EXPERIMENTAL COMMERCIAL HARVEST OF PTARMIGAN, KITIKMEOT REGION, 1989

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ABSTRACT

A survey of traditional knowledge on ptarmigan ecology and harvesting in Cambridge Bay and a literature survey for scientific studies of ptarmigan (*Lagopus* spp.) ecology were undertaken as preliminary steps toward establishing a commercial harvest of ptarmigan. An experimental commercial harvest was attempted in September 1989 but was only partially successful, as few ptarmigan were found.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

More Hunters' and Trappers' Associations (HTA) have become involved in commercial meat sales but their product line is limited to caribou (*Rangifer tarandus*), muskoxen (*Ovibos moschatus*) and charr (*Salvelinus alpinus*). Harvesting specifically for ptarmigan (*Lagopus* spp.) and subsequent packaging as a frozen product or further processing as a smoked product would create part-time employment and diversify the product line of the commercial wildlife sales of the HTAs. Ptarmigan are common in many parts of the Northwest Territories (NWT) and are usually harvested incidentally during the harvesting of other species.

The population dynamics of ptarmigan have been studied at Hope Bay, a mainland coastal area east of Bay Chimo (R. Cotter in prep.). The effects of the harvesting are, however, almost unknown for ptarmigan in the Canadian Arctic. Ptarmigan and grouse populations and their responses to hunting are, by comparison, relatively well documented in Europe (Robertson and Rosenberg 1988).

The purpose of this study was to evaluate the potential for commercial harvesting of ptarmigan in the Kitikmeot Region. A proposal was submitted to the Renewable Resource Demonstration Project review committee for funding. Subsequently, the proposal was modified to have the following specific objectives:

1) Compile local ecological knowledge of ptarmigan and subsistence

ptarmigan hunting in the Kitikmeot Region. The existing information on ptarmigan subsistence harvesting would be compiled from the Kitikmeot Harvest Study and hunters in Cambridge Bay would be interviewed to record local knowledge of ptarmigan hunting and ecology.

2) Initiate population monitoring and ecological studies of ptarmigan by compiling the available literature on ptarmigan ecology with emphasis on feeding habits and harvesting as the first step toward understanding the effects of harvesting.

3) Evaluate harvesting procedures, processing and marketing of commercial ptarmigan harvesting by experimentally harvesting up to 250 ptarmigan in the fall of 1989, and use the harvest to monitor sex/age composition, condition and feeding habits from carcass examination. The handling, packaging and marketing of the ptarmigan will be monitored under a contractual arrangement with Central Arctic Meats Ltd. to report on the feasibility of commercial ptarmigan harvesting.

The study was centred at Cambridge Bay because a meat plant (Central Arctic Meats Ltd.) is already in operation. A second reason was the proximity of the ptarmigan studies at Hope Bay to provide information on ptarmigan ecology.

METHODS

Survey of traditional knowledge

George Hakungak was contracted to interview 20 people in Cambridge Bay to record their knowledge of ptarmigan. The people were older people who had considerable experience on the land and who were comfortable being interviewed. The interviews were unstructured except that the people were asked their opinion of commercial harvesting. The interviews were recorded on a pocket tape-recorder and later transcribed.

Ptarmigan ecology and population dynamics

Richard Cotter (University of Alberta) was contracted to compile the available literature on ptarmigan ecology with emphasis on feeding habits as the first step toward understanding the effects of harvesting.

Experimental ptarmigan harvest

Dr. Wolf Schroeder (University of Munich), David Kaomayok (Renewable Resources) and Jack Epakohak (Hunters' and Trappers' Association) hunted for ptarmigan 10-13 September, 1989 travelling by boat and ATV in the vicinity of Cambridge Bay. The objective was to drive flocks of ptarmigan into fish nets to determine the

processing time that would be required for a commercial harvest. The shortage of ptarmigan necessitated that a small sample of birds was finally collected by shooting.

The birds were kept cool overnight then body weight, sex and age class were recorded for each bird. One method of processing (whole body) was to pull the skin off at the first leg joint then working up to remove the skin from the rest of the body. The head, outer wings and legs were removed. The second method (breast only) involved tearing the skin at the breast, pushing back and working the skin around the bird and back onto the wing. The head and outer wings were then cut off. The abdominal ski below the sternum was cut and the back snapped. The lower half was discarded as it consisted of the legs, part of the back and skin. The intestines fall out of the empty cavity which facilitates retrieval of the heart and liver while the lungs are discarded. The birds were washed and dried.

RESULTS

Interviews with hunters in Cambridge Bay (George Hakungak)

George Hakungak conducted 20 interviews in Inuinnaqtun in May 1989 (Appendix A). His summary of the interviews follows:

"The last two weeks that I had spent in Cambridge Bay with some elders was a very good experience for me, I was able to capture a lot of good stories on the traditional uses of the ptarmigan. Their knowledge was invaluable to this study and I wasn't able to gather as much in drawings but what I did get was good for the general idea. Since the ptarmigan was a small part of the food chain in their daily lives most of the stories seem very much alike. There was no real deviation in the way that the Inuit caught them or prepared the ptarmigan for their meals as well as the uses they had for certain parts of the bird, none was wasted as with the rest of the animals the Inuit hunted. In most of the stories the elders talked about the two types of ptarmigan found, the AKILGIVIK [Willow] and NIGHAKTUK [Rock]. The Akilgivik is slightly larger and is from the mainland and has tougher meat, the Nighaktuk is of the islands and because of its diet of leaves, grass and certain flowers the meat was tender and tastier. In many cases the ptarmigan was usually saved for last resort and the legs and neck were usually stored for snacks on the trail or

for leaner times. It seemed that the ptarmigan was insignificant in times of plenty but the Inuit caught them for a change in diet and also for their eggs in the spring and the young in the fall as well because of the fresh, rich meat they provided after a summer of feeding. The small dictionary I'm providing indicates the words that describe some of the parts of the ptarmigan.

Puviak - The crop or bag that stores the undigested food of the ptarmigan.

Akotok - Ptarmigan intestines after they had been cooked up to make a soup. The contents were emptied and then placed in a pot for boiling.

Akilgivik - Ptarmigan from the mainland, slightly larger than the...Nighaktuk.

Nighaktuk - Ptarmigan of the islands.

Tinguk - Liver.

Atungauyak - Leaves found on the island that the ptarmigan ate.

Negavaktaot - String snare for ptarmigan and other birds. A length of rope tied to a stone and the snare end propped up in front of the bird's path by an upside down "V" shaped straw.

Ogonik - Ptarmigan intestines mixed with seal fat.

Okpinalok - Fluff on the lousewart that the ptarmigan ate.

Angnalluk - female ptarmigan.

Angoloit - male ptarmigan.

Akilgiak - young ptarmigan.

The one idea I received from the people about how to prepare the ptarmigan for sale out of the meat plant never changed, in that it should be prepared the way chicken is. The fall time would be sensible to gather as much ptarmigan for the meat plant as the bird is more plentiful during the period, but it would be a good idea to keep the stock up as people like a variety of meat. Some of the elders seemed a bit shy when I asked them for stories but in the end I was able to write down their stories and am grateful for their knowledge. The stories many told to me are almost alike but it is hard to get their own feelings on paper. A person has to be there to feel it to capture emotions and actions."

Subsistence harvest (Kitikmeot Harvest Study)

The Kitikmeot Harvest Study (Gunn et al. 1987) started in 1982 and ran until 1988. The harvest of ptarmigan (Table 1) is the recorded harvest and has not been extrapolated for hunters who were not available or contacted each month. The harvest is reported for the year beginning 1 July and ending 30 June.

Experimental commercial harvest

Only 8 ptarmigan were harvested, weighed and processed (Table

2) as they were the only birds seen. The processed weight (whole body) is about half the body weight (260 - 320 g) and about 100 g less when only the breast is saved. The average time for skinning and packaging was about 10 min./bird.

Table 1. Subsistence harvest of ptarmigan in the Kitikmeot Region, NWT, 1982-88.

	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Holman	34	81	31	110	9	--[1]
Coppermine	129	660	437	401	721	392
Bay Chimo/Bathurst Inlet	51	102	40	76	84	6
Cambridge Bay	372	856	252	120	1061	392
Spence Bay	161	514	614	555	514	142
Gjoa Haven	7	104	76	184	127	340
Pelly Bay	6	15	0	86	0	0

[1] The Harvest Study was transferred to the Inuvialuit Harvest Study in 1987.

Table 2. Body and processed weights of ptarmigan, Cambridge Bay, NWT, September 1989.

Sex	Body weight (total) (g)	Processed carcass weight (g) whole body thighs+breasts	breast only
F	520	-	210
F	550	-	190
F	470	-	210
F	510	-	200
M	570	300	-
M	520	280	-
M	510	260	-
M	590	320	-

DISCUSSION

Traditional knowledge

The interviews all expressed support for the idea of commercial harvesting of ptarmigan with the stipulation that the birds be sold with the heart, liver and gizzard included. The interviews also seemingly indicated that a local market could be developed.

One interesting observation noted by several hunters is the association among ptarmigan and caribou and muskoxen in the winter (Appendix A). This relationship was the focus of a research sub-project in 1989 (A. Gunn unpubl. data) and appears to be common in the spring where the snow is either wind-packed or has a sun crust. Perhaps in anticipation of snow conditions favourable for foraging, ptarmigan are attracted to large dark objects on the snow such as snowmachines and komatiks - an attribute hunters expect and use to hunt ptarmigan opportunistically (D. Kaomayok pers. comm.).

Potential for and operation of commercial harvest

Cambridge Bay has advantages for the development of commercial ptarmigan harvesting, notably the meat processing plant. Air connections are good with either Yellowknife or Edmonton which are potential markets. Possibly, an effective approach to marketing would be to establish an arrangement with larger hotels and

restaurants as well as country food stores (W. Schroeder pers. comm.).

Legislative changes to the NWT Wildlife Act (R.S.N.W.T. 1988, c.W-4) would be required before commercial harvesting could start. Although Section 55(5) permits sales between General Licence Holders (GHLs), while Section 55(1)(b) prevents sales to non-GHLs. Precedents exist, however, for commercial quotas for other species such as caribou in the Wildlife Act.

Robertson and Rosenberg (1988) discuss strategies for harvesting game birds and they note that the concept of maximum sustained yield is inadequate for cyclic populations of gamebirds which would include ptarmigan in the central Arctic. They recommend reducing variation in the yield so as to maximize the average yield. However desirable this may be as a future strategy, it is infeasible in practice unless the population is intensively monitored. Nevertheless, it is possible to facilitate commercial harvesting of ptarmigan without incurring exorbitant monitoring costs by regulating the harvesting effort (Caughley et al. 1987). Regulating either the number of hunters and or their season (specifically for commercial harvesting) would effectively track the ptarmigan densities. Caughley et al. (1987) clearly state the inefficiencies and dangers of harvesting a constant number of animals each year (i.e., the type of harvest regulation typical in the NWT) in a fluctuating environment - again characteristic of the NWT.

The preferred season for subsistence harvesting is spring, but

commercial harvesting should be encouraged in a late fall season. The birds tend to be flocking in preparation for fall migration and include many birds-of-the-year. Harvesting of the young inexperienced birds will increase the compensatory mortality effect of harvesting as the first year cohort likely suffers higher natural mortality. In addition, young birds are better eating (Appendix A) and a fall commercial season would avoid the timing of most of the subsistence harvesting. There are disadvantages to a fall commercial season: the timing of fall migration is less predictable; until the first snows fall, the brown-plumage birds are relatively inconspicuous and their habitat preferences are less predictable (D. Kaomayok pers. comm.).

The literature search did not find any references to commercial harvesting in the sense of non-recreational hunting intended specifically for marketing of the birds (R. Cotter pers. comm.). In Europe, landowners can sell gamebirds harvested on their land and the principle form of harvesting is driving and shotguns. In what was formerly the U.S.S.R., there are no reports of commercial harvesting, but for private use, snares are set side by side along a fence. Ptarmigan are slowly "herded" (so as not to flush them) toward the fence where they are caught in the copper wire snares as they attempt to slip through the holes (Dr. D. Boag to R. Cotter; pers. comm.).

Commercial harvesting of ptarmigan using driving and netting or snaring birds would increase the quality of the product and efficiency of both the hunting and processing. Wounding loss and

wastage of meat through shot damage will be negligible. Given the small size of each carcass, any trimming reduces the attractive appearance of the product and is labour intensive.

A fixed-effort harvest system will require initial studies to gauge the appropriate harvesting effort, but once in place, less monitoring will be required than for a commercial harvest based on a fixed number of birds. Once the marketing of ptarmigan gathers momentum, it will become increasingly difficult to regulate the harvest thus the necessary steps must be taken at the inception of commercial harvesting. The economic impetus of commercial harvesting to drive even an apparently numerous species to extinction should never be under-estimated.

RECOMMENDATIONS

1. Develop a legislation package to open commercial harvesting based on a fixed-effort harvest (number of commercial licenses and season).

2. Allocate an experimental harvest for the Central Arctic Meats Ltd. based on 1-31 October (5 hunters) with the requirement of accurate kill records being maintained.

3. Initiate population monitoring of ptarmigan in the vicinity of Cambridge Bay to investigate the effects of harvesting.

ACKNOWLEDGEMENTS

Dr. Wolf Schroeder and Jack Epakohak patiently helped by Renewable Resource Officers David Kaomayok and Duane Smith, contributed many practical ideas and help during the experimental commercial harvest at Cambridge Bay. The people of Cambridge Bay opened new insight on the traditional knowledge of ptarmigan ecology and harvesting and their participation in the interviews with George Hakungak is highly appreciated. George Hakungak's enthusiasm and diligence is warmly acknowledged. Richard Cotter efficiently compiled a detailed bibliography. Ed Bowden gave advice on legislation; Chris Shank adroitly fielded inquiries on ptarmigan ecology and Hugh McKeith advised on recipes. A special word of appreciation is owed to Doug Stewart for his unstinting support of regional resource development programs.

PERSONAL COMMUNICATIONS

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APPENDIX A. Traditional knowledge on ptarmigan based on interviews by George Hakungak in Cambridge Bay, NWT, May 1989.

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1. Interview with **James Kavana** an employee of the Inuit Broadcasting Corporation and one of the most visible elders in the community. During the interview I had an opportunity to find out some interesting information on how the inuit hunted and utilized the ptarmigan in their daily lives. Before the inuit were introduced to the rifle they had several means of capturing the ptarmigan. One of the means was with the bow and arrow and also they used stones, whether or not they were in a flock did not really matter. In the early spring and fall when the ptarmigan were in larger flocks inuit used sinew nets and later on with the nylon nets that were introduced. The inuit would try and herd the birds to a predetermined area where a person was waiting before throwing the net at the flock. In the fall after having a summer of feeding, inuit tended to catch more ptarmigan as the meat was fatter and richer, the first part of the bird that was eaten was the breast meat as it was more plentiful and also the gizzard was eaten raw and at times the meat was also eaten raw but most of the people preferred it cooked. In the summer when men were out hunting they would build a pit in the ground, fill it with moist moss and place the bird on the top of a flat rock and light a fire, as soon as they had a fire the whole thing was covered with moss and left until the meat was done.

Another part the inuit ate was the intestines, they would cook it up like a soup and eat it, the word in inuktitun is AKOTOK. The favoured way of preparing the ptarmigan was to boil it and in the spring and summer months the inuit dried the meat in the sun. The legs were often gathered up, cooked and used as snacks often on long trips or as fillers.

The wings were used as brooms by the women and the skins were dried out and used as cloths and at times used as insulation when mitts and boots wore thin. Some people used the forearm bone in the wing as needles and probably used the breastbone as a scoop. The crop was often dried up and used as a rattle by the children, it also held its food in it before digesting the contents.

In the gizzard was a storage of sand that enabled the ptarmigan to help digest the food and was always kept with a supply of sand.

Ptarmigan mostly ate willow buds, leaves and at times berries. The liveliest time of the year was in the spring and fall when new food was plentiful and they fattened up for the winter.

During the winter the ptarmigan followed the musk-ox and caribou as they provided upturned snow and bare patches of land where food was found but when the snow was soft they themselves would dig or be in

the areas where willows were found. In the winter months ptarmigan were leaner in taste.

There is no real distinct taste difference in male or female but however the meat was always tenderer in the younger birds. Age was determined by tenderness or lack of and it was hard to tell how old a bird was by physical appearance.

One way to tell the difference between the sexes was that the female kept a red eyebrow during the whole year even in the summer while it was nesting. They both changed plumage at about the same time.

James thought it would be good idea to sell the ptarmigan as people like a different variety of meat and the two seasons most likely to yield enough birds are in the spring and fall.

One of the ways to sell it would be uncooked and in bags so that people can prepare it in whatever their choice may be.

2. An interview with **Luke Novoligak,** an employee of Northwest Territories Power Corporation. Although Luke did not know too much about the ptarmigan as they were a lesser part in the food chain I was able to get some important information on names and feeding habits.

As with the other interview, inuit hunted the bird with bow and arrows often and at times using stones. The easiest time was during the spring and fall when the ptarmigan gathered in flocks to feed or mate. At times they were caught alone or in pairs.

One other item I learned was that during the summer months when the weather was warm the ptarmigan did not eat as much and preferred eating more during the fall and at the time they were harvested as the meat was richer in taste whereas in the winter they were leaner. The first part that the inuit ate was the breasts as that was the most meat and people mostly boiled them, also the gizzard was eaten raw or cooked but none of the bird was thrown out except for the bones. The wings were used a brooms and the skin dried out to be used as cloths for wiping. There was no really favoured part of the bird. The main diet of the bird was leaves, willow buds and berries. The caribou, musk-ox, rabbit were found in the same areas as they had about the same type of food they ate but not always as they had their own type of food they ate.

The male was known as ANGUT and the female as ANGNALLUK. The ptarmigan found on the island was known as NIGHAKTUK and the ones found on the mainland were, AKINGIVIK. There was a noticeable difference in size as the Akilgivik was about an inch taller and had more meat. The Akilgivik male had a black head and brown plumage in the summer and the female went brown but the female also

kept the red brow year round and both turned pure white for the winter months. The crop was used as a rattle for children while the rest of the bird was thrown out, the inuktitun word for the crop is PUVIAK because a person was able to blow it up like a balloon.

It would be a good idea to sell ptarmigan meat but he wonders if they can catch enough to sell to the consumers and he figures that the best way to sell it is in bags, uncooked so people can prepare it how they please.

3. I had a chance to have an interview with both **Paul and Bessie Omilgoetok** who had moved up to Cambridge Bay from Bathurst Inlet in the early 1960's.

When they were children and before the use of modern firearms the inuit used mainly the bow and arrow as a means of capturing the birds and in the summer because of their camouflaged coat it was easier to catch the birds as they seemed to be a lot tamer for some reason. The season that they were more plentiful was during the fall when the chicks were able to fly and they were feeding more for the coming winter.

The first part of the ptarmigan that was usually eaten first was the gizzard and that was just after plucking the bird, also the liver and the heart were also eaten, raw and uncooked was the preferred way and some Inuit cooked up the intestines to make a soup. The whole bird was cooked in water and boiled as it was the preferred method of preparing the ptarmigan.

A ptarmigan's diet consisted of leaves and grass, willow buds, leaves. In the winter the birds would be around the caribou and musk-ox as they provided bare patches of land when feeding and if the snow was soft enough they themselves would dig in the snow for food. In the winter the ptarmigan tended to carry more food in the crop to digest during times of need and they didn't know how long a full crop would last. There are two types of ptarmigan, the AKILGIVIK from the mainland which during the summer the male had a black neck band up to the back of its head and the red brow was much bigger during courting. It was also a little bit bigger and heavier than the NIGHAKTUK, the island ptarmigan. One other noticeable difference was that the Akilgivik had darker meat and was tougher because of its diet of willow leaves and buds. Although there were two types of ptarmigan you could not really tell any age difference in the male or female...but the young ones from the previous hatching were more tender and also the female tend to be more tastier. In the summer during incubation the female wore it's brown camouflage for protection. The Akilgivik were found to be more in flocks throughout the year but why is not known and both the Akilgivik and Nighaktuk turned pure white for the winter months.

The traditional uses of the ptarmigan are that the skins were used as rags and the wings as brooms or dusters and when the rifle was introduced the wings were used as oilers and the long feathers used to clean the barrel of a gun, much like today's gun cleaners. The children blew up the crop and made balloons and the head and wishbones were used to make toy caribou. The wishbone was stuck into the top of the head as antlers and the gizzard was sometimes dried out and used as a rattle also.

The idea of selling ptarmigan out of the meat plant is a good one as people like a variety of meats and the way to prepare them is like chicken, packaged along with the gizzard, liver and heart and frozen as soon as possible.

The better season to sell them would be in the spring when they migrate and in the fall when they gather in larger flocks to forage for food.

4. **Frank Analok** is a long time resident of Cambridge Bay and I was able to ask him some questions about his traditional knowledge of the ptarmigan.

As the ptarmigan is a lesser part in the food chain and often over looked he knew that the way the inuit caught the ptarmigan was to use the bow and arrow and at times in the summer when the chicks were up and walking young children would often catch them using stones and gather them up for a meal. In the summer and fall they were favoured as the young were tender and in the fall the meat was much richer after feeding on fresh leaves, grass and willow buds. When it came time to eat them the first meal was usually the gizzard and it was eaten raw as well as the liver and intestines.

After plucking the birds the whole bird was boiled in water and eaten, sometimes the intestines were cooked and eaten with seal fat or given to the dogs for their meal. The most likely uses of the ptarmigan was that the wings were used as dusters and the skins were dried out and stored for winter use as rags or at times as liners in mitts and boots. And in the spring the breast meat was cut up and made into dry meat also. So one of the better seasons to catch ptarmigans was in the fall when the meat was richer and tastier. The favourite meal in the ptarmigan was the breast as it contained the most meat for a meal but the whole bird was used.

The ptarmigans diet consisted of leaves, grass, willow buds and berries, this food was held in the crop and digested by the gizzard. Atungauyak and Naunigayuk are two of their foods also. There was no real distinct difference between male and female however the older birds were not as tender and age could really be defined. The only way to tell the age was tenderness of the meat. During the winter both sexes turned pure white for protection and in the spring the male stayed white longer and the female went

brown while having a white plumage on its belly and breast. When asked if it would be a good idea to sell ptarmigan he agreed as people love a variety of meat and as long as there is a demand. The way to sell it would be to package it like chicken so people can do it up the way that they desire.

5. **Steven Anavilok** is a local hunter who spends a good part of the winter at Wellington Bay and is often on the land. His knowledge of how the inuit hunted or captured the ptarmigan was very interesting.

As with the other interviews he stated that the inuit used rocks in the summer when the ptarmigan were more tame and they also used the bow and arrow. The arrow used was just a whittled piece of wood that had a very blunt end as the metal used for catching big game was precious at the time before the rifle was introduced. Another interesting method was the use of an instrument like a bolo that the inuit called...NEGAVKTAOT. The main piece of rope was about 2 feet long and at the end was a collection of 3 to what was desired, 12 inch long weighted rope. A person made it to their comfort of control. The weights were either rocks or thick willow stumps. Negavaktaot - this tool was also used to catch game birds and geese.

In the summer and early fall was an easy time to capture baby ptarmigan before they had learned to fly and they were favoured for their tenderness and the parent birds usually did not fly too far off.

In the late fall ptarmigan after feeding on grass and leaves on the island were tastier as during the winter they fed on willow leaves and buds on the mainland.

So at times it did not matter what season they were eaten, the inuit did not have a particular season they favoured them. And sometime during the winter the ptarmigan had a bit of backfat for warmth and it added to the flavour of the ptarmigan meat and soup. Ptarmigan also were found to be in the vicinity of caribou and musk-ox as they provided upturned snow and bare patches of land that provided the food they needed.

The gizzard, liver and heart were eaten first after plucking the bird and inuit preferred to boil the meat and at times inuit would cook the intestines or feed them to their dogs.

There was not a real taste difference in male and female but age was determined by the tenderness of the meat. Yearlings from the previous fall were much more tender and when plucking the bird it was another way of telling the age. The easier to pluck that was an indication of a younger bird. In the gizzard there was a storage of sand that helped in the digestion of leaves and grass

and he did not know for sure how often it was changed. The skin and feathers were used as wiping cloths and the wings used as brooms. The head and wishbone were used as play caribou while the crop was blown up and used as a balloon or rattle. In the spring the male stayed white a little bit longer and had a red brow during courting, a female turned colour just before the nesting period to be camouflaged during nesting.

The idea of selling ptarmigan meat out of the meat plant is a good idea and that would add to the variety and a good way of preparing it would be like the way the stores sell chicken meat. Packaged with the gizzard, liver and heart and should be frozen as soon as possible.

6. **Tommy Maghagak** is a retired employee of the Hamlet Council and is often out on the land during the spring and hunts in the winter.

Again the traditional way of catching the birds was with the use of stones or the bow and arrow and these were used year round. The seasons that they were more plentiful was in the spring when the birds migrate back north from the winter on the mainland and in the fall when the hatchlings were learning to fly and at that time of the year the Inuit caught more as the meat of the bird was tastier after feeding on grass and leaves during the summer. The favourite part of the bird was the breast meat and the wings as they had the most meat on them, and the inuit usually just boiled them in water and the gizzard, liver and heart were eaten after plucking, most of the time raw. When the inuit were done plucking the birds the skin was used as a rag and the wings as a duster but most of the time the feathers and bones were discarded. The crop however served as a balloon or rattle for the children. In the winter when food was scarce the ptarmigan tended to follow the caribou and musk-oxen as they pawed through the snow to forage for food and the ptarmigan would also forage for food in these areas.

In the winter both sexes turned pure white and the island ptarmigan turned brown at about the same time whereas the Nighaktuk or Mainland ptarmigan male bird had the black neck and head.

Age could not really be determined but by the tenderness of the meat, the young hatchlings turned white also for the winter. The idea of selling ptarmigan to the consumers is a good one and the best time would be in the fall when the snow flies. Once again selling it like the way chicken is would be a preferred way as people can be able to prepare it the way they choose.

In the fall the birds fed on leaves and grass on the island and the meat was richer in taste. When the birds ate willow buds and leaves, the meat tended to be tougher and darker.

7. **Sam Angohaitok** is a retired Hamlet employee who spends some time on the land during the winter and spring. He remembers that the inuit used the traditional bow and arrow to catch the ptarmigan during the year and in the summer they used rocks also. While growing up he was introduced to the rifle. The best time to catch the ptarmigan was in the early spring and summer when the birds turned brown and seemed tamer. And in the fall the inuit favoured the meat as it was richer after eating grass and leaves during the summer but they did not have the preferred season.

Sam liked to chew on some seal blubber and then mix it with cooked ptarmigan meat as the two combinations made a tasty meal. The intestines also were eaten with seal fat when it was hard to find food.

The gizzard and intestines were eaten first after skinning the bird and the preferred way of eating the ptarmigan was to boil it up. There was no real difference in taste in the male and female bird or the age, the only noticeable thing was the tenderness of younger birds. The skins were often dried out and used as wiping rags along with the wings. The bones and leftovers were given to the dogs so not to waste any part of the bird.

During the winter months the ptarmigan usually migrate south and eat on willow leaves and buds. In this time it would not be a good time to sell the meat but the time would be at spring when they come back up and in the fall when the hatchlings are grown. They should be prepared like chicken, in trays and frozen so people can prepare them the way they desire.

8. **May Hakongak** is an elder who moved to Cambridge Bay in the early 1970's after living in the Bay Chimo, Bathurst Inlet area for most of her life and I had an opportunity to ask her some questions on the traditional uses of ptarmigan.

When she was a young girl she remembers that the method of catching ptarmigan was with the bow and arrow and in the spring the inuit would try and catch the ptarmigan while they nested and the method was to tie a long string of sinew to a rock and place the looped end on an upside down V shaped straw so when the ptarmigan left the nest it acted like a noose... therefore trapping it in one place, the word to describe it is NIGAKPAKTAIT.

Both the female and male were usually caught and the inuit would cook up the birds and eggs together. In the late summer when the young were able to fly the inuit tended to catch more as the birds were plentiful. After the skin and feathers were plucked the first part to be ate was the gizzard and the whole bird was usually boiled. There was no real taste difference in male and female but the young ptarmigan were much more tender. In the spring the female turned brown just before nesting and the male had the red

brow. The daily uses of the ptarmigan was that the skins were dried out and used as rags and the wings were used as dusters, the longer wing feathers were used on the arrow shaft to give it stability in the air. Sometimes the crop was emptied and used to store liquified caribou fat for winter use and also for children's balloons. The ptarmigan diet was mainly willow leaves, buds, grass, small leaves and sometimes berries. The idea of selling ptarmigan out of the meat plant would be a good idea as it would give people a variety of meat to choose from they should be prepared much like the way the commercial chicken is, uncooked, in trays along with the gizzard, liver and heart.

9. **Mabel Angulik** is an elder who lived with her trader husband Stephen in the Perry river area before moving to Cambridge Bay.

She remembers that before the inuit were introduced to the rifle they used the bow and arrow to capture the birds and this method was used year round, and during the spring and summer rocks were also used when the ptarmigan were in their summer plumage and the inuit would try and catch the female when they found the nest. Whenever ptarmigan were caught the gizzard and intestines were usually cooled off and eaten first, sometimes in the summer the bird was roasted over an open pit fire but the most preferred way of eating the ptarmigan was to boil it in water and drink the broth. In the fall when they were gathered in larger flocks the inuit caught more as the ptarmigan meat was richer in taste and the young were able to fly. There was no real distinct taste difference between the male and female but a younger ptarmigan was more tender and the age was also defined by the tenderness of the meat. The only uses of the ptarmigan was that the skins were gathered up and dried out in the summer and stored to be used as rags, the wings were as pipe cleaners and the shorter ones made ideal toothpicks as the base was skinny enough. The bones were given to the dogs and the wishbone and head put together served as toy caribou. The winter plumage made it hard to tell which was male or female but in the spring the female of both the Akilgivk and Nighaktuk went brown sooner to keep it camouflaged while it nested. The Akilgivk male of the mainland had a black neck during the summer months.

The Nighaktuk of the island had much tender meat and it was due to the diet of mostly grass and small leaves. The main diet of the birds was grass, leaves, berries, willow buds and leaves, the two types of birds shared the same diet as the large game.

The idea of selling ptarmigan meat out of the meat plant is a good idea as it would give people a variety of meat to choose from and the best way to prepare it would be to freeze the meat like they do with chicken.

10. **Mackie and Annie Kaosoni** are elders who lived around the Ellice River area before moving to Cambridge Bay for good.

When they were young children before the rifle was introduced to the north the best means of catching the ptarmigan was to use the traditional bow and arrow method but in the winter they hardly caught any as the birds were well hidden with their winter plumage. The early spring was a better time to catch as they were coming back north to nest for the summer. After plucking the ptarmigan the gizzard was eaten first and sometimes they eat them with seal fat mixed. The rest of the ptarmigan was boiled in water and the broth was like a tea then as there was none. There was no taste difference in the sexes but the age was usually determined by the tenderness of the meat. Another meal that was well liked and often eaten was called OGNIK, ptarmigan intestines and seal fat mixed together. The whole ptarmigan was not wasted as the skins were dried out in the summer to be used as rags and the wings as brooms and the leftovers and bones were given to the dogs. The type of ptarmigans found on the islands was the Nighaktuk which was smaller that the Akilgivik which was found on the mainland. The Akilgivik male had a black neck and head during courting.

The female of both types went brown sooner for protection during the nesting period. The Nighaktuk male had a red brow year round. Their diet was mainly willow buds, leaves and berries on the mainland and grass and leaves on the islands.

If they should sell ptarmigan meat out of the meat plant it would give the consumers a variety of meat to choose from. The one way that they should be prepared is just like the way chicken is sold in the stores, cut up and the gizzard, liver and heart packed in bags then frozen.

11. **Sam and Lena Emingak** were originally from the Perry River area before moving to Cambridge Bay permanently.

When they were younger and growing up the inuit would catch ptarmigans and the widely used method was to use the bow and arrow mainly but during the summer when the female was nesting and the birds seemed tamer, rocks were used as another weapon. In the spring when they came back north for the summer the inuit caught more as they were in flocks and another season was in the fall when the young were flying, during the winter ptarmigan were hardly hunted as they were less in numbers and harder to spot because of their white plumage. During the spring and summer the female turned brown sooner for protection and the male soon after but not as dark.

Soon after skinning the ptarmigan the inuit would eat the gizzards and the intestines raw when they cooled. There was no real favoured part to the bird and the way they ate them was to boil

APPENDIX B. A LITERATURE REVIEW OF THE FOOD HABITS OF ROCK PTARMIGAN (*LAGOPUS MUTUS*) AND WILLOW PTARMIGAN (*LAGOPUS LAGOPUS*). by Richard C. Cotter, March 1990

TABLE OF CONTENTS

LIST OF TABLES

protected sites. Creeping or decumbent woody plants are common, particularly birch (*Betula* spp.) and willow (*Salix* spp.). Herbaceous plants are generally abundant, the most common types being rosette forms, sedges, and lichens. Most herbs are less than 1 foot in height (Johnsgard 1983). Nesting habitat is usually dry and rocky, with nests placed in well concealed depressions in grassy clumps or mossy hummocks in open tundra, or grassy areas within rock outcrops (Johnsgard 1983, Cotter pers. obs.). Brooding habitat is similar to nesting habitat, but broods tend to gather in swales on ridges and upper slopes (Weeden 1965). During this period of brood rearing (late summer and early autumn), rock ptarmigan gather in flocks. Flock sizes commonly range from 20 to 200 individuals, and contain representatives of every population unit (hens with broods, hens that failed to rear chicks, and groups of cocks) (Weeden 1963). This period is characterized by increased gregariousness and commencement of movements from breeding areas to wintering areas. Net displacements away from breeding areas may be as much as 800 km, although shorter movements are more common, particularly in hilly subarctic regions (Weeden 1963).

In autumn, rock and willow ptarmigan are still separated as rock ptarmigan tend to keep to higher, more open ground than willow ptarmigan (Moss 1974). However, with the onset of snow in early winter, most plants which rock ptarmigan feed upon at higher elevations become inaccessible. Rock ptarmigan must, therefore, move to lower elevations into better protected areas for food and shelter. Often these areas are co-inhabited by willow ptarmigan

(Moss 1974). Consequently, during winter, rock and willow ptarmigan may be observed together in mixed flocks, although usually they remain in flocks of one species (Moss 1974). In Alaska, wintering rock ptarmigan tend to inhabit the shrubby slopes at timberline, or in large forest openings where shrubs, especially birch, project above snow level, or in riparian willow thickets (Weeden 1965). In the Hudson Bay Lowlands of northern Ontario, both rock and willow ptarmigan are found in or adjacent to the coastal fens or bogs during winter (Thomas 1984). In rock ptarmigan, partial segregation of the sexes during winter has been reported from several regions, with males remaining in more alpinelike habitats, while females inhabit more protected areas (Johnsgard 1983, Weeden 1964).

In spring, rock ptarmigan begin migrating to breeding areas. These spring movements begin in late March in Alaska (Weeden 1964).

In willow ptarmigan, spring movements to breeding areas probably coincides closely with those of rock ptarmigan, as mixed flocks of the two species have been observed during such migrations (Godfrey 1986). The breeding range of willow ptarmigan is primarily arctic tundra, although it extends southward into alpine mountain ranges. Basic breeding habitat is level or gently sloping, frequently extending along river valleys (Johnsgard 1983). Willow ptarmigan generally prefer moister, better vegetated country than rock ptarmigan (Godfrey 1986). Vegetation is usually luxuriant, with shrubs 3 to 8 feet in height, interspersed with open areas dominated by grasses, sedges, mosses, dwarf shrubs, and low herbs

(Weeden 1965). Elevated sites, such as rocks, tall shrubs, or hummocks, are used by males for displaying (Johnsgard 1983). Nesting habitat are areas with good cover, with nests placed in grassy clumps, mossy hummocks, or similar sources of screening protection (Johnsgard 1983). Brooding habitat is similar to nesting habitat; generally areas with good overhead cover such as upland dwarf shrub and sedge tundra, as well as riparian shrub and willow shrub at the base of hills (Johnsgard 1983).

As observed in rock ptarmigan, willow ptarmigan gather in flocks in late summer and early fall and begin moving to overwintering areas that provide good forage and shelter (Godfrey 1986, Moss 1974). Willow ptarmigan inhabit similar habitats as rock ptarmigan during winter, primarily willow thickets along streams, areas of tall shrubs around timberline and burns, interior valleys, lake and river margins, and forest openings (Godfrey 1986, Johnsgard 1983, Weeden 1965). Winter segregation of sexes has been reported in willow ptarmigan, although to the exact extent is difficult to assess because it is not possible to sex willow ptarmigan at a distance during winter (Godfrey 1986, Weeden 1964).

FOOD HABITS

Rock Ptarmigan

a) Winter

Most research on the winter diet of rock ptarmigan has been centred in Alaska and Fennoscandia, with a few studies in the

U.S.S.R., Scotland, Iceland, and Canada (Table 1). During winter, rock ptarmigan are limited to foraging on plants (and parts thereof) exposed through the snow cover. According to studies, buds and catkins of birch (*Betula* spp.) appear to be the most consumed winter food, generally in the 70 to 90% range (Weeden 1969, Pulliainen 1970, Gardarsson and Moss 1970, Moss 1974, Gasaway 1976, Thomas 1984; Table 1). In the Hudson Bay lowlands of northern Ontario, Thomas (1984) found rock ptarmigan ate more than twice as much birch as they did willow (*Salix* spp.): 69% vs. 31%. Of the willow consumed, buds and catkins were fed upon approximately four times as much as stems (Thomas 1984). Thomas (1984) observed no dietary difference with respect to age or sex over winter. Also, Pulliainen (1970), in Finland, and Bossert (1980), in the Swiss Alps, reported no difference in diet between males and females. In Fennoscandia and Alaska, rock ptarmigan fed primarily on birch catkins and, to a lesser extent, on foliar buds (Pulliainen 1970, Weeden 1969, Moss 1974). In Alaska, the buds and internodes of willow and the catkins of alder (*Alnus* spp.) comprised the rest of the winter diet (Weeden 1969, Moss 1974). In Fennoscandia, the remainder of the winter diet was composed of the berries *Empetrum* spp. and the leaves of *Vaccinium* spp. (Pulliainen 1970).

Of all birch species consumed by this ptarmigan, dwarf birch (*B. nana*) predominated in the diet (Weeden 1969, Gardarsson and Moss 1970, Moss 1974, Bernard-Laurent 1987). Resin birch, *B. glandulosa*, was also reported in the diet of rock ptarmigan

Table 1. Review of studies on the winter diet of rock ptarmigan (*Lagopus mutus*).

Author(s)	Weeden	Pulliainen	Gardarsson and Moss	Gardarsson and Moss	Moss	Gasaway	Thomas	Unander et al.
Year	1969	1970	1970	1970	1974	1976	1984	1985
After	Table 1	Table 2	Table 7	Table 7	Table 5	Table 1	Table 1	Table 1
Location	Alaska	Finland	Iceland	Iceland	Alaska	Alaska	N. Ontario	Svalbard
Date	11 Oct.-9 May	8 Oct.-28 Nov.	18 - 19 March	20 - 21 March	no date given	November-December	28 - 30 Mar., 11 April	Nov. - December
Sex	m,f	m,f	m,f	m,f	m,f	m,f	m,f	m
N (crops)	309	7	18	23	?	7	51	7
Alnus crispa	4				<10			
Alopecurus alpinus								10.1
Arctostaphylos spp.				0.1				
Betula spp.	86	83.6	8.6	88.1	90	73.8	68.5	
Calluna vulgaris		tr.						
Dryas octopetala			5.3	0.9				12.2
Empetrum spp.		10.9	39.1	7.7				
Luzula arcuata								10.4
Poa spp.								13.5
Populus tremuloides					25.6			
Salix spp.	6		36.3	2.9	<10	0.6	31.4	15.6
Saxifraga spp.								27.9
Vaccinium spp.	3	4.6	3.8	0.5				

Results from all studies are presented as percentage of total dry weight, with the exception of Gardarsson and Moss (1970) whose results are presented as percentage of total volume of foods in crops.

tr. = < 0.1

overwintering in northern Ontario (Thomas 1984) and in Alaska (Weeden 1969, Moss 1974). Weeden (1969), however, found these two birch species difficult to distinguish in crops and, therefore, clumped and designated them as dwarf birch. Similarily, *B. pubescens* was reported in the diet of Icelandic ptarmigan but was also clumped with *B. nana* (Gardarsson and Moss 1970). These results, therefore, cannot be used reliably for birch cross-species comparisons. In Finland, a fourth birch species was found, *B. tortuosa*, which accounted for 81.3% of the winter diet as opposed to only 2.3% for *B. nana* (Pulliainen 1970).

The two noticeable exceptions (Table 1) to a high birch component in the winter diet of rock ptarmigan were found in studies conducted in Svalbard and Iceland. Birch is scarce on the island of Svalbard whereas mountain avens (*Dryas octopetala*) are somewhat abundant (Unander *et al.* 1985). The relative availabilities of these two plants correspond directly with their respective dietary importance at this site (Table 1). In Iceland, Gardarsson and Moss (1970) reported a low birch content in crops from birds collected on March 19 and 20, a period when there was little snow cover. The most abundant foods recorded during these days were common crowberries (*Empetrum nigrum*) (shoots 28.3%; berries 10.8%) followed closely by willow (*Salix* spp.). The diet of birds collected on March 21-22, after a heavy snowfall (snow cover > 30 cm), was significantly different; birch predominated rather than crowberries and willow (Gardarsson and Moss 1970; Table 1). Weeden (1969) also reported that birch dominated the rock

ptarmigan diet when snow cover exceeded more than a few inches in depth. Gardarsson and Moss (1970) reported the willow, *Salix herbacea*, to be clearly preferred over birch. In order of preference, rock ptarmigan were found to feed on willow, birch catkins, birch foliar buds and internodes. Gardarsson and Moss (1970) also observed the leaves of *Dryas* spp. and the berries of *Empetrum* spp. to be taken in greater amounts than would be anticipated solely from their abundance.

Chemical analyses of several shrub species revealed *Salix herbacea* to be more nutritional than all other common shrub species tested (Gardarsson and Moss 1970). Birch catkins and buds were found to have a higher content of nitrogen, phosphorous, and soluble carbohydrates, and a lower fibre content than twigs. Catkins and buds are, therefore, regarded as having a greater food value than twigs, which perhaps explains the observed preference in all studies for catkins and/or buds over twigs and bark, as well as the preference of willow, when accessible, over birch.

Competition from conspecifics is also a determining factor on diet composition. On Svalbard and Iceland, for example, where willow ptarmigan are absent, rock ptarmigan feed predominantly on willow (Gardarsson and Moss 1970, Unander *et al.* 1985). In autumn, Alaskan rock and willow ptarmigan occupy different habitats and feed predominantly on willow. During the winter months, when both species occupy the same habitat, rock ptarmigan generally feed on birch, while willow ptarmigan remain feeding on willow (Moss 1974). Moss (1974) speculates this change in diet by rock ptarmigan to be

a result of conspecific competition: rock ptarmigan overcome competition for food resources with willow ptarmigan by feeding on different plants. Interestingly, where the two species feed on the same plants different parts of the plants are consumed (Moss 1974, Thomas 1984). As well, they may feed in different manners: willow ptarmigan perch in tall shrubs while feeding, whereas rock ptarmigan feed from the snow (Weeden 1969). Morphological specializations may also play a role: rock ptarmigan have smaller, narrower bills than willow ptarmigan and are probably more efficient in picking up the relatively smaller-sized buds and catkins of birch than those of willow (Weeden 1969).

In Finland, there appears to be no significant differences in the composition of the winter diet between sex and age groups of rock ptarmigan during winter (Pulliainen 1970).

b) Spring

The emergence of freshly growing herbaceous plants in spring marks an increased accessibility to a greater variety and number of both plant species and plant parts. Consequently, rock ptarmigan are presumed to have a more nutritious diet during this season than during winter (Watson 1964, Weeden 1969, Bossert 1980 *in* Bernard-Laurent 1987).

The spring diet is transitory in nature, overlapping both the winter and summer diets in composition. Ptarmigan selectively feed upon emerging shoots, flowers, and leaves of plants (Weeden 1969). The timing of emergent plants, however, can vary greatly from one

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year to the next in any given area. As a consequence, birch buds and catkins are observed in the spring diet of most populations (Table 2), although not to the same extent as observed during the winter months (Table 1). The highest observed birch component in the spring diet (31%) was reported by Weeden (1969) in Alaska (Table 2). This percentage, however high, marks a reduction of greater than 50% from that of their winter diet (86%; Table 1).

Most studies report a marked shift in the spring diet from the winter predominance of birch and willow to other woody and herbaceous plants, such as *Vaccinium* spp., *Empetrum* spp., *Dryas octopetala*, *Saxifraga* spp., *Calluna vulgaris*, and *Polygonum* spp. (Table 2). An exception to this general observation was reported from Svalbard. Unander *et al.* (1985) observed that as spring progressed, the amount of willow (*Salix polaris*) in the diet increased from approximately 50% in April to almost 90% in May and June. Unfortunately the authors did not speculate on this apparent anomaly, nor did they state which parts of the willow were being utilized.

Mountain avens (*Dryas octopetala*), although never the dominant plant species in the spring diet, maintain a relatively high percentage of utilization in several locations (Weeden 1969, Gardarsson and Moss 1970, Unander *et al.* 1985). Following snow melt, those leaves surviving through the winter become accessible to ptarmigan and appear to be selected (Table 2) (Gardarsson and Moss 1970).

In Scotland, spring diet is composed almost entirely of three

Table 2: Review of studies on the spring diet of rock ptarmigan (*Lagopus mutus*).

Author(s)	Weeden	Gardarsson and Moss	Moss and Watson	Moss and Watson	Unander *et al.*	Unander *et al.*
Year	1969	1970	1984	1984	1985	1985
after	Table 1	Table 10	Table 2	Table 2	Table 1	Table 1
Location	Alaska	Iceland	Scotland[1]	Scotland[2]	Svalbard	Svalbard
Dates	10 May - 5 June	23 - 25 May	May - June	May - June	April	May - June
Sex	m,f	m	f	f	m	m
N (crops)	41	43	5	3	12	16
Arctostaphylos spp.	tr.	7.4				
Betula spp.	31	20.2				
Calluna vulgaris			46	10		
Dryas octopetala	11	17.6			21.5	0.7
Empetrum spp.	16	38.7	30	13		
Equisetum spp.	3	0.3				
Polygonum spp.					2	0.9
Salix spp.	12	11.1			50.6	89.5
Saxifraga spp.					19.7	3.7
Vaccinium spp.	21		27	75		

Results from all studies are presented as percentage of total dry weight, with the exception of Gardarsson and Moss (1970) whose results are presented as percentage of total volume of foods in crops.

tr. = < 0.1

[1] Derry Cairngorm, Scotland
[2] Cairnwell, Scotland

herbaceous plant species (Table 2); the relative importance of each appears to be dependant upon availability. Near Cairnwell, *Vaccinium myrtillus* is abundant (Moss and Watson 1984). This relative abundance is reflected in the diet of local ptarmigan, as this plant comprised 75% of their diet (Table 2). At Derry Cairngorm, heather (*Calluna vulgaris*) was much more abundant than *Vaccinium myrtillus* and was the dominant plant species in the diet of local rock ptarmigan (Table 2). Although Moss and Watson (1984) did not report which part of the plants were consumed, only growing buds and shoots were found in the diet by Watson (1964).

Although Watson (1964) reported that overwintered berries of *Vaccinium* and *Empetrum* spp. were not consumed by Scottish ptarmigan, they did comprise up to 40% of the diet in Alaska (Weeden 1969) and Iceland (Gardarsson and Moss 1970) (Table 2).

A sexual variation in spring diet was observed by Gardarsson and Moss (1970) in Iceland; females fed much more on "freshly growing deciduous herbs" and less on berries than did males. It is suggested that this apparent difference is due to the female's additional nutritional and energetic requirements, necessary for egg laying which commences in early summer (Gardarsson and Moss 1974, Moss and Watson 1984).

c) Summer

The greatest diversity in the diet of rock ptarmigan occurs during the summer months. The trend towards a greater prevalence of herbaceous species, observed initially during spring, continues

into summer. Leaves and flowers are important in early summer and fruit (berries and bulbils) and seeds in late summer (Johnsgard 1983). Species of *Vaccinium* and *Empetrum* remain important; composing up to 81% of the total volume of food consumed by female ptarmigan in Iceland (Gardarsson and Moss 1970; Table 3). Watson (1964) reported that Alaskan ptarmigan consume the leaves, flowers, and berries of *Empetrum* spp. (probably *E. hermaphroditum*) and three species of *Vaccinium* (primarily *V. myrtillus*). Weeden (1969), however, found only the berries of these plants in the diet. Several studies report a high dietary component of *Polygonum* spp. In Iceland, of the total volume of food consumed during mid-July, up to 82% was *Polygonum* spp. (Gardarsson and Moss 1970). Bernard-Laurent (1987) reported similarly high values for this genus (>75%) in studies conducted in Greenland and Spitzbergen. Weeden (1969) also found that ptarmigan feed primarily on bulbils of *Polygonum* in early summer, switching to the seeds of the same plant in late summer.

Birch and willow were reported in most studies concerning summer diet. They accounted for as much as 32.8% of total dry weight of diet in Svalbard ptarmigan (Unander *et al.* 1985; Table 3). The buds and catkins of birch, and the leaves, stems and buds of willow were the principal parts consumed. Also featured in the summer diet of rock ptarmigan, although to a much lesser degree than those plants previously discussed, are the seeds of *Carex* and *Rumex* spp., the leaves of *Oxytropis* spp., and the leaves and flowers of *Calluna vulgaris* (Watson 1964, Weeden 1969, Gardarsson and Moss

Table 3: Review of studies on the summer diet of adult rock ptarmigan (*Lagopus mutus*).

Author(s)	Watson	Weeden	Weeden	Weeden	Gardarsson and Moss	Gardarsson and Moss	Gardarsson and Moss	Unander *et al.*
Year	1964	1969	1969	1969	1970	1970	1970	1985
after	Table 1	Table 1	Table 1	Table 1	Figure 1	Figure 2	Figure 2	Table 1
Location	Scotland	Alaska	Alaska	Alaska	Iceland	Iceland	Iceland	Svalbard
Dates	May - September	early summer	early summer	late summer	3 July	20 - 21 July	20 - 21 July	July - August
Sex	m,f	m,f	chicks	m,f	f	m,f	chicks	m
N (crops)	5	28	18	75	3	12	13	7
Alnus crispa		3						
Arctostaphylos spp.						10		
Betula spp.		11		13		3		
Calluna vulgaris	1.8							
Carex spp.				4				
Dryas octopetala		16		6				
Empetrum spp.	31	2	6	25		3	2	
Equisetum spp.								17.6
Oxytropis spp.		9						
Papaver dahlianum								6.7
Polygonum spp.		14	47	7		82	63	20.8
Ranunculus sulphureus								6.7
Rumex spp.	5.7							
Salix spp.	6.4	28	11	1	20			32.8
Saxifraga spp.								3.5
Thalictrum alpinum					tr.	3	5	
Vaccinium spp.	30.6	9	10	12	78	1		
Arthropods	4		8				29	

Results from all studies are presented as percentage of total dry weight, with the exception of Gardarsson and Moss (1970) whose results are presented as percentage of total volume of foods in crops.

tr. = < 0.1

Unander *et al.* 1985; Table 3).

The most common food item found in diet of chicks were the bulbils of *Polygonum* spp. (Weeden 1969, Gardarsson and Moss 1970; Table 3). Chicks also fed on invertebrates, primarily snails and various arthropods including Lepidoptera larvae. According to Thaler (1983 *in* Bernard-Laurent 1987), at a very young age, 1 to 4 days, chicks fed almost exclusively on insects, but by 4 to 5 days post hatching they began to feed on leaves of such plants as *Vaccinium* and *Taraxacum* spp. It is not until approximately 3 to 8 weeks of age that the chicks' diet begins to mirror the adult's (Bernard-Laurent 1987). Weeden (1969), in an examination of 18 crops of chicks collected in early summer, found less than 10% of the dry weight to comprise insects. In early summer Weeden (1969) found the diet of chicks differing somewhat from that of adults, but not so in late summer. In early summer Weeden found that chicks fed less on leaves than adults did (14% as opposed to 50%), slightly more on berries (16% vs 11%), and far more on bulbils of *Polygonum viviparum* (Weeden 1969). In Iceland, Gardarsson and Moss (1970) found insects made up almost a third of the diet of chicks, with the bulbils of *Polygonum* making most of the remainder of the diet.

d) Autumn

During autumn, the diet of rock ptarmigan is characterized by a return to a predominance by birch and willow. Studies from Alaska (Moss 1974), Iceland (Gardarsson and Moss 1970), Svalbard

(Unander *et al.* 1985), and France (Bernard-Laurent 1987) reveal willow to be more abundant in the fall diet than birch (Table 4). Moss (1974), from an examination of 26 crops collected on October 18 in Alaska, revealed that rock ptarmigan feed more on willow (*Salix pulchra*) than birch (*Betula nana*), although birch was more abundant than willow (Figure 2). Weeden (1969) reported birch accounting for over 50% of the diet in Alaskan rock ptarmigan, whereas Gardarsson and Moss (1970) reported very little birch in the diet from Iceland but instead found willow accounting for up to 97.4% of the diet. As was observed in other seasons, the buds and catkins of birch were the preferred plant parts, as were the buds and twigs of willow. Although birch and willow dominate the fall diet, a wide variety of other shrubs and herbs are still consumed, including relatively high levels of *Empetrum* spp. and *Dryas octopetala* in Iceland, *Saxifraga* spp., *Poa* spp., and *Polygonum* spp. in Svalbard, *Vaccinium* spp. in Alaska, and *Dryas octopetala* and *Saxifraga* spp. in France (Bernard-Laurent 1987; Table 4).

Summary of Rock Ptarmigan food habits

Throughout most of its range, the dominant winter foods of rock ptarmigan are the buds and catkins of birch, followed by the buds and twigs of willow. Allopatric populations of rock ptarmigan feed more heavily on willow, turning only to birch when willow becomes unavailable. Dried leaves of other shrubs (such as *Vaccinium* spp.), evergreen herbs (such as *Andromeda* spp.), and berry-producing species are also taken in limited quantities.

Table 4: Review of studies on the fall diet of rock ptarmigan (*Lagopus mutus*).

Author(s)	Weeden	Gardarsson and Moss	Gardarsson and Moss	Gardarsson and Moss	Unander *et al.*	Bernard-Laurent
Year	1969	1970	1970	1970	1985	1987
after	Table 1	Figure 3	Figure 4	Figure 4	Table 1	Figure 4
Location	Alaska	Iceland	Iceland	Iceland	Svalbard	France
Dates	1 September - 10 October	4 October	9 - 12 October	17 October	October	September - October
Sex	m,f	m,f	m,f	m,f	m	m,f
N (crops)	248	35	22	36	18	?
Betula spp.	51		6			
Calluna vulgaris			tr.			
Carex spp.	4					
Cerastium alpinum		4		0.7	4.8	
Dryas octopetala	3		29		0.4	11
Empetrum spp.	10		37			
Equisetum spp.				tr.	5.4	
Oxytropis spp.	tr.					
Poa spp.					16.9	
Polygonum spp.	tr.				13.1	2
Salix spp.	11	51	20	97.4	31.1	61
Saxifraga spp.		42		tr.	18.9	15
Stellaria crassipes					4.6	
Vaccinium spp.	15		3			6

Results from all studies are presented as percentage of total dry weight, with the exception of Gardarsson and Moss (1970) whose results are presented as percentage of total volume of foods in crops.

tr. = < 0.1

Winter foods are influenced by snow conditions which affects accessibility, as well as the nutritive value. Ptarmigan generally select foods with high sugar content, although those with high protein content are distinctly preferred when available (Bossert 1980 *in* Johnsgard 1983).

Spring marks a dietary switch to emerging shoots, flowers, buds and leaves of plants. The buds and catkins of birch and willow remain dominant through parts of their range, however, they are generally fed upon much less so than during winter. Many other shrubs and herbaceous plants are important foods in the spring as they become accessible with the melting snow. These include the growing shoots and buds of several species of *Vaccinium*, *Empetrum*, *Saxifraga*, *Polygonum*, the leaves of *Dryas octopetala*, tips of horsetails (*Equisetum* spp.) and, in Scotland, *Calluna vulgaris*.

Rock ptarmigan have access to the widest variety of foods during summer, and this is reflected in the wide range of plant species and plant parts consumed. Buds and catkins of birch and willow are still consumed in early summer, as well as leaves as they emerge. Those plant species important in spring are important in summer as well, although varying in importance depending upon location and time of season. Particularly important are *Empetrum*, *Polygonum* and *Vaccinium*. Leaves and flowers are important in early summer, and fruit (berries and bulbils) and seeds in late summer. Chicks appear to favour, where they exist, bulbils of *Polygonum* spp., as well as berries of *Vaccinium* and *Empetrum*, leaves of *Salix*, and insects.

The autumn diet is transitory in nature, marking a return to the

birch and/or willow dominated winter diet. In most studies, willow is clearly preferred over birch during autumn. In autumn, rock ptarmigan do not generally occupy the same habitats as willow ptarmigan where their ranges overlap, and it is clear from most studies that they feed preferentially on willow, switching to birch in late fall or early winter as willow becomes inaccessible. Fruit of *Vaccinium* species and *Empetrum* spp. are also important as are the seeds of sedges (*Carex* spp.) and perennial grasses (*Poa* spp.).

Willow Ptarmigan

a) Winter

As with rock ptarmigan, the bulk of the research conducted on the winter diet of willow ptarmigan has originated from Alaska and Fennoscandia, with a few studies from the U.S.S.R., Scotland, and Canada. Those studies with comparable results are presented in Table 5.

The dominant feature of the winter diet of willow ptarmigan is their reliance on woody plants, particularly willow (*Salix* spp.) and birch (*Betula* spp.). As with rock ptarmigan, willow ptarmigan feed predominantly on the catkins, buds, and twigs of birch, and the buds and twigs of willow. As opposed to observations on rock ptarmigan, however, the importance of birch to willow ptarmigan is less clear; willow appeared to dominate over birch in most studies. In Alaska, West and Meng (1966) reported that willow accounted for 65 to 100% of the diet in February (Table 5) from several sites. Similarly, Weeden (1969) found high values for willow (62 to 100%)

Table 5: Review of studies on the winter diet of willow ptarmigan (*Lagopus lagopus*).

Author(s)	West and Meng	Weeden	Moss	Moss	Pulliainen and Iivanainen	Thomas	Myrberget and Aabakken	Brittas
Year	1966	1969	1972	1973	1981	1984	1987	1988
after	Tables 2, 3, 4	Table 2	Table 2	Table 3	Figure 2	Table 1	Table 2	Table 2
Location	Alaska	Alaska	Scotland	Alaska	Finland[1]	n. Ontario	Norway[2]	Sweden
Dates	February	October - May	December - February	February - May, 1972	February - early May	November - December	January - Feb., 1968	Nov. - December
Sex	m,f	m,f	m,f	m,f	m,f	m,f	m,f	m,f
N (crops)	56	1097	11	21	142	34	476	39
Betula spp.	0.1 - 32.7	0 - 27	96.1	5	92	21.8	95.8	39.2
Calluna vulgaris								
Empetrum spp.		0 - 7						
Graminoids			2					
Populus spp.	0 - 1.8	0 - 20						
Salix spp.	65 - 100	62 - 100		95	6	67.5	3.2	25.7
Sorbus spp.							0.2	
Vaccinium spp.								33.6
Miscellaneous	0 - 3	0 - 7				10.3	0.8	

Results from all studies are presented as percentage of total dry weight of foods in crops.

[1] Utsjoki, Finland

[2] Lierne, Norway

at a number of locations (n=13) in Alaska, Yukon, and northern British Columbia (Table 5). Both of the above mentioned studies reported relatively low percentages of birch; the highest recorded value being only 32.7% of the total diet (Table 5). Similar findings were reported by Moss (1973; Alaska) and Thomas (1984; northern Ontario) (Table 5). Willow comprised 67.5% of the winter diet of willow ptarmigan from northern Ontario (Thomas 1984), and the stems were consumed in greater quantities than buds (46.5% and 21.0%, respectively). Although the majority of studies reported a dominance of willow over birch in the winter diet, some results were opposed. For example, Pulliainen and Iivanainen (1981) found the birch, *Betula pubescens*, constituted 97.8% of the winter diet of willow ptarmigan at Utsjoki, Finland (Table 5). The shoots of this birch accounted for approximately 64% of the diet, with buds and catkins the remainder. The willow consumed at Utsjoki was mainly shoots. In Norway, Myrberget and Aabakken (1987) reported similar findings, with birch (mostly *B. pubescens* and *B. nana*) accounting for 73.3 to 97.2 % of the diet over four winters. Johnsgard (1983) cited a study by Dementiev and Gladkov (1967) in which willow and birch dominated the winter diet of willow ptarmigan in the U.S.S.R.

In Scotland, a third plant was found to dominate the winter diet of the red grouse (*L. lagopus scoticus*). This subspecies of willow ptarmigan inhabits subalpine-like territories year-round, where heather, *Calluna vulgaris*, is the most abundant plant species, and birch and willow are rare (Hudson 1986). Consequently, heather

accounts for 96.1% of the red grouse winter diet (Moss 1972). In contrast to the above mentioned studies, Brittas (1988) found no clear predominance of any one genus in the winter diet of willow ptarmigan from Sweden. The shoots and catkins of birch were the most abundant foods in the diet, but accounted for less than 40% (*B. pubescens* 31.8%; *B. nana* 7.4%). The stems of bilberry (*Vaccinium mytrillus*) followed (33.6%), with shoots and flower buds of willow (25.7%) accounting for the bulk of the remainder of the diet.

A variety of other plant species are consumed in low amounts by willow ptarmigan during winter. In some areas of Alaska, the buds of poplars (*Populus tremuloides*, *P. balsamifera*) as well as the berries of *Empetrum nigrum* were found to account for as much as 20 and 7% of the winter diet, respectively (Weeden 1969; Table 5). Although not presented in Table 5, Weeden (1969) analyzed 16 crops collected from mid-November to early February at Cold Bay, Alaska. Willow buds accounted for 45% of the total dry weight consumed, followed by salmonberry (*Rubus spectabilis*) buds (27%) and *E. nigrum* leaves (26%). In northern Ontario, bearberries (*Arctostaphylos* spp.) accounted for almost 10% of the diet (Thomas 1984). On the Avalon peninsula of Newfoundland, Peters (1958) found the winter diet of willow ptarmigan composed mainly of buds and catkins of *Vaccinium* spp., *Betula* spp. (birch) and *Alnus* spp. (alder), and buds of *Myrica gale*. As well, Peters (1958) observed willow ptarmigan feeding on the buds of *Ledum groenlandicum* and *Rhododendron canadense*.

With respect to age and/or sex classes, Pulliainen and Iivanainen (1981) did not observe significant differences in the winter diet composition.

b) Spring

In willow ptarmigan, spring diet is governed by the same factors as those for rock ptarmigan; warming temperatures accompanied by snow melt permitting new growth and accessibility to an increased variety of herbaceous and shrubby plants. The timing of this dietary change is variable depending on climatic factors. In the interior of Alaska, this transition occurs mid- to late-May, a period which coincides with the peak in territorial defence and egg-laying in this species (Weeden 1969). West and Meng (1966) observed willow ptarmigan decreasing gradually their relative consumption of willow (*Salix* spp.) as more types of plants became available with the onset of snow melt. However, from June through August willow still constituted as much as 47.4% of the willow ptarmigan's diet (West and Meng 1966). As in winter, the buds and twigs of willow were generally taken.

In Newfoundland, Bergerud and Mercer (1972) found that willow ptarmigan feed almost exclusively on *Vaccinium* species (92.1% of total dry weight) throughout the months of April and May. In descending order of utilization, the important foods were: 1) berries of *V. oxycoccus*, 2) fruit of *V. vitis-idaea*, 3) twigs and buds of *V. angustifolium*, and 4) leaves of *V. oxycoccus*. In Sweden, Brittas (1988) found *Vaccinium* spp. to be of primary

importance in the spring diet of local willow ptarmigan, comprising as much as 63% of the diet (Table 6). The stems of *V. myrtillus* were most utilized, in this case, with berries of *V. oxycoccus* accounting for only a small fraction of the diet (Brittas 1988).

A few notable dietary exceptions were noted in some locales. Only in Sweden did birch (*Betula* spp.) account for more than 10% of the total dry weight. The shoots and catkins of *B. nana* made up 10.8% of the spring diet in that country (Brittas 1988). The spring diet of red grouse in Scotland changed little from the winter diet, as heather (*Calluna vulgaris*) accounted for over 90% of the diet (Moss 1972; Table 6), likely a reflection of the relative availability of heather at this site.

c) Summer

During summer, adult willow ptarmigan forage predominantly on the leaves and berries of a small number of woody and herbaceous plants (Table 7). In Alaska, the dominant summer food is willow (*Salix* spp.) (West and Meng 1966, Weeden 1969, Williams *et al.* 1980; Table 7). Williams *et al.* (1980) analyzed the summer (June to August) diet of Alaskan willow ptarmigan on a month by month basis. Although the relative percentage of willow did not change a great deal from June to August (range: 57.6-86.6%; Table 7), the parts of the willow consumed changed dramatically. In June, catkins and buds accounted for 98% of the total willow consumed, whereas in July they accounted for less than 2%, and the leaves and fruit constituted 58.5% and 39.6%, respectively. Leaves were taken

Table 6: Review of studies on the spring diet of willow ptarmigan (*Lagopus lagopus*).

Author(s)	West and Meng	West and Meng	Bergerud and Mercer	Moss	Brittas
Year	1966	1966	1972	1972	1988
after	Table 2	Table 3	Table 2	Table 2	Table 2
Location	Alaska	Alaska	Newfoundland	Scotland	Sweden
Dates	May	May	April - May	April - early May	May
Sex	m,f	m,f	m,f	m,f	m,f
N (crops)	55	130	63	46	58
Amelanchier spp.			0.7		
Andromeda spp.			2.9		2.9
Betula spp.	0.9	9.6			10.8
Calluna vulgaris				90.4	
Dryas octopetala	tr.	19			
Empetrum spp.			2.1		3.3
Erica spp.				8.1	
Ledum groenlandicum				0.7	
Pyrus floribunda			1.4		
Salix spp.	94.1	70			1.2
Vaccinium spp.	1.4		92.1		62.9
Miscellaneous	0.7	1.4			

Results from all studies are presented as percentage of total dry weight, with the exception of Bergerud and Mercer (1972) whose results are presented as percentage of total volume of foods in crops.

tr. = < 0.1

Table 7: Review of studies on the summer diet of adult willow ptarmigan (*Lagopus lagopus*).

Author(s)	West and Meng	Weeden	Williams *et al.*	Williams *et al.*	Williams *et al.*
Year	1966	1969	1980	1980	1980
After	Table 2	Table 3	Table 1	Table 1	Table 1
Location	Alaska	Alaska	Alaska	Alaska	Alaska
Dates	June - August	August	June	July	August
Sex	m,f	m,f	m,f	m,f	m,f
N (crops)	23	18	11	13	17
Arctostaphylos spp.	8.4				
Betula spp.	4.8	2	2.4	0.1	6.8
Carex spp.		5			
Cassiope tetragona				6.1	7.4
Dryas octopetala				21.5	
Equisetum spp.	15.7	6			
Eriophorum spp.			2.5		
Graminoids				0.4	8
Polygonum spp.		9		7.9	2.6
Salix spp.	47.4	39	86.6	57.6	67.3
Saxifraga spp.		1			
Vaccinium spp.	10.1	35			
Miscellaneous	13.2				

Results from all studies are presented as percentage of total dry weight of foods in crops.

most frequently in August, accounting for 70% of the diet. Buds and stems were also taken (26.5%) in August, but little fruit (3.5%) and no catkins were noted (Williams *et al.* 1980). Weeden (1969) reported similar findings for August, with willow accounting for 39% of the diet (Table 7), approximately 92% of which was leaves. West and Meng (1966) combined the results for June, July, and August and reported a high component of willow during these summer months, accounting for nearly 50% of the diet (91% leaves and 9% buds and twigs; Table 7).

Birch (*Betula* spp.) was also reported in the summer diet (West and Meng 1966, Weeden 1969, Williams *et al.* 1980; Table 7). Birch catkins, buds, and stems were all present, but because of the somewhat minor amounts consumed (<10%; Table 7), birch does not appear to be a major food during the summer months.

In addition to willow, willow ptarmigan feed on a variety of other shrubs and herbaceous plants. The species used and the parts eaten are dependant upon the local distribution of the plants as well as their phenology. Weeden (1969) reported that of all plant parts consumed in August, leaves were the most heavily utilized, comprising 47% of the diet, followed by berries (27%) and seeds or bulbils (15%). The remainder of the diet was composed of flowers, stems, buds and other plant parts. The flowers of *Dryas integrifolia*, *Eriophorum* spp., *Polygonum* spp., and *Cassiope tetragona*, and the ripening fruit of the latter are fed upon mostly during July in Alaska (Williams *et al.* 1980). The bulbils of *Polygonum* spp. (primarily *P. nigrum*) are also taken, as are the

seeds of various graminoids and *Carex* spp., and the stems and tips of *Equisetum* spp. Berries and leaves of a number of *Vaccinium* spp. (primarily *V. vitis-idaea* and *V. uliginosum*) have also been recorded in the summer diet, accounting for as much as 35% of the diet during August in Alaskan willow ptarmigan (Weeden 1969; Table 7). Bearberries (*Arctostaphylos uva-ursi*) have also been documented (West and Meng 1966; Table 7).

The diet of chicks has been examined by several researchers; those with comparable results are presented in Table 8. Chicks of both rock (Table 3) and willow ptarmigan appear to rely less on animal matter than what is generally assumed for most galliforms, such as the Grey Partridge (*Perdix perdix*) which eats over 90% insects (by volume) in its first 2 weeks of life (Ford, Chitty, and Middleton 1938 *in* Savory 1977). In willow ptarmigan chicks, the proportion of plant versus animal matter varies greatly depending upon location. Spidso (1980) observed a decreasing relationship in the proportion of animal matter in the diet of chicks from Norway. The animal matter consumed decreased from almost 60% of dry weight (total food in crops) for 0-3 day old chicks to approximately 4% in chicks over 20 days old. Insect larvae comprised over 50% of animal matter consumed, the most important group of which was the Geometridae larvae. Of plant matter, Spidso (1980) found chicks fed mainly on the fruit and leaves of various plant species, with fruit predominating. Preferred foods included the fruit and leaves of *Vaccinium* species, seed heads of *Carex* spp., leaves of *Gymnocarpium dryopteris*, and fruit of *Cerastium* spp., *Polygonum*

spp. and *Bryales* spp. (Spidso 1980; Table 5).

In most studies, in contrast to Spidso (1980), little animal matter was observed in the diet of chicks, even at a very young age (Savory 1977, Williams *et al.* 1980, Hunt 1989; Table 8). In Scotland, the proportion of insects in the diet of red grouse chicks did not surpass 6% from day 1 to 42 days post hatching. Of the animal matter consumed, members of the order Diptera (Class Insecta) made up the bulk of the chicks' diet. The shoot tips of heather (*Calluna vulgaris*) was the single most important food, ranging from a low of 64.5% at age 21-42 days to 94.6% at 9-17 days (Savory 1977). The capsules of mosses were important in the diet of very young chicks (1-5 days) accounting for almost 15% of the diet; however, they were consumed in minor amounts by older chicks (Table 8). During their first week or so, chicks also fed upon the leaves and flowers of *Vaccinium myrtillus* and *Rumex acetosella*, and subsequently on the shoots of *Erica* spp. throughout the next 4 weeks. Later in summer, at approximately one month, the chicks also consumed the ripened seeds of *Carex* and *Juncus* spp. (Savory 1977; Table 8). The diet of red grouse chicks generally begin to mirror that of the adults after approximately 4 weeks of age. Savory (1977) examined crop contents of adults and chicks collected in late August and September and found no differences in diet between the two age groups.

North American studies show that plants dominate the diet of willow ptarmigan chicks, apparently regardless of age (Williams *et al.* 1980, Hunt 1989). In 1 to 18 day old chicks collected at

Table 8: Review of studies on the summer diet of willow ptarmigan chicks (*Lagopus lagopus*).

Author(s)	Savory	Savory	Savory	Williams *et al.*	Williams *et al.*	Myrberget	Hunt
Year	1977	1977	1977	1980	1980	1981	1989
after	Table 1	Table 1	Table 1	Table 2	Table 2	Table 2	Figure 4
Location	Scotland	Scotland	Scotland	Alaska	Alaska	Norway	British Columbia
Dates	summer	summer	summer	July - August[1]	July - August[2]	June - July	July
Age (days)	0 - 5	9 - 17	21 - 42	?	?	?	1 - 18
N (crops)	62	46	17	14, 12	17, 10	53	17
Arctostaphylos spp.				0, 3	2.4, 20.5		
Andromeda spp.						7.7	
Betula spp.						tr.	5.4
Bryales spp.						0.9	
Calluna vulgaris	75.9	94.6	64.5			0.6	
Cardamine pratense				0, 4.4			
Carex spp.		tr.	8.3			0.1	35.7
Cassiope tetragona				5.1, 3	0.3, 0		
Cerastium spp.			1.9				
Dryas integrifolia				8.6, 4.5			
Echinochloa crusgalli						3.6	
Empetrum spp.		0.1				16.2	
Equisetum spp.				0, 7.9	tr., 1.9		
Erica spp.	0.3	1.7	2.8				6.5
Ericacea[3]							
Ferns	0.1	0.3	0.3				
Fungi		tr.	0.1	1.1, 0	tr., 17.4		
Galium boreale						3.1	
Graminoids			tr.	0.7, 10.3	0, 19.9		
Gymnocarpium spp.						5.9	
Juncus spp.	0.2	tr.	11				3.4

Table 8 (continued)

Author(s)	Savory	Savory	Savory	Williams *et al.*	Williams *et al.*	Myrberget	Hunt
Year	1977	1977	1977	1980	1980	1981	1989
after	Table 1	Table 1	Table 1	Table 2	Table 2	Table 2	Figure 4
Location	Scotland	Scotland	Scotland	Alaska	Alaska	Norway	British Columbia
Dates	summer	summer	summer	July - August[1]	July - August[2]	June - July	July
Age (days)	0 - 5	9 - 17	21 - 42	?	?	?	1 - 18
N (crops)	62	46	17	14, 12	17, 10	53	17
Luzula pilosa						0.8	
Moss		14.5	1	19, 0			
Oxytropis spp.					3.6, 0		
Polygonum spp.				7.6, 10.3	89.3, 0.2	9.5	
Pyrola spp.							6.2
Ranunculus acris						4.6	
Rumex spp.	2						
Salix spp.				41.1, 34	0.9, 31.5		10
Saxifraga spp.				0.1, 10.1			
Thalictrum spp.							3.4
Trifolium repens						1.2	
Vaccinium spp.	3.1	0.4	0.9			36	
Vicia cracca						13.1	
Arthropods	4.6	1.9	6	6.4, 0.7	0.6, 0	6.7	24.9
Insect gall				0, 4			

Results from all studies are presented as percentage of total dry weight of foods in crops.
tr. = < 0.1
[1] Year = 1976; results for July and August are presented separately. Note: during July, chick weight averaged 68.2g.
[2] Year = 1977; results for July and August are presented separately. Note: during July, chick weight averaged 73.0g.
[3] *Andromeda polyfolia* and *Arctostaphylos uva-ursi*.

Chilkat Pass in northern British Columbia, plants comprised 75% of the diet (Hunt 1989). Similarly in Alaska, plants comprised over 90% of the total diet during July and August (Williams *et al.* 1980; Table 8). At Chilkat Pass, the three dominant foods, in decreasing order (percent of dry weight of foods consumed), were the seeds of *Carex* spp., Diptera larva, and willow (*Salix* spp.) (Hunt 1989). Willow was the dominant food of chicks from Alaska, with leaves predominating and minor amounts of buds and stems taken (Williams *et al.* 1980; Table 8). This dominance by willow was not complete: Williams *et al.* (1980) found in July of the second year of their study that bulbils of *Polygonum* spp. accounted for almost 90% of the diet. Other important foods include moss capsules, seeds of grasses, and fruits of *Cassiope tetragona*, *Dryas integrifolia*, and *Arctostaphylos* spp. (Williams *et al.* 1980; Table 8).

d) Autumn

In Alaska, the fall diet of willow ptarmigan is characterized by a return to dominance by willow buds and twigs, accounting for as much as 84% in some regions (West and Meng 1966, Weeden 1969; Table 9). Weeden (1969) observed a rapid increase in the consumption of willow buds and twigs and a rapid drop in utilization of willow leaves during this season. Birch was also reported in the fall diet, although generally in low quantities (Table 9). Fruits from a variety of plants were recorded, including those of *Gaylussacia baccata* (Peters 1958), *Empetrum* spp. (Peters 1958, Weeden 1969, Brittas 1988) and *Vaccinium* spp. (Peters

Table 9: Review of studies on the fall diet of willow ptarmigan (*Lagopus lagopus*).

Author(s)	Peters	West and Meng	West and Meng	Weeden	Weeden	Moss	Brittas
Year	1958	1966	1966	1969	1969	1972	1988
after	Table 2	Table 2	Table 3	Table 3	Table 3	Table 2	Table 2
Location	Newfoundland	Alaska	Alaska	Alaska [1]	Alaska [2]	Scotland	Sweden
Dates	October	October	October	September	September	November	August - September
Sex	m,f	m,f	m,f	m,f	m,f	m,f	m,f
N (crops)	223	48	41	27	27	17	69
Andromeda spp.	1						5.3
Betula spp.	tr.	9	11.8	2	3		6.8
Calluna vulgaris						98.5	
Chamaedaphne calyculata		3					
Dryas spp.		3.5	2.6				
Empetrum spp.	2			3	11		17.9
Equisetum spp.	tr.	0.2		13			
Erica spp.						0.1	
Gaylussacia baccata	11						6.3
Potentilla tridentata	7						
Prenanthes trifoliolata	3						
Rhododendron canadense		1					
Salix spp.		76.8	84.4	61	83		0.1
Vaccinium spp.	67	9.7		19			48.6
Miscellaneous		0.8	1.3	2	2		15.2

Results from all studies are presented as percentage of total dry weight, with the exception of Peters (1958) whose results are presented as percentage of total volume.

tr. = < 0.1

[1] Interior, Alaska

[2] Nome, Alaska

1958, Weeden 1969, Brittas 1988). *Vaccinium* species observed in the fall diet include *V. angustifolium* (Peters 1958), *V. oxycoccus* (Peters 1958, Brittas 1988), *V. vitis-idaea* (Peters 1958, Weeden 1969), *V. uliginosum* (Weeden 1969, Brittas 1988), and *V. myrtillus* (Brittas 1988). The leaves, buds and twigs of *Vaccinium* were also reported. In Newfoundland and Sweden, *Vaccinium* predominated (49% and 67%, respectively) and willow was scarce (Peters 1958, Brittas 1988; Table 9). Seeds of various graminoid species and the stems and leaves of *Andromeda polifolia*, were also reported in the fall diet of Swedish ptarmigan (Brittas 1988).

Summary of willow ptarmigan food habits

The most important food sources of Alaskan willow ptarmigan are willow (*Salix* spp.) buds and twigs (Johnsgard 1983). Except for late summer, willow accounts for over 50% of the diet throughout the year, regardless of season. Birch is also taken, although generally in minor amounts. In the U.S.S.R., the major foods are willow and birch (Johnsgard 1983). An exception to a willow dominated winter diet is found in Newfoundland where willow ptarmigan were observed to feed mainly on buds and twigs of *Vaccinium* spp, buds and catkins of birch (*Betula* spp.) and alder (*Alnus* spp.), and buds of *Myrica* spp. In Scotland and Scandinavia, willow as the dominant food is replaced by heather (*Calluna vulgaris*) and birch (*Betula* spp.), respectively. In these countries, willow is not taken in great amounts, primarily due to low abundance and inaccessibility.

Shrubby plants dominate the spring diet of willow ptarmigan. In Alaska, the buds and twigs of willow are the most dominant food, whereas in Newfoundland and Sweden, the fruit and stems of *Vaccinium* spp. predominate. In Scotland, as during winter, heather dominates the diet.

The summer diet of adult willow ptarmigan is dominated by leaves and berries of a small number of woody and herbaceous plants. In Alaska, willow dominates the diet throughout the summer, with willow ptarmigan feeding on catkins and buds in June, leaves and developing fruit in July, and leaves and buds in August. Birch is also taken, as are the flowers of *Dryas integrifolia*, *Eriophorum* spp., *Polygonum* spp., and *Cassiope tetragona*. During the latter half of summer chicks generally feed on fruit, particularly bulbils of *Polygonum* spp., berries of *Vaccinium*, and seeds from various graminoids and *Carex* spp. Willow ptarmigan chicks are apparently less insectivorous than are chicks of more temperate-adapted grouse. Most studies report animal matter to account for less than 10 percent of the diet of chicks, even at a young age. In those areas where animal matter was found to comprise a significant portion of the diet, it was only at a very young age, and the proportion decreased as the chicks grew older. By approximately four weeks of age the diet was apparently mainly plant matter. Major animal foods reported are larvae of Geometridae and Diptera (Class Insecta). Preferred plant foods are fruit and leaves of *Vaccinium* spp., seed heads of *Carex* spp. and *Juncus* spp., shoot tips of heather, capsules of mosses, leaves of *Gymnocarpium*

dryopteris, and fruit of *Cerastium* spp., *Dryas integrifolia*, *Arctostaphylos* spp., *Polygonum* spp., and *Bryales* spp..

The fall diet of willow ptarmigan in Alaska and Newfoundland is characterized by a return to dominance of buds and twigs of willow and *Vaccinium* spp., respectively. This occurs as berry supplies become exhausted and the leaves fall from the bushes. In Sweden, the buds and twigs of *Vaccinium* spp. dominate the fall diet, followed in preference by seeds of various graminoids and the stems and leaves of *Andromeda polifolia*.

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