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Final Report

Pittman–Robertson Project 8-R

TECHNICAL WILDLIFE BULLETIN NUMBER 4

Game Management Division

WISCONSIN CONSERVATION DEPARTMENT

Madison 2, Wisconsin

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FOOD HABIT STUDIES OF RUFFED GROUSE, PHEASANT, QUAIL AND MINK IN WISCONSIN

by

BRUCE P. STOLLBERG and RUTH L. HINE

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Note: *Only four of the problems investigated under Pittman-Robertson Research Project 8-R are reported in this bulletin. Food habit studies by this project on fox and deer will appear in forthcoming bulletins on each of these species. Waterfowl food habit investigations have been published previously by the senior author (Food habits of shoal-water ducks on Horicon Marsh, Wisconsin, Jour. Wildl. Mgt. 14(2):214-217, April, 1950; Competition of American coots and shoal-water ducks for food, Jour. Wildl. Mgt. 13 (4): 423-424, December, 1949).*

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FOREWORD

The environment in which we live is constantly changing. Man has been able to adapt himself to these changes in some areas and has continued to raise his standard of living. The tolerance of the wild animal to both natural and man-made disturbances, however, is more limited; he has a harder time rearranging his life as food and cover resources alter. It is frequently necessary, therefore, to check on how he is making out in our evolutionary world. One key to his well-being is his food habits. What foods are eaten in relation to those present? Can game managers help in the readjustments of wildlife by manipulating parts of the environment in order to provide more preferred foods?

The purpose of early food habit studies was to find out what animals ate and refine the techniques for obtaining this information. Their main weakness was the lack of data on the availability of the foods eaten. On February 1, 1947, Wisconsin resumed its Pittman-Robertson food habits research project under the leadership of Bruce P. Stollberg. The project terminated on January 22, 1949, when Mr. Stollberg resigned to take employment with the U. S. Fish and Wildlife Service. The objectives of these studies were not only to determine what foods were eaten by various species of wildlife, but to correlate the foods taken with their availability. This type of information should give us greater insight into the preferences shown for certain foods, and may help to explain certain features of wildlife population behavior.

The studies reported in this bulletin represent an analysis of the use of existing food resources by certain Wisconsin species. Wildlife food problems, however, will never be permanently solved. In the future there will be need for other food habit studies whenever environmental conditions and population behavior dictate.

Cyril Kabat
Chief of Wildlife Research

INTRODUCTION

Knowledge of the seasonal food habits of Wisconsin animals has numerous blank pages. Many of our sportsmen are unaware of the feeding requirements of the game they hunt, and many conservationists cannot answer the questions that food habits pose with regard to the actual food and cover needs of faltering species. Food habit studies are important not only in determining the food preferences of a particular species, but also in discerning the food relationships existing between the animals in a community.

The objectives of these studies were to determine by laboratory analyses and field inspection the food habits of certain Wisconsin game animals, and to correlate where possible the foods eaten with their availability. Information on food preferences in relation to the availability of the foods eaten will provide game managers with the means for charting a course of habitat management that will best satisfy the needs of each game species present in an area. Although numerous studies on food habits have been published in other states, problems arising under different local conditions necessitated a Wisconsin study.

MATERIALS AND METHODS

Animals were collected for food habit studies only when information could be obtained on the availability of the foods eaten.

Analyses were carried on in the food habits laboratory at the State Experimental Game and Fur Farm, Poynette, Wisconsin. Crop and stomach contents were first placed in a fine-mesh strainer and washed thoroughly. Leaf fragments were removed, placed between two glass slides, and allowed to dry. The rest of the food material was dried in an oven. Food items were then sorted into separate petri dishes according to species. Identifications were made with the aid of reference collections at the Poynette laboratory and at the University of Wisconsin. All food items were measured volumetrically. In measuring bulky items, air spaces were displaced with lead shot. Additional techniques, used in some of the following studies, will be discussed in connection with the species under consideration.

RUFFED GROUSE

Investigators in other states have found that ruffed grouse eat a great variety of foods. Former Wisconsin studies, reported by Grange (1948), also indicated a wide range of food preferences. Further food habit studies were carried out on ruffed grouse in northern Wisconsin not only to obtain a list of the foods eaten in this area, but to correlate the foods taken with the local availability of the plant species. Such information will refine our knowledge of grouse food preferences. It will also help to determine how well these birds exist on the foods in Wisconsin forests and how well the range will support ruffed grouse in the future.

Materials and Methods

One hundred ruffed grouse *(Bonasa umbellus)* were collected in Bayfield and northeastern Sawyer counties during the first three weeks of October, 1948. Birds were collected at random, usually in the early morning or late evening. Crops were removed and placed in a solution of F.A.A. (formalin, acetic acid and alcohol), where they remained for about three months before analysis. Eleven crops were empty, and only crops from the remaining eighty-nine birds were considered in the analyses.

At each collection site, the abundance of the potential food species available to the grouse was estimated visually in terms of the amount of overhead cover within a radius of approximately 100 yards. The tally involved only tree species. The inclusion of low-growing herbs and shrubs would have required too much time. Since many grouse were still taking considerable food from ground vegetation, the value of the tally may be somewhat lessened. The overhead tree cover, however, bears a definite relationship to the understory, thus allowing a general estimate to be made of the available food sources in the lower plant strata without an accumulation of actual data. Nevertheless the method yielded interesting correlations between the tree foods taken and their availability, and should prove useful in future food habit studies.

Results and Discussion

The foods eaten by the grouse collected during the fall of 1948 are listed in Table 1. A correlation between the overhead tree cover at the collection site and the amount of tree food eaten is presented in Table 2. This type of comparison offers more precise data on food preferences

Table 1

Food Habits of Eighty-Nine Ruffed Grouse

October, 1948

Food Items and Part Eaten	*Per Cent of Total Volume*	*Per Cent Occurrence*
Aspen (*Populus* sp.)	29	49
P. tremuloides (leaves 59%; buds 41%)	(22)	(39)
P. grandidentata (leaves 63%; buds 37%)	(6)	(8)
P. alba (leaves)	(0.5)	(1)
Populus species unknown (leaves)	(0.5)	(3)
Clover (*Trifolium* sp., leaves)	21	78
Ironwood (*Ostrya virginiana*, catkins 99%; buds 1%)	9	10
Plantain (*Plantago* sp., leaves)	7	15
Oak (*Quercus* sp.)	5.5	19
Acorns	(5.4)	(16)
Galls	(0.1)	(3)
Dandelion (*Taraxacum* sp., leaves; flowers)	5	25
Black cherry (*Prunus serotina*, buds and twigs 100%; seeds, trace)	2	8
Birch (*Betula* sp.)	2	6
B. papyrifera (seeds 80%; buds 20%)	(2)	(4)
B. lutea (seeds 50%; buds 50%)	(trace)	(2)
Strawberry (*Fragaria* sp., leaves)	1	20
Sheep sorrel (*Rumex Acetosella*, leaves)	1	16
Avens (*Geum canadense*, seeds)	1	2
Juneberry (*Amelanchier canadensis*, fruit 97%; buds 3%)	1	5
Hazel (*Corylus* sp.)	0.8	24
C. americana (buds 42%; nuts 38%; catkins 20%)	(0.4)	(21)
C. cornuta (catkins)	(0.4)	(3)
Wood fern (*Dryopteris* sp., leaves 98%; buds 2%)	0.7	5
Hepatica (*Hepatica americana*, leaves)	0.7	2
Bramble (*Rubus* sp., leaves 99%; seeds 1%; buds, trace)	0.4	15
Wintergreen (*Gaultheria procumbens*, berries 90%, leaves 10%)	0.4	13
Barren strawberry (*Waldsteinia fragarioides*, leaves)	0.4	1
Grass (Graminae, leaves)	0.2	20
Maple (*Acer* sp., mostly seeds; buds)	0.1	14
March flies (Bibionidae)	Trace	12
Unidentified (leaves)	4	25

Table 1 (Cont'd)

The following food items were found in quantities less than .1 per cent of the total volume of food and in not more than four crops:

Maple-leaved viburnum *(Viburnum acerifolium)*
May flower *(Maianthemum canadense)*
Bishop's cap *(Mitella nuda)*
Wild chamomile *(Matricaria* sp.)
Wild geranium *(Geranium* sp.)
Sedge *(Carex* sp.)
Honeysuckle *(Lonicera* sp.)
Pussy toes *(Antennaria* sp.)
Prince's pine *(Chimaphila umbellata)*
Chickweed *(Stellaria* sp.)
Lousewort *(Pedicularis* sp.)
Sweet fern *(Comptonia peregrina)*
Bedstraw *(Galium* sp.)
Touch-me-not *(Impatiens biflora)*
Mountain holly *(Nemopanthus mucronata)*
Anemone *(Anemone* sp.)
Blueberry *(Vaccinium angustifolium)*
Gooseberry *(Ribes* sp.)
Canada balsam *(Abies balsamea)*
Oleaster *(Shepherdia canadensis)*
False solomon's seal *(Smilacina racemosa)*
Meadow rue *(Thalictrum dioicum)*
Ant (Formicinae)
Spider (Arachnida)

Table 2

Overhead Tree Cover at Eighty-Nine Ruffed Grouse Collection Sites

Tree	*Average Per Cent of Overhead Cover*	*Per Cent Total Tree Food*
Aspen	27	59
Maple	25	0.2
Birch	16	6
Oak	14	11
Conifers	13	Trace
Basswood	2	0
Cherry	0.5	4
Ash	0.4	0
Willow	0.4	0
Alder	0.3	0
Ironwood	Trace	19
Elm	Trace	0

than food listings alone, and tends to alter the picture given only by crop analyses. The information in Table 2 brings out several interesting facts concerning the fall food preferences of the ruffed grouse:

(1) Ruffed grouse tend to eat the food that is most available. Aspen (popple) was the most abundant tree species present at the collection sites, representing 27 per cent of the total tree cover. It was also the favorite tree food eaten, comprising over half of the total tree food taken during the study period. Maple ranked second highest in abundance according to the overhead cover tally, but maple seeds formed only a small fraction of the grouse diet. However, the relatively high rate of occurrence of maple in the crops (Table 1) suggests that maple seeds were preferred but that seeds were not available to the birds at this time of the year. Oak was fairly abundant and acorns were taken frequently by the birds.

(2) Although many foods are available to grouse, they are not preferred as food items. Birch, for example, was quite abundant at the collection sites, averaging 16 per cent of the overhead tree cover, but formed only a small part of the total amount of tree food taken. Conifers were about as abundant as oak and birch, but occurred as only a trace of the total tree food.

(3) Some tree species are unimportant components of the community, but nevertheless form a significant part of the grouse diet. Ironwood formed only a trace of the overhead cover, but was the second most important tree food eaten. Cherry was also present in very low density, but occurred as 4 per cent of the total tree food. Although this is a relatively small amount of cherry eaten, the fact that it was taken even this much in view of its scarcity in the overhead tree cover is perhaps significant. Such correlations suggest decided preferences on the part of ruffed grouse for these foods, particularly ironwood in this case.

Herbaceous plants constituted an important part of the grouse fall diet. Clover was present in crops more often than any other food item and occurred as 21 per cent of the total volume of food, only a little less than aspen. Plantain and dandelion also made up a significant portion of the crop contents.

The crop analyses provide another interesting problem in the interpretation of food preferences based on both volumetric measurements and occurrence data. Several food items, for example, occurred as a relatively low percentage of the total volume of food but were found

in a relatively large number of crops. Strawberry, sheep sorrel, hazel, grass, bramble, wintergreen, and march flies belong to this group. There are several possible explanations for this, and perhaps all are involved in these analyses:

(1) These foods may be preferred but were unavailable to the grouse. This may be true in the case of maple seeds and march flies; other species mentioned above, however, were abundant at the collection sites.

(2) The repeated occurrence of these foods may represent incidental intake along with the other more preferred food items. Grass may fall into this category.

(3) Their high rate of occurrence in crops may indicate a true preference for these food species. However, volumetric measurement data may be clouded by the fact that larger fruits and leaves "outmeasure" the smaller herbaceous species such as strawberry and sheep sorrel.

There is great variety among published works in the food listings for ruffed grouse. It is difficult to compare regional food habit studies because of differences in the distribution of food plants and their availability during various seasons and years. In general, the findings of this study are similar to those of other studies. Most authors list a number of foods as important in the fall ruffed grouse diet, including clover, sheep sorrel, strawberry, aspen, birch, oak (acorns), hawthorn, and cherry. Birch, however, was apparently an unimportant part of the grouse diet in northern Wisconsin. Maple, which was frequently taken in small amounts, was listed as a secondary food for ruffed grouse in the northeast by Edminster (1947). This author reported that maple buds were taken in the winter, and seeds in the summer. Grange (1948) pointed out that hardy greens surviving early frosts, such as clover, dandelion, and strawberry, as well as aspen and acorns, were heavily eaten by Wisconsin grouse in the fall.

Clover is apparently an almost universal favorite among grouse. In food habit studies in Maine, Brown (1946) found that whereas clover was common in the various forest types studied, the high occurrence (94 per cent) in 188 crops seemed inconsistent with its availability, indicating a high degree of preference. The species of clover in the crops examined in the present study was not determined. Grange (1948) found three species of domestic clovers represented in the crops of ruffed grouse examined in Wisconsin: white clover *(Trifolium repens)*, taken most frequently by the grouse; alsike *(T. hybridum)*;

and red clover *(T. pratense)*. Chaddock (1940) listed alsike clover as one of the most important ruffed grouse foods in Wisconsin as a result of the analysis of 259 crops collected over a two-year period.

Almost 90 per cent of the foods eaten consisted of leaves and fruit (nuts, seeds, catkins). This is a slightly higher percentage than Edminster (1947) indicated for grouse in fall in the northeastern states. The birds showed considerable individuality in their method of eating acorns. Some grouse split the acorns, some shelled them and ate only the nut, and others swallowed the fruit whole.

Sixteen of the eighty-nine grouse collected were adults and a study was made to discover any particular differences in the food habits of the two age groups. The shift from the summer and fall diet of principally herbaceous vegetation to the winter diet of buds and twigs seemed to be a little slower on the part of the juveniles. Clover, for example, rated 8 per cent higher by volume in the juvenile crops, and dandelion 4 per cent higher. The adults, on the other hand, consumed 31 per cent more quaking aspen *(P. tremuloides)* than did the young birds.

Summary and Conclusions

A large number of woody and herbaceous food plants were eaten by ruffed grouse in northern Wisconsin during the fall of 1948. High palatability foods included clover, quaking aspen, ironwood, oak, cherry, plantain, dandelion, and possibly maple seeds. Hazel, strawberry, sheep sorrel, bramble, wintergreen, and march flies were present in low volume, but were apparently palatable fall foods, judging from the relatively high rate of occurrence in the crops. Conifers, basswood, and birch were low on the fall palatability rating for ruffed grouse.

Food is apparently no problem to ruffed grouse in Wisconsin. Aspen in particular bears an important relationship to these birds. It was a favored food item in the fall diet, and is eaten all year round according to other investigators. Since aspen is very abundant in Wisconsin at present and will in the future enter profusely into areas as second growth forest, it practically insures Wisconsin of a good ruffed grouse food supply, especially in the northern part of the state. The wide choice of foods also guarantees a steady diet.

The foods eaten suggest the cover types preferred by ruffed grouse in the fall. The principal food species taken by the birds are found in second growth forests, with openings that foster the abundant growth

of herbaceous plants. The preference shown for such herbaceous species as clover suggests the encouragement of their growth in some areas as a part of a ruffed grouse habitat improvement program. A rather extensive program of trail planting with legumes in both federal and state forests, which is now being carried on in northern Wisconsin, should provide an important feature of ruffed grouse habitat in these areas.

PHEASANT

A. Wild vs. Released Birds

The purpose of this study was primarily to determine whether weed seeds or grains were taken by pheasants in the fall, and secondarily to find out if any difference in the choice of food or any preferences for certain available foods were shown by released birds. Such information might provide further explanation for the adaptability and high survival of released pheasants in new areas. It might also offer clues to the management of artificially propagated birds that are stocked in the wild.

The crops analyzed were removed from birds shot during the hunting season in October 1948 on Potter's Marsh (Sauk county), one of the public hunting grounds of southern Wisconsin.

Results

A summary of the crop contents of fourteen wild pheasants *(Phasianus colchicus torquatus)* and twenty released pheasants is presented in Tables 3 and 4. The wild birds consumed mainly buckwheat, and corn to a lesser extent. Grasshoppers occurred in 36 per cent of the crops examined, but formed only a small fraction of the total volume of food.

Corn topped the food list for the game farm releases, with buckwheat second in importance. A great variety of other foods, primarily weed seeds, were taken in small quantities.

Discussion

Pheasant food preferences found as a result of this study were similar to the findings of George B. Rossbach in Wisconsin (in Buss 1946). This investigator determined that cultivated grains, especially corn, were most important in the fall diet of pheasants. Weed seeds, primarily lesser ragweed and foxtail, however, rated almost equal in

importance in Rossbach's study, but were less frequently taken by the pheasants examined from Potter's Marsh. Foods of all types were very abundant on the study area; the selection of certain foods by pheasants was, therefore, unbiased by limitations on availability.

Table 3

Food Habits of Fourteen Wild Pheasants

October, 1948*

Food Item	*Per Cent of Total Volume*	*Per Cent Occurrence*
Buckwheat (*Fagopyrum sagittatum*)	77	71
Corn (*Zea Mays*)	13	14
Giant ragweed (*Ambrosia trifida*)	5	14
Oak (acorns) (*Quercus* sp.)	2	7
Grape (*Vitis vulpina*)	1	14
Bittersweet (*Solanum Dulcamara*)	T**	14
Spotted touch-me-not (*Impatiens biflora*)	T	7
Unidentified leaf	T	7
Grasshopper (*Melanoplus femur-rubrum*)	1	36
Ant (Formicinae)	T	7
Snail (Gastropoda)	T	7

*Part of plant taken is seed.
**Trace.

Two main differences in food preferences were shown by the wild and released birds. Firstly, the wild birds preferred buckwheat, with corn as second choice. Released birds, on the other hand, preferred corn, with buckwheat as the second choice food. This may be partially explained by the fact that the game farm birds were fed corn before they were released and may therefore have become "used" to this grain. McCabe and Hawkins (1946) obtained a similar result with Hungarian partridge. In a food selection experiment during the winter of 1941–42, they found that the Huns preferred wheat, which had been fed to them during the pre-test period. These same authors also fed a variety of grains in feeding troughs to Huns, pheasants, and quail in the wild during the winter of 1940. These birds were fed yellow corn in the feeding shelters before the experiment was run, and results showed that of the nine grains offered, corn was eaten the most.

Secondly, there seemed to be no hesitancy on the part of released birds to sample a variety of new foods, and more than twice as many

Table 4

Food Habits of Twenty Released Pheasants

October, 1948*

Food Item	Per Cent of Total Volume	Per Cent Occurrence
Corn (*Zea Mays*)	68	65
Buckwheat (*Fagopyrum sagittatum*)	13	10
Rye (*Secale cereale*)	8	10
Skunk cabbage (*Symplocarpus foetidus*)	3	5
Pennsylvania smartweed (*Polygonum pennsylvanicum*)	1	25
Giant ragweed (*Ambrosia trifida*)	2	15
Lesser ragweed (*Ambrosia artemisiifolia*)	T**	20
Spotted touch-me-not (*Impatiens biflora*)	T	15
Black bindweed (*Polygonum Convolvulus*)	T	10
Red-osier dogwood (*Cornus stolonifera*)	T	5
Stick-tight (*Bidens vulgata*)	T	5
Dandelion (*Taraxacum officinale*)	T	5
Lady's thumb (*Polygonum Persicaria*)	T	5
Pigweed (*Chenopodium album*)	T	5
Smartweed (*Polygonum cristatum*)	T	5
Smartweed (*Polygonum lapathifolium*)	T	5
Yellow foxtail (*Setaria glauca*)	T	5
Unidentified leaf	T	5
Vegetable debris	T	5
Grasshopper (*Melanoplus femur-rubrum*)	4	20
Ant (Formicinae)	T	5
Cricket (Gryllinae)	T	5
Snail (Gastropoda)	T	5

*Part of plant eaten is seed.
**Trace.

foods were sampled by the released than by the wild birds. Cultivated grains, however, were preferred by both groups of birds during this fall period, despite the comparative abundance of such species as smartweed and ragweed. This fact is an aid to management, for the emergency wild food of the next winter's population will not have been depleted by birds shot by hunters. It is interesting to note that although climbing false buckwheat *(Polygonum scandens)* was abundant on the area, it was not taken by any of the pheasants examined.

Summary and Conclusions

Cultivated grains were the preferred foods taken by pheasants on Potter's Marsh during the fall of 1948. It is apparent that pheasants

released into the wild before the hunting season are able to adapt themselves to existing food conditions on the release areas. Released birds actually tended to show a greater propensity for foraging than did the wild birds.

A preference was shown by the game farm pheasants for the grain fed prior to their release. The pre-feeding activities carried on at the game farm and in the release pens may have been partially responsible for the adaptability of the birds to the release areas. They may also explain in part the relatively high survival of released pheasant cocks, which was indicated by a high hunting season return (an average of 54 per cent of the stocked birds from 1948–50 according to Kabat, Kozlik, and Thompson, unpublished). It is a standard practice at the state game farm to feed some grain to all birds prior to their liberation in the wild.

B. Feeding Experiment

A limited feeding experiment was carried on at the game farm to determine the effect of a 100 per cent diet of smartweed and ragweed seeds on pheasants. The experiment was occasioned by the death of a number of pheasants in a two-acre game farm holding pen. Before dying, the birds exhibited paralysis of the legs and other body parts, although they were alert until death. There was no response to vitamin or mineral enriched foods, or to botulism antitoxin. A survey of the holding pen revealed that the principal plant species present were Pennsylvania smartweed *(Polygonum pennsylvanicum),* and lesser ragweed *(Ambrosia artemisiifolia).* There was a possibility that these plants might be poisonous during some stage of growth. Under certain conditions some plants cause death by poisoning. Certain seeds, such as vetch, may sometimes contain dangerous amounts of a poison-complex (Morrison 1948).

To investigate this possibility, six birds were divided into groups of two. A control group was fed a corn, wheat, and grower mixture. One experimental group was fed a diet of 100 per cent smartweed seeds, and the other a diet of 100 per cent ragweed seeds. The feeding was carried on for a week in early November, 1947.

Results and Discussion

The results of the feeding experiment are presented in Table 5. All birds were in a healthy condition at the end of the experiment, indicating that the seeds were not highly toxic and probably not at all poison-

ous during this period. This conclusion was further substantiated by the fact that twenty birds placed in the original holding pen at the time the experimental feeding was begun showed no indication of sickness after a week's time.

Table 5

Pheasant Feeding Experiment

	Bird No.	*Date*	*Weight (Grams)*	*Gain*	*Loss*
Pen No. 1 (Control)	1	Nov. 1, 1947	858		
Corn, wheat, grower		Nov. 7, 1947	812		46
	2	Nov. 1, 1947	683		
		Nov. 7, 1947	746	63	
Pen No. 2 (Exper.)	1	Oct. 30, 1947	742		
100 per cent smartweed		Nov. 7, 1947	695		47
	2	Oct. 30, 1947	735		
		Nov. 7, 1947	695		40
Pen No. 3 (Exper.)	1	Oct. 30, 1947	750		
100 per cent ragweed		Nov. 7, 1947	695		55
	2	Oct. 30, 1947	730		
		Nov. 7, 1947	675		55

The experimental birds did lose weight, however, suggesting that an exclusive diet of ragweed and smartweed seeds was less nutritious than the more varied control diet of corn, wheat, and grower. More weight was lost by the birds fed ragweed than by those fed smartweed. These results may be somewhat obscured, however, by the short feeding period and the switch from one food to another at the start of the experiment.

The results of the present study are in line with the findings of Errington (1937). In an experiment testing the emergency values of some winter pheasant foods, he found that pheasants fed 100 per cent smartweed did not maintain their weights as steadily as did the corn-fed birds. They lost an average of 3.3 ounces (93.5 grams) per bird during the first week of experiment and 1.5 ounces (42.5 grams) per bird during the second and third weeks.

QUAIL

Very little quantitative material is available on the food habits of Wisconsin quail *(Colinus virginianus)*. The analyses of twenty-six quail crops collected during the fall of 1947 at the Mazomanie Public Hunting Grounds, Dane county, are therefore presented here to provide an example of fall quail foods taken in this locality. Also, since Mazomanie is a managed public hunting ground area, a study of quail crop contents might suggest possible management needs.

A large number of foods were sampled, but cultivated grains (corn and popcorn), ragweed and foxtail seeds made up the largest portion of the diet (Table 6). These data further indicate the characteristic habit of quail to select a wide variety of seeds. Although pigweed *(Chenopodium album)* was abundant on the area, quail were apparently not interested in it as a food item.

Table 6

Food Habits of Twenty-Six Quail Collected at Mazomanie, Wisconsin

October–November, 1947*

Food Item	*Per Cent of Total Volume*	*Per Cent Occurrence*
Lesser ragweed (*Ambrosia artemisiifolia*)	25	61
Corn (*Zea Mays*)	17	19
Popcorn (*Zea Mays*, var. *everta*)	10	7
Yellow foxtail (*Setaria glauca*)	9	46
Green foxtail (*Setaria viridis*)	7	30
Soybean (*Glycene Max*)	6	11
Arrow-leaved tear-thumb (*Polygonum sagittatum*)	6	11
Spotted touch-me-not (*Impatiens biflora*)	6	19
Water smartweed (*Polygonum punctatum*)	3	7
Oak (*Quercus* sp.)	2	3
Black bindweed (*Polygonum Convolvulus*)	1	26
Old witch grass (*Panicum capillare*)	Trace	23
Insects (Insecta)	0.5	15

*Part of plant taken is seed.

The following food items represented less than one per cent of the total volume, and occurred in not more than three crops examined:

Dock *(Rumex* sp.)
Water pepper *(Polygonum Hydropiper)*
Oats *(Avena sativa)*
Frost grape *(Vitis vulpina)*
Ground cherry *(Physalis heterophylla)*
Wheat *(Triticum aestivum)*
Barley *(Hordeum vulgare)*
Red clover *(Trifolium pratense)*
Water parsnip *(Sium suave)*
Clammy weed *(Polanisia graveolens)*
Lupine clover *(Medicago lupulina)*
Sedge *(Carex* sp.)
Three-seeded mercury *(Acalypha* sp.)
Hemp *(Cannabis sativa)*
Water hemp *(Acnida altissima)*
Bull thistle *(Cirsium vulgare)*
Climbing false buckwheat *(Polygonum scandens)*
Tumbleweed *(Amaranthus graecizans)*
Rough cinquefoil *(Potentilla monspeliensis)*
Bedstraw *(Galium* sp.)
Millipede (Diplopoda)
Ant (Formicinae)
Snail *(Pseudosuccinea* sp.)
Grasshopper *(Melanoplus* sp.)

These findings are similar to the studies of other investigators. In an analysis of thirty-two quail crops collected during November and December of 1949 in Dane and Green Lake counties, Wisconsin, Fred H. Wagner (unpublished) found corn, lesser ragweed, and acorns most important in the fall and early winter diet of quail. Many other seeds were also sampled in smaller quantities. Errington (1931) found that corn was the most important article in the winter diet of quail in the North Central region, but that lesser ragweed was their preferred food.

MINK

The depredations of mink upon muskrat populations have been found by other investigators to be of considerable importance. Sealander (1943) reported the muskrat to be the most important individual prey item in a study of 102 stomachs and 101 intestines. Errington (1943) found that mink predation on muskrats varied according to the behavior of the muskrat population and the condition of the local environment. There was much more predation when conditions of drought or over-population prevailed.

A study of the food habits of mink *(Mustela vison)* from the Horicon Marsh Wildlife Area in Dodge county was undertaken to investigate the relationship between this predator and its various prey species. Information pointing to the existence of a specific relationship between

mink and muskrats in this area may have an important bearing upon the management of these game animals for maximum fur production.

Materials and Methods

Examination was made of 57 mink stomachs from animals trapped on Horicon Marsh during the winters of 1945–46 and 1947–48. Volumetric percentages and occurrences were believed to be the most accurate means of presenting data gathered from mammal stomach analyses. Considerable error would probably be introduced if individual items were counted, since small mammal bones are easily digested and the proper number taken could seldom be evaluated.

Table 7

Food Habits of Mink Trapped on Horicon Marsh (State Area) During Two Winters

	1945–46 (27 Mink)		*1947–48 (18 Mink)*	
Food Item	*Per Cent of Total Volume*	*Per Cent Occurrence*	*Per Cent of Total Volume*	*Per Cent Occurrence*
MAMMALS				
Muskrat (*Ondatra zibethica*)	39	55	—	—
Mink (*Mustela vison*)	T*	22	9	5
Cottontail (*Sylvilagus floridanus*)	1	7	—	—
Field mice (*Microtus* sp.)	35	14	20	5
Deer mice (*Peromyscus* sp.)	3.5	7	—	—
Shrews (*Sorex* sp.)	15	18	3	16
BIRDS	—	—	20	27
AMPHIBIANS				
Frog (*Rana* sp.)	—	—	14	27
FISH	3.5	7	26	27
INVERTEBRATES				
Crayfish (*Cambarus* sp.)	—	—	3	11
Beetle (*Coleoptera* larva)	T	3	—	—
PLANTS				
Star duckweed (*Lemna trisulca*)	—	—	T	11
DEBRIS	2	14	5	22

*Trace.

The teeth of small mammals were often so digested that identification down to species was impossible. Hairs did not seem to disintegrate as rapidly, and were used to differentiate genera, or at least families. Hairs often vary considerably in size, shape, and composition, and a thorough search is usually necessary before a typical type is found. Although hair scales vary considerably in shape, even on various parts of the same hair, they were often useful in supporting an identification based on other characters.

Results

Information from stomach analyses of mink trapped during the winters of 1945–46 (27 mink) and 1947–48 (18 mink) in the Horicon Marsh state area are presented in Table 7. Muskrats, field mice, and shrews made up the bulk of the mink diet in 1945–46. Little or no predation on muskrats occurred during the winter of 1947–48; field mice, fish, frogs, and birds occurred in greatest amount in the stomachs examined. Stomachs of twelve mink taken from the Horicon Marsh federal area during the winter of 1947–48 contained birds, frogs, and muskrats (muskrats occurred in three stomachs and amounted to 27 per cent of the total volume of food). Mink remains found in some of the stomachs were largely hairs and probably represented attempts on the part of the mink to chew themselves out of the traps, rather than actual intra-specific strife.

Discussion

It is necessary to have some knowledge of the difference in conditions existing on the state area for the two years studied in order to evaluate properly the above analyses. The abundance of prey species differed between the two winters. In 1945–46 the mouse population was relatively high, but in 1947–48 it was low according to Harold A. Mathiak, a biologist on the area during both winters. On the other hand, fish probably were more available during the 1947–48 winter due to a serious die-off from a lack of oxygen. This suggests that buffer species were present on the marsh during both winters.

The problem of muskrat availability to mink is an important consideration. During the winter of 1945–46, when there was heavy predation on muskrats by mink, the muskrat population was considerably denser than during 1947–48, when there was relatively little predation. In 1945–46 there was an estimated total of about 22,000 houses compared with 15,000 during the winter of 1947–48. Allowing two

rats per house, the former year showed about 14,000 more muskrats living on the marsh. During this winter, furthermore, only 1,016 muskrats were trapped, compared with 9,535 in 1947–48.

The muskrat remains found in mink stomachs may in part represent trapped animals. However, since trapped muskrats are always available to mink, and some muskrats caught in traps are damaged by mink every year, the rather striking difference in the amount of muskrat predation noted between the two winters was not believed to be caused entirely by the presence of trapped muskrats. Also, fewer animals were actually trapped during 1945–46, the winter of greater muskrat predation.

Muskrats were, on the other hand, more available to mink during 1945–46 because runners were apparently more common. Runners are transient animals who leave the safety of their aquatic habitat and wander overland sometimes several miles. Basically, muskrats run at Horicon when the frost or ice is so deep that all food supplies become unavailable. Running is more common and takes place earlier during times of high population, because the larger number of muskrats exhaust their food supplies more quickly. When conditions force muskrats to run, the runners and many other muskrats still associated with their homes become more vulnerable to mink. Often houses inhabited by muskrats have holes opening to the outside through which mink have easy access to the occupants of the house. Mink will also find openings through the ice and swim under water to nearby houses or food piles. Mink will kill for "sport" many more muskrats than they can eat under these conditions.

Summary and Conclusions

It seems, therefore, from the above considerations, that muskrat predation by mink was related to muskrat density. More predation occurred during the winter of 1945–46 when the muskrat population was high and runner muskrats were more available due to population pressure, than during the winter of 1947–48 when the muskrat population was lower. The findings of this study, although based upon a small number of samples, support those of Errington (1943).

This information suggests that mink constitute a potential threat to muskrats during years of high muskrat population, but that during years of low muskrat abundance, mink predation is apparently not a serious limiting factor. However, recent observations by Harold Mathiak (letter, February 21, 1952) indicate that although many more muskrats may be taken during muskrat highs, the per cent of the total popula-

tion taken is probably low. If runner muskrats are taken in numbers by mink in the winter, there is little real loss, since these runners are considered "doomed" anyway. If mink are working on an undertrapped population, the end result may be beneficial, in that it may prevent the build-up of a too-dense muskrat population.

On the other hand, when muskrat populations are low, mink could conceivably be very harmful, since even a few muskrats taken prior to the breeding season might involve a relatively larger per cent of the population.

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