SUMMER DISTRIBUTION, NUMBERS, AND FOOD HABITS OF THE GYRFALCON (*Falco rusticolus* L.) ON THE SEWARD PENINSULA, ALASKA

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A

THESIS

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ABSTRACT

During the summers of 1968, 1969, and 1970 aerial and ground surveys were made of approximately 17,000 square miles of the Seward Peninsula, Alaska, to locate nesting Gyrfalcons (Falco rusticolus L.). During the three summers 131 nestings were observed and populations remained both high and relatively stable on a region-wide basis. Re-utilization of specific nest cliffs was low, however, and cliff-shifting was conspicuous. In smaller areas of the peninsula the numbers of pairs utilizing a given area changed from year to year in a manner correlated with prey availability.

Prey remains and pellets were collected from 37 nests over the course of the study and 1,483 kills were identified. A minimum of 40 species was represented including 32 bird species and eight mammal species. This is a considerably longer list of prey species than has been reported previously. Four species dominate the food sample (Rock Ptarmigan, Lagopus mutus, Willow Ptarmigan, L. lagopus, the Arctic Ground Squirrel, Spermophilus undulatus, and the Long-tailed Jaeger, Stercorarius longicaudus), making up 81 per cent by number and 92 per cent by weight. Prey utilization varied with availability both from year to year and from habitat type to habitat type between the hunting ranges of nesting pairs.

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Sam Stoker donated valuable time during a memorable

exploration of the peninsular coast between Nome and Unalakleet in 1969.

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INTRODUCTION

The Gyrfalcon (*Falco rusticolus* L.), largest of the falcons, is found north of 59° N. Latitude around the world. It is the Arctic counterpart of the desert falcons, considered by Otto Kleinschmidt (as cited in Voous, 1960) "as the arctic form of the semi-cosmopolitan group of the Saker (*Falco cherrug* Gray) and Lanner (*Falco biarmicus* Temminck)." This species is closely associated with treeless arctic and alpine terrain, and is adapted for catching birds and small mammals on or near the ground.

In Alaska, the Gyrfalcon lives and breeds throughout the foot-hills of the Brooks Range, the De Long Mountains, the Baird Mountains, the Bering Sea coast and Seward Peninsula, the high uplands between the Yukon and Tanana Rivers, the foot-hills of the Alaska Range, the hills between the Kuskokwim River and Bristol Bay, parts of the Alaska Peninsula, and (almost certainly) some of the larger islands in the Aleutian Chain. They also have been said to breed sparingly on Kodiak and Nunivak Islands and possibly on St. Lawrence Island (Cade, 1960). Cade (1960) mentions the Talkeetna and Chugach Mountains as additional possible habitats. I have knowledge of at least three successful nestings (Roseneau, unpublished) and at least four eyrie sites (Peter Isleib, pers. comm.,

1971) in the Chugach Mountains. Breeding may also occur in portions of the Chigmit Mountains (pers. observation).

Prior to the present study, little was known about Alaskan Gyrfalcon populations, their numbers, and food habits, except from Cade's (1960) research. Cade collected data from portions of the Arctic Slope from the Colville River in the Brooks Range and relied heavily on Alaska Range data collected by Murie (1946, unpublished), M. W. Nelson, and J. H. Doyle. He further attempted to piece together all breeding records of Gyrfalcons in Alaska and to summarize what little was known about food habits. Cade's data indicated that the highest densities of Gyrfalcons were likely to be found in western Alaska, adjacent to the Bering Sea (including the Seward Peninsula). He estimated the entire Alaskan population to be between 200 and 300 pairs.

OBJECTIVES

This study was formulated to pursue the following specific objectives: 1) to determine the summer distribution and numbers of Gyrfalcons on the Seward Peninsula, Alaska; and 2) to determine the food habits of breeding Gyrfalcons.

Often studies of predatory animals are confined to relatively small areas by logistic and other problems, and I feel that this is unfortunate. Predators in general tend to be more thinly distributed than the members of lower trophic levels and for this reason, studies of small areas are likely to be representative of highly local conditions and to suffer from small sample sizes. Accordingly, I have attempted to study Gyrfalcons over a very large area, an area which also possesses the advantage of being well circumscribed geographically. This study was intended to be broadly applicable to the breeding range of the Gyrfalcon and thus to permit extrapolation and perspectives on Gyrfalcons in the whole circumpolar zone.

METHODS

Study Area

The Seward Peninsula is the westernmost extension of mainland Alaska and, because most of it seemed likely to be comprised of good Gyrfalcon habitat, it was chosen as the major study area. Although one aerial search was made east of Golovin, the formal study was conducted west of 162° W. Although potential Gyrfalcon habitat exists east of 162° W., only one aerial survey was made east of that line due to logistical factors. A portion of the major study area was selected as a sub-study area for intensive investigation near Nome and is described later (see Figure 1). Extensive ground and aerial work was done during the periods 24 May through 30 August 1968, 22 May through 15 August 1969, and 23 May through 25 August 1970.

The Seward Peninsula is situated between 64° 30' N. and 66° 30' N. Although the region lies at approximately the same latitude as Fairbanks, which is in the center of typical sub-arctic boreal forest, maritime influences help create biotic conditions on the Seward Peninsula that are arctic in nature. The tree-line stops at a north-south line representing approximately 162° 32' W., and the peninsula is practically treeless west of this line. However, some spruce forest extends west along the southern coast to Golovnin Bay and northwest up the Nuikluk River valley to a point approximately 15 miles upriver from Council. Scattered spruce continue almost to the North Fork of the Nuikluk River and reach the southern and eastern portions of McCarthy's Marsh.

The topographic profile is characterized by low rolling hills, generally under 1,500 feet elevation. The land is drained by a complex network of shallow rivers and tributary creeks, many of which usually become dry by mid-July. Four small mountain ranges exist.

The York Mountains, near the western tip of the peninsula, are barren and rugged, rising abruptly from the sea to become high rolling tundra-covered hills a few miles north and offer few suitable outcrops but afford some sea-cliff sites. The Darby Mountains northeast of Golovnin Bay extend north to merge with the more centrally located Bendeleben range. The Darby Mountains contain a large section of granite intrusives in the southeast section providing many spires and "blocks" suitable for large cliff nesting raptors. The Bendeleben Mountains are extensively weathered and rounded. The Kigluiak Mountains, just south of the Kuzitrin River and Imuruk Basin, are rugged and rise abruptly from relatively low elevation. A large section of the peninsula north of the Bendeleben Mountains contains numerous cinder cones and is covered by geologically recent lava flows. Cinder cones and kettle lakes cover much of the Cape Espenberg sector north of 66° N.

Rock outcrops, often of limestone or its metamorphic products, occur commonly throughout the peninsula. These outcroppings tend to face south. River bluffs occur on some of the larger rivers and some small canyons exist along deep-cutting streams. Sea-cliffs are limited to a few important stretches of coast east of Nome, the Grantley Harbor and Tuksuk Channel area, the York Mountain section between Lost River and Tin City, and some sections of the northern coast between the Goodhope River and the Buckland River.

Numbers and Distribution

In 1968, exploratory work began on the outskirts of Nome and continued along the three major roads (to Teller, Taylor, and Council) as they opened to vehicular traffic. Most of the intensive work on study eyries was done on foot and with road vehicles. Snow machines were utilized from arrival through mid-June to explore areas well off of the roads. Rivers were crossed on foot and occasionally by canoe. A skiff and a 38 foot inboard patrol vessel (lent to the Alaska Department of Fish and Game by the Department of the Army) were used for coastal travel eastward and westward from Nome. A Cessna 180 and a PA-18 Super Cub were used for the aerial surveys. My previous familiarity with Gyrfalcon nesting requirements and situations often allowed me to travel on the ground or in aircraft directly to likely nest sites.

Aerial survey techniques were developed which allowed me to locate nesting cliffs, nest sites, count young in the nests, and, in some instances, observe eggs. Ratcliffe (1962a) has defined the concepts of "nesting cliff," "nest site," and "eyrie." His definitions will be followed throughout the text of this thesis. Low level flights were conducted during June and early July and on favorable days lasted up to 6 hours. Optimum flight duration was 3 to 4 hours; beyond this time, fatigue and eye-strain affected efficiency. PA-18 Super Cub flights were manned by a pilot experienced in aerial survey operations and one observer; an additional observer could be accommodated on Cessna 180 flights. Total search hours flown were: PA-18 Super Cub, 32.2 hours; Cessna 180, 13.1 hours.

Efficiency in the Cessna 180 was initially marginal because of higher speeds and reduced visibility from the aircraft windows. With experience, efficiency using the Cessna 180 increased reaching a level comparable with the slower PA-18 Super Cub by May 1970. United States Geological Survey topographic maps of scales 1:63000 and 1:250000 were used to record positions. A Sony Model TC-100 cassette tape recorder was used to record aerial observations. Access to nests visited on foot was gained by routine rock-climbing techniques.

Methods used in 1969 and 1970 were identical to those described for 1968 with a few exceptions. Snow machines were not employed in 1969 or 1970 because of early snow-melt. In 1969 26.9 search hours were spent in a PA-18, 8.8 in a Cessna 180. In 1970, the aerial survey was conducted solely from the Cessna 180 aircraft (28.4 hours). One helicopter trip to a remote sector was provided by Standard Oil Company geologists in late July 1970. During all three years of the study, various men from the U. S. Geological Survey, particularly Dr. C. L. Sainsbury, provided valuable information and assistance.

Food Habits

Collection of the uneaten portions of prey items (hereinafter referred to as "prey remains"), along with regurgitated pellets, were made from all accessible occupied nesting sites. Prey remains were analyzed to determine the prey species utilized for food by nesting Gyrfalcons. Although an analysis of pellets was made for comparative purposes, prey remains received the major emphasis. Pellets, with the exception of their microtine contents, were less informative, due to the qualitative nature of the contents and to the fact that upon analysis the pellets rarely offered evidence of prey species other than those already represented in the prey remains (with the exception of microtines).

Regurgitated pellets and prey remains were collected from 10 nesting sites in 1968, 14 nesting sites in 1969, and 16 nesting sites in 1970 (see Table 5, page 45). On the first visit to a nest site, a "clean-up" of the nest and its surroundings was made. Weathered pellets and remains were discarded, and only fresh specimens were collected, leaving the places of accumulation clean of food residues. On subsequent visits only those residues accumulated by the breeding pair would be present in the sample. Outcrops, ridgetops, and grassy hummocks in the immediate area were searched to determine the locations of favorite perching places. Pellets found away from the known perches or the nest were discarded since usually they could not be attributed to any one species of raptor (Weir, 1967). Throughout the summer, the nearby slopes were criss-crossed on foot; additional kills usually in the form of a ring of plucked ptarmigan feathers were noted. The majority of the samples came from the occupied nests, the slopes directly beneath them, and the two or three primary perching places nearby.

The tables were constructed using data from the remains collected at these locations. These remains usually consisted of actual skeletal material with adhering flesh, fur, or feathers. Feather-rings on the nearby slopes were usually omitted, since almost all such feather-rings represented ptarmigan (Lagopus lagopus and Lagopus mutus) in winter plumage and were obviously from the previous winter or early spring. It was generally impossible to determine if feather-rings from a prey species represented other kills of that species or if they belonged to the skeletal remains of that species collected from the nest area.

When searching a nest for uneaten remains a careful search was made for significant small feathers or skeletal material, in recognition of the fact that the larger avian and mammal remains would be the most conspicuous and, therefore, most often recorded species (Errington, 1932). This search usually produced passerine and/or microtine remains hidden in the nest litter.

Collections made at each nest site were placed in labeled plastic bags. It was common to find portions (feet, feathers, etc.) from two or three separate kills of the same species at the perching and plucking places. Each set was placed in its individual plastic bag before being added to the total collection.

The collection from any one eyrie on any one date was treated as follows: each labeled plastic bag was vented to allow drying and to prevent mold and decomposition and placed in a labeled paper bag, with a liberal quantity of naptha crystals. These bags were stored in a cool, dry place whenever possible and, once remains were safely dry, the sealed paper bags were packed in cartons for shipment to Fairbanks.

Identification of the skeletal material, feathers, and other uneaten portions was carried out during 1970 and 1971 at the bird and mammal collection of the University of Alaska.

Whole pellets were broken apart and examined for content. In the majority of cases, the pellets were composed of mammal hair, small bones, and feathers from the heads, necks, and breasts of birds (as described by Bond, 1936). Pellets resulting from a meal of ptarmigan commonly contained the antebrachium and the manus and often the humerus of a wing, or the tibio-tarsus, tarso-metatarsus, phalanges, and often the femur of a leg. Rarely did the examination of a pellet reveal signs of a species not already present among the uneaten prey remains. In almost all cases species represented in pellet contents were proportional to those found in the corresponding prey remains. Evidence of microtines was more often found in pellets than in prey remains (by a factor of about five). This indicates that microtine rodents are taken to a greater degree than would be assumed if only prey remains are examined.

Pellet examination tends to reveal qualitative, but not quantitative, information (Errington, 1930, 1932). Therefore, only the uneaten portions of prey remains were used to develop a quantitative picture of Gyrfalcon diet in northwestern Alaska.

RESULTS

Numbers and Distribution

The major study area comprises approximately 17,000 square miles of potential Gyrfalcon habitat, and includes essentially the whole Seward Peninsula. Virtually all of this large area was examined from aircraft or on the ground. The first survey flights conducted in 1968 served to familiarize me with the topography and terrain of the Seward Peninsula. By aerial observation, it became clear that because of geologic and altitudinal factors some areas were essentially devoid of nesting sites. The Kigluiak Mountains are steep, with crests averaging about 3,000 feet above sea level. Valleys are narrow, barren, and do not support an abundance of prey species. More important, outcrops suitable as nest sites are rare. The surrounding hills are rounded and are also not characterized by rock outcrops. In the course of this study, no cliff-nesting raptors have been observed in this region.

In contrast to the rugged Kigluiaks much of the Bendeleben range is well weathered and rounded. Some scattered rock outcrops do occur, most in the form of tors, but few offer suitable ledges for nest construction. A few suitable outcroppings exist, primarily along the water courses, generally not far above the valley floors. A relatively small number of nestings occurred in the Bendeleben Mountains; the few outcrops available were not heavily utilized.

Rock outcrops are rarely encountered in the marshes, coastal plains, lava flows, and broad low basins associated with the larger inland river systems; consequently, few nesting sites are available. Rock outcrops do occur in upland "hilly" regions, in faulted areas, on some upland benches, on the shoulders of some hills, and along some water courses. Granitic intrusions in some well-faulted zones have produced spires and tors well suited as nesting sites. A relatively small proportion of the coast line offers sea-cliffs suitable for nesting.

The sub-study area (Figure 1) covers about 2,400 square miles and includes the rugged Kugluiak Mountains, coastal marshes and plains along the southwestern coast, and two relatively minor stretches of sea cliffs. The remaining portion of the sub-study area, primarily south of the Kigluiak Mountains, is good nesting habitat and is characterized by high (1,000 to 2,000 feet) rolling hills interlaced by 12 relatively short (16 to 40 miles) drainage systems. A large part of this hilly region consists of metamorphic schist and limestone. These two basic rock types are interspersed and lend themselves well to the formation of numerous outcrops and tors through faulting, folding, thrusting, and erosion. These outcrops and tors

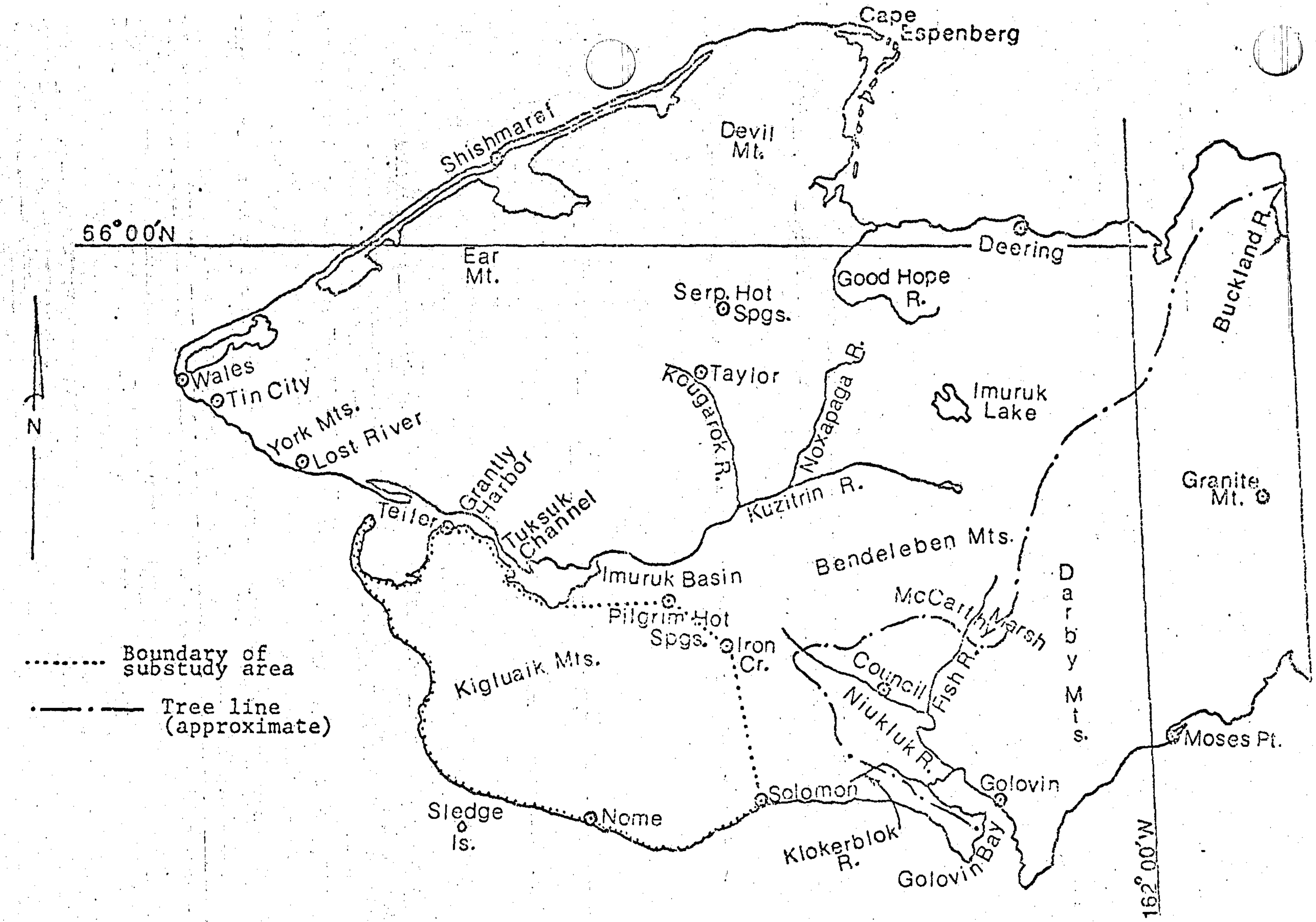

Figure 1. The Seward Peninsula, Alaska, showing the boundaries of the 1968 - 1970 substudy area, the approximate tree line and the 162°00' W meridian.

are heavily utilized by Gyrfalcons and other cliff nesting species. This area includes about 1,000 square miles and has been designated as Area I.

The remaining approximately 14,600 square miles of the Seward Peninsula includes the Darby Mountains, the Bendeleben Mountains, and the rugged York Mountains. These ranges interrupt the general pattern of rolling 1,000 to 2,000 foot hills and are interlaced by numerous stream systems. This general pattern of tundra covered hills has a few exceptions; a large lava and cinder cone-covered area lies between the Bendeleben Mountains and Imuruk Lake and extends west to a point near the junction of the Kuzitrin River and the Noxapaga River. A large marshy lowland basin contains the extensive Kuzitrin and Noxapaga River systems and Imuruk Basin. These river systems and surrounding pattern of tundra ponds drain into Imuruk Basin north of the Kigluiak Mountains. An additional large area (about 2,500 square miles) extending from Wales to the mouth of the Goodhope River consists of wet lowland tundra with extensive systems of sloughs, ponds, and rivers flowing into large coastal lagoons. Finally, a Spruce forest extends over an eastern portion of the peninsula (see Figure 1). In all, about four to five thousand square miles of the Seward Peninsula outside of the sub-study area are rarely utilized by nesting Gyrfalcons because of the lack of suitable nesting sites.

In the remaining 9,600 to 10,600 square miles, the occurrence of suitable outcrops is generally low, though these outcrops are important to Gyrfalcon pairs as nesting cliffs. These outcrops tend to be widely scattered or concentrated in small unevenly distributed clusters, with one important exception--an area of about 1,200 square miles in the central-western portion of the peninsula where numerous outcrops occur. This area has been designated Area II for purposes of discussion. Area II is similar to Area I in that it consists mainly of schist and limestone. In addition, Area II has a major faulted zone running through its northern half. Igneous rock in the form of granitic intrusions now existing as large granitic tors occurs where a second important fault trend intersects the first. These large complex formations are contained within a relatively small 20 square mile portion of Area II and offer many suitable nesting sites (see Table 2).

During 1968, 1969, and 1970, the sub-study area (Figure 1) was given comprehensive aerial and ground coverage. This region of about 2,400 square miles contains about 140 outcrops suitable for nesting by at least one of three species of cliff-nesting raptors--Gyrfalcons, Rough-legged Hawks (<u>Buteo lagopus</u>), and Golden Eagles (<u>Aquila chrysaetos</u>). These outcrops also serve as potential nesting cliffs for Ravens (<u>Corvus corax</u>). Thirty-eight of the 140 outcrops are known to be suitable as Gyrfalcon

Table 1. Numbers and densities of breeding Gyrfalcon pairs on the Seward Peninsula, Alaska

Area	Sq. Mi.	Year	No. of Active Nests	Sq. Mi. Per Pr.
Sub-study	2,400	1968	19[1]	126.3
		1969	14	171.4
		1970	19[2]	126.3
		3 years	52 $\bar{x}$ = 17.3	$\bar{x}$ = 141.3
Area I	1,000	1968	16	62.5
		1969	12	83.3
		1970	16	62.5
		3 years	44 $\bar{x}$ = 14.7	$\bar{x}$ = 69.4
Area II	1,200	1968	7[3]	171.4
		1969	16	75.0
		1970	19	63.16
		3 years	42 $\bar{x}$ = 14.0	$\bar{x}$ = 103.2
Area II	1,200	Good coverage years (1969, 1970)	35 $\bar{x}$ = 17.5	$\bar{x}$ = 69.1
Entire Seward Peninsula (West of 162° W.)	17,000	1968	34	500.0
		1969	48	354.2
		1970	49	346.9
		3 years	131 $\bar{x}$ = 43.7	$\bar{x}$ = 401.3
Entire Seward Peninsula (West of 162° W.)		Good coverage years (1969, 1970)	97 $\bar{x}$ = 48.5	$\bar{x}$ = 350.5

[1]In addition, one other pair was located that appeared to have lost their clutch but continued to frequent the nesting cliff until about mid-July.

[2]One additional single bird was found defending an outcrop where only an empty nest was repeatedly observed from the aircraft.

[3]This area received poor aerial coverage during 1968, which resulted in what is certainly a lower number of nestings that actually occurred. The total number listed for 1968 reflects this.

Table 2. Successive use of nesting cliffs[1] by predatory birds on a 20-square-mile portion of the Seward Peninsula, 1968-1970

Site No.	Use in 1968	Use in 1969	Use in 1970
1	Gyrfalcon		
2	Gyrfalcon		
3	Rough-Legged Hawk	Rough-Legged Hawk	Rough-Legged Hawk
4	Rough-Legged Hawk		Rough-Legged Hawk
5	Golden Eagle		Golden Eagle present[2]
6	Raven		
7		Gyrfalcon	Gyrfalcon[3]
8		Gyrfalcon	
9		Gyrfalcon	
10		Gyrfalcon	
11		Rough-Legged Hawk	
12		Rough-Legged Hawk	
13		Raven	
14		Raven	
15			Gyrfalcon
16			Rough-Legged Hawk
17			Rough-Legged Hawk
18			Rough-Legged Hawk
19			Rough-Legged Hawk
20			Rough-Legged Hawk
21			Rough-Legged Hawk
22			Raven
23			Unidentified
	NOT USED BY ANY SPECIES DURING 1968 - 1970		
36			

[1] All these cliffs have at least one old stick nest or an eyrie ledge formed by the remains of a stick nest on them.
[2] At least one bird spent considerable time here and was observed a number of times but no evidence of breeding was found.
[3] This was the same pair based on color and behavioral characteristics.

nesting cliffs. Gyrfalcons were observed utilizing these outcrops over the three-year study period; reliable local residents reported that Gyrfalcons had used six additional outcrops prior to 1968. About 30 more outcrops appear to be useable based on comparisons of cliff height, ledge size, and the presence of old, large stick nests.

Table 1 lists the numbers of breeding Gyrfalcon pairs and their relative densities for the Seward Peninsula including three sub-areas. During the 1969 survey a decrease in the number of breeding pairs was observed in the sub-study area and in its sub-unit, Area I. This decline amounted to about 25 per cent and occurred in a year when some important prey populations declined and will be discussed further in the Food Habits section. In 1970 the number of breeding pairs was found to have returned to the 1968 level. This occurred in a year when some important prey species populations appeared to have recovered to a level somewhat below the 1968 "high" but markedly above that of the 1969 "low" (see Food Habits section).

During the course of the study, 52, or 39.7 per cent of the 131 total Gyrfalcon nestings observed on the peninsula, occurred within the approximately 2,400 square mile sub-study area. Forty-four, or 33.6 per cent of the 131 total Gyrfalcon nestings, occurred within the approximately 1,000 square mile Area I. Of the 52 total Gyrfalcon nestings observed within the sub-study area, 84.6 per cent occurred in Area I.

Area II was discovered during the last survey flight conducted in 1968. Thorough coverage was not possible that season. In succeeding years (1969 and 1970) Area II was given thorough coverage. The mean density figure from 1969 and 1970, omitting 1968, is probably a reasonable representation of Area II although it lacks the full perspective of all three years of the study. During the course of the study, 42, or 32.1 per cent of the total 131 Gyrfalcon nestings observed, occurred within this approximately 1,200 square mile area. Combining both areas of good nesting habitat (Area I and Area II), 86, or 65.7 per cent of all observed nestings, occurred within only approximately 2,200 square miles or about 13 per cent of the Seward Peninsula.

Within the entire 17,000 square miles of the Seward Peninsula (west of 162° W.) a total of 131 breeding pairs of Gyrfalcons with a mean density of about one pair per 401 square miles was observed over the course of the study. Because I was unfamiliar with the terrain and a larger portion of the 1968 search time (about one half) was utilized to locate areas of concentration and re-check possible nesting situations, I consider the 1968 total of 34 breeding Gyrfalcon pairs to be low and not representative of the Seward Peninsula as a whole for that year. In 1969, a total of 48 breeding pairs of Gyrfalcons was found, and in

1970 a total of 49 breeding pairs (Table 1). The mean density for these two years is about one pair per 350 square miles. This figure, in my judgment, is minimal for the Seward Peninsula, but may be representative of a few other areas of upland coastal habitat in western Alaska.

From the present data it appears that Cade (1960) was correct in attributing high densities of Gyrfalcons to the Seward Peninsula and the western coast of Alaska adjacent to the Bering Sea. He reported from Eskimo information (the reliability of which he was uncertain) that there were "30 known nesting areas on the Seward Peninsula." It is possible that the Seward Peninsula supports more breeding Gyrfalcons than any other area of comparable size in Alaska when prey levels are high.

I have previously estimated (Roseneau, 1970) the total Seward Peninsula Gyrfalcon population during abundant prey years at about 70 pairs. This estimate is based on aerial views of the entire peninsula and knowledge of the availability of nesting sites in some areas that were not intensively surveyed. Assuming the estimate to be accurate, it is possible that densities of Gyrfalcons on the Seward Peninsula may be as high as one pair per 243 square miles for these 17,000 square miles.

Cade (1960) estimated the total Alaskan Gyrfalcon population including both breeders and non-breeders to be 200 to 300 pairs. Because of the lack of Alaskan

Gyrfalcon data, he felt that an "adequate conception of the size of the Gyrfalcon population in Alaska" could not be formulated. The Seward Peninsula generally has an unusually large number of Gyrfalcons. While it is doubtful that many large areas of habitat as good as the Seward Peninsula exist in Alaska, very little of inland Alaska has been examined, with the exception of some river courses. Aerial reconnaissance is desirable before reliable population estimates can be made, but it is possible that the total population in Alaska during good years may exceed Cade's estimate.

Population Changes

Little information on changes in Gyrfalcon populations is available. Cade (1960) has summarized the scanty work on Alaskan populations and best sums up the situation when he states: "Mount McKinley Park and the Colville River are the only two regions of Alaska where any kind of continuous record of the numbers of Gyrfalcons has been kept." In Mount McKinley National Park data are sparse. Cade (from Dixon, 1938, and Murie, 1946) cites only five known nesting cliffs supporting a maximum of three pairs in any single year. The Colville River data indicate a population of three pairs of Gyrfalcons inhabitating the upper and middle reaches of the river in 1952. In 1959, this same stretch of river supported 12 pairs.

During those two years peregrine numbers remained relatively constant (17 pairs in 1952 and 15 pairs in 1959). In another example from the Colville, a maximum of six pairs of Gyrfalcons have bred in any one year (1959), with an average over five years of only 2.6 pairs (Cade, 1960). Apparent numerical conflicts in Cade's data make the total counts for 1959 uncertain (pages 177 and 256, Cade, 1960).

On the Seward Peninsula during good survey coverage years (1969 and 1970), a relatively constant number of breeding pairs was found. In 1968, only 34 breeding pairs were located, but this almost certainly reflects the poor survey coverage. In addition, 1968 was the year when the abundance of prey species (including two major food species) was the greatest (see Food Habits section). So far my data suggest that on a regional basis Gyrfalcon populations, within these large areas of nesting habitat, remain relatively constant, at least on the Seward Peninsula.

Fluctuations in numbers did occur within some areas of the Seward Peninsula. These fluctuations in numbers of breeding pairs are similar to those commonly mentioned throughout most of the Gyrfalcon literature, e.g., Cade (1960) and Hagen (1952).

In one 20 square mile portion of Area II offering abundant outcrops, careful ground and aerial reconnaissance located a minimum of 36 potential nesting cliffs showing signs of previous use by at least one of the four large cliff-nesters found on the Seward Peninsula (Gyrfalcons, Rough-legged Hawks, Golden Eagles, and Ravens). Of these 36 potential nesting cliffs, about half appeared to offer nesting conditions similar to most known Gyrfalcon eyries. Twenty-two of the 36 cliffs were observed to be utilized by the four cliff-nesting species over the period 1968 to 1970. Table 2 presents the history of occupation of the nesting cliffs in this small section of Gyrfalcon habitat. It would appear that this relatively small and isolated "community" of large cliff-nesters, including Gyrfalcons, is in a constant state of flux.

In another area, an approximately 50 mile section of a river system had one pair of Gyrfalcons breeding on it in 1968, two pairs in 1969, and five pairs in 1970. On another large inland river (over 100 miles long) only five nesting cliffs occur. In 1968, one was occupied by Ravens and four were unused. In 1969, the cliff used by the Ravens was occupied by Gyrfalcons. Of the four unused cliffs occurring on the same bank of a one-half-mile stretch of the river, one was unused, one was occupied by Gyrfalcons, one was occupied by Rough-legged Hawks, and one was occupied by Ravens. In 1970 Ravens were nesting again at their 1968 cliff. Of the other four cliffs, Gyrfalcons again used their 1969 site. Ravens used the 1969 Rough-legged Hawk cliff and Rough-legged Hawks used the 1969 Raven site. The one nesting cliff with a well-constructed large stick nest situated under an overhang offering excellent shelter had remained unused all three years.

In one five-mile stretch of creek in 1968 I found eight nesting cliffs. Three of these were occupied by breeding Gyrfalcons, three by breeding Rough-legged Hawks, and two were empty. In 1969, this same section of creek was utilized by three pairs of Gyrfalcons. A pair of Rough-legged Hawks inhabited one of the remaining five nesting cliffs. In 1970, only one Gyrfalcon pair was found nesting in the vicinity of the creek (four miles north), and one of the 1968 Gyrfalcon eyries was being utilized by a pair of breeding Lesser Canada Geese (*Branta canadensis*).

In two successively larger areas of habitat, Area I and the sub-study area, variation in yearly numbers of breeding Gyrfalcons occurred (Table 1). Area I, sub-study area, lost four pairs in 1969. The larger sub-study area lost five pairs this same year. Considering both areas separately, both experienced a decline in breeding Gyrfalcon pairs of about 25 per cent in 1969. The 1969 decline can be attributed in part to a decline in some of the important food species (see Food Habits section). The yearly numbers of Rough-legged Hawks and Golden Eagles (i.e., breeding pairs) support this hypothesis. In the sub-study area, 28 pairs of Rough-legged Hawks bred in 1968, only 8 pairs in 1969, and 35 pairs in 1970. In 1968 seven pairs of breeding Golden Eagles were present, in 1969 only two pairs, and in 1970 again seven pairs. The Rough-legged Hawk numbers, in particular, clearly reflect the 1969 microtine "crash." It is possible that the decline in breeding numbers of Gyrfalcons in the sub-study area also reflects the microtine crash as well as a simultaneous decline in the ptarmigan population (see Figure 3 and Figure 5).

Frequent references are made in the literature to the apparent response of Gyrfalcons to microtine and ptarmigan cycles (Dementiev and Gortchakovskaya, 1945; Hagen, 1952; Cade, 1960; Gudmundsson, 1970; Bengtson, 1971). Gyrfalcons are reported to be nonexistent cr scarce breeders in many areas during microtine or ptarmigan "lows." It should be noted that these areas tend to represent situations in which Gyrfalcons are dependent primarily on these two categories of food. Dementiev and Gortchakovskaya (1945) did not find an interdependence between Gyrfalcons and lemmings and suggests Gyrfalcon utilization of a sea bird colony as an explanation.

There are indications that some food species, notably ptarmigan, Long-tailed Jaegers, and microtines, did not decline to the same degree in the northern half of the Seward Peninsula during 1969 as they did in the southern half. If these indications are correct, one might speculate that numbers of raptors, including some Gyrfalcons, shifted breeding activities to the northern parts of the peninsula in response to this situation.

Although Rough-legged Hawks were not of primary concern, nest locations were noted. Only six occupied nest sites were observed in 1968 in the northern half of the peninsula. About six more pairs were observed from a distance and were probably breeding in this sector. A higher concentration (28 pairs) occurred in the southern sub-study area. In 1969 34 breeding pairs of Rough-legged Hawks were found in the northern half of the peninsula, but only eight breeding pairs were evident in the sub-study area. 1970 appeared to be a year of general abundance for Rough-legged Hawks over the entire Seward Peninsula. Thirty-five pairs were found nesting in the sub-study area and 38 pairs in the northern half of the peninsula. In 1969, when 14 breeding pairs of Gyrfalcons inhabited the sub-study area, more nesting pairs were evident in a strip north of the sub-study area but south of Area II.

In a very large region of habitat, such as the 17,000 square miles of the Seward Peninsula considered in this study, the numbers of Gyrfalcons probably remain relatively constant unless a major portion (or all) of the region is affected by drastic changes in prey population size, availability, or vulnerability.

Cade (1960), speaking of Gyrfalcons, states: "One pair may have several alternate aerie areas, or, as appears to be true on the Colville, pairs actually breeding from year to year fluctuate greatly in any given region; hence, there is no meaning to a static estimate of breeding population size."

I contend that estimates of the breeding population size of Gyrfalcons have meaning only when applied to "regions" of an isolated nature and/or of large size (such as the Seward Peninsula). From my observations, it is possible that the changes in cliff occupancy or the fluctuations in numbers of breeding pairs in areas reported in the present Gyrfalcon literature may be relatively local in nature. These changes probably reflect a population shift to other areas of a large region rather than a general non-breeding of Gyrfalcon pairs. Few authors state whether non-breeding Gyrfalcons were observed attached to nesting cliffs or if they were in the vicinity of the cliffs. The implication is usually that they were not. Hagen (1952) claimed the ". . .existence of non-breeding years in the life of a gyr-falcon pair." and is based on what is, in my opinion, insufficient data. Cade (1960) implied that a Gyrfalcon pair, if not breeding at the same nesting cliff each year, was not breeding at all that year. Within a large region of abundant nesting sites, the possibilities of local population shifts or at least breeding attempts in other areas would seem more reasonable than actual non-breeding. On the Seward Peninsula during 1968-1970 only two pairs and four other individual Gyrfalcons were observed that could be termed possible non-breeders. Further research will be required to gain a better understanding of the possible non-breeding of Gyrfalcon pairs and how such occurrences may relate to the population as a whole.

The theme that Gyrfalcons not breeding in one area or region may in fact breed in another area or region that was not investigated is often understated. The only circumpolar region where there are definite indications that Gyrfalcons actually stay in an area, or actually occupy an eyrie and do not attempt to breed, is Iceland. Gudmundsson (pers. comm., 1969) mentioned such observations in the Lake Myvatn region. Gudmundsson (1970) states: "As the ptarmigan is the staple diet of the Gyrfalcon in Iceland it is not surprising that the Gyrfalcon fluctuates with the ptarmigan and that during years of ptarmigan scarcity many Gyrfalcons do not nest at all."

Region-wide Gyrfalcon population fluctuations probably do, in fact, occur in Alaska (and throughout the Gyrfalcon range), but further study is needed to document the scope and degree of these changes in population numbers, and to document non-breeding.

Gyrfalcon nesting cliff tenacity was low on the Seward Peninsula. Of the 34 active Gyrfalcon nesting cliffs located in 1968 (Table 3), 18 (53 per cent) were found inactive and unused by any species of cliff-nester in 1969. Eight (24 per cent) were used again by breeding Gyrfalcons. Of the remaining seven, three were occupied by Ravens, two by Rough-legged Hawks, one by a pair of Lesser Canada Geese, one by an unidentified species, and one was not checked. In 1970, 22 (65 per cent) of the 1968 Gyrfalcon nesting cliffs were found to be inactive. Four (12 per cent) were utilized by Gyrfalcons. Of the remaining eight, one was occupied by Ravens, five were occupied by Rough-legged Hawks, one by Golden Eagles, and one by an unidentified species. Twenty-three (48 per cent) of the 48 active Gyrfalcon nesting cliffs located in 1969 (see Table 4) were found unoccupied by any species in 1970. Fourteen (about 30 per cent) were occupied again by nesting Gyrfalcons. Of the remaining 11, three were occupied by Ravens, one by Rough-legged Hawks, one by Golden Eagles, and six were not checked. In about five to six per cent of the cases where the nesting cliff was unoccupied, the nests were gone, making the nesting cliffs at least temporarily unusable.

A total of 131 Gyrfalcon nestings were observed

Table 3. Species utilizing the 34 active Gyrfalcon nesting cliffs observed on the Seward Peninsula, Alaska, 1968-1970

Species	1968 Number	1969 Number	1970 Number
Gyrfalcon	34	8	4
Unoccupied		18	22
Rough-legged Hawk		2	5
Raven		3	1
Golden Eagle			1
Lesser Canada Goose		1	
Unidentified Species		1	1
Unknown		1	
Total	34	34	34

Table 4. Species utilizing the 48 active 1969 Gyrfalcon nesting cliffs observed on the Seward Peninsula, Alaska, 1968-1970

Species	1968 Number	1969 Number	1970 Number
Gyrfalcon	9	48	14
Unoccupied	22		23
Rough-legged Hawk	4		1
Raven	1		3
Golden Eagle	2		1
Unidentified	1		
Unknown	10	—	6
Total	48	48	48

over the course of the study. These nestings occurred at 107 nesting cliffs. Seventeen nesting cliffs (16 per cent) were involved in Gyrfalcon nestings during two successive years (1968 and 1969, or 1969 and 1970). Only 20 (19 per cent), including the 17 mentioned above, were utilized two out of every three years. Only four other nesting cliffs (four per cent) were occupied by breeding Gyrfalcons during all three years (1968, 1969, and 1970). Eighty-three (about 77 per cent) of the 107 nesting cliffs were utilized by Gyrfalcons only one during the three years. Twenty-seven (about 25 per cent) of the 107 nesting cliffs were utilized once during the three years by other cliff-nesting species. Sixteen of these cases involved Rough-legged Hawks, five involved Ravens, four involved Golden Eagles, one involved Lesser Canada Geese, and one involved an unidentified species.

Most nesting cliffs had at least one and often two (or more) alternate nest sites that had been utilized by the cliff-nesting species at some time in the past. Of the 20 nesting cliffs where Gyrfalcon nestings occurred in two out of the three years, the same nest site was occupied in at least ten cases. In the other four instances where the nesting cliff was occupied all three years by Gyrfalcons, there are a total of eight possible nest sites (two at each nesting cliff). Two of these nest sites were utilized all three years, two were utilized two out of the three years, two were utilized only once, and two were never used.

In general, all existing nest cliffs on the Seward Peninsula that showed signs of having had at least one stick nest constructed on them sometime in their history (estimated to be 400-500) had one nest site that appeared from signs of useage to play a predominant role in nestings by any of the cliff-nesting species. In subjective terms the situation appeared to follow that of the nest site useage observed in the sub-study area and I believe that these predominant nest sites are involved in about 50 per cent of the nestings occurring on these nesting cliffs and therefore might be considered as "traditional" nest sites.

This low nest site and nesting cliff tenacity (compared to that attributed to Gyrfalcons and some of the other large falcons [Cade, 1960]) is somewhat opposed to the limited Alaska Range data. In one case, Gyrfalcon pairs have occupied a nesting cliff with only one nest site for the last nine years and probably longer. Prior to 1963, this nest was occasionally visited by successful egg collectors and in at least two years (Mr. Vern Seifert, pers. comm., 1969) the pairs were shot. Cade (1960) discusses traditional nesting cliffs and how nesting cliffs such as this one may develop relatively long histories of use by falcons.

It is clear that although the total Gyrfalcon population probably remained constant the population underwent considerable shifting from area to area, nesting cliff to nesting cliff, and nest site to nest site.

It appears that in a small area of habitat or along a short stretch of creek where nesting cliffs are common considerable "cliff-shifting" occurs (i.e., the utilization of different nesting cliffs by what may be the Gyrfalcon pairs). It is also common for the number of breeding Gyrfalcon pairs inhabiting the area to change from year to year, and for some vacated nesting cliffs to function as nesting cliffs for other large cliff-nesting species. The degree to which these phenomena occur may vary locally due to changes in local prey populations, reduction of nest sites (nests falling off of cliffs or being destroyed by rock-falls), creation of nest sites (the construction of a stick nest on some cliff ledge by Rough-legged Hawks, Ravens, or Golden Eagles), or even the behavior of Gyrfalcons themselves.

This cliff shifting and alternation of nesting cliffs and nest sites probably does not reflect the implications of the comment made by Dementiev and Gortchakovskaya (1945) when they stated: "Thus it may be seen that the Gyrfalcon used to breed on the same territory constantly enough, though not every successive year, having probably been chased off by the Raven." I believe it is unlikely that Gyrfalcons are "chased" from or forced to abandon nesting cliffs and nest sites by any of the three other important species of cliff-nesters. Cade (1960) comments on this same statement and our conclusions coincide. Cade (1960) also reports that he found a dead uneaten Raven, presumably killed by Gyrfalcons, below an eyrie on the Oolamnagavik River in 1956 and he mentions one other similar instance recorded in the literature (Brull, 1938). At one 1969 Gyrfalcon eyrie I found a freshly killed but uneaten body of a Raven "cached" beside the nest--an obvious loser in some aerial encounter.

Information on nesting relationships between Gyrfalcons and Ravens, Golden Eagles, Rough-legged Hawks, and Peregrines is summarized by Cade (1960). In 1968 I observed the successful nesting of a Raven pair and a Gyrfalcon pair on the same hillside about 300 yards apart. In 1969 and 1970 a pair of Ravens successfully nested about 100 yards from an active Gyrfalcon eyrie in the sub-study area. The nests were at approximately the same level and in plain sight of one another. On one occasion in 1969, a 45-minute battle between the pairs was observed (the birds were unaware of my presence both before and during the conflict). The initial encounter was not witnessed, but from that point on the Gyrfalcons were the aggressors. The male Gyrfalcon as initial combatant against both Ravens was joined at the end of the first ten minutes by the female which had been brooding eggs or newly hatched young at the eyrie. The male immediately stepped up the force and frequency of his attacks. The female Gyrfalcon retired to her eyrie after 35 minutes and her mate broke off the attack moments afterward. On many occasions one or both of the Ravens succeeded in returning to their nest to perch or brood the newly-hatched young and were forced to leave the nest because of extremely powerful close passes by the male Gyrfalcon. The female Gyrfalcon also was successful in driving the Ravens from their nest a few times, but she did not put as much effort into her attacks, often breaking off her passes before an actual encounter occurred. However, she tended to be more vocal. The Ravens were completely successful in avoiding actual contact, usually by side-slipping at the last moment. At each encounter of a Gyrfalcon and Raven, the Gyrfalcon presented its feet as if to strike, while the Raven countered by rolling and presenting its feet toward the falcon (usually while in the act of side-slipping). In two cases, one of the Ravens actually flew upwards to meet the male Gyrfalcon on a direct collision course, forcing the falcon to flare off, but without a doubt the Gyrfalcons demonstrated a clear advantage over the Ravens. The termination of the aerial battle appeared to result from fatigue and loss of interest on the part of the falcons. The Ravens did not appear to withstand the physical demands of the battle as well as the falcons. During other observations at this eyrie, including two three-day periods, no other encounters or conflicts were observed between the two species as they both attended to the feeding of their young. From 1968 to 1970 Raven pairs nested in close proximity (100-400 yards) to Gyrfalcon in seven instances.

No encounters between Golden Eagles and Gyrfalcons were observed, though they must occur (Cade, 1960). In one instance Golden Eagles nested about 400 yards away from a Gyrfalcon eyrie on the same hillside and at nearly the same elevation. On one occasion, both Gyrfalcons were observed to watch one of the eagles from their nesting cliff as it soared briefly over the hill top. The nests were hidden from each other by a small series of outcrops and the falcon nesting cliff faced the back side of the eagle nesting cliff.

Rough-legged Hawk encounters with Gyrfalcons were numerous and paralleled the observations of Cade (1960). In one instance, a male Gyrfalcon was observed stooping at a male Rough-legged Hawk that had its nest about 200 feet away on the same cliff. Both birds were unaware of my presence. The conflict began when the Rough-legged Hawk, soaring parallel to the cliff, passed directly in front of the falcon eyrie (and about 100 feet out from it). The male Gryfalcon was resting on a perch about 100 feet beyond his eyrie (where his mate was brooding eggs) and as the Rough-legged Hawk glided past, he immediately flew to intercept the intruder. The Rough-legged Hawk side-slipped to avoid contact and both birds began loudly vocalizing. During the next ten minutes the Rough-legged Hawk continued to circle about on a course that brought him closer to his own nest while the Gyrfalcon repeatedly stooped at him from above. I was impressed with the apparent ease with which the Rough-legged Hawk avoided the Gyrfalcon's intent stoops by employing a combination of watchfulness, abrupt hovering and side-slipping. The intensity of the battle slowed down after about the first five minutes and continued to do so until both birds drifted back to their respective portions of the cliff to perch. In another instance, where Rough-legged Hawks nested on the same cliff and about 100 yards away in direct view from nesting Gyrfalcons, my approach flushed a newly fledged Gyrfalcon. The young falcon flew up the river and under the Rough-legged Hawk nest (which contained five young about to fledge). Both Rough-legged Hawk adults dove on the young Gyrfalcon almost forcing it into the river. The female Gyrfalcon, soaring overhead, responded immediately and "kekking," stooping hard at the Rough-legged Hawks, narrowly missing one before they could continue their harassment of the young Gyrfalcon. The Rough-legged Hawks retreated and the female Gyrfalcon turned her attention to me.

During the course of the study, Rough-legged Hawks are known to have shared the same cliff with Gyrfalcons in at least nine instances. The proximity of the nests varied from 200 feet in one case to about 400 yards. Many additional cases existed in which Rough-legged Hawks nested on another, often smaller outcrop, within 200 to 400 yards from active Gyrfalcon nesting cliffs.

Food Habits

No attempt is made in this paper to condense the circumpolar data pertaining to species known to have been killed by Gyrfalcons. Hagen (1952) and Cade (1960) have already summarized a considerable portion of this information; those and three other papers (Murie, 1946; Dementiev and Gortchakovskaya, 1945; and Bengtson, 1971) are of primary importance because they involve: (1) reasonably large sample sizes; (2) observations over more than one year's time; and/or (3) observations at more than one eyrie.

The general characteristics of Gyrfalcon diets, based on these papers, can be summarized into the following points:

1. Gyrfalcons rely heavily on resident species of birds and mammals in the Arctic and subarctic.

a. Gyrfalcons prey heavily on Willow Ptarmigan (Lagopus lagopus) and Rock Ptarmigan (L. mutus). Ptarmigan can be considered as the single most important food item (Cade, 1960; Hagen, 1952; Bengtson, 1971) on a circumpolar basis.

b. Small mammals are known to be an important food source on a weight basis in Alaska (Murie, 1946; Cade, 1960). The Arctic Ground Squirrel is particularly important and can surpass ptarmigan as the most utilized food species in some areas of Alaska (Murie, 1946; Cade, 1960). The lemmings (Lemmus lemmus, the Norwegian Lemming, L. trimucronatus, the Brown Lemming, and Dicrostonyx groenlandicus, the Collared Lemming) on a world wide basis seem to play more variable roles and usually are not as important as food (Dementiev and Gortchakovskaya, 1945; Hagen, 1952; Cade, 1960). In Alaska the Brown Lemming, the Collared Lemming, the Tundra Vole (Microtus oeconomus), the Singing Vole (M. miurus), and the Red-backed Vole (Clethrionomys rutilus) appear to play an important but indirect role in relation to Gyrfalcon food habits (Cade, 1960). Large numbers of microtines commonly attract large numbers of rodent-eating birds, many of which are utilized by Gyrfalcons for food probably in greater proportion (at least by weight) than the microtines themselves.

2. In Iceland a relatively stable and large population of ducks is heavily utilized as an important source of food by Gyrfalcons nesting in, or frequenting, the Myvatn area. Utilization of Rock Ptarmigan increased as the ptarmigan population increased suggesting a preference for this food species over the ducks (Bengtson, 1971).

Salomonsen (1951) considers waterfowl to be one of two principal sources of food to Gyrfalcons during the nesting season in Greenland.

3. Dementiev and Gortchakovskaya (1945) documented a high utilization of seabirds (Alcids, Larids, and Anatids) by Gyrfalcons nesting near seabird colonies on Kharlov Island. Salomonsen (1951) considers seabirds to be a principal source of food for nesting Gyrfalcons in Greenland and indicates that Gyrfalcons usually nest near seabird colonies.

4. Gyrfalcons, on a circumpolar basis, take a relatively wide range of prey other than the species listed above, ranging from small passerines to other raptors. Gyrfalcons, however, tend to take a narrower range (in terms of numbers of species) of prey than do Peregrine Falcons (Falco peregrinus) (Cade, 1960).

5. In general, it appears that Gyrfalcons rely principally on two or three prey species as a source of food (Cade, 1960), and that coastal-nesting pairs feed chiefly on Alcids, Larids, and Anatids while inland-nesting birds feed chiefly on ptarmigan and small mammals (Dementiev and Gortchakovskaya, 1945; Cade, 1960).

6. Gyrfalcons also appear to be opportunistic, capable of taking a wide range of sizes of prey, and are able to shift to other food sources when ptarmigan become scarce (Bengtson, 1971; Cade, 1960).

7. In some parts of the world Gyrfalcons probably fluctuate with ptarmigan cycles (Gudmundsson, 1970) and in some instances appear to breed in lower numbers in response to ptarmigan lows. The degree of this relationship to ptarmigan populations probably varies from region to region and is poorly understood. Fluctuations of Gyrfalcon numbers have been reported by Salomonsen (1951) in connection with lemming numbers in Northeast Greenland.

Prey utilization on the Seward Peninsula

During the course of this study a total of 1,483 Gyrfalcon kills were identified from the immediate area around 40 Gyrfalcon nestings (see Table 5). Avian species constituted 85 per cent by number and approximately 87 per cent by weight of the total kill. Mammalian species constituted the remaining 15 per cent by number and 13 per cent by weight of the prey remains (see Table 6). Cade (1960) reports lower mammal subtotals for ten Colville River eyries (13.6 per cent of total/6.6 per cent of total/1.2 per cent by weight based on 142 kills), but a much higher mammal subtotal (76.2 per cent of total/80.1 per cent by weight based on 429 kills) for three Alaska Range eyries (data obtained from Murie, 1946, and unpublished; M. W. Nelson; and J. H. Doyle). This marked difference in the proportion of mammal remains can be attributed almost entirely to the differences in frequency of occurrence of

Table 5. Collection dates of Gyrfalcon prey remains

Eyrie	Year	Dates of Food Remains Collected
1	1968	22 June; 16 August
2	1968	6 June; 11 July
3	1968	16 June; 6 July; 23 August
5	1968	4, 9, 14, 25 June; 5, 23 July
8	1968	21 July
9	1968	31 May; 9 July
10	1968	9, 14, 23 June; 6 July
17	1968	13 June; 12 July
18	1968	21 June
19	1968	19 July
Total eyries = 10		Number of visits = 24
2	1969	19 June; 3, 13 July; 12 August
3	1969	24 May; 16, 23, 24 June; 7, 11, 17 July
4	1969	20 July
5	1969	16 June
6	1969	21, 26 June; 8, 12 July; 5 August
7	1969	11 August
8	1969	13 June
12	1969	5, 13 July
16	1969	27 May
20	1969	13 June
21	1969	13 June
22	1969	20 June
23	1969	16 July
Vern-69-1[2]	1969	July (date unknown)
Total eyries = 14		Number of visits = 26
1	1970	25 July
2	1970	1 June; 1 July
5	1970	29 May; 4 June
9	1970	8 June
11	1970	7, 8, 13, 14 July
12	1970	6 June; 7, 8, 13 July
13	1970	27 July
14	1970	28 May; 20 June
15	1970	24, 25 June
16	1970	31 May; 5, 12, 22, 27 June; 9 July
21	1970	26 July
24	1970	23 June
25	1970	August
26	1970	15 July
27	1970	15 June
28	1970	27 July
Total eyries = 16		Number of visits = 29
Total eyries = 29		Grand total number of visits = 79
Total nestings = 40		

[1]Not included in the total.
[2]This eyrie was located by Mr. Vern Seifert, who collected what remains he could find for donation to this project.

Table 6. Total 1968-1970 Gyrfalcon food remains

	Total Kills	Per cent of Total	Per cent Bird-Mammal	Appropriate weight class in grams	Per cent of total by weight
Ptarmigan species (*Lagopus lagopus* & *L. mutus*)	876	59.1	69.5	*550	71.6
Long-tailed Jaeger (*Stercorarius longicaudus*)	155	10.5	12.3	*320	7.4
American Golden Plover (*Pluvialis dominica*)	30	2.0	2.4	*135	0.6
Unidentified passerine species	29	1.5	2.3	* 30	0.1
Unidentified birds	23	1.6	1.8		
Unidentified shorebirds	14	0.9	1.1	100	0.2
Black-legged Kittiwake (*Rissa tridactyla*)	14	0.9	1.1	330	0.8
Common snipe (*Capella gallinago*)	13	0.9	1.0	100	0.2
Short-eared Owl (*Asio flammeus*)	12	0.8	1.0	*400	0.7
Whimbrel (*Numenius phaeopus*)	11	0.7	0.3	370	0.6
Robin (*Turdus migratorius*)	11	0.7	0.9	80	0.1
Unidentified waterfowl	8	0.5	0.6	800	0.1
Pintail (*Anas acuta*)	7	0.5	0.6	*900	0.9
Tufted Puffin (*Lunda cirrhata*)	7	0.5	0.6	600	0.6
Bar-tailed Godwit (*Limosa lapponica*)	6	0.4	0.5	275	0.3
Oldsquaw (*Clangula hyemalis*)	5	0.3	0.4	*900	0.7
Lapland Longspur (*Calcarius lapponicus*)	5	0.3	0.4	* 30	0.1
Pigeon Guillemot (*Cepphus columba*)	4	0.3	0.3	500	0.3
Unidentified jaegers	3	0.2	0.2	320	0.1
Unidentified Alcids	3	0.2	0.2	500	0.2
Gray-cheeked Thrush (*Catharus minima*)	3	0.2	0.2	30	0.1
Ruddy Turnstone (*Arenaria interpres*)	2	0.1	0.2	110	0.1
Redpoll species (*Acanthis flammea/A. hornemanni*)	2	0.1	0.2	12	0.1
Tree Sparrow (*Spizella arborea*)	2	0.1	0.2	17	0.1
Snow Bunting (*Plectrophenax nivalis*)	2	0.1	0.2	35	0.1
Black Brant (*Branta nigricans*)	1			1,450	0.2
Green-winged Teal (*Anas carolinensis*)	1	0.1	0.1	300	0.1
Semipalmated Plover (*Charadrius semipalmatus*)	1			45	0.1
andering Tattler (*Heteroscelus incanum*)	1				0.1
esser Yellowlegs (*Totanus flavipes*)	1			100	0.1
Unidentified sandpipers	1			* 30	0.1
Parasitic Jaeger (*Stercorarius parasiticus*)	1			450	0.1
Parakeet Auklet (*Cyclorrhynchus psittacula*)	1			200	0.1
Unidentified Auklets	1			200	0.1
Say's Phoebe (*Sayornis saya*)	1			30	0.1
Varied Thrush (*Ixoreus naevius*)	1			80	0.1
Water Pipit (*Anthus spinoletta*)	1			20	0.1
Fox Sparrow (*Passerella iliaca*)	1			35	0.1
TOTAL BIRDS	1,260	83.5	97.6		86.9
Arctic Ground Squirrel (*Spermophilus undulatus*)	170	11.5	61.1	*500	12.6
Collared Lemming (*Dicrostonyx groenlandicus*)	24	1.6	10.8	50	0.2
Unidentified lemmings	8	0.5	3.6	50	0.1
Brown Lemming (*Lemmus trimucronatus*)	6	0.4	2.7	50	0.1
Unidentified voles	5	0.3	2.3	30	0.1
Red-backed Vole (*Clethrionomys rutilus*)	44	0.3	16.8	30	0.1
Unidentified microtines	2	0.1	0.9	30	0.1
Tundra Vole (*Microtus oeconomus*)	1	0.1	0.5	40	0.1
Short-tailed Weasel (*Mustela erminea*)	1	0.1	0.5	200	0.1
Mink (*Mustela vison*)	1			640	0.1
TOTAL MAMMALS	262	14.9	107.7		12.9
Unidentified kills	1	0.1			
TOTAL KILLS	1,483	100.0 ± .02			100.0

Total categories - 49
Total identified species - 39 (31 avian, 8 mammal)
Total minimum species - 40 (32 avian, 8 mammal)

*Data from Cade, 1960

the Arctic Ground Squirrel in the prey remains reported for these different regions, and probably reflects this species' availability at the times the data were collected.

On the Seward Peninsula, three categories of prey stand out as major sources of food to the Gyrfalcons, both by number and weight (see Table 6). These major prey species are shown separately in Table 7. Ptarmigan clearly appear as the primary prey. Though no attempt was made to separate the two species (L. lagopus and L. mutus), it is known that both were taken. Ptarmigan comprised 59.1 per cent of the total prey remains and 71.6 per cent by body weight. That the various species of ptarmigan form a major portion of Gyrfalcon prey throughout the Gyrfalcon's circumpolar distribution is generally well known (Dementiev and Gortchakovskaya, 1945; Hagen, 1952; Cade, 1960; Brown and Amadon, 1968; White and Weeden, 1966; Bengtson, 1971). Cade (1960) noted a preference "even in a year when they (i.e., ptarmigan) were scarce" from his Colville River data. Hagen (1952) comments on this preference when microtines were abundant and available to Gyrfalcons in Dovre, Norway, and Bengtson (1971) states that in the Myvatn area of Iceland, "Ptarmigan, when abundant, are the preferred prey even in areas containing excellent habitat for waterfowl." Bengtson (1971) reports an interesting increase in ptarmigan utilization by Gyrfalcons as ptarmigan increased in numbers

Table 7. The three major Gyrfalcon food items

Name	Number	Per cent 1968 Total	Per cent Bird-Mammal	Number	Per cent 1969 Total	Per cent Bird-Mammal	Number	Per cent 1970 Total	Per cent Bird-Mammal
Ptarmigan	294	64.5	74.8	143	48.6	62.7	439	59.9	68.7
Ground squirrels	43	9.4	68.3	63	21.4	95.5	64	8.7	68.8
Long-tailed Jaegers	42	9.2	10.7	16	5.4	7.0	97	13.2	15.2
TOTAL	379	83.1		222	75.4		600	81.8	

Per cent 1968-1970

Ptarmigan	876	59.1	69.5
Ground squirrels	170	11.5	76.6
Long-tailed Jaegers	155	10.4	12.3
TOTAL	1,201	81.0	

Note: Willow Ptarmigan (*L. lagopus*) and Rock Ptarmigan (*L. mutus*) were considered as one category. No attempt was made to separate these two species. Three additional Jaeger kills could not be identified to species, but were probably Long-tailed Jaegers (*S. longicaudus*). A fourth kill was a Parasitic Jaeger (*S. parasiticus*).

in an area where thousands of ducks formed a readily available and heavily utilized food source.

It appears that these observations of ptarmigan "preference" are generally valid. Such a preference for ptarmigan by hunting Gyrfalcons seems logical and expected for an avian predator that is almost completely dependent upon them for about two-thirds of the year. From the extensive literature of falconry, it is generally known that trained falcons and hawks can readily develop specific interests in a particular prey species or type. Although almost no data are available to explain what young Gyrfalcons do during the winter months, it is probable that they too are strongly dependent upon ptarmigan for food as winter sets in. It seems likely that ptarmigan are strongly fixed as a "prey image" in Gyrfalcons; that this occurs early in the life of a Gyrfalcon; and that the "preference" could be termed one of necessity.

Cade (1960) reported that "On the arctic slope ptarmigan usually make up nearly 90 per cent by weight of the total consumed." Certainly the high availability of Long-tailed Jaegers and Arctic Ground Squirrels on the Seward Peninsula accounts for a large portion of the approximately 18 per cent difference between Cade's data and mine.

Arctic Ground Squirrels were the second most frequently occurring prey species in the Seward Peninsula prey remains (see Table 7) and comprised about 13 per cent by weight of the total Gyrfalcon prey remains (see Table 6). Cade (1960) recorded only six ground squirrels constituting about 5.8 per cent of the total prey remains and about six per cent by weight from ten Gyrfalcon eyries on the Colville River in 1959. Eight arctic slope eyries where prey remains were picked up from 1952-1957 produced only one ground squirrel which contributed a small 0.7 per cent by number and 0.8 per cent by body weight of the total prey remains. Murie's (1946, unpublished) Alaska Range data (reported in Cade, 1960) from three eyries reports 259 ground squirrels totalling 60.5 per cent by number and 78.9 per cent by weight of the total prey remains. One Sheenjek River eyrie visited by George B. Schaller (reported in Cade, 1960) produced ten kills, three of which were ground squirrels. In my opinion these differences in ground squirrel useage are due to differences in their availability to Gyrfalcons at the times and places these collections were made.

Cade's (1960) comment that "Gyrfalcons are much more specialized than peregrine falcons, Falco peregrinus, on a population-wide basis in their food habits, depending primarily upon one or two resident species of prey," is supported by the fact that ptarmigan and Arctic Ground Squirrels accounted for 1,046 (about 70 per cent) of my total 1,483 identified Gyrfalcon kills. By body weight these resident species (Willow Ptarmigan, Rock Ptarmigan, and Arctic Ground Squirrels) comprise about 84 per cent of the total biomass (see Table 6). Cade (1960) found a comparable situation when he analyzed Murie's Alaska Range data and his own Arctic slope and Colville River data. Of the three data sets, Cade found ground squirrels predominant in the Alaska Range data and ptarmigan predominant in the Arctic slope and the Colville River data. My own observations indicate that Gyrfalcons in the Alaska Range do indeed take large numbers of ground squirrels.

Ground squirrels, unavailable to Gyrfalcons from about 1 October to 1 May, contributed almost twice the biomass on a weight basis than Long-tailed Jaegers did in the summer on the Seward Peninsula. However, it should be made clear that Gyrfalcons do not normally consume the digestive tract of ground squirrels and this portion plus the heavier mammalian bones constitute a relatively large percentage of the weight of this species. Conversely, Gyrfalcons often appear to consume the digestive tracts of jaegers and this probably results in a more equal ratio of consumed biomass for these two important species. Two captive birds were also observed to follow this feeding "habit."

Long-tailed Jaegers were the third most frequently occurring prey species in the Seward Peninsula Gyrfalcon prey remains (see Table 6 and Table 7). This species accounted for 10.5 per cent by number and 7.4 per cent by weight of the total prey remains. On a weight basis all jaegers combined (Long-tailed Jaegers, Parasitic Jaegers

Table 8. Total migratory bird species identified from the 1968-1970 Gyrfalcon prey remains and listed in various important groups

	Number	Per cent of total kill	Percent by weight of total kill	Per cent of total migratory bird kill	Per cent by weight of total migratory bird kill
Jaegers	159	10.7	7.5	41.5	49.3
Shorebirds	79	5.3	2.2	20.6	12.5
Short-eared Owls	12	0.8	0.8	3.1	4.6
Passerines	58	3.9	0.4	15.2	2.2
Seabirds (excluding jaegers and ducks)	30	2.0	2.3	7.8	13.0
Ducks	22	1.5	3.2	5.7	18.3
Unidentified migratory bird spp.	23	1.6	—	6.0	—
TOTAL	383	25.8	17.6	99.9	99.9

[S. parasiticus], and three unidentified Stercorarius spp.) accounted for about 7.5 per cent of the total biomass. Cade (1960) recorded only three Long-tailed Jaegers in his Colville data and two Parasitic Jaegers from his Arctic slope data. White and Springer (1965) reported only one Long-tailed Jaeger from among 38 kills they identified from a Gyrfalcon eyrie near Hooper Bay, Alaska. It is possible that the Seward Peninsula, jutting out into the Bering Sea, is a more desirable jaeger habitat.

It appears that large lemming-vole populations influence Gyrfalcon utilization of some migratory avian species, notably Long-tailed Jaegers, Short-eared Owls (Asio flammeus), Marsh Hawks (Circus cyaneus), and Rough-legged Hawks, since the availability of these species to Gyrfalcons depends strongly on the presence of microtines. Cade (1960) states that "The significant fact for the gyrfalcons on the Colville was not their predation on microtines, but the presence of rodent-eating birds which had been drawn into the region by the microtines." Cade found that "on a weight basis more than 20 per cent of the 1959 sample of gyrfalcon food consists of rodent-eating birds." Of the total 1,483 Gyrfalcon kills identified from the Seward Peninsula, 171 or about 11.5 per cent were rodent-eating birds (jaegers and Short-eared Owls). On a weight basis this food source totaled about 8.3 per cent of the biomass (see Table 8). These data appear to indicate that this food source is important to Gyrfalcons whenever it is available to them.

Cade (1960) found that the summer foods of Gyrfalcons in Alaska characteristically contained two or three species that contributed "more than 70 percent of the total sample." From the literature, it appears that this can be considered a general circumpolar characteristic of Gyrfalcons, and that it is not unusual for the percentage to become as high as 90 per cent in certain regions if we consider ducks in general as one category of prey (Bengtson, 1971). My data agree with this generalization and with Cade's statement. In order of occurrence (see Table 6), ptarmigan, Arctic Ground Squirrels, and Long-tailed Jaegers constituted about 81 per cent (1,201 kills) of the total 1,483 Gyrfalcon kills from the Seward Peninsula. By body weight, this small group of species, including three resident species, accounted for nearly 92 per cent of the total biomass. The remaining prey species constitute a small proportion of the total prey remains and are generally comparable to the data of others (e.g., Murie, 1946; Hagen, 1952; Cade, 1960; Bengtson, 1971). Cade (1960) states in reference to Gyrfalcons that, "In Alaska the data on food habits of interior populations support the conclusion of Dementiev and Gortchakovskaya (1945) that gyrfalcons, in distinction from peregrines, are primarily oriented toward predation on permanently resident arctic species of prey whereas peregrines prey on migratory species." My data further support the fact that Gyrfalcons do indeed prey heavily on permanent resident species, particularly those Gyrfalcons nesting at some point removed from an actual coastline but that these resident species play an important part in the food habits of Gyrfalcons more closely associated with the coast.

The occurrence of one Mink (Mustela vison) in 1968 must be considered unusual. This mammal is a rare species over the western portion of the Seward Peninsula (John Burns, pers. comm., 1968), and it is doubtful that Mink are often in a position in which Gyrfalcons may take them. The occurrence of one Short-tailed Weasel (Mustela erminea) in 1970 is also unusual, though this species is fairly common on the Seward Peninsula particularly in high lemming years, and is often observed hunting on the open tundra where it is exposed to aerial attack. Dementiev and Gortchakovskaya (1945) identified the only other specimen of this species reported in the Gyrfalcon literature from an eyrie on Kharlov Island.

The role of migratory birds in the food of Seward Peninsula Gyrfalcons is of considerable intrinsic interest since it is this component that lends the majority of diversity to the spectrum of prey taken. The migratory species have been divided into various groups for comparative purposes. As a whole, migratory species comprised about 26 per cent by number and approximately 10 per cent by weight of the total prey remains. These data indicate that Gyrfalcons do take a significantly smaller proportion of migratory species than arctic peregrines tend to take (based in part on Cade's 1960 data). It is interesting, in addition, that this food source is of a large enough size to serve as a relatively steady and probably significant source of pesticide and PCB (polychlorinated biphenyl compounds) contamination to Gyrfalcons if in fact these migratory species are contaminated themselves.[1]

It is interesting to compare Cade's (1960) Arctic slope and Colville River data with my total list of prey species (see Table 6). By combining his data with that of Murie (1946, unpublished), Cade (1960) summarized most of the available Alaskan information on the summer food habits of Gyrfalcons. These combined Gyrfalcon data contain ". . .only twenty-one species of prey as compared to fifty-seven species that are listed for peregrines. . ." (Cade, 1960). Three of these 21 categories are comprised of unidentified ducks, unidentified passerines and vole species that

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[1]Preliminary investigations by Wayman E. Walker, University of Alaska, indicate that all specimens of Gyrfalcon prey species collected in 1970 analyzed so far contained detectable levels of both chlorinated hydrocarbons and PBC. This study will be published separately.

may or may not have been different from those similar species listed. The arctic slope data for 1952-1957 comprise a total of 142 kills collected from eight eyries, and consist of only 12 categories including unknown vole species and unidentified ducks. A similar situation exists with the Colville data--103 kills consisting of 11 categories of prey species including that of unidentified passerines. Murie's Alaska Range data (reported in Cade, 1960) are even less diverse--429 kills consisting of seven categories of prey species including a known total of at least six species. My data for the Seward Peninsula, presented in Table 6, list a total minimum of 32 avian and eight mammalian species.

Cade (1960) stated that, "I have had to utilize pellet analysis to a great extent because of the infrequency with which other types of remains have been found at most of the aeries during the time of my visits." In my experience it is unusual not to find numerous skeletal material with attached feathers or fur in or below eyries. Since Cade was primarily studying eyries situated on river cliffs, river break-up and changes in water levels may explain his difficulty in finding prey remains. The striking differences between Cade's (1960) data and mine may reflect: (1) a difference in diversity and availability of prey species between the regions (i.e., at the time of study) and (2) a difference in sample sizes. It is possible to extract a number of combinations of eyrie collections (see Tables 12a,b to 27a,b) from my data that will construct data sets of similar numbers of eyries and numbers of kills and thus give results comparable to the low diversity of species found by Cade.

Bengtson's (1971) Icelandic data are more comparable to mine. He lists 24 identified avian species (11 of which are duck species) and three additional prey categories (Anas spp., unidentified ducks, and small ducklings) from a region lacking small mammals. The data that best compare with mine are those of White and Springer (1965). Their data are from only one Gyrfalcon eyrie near Hooper Bay, Alaska, and consist of 38 kills collected in a brief 15-day segment of time during the Gyrfalcons' nesting period. White and Springer (1965) list 18 categories involving a minimum of 14 species. Eleven (28.9 per cent) of the total kills were shorebirds, nine (23.8 per cent) were ptarmigan, six (15.7 per cent) were Larids, six (15.7 per cent) were passerines, and four (10.5 per cent) were Anatids. While Cade's (1960) data ". . .pertain mostly to eyries in the more inland tundra and mountainous areas. . ." (as stated by White and Springer, 1965), my data and that of White and Springer (1965) are from coastal areas or peninsular areas strongly influenced by the coast.

Yearly variations in prey utilization

Gyrfalcon prey remains from the Seward Peninsula were segregated by year and the yearly compositions of the 1968-1970 prey remains are listed in Table 9. In attempting to compare the 1968, 1969, and 1970 collections, consideration must be given to: (1) the consistency of the search effort; (2) the consistency of the timing of the collection visits; (3) the number of eyries visited during each year; and (4) the changes in prey species numbers and their availability to Gyrfalcons.

1. Search effort: Search effort was generally consistent throughout the study. However, in 1969, some nests were not climbed to though they were visually observed from close range. Such nests were not climbed to because they appeared essentially devoid of prey remains. In 1969 more effort was expended in search below nesting cliffs and at nearby perching places. For unknown reasons, prey remains were scarcer both in the nests and below them in 1969. During that year only 294 kills were collected--a much lower figure compared to those of 1968 and 1970.

2. Timing of visits: During 1968, visits to Gyrfalcon eyries were spread fairly evenly over the period 31 May to 23 July. In 1969, the majority of the visits occurred between 15 June and 20 July. It is possible that some remains, accumulated prior to 15 June, were scattered and thus unrecoverable. In 1970, visits corresponded

closely with those of 1968, occurring evenly over the period 28 May to 27 July.

3. Number of eyries visited: In 1968, ten Gyrfalcon eyries were visited to collect prey remains and pellets. In 1969, 14 eyries were visited, representing an increase of 30 per cent in the eyrie sample size over that of 1968. In 1970, 16 eyries were visited, representing an increase of 60 per cent in the eyrie sample size over that of 1968 and 33 per cent over 1969.

4. Prey abundance and availability: Prey species' numbers changed markedly in some instances from 1968 to 1970. The scope of this study did not permit detailed census of prey species, but general day to day observations were made and are discussed later.

It is evident from Table 9 that ptarmigan, ground squirrels, and Long-tailed Jaegers stand out both by number and weight as the prominent prey species during each summer (also see Table 7). It is significant that, by weight, these three prey categories together comprised 92.4 per cent, 85.3 per cent, and 93.5 per cent, respectively, of the 1968, 1969, and 1970 prey remains. It is also interesting to note that the two avian categories (ptarmigan and Long-tailed Jaegers) together accounted for a large proportion (82.3, 62.0, and 83.7 per cent, respectively) by weight of the yearly total kills, and a very large proportion by weight (92.6, 80.9, and 93.5 per cent, respectively) of the avian species taken. By comparison, ground squirrels constituted a relatively small, though obviously important, segment of the yearly total kill by weight (10.1, 23.3, and 9.8 per cent, respectively), but comprise a very large portion (93.4, 99.5, and 95.7 per cent, respectively) by weight of the yearly mammal kill. Further, it is note-worthy that the two major resident species' categories (ptarmigan and ground squirrels) together by weight constituted a large and relatively stable portion (86.1, 81.5, and 84.0 per cent, respectively) of the yearly total kill. The remainder of the yearly prey remains consisted primarily of small numbers of a variety of migratory bird species and microtines, and constituted a relatively small portion by weight (7.6, 14.7, and 6.5 per cent, respectively) each summer of the yearly total kill. During each summer of the study, Gyrfalcons on the Seward Peninsula took a significant proportion of migratory bird species. These data are presented in Table 10. It should be emphasized, in view of potential pesticide and PCB contamination, that a relatively large proportion of these migratory birds are top level consumers in their own right.

The yearly data generally follow the overall data from the Seward Peninsula listed in Table 6 and previously discussed in this paper. In general, the same conclusions as those obtained from the data in Table 6 could be drawn from any one year's data. The most interesting aspects of

Table 9. 1968-1970 Gyrfalcon food remains computed on a yearly basis

	1968			1969			1970		
	Total Kills	Per cent of total	Per cent Bird-Mammal	Total Kills	Per cent of total	Per cent Bird-Mammal	Total Kills	Per cent of total	Per cent Bird-Mammal
Ptarmigan species	294	64.5	74.8	143	48.6	62.7	439	59.9	68.7
Long-tailed Jaeger	42	9.2	10.7	16	5.4	7.0	97	13.2	15.2
American Golden Plover	4	0.9	1.0	11	3.7	4.8	15	2.0	2.3
Unidentified passerine	5	1.1	1.3	8	2.7	3.5	16	2.9	2.5
Unidentified birds	5	1.1	1.3	2	0.7	0.9	16	2.9	2.5
Unidentified shorebirds	3	0.7	0.8	5	1.7	2.2	6	0.8	0.9
Black-legged Kittiwake	3	0.7	0.8				11	1.5	1.7
Common snipe	7	1.5	1.8				6	0.8	0.9
Short-eared Owl	8	1.8	2.0	2	0.7	0.9	2	0.3	0.3
Whimbrel	4	0.9	1.0	2	0.7	0.9	5	0.7	0.8
Robin	1	0.2	0.3	8	2.7	3.5	2	0.3	0.3
Unidentified waterfowl	1	0.2	0.3	3	1.0	1.3	4	0.5	0.6
Pintail	3	0.7	0.8	3	1.0	1.3	1	0.1	0.2
Tufted Puffin				7	2.4	3.1			
Bar-tailed Godwit	3	0.7	0.8				3	0.4	0.5
Oldsquaw				4	1.4	1.8	1	0.1	0.2
Lapland Longspur	1	0.2	0.3	2	0.7	0.9	2	0.3	0.3
Pigeon Guillemot				4	1.4	1.8			
Unidentified jaegers	2	0.4	0.5				1	0.1	0.2
Unidentified alcids	3	0.7	0.8						
Grey-cheeked Thrush				3	1.0	1.3			
Ruddy Turnstone	1	0.2	0.3				1	0.1	0.2
Redpoll species				2	0.7	0.9			
Tree Sparrow				1	0.3	0.4	1	0.1	0.2
Snow Bunting							2	0.3	0.3
Black Brant							1	0.1	0.2
Green-winged Teal	1	0.2	0.3						
Semipalmated Plover				1	0.3	0.4			
Wandering Tattler	1	0.2	0.3						
Lesser Yellowlegs							1	0.1	0.2
Unidentified sandpipers	1	0.2	0.3						
Parasitic Jaeger							1	0.1	0.2
Parakeet Auklet							1	0.1	0.2
Unidentified auklets				1	0.3	0.4			
S[illegible]							1	0.1	0.2
Varied Thrush							1	0.1	0.2
Water Pipit							1	0.1	0.2
Fox Sparrow							1	0.1	0.2
TOTAL BIRDS	393	86.2	100.0	228	77.6	100.0	639	87.2	100.0
Arctic Ground Squirrel	43	9.4	68.3	63	21.4	95.5	64	8.7	68.8
Collared Lemming	11	2.4	17.5	3	1.0	4.6	10	1.4	10.8
Unidentified lemmings							8	1.1	8.6
Brown Lemming	5	1.1	7.9				1	0.1	0.2
Unidentified voles	1	0.2	1.6				4	0.5	4.3
Red-backed vole							4	0.5	4.3
Unidentified microtines	2	0.4	3.2						
Tundra Vole							1	0.1	0.2
Short-tailed Weasel							1	0.1	0.2
Mink	1	0.2	1.6						
TOTAL MAMMALS	63	13.8	100.0	66	22.5	100.0	93	12.7	100.0
Unidentified kills							1	0.1	
TOTAL KILLS	456			294			733		

Table 10. Migratory species[1] identified from the 1968-1970 Gyrfalcon prey remains compared on a yearly basis and listed in various important groups

	1968			1969			1970		
	Number	of total kill (456)	Per cent of migratory species	Number	of total kill (29[illegible])	Per cent of migratory species	Number	of total kill (733)	Per cent of migratory species
Jaegers	44	9.7	44.9	16	5.4	18.8	99	13.5	49.5
Shorebirds	23	5.0	23.5	19	6.5	22.4	37	5.0	18.5
Short-eared Owls	8	1.8	8.2	2	0.7	2.4	2	0.3	1.0
Passerines	7	1.5	7.1	24	8.2	28.2	27	3.7	13.5
Seabirds (excluding jaegers)	6	1.3	6.1	12	4.1	14.1	12	1.6	6.0
Ducks	5	1.1	5.1	10	3.4	11.8	7	1.0	3.5
Unidentified migratory species	5	1.1	5.1	2	0.4	2.4	16	2.2	8.0
TOTAL	98	21.3	100	85	28.9	100	200	24.3	100

[1]These are avian species and it is assumed that migratory species as a whole are the major source of pesticide and PCB contamination to Gyrfalcons.

the yearly comparisons made in Tables 7, 8, 9, and 10 are those of the changes in the frequency of occurrence of some species in the Gyrfalcon diet over the three-year period. To clarify the significance of these changes a brief introduction to some of the changes in prey species levels on the Seward Peninsula is needed.

It is typical of the far north that both migratory species and resident species may vary greatly in numbers from year to year. As a consequence, the availability of Gyrfalcon prey species (particularly microtines, rodent-eating birds, and ptarmigan) may change from year to year. Gyrfalcons appear to be well adapted to cope with this situation, at least in the Alaskan Arctic and subarctic. Cade (1960) notes that on the Colville River in 1959, ptarmigan became scarce by mid-June and "that the final good fledging success of these gyrfalcons was made possible through the fortunate coincidence of a suitable alternate population of large-sized prey animals" (Short-eared Owls, Marsh Hawks, Long-tailed Jaegers, and Parasitic Jaegers attracted to the region by "a moderately high density of microtines"). It appears that a similar situation occurred on the Seward Peninsula in 1968 and 1970 when microtine populations attracted numbers of rodent-eating birds to the area, particularly the Long-tailed Jaeger which played an important part in the Gyrfalcons' diet these two years.

In 1968, considerable amounts of snow remained until late June on the Seward Peninsula. Many migratory bird species were concentrated along the road system and in other scattered areas free of snow until early June. Lemmings, particularly Collared Lemmings, were plentiful. This species had even appeared in numbers on the snow surface in mid-winter (John Burns, pers. comm., 1971). Red-backed Voles were also quite common in grassy areas. Consequently, Long-tailed Jaegers and Short-eared Owls were found in large numbers over the tundra. Both Rock Ptarmigan and Willow Ptarmigan were found in large numbers throughout the peninsula. Rock Ptarmigan were often located at low elevations in habitat more characteristic of Willow Ptarmigan, and in many instances both species were found nesting in the same locations. Ground squirrels appeared plentiful and were observed over a wide variety of habitat types. Waterfowl were generally abundant. Pintails (Anas acuta), in particular, frequently nested in valley bottoms and marshes, and occasionally under willows at considerable distances from streams. In 1969, light winter snowfalls and high May temperatures resulted in a rapid snow-melt which was completed approximately 30 days ahead of the 1968 melt. Returning passerines and shorebirds were observed scattered across the tundra instead of concentrated along the cleared road system. During the 1969 summer, microtines appeared to be virtually non-existent. Only nine Short-eared Owls were observed during the entire summer. Long-tailed Jaegers were thinly scattered across the peninsula and the majority of those present were non-breeders ranging about in small groups and feeding on insects and berries. Ptarmigan numbers were reduced from the 1968 level and species segregation was more noticeable. Ground squirrels were present in large numbers comparable to the 1968 levels but also appeared to be more restricted to particular locales. Waterfowl were less common than they had been in 1968. No ducks were discovered nesting outside of large marshes or river systems. In 1970, generally light snow-falls and warm May temperatures were again the cause of a rapid snow-melt. Winter conditions (1969-1970) were such that a major portion of the peninsula's road system was open to the public (the 71 mile Nome-Teller road) almost all winter. As in 1969, snow-melt was completed approximately 30 days ahead of the 1968 melt. Returning migratory bird species, particularly passerines and shorebirds again did not concentrate along the road system but were scattered across the relatively snow-free tundra. During the 1970 summer considerable microtine activity was observed. Bodies of Tundra Voles were commonly found in active Rough-legged Hawk nests, but Red-backed Voles and lemmings were rarely observed. Long-tailed Jaegers were common breeders although they did not appear to be as numerous as they did in 1968.

Short-eared Owls were also common, but were not as numerous as in 1968. Ptarmigan numbers appeared to be slightly higher than in 1969. However, almost all ptarmigan observed were Willow Ptarmigan; very few Rock Ptarmigan were evident and ptarmigan species segregation again occurred. Ground squirrels were present in large numbers but, as in 1969, appeared more restricted to particular locales. Waterfowl numbers did not appear to change from the 1969 level.

Table 11 compares by year the occurrence of nine major groups of Gyrfalcon prey species in the Seward Peninsula Gyrfalcon prey remains. These prey groups include the three primary categories of Gyrfalcon prey remains, ptarmigan, ground squirrels, and jaegers and six additional groupings that include the total numbers of shorebirds, passerines, microtines, seabirds (Alcids and Larids), ducks, and Short-eared Owls. The yearly changes in the occurrence of some Gyrfalcon prey species on the Seward Peninsula are shown in Figure 2. The following discussion will pertain primarily to these data.

The occurrence of ptarmigan remains fell sharply in 1969, and increased to near the 1968 level in 1970 (see Table 11 and Figure 2). 1968 was a "high" ptarmigan year, and both Rock Ptarmigan and Willow Ptarmigan were common along the road system (three to five pairs per mile) and were constantly flushed while hiking across country. In 1969, few Rock Ptarmigan were observed after mid-June.

Table 11. Comparisons of the occurrence of nine prey groups in Seward Peninsula Gyrfalcon prey remains computed on a yearly basis

Group	1968 Per cent Total (456)	1969 Per cent Total (294)	1970 Per cent Total (733)
Ptarmigan	64.5	48.6	59.9
Ground squirrels	9.4	21.4	8.7
Jaegers	9.6	5.4	13.5
Shorebirds	5.0	6.5	5.0
Passerines	1.5	8.2	3.8
Microtines	4.2	1.0	3.8
Seabirds	1.3	4.1	1.6
Short-eared Owls	1.8	0.7	0.3

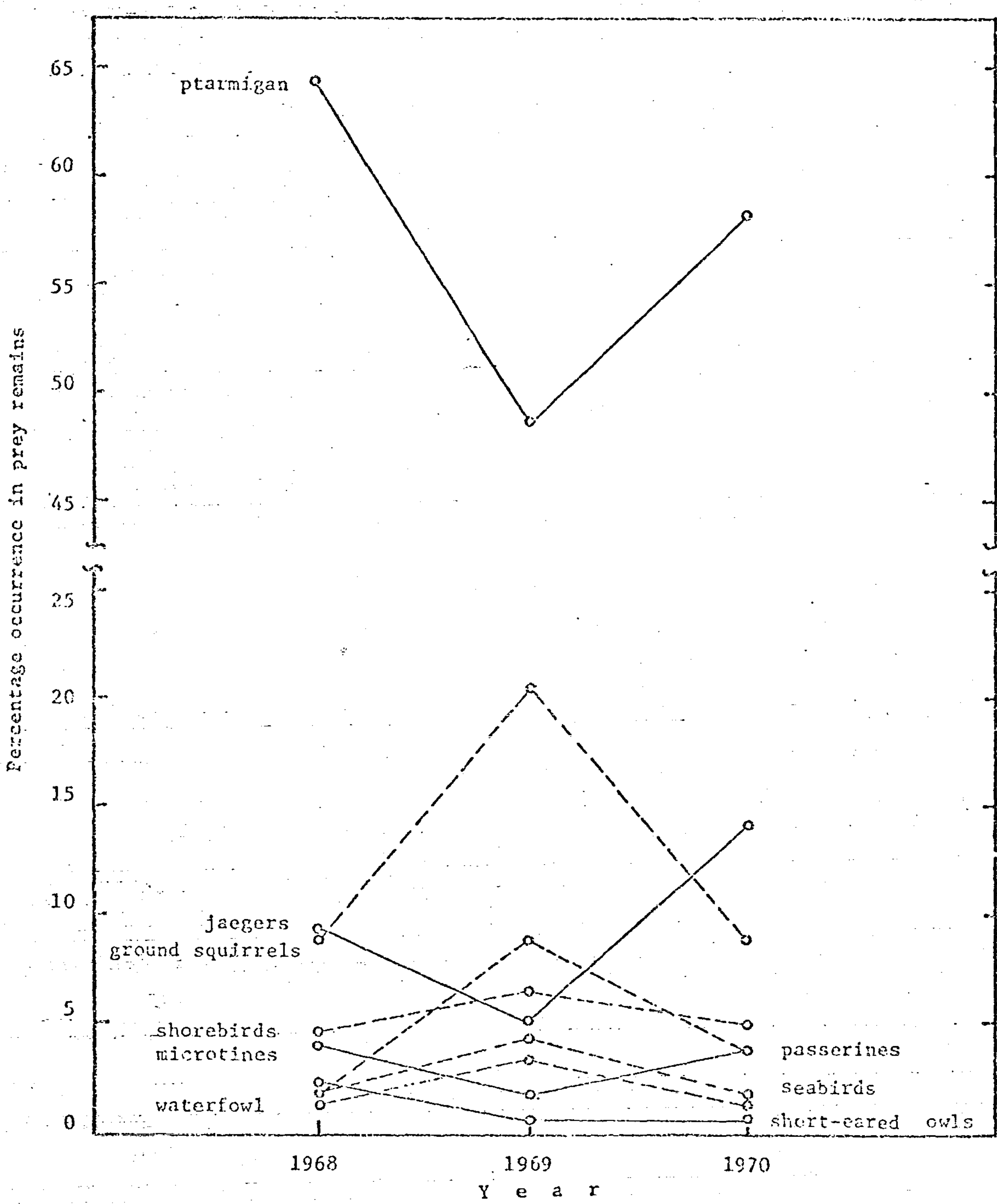

Figure 2. Percentage occurrence of selected groups of prey species in summer Gyrfalcon prey remains from the Seward Peninsula, Alaska, 1968 - 1970. Prey groups that increased during 1969 are represented by dashed lines.

Willow Ptarmigan observations averaged about one pair per three to five miles of road in some of the optimal Willow Ptarmigan habitat. In 1970, Rock Ptarmigan, never observed to be numerous that summer, were not seen after about the first week of June with the exception of three specimens collected in August. Willow Ptarmigan were commonly observed all summer but remained below the observed 1968 level. Family groups and small flocks of this species became common in mid-July and August. Local hunters commented that ptarmigan seemed scarce in 1969, but that in 1970 hunting was better and that there were again "lots of birds." These observations suggest that the entire ptarmigan population declined in 1969 but rose again in 1970 due primarily to an increase in Willow Ptarmigan. However, the 1970 level did not attain that of the 1968 high. Figure 3 shows that the frequency of ptarmigan in the Gyrfalcon prey remains agrees with my subjective observations of the ptarmigan population.

The occurrence of jaegers in the Gyrfalcon prey remains fell in 1969, but increased in 1970 to a level above that found in 1968 (see Table 11 and Figure 2). Nineteen sixty-eight was a high jaeger year. All three species were common breeders, especially in the southern half of the peninsula. Long-tailed Jaegers were by far the most abundant; Pomarine Jaegers were the least abundant. Long-tailed Jaegers were commonly observed catching and eating

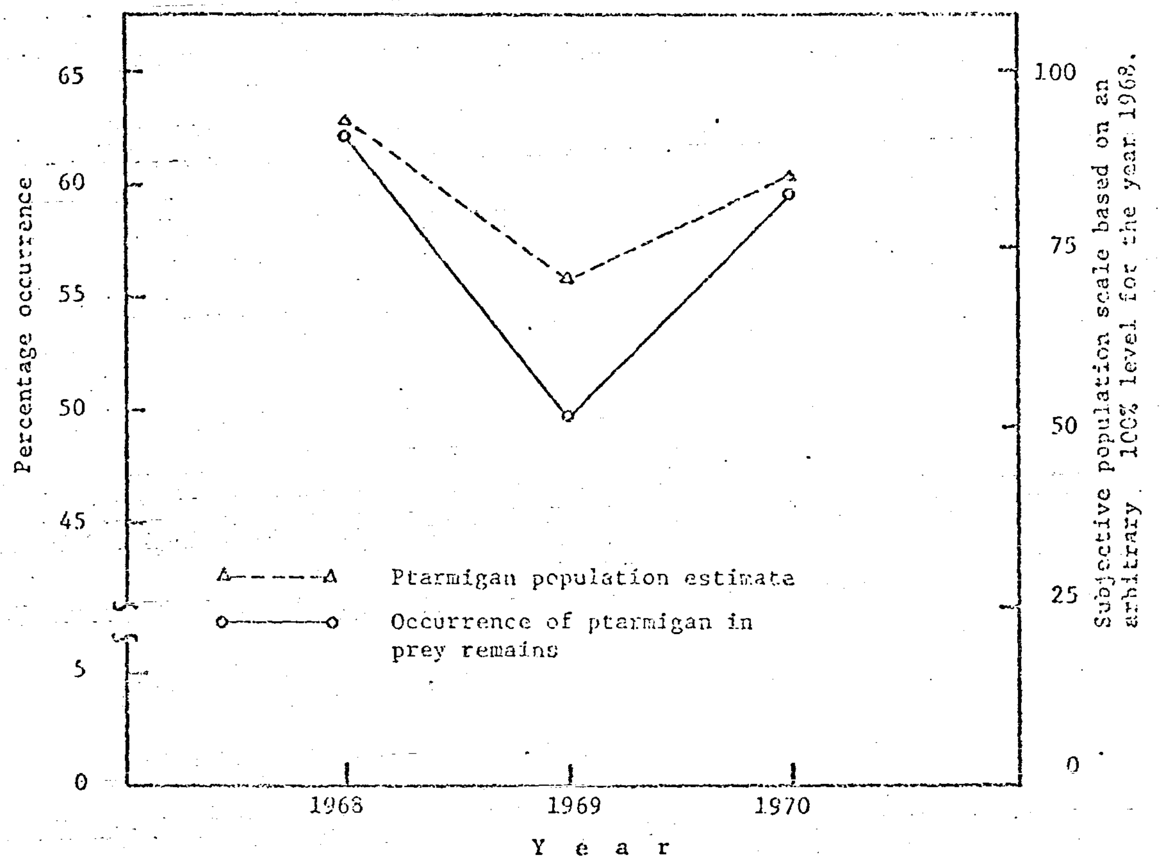

Figure 3. The percentage occurrence of ptarmigan in the 1968 - 1970 Gyrfalcon prey remains compared with an observed subjective estimate of ptarmigan population trends from the Seward Peninsula, Alaska.

Collared Lemmings, Brown Lemmings, and voles. Counts as high as 100 birds were common on one 35-mile stretch of the Teller Road.

In 1969, only one observation of a small group of Pomarine Jaegers was made, and that occurred during spring migration. A few Parasitic Jaegers were observed along the southern coast and a few pairs of this species apparently bred near Safety Lagoon. Long-tailed Jaegers were thinly scattered across the peninsula. A few nesting pairs of this species were found but the majority of those observed did not appear to breed and were in small groups of 10 to 20 that were wandering across the tundra eating insects and berries. In 1970, Pomarine Jaegers, though present, were scarce. Parasitic Jaegers were again present, though not in the numbers observed in 1968. Long-tailed Jaegers were again common although somewhat below their 1968 level. Long-tailed Jaegers were observed catching and eating voles (almost certainly Tundra Voles). Observations therefore suggest that the jaeger populations, and in particular Long-tailed Jaegers, declined in 1969 and rose again in 1970 probably due to an increase in Tundra Vole numbers, to a level approaching but below the 1968 high. In Figure 4 the frequency plot of jaeger[2] remains also

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[2]The total jaeger remains are almost entirely Long-tailed Jaegers. It is interesting to note that for unknown reasons this species took the brunt of Gyrfalcon predation, while the other two jaeger species were almost entirely untouched.

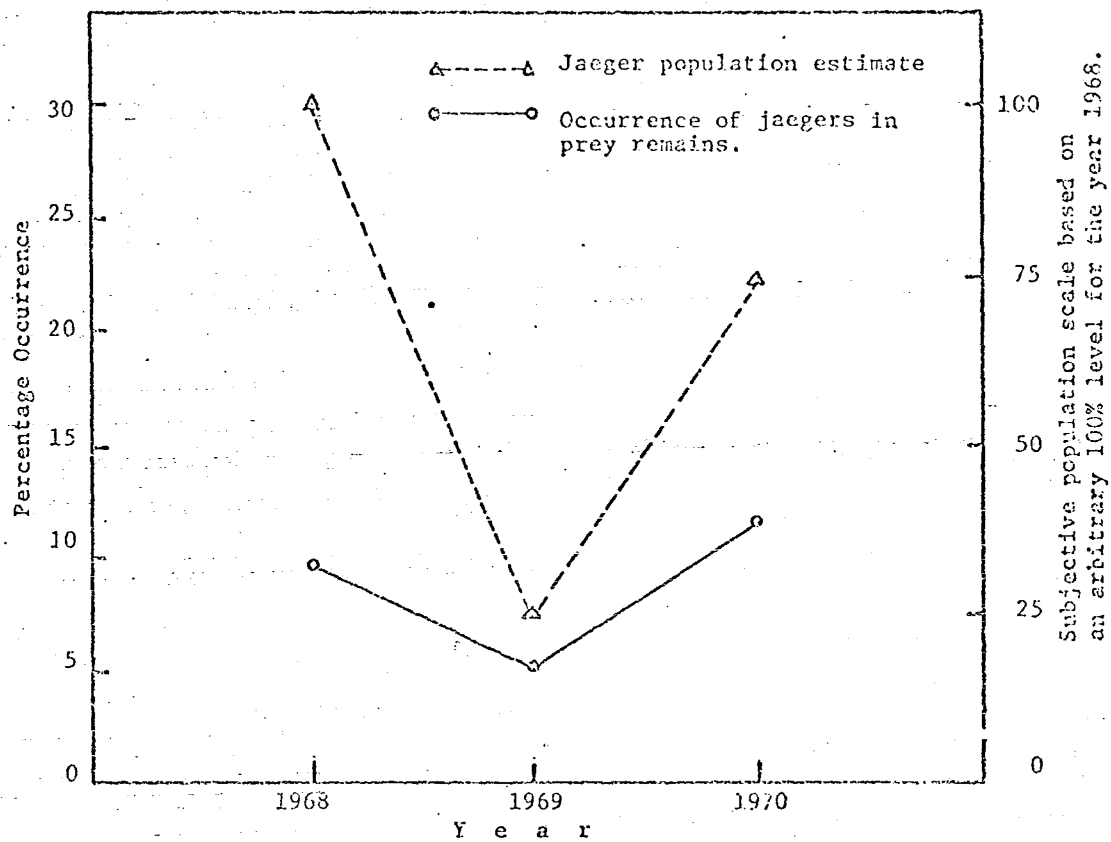

Figure 4. The percentage occurrence of jaegers in the 1968 - 1970 Gyrfalcon prey remains compared with an observed subjective estimate of jaeger population trends from the Seward Peninsula, Alaska.

appears to follow the trend of my subjective observation of the jaeger population.

The percentage of microtine kills in the Gyrfalcon prey remains fell in 1969 and rose again in 1970 to a level comparable to that of 1968 (see Table 11 and Figures 2 and 5). The 1968 season was a year of abundance for microtine species in general, particularly Collared Lemmings and Red-backed Voles; Brown Lemmings and Tundra Voles were also common. In many areas Collared Lemmings were found on the tundra in quantities that allowed a collector to capture numbers of them by hand. Prior to the 1968 summer a build-up in microtine numbers had apparently occurred. Microtine trapping data from John Burns (pers. comm., 1971) indicate that in the vicinity of Nome trapping success increased from about 11 per cent in July 1967 (143 trap-nights) to about 20 per cent in October (409 trap-nights). During mid-October one area produced 41 animals in 144 trap-nights--a success of about 28 per cent. Following this general build-up, primarily of Collared Lemmings and Red-backed Voles, Collared Lemmings were observed moving about on top of the snow during the winter 1967-1968--an apparently unusual occurrence (John Burns, pers. comm., 1971). During the summer of 1968 Burns reported a trapping success of about 40 per cent in early summer with an increase to as high as 65 per cent by late August. These trapping data indicate that of the four species discussed, Collared

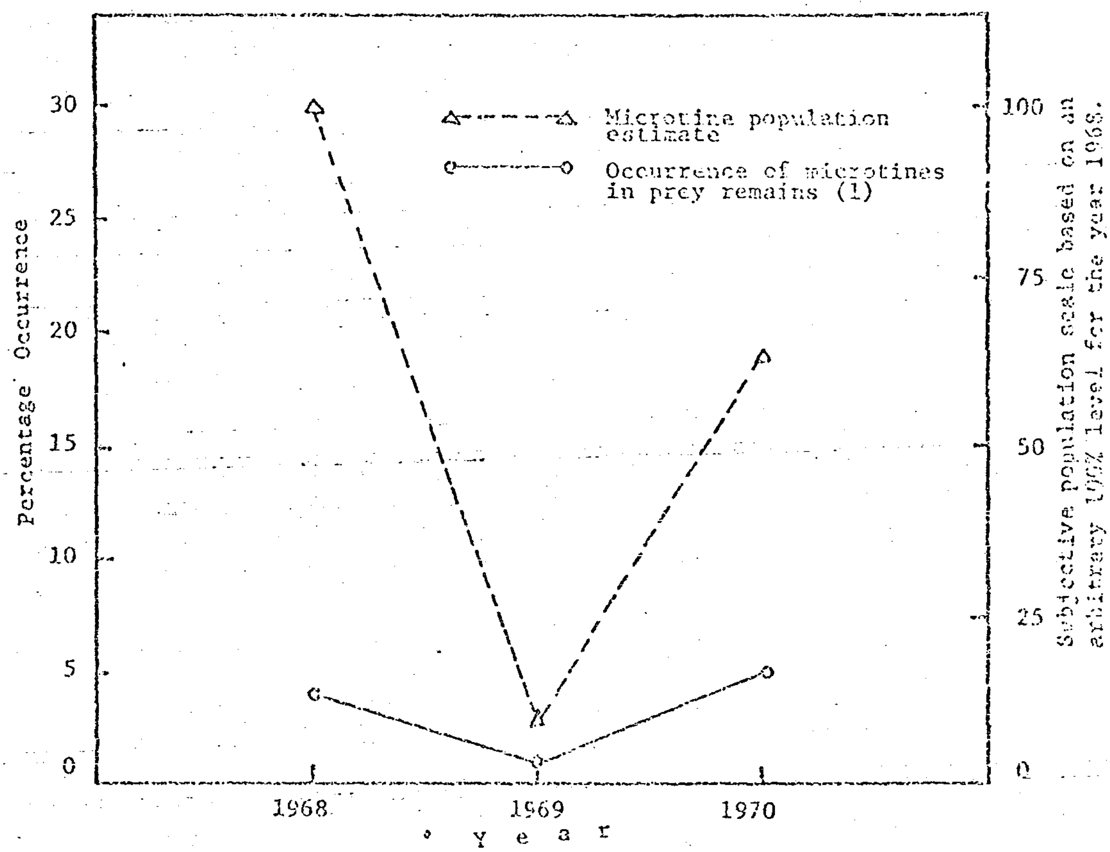

Figure 5. The percentage occurrence of microtines in the 1968-1970 Gyrfalcon prey remains compared with an observed subjective estimate of microtine population trends from the Seward Peninsula, Alaska.

(1) Pellet analysis indicates microtines occur about five times as often as the prey remains plotted on this graph.

Lemmings were the dominant species and the Tundra Vole was the least abundant. In 1969, all microtine species appeared scarce; however, a few Tundra Voles were observed crossing roads and small numbers of this species were present in some areas, at least on the southern half of the peninsula. Three hundred fifty trap-nights in three good 1968 microtine habitats near the active Gyrfalcon eyries produced only one Red-backed Vole. Burns (pers. comm., 1971) reported a catch of only 25 animals of the assorted species in 1,070 trap-nights in July 1969. During 1970, a few Collared Lemmings and Red-backed Voles were observed crossing roads and were rarely encountered on the tundra. Only Tundra Voles were frequently observed. Rough-legged Hawks, jaegers, and Short-eared Owls were observed catching and eating them; they were commonly found in Rough-legged Hawk nests. The percentage of microtine kills found in the prey remains generally followed the estimate of the three year trend in the microtine populations (see Figure 5).

The general high population of microtines in 1968 attracted a large number of rodent-eating birds, including, besides the jaegers, a few Marsh Hawks and many Short-eared Owls. In 1968 up to 12 Short-eared Owls were commonly observed along many one-mile sections of road. By May 1969, the microtines had undergone a general population "crash" and were scarce. This condition drastically reduced the numbers of rodent-eating birds on the Seward Peninsula that season. Only nine Short-eared Owls were observed during the entire 1969 summer and eight of these birds were in two family groups observed hunting along the Kuzitrin River during mid-August. In 1970, an increase in the numbers of the microtines, primarily the Tundra Vole, again attracted large numbers of rodent-eating birds to the Seward Peninsula (again including a few Marsh Hawks), although below the numbers observed in 1968. Short-eared Owls were again common. Counts along a 30-mile stretch of road in the Kougarok-Kuzitrin-Pilgrim River systems ranged from 25-30 individuals throughout the summer--an average of about one Short-eared Owl per mile. The percentage of Short-eared Owls in the prey remains fell in 1969 and continued to fall in 1970 in spite of an observed increase in number in 1970 (see Table 10 and Figure 2). The significance of this case, inconsistent with the general picture, cannot be assessed.

The foregoing outlines a situation in which 1969 population declines in three groups of prey species, ptarmigan, rodent-eating birds, and microtines, were correlated with a lower percentage of these species in collected Gyrfalcon prey remains. The remaining Gyrfalcon prey groups of ground squirrels, shorebirds, passerines, seabirds, and ducks (see Table 11 and Figure 2) rose in proportionate representation in Gyrfalcon food in 1969.

The occurrence of ground squirrels in Gyrfalcon food remains, while rising in 1969, declined to slightly below the 1968 level in 1970 (see Table 11 and Figure 2). Ground squirrels were abundant over most of the Seward Peninsula during all three years and were commonly observed the entire length of the road system and on every over-land hike. Actual numbers of ground squirrels did not really appear changed from those found in 1968 and certainly any change that may have occurred was relatively small and not easily detected. Figure 6 shows the sharp increase in the per cent of ground squirrels in the Gyrfalcon prey remains in 1969, while the estimated ground squirrel population indicates little change over the three-year period.

The remaining groups of prey species, consisting of passerines, shorebirds, ducks, and seabirds, all show the same upward tendency in their occurrence in the 1969 Gyrfalcon prey remains. These groups did not appear to exhibit any note-worthy changes in population numbers over the years.

These data indicate that the 1969 declines in numbers and availability of some Gyrfalcon prey species, primarily ptarmigan and Long-tailed Jaegers, on the Seward Peninsula resulted in these species being taken to a lesser degree by Gyrfalcons, and that other species, specifically the Arctic Ground Squirrel, were taken to a higher degree as a means of compensation. Because ground squirrels are an important Gyrfalcon prey species on the Seward Peninsula, both by number and by weight, and were relatively plentiful, these data suggest that Gyrfalcons relied heavily on this species in 1969 to compensate for the lack of other prey species. Since ground squirrel numbers did not appear to change to any important extent over the three-year period, I believe that the increase in the occurrence of this species in the Gyrfalcon prey remains indicates a higher degree of utilization, not because ground squirrels were more abundant but because other prey species were less abundant. Whether ground squirrels were hunted selectively, or whether they were simply killed more frequently because they were there and available is unknown. In either case, however, it appears that the increase in utilization of the Arctic Ground Squirrel was an important form of compensation in 1969, when ptarmigan, jaegers, and microtines declined. It appears that, like ground squirrels, the passerines, shorebirds, ducks, and seabirds played a role in the 1969 Gyrfalcon diet as compensation for the decline of the other prey population, though to a much lesser extent. Though important prey compensation apparently took place in 1969, there was an approximate 25 per cent decline of the Gyrfalcon population within the sub-study area and its sub-unit, Area I, that year (see page 20). It is possible that the prey compensation, primarily in the form of ground squirrels, became available too late in the Gyrfalcon breeding cycle to prevent some pairs from abandoning the area. Ground

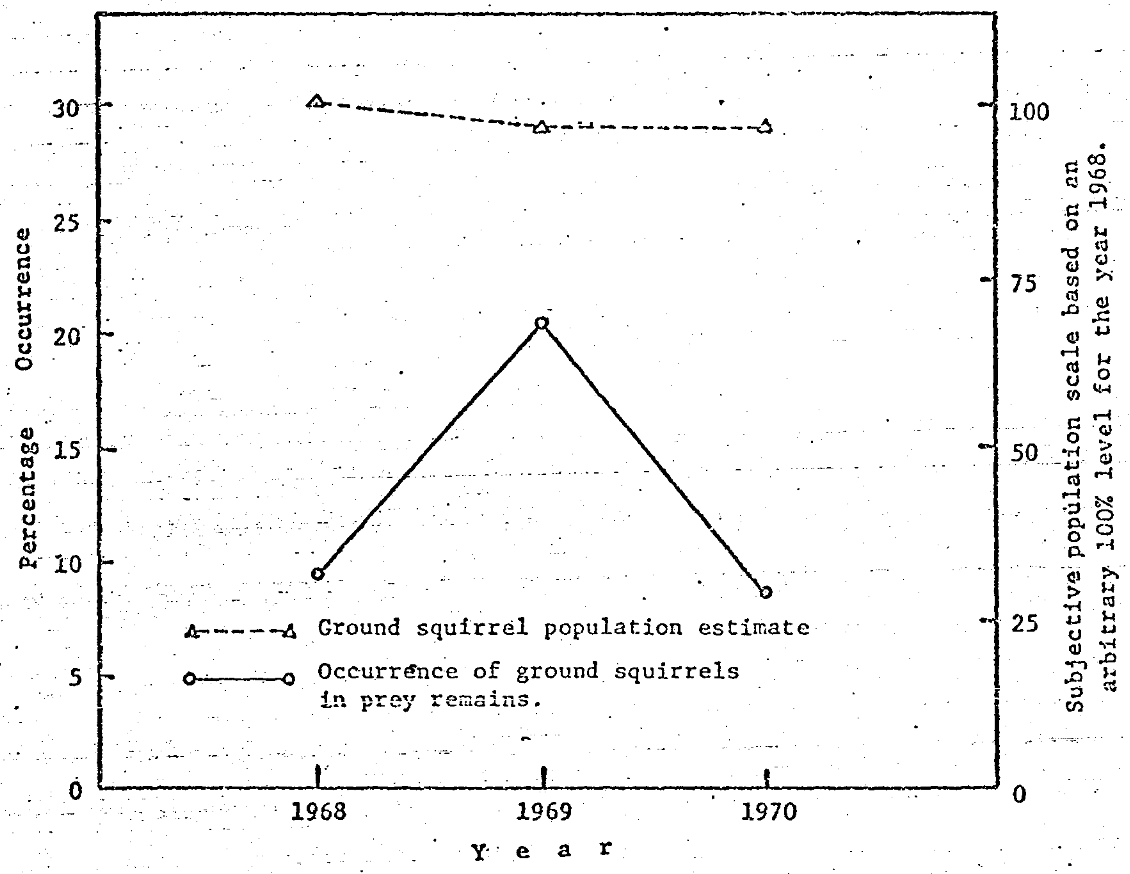

Figure 6. The percentage occurrence of Arctic Ground Squirrels in the 1968-1970 Gyrfalcon prey remains compared with an observed subjective estimate of the ground squirrel population trends from the Seward Peninsula, Alaska.

squirrels are unavailable to Gyrfalcons from about 1 October to 1 May due to their winter hibernation.

To emphasize the apparent importance of ground squirrels to Gyrfalcons nesting on the Seward Peninsula in 1969, a plot of the calculated per cent by weight of the yearly sums of avian species and mammalian species identified from the prey remains has been made (see Figure 7). This figure indicates that, by weight, avian species declined about 13 per cent in 1969, while in this same year ground squirrels, by weight, increased about 13 per cent in the Gyrfalcon prey remains. Table 6 (from which the plot was obtained) shows that during all three years ground squirrels, by weight, constituted almost all of the mammalian contribution to the prey remains. Similarly, the approximately 13 per cent decrease in the 1969 avian kill can be attributed to a large extent to the decline, by weight, of ptarmigan and jaegers.

Figure 8 is an attempt to show the compensatory role played by ground squirrels and the relationships of the three important categories (ptarmigan, jaegers, and ground squirrels). Ptarmigan and jaegers, together by weight, declined sharply in 1969 (Curve C). On the other hand, the three primary categories including ground squirrels (Curve A), together by weight, did not decline as sharply in 1969. Grouping ptarmigan and ground squirrels (Curve B), these two categories by weight resulted in the

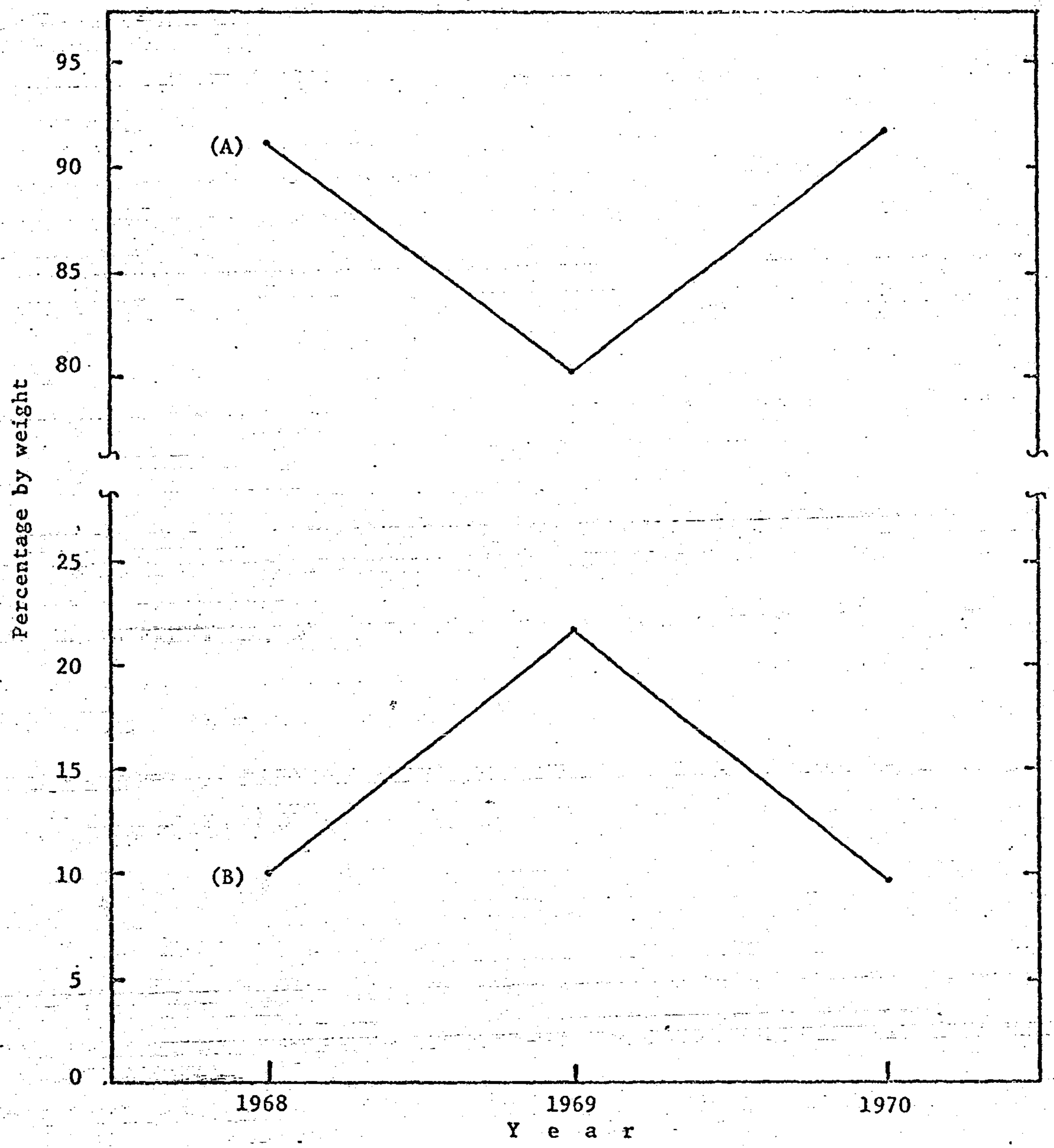

Figure 7. (A) The estimated biomass of ptarmigan and Long-tailed Jaegers calculated as a percentage by weight of the avian remains, and (B) the estimated biomass of Arctic Ground Squirrels calculated as a percentage by weight of the mammalian remains identified from the 1968 - 1970 Seward Peninsula Gyrfalcon prey remains.

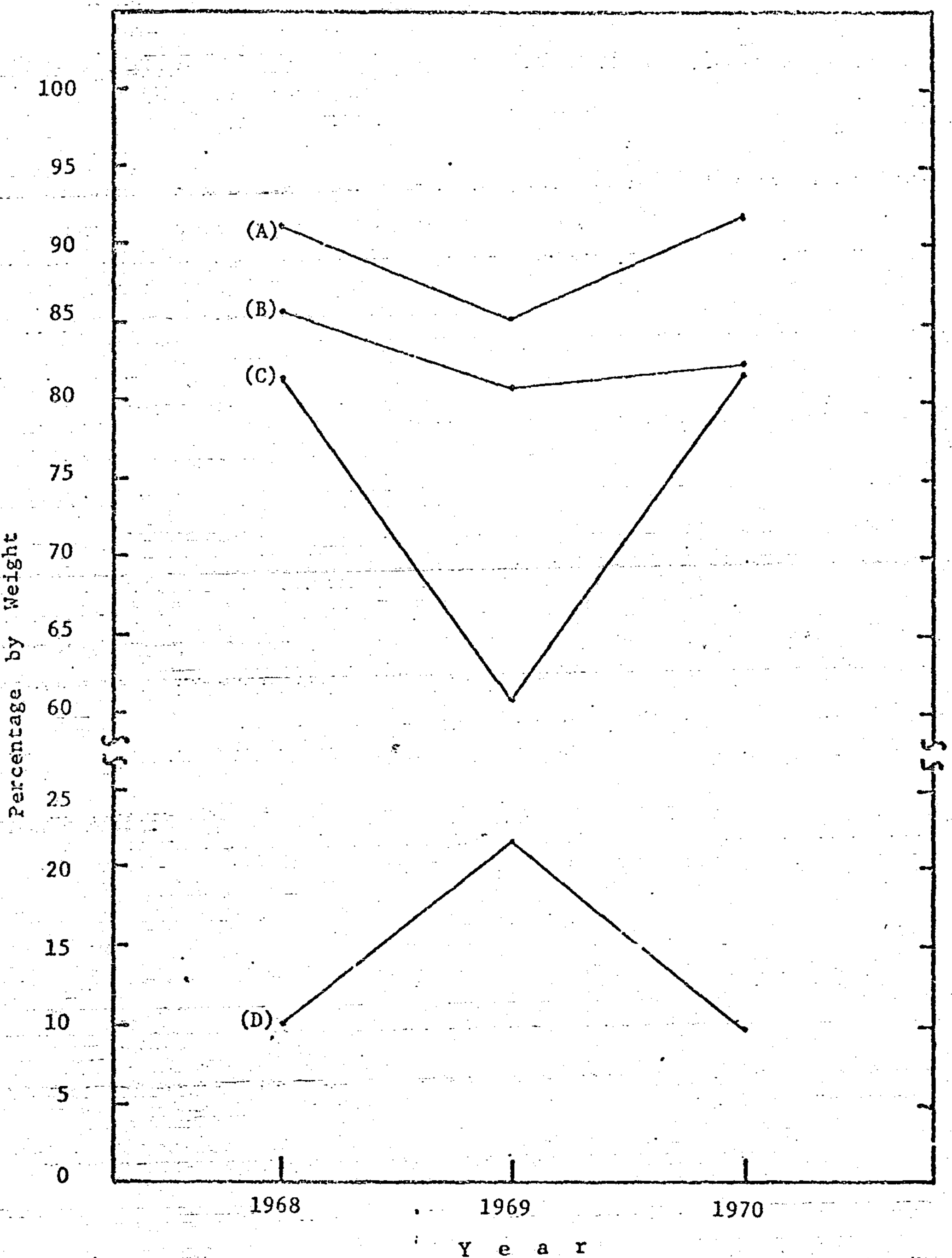

Figure 8. Major Gyrfalcon prey items expressed as a percentage of the total of yearly kills by weight: (A) ptarmigan, jaegers, ground squirrels; (B) ptarmigan, ground squirrels; (C) ptarmigan, jaegers; (D) ground squirrels, jaegers.

flattest curve. This indicates a more stable yearly utilization of these two resident species in changing combinations. However, grouping ground squirrels and jaegers (Curve D) shows that these two categories together by weight, increased in 1969, even though jaegers contributed the least amount by weight and, in fact, declined in number of occurrences that year. The increased occurrence of ground squirrels indicates them to be an important source of food that helped "buffer" the declines in ptarmigan and jaeger biomass.

It must be reiterated that based on pellet examination, it was estimated that microtines occurred up to 5 times more frequently than was evident from the prey remains. In terms of calculated biomass and percentage by weight, this fact has very little effect on the calculated values presented on the basis of the prey remains alone (one per cent or less). In fact, were microtines to occur up to ten times the number they represent in terms of prey remains, the results in terms of percentage by weight calculations are still affected only to a minor degree.

Because of the differences in the yearly sample sizes of the Gyrfalcon prey remains, a 2 x 2 contingency table was constructed and chi-square values were obtained to help compare by year the prey groups listed in Table 11. In all cases, with the exception of the Short-eared Owls, the chi-square value followed a pattern that is consistent with the picture presented by Figure 2 and the hypothesis that utilization of some prey groups increased in 1969 when other prey groups became less available to Gyrfalcons.

Variation in prey species utilization between different pairs

Tables 12a,b to 27a,b list prey remains from a series of Seward Peninsula Gyrfalcon eyries where 25 or more kills were found. These tables describe a range of variability of prey within a sample of 23 Gyrfalcon nestings in differing habitats and situations. Two factors may account for this variation: (1) the location of the eyries in relation to prey species habitat and numbers, and (2) pair or individual preferences on the part of the Gyrfalcons. To demonstrate the variation in prey remains that occurred between the Gyrfalcon eyries described in Tables 12a,b through 27a,b, the three major prey categories (ptarmigan, jaegers, and ground squirrels), migratory bird species and resident species were extracted and are presented in Table 28. It may also be noted that of the 23 nestings listed where prey remains were collected, ptarmigan occur in every instance, ground squirrels occur in 21, and jaegers occur in 14. One or more of the resident species occurred in all the nestings and migratory bird species occurred in 22.

It has been previously mentioned that Gyrfalcons nesting in insular situations feed primarily on Alcids,

Table 12a. Gyrfalcon eyrie no. 1[1], Seward Peninsula, Alaska

	1968		1970	
Name	Number	Per cent of kill	Number	Per cent of kill
Long-tailed Jaeger	15	29.4	81	55.9
Ptarmigan species	18	35.3	24	16.6
Black-legged Kittiwake	3	5.9	11	7.6
Unidentified birds	3	5.9	5	3.4
American Golden Plover	1	2.0	3	2.1
Whimbrel	1	2.0	3	2.1
Pintail	2	3.9	1	0.7
Unidentified waterfowl			3	2.1
Unidentified shorebirds			3	2.1
Bar-tailed Godwit	1	2.0	2	1.4
Unidentified Alcids	3	5.9		
Black Brant			1	0.7
Green-winged Teal	1	2.0		
Ruddy Turnstone			1	0.7
Parasitic Jaeger			1	0.7
Short-eared Owl	1	2.0		
Lapland Longspur	1	2.0		
Unidentified passerines			1	0.7
TOTAL BIRDS	50	98.3	140	95.7
Arctic Ground Squirrels	1	2.0	4	2.8
Vole species			1	0.7
TOTAL MAMMALS	1	2.0	5	3.5
TOTAL KILLS	51		145	

[1]Eyrie no. 1 is located overlooking the sea above a narrow coastal plain.

Table 12b. Gyrfalcon food remains from Table 12a grouped in various major food categories

Category	1968[1] Number	1968[1] Per cent of kill	1970[2] Number	1970[2] Per cent of kill
Ducks	3	5.9	5	3.4
Shorebirds	3	5.9	12	8.3
Passerines	1	2.0	1	0.7
Jaegers	15	29.4	82	56.5
Seabirds	6	11.7	11	7.6
Short-eared Owl	1	2.0		
Unidentified birds	3	5.9	5	3.4
Migratory birds subtotal	32	61.5	116	80.0
Ptarmigan	18	34.6	24	16.6
Ground squirrels	1	1.9	4	2.8
Microtines			1	0.7
Resident species subtotal	19	36.5	29	20.0
Ptarmigan, jaegers, and ground squirrels	34	65.4	109	75.2
Ptarmigan and jaegers	33	63.5	105	72.4
Ptarmigan and ground squirrels	19	36.5	28	19.3

[1]Figures for 1968 are calculated on the basis of 51 kills.

[2]Figures for 1970 are calculated on the basis of 145 kills.

Table 13a. Gyrfalcon eyrie no. 2[1], Seward Peninsula, Alaska

Name	1968 Number	1968 Per cent of kill	1969 Number	1969 Per cent of kill	1970[2] Number	1970[2] Per cent of kill
Ptarmigan species	24	43.6	37	74.0	74	88.1
Long-tailed Jaegers	27	49.1	6	12.0	4	4.8
Jaeger species	1	1.8				
Unidentified shorebirds	1	1.8	1	2.0		
American Golden Plover			1	2.0		
Whimbrel					1	1.2
Parakeet Auklet					1	1.2
Unidentified passerines					1	1.2
Unidentified birds					1	1.2
TOTAL BIRDS	53	96.4	48	96.0	82	97.7
Arctic Ground Squirrel	1	1.8	2	4.0	1	1.2
Brown Lemming	1	1.8				
Collared Lemming					1	1.2
TOTAL MAMMALS	2	3.6	2	4.0	2	2.4
TOTAL KILLS	55		50		84	

[1]Eyrie no. 2 is located at an inland river bluff in a narrow valley, 10 air-miles from the coast.

[2]This eyrie was occupied by the same pair of gyrfalcons during 1968 and 1969, and probably 1970.

Table 13b. Gyrfalcon food remains from Table 13a grouped in various major categories

Category	1968[1]		1969[2]		1970[3]	
	Number	Per cent of kill	Number	Per cent of kill	Number	Per cent of kill
Ducks						
Shorebirds	1	1.8	2	4.0	2	2.4
Passerines			2	4.0	1	1.2
Jaegers	28	50.9	6	12.0	4	4.8
Seabirds						
Unidentified birds			1	2.0	1	1.2
Migratory birds subtotal	29	52.7	11	22.0	8	9.5
Ptarmigan	24	43.6	37	74.0	74	88.1
Ground squirrels	1	1.8	2	4.0	1	1.2
Microtines	1	1.8			1	1.2
Resident species subtotal	26	47.3	39	78.0	76	90.5
Ptarmigan, jaegers, and ground squirrels	53	96.4	45	90.0	79	94.0
Ptarmigan and jaegers	52	94.5	43	86.0	78	92.9
Ptarmigan and ground squirrels	25	45.4	39	78.0	75	89.3

[1]Figures for 1968 are calculated on the basis of 55 kills.
[2]Figures for 1969 are calculated on the basis of 50 kills.
[3]Figures for 1970 are calculated on the basis of 84 kills.

Table 14a. Gyrfalcon eyrie no. 3[1], Seward Peninsula, Alaska

	1968		1969[2]	
Name	Number	Per cent of kill	Number	Per cent of kill
Ptarmigan species	10	32.3	16	38.1
Robins			3	7.1
Unidentified passerines	3	9.7	2	4.8
Bar-tailed Godwits	2	6.5		
American Golden Plover			2	4.8
Long-tailed Jaegers			2	4.8
Redpolls			2	4.8
Jaeger species	1	3.2		
Whimbrel			1	2.4
Ruddy Turnstone			1	2.4
Tree Sparrow			1	2.4
Gray-cheeked Thrush			1	2.4
Unidentified shorebird			1	2.4
Unidentified bird			1	2.4
TOTAL BIRDS	16	51.7	33	64.5
Ground squirrels	15	48.4	9	21.4
TOTAL MAMMALS	15	48.4	9	21.4
TOTAL KILLS	31		42	

[1]Eyrie no. 3 is located on the lower slopes of a narrow river valley 8 air-miles from the coast.

[2]This eyrie was occupied by the same pair of Gyrfalcons 1968-1969.

Table 14b. Gyrfalcon food remains from Table 14a grouped in various major categories

Category	1968[1] Number	1968[1] Per cent of kill	1969[2] Number	1969[2] Per cent of kill
Ducks				
Shorebirds	2	6.5	5	11.9
Passerines	3	9.7	9	21.4
Jaegers	1	3.2	2	4.8
Seabird				
Unidentified birds	—	—	1	2.4
Migratory birds subtotal	6	19.4	17	40.5
Ptarmigan	10	32.3	16	23.8
Ground squirrels	15	48.4	9	21.4
Microtines	—	—	—	—
Resident species subtotal	25	80.7	25	59.5
Ptarmigan, jaegers, and ground squirrels	26	83.9		
Ptarmigan and jaegers	11	35.5		
Ptarmigan and ground squirrels	25	80.7	25	59.5

[1]Figures for 1968 are calculated on the basis of 31 kills.

[2]Figures for 1969 are calculated on the basis of 42 kills.

Table 15a. Gyrfalcon eyrie no. 4[1], Seward Peninsula, Alaska

Name	1969 Number	1969 Per cent of kill
Ptarmigan species	11	26.8
Tufted Puffins	7	17.1
Pigeon Guillemots	4	9.8
Unidentified waterfowl	3	7.3
Unidentified passerines	2	4.9
Unidentified birds	2	4.9
Whimbrel	1	2.4
Unidentified shorebirds	1	2.4
Long-tailed Jaegers	1	2.4
Robins	1	2.4
TOTAL BIRDS	33	80.4
Ground squirrels	8	19.5
TOTAL MAMMALS	8	19.5
TOTAL KILLS	41	

[1]Eyrie no. 4 is located on a sea-cliff on the periphery of a seabird colony.

Table 15b. Gyrfalcon food remains from Table 15a grouped in various major categories

Category	1969[1] Number	Per cent of kill
Ducks	3	7.3
Shorebirds	2	4.9
Passerines	3	7.3
Jaegers	1	2.4
Seabirds	11	26.8
Unidentified birds	2	4.9
Migratory birds subtotal	22	53.7
Ptarmigan	11	26.8
Ground squirrels	8	19.5
Microtines	—	—
Resident species subtotal	19	46.3
Ptarmigan, jaegers, and ground squirrels	20	48.7
Ptarmigan and jaegers	12	29.3
Ptarmigan and ground squirrels	19	46.3

[1]Figures for 1969 are calculated on the basis of 41 kills.

Table 16a. Gyrfalcon eyrie no. 5[1], Seward Peninsula, Alaska

Name	1968 Number	1968 Per cent of kill	1969 Number	1969 Per cent of kill	1970 Number	1970 Per cent of kill
Ptarmigan species	8	21.1	8	72.7	29	67.4
Common snipe	5	13.2			1	2.3
American Golden Plover	2	5.3	1	9.1	3	7.0
Jaeger species					1	2.3
Short-eared Owl	1	2.6				
Robin	1	2.6	1	9.1		
Unidentified passerines					1	2.3
TOTAL BIRDS	17	44.8	10	90.9	35	81.3
Arctic Ground Squirrels	8	21.1	1	9.1	5	11.6
Collared Lemming	8	21.1			2	4.7
Brown Lemming	4	10.5			1	2.3
Vole species	1	2.6				
TOTAL MAMMALS	21	55.3	1	9.1	8	18.6
TOTAL KILLS	38		11		43	

[1]Eyrie no. 5 is located on a hillside in a narrow valley system 23 air-miles from the coast.

Table 16b. Gyrfalcon food remains from Table 16a grouped in various major categories

Category	1968[1] Number	1968[1] Per cent of kill	1969[2] Number	1969[2] Per cent of kill	1970[3] Number	1970[3] Per cent of kill
Ducks						
Shorebirds	7	18.4	1	9.1	4	9.3
Passerines	1	2.6	1	9.1	1	2.3
Jaegers					1	2.3
Seabirds						
Short-eared Owl	1	2.6				
Migratory birds subtotal	9	23.7	2	18.9	6	14.0
Ptarmigan	8	21.1	8	72.7	29	67.4
Ground squirrels	8	21.1	1	9.1	5	11.6
Microtines	13	34.2			3	7.0
Resident species subtotal	29	76.3	9	81.8	37	86.0
Ptarmigan, jaegers, and ground squirrels					35	81.3
Ptarmigan and jaegers					30	69.7
Ptarmigan and ground squirrels	16	42.1	9	81.8	34	79.0

[1]Figures for 1968 are calculated on the basis of 38 kills.
[2]Figures for 1969 are calculated on the basis of 11 kills.
[3]Figures for 1970 are calculated on the basis of 43 kills.

Table 17a. Gyrfalcon eyrie no. 6[1], Seward Peninsula, Alaska

Name	1969 Number	1969 Per cent of kill
Ptarmigan species	8	12.7
American Golden Plover	6	9.5
Robin	3	4.8
Gray-cheeked Thrush	2	3.2
Long-tailed Jaeger	1	1.6
Semipalmated Plover	1	1.6
Unidentified shorebirds	1	1.6
Lapland Longspur	1	1.6
Unidentified passerines	1	1.6
TOTAL BIRDS	24	38.2
Ground squirrels	38	60.3
Collared Lemming	1	1.6
TOTAL MAMMALS	39	61.9
TOTAL KILLS	63	

[1]Eyrie no. 6 is located on a hilltop in a wide river valley 11 air-miles from the coast.

Table 17b. Gyrfalcon food remains from Table 17a grouped in various major categories

Category	1969[1] Number	1969[1] Per cent of kill
Ducks		
Shorebirds	8	12.7
Passerines	7	11.1
Jaegers	1	1.6
Seabirds		
Migratory birds subtotal	16	25.4
Ptarmigan	8	12.7
Ground squirrels	38	60.3
Microtines	1	1.6
Resident species subtotal	47	74.6
Ptarmigan, jaegers, and ground squirrels	47	74.6
Ptarmigan and jaegers	9	14.3
Ptarmigan and ground squirrels	46	73.0

[1]Figures for 1969 are calculated on the basis of 63 kills.

Table 18a. Gyrfalcon eyrie no. 7[1], Seward Peninsula, Alaska

	1969	
Name	Number	Per cent of kill
Ptarmigan species	36	78.3
Unidentified waterfowl	4	8.7
Pintails	3	6.5
TOTAL BIRDS	43	93.5
Ground squirrels	3	6.5
TOTAL MAMMALS	3	6.5
TOTAL KILLS	46	

[1]Eyrie no. 7 is located on a river bluff in a broad, marshy valley 36 air-miles from the nearest coast.

Table 18b. Gyrfalcon food remains from Table 18a grouped in various major categories

Category	1969[1] Number	Per cent of kill
Ducks	7	15.2
Shorebirds		
Passerines		
Jaegers		
Seabirds		
Migratory birds subtotal	7	15.2
Ptarmigan	36	78.3
Ground squirrels	3	6.5
Microtines		
Resident species subtotal	39	84.8
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels	39	84.8

[1]Figures for 1969 are calculated on the basis of 46 kills.

Table 19a. Gyrfalcon eyrie no. 8[1], Seward Peninsula, Alaska

Name	1968 Number	1968 Per cent of kill
Ptarmigan species	54	84.4
Whimbrel	2	3.1
Short-eared Owl	2	3.1
Unidentified passerines	1	1.6
Unidentified bird	1	1.6
TOTAL BIRDS	60	93.8
Ground squirrel	4	6.3
TOTAL MAMMALS	4	6.3
TOTAL KILLS	64	

[1]Eyrie no. 8 is located on the shoulder of a ridge in a high barren valley system 32 air-miles from the nearest coast.

Table 19b. Gyrfalcon food remains from Table 19a grouped in various major categories

	1968[1]	
Category	Number	Per cent of kill
Ducks		
Shorebirds	2	3.1
Passerines	1	1.6
Jaegers		
Seabirds		
Short-eared Owl	2	3.1
Migratory birds subtotal	6	9.4
Ptarmigan	54	84.4
Ground squirrels	4	84.4
Microtines		
Resident species subtotal	58	90.6
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels	58	90.6

[1]Figures for 1968 are calculated on the basis of 64 kills.

Table 20a. Gyrfalcon eyrie no. 9[1], Seward Peninsula, Alaska

Name	1968 Number	1968 Per cent of kill	1970 Number	1970 Per cent of kill
Ptarmigan species	153	93.9	21	65.6
Short-eared Owl	3	1.8		
Unidentified shorebirds	2	1.2	1	3.1
Pintail	1	0.6		
Long-tailed Jaeger			8	25.0
TOTAL BIRDS	159	97.5	30	93.7
Arctic Ground Squirrel	2	1.2	2	6.3
Unidentified microtine	1	0.6		
Mink	1	0.6		
TOTAL MAMMALS	4	2.4	2	6.3
TOTAL KILLS	163		32	

[1]Eyrie no. 9 is located on a hillside in a broad valley system, 16 air-miles from the nearest coast.

Table 20b. Gyrfalcon food remains from Table 20a grouped in various major categories

Category	1968[1] Number	1968[1] Per cent of kill	1970[2] Number	1970[2] Per cent of kill
Ducks	1	0.6		
Shorebirds	2	1.2	1	3.1
Passerines				
Jaegers			8	25.0
Seabirds				
Short-eared Owl	3	1.8		
Migratory birds subtotal	6	3.7	9	28.1
Ptarmigan	153	93.9	21	65.6
Ground squirrels	2	1.2	2	6.3
Microtines	1	0.6		
Resident species subtotal	157	96.3	23	71.9
Ptarmigan, jaegers, and ground squirrels			31	96.9
Ptarmigan and jaegers			29	90.7
Ptarmigan and ground squirrels	155		23	71.9

[1]Figures for 1968 are calculated on the basis of 163 kills.

[2]Figures for 1970 are calculated on the basis of 32 kills.

Table 21a. Gyrfalcon eyrie no. 10[1], Seward Peninsula, Alaska

Name	1968 Number	1968 Per cent of kill
Ptarmigan species	11	44.0
Unidentified waterfowl species	1	4.0
Unidentified sandpiper species	1	4.0
Unidentified passerines	1	4.0
TOTAL BIRDS	14	56.0
Arctic Ground Squirrel	8	32.0
Collared Lemming	2	8.0
Unidentified microtine	1	4.0
TOTAL MAMMALS	11	44.0
TOTAL KILLS	25	

[1] Eyrie no. 10 is located high on the side of a river valley 15 air-miles from the nearest coast.

Table 21b. Gyrfalcon food remains from Table 21a grouped in various major categories

Category	1968[1] Number	1968[1] Per cent of kill
Ducks	1	4.0
Shorebirds	1	4.0
Passerines	1	4.0
Jaegers		
Seabirds		
Migratory birds subtotal	3	12.0
Ptarmigan	11	44.0
Ground squirrels	8	32.0
Microtines	3	12.0
Resident species subtotal	22	88.0
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels	19	76.0

[1]Figures for 1968 are calculated on the basis of 25 kills.

Table 22a. Gyrfalcon eyrie no. 11[1], Seward Peninsula, Alaska

Name	1970 Number	1970 Per cent of kill
Ptarmigan species	45	100.0
TOTAL BIRDS	45	100.0
TOTAL KILLS	45	100.0

[1]Eyrie no. 11 is located on a river bluff at the edge of the central lowlands in a large drainage system 42 air-miles from the nearest coast.

Table 22b. Gyrfalcon food remains from Table 22a grouped in various major categories

Category	1970[1]	
	Number	Per cent of kill
Ducks		
Shorebirds		
Passerines		
Jaegers		
Seabirds		
Migratory birds subtotal		
Ptarmigan	45	100.0
Ground squirrels		
Microtines		
Resident species subtotal	45	100.0
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels		

[1]Figures for 1970 are calculated on the basis of 45 kills.

Table 23a. Gyrfalcon eyrie no. 12[1], Seward Peninsula, Alaska

Name	1970 Number	1970 Per cent of kill
Ptarmigan species	62	89.9
Short-eared Owl	2	2.9
Long-tailed Jaeger	1	1.4
TOTAL BIRDS	65	94.2
Red-backed Vole	3	4.3
Lemming species	1	1.4
TOTAL MAMMALS	4	5.7
TOTAL KILLS	69	

[1]Eyrie no. 12 is located on a river bluff at the edge of the central lowlands in a large drainage system 42 air-miles from the nearest coast.

Table 23b. Gyrfalcon food remains from Table 23a grouped in various major categories

Category	1970[1] Number	1970[1] Per cent of kill
Ducks		
Shorebirds		
Passerines		
Jaegers	1	1.4
Seabirds		
Short-eared Owl	2	2.9
Migratory birds subtotal	3	4.3
Ptarmigan	62	89.9
Ground squirrels		
Microtines	4	5.8
Resident species subtotal	66	95.7
Ptarmigan, jaegers and ground squirrels		
Ptarmigan and jaegers	67	97.1
Ptarmigan and ground squirrels		

[1]Figures for 1970 are calculated on the basis of 69 kills

Table 24a. Gyrfalcon eyrie no. 13[1], Seward Peninsula, Alaska

Name	1970 Number	1970 Per cent of kill
Ptarmigan species	84	77.1
Unidentified birds	10	9.2
Oldsquaw	1	0.9
American Golden Plover	1	0.9
Common snipe	1	0.9
Lesser Yellowlegs	1	0.9
Long-tailed Jaeger	1	0.9
Tree Sparrow	1	0.9
Snow Bunting	1	0.9
Unidentified passerine	1	0.9
TOTAL BIRDS	102	93.5
Arctic Ground Squirrel	7	6.4
TOTAL MAMMALS	7	6.4
TOTAL KILLS	109	

[1]Eyrie no. 13 is located high on the edge of a plateau region falling off to the coastal lowlands and 27 air-miles from the nearest coast.

Table 24b. Gyrfalcon food remains from Table 24a grouped in various major categories

Category	1970[1] Number	1970[1] Per cent of kill
Ducks	1	0.9
Shorebirds	3	2.8
Passerines	3	2.8
Jaegers	1	0.9
Seabirds		
Unidentified birds	10	9.2
Migratory birds subtotal	18	16.5
Ptarmigan	84	77.1
Ground squirrels	7	6.4
Microtines	—	—
Resident species subtotal	91	83.5
Ptarmigan, jaegers, and ground squirrels	92	84.4
Ptarmigan and jaegers	85	78.0
Ptarmigan and ground squirrels	91	83.5

[1]Figures for 1970 are calculated on the basis of 109 kills.

Table 25a. Gyrfalcon eyrie no. 14[1], Seward Peninsula, Alaska

	1970	
Name	Number	Per cent of kill
Ptarmigan species	11	37.9
Unidentified passerines	3	10.3
Golden Plover	2	6.9
Common snipe	1	3.4
Whimbrel	1	3.4
TOTAL BIRDS	18	61.9
Arctic Ground Squirrel	8	27.6
Collared Lemming	2	6.9
Lemming species	1	3.4
TOTAL MAMMALS	11	37.8
TOTAL KILLS	29	

[1] Eyrie no. 14 is located on a creek bluff in a broad relatively open valley system 17.5 air-miles from the nearest coast.

Table 25b. Gyrfalcon food remains from Table 25a grouped in various major categories

Category	1970[1] Number	1970[1] Per cent of kill
Ducks		
Shorebirds	3	10.3
Passerines	3	10.3
Jaegers		
Seabirds		
Migratory birds subtotal	7	24.1
Ptarmigan	11	75.9
Ground squirrels	8	27.6
Microtines	3	10.3
Resident species subtotal	22	75.9
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels	19	65.5

[1]Figures for 1970 are calculated on the basis of 29 kills.

Table 26a. Gyrfalcon eyrie no. 15[1], Seward Peninsula, Alaska

Name	1970 Number	1970 Per cent of kill
Ptarmigan species	17	41.5
Unidentified passerines	5	12.2
American Golden Plover	4	9.8
Unidentified shorebirds	1	2.4
Long-tailed Jaeger	1	2.4
Snow Bunting	1	2.4
Unidentified birds	1	2.4
TOTAL BIRDS	30	73.1
Arctic Ground Squirrel	6	14.6
Lemming species	2	4.9
Collared Lemming	1	2.4
Vole species	1	2.4
TOTAL MAMMALS	10	24.3
Unidentified kill	1	2.4
TOTAL UNIDENTIFIED KILLS	1	2.4
TOTAL KILLS	41	

[1]Eyrie no. 15 is located high on the side of a narrow creek valley surrounded by high hills 15 air-miles from the coast.

Table 26b. Gyrfalcon food remains from Table 26a grouped in various major categories

	1970[1]	
Category	Number	Per cent of kill
Ducks		
Shorebirds	5	12.2
Passerines	6	14.6
Jaegers	1	2.4
Seabirds		
Unidentified birds	1	2.4
Migratory birds subtotal	13	31.7
Ptarmigan	17	41.5
Ground squirrels	6	14.6
Microtines	4	9.8
Resident species subtotal	27	65.9
Ptarmigan, jaegers, and ground squirrels	24	31.5
Ptarmigan and jaegers	18	43.9
Ptarmigan and ground squirrels	23	29.1

[1]Figures for 1970 are calculated on the basis of 41 kills.

Table 27a. Gyrfalcon eyrie no. 16[1], Seward Peninsula, Alaska

	1970	
Name	Number	Per cent of kill
Ptarmigan species	27	36.0
Common snipe	3	4.0
Unidentified passerines	3	4.0
Robin	2	2.7
Lapland Longspur	2	2.7
Bar-tailed Godwit	1	1.3
Unidentified shorebirds	1	1.3
Say's Phobe	1	1.3
Varied Thrush	1	1.3
Water Pipit	1	1.3
Fox Sparrow	1	1.3
TOTAL BIRDS	43	57.2
Arctic Ground Squirrel	25	33.3
Collared Lemming	4	5.3
Lemming species	2	2.7
Vole species	1	1.3
TOTAL MAMMALS	32	42.6
TOTAL KILLS	75	

[1]Eyrie no. 16 is located high on the side of a broad river valley 12 air-miles from the coast.

Table 27b. Gyrfalcon food remains from Table 27a grouped in various major categories

Category	1970[1] Number	1970[1] Per cent of kill
Ducks		
Shorebirds	5	6.7
Passerines	11	14.7
Jaegers		
Seabirds		
Migratory birds subtotal	16	21.3
Ptarmigan	27	36.0
Ground squirrels	25	33.3
Microtines	7	9.3
Resident species subtotal	59	78.7
Ptarmigan, jaegers, and ground squirrels		
Ptarmigan and jaegers		
Ptarmigan and ground squirrels	52	69.4

[1]Figures for 1970 are calculated on the basis of 75 kills.

Table 28. The range[1] in the per cent occurrence and numbers of the three major prey categories, migratory bird species, and resident species at 23 Seward Peninsula Gyrfalcon nestings

Prey Category or Group	1968 Per cent Range	1968 Numbers Range	1969 Per cent Range	1969 Numbers Range	1970 Per cent Range	1970 Numbers Range
Ptarmigan	21.1; 93.9	8; 153	12.7; 78.3	8; 37	16.6; 100.0	11; 84
Jaegers	0.0; 50.9	0; 28	0.0; 12.0	0; 6	0.0; 56.5	0; 82
Ground squirrels	1.2; 48.4	1; 15	4.0; 60.3	1; 38	0.0; 33.3	0; 25
Migratory bird species	3.7; 63.5	3; 33	15.2; 53.7	2; 22	0.0; 80.0	0;116
Resident species	35.5; 96.3	19; 157	46.3; 84.8	9; 47	20.0; 100.0	22; 91
TOTAL NESTINGS	7		6		10	

[1]All arithmetic figures represent the minimum and maximum values obtained from Tables 12b through 27b.

Larids, and Anatids, and that pairs nesting inland feed primarily on ptarmigan (Dementiev and Gortchakovskaya, 1945; Cade, 1960). This suggests that Gyrfalcons will tend to utilize those species that are the most abundant (i.e., available and therefore possibly the easiest to catch) in the general vicinity of the Gyrfalcon nesting cliff. From my data on the food habits of Gyrfalcon nesting on the Seward Peninsula, it is apparent that pairs nesting on the coast or in an area strongly influenced by the coastal environment prey upon species associated with both the coastal and the inland habitats (especially Larids, Alcids, jaegers, ground squirrels, and ptarmigan). In general, the prey taken by a nesting Gyrfalcon pair on the Seward Peninsula reflects the habitat characteristics of the hunting range of that pair such that pairs nesting in the vicinity of a particular species "concentration" will prey substantially on that species. For example, pairs (eyrie numbers one and four) nesting on the coast will take a substantial number of jaegers, Alcids, and Larids compared with a pair nesting in the uplands where ptarmigan and ground squirrels will predominate.

Little is known about pair or individual preference. It is note-worthy that the nesting pair at the eyrie designated "2" in the tables took large numbers of Long-tailed Jaegers during a time when Rock Ptarmigan were very plentiful in the immediate vicinity of their nest (about 40 territorial male Rock Ptarmigan were in view of their nesting cliff).

In 1969 this same pair (as judged by the color of the members of the pair) accounted for at least six Long-tailed Jaegers at a time when jaegers were much scarcer and when 11 other nesting pairs of Gyrfalcons accounted for only ten Long-tailed Jaegers (based on the prey remains).

Tables 12a,b to 27a,b describe a continuum of the variability of Gyrfalcon prey over a large sample of eyries in differing habitats and situations. It is possible to fit all previous Gyrfalcon food studies reported in the literature into this broad picture. A broad continuum of situations exists ranging from insular seabird eaters to interior ptarmigan/ground squirrel eaters. This general continuum will be affected, for example, by the nearness of waterfowl habitat (Bengtson, 1971). Each general area of Gyrfalcon nesting habitat can be defined by geographical criteria (the existence of marshes, coast lines, rivers and uplands, for example) and each of these areas will tend to have its own general falcon/prey relationship. Each Gyrfalcon pair, dependent upon their location in relation to prey species, will produce a uniform dietary prey list, but that list will be strongly related to those prey species found in the vicinity of the Gyrfalcons' nest. Such a dietary list from one pair may or may not closely resemble the dietary lists from other Gyrfalcon pairs depending upon whether or not all the pairs are nesting in similar habitat situations.

SUMMARY AND CONCLUSIONS

1. Breeding Gyrfalcon populations on the Seward Peninsula during the summers of 1968, 1969, and 1970 were stable on a region-wide basis at a high level. Of 131 nestings observed, 34 occurred in 1968, 48 in 1969, and 49 in 1970. The low figure for 1968 reflects poor survey coverage in that year.

2. Local shifting of populations within smaller units of the peninsula occurred which were correlated with prey abundance.

3. Nesting-cliff tenacity was low. Over the three summers only four per cent of the nesting sites were occupied all three years. The interrelationships between Rough-legged Hawks, Golden Eagles, and Ravens, all of which also utilize cliffs as nesting sites, is complex and as yet poorly understood.

4. Distribution on the peninsula is not uniform, but controlled by the availability of nesting cliffs. Over all three years 66 per cent of the observed nestings occurred in only about 2,200 square miles of the peninsula or approximately 13 per cent.

5. Prey remains were collected from 37 nestings and 1,483 kills were identified, representing 32 species of birds and eight species of mammals. This is a considerably

more diverse list of Gyrfalcon prey than has previously been reported.

6. Four species were of overriding importance: Rock Ptarmigan, Willow Ptarmigan, the Arctic Ground Squirrel, and the Long-tailed Jaeger. These four made up 81 per cent by number and 92 per cent by weight of the sample.

7. Prey utilization varied with availability both temporally and spatially. While the four species mentioned above continued to be important during all summers, it is apparent that Gyrfalcons readily shift their attentions to members of a wide spectrum of other prey species as availability dictates.

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