November 1979

SEASONAL, HABITAT AND SEX-SPECIFIC PATTERNS OF FOOD UTILIZATION BY RED-WINGED BLACKBIRDS (Agelaius phoeniceous) IN EASTERN ONTARIO AND THEIR ECONOMIC IMPORTANCE

Donald K. McNichol
Queen's University, Kingston, Ontario

Raleigh J. Robertson
Queen's University, Kingston, Ontario

Patrick J. Weatherhead
MacDonald Campus of McGill University, Ste. Anne de Bellevue, Quebec

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Donald K. McNicol and Raleigh J. Robertson
Biology Department, Queen's University
Kingston, Ontario

Patrick J. Weatherhead
Department of Renewable Resources
MacDonald Campus of McGill University
Ste. Anne de Bellevue, Quebec

Crop depredation by red-winged blackbirds *(Agelaius phoeniceus)* causes serious economic losses to agricultural crops each year in both Canada and the United States. The concentration of vulnerable, monocultural crops, particularly corn, during periods when large flocks of blackbirds congregate in roosting areas prior to migration has invariably led to heavy feeding pressure (Stone et al., 1972; Wiens and Dyer, 1975; Tyler et al., 1978). Efforts to reduce damage levels by mechanical and chemical dispersal agents have been largely unsuccessful, at least in terms of a long-term solution to the problem.

Recently, the lethal control of blackbird populations using surfactants has been proposed. However, the potential repercussions of the removal of substantial numbers of birds from northern breeding areas are virtually unknown (Robertson et al., 1978). Much of the research dealing with the feeding ecology of red-winged blackbirds has been limited to fall and winter periods when large aggregations of birds are actively involved in crop depredation (Goddad, 1969; Williams, 1976; Dolbeer et al., 1978) or pose a potential health hazard (Monroe and Cronholm, 1976).

However, what is not known is the degree to which the removal of deleterious weed seed and insect pests cited in several studies (Bird and Smith, 1964; Mott et al., 1972; Robertson et al., 1978) might be of potential value to agriculture. The issue of whether the benefits derived from redwing foraging compensate for the negative aspects associated with crop depredation and health hazards remains largely unresolved.

The present study attempted to evaluate the pest status of this species using diet information derived from food habits analysis conducted during the residency of red-winged blackbirds in a northern breeding area. By determining how the feeding ecology of red-winged blackbirds varies on a seasonal basis, among different breeding habitats and between sexes, we hoped to determine more realistically which segments of the population might be responsible for the greatest benefits or detriments and, thereby, more accurately evaluate the economic impact of the species as a whole. To achieve this aim, the study provides an accurate description of the common insects and weed pests utilized by redwings. By determining the relative proportions of those items known to be detrimental, we hoped to illustrate, at least qualitatively, the degree to which redwing foraging is comprised of both beneficial and harmful components.

METHODS

Study Area

The study was conducted in Frontenac and Leeds counties in eastern Ontario during

March to October, 1977 (Fig. 1). Both counties are subject to high levels of bird damage to corn during the fall (Tyler, et al., 1978).

From early March to mid-July, two distinct sampling areas, classified as Agricultural and Non-Agricultural, according to the level of land use related to farming practices, were monitored. This classification was designed to study the food habits of redwings nesting in different eco-systems, and provide information on the importance of resources associated only with agricultural areas to nesting red-winged blackbirds. In addition, the types and economic (harmful versus beneficial) importance of insects consumed in the two areas can be evaluated.

Non-Agricultural specimens were collected in the vicinity of the Queen's University Biological Station at Crosby, Ontario (Fig. 1), an area dominated by mixed deciduous woodland, low-lying marshes and lakes which provided excellent Non-Agricultural (traditional) marsh nesting habitat subject to minimal disruption due to agriculture.

Alternatively, farming areas in the vicinity of Kingston and Wolfe Island, Ontario, were considered Agricultural, having undergone extensive agricultural expansion, including a marked increase in corn production in recent years (Erskine, 1977). To examine the full range of breeding habitats, birds were collected from both agricultural marsh and upland habitats. Low-lying wetland areas around the periphery of cultivated fields dominated by marsh vegetation, including predominantly cattail *(Typha Lattifolia),* commonly supported marsh nesting redwings. Birds breeding in upland areas, including hayfields, oldfields and pastures, were also sampled. Upland sites were characterized by a mixture of agricultural legumes including timothy *(Phleum pratense),* red clover *(Trifolium pratense),* and alfalfa *(Medicago sativa),* as well as several weed species, such as dock *(Rumex crispus),* and bittersweet *(Erigeron canadensis).*

During the fall, flocks of red-winged blackbirds were monitored only in the Kingston-Wolfe Island region, since flocks did not occur in non-agricultural areas. An attempt was made to randomize sampling locations and times, such that an unbiased representation of the entire range of possible food habits might be achieved.

Dietary Analysis

Specimens were collected using a 12-gauge shotgun with number 8 shot. Crops and gizzards were removed and preserved in alcohol. Material contained in the esophagael-proventricular region was preserved separately. Using a dissecting microscope, a visual estimate of the percent by volume of each identifiable component was made. To reduce biases associated with differential retention rates of certain food types, volumetric percentages derived from a separate analysis of both esophagael and gizzard contents were averaged together. Identification of common insect types was completed by experts at Agriculture Canada, Ottawa, Ontario.

RESULTS

Dietary Information

The generalized diet of red-winged blackbirds during their residency in a northern breeding area, includes a combination of both animal and vegetable matter (Fig. 2). Cereals (corn and oats) comprise approximately the same overall volumetric percentage (37.4) as does insect matter (39.6). In addition, weed seeds constituted a relatively important dietary component.

To evaluate food utilization patterns, seasonal, habitat and sex-specific dietary information are presented in Figures 3 to 7. Seasonal changes in food habits are similar among all groups sampled, regardless of habitat or sex. Figures 3 and 4 depict food habits of redwings in agricultural and non-agricultural areas during the pre-breeding (March 8 to April 28) and breeding periods (April 29 to July 10). All birds demonstrated a

shift from vegetable matter, a combination of cereals and weed seeds, to insects during the breeding season. Following the nesting season, food habits shift back to vegetable matter as the birds form autumn roosting and flocking aggregations (Fig. 7).

Habitat differences in food utilization patterns were observed. During March and April, male redwings form gregarious flocks during midday. At this time, the availability and abundance of detrital grains, particularly waste corn, in cultivated fields constituted a major source of food for birds returning to natal breeding areas in agricultural regions (Fig. 3). During a comparable period, non-agricultural males preferred weed seeds, with waste grain representing a minor dietary component.

During the breeding season, agricultural males continue to exploit waste grain, while non-agricultural males switch to an insectivorous diet, consuming twice the volume of insect material than was identified in the gut contents of comparable agricultural birds (Fig. 3). Habitat differences in food also were apparent among female redwings during the breeding season (Fig. 4). Food habit analyses were not conducted during the pre-breeding period, since females did not return to the study area until mid to late April, prior to nest initiation. Waste grain also represented an important dietary item for agricultural females during the breeding season, accounting for 51 % of the diet during early stages of reproduction, the mating and incubation period (April 29 to May 24) (Fig. 4). Cereal matter was not found in non-agricultural gut contents. Following hatch (May 24 to July 10), females in both habitats consumed primarily insects. Females alone are responsible for feeding the young, predominately with insects (Orians, 1961); and as a result, they undoubtedly remove greater numbers of insects from the environment than indicated by the estimate of individual consumption depicted in Figure 4.

A comparison of intersexual feeding differences during the breeding season is outlined in Figures 5 and 6. Both sexes adopt an insectivorous diet in non-agricultural marshes, resulting in a high degree of similarity in foraging habits. Within agricultural areas, males rely to a greater extent on detrital grains that females (42% versus 21 %). While both sexes consume substantial quantities of waste grains during the mating and incubation period (males 72% versus females 51%), males continue to supplement their diet with primarily waste corn following hatch, while females switch to a predominantly insectivorous diet. Female redwings, regardless of habitat type, exploit more non-insect material than males during the breeding season (Figs. 5 and 6).

During mid-July, redwings vacate breeding areas and join roosting and flocking aggregations which are maintained until migration in early November. As documented in earlier studies (Orians, 1961; Dyer, 1967; Crase and DeHaven, 1978), segregation into sex-specific flocks was observed throughout the fall flocking period. A highly omnivorous diet, including both insects and vegetable matter, a mixture of waste grain, maturing oats and seeds, was exploited by both sexes (including adults and hatchyear birds) during the early post-breeding period (July 11 to August 11). Maturing oat crops suffered a heavy feeding pressure in the study area, although alternate insect prey comprised a larger overall proportion of the diet (Fig. 7).

Important intersexual differences were observed during the period from August 12 to October 28, during which time the corn crop in the Kingston area suffered heavy feeding pressure from red-winged blackbirds. From August 12 to September 2, field corn was undergoing rapid development and was most susceptible to feeding pressure (Tyler et al., 1978). At this time, males exhibited a greater dependency on maturing corn (71%) than females (46%), which also exploited weed seeds (41%). These basic intersexual differences were maintained throughout the remainder of the fall flocking period with males utilizing large quantities of dented corn, whiles females relied to a greater extent on weed seeds (Fig. 7).

Economic Implications of Dietary Analysis

Both positive and negative aspects of red-winged blackbird feeding habits were

observed in the present study. A summary of the major food types utilized, with specific reference to their potential value, is presented in Table 1. During peak periods of crop depredation in eastern Ontario, high proportions of corn and to a lesser extent oats were major components in the diet of redwings. The results indicate that males consumed approximately twice as much corn as females. However, to assess potential crop damage, it is necessary to determine the source of the grains. Waste grain (corn and oats), gleaned from cultivated fields in agricultural areas during the spring arrival and breeding periods, comprised greater than one-half of the entire cereal component of all males sampled (waste grain 22.8% versus standing grain 21.9%). Standing corn biomass, considered to be that material present in gut contents following the maturation of the current crop, constituted nearly 20% of the male diet, but only 13% of the female diet (Table 1). Total estimates indicate that although the overall use of cereals is high (37.0%), the ratio of detrital versus standing material is nearly equivalent (16.6% versus 20.4%).

Potential benefits resulting from redwing foraging are also outlined in Table 1. Noxious weed seeds and insects comprise a major portion of the overall diet. Females consume a larger volume of weed seeds than males (Table 1), a greater proportion of which was identified as noxious agricultural pests (Table 2). Members of the grass family, including foxtail *(Setaria spp.)* and barnyard grass *(Ecninochloa crusgali)* were major weed species present in female diets during the fall flocking period. Several weeds common in a variety of habitats in agricultural areas throughout Ontario were also identified (Table 2). Male redwings preferred a mixture of noxious weeds (33.8%) and larger neutral seeds (40.8%), such as bulrush*(Scirpus americanus)* and waterlily*(Nymphaea spp.),* which are commonly associated with marsh habitats and are not considered detrimental to agriculture.

Much of the animal matter, primarily Insecta, but including some Chilopoda (centipedes), Araneida (spiders) and Gastropoda (snails), identified in gut contents during the breeding period was comprised of economically important species. Of the nearly 40% by volume of insect material in the combined diet of males and females, noxious insects constituted 16% compared to only 2% for potentially beneficial insects (Table 1). A substantial proportion of insect matter analysed was unclassified due either to the advanced state of digestion of the material, or the fact that immature insects (larvae and pupae) were difficult to identify precisely. However, based on identifiable insects, it should be emphasized that the major fraction of unclassified material is suspected to consist primarily of injurious insects. As such, the volumetric percentages of noxious insects outlined in Table 1 probably represent very conservative estimates and are undoubtedly much higher in comparison to the potentially beneficial component.

Although females consume more insect matter than males, both sexes utilized higher overall percentages of noxious versus beneficial insects (Fig. 8). In addition, it would appear that the removal of injurious insects is not confined to agricultural areas, but also extends throughout all potential breeding habitats monitored including both agricultural and non-agricultural areas, as well as marsh and upland nesting habitats.

Foremost among important insect pests consumed were several types commonly associated with agricultural forage crops. Numerous Coleoptera, including a variety of Curculionidae (weevils), were common (Table 3). Immature Lepidoptera, including Hesperlidae (skippers), Geometridae (measuring worms), army worm *(Pseudaletia unipuncta; Noctuidae)* and European corn borer (Pyralidae) attack grasses, small grains and corn. Other common agricultural pests were from three families of Homoptera, Cicadellidae (leafhoppers), Cercopidae (froghoppers) and Aphidae (aphids).

Injurious forest insects were also identified. A serious defoliator in deciduous woodlands in eastern Ontario, namely the forest tent caterpillar *(Malacosoma disstria),* constituted the most important dietary item of redwings (both sexes) breeding in non-agricultural marshes.

DISCUSSION

This study indicates that red-winged blackbirds are highly opportunistic feeders while in their northern breeding range. Temporal (seasonal) and spatial (habitat/ecosystem) patterns of resource availability and abundance were found to underlie major variations in dietary preferences.

Seasonal shifts in diet composition were comparable to those recorded by several authors (Beal, 1900; Hintz and Dyer, 1970; Mott et al., 1972; Potvin et al., 1976; Crase and DeHaven, 1978). Animal matter, particularly preferred nestling foods such as Lepidopteran larvae and pupae, was exploited during the breeding season, at which time the abundance of insects in marsh and upland nesting habitats was at its peak (Brenner, 1967). Prior to nest initiation (March and April) and during the fall flocking period (August 12 to October 28), flocks of red-winged blackbirds utilized vegetable matter. Lowered abundance of insects and maturation of alternate food sources, including primarily oats and corn during late summer, as well as the availability of an abundant supply of weed seeds, forms the basis of this dietary shift.

Habitat variations in food utilization patterns were largely a function of differences in the availability and abundance of resources in the vicinity of breeding habitats. Much of the cereal matter identified in the gut contents of male redwings was waste grain and not material derived from standing crops. The damage inflicted by redwings on the current corn crop resulted from an overall level of usage of only 17% of the total diet of redwings sampled. As such, standing corn represents only one of several important items in the diets of redwings while in a northern breeding area. Therefore, it is imperative that the negative aspects of redwing foraging associated primarily with crop depredation be put in perspective with the potential economic value of the other major food types utilized during the study.

The reliance on detrital grains by birds breeding in agricultural areas might provide several benefits. Wiens and Dyer (1975) suggested that an increased availability of alternate sources of food, including waste grains, might reduce preference for standing corn/oats. Benefits of waste grain removal also include the elimination of "volunteer" corn (kernels of corn spilled during harvest often germinate the following spring). Robertson et al. (1978) speculated that blackbirds compete with rodent populations for waste grain, and would therefore provide a service to farmers in controlling rodent outbreaks. There is also a strong indication that the exposure of detrital material in cultivated fields leads to the consumption of a variety of noxious insects that commonly infest developing grains (Table 3).

Regardless of habitat type, a substantial proportion of identifiable insects utilized were potentially noxious compared to the small percentage of beneficial insects used. Certainly the types of insects and the nature of their injury varied between habitats. In addition to insect pests exploited within cultivated fields, agricultural redwings consumed several insects that cause serious damage to legumes and grasses. In non-agricultural areas, both sexes relied heavily on forest tent caterpillar pupae. Since this insect is a serious defoliator of several common forest species and few predators of this pest are known, the benefits that might be derived from such feeding preferences could be great.

Intersexual differences in food habits observed in this study have important economic implications. Following hatch, female redwings are subject to considerable time and energy stresses while attempting to provide food for their young to ensure proper growth and development (Orians, 1961). As such, females spend most of their time foraging. Wilson (1978) calculated that a parent bird would have to deliver approximately 2940 "average-sized" items per nestling the first nine days of life. Thus in economic terms, females would remove greater numbers of deleterious insects from the environment than males which forage exclusively for themselves.

During the fall flocking period, differences in food utilization patterns have been correlated to differential habitat utilization, arising from sexual segregation of flocks (Orians, 1961; Dyer, 1967), and dimorphic differences in the size and structure of the feeding apparatus (Crase and DeHaven, 1978). Although redwings inflict considerable damage (8.3 bu./acre) to corn crops in Frontenac and Leeds counties each year (Tyler et al., 1978), the results suggest that male red-winged blackbirds are responsible for greater levels of depredation than females, particularly during the vulnerable milk stage of corn development (August 12 to September 2). In addition, males consume quantitatively greater amounts of food (primarily corn) than females during this period (unpublished data).

Differences in the potential pest status of male versus female redwings are further magnified by the fact that females exploited higher volume of deleterious weed species than males. Many of the common weed species used, including foxtail, barnyard grass, and smartweed, are major weed problems in agricultural areas in Ontario. Males prefer larger, neutral seeds such as bulrush and waterlily, commonly found in wetland habitats where they present no serious problem to agriculture.

As a result, male redwings are undoubtedly responsible for the greatest potential harm in terms of crop depredation during the fall. Females perhaps offset their contribution to crop damage by removing proportionately greater volumes of noxious insects and weed seeds than males during the breeding and fall flocking periods, respectively. This information is important to the implementation of programs designed to reduce blackbird depredation.

The present study indicates that in order to gain a complete understanding of the pest status of this species, upon which control programs can be based, an accurate examination of the complete range of food habits taken during the redwing's residency in a northern breeding area is essential. Food utilization patterns monitored over an extended period of time indicate that the economic importance of this species is comprised of both negative and positive components. The study also establishes that a cost/benefit approach to red-winged blackbird feeding habits must consider important habitat and sex-specific relationships in which the pest status of specific segments of the population has been assessed realistically. This study was not designed to quantity these relationships, but rather to show that they exist and should be considered. Having done this, it is now essential that a more accurate estimate of the costs and benefits of redwing foraging be derived. In particular, further studies must be conducted in order to determine, in economic terms, the importance of the removal of deleterious agricultural pests, both weeds and insects, to overall crop production and the degree to which beneficial food habits compensate for the negative aspects of redwing foraging. Only after such information has been collected can we really determine whether the wholesale extermination of millions of red-winged blackbirds would be a viable solution to the blackbird problem or whether the repercussions that might follow such drastic measures might in fact be potentially more dangerous and costly than the problem as it exists today.

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TABLE 1. Summary of the volumetric percentages of the major good categories utilized by male and female Red-winged Blackbirds *(Agelaius phoeniceus)* during the entire sampling period (March - October, 1977).

FOOD ITEM	STATUS	MALES (%) (N= 437)	FEMALES(%) (N= 287)	TOTAL(%) (N= 724)
SEEDS	Noxious Weeds	5.5	18.8	10.7
	Total	15.3	23.3	18.5
Oats	Detrital	4.8	<1	3.2
	Standing	2.0	5.3	3.3
	Total	6.8	6.1	6.5
Corn	Detrital	18.0	6.3	13.4
	Standing	19.9	12.8	17.1
	Total	37.9	19.1	30.5
TOTAL VEGETABLE		60.7	48.3	55.9
INSECTS	Noxious	14.1	19.0	16.0
	Beneficial	1.9	2.9	2.3
	Unclassified	19.4	24.2	21.3
	Total	35.4	46.1	39.6
NON-INSECTS	(snails, spiders)	1.1	3.3	1.9
TOTAL ANIMAL		36.5	49.4	41.5
UNIDENTIFIED MATERIAL		2.8	2.2	2.6

TABLE 2.

A Comparison of the relative proportions of noxious versus neutral weed species utilized by male and female Red-winged Blackbirds *(Agelaius phoeniceus)* during the study. Habitat distributions of common weed species in Ontario has also been presented.

SEED TYPE	SEX		DISTRIBUTION (X)					
	Males (n = 437) (%)	Females (n = 287) (%)	Cultivated Land Corn	Cultivated Land Small Grains	Hayfields Pastures	Roadsides	Gardens	Lawns
TOTAL NOXIOUS	33.8	80.7						
Foxtail *Setaria* spp.	19.1	57.1	X	X		X	X	
Barnyard Gr. *Echinochloa crusgalli*	3.8	19.3	X	X		X	X	
Smartweed *Polygonum* spp.	6.4	3.0	X	X	X	X	X	
Gromwell *Lithospermum* spp.	4.5	—	X			X		
Chicory *Chicorum intybus*	—	1.3				X	X	
Miscellaneous Weed Species								
Quackgrass *Agropyron repens*			X	X	X	X	X	X
Chickweed *Stellaria media*			X		X		X	X
Dandelion *Taraxacum officinale*			X	X		X	X	X
Witchgrass *Panicum capillare*			X	X	X	X	X	
Pigweed *Amaranthus retroflexus*			X	X	X	X	X	
Lamb's-quarters *Chenopodium album*			X	X	X	X	X	
TOTAL NEUTRAL	40.8	8.6						
Bulrush *Scirpus americanus*	34.4	6.6	commonly found in low, wetland habitats					
Waterlily *Nymphaea* spp.	6.4							
Sedges *Carex* spp.	tr	tr						
TOTAL UNKNOWN	25.4	10.7						

TABLE 3. A summary of the major injurious insects identified in the gut contents of Red-winged Blackbirds *(Agelaius phoeniceus)* during the study, illustrating their overall importance in the diet and their major sources of injury.

INJURIOUS INSECTS	Importance high 20% medium 5-20% low 5%	Source of Injury
A. COLEOPTERA		
1. Curculionidae Weevils	medium	Legumes, corn
2. Elateridae Wireworms	low	corn, grains, grasses
3. Scarabidae June Beetles	low	grasses, cultivators
4. Chrysomelidae Leaf Beetles	low	defoliators of forest,
5. Cerambycidae Longhorned Beetles	low	shade and fruit trees
B. LEPIDOPTERA		
1. Lasiocampidae Forest tent caterpillar	high	serious defoliation of several deciduous
2. Geometridae Measuring worms	low	trees
3. Noctuidae Armyworm	low	attacks grasses, small grains, corn
4. Hesperiidae Skippers	high	legumes
5. Pyralidae European corn borer	low	corn kernels
C. HOMOPTERA		
1. Cicadellidae Leafhoppers	medium	vector of several plant diseases
Cercopidae Froghoppers (spittlebug)	medium	grasses, stunts clover
3. Aphidae Aphids	low	cultivated plants, plant disease vector
Miscellaneous Pests		
1. O. DIPTERA - mosquitoes, horseflies		
2. O. HEMIPTERA - chinch bugs		corn leaves
3. O. ORTHOPTERA - grasshoppers		herbivorous

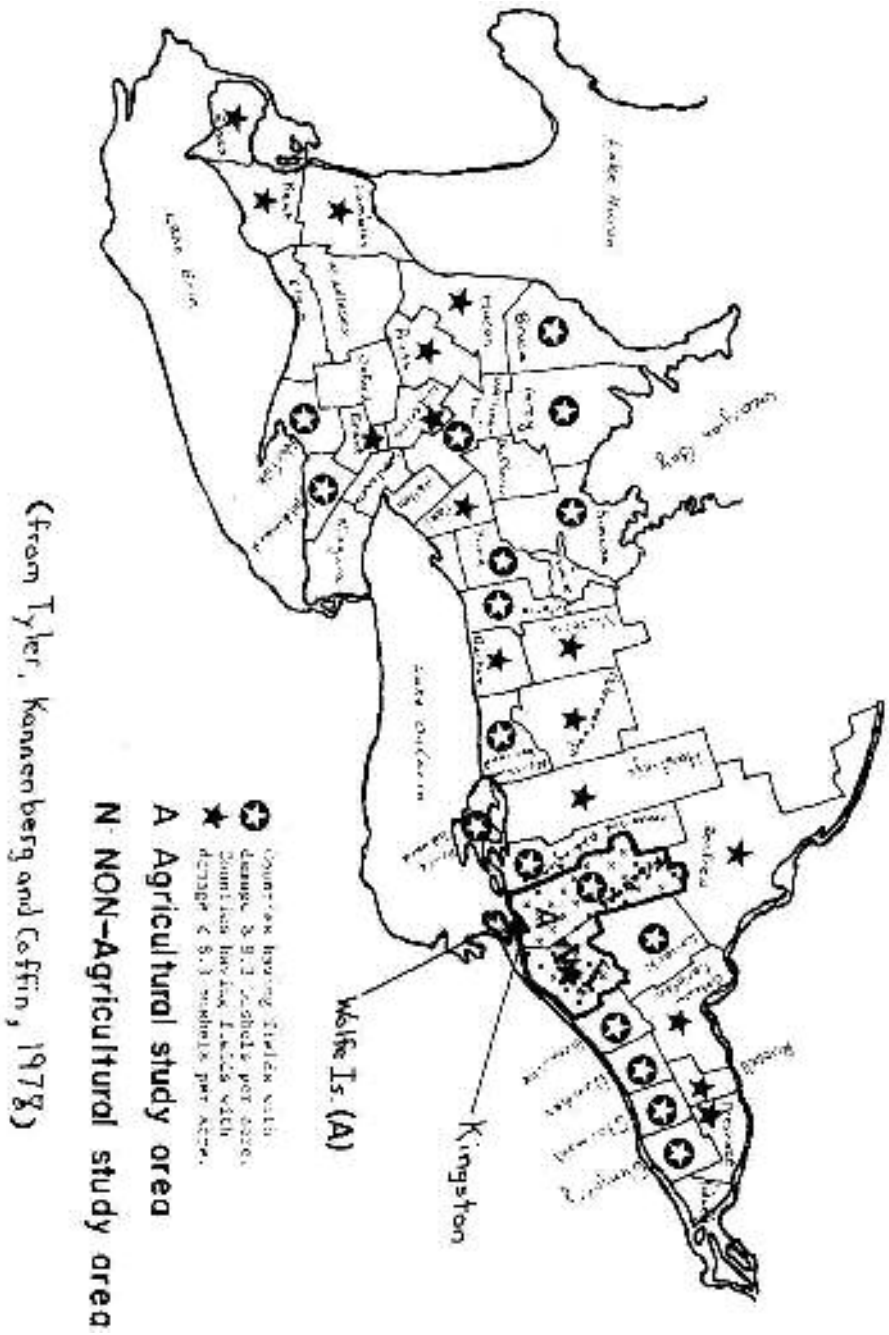

FIGURE 1. Map outlining the general study area and illustrating sampling areas categorized as agricultural (Kingston-Wolfe Island) and non-agricultural (Lake Opinicon). In addition, recent estimates of bird damage to corn in corn-producing counties in Ontario are also depicted (from Tyler et al., 1978).

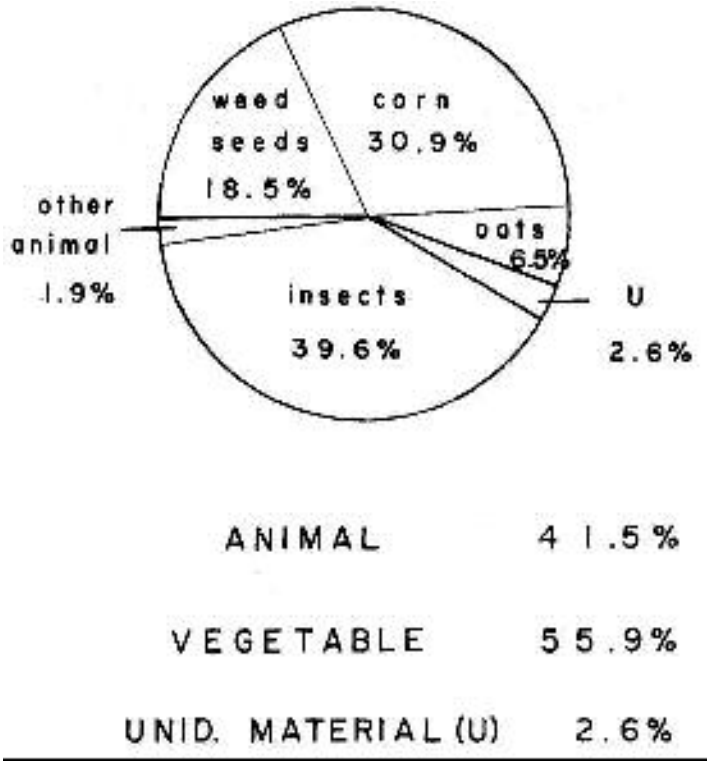

FIGURE 2. **Generalized diet of all red-winged blackbirds collected during the entire sampling period (March to October, 1977).**

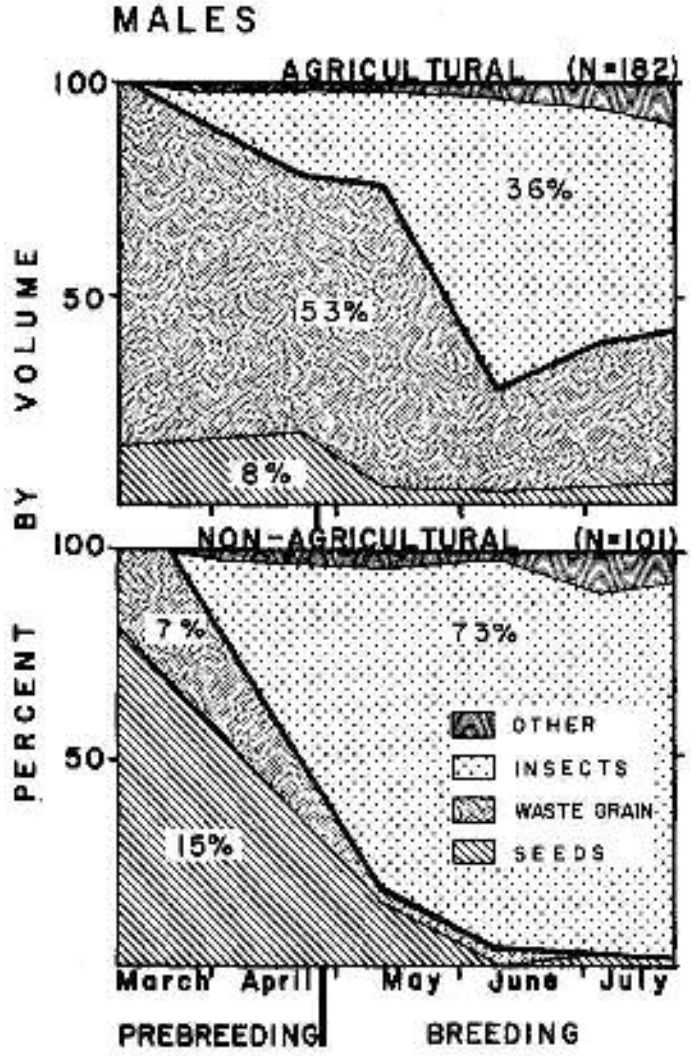

FIGURE 3. **Comparison of habitat differences in the cumulative percent by volume estimates of major food types identified in the gut contents of male red-winged blackbirds collected in agricultural versus non-agricultural habitats during prebreeding and breeding periods (March 8 to July 10).**

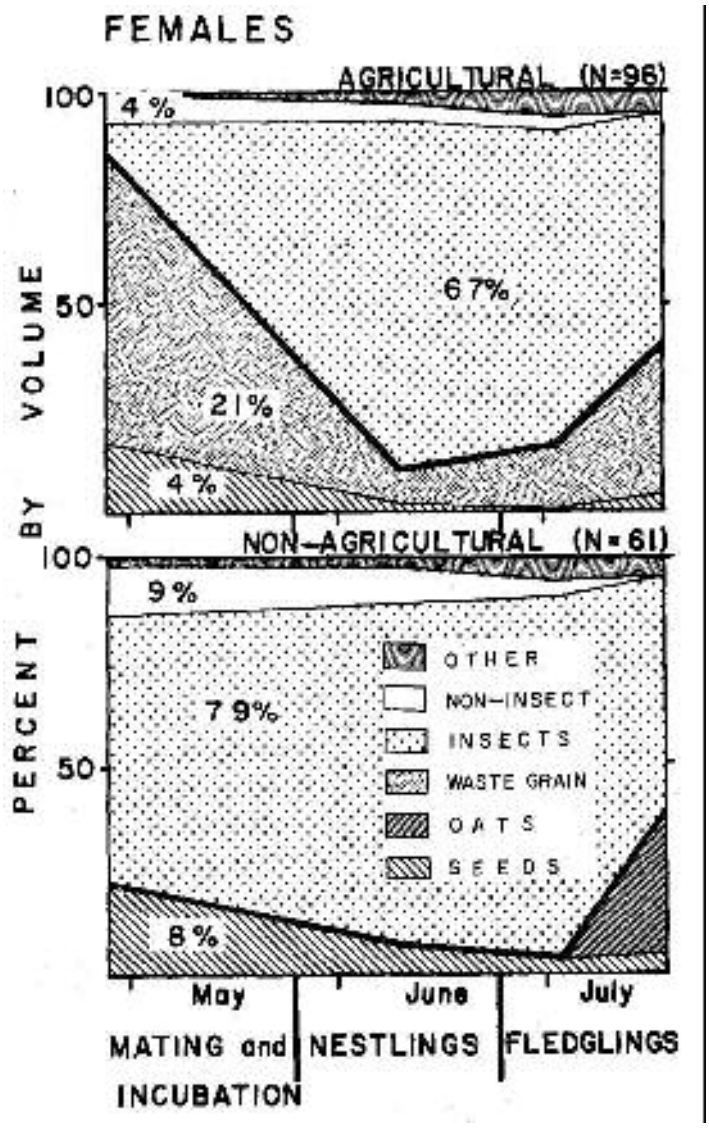

FIGURE 4. Comparison of habitat differences In the cumulative percent by volume estimates of major food types identified in the gut contents of female red-winged blackbirds collected in agricultural versus non-agricultural habitats during breeding periods (April 28 to July 10).

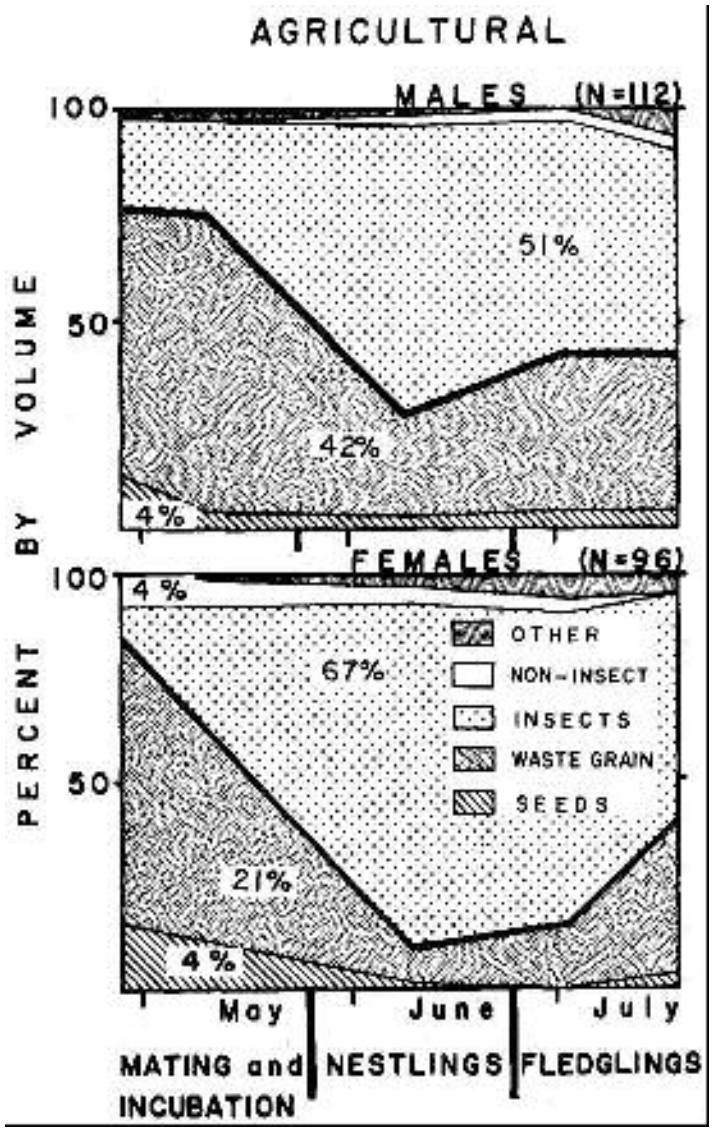

FIGURE 6. **Comparison of intersexual differences in the cumulative percent by volume estimates of major food types identified in the gut contents of male and female red-winged blackbirds collected in non-agricultural areas during the breeding periods (April 28 to July 10).**

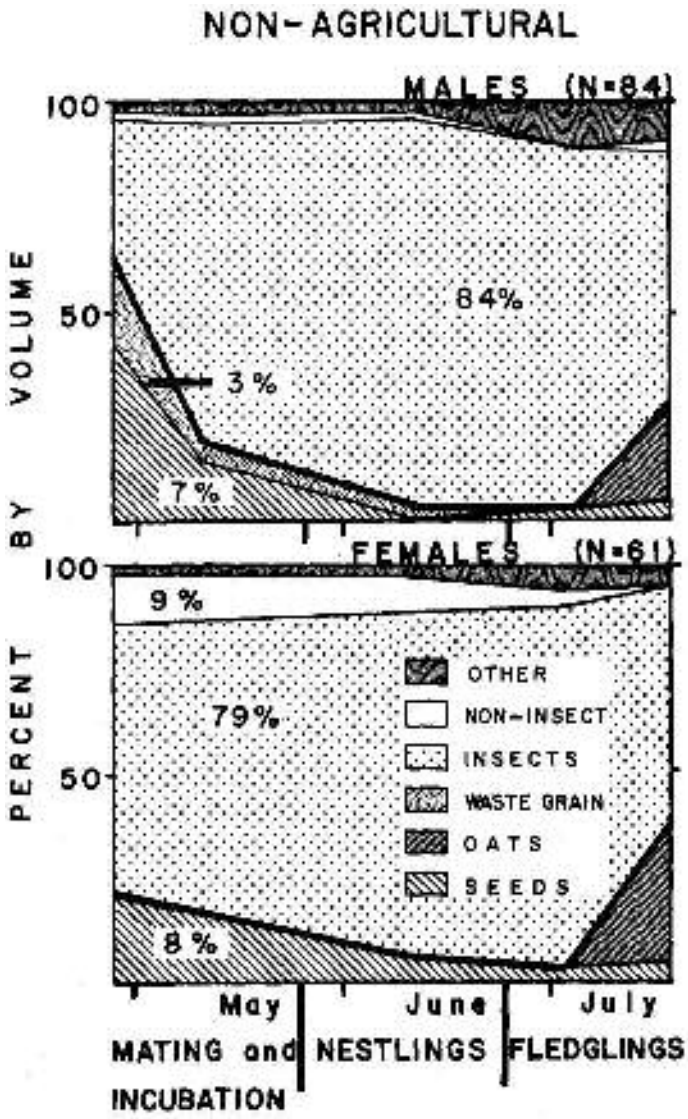

FIGURE 6. **Comparison of intersexual differences in the cumulative percent by volume estimates of major food types identified in the gut contents of male and female red-winged blackbirds collected in non-agricultural areas during the breeding periods (April 28 to July 10).**

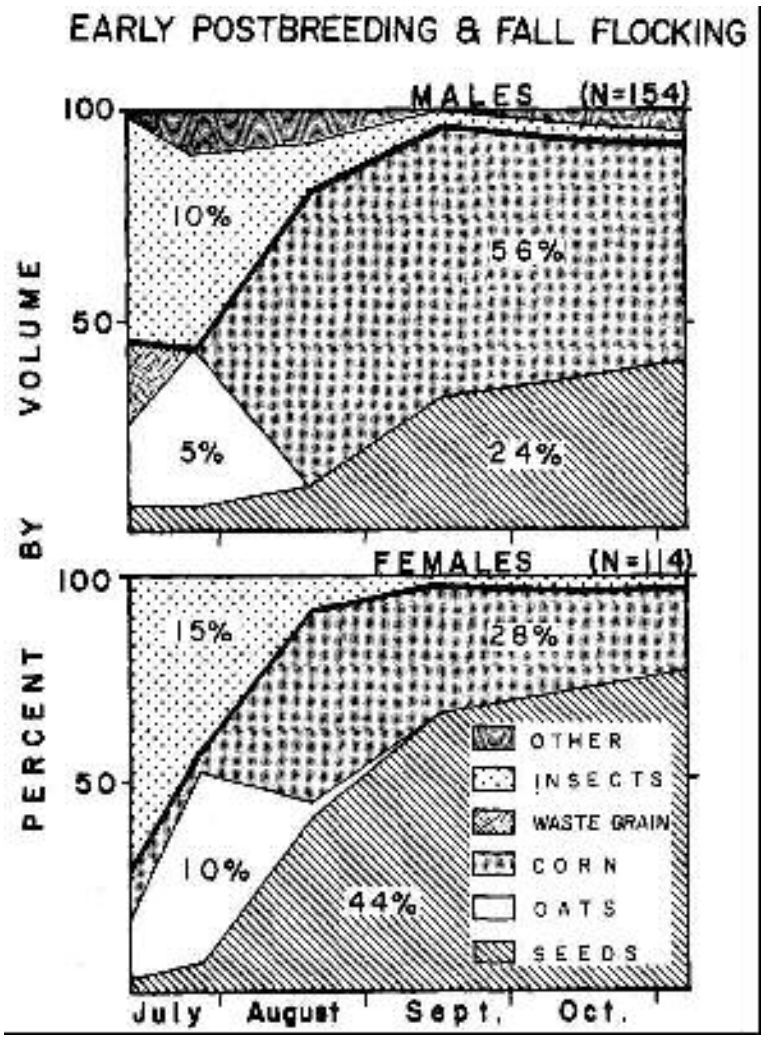

FIGURE 7. **Comparison of intersexuai differences In the cumulative percent by volume estimates of major food types identified in the gut contents of male and female red-winged blackbirds collected during the early post-breeding (July 11 to August 11) and fall flocking periods (August 12 to October 28).**

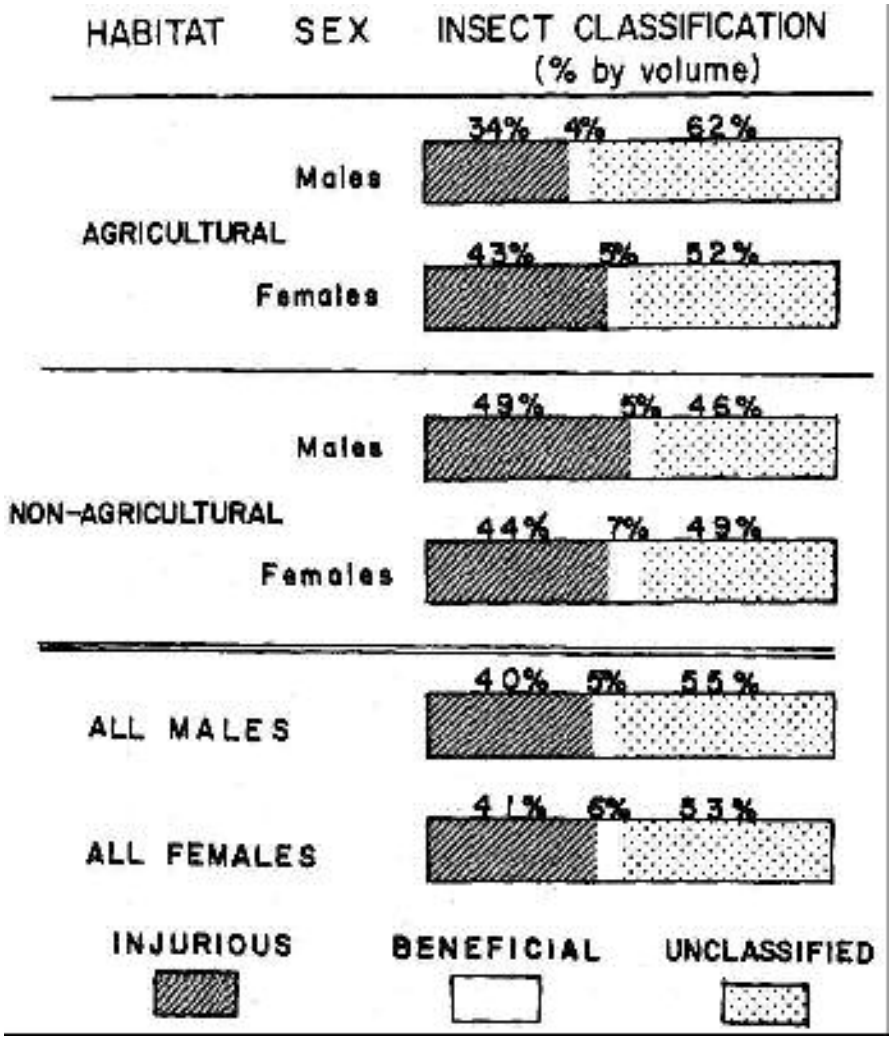

FIGURE 8. Summary of habitat and sexual differences in the relative proportions of Injurious, beneficial and unclassified insect material present in the gut contents of red-winged blackbirds collected during the study (estimates based on the total insect component in the diet adjusted to 100%).