38"x24"x20"	29'	Spruce Twigs-Birch Bark	Birch	12.1"	Birch	Upper 1/3	S	1,150'	1	♂ Ad. ♀ Ad.
7-71	36"x24"x24"	20'	None	Birch	12.4"	Birch	Lower 1/3	NW	650'	0	♂ ? ♀ Juv.
8-71	32"x24"x16"	35'	Birch Bark	Aspen	7.6"	Aspen	Middle 1/3	SE	1,100'	1	♂ ? ♀ Juv.
9-71	30"x30"x18"	30'	Birch Bark	Birch	11.5"	Birch-Aspen	Lower 1/3	S	1,000'	2	♂ ? ♀ Juv.

Appendix A. Data collected at 11 goshawk nest sites, 1971. (Continued)

Nest No.	Nest Size	Height of Nest Above Ground	Nest Lining	Species of Nest Tree	DBH of Nest Tree	Timber Type	Position on Slope	Aspect of Slope	Altitude of Nest Site	No. of Other Stick Nests Nearby	Plumage of Adults*
10-71	36"x36"x28"	15'	None	Birch	7.3"	Birch-Spruce	Flat	Flat	900'	0	♂ ? ♀ Ad.
11-71	35"x35"x18"	37'	Cottonwood leaves and spruce twigs	Cottonwood	9.2"	Cottonwood-Spruce	Flat	Flat	1,800'	1	♂ ? ♀ Ad.

* Plumage judged to be adult if breast was gray and major portion of body plumage blue-gray, and juvenile if breast was streaked with brown.

Appendix B. Goshawks handled in 1971, Interior Alaska.

Band #	Color*	Date	Location	Sex	Plumage
877-10003	R. Rt.	4-14-71	Pearl Creek	♂	Juvenile
**557-47116	B. L.	4-30-71	Pearl Creek	♂	Ad. II
***877-10004	B. L.	6-08-71	Pearl Creek	♂	Ad. I
877-10014	B. L.	6-18-71	Pearl Creek	♂	Ad. I
877-10005	R. Rt.	6-18-71	Birch Creek	?	Downy Chick
877-10006	R. Rt.	6-18-71	Birch Creek	?	Downy Chick
877-10007	R. Rt.	6-18-71	Birch Creek	?	Downy Chick
877-10008	R. Rt.	6-22-71	Gilmore Creek	?	Downy Chick
877-10009	R. Rt.	6-22-71	Gilmore Creek	?	Downy Chick
***877-10010	R. Rt.	6-22-71	Gilmore Creek	?	Downy Chick
877-10011	R. Rt.	6-22-71	Grenac Road	?	Downy Chick
877-10012	R. Rt.	6-22-71	Grenac Road	?	Downy Chick
877-10013	R. Rt.	6-22-71	Grenac Road	?	Downy Chick
877-10015	R. Rt.	6-23-71	St. Pat. Cr.	?	Downy Chick
877-10016	R. Rt.	6-23-71	St. Pat. Cr.	?	Downy Chick
877-10017	R. Rt.	6-23-71	St. Pat. Cr.	?	Downy Chick
877-10018	R. Rt.	6-23-71	St. Pat. Cr.	?	Downy Chick
877-10019	R. Rt.	6-23-71	Vault Creek	?	Downy Chick
877-10020	R. Rt.	6-23-71	Vault Creek	?	Downy Chick
***877-10021	R. Rt.	6-22-71	Dome Creek	?	Downy Chick
877-10022	R. Rt.	6-23-71	Vault Creek	?	Downy Chick
877-10023	R. Rt.	6-23-71	Vault Creek	?	Downy Chick
877-10024	R. Rt.	6-24-71	Eng. Creek	?	Downy Chick

Appendix B. Goshawks handled in 1971, Interior Alaska (Continued)

Band #	Color*	Date	Location	Sex	Plumage
877-10025	R. Rt.	6-24-71	Eng. Creek	?	Downy Chick
877-10026	R. Rt.	6-24-71	Eng. Creek	?	Downy Chick
877-10027	R. Rt.	7-06-71	Birch Hill	?	Downy Chick
877-10028	R. Rt.	7-06-71	Birch Hill	?	Downy Chick
877-10029	R. Rt.	7-07-71	Ketchem Creek	?	Downy Chick
877-10030	R. Rt.	7-07-71	Ketchem Creek	?	Downy Chick
877-10031	R. Rt.	7-07-71	Ketchem Creek	?	Downy Chick
***877-10032	R. L.	8-04-71	Pearl Creek	♀	Juvenile
***617-23811	Y. Rt.	8-17-71	Pearl Creek	♂	Ad. I.
877-10033	R. L. #2	8-29-71	Frenchman Creek	♂	Juvenile
877-10034	Y. Rt.	8-30-71	Gilmore Trail	♂	Ad. I.
877-10035	R. L. #3	9-04-71	Frenchman Creek	♂	Juvenile
877-10036	R. L. #4	9-06-71	Gilmore Trail	♀	Juvenile
877-10037	R. L. #5	9-05-71	Goldstream Creek	♀	Juvenile
877-10038	R. L. #1	8-28-71	Frenchman Creek	♀	Juvenile
877-10039	R. L. #6	9-06-71	Frenchman Creek	♂	Juvenile
877-10040	R. L. #7	9-10-71	Frenchman Creek	♀	Juvenile
877-10041	G. Rt.	9-11-71	Frenchman Creek	♀?	Ad. II
877-10042	R. L. #8	9-12-71	Gilmore Trail	♂	Juvenile
877-10043	R. L. #9	9-02-71	Birch Hill	♂	Juvenile
877-10044	R. L. #10	9-14-71	Gilmore Trail	♂	Juvenile
877-10045	R. L. #11	9-19-71	Gilmore Trail	♂	Juvenile
877-10046	Y. L.	9-20-71	Gilmore Trail	♀	Ad. I
877-10047	R. L. #12	9-25-71	Gilmore Trail	♂	Juvenile

Appendix B. Goshawks handled in 1971, Interior Alaska (Continued)

Band #	Color*	Date	Location	Sex	Plumage
877-10048	R. L. #13	10-01-71	Gilmore Trail	♀	Juvenile
877-10049	R. L. #14	10-05-71	Gilmore Trail	♂	Juvenile
877-10050	R. L. #15	10-05-71	Yankovich Road	♂	Juvenile
877-10051	R. L. #16	10-05-71	Harper Creek	♀	Juvenile
877-10052	R. L. #17	10-06-71	Gilmore Trail	♀	Juvenile
877-10053	Y. R.	10-07-71	Yankovich Road	♂	Ad. I
877-10054	R. L. #18	10-09-71	Harper Creek	♀	Juvenile
877-10055	R. L. #20	10-09-71	Gilmore Trail	♂	Juvenile
877-10056	R. L. #19	10-10-71	Gilmore Trail	♀	Juvenile
877-10057	R. L. #21	10-10-71	Yankovich Road	♂	Juvenile
877-10058	Y. Rt.	10-12-71	Pearl Creek	♀	Ad. I
877-10059	R. L. #22	10-13-71	Gilmore Trail	♂	Juvenile
877-10060	G. Rt.	10-13-71	Harper Creek	♀	Ad. II
877-10061	R. L. #23	10-14-71	Harper Creek	♀	Juvenile
877-10062	R. L. #24	10-16-71	Harper Creek	♀	Juvenile
877-10063	R. L. #25	10-21-71	Harper Creek	♂	Juvenile
877-10064	R. L. #1	10-22-71	Gilmore Trail	♀	Juvenile
877-10065	R. L. #2	10-22-71	Gilmore Trail	♂	Juvenile
877-10066	G. Rt.	10-23-71	Harper Creek	♂	Ad. II
877-10067	R. L. #3	10-24-71	Gilmore Trail	♂	Juvenile
877-10068	R. L. #4	10-26-71	Harper Creek	♀	Juvenile
877-10069	R. L. #5	10-27-71	Gilmore Trail	♀	Juvenile

Appendix B. Goshawks handled in 1971, Interior Alaska (Continued)

Band #	Color*	Date	Location	Sex	Plumage
877-10070	R. L. #6	10-27-71	Harper Creek	♂	Juvenile
Bird Lost in Handling		10-30-71	Gilmore Trail	♂	Juvenile
877-10071	G. Rt.	11-01-71	Pearl Creek	♀	Ad. II
877-10072	R. L. #7	11-03-71	Gilmore Trail	♀	Juvenile
Escaped from Trap		11-06-71	Harper Creek	♀	Juvenile
877-10073	R. L. #8	11-05-71	Frenchman Creek	♀	Juvenile
877-10074	R. L. #9	11-09-71	Gilmore Trail	♀	Juvenile
877-10075	R. L. #10	11-10-71	35 Mi. Nenana Rd.	♂	Juvenile
877-10077	R. L. #12	11-10-71	Gilmore Trail	♀	Juvenile
877-10076	Y. Rt.	11-13-71	Gilmore Trail	♂	Ad. I
877-10078	R. L. #13	11-18-71	Harper Creek	♀	Juvenile
877-10079	R. L. #14	11-26-71	Yankovich Road	♀	Juvenile
877-10080	R. L. #15	11-28-71	Gilmore Trail	♀	Juvenile
877-10081	R. L. #17	11-29-71	Gilmore Trail	♂	Juvenile
877-10082	R. L. #18	11-30-71	Gilmore Trail	♀	Juvenile

* Color banding code: Rt., right leg; L, left leg; R, red; B, blue; Y, yellow; G, green.

** Originally banded by other worker and recaptured during this study.

***Banded in this study and recaptured or recovered.

Appendix C. Measurement data for juvenile goshawks of known sex.

Measurement	Sex	n	Mean	S. D.	Range
Length P1 (cm)	♂	7	14.9	0.48	14.3-15.5
	♀	5	16.5	0.87	15.5-17.4
Length P4 (cm)	♂	6	25.0	0.66	24.1-25.7
	♀	6	27.4	0.66	26.4-28.0
Length Center Rectrix (cm)	♂	6	24.5	1.00	23.3-26.0
	♀	6	28.1	0.84	26.7-29.0
Body Length (cm)	♂	5	54.6	1.52	52.0-55.9
	♀	6	61.8	1.64	59.6-64.2
Wing Chord (cm)	♂	5	31.8	1.00	30.2-32.6
	♀	5	35.4	0.52	34.9-36.2
Extent (cm)	♂	4	106.1	4.20	101.6-111.7
	♀	5	109.3	4.41	104.7-114.6
Bill Length (cm)	♂	6	2.2	0.04	2.1-2.2
	♀	6	2.4	0.03	2.4-2.5

Appendix D. Weight and measurement data for goshawks of assumed sex.

Measurements	Age	Sex	n	Mean	S.D.	Range
Body Weight (gms)	Juv	♂	24	831.3	80.17	675-1,000
	Juv	♀	25	1,090.8	89.16	925-1,250
	Ad	♂	9	995.2	87.60	875-1,125
	Ad	♀	5	1,140.0	94.54	1,000-1,250
Length P1 (cm)	Juv	♂	22	15.0	0.46	13.8-15.9
	Juv	♀	24	16.6	0.43	15.7-17.4
	Ad	♂	5	14.7	0.48	14.2-15.4
	Ad	♀	2	16.3	0.14	16.2-16.4
Length P4 (cm)	Juv	♂	22	24.8	0.55	23.9-26.0
	Juv	♀	24	27.2	0.78	26.3-28.2
	Ad	♂	7	25.3	0.47	24.5-26.1
	Ad	♀	4	27.7	0.42	27.2-28.1
Length P5 (cm)	Juv	♂	19	25.0	0.51	24.3-26.0
	Juv	♀	23	27.6	0.76	25.0-28.5
	Ad	♂	6	25.8	0.396	25.2-26.3
	Ad	♀	4	27.7	0.55	27.2-28.2
Length Center Rectrix (cm)	Juv	♂	22	24.5	0.79	22.3-25.9
	Juv	♀	24	27.8	0.93	25.6-30.0
	Ad	♂	4	23.9	1.65	22.0-26.0
	Ad	♀	4	27.3	0.95	26.0-28.1
Body Length (cm)	Juv	♂	22	53.9	1.30	51.5-57.1
	Juv	♀	24	59.2	1.92	53.7-61.8
	Ad	♂	7	53.3	1.67	51.4-56.1
	Ad	♀	4	59.7	2.36	56.7-62.3
Wing Chord (cm)	Juv	♂	21	32.4	0.69	31.0-34.0
	Juv	♀	23	35.0	1.16	31.0-36.5
	Ad	♂	7	33.5	0.49	32.7-34.0
	Ad	♀	4	35.3	1.45	33.2-36.6
Extent (cm)	Juv	♂	21	102.2	2.96	93.3-106.9
	Juv	♀	22	111.9	1.84	107.3-116.0
	Ad	♂	7	105.8	1.90	102.2-108.0
	Ad	♀	4	112.7	6.95	102.5-117.5
Bill Length (cm)	Juv	♂	20	2.2	0.09	2.0-2.4
	Juv	♀	24	2.5	0.09	2.1-2.6
	Ad	♂	8	2.3	0.17	2.0-2.5
	Ad	♀	4	2.5	0.08	2.4-2.6