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DIETARY COMPARISONS OF RED-WINGED BLACKBIRDS, BROWN-HEADED COWBIRDS, AND EUROPEAN STARLINGS IN NORTH-CENTRAL OHIO[1]

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Abstract. Stomach contents from 99 red-winged blackbirds, 97 brown-headed cowbirds, and 69 European starlings collected along the southern edge of Lake Erie in north-central Ohio were compared using aggregate volume measurments. Agricultural products comprised 73.9%, 54.8%, and 28.1% of the redwing, cowbird, and starling diets, respectively. Corn accounted for 70.8%, 26.2%, and 3.3% of the diets, respectively. Animal material represented 7.6%, 3.4%, and 30.3% of the diets, respectively. Injurious insects comprised 13.5% of the starling diet but were relatively unimportant in the diets of redwings and cowbirds. Beneficial arthropods were relatively unimportant in all the diets.

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The economic importance of vertebrate agricultural pests has become a critical concern worldwide. The annual losses to corn production in Ohio resulting from avian depredation represents a well-known example of agricultural vertebrate pest pressure within the United States (Anon. 1974). Our study focused on the agricultural depredation in north-central Ohio and was designed to evaluate and compare the food habits of the 3 prominant summer-fall flocking species, the red-winged blackbird (*Agelaius phoeniceus*), the brown-headed

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cowbird (*Molothrus ater*), and the European starling (*Sturnus vulgaris*), in relation to agricultural production.

STUDY AREA

This study was conducted during the 1974 summer-fall flocking season along the southern edge of Lake Erie where extensive agricultural depredations have been reported (Anon. 1974). We made collections at the Winous Point Shooting Club, about 5 miles southwest of Port Clinton in Ottawa County, and at the Northcentral Branch, Ohio Agricultural Research and Development Center, about 15 miles southwest of Sandusky in Western Erie and eastern Sandusky Counties. Both areas, characterized by a combination of marsh lands, open fields, and cornfields, were located within an important concentration area for blackbird flocks. Meanley (1974) estimated a 1973 blackbird population of about two million birds distributed among ten roots along the Lake Erie marshes between Toledo and Huron, Ohio. The largest roost, an estimated one million birds (65% redwings, 15% cowbirds, 15% starlings, and 5% grackles), was located in the marshes of the Ottawa Gun Club, approximately 4 miles south of Winous Point and 20 miles west of the Research and Development Center.

METHODS AND MATERIALS

Collections

A low-velocity load of 12-gauge, #8 shot was used to collect specimens during a 10-week period from August to October of the 1974 summer-fall flocking season. We gathered specimens three times weekly, primarily along flyways between roosting and feeding areas. Although most collections took place between mid-afternoon and sunset as the birds were returing from feeding grounds, we also made some during early morning activities. Collecting times and locations were chosen arbitrarily to obtain representations of all foods being utilized. Records were kept on all specimens: sex and approximate age, determined from plumage charactistics and/or internal sex organs; date and location of collection; time of day; and general flocking conditions.

Laboratory Determinations

All specimens were returned to the laboratory where we took body weights. The esophagous, proventriculus, and gizzard were removed together, weighed, and placed immediately into preservative. Later dissection of the esophagous-proventriculus-gizzard complex (hereafter referred to as the stomach) revealed the contents, which were then visually separated into two categories: plant and animal. Grit content was removed and excluded from all measurements and analytical computations. Where possible, animal material (largely arthropod fragments) was categorized to family assemblages, and plant material (largely seeds and fruits) was identified to generic level. We used standard reference texts for identification (Metcalf and Metcalf 1928, United States Forest Service 1948, Borror and DeLong 1971, Borror and White 1970, Kurtz and Harris 1962, Musil 1963).

After separating food items into groups, we removed external moisture from the plant matter by blotting and measured volumes by liquid displacement to the nearest 0.01 cc in a 0.05 cc syringe. Due to difficulty in submerging manv insect fragments, the volume of the animal matter, relative to that of the plant matter, was estimated visually. Only total samples exceeding 0.05 cc were included in this analysis.

Data Analyses

We summarized the content data for each species by dividing food items into several categories. Animal matter was categorized as either "injurious" or "beneficial" according to the general feeding habits of family representatives (Herrick 1925, Little 1972). Since much of the material, notably unidentified orthopterans, coleopternas, dipterans, and hymenopterans, could have been either detrimental or beneficial, we could not always assess the economic status. All such groups plus unidentified animal matter were pooled in the "unclassified" category.

We divided plant matter into "non-agricultural," "agricultural," "corn," and "unidentified plant matter" categories. Weeds (both agricultural and marsh) were classified as "non-agricultural." All crop materials, including grains found in cattle feed, were classed as "agricultural." This classification was at most a crude estimate since the specific origin of the food items generally was unknown, but based on observation of all 3 species and on discussion with local farmers, corn was assumed to come from the standing crops; wheat, oats, and barley were, in part, from roadside patches and fallow fields, but mostly from livestock feeding bins; and grapes were from both wild and domestic sources.

We represented data for each species by using a combination of frequency-occurrence, percent-occurrence, and aggregate volume measures (Williams 1975). Percentage data for each age and sex classification within each species were compared using a Basic 1 paired t-test computer program (Sokal and Rohlf 1969). We have calculated and similarly compared equivalent volume measurements. Only comparisons of aggregate volume measures among the three bird species are reported here.

RESULTS AND DISCUSSION

Collection Procedures. Bartonek and Hickey (1969) and Swanson and Bartonek (1970), in their studies of waterfowl food habits, discussed the differences in species composition between food items contained in the esophagous and gizzard and showed that food identified from the two sites were not identical. Due to postmortem digestion, the proportion of harder food items in the gizzard increased as the time lapse between feeding and sampling increased. Soft foods (*e.g.*, arthropods), less resistant to digestive enzymes and grinding action of the gizzard, broke down within minutes, while harder items (*e.g.*, seeds) were retained for up to several days. Swanson and Bartonek (1970) therefore concluded that a more reliable food habits anal-

TABLE 1

Systematic list of food materials found in 265 stomachs from birds collected in north-central Ohio during the late summer and early fall of 1974.

Values represent aggregate volume measures (percent of total volume in species' samples.)

Scientific Classification	Common Name	Redwing (N=99)	Cowbird (N=97)	Starling (N=69)
PLANT MATTER		92.4	96.6	69.7
Family Gramineae	Grass Family	75.2	56.8	15.5
Bromus	chess	-	-	0.7
Triticum*	wheat	2.5	28.0	10.9
Secale	wild rye	0.1	0.9	0.1
Hordeum	barley	-	-	0.2
Avena*	oats	-	0.6	0.2
Eleusine	goosegrass	trace	trace	-
Digitaria	crabgrass	trace	0.2	-
Paspalum	paspalum	0.4	0.1	-
Panicum	witchgrass	0.3	0.1	-
Echinochloa	wild millet	0.7	0.5	-
Setaria	bristlegrass	0.2	0.1	trace
Zea*	corn	70.8	26.2	3.3
unidentified blades		0.2	0.1	0.1
Family Cyperaceae	Sedge Family	4.9	17.4	trace
Cyperus	flatsedge	2.0	10.6	-
Eleocharis	spikerush	0.4	-	-
Scirpus	bulrush	2.3	6.6	trace
Carex	sedge	0.2	0.2	-
Family Corylaceae	Hazel Family	-	-	26.0
Ostrya	hop-hornbeam	-	-	26.0
Family Polygonaceae	Buckwheat Family	1.4	6.3	0.1
Polygonum	smartweed/knotweed	1.4	6.3	0.1
Family Chenopodiaceae	Goosefoot Family	0.1	0.1	0.1
Chenopodium	goosefoot	0.1	0.1	0.1
Family Amaranthus	Amaranth Family	trace	trace	-
Amaranthus	pigweed	trace	trace	-
Family Cruciferae	Mustard Family	trace	trace	-
Barbarea	winter cress	trace	trace	-
Family Rosaceae	Rose Family	-	-	1.4
Prunus*	cherry	-	-	1.4
Family Leguminosae	Pea Family	trace	-	-
Lathyrus	peavine	trace	-	-
Family Euphorbiaceae	Spurge Family	0.6	0.1	6.4
Croton	doveweed	0.1	-	6.4
Acalypha	copperleaf	0.5	0.1	-
Family Vitaceae	Grape Family	0.6	-	12.3
Vitus*	grape	0.6	-	12.3
Family Labiatae	Mint Family	trace	trace	trace
Hedeoma	false pennyroyal	trace	trace	trace
Family Solanaceae	Nightshade Family	0.1	-	-
Datura	jimsonweed	0.1	-	-
Family Caprifoliaceae	Honeysuckle Family	-	-	0.2
Viburnum	arrow-wood	-	-	0.2
Unidentified plant matter		9.5	15.9	7.7

TABLE 1. *Continued.*

Scientific Classification	Common Name	Redwing (N=99)	Cowbird (N=97)	Starling (N=69)
ANIMAL MATTER		7.6	3.4	30.3
Phylum Arthropoda		7.5	3.2	24.6
Class Insecta		6.5	3.1	24.4
Order Odonata		0.7	1.0	0.8
Family Libelluilidae+	common skimmers	trace	-	trace
Family Coenagrioonidae+	narrow-winged damselflies	0.1	-	0.7
unidentified Odonata+		0.6	1.0	0.1
Order Orthoptera		2.0	0.2	10.8
Family Acrididae**	short-horned grasshoppers	1.2	-	5.9
Family Tettigoniidae	long-horned grasshopers	-	-	0.7
Family Blattidae**	cockroaches	trace	trace	2.3
unidentified Orthoptera		0.8	0.2	1.9
Order Isoptera		-	-	trace
unidentified Isoptera**	termites	-	-	trace
Order Hemiptera		trace	-	1.0
Family Nepidae+	water scorpions	trace	-	-
Family Pentatomidae	stinkbugs	-	-	0.2
unidentified Hemiptera		trace	-	0.8
Order Homoptera		0.3	trace	trace
Family Cicadellidae**	leafhoppers	-	trace	trace
Family Achillidae	achillids	0.3	trace	-
Family Aphididae**	aphids	trace	trace	trace
unidentified Homoptera		-	trace	-
Order Coleoptera		2.3	0.8	8.1
Family Carabidae+	ground beetles	trace	-	1.1
Family Elateridae**	click beetles	0.3	0.1	1.0
Family Chrysomelidae**	leaf beetles	0.4	0.4	0.6
Family Curculionidae**	snout beetles	1.0	0.2	3.0
unidentified Coleoptera		0.5	0.1	2.4
Order Lepidoptera		0.1	0.1	0.1
unidentified Lep. larvae**	moth or butterfly larvae	0.1	0.1	0.2
Order Diptera		0.9	0.8	2.0
Family Chironoomidae**	midges	0.6	trace	0.5
Family Asilidae	robber flies	trace	-	-
Family Empiidae	dance flies	trace	-	-
Family Dolichopodidae	long-legged flies	-	0.1	0.1
Family Syrphidae+	syrphid flies	-	-	0.1
Family Muscidae**	muscid flies	-	0.3	-
unidentified Diptera		0.3	0.4	1.3
Order Hymenoptera		0.3	0.2	1.5
Family Tenthredinidae	common sawflies	-	trace	0.2
Family Braconidae+	braconid wasps	-	-	0.2
Family Formicidae+	ants	0.2	0.1	0.9
Family Sphecidae+	sphecid wasps	-	-	trace
unidentified Hymenoptera		0.1	0.1	0.2
Class Arachnida		1.0	0.1	0.2
Order Phalangida+	harvestmen	-	-	0.1
Order Araneida+	spiders	1.0	0.1	0.1
Phylum Mollusca		trace	-	trace
Class Gastropoda	snails	trace	-	trace
Unidentified animal matter		0.1	0.2	5.7
Grit present		yes	yes	yes

*Agricultural products.
**Injurious insects.
+Beneficial insects.

ysis could be performed by using only the esophageal contents removed immediately upon collection.

The application of this procedure, however, proved to be impractical in our study because of the large numbers of birds collected, making field dissections and measurements extremely time-consuming, and because of the relatively few birds with esophageal contents. In addition, storage capacities of the birds in this study were relatively small; contents from all the structures—esophagous, proventriculus, and gizzard—had to be utilized to obtain a sufficient amount of material for analysis. Since a four-hour time lag from specimen collection to placement of the stomach into preservative did occur, however, and since the gizzard contents were utilized, we recognized overall content analyses in this study as possibly biased toward harder items.

Stomach Content Analysis. Plant matter comprised 92.4%, 96.6%, and 69.7% of the redwing, cowbird, and starling seasonal diets, respectively (table 1. For a detailed analsysis refer to Williams 1975). Agricultural matter (*e.g.*, corn, wheat, and grapes) was the predominant food item in both redwings and cowbirds, representing 73.9% and 54.8% of their diets, respectively. Corn (*Zea mays*) comprised 70.8% of the redwing's diet, a significantly greater dietary proportion than any other food item ($P<0.05$). Wheat (*Triticum aestivum*), bulrush (*Scirpus* spp.), flatsedge (*Cyperus* spp.), and smartweed (*Polygonum* spp.) (together comprising 8.2% of the diet),. and a mixture of 19 additional species, mostly grasses and sedges (comprising 3.9% of the diet), and unidentified plant material constituted the plant portion of the redwing diet.

The major food items of the cowbird's diet (table 1) were wheat and corn, comprising 28% and 26.2%, respectively. The remaining identifiable plant diet consisted of flatsedge, bulrush, and smartweed, together accounting for about 25% of the total diet, plus 13 additional food items, primarily sedges.

The most prominent item in the starling diet (table 1) was hop-hornbeam fruits (*Ostrya virginiana*), amounting to 26% of the diet. Grapes (*Vitus* spp.) and wheat accounted for 12.3% and 10.9% of the diet, respectively. Doveweed (*Croton* spp.), corn, and cherry (*Prunus* spp.), plus 11 additional species, many of them grasses, constituted the remaining part of the identifiable plant component of the starling diet. Agricultural products—grapes, wheat, corn, barley (*Hordeum* spp.), and cherries—amounted to 28.3% of the starling diet, slightly less than the 33.7% of the remaining non-agricultural plant material (*e.g.*, weeds).

Animal material was relatively unimportant in the redwing and cowbird diets; it amounted to nearly one-third of the starling diet. Injurious insects accounted for almost half of the starling's animal diet, a significantly greater proprotion ($P<0.05$) than the beneficial insects. Short-horned grasshoppers (Acrididae), snout beetles (Curculionidae), and unidentified coleopterans, each found in approximately 25% of the samples, totaled over one-third of the animal portion of the starling diet. Most of the remaining representatives were found in less than ten percent of the samples and represented less than one percent of its diet.

Diet Comparisons. While the overall summary of data from this season of the year from north-central Ohio (table 1) suggested a broad utilization of food types by red-winged blackbirds, European starlings, and brown-headed cowbirds, some foods were represented only in trace or very small amounts. Approximately 20 species of both plants and animals, representing about 10 families of plants and 8 orders of animals, constituted each species' diet. Redwings and, to a lesser extent, cowbirds, greatly preferred the grasses. Starlings, however, utilized equally the grasses and hop-hornbeam fruits. In addition, animal material, particularly orthopterans and coleopterans, was significantly more important in the starling diet than in either the redwing or the cowbird diets.

Figure 1 represents a pictoral summary

of these dietary findings showing the relative importance of the various food-type categories already discussed. For all the samples, over half the pooled contents consisted of agricultural products, reflecting the great proportion in both the redwing and cowbird diets. Corn was the most utilized food type, again reflecting the significant proportion in the redwing diet. Non-agricultural products and animal matter each constituted a relatively low proportion. This pooled diet, however, does not suggest total population preferences, since it does not consider the relative proportion of the individual bird species in the total local roosting and foraging population.

An extrapolation of these dietary findings weighed according to the proportion of the total local roosting population represented by the individual species (Meanley 1974) is shown in figure 2. These values represented only 95% of the com-

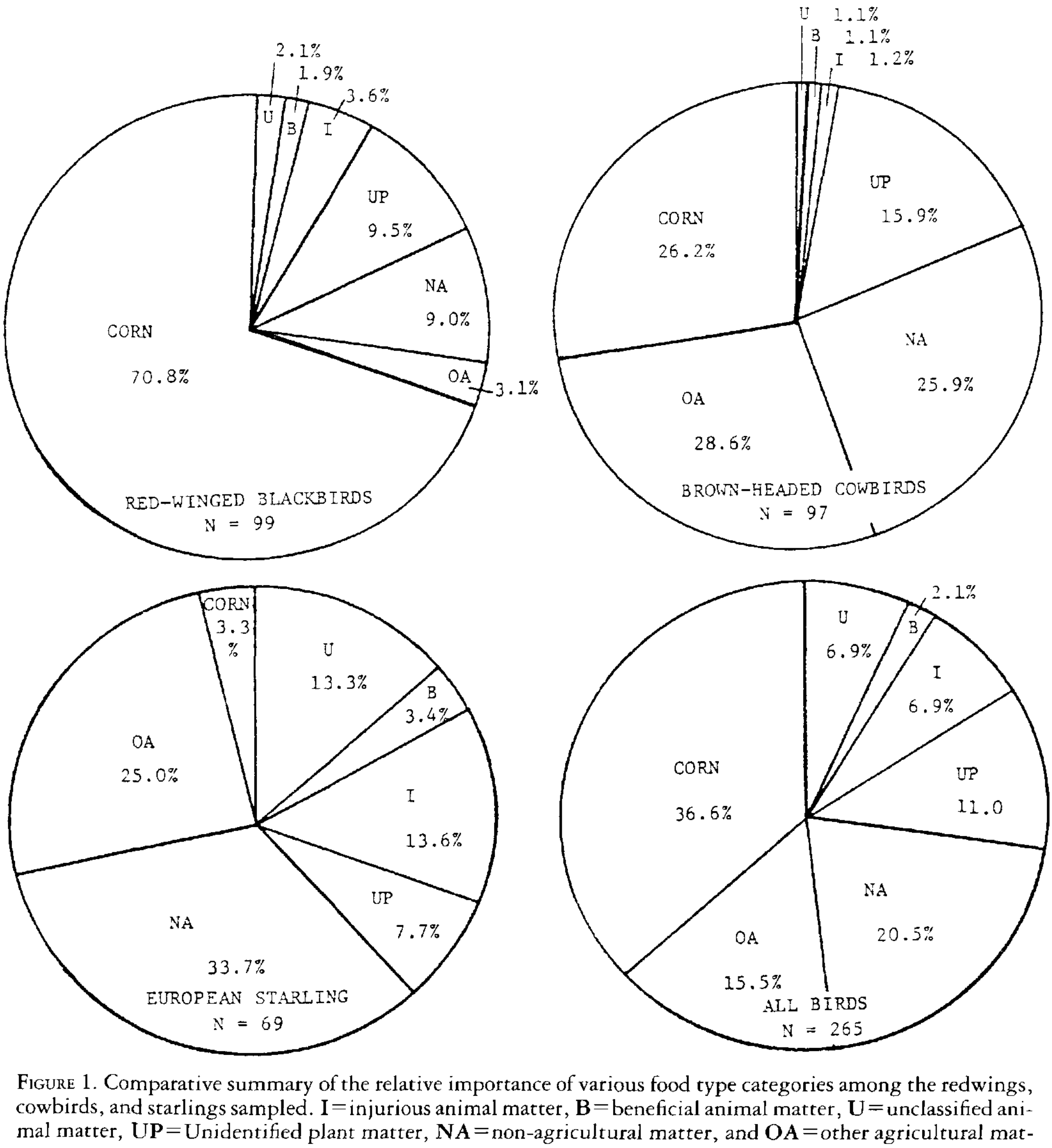

FIGURE 1. Comparative summary of the relative importance of various food type categories among the redwings, cowbirds, and starlings sampled. I=injurious animal matter, B=beneficial animal matter, U=unclassified animal matter, UP=Unidentified plant matter, NA=non-agricultural matter, and OA=other agricultural matter.

bined diet of the entire roosting population since 5% of the population was grackles whose stomach content analyses were not included in this study. The weighted diet shown here, however, would vary only slightly with the addition of the grackle diet and therefore is still a valid representation of the overall dietary preferences of the local roosting and foraging population. As indicated in figure 2, agricultural products accounted for a substantial portion of the weighed diet (60.5%), reflecting the high percentage of corn in the redwing diet (70.8%), which was 65% of the weighted total. Non-agricultural products represented only a moderate portion of the weighted diet (14.8%) while the combined animal portion of the diet (9.9%) was even less important.

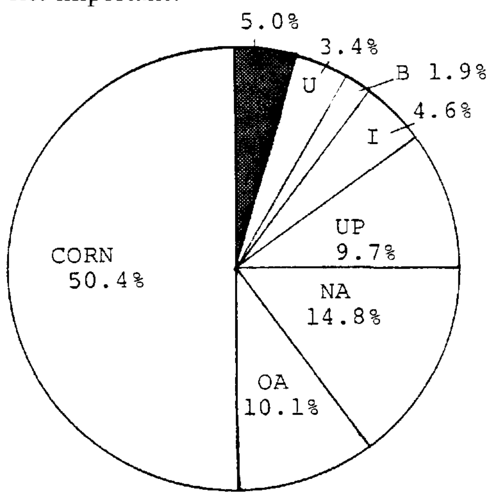

FIGURE 2. Weighted percent of total stomach contents of entire local roosting and foraging bird population diet in North-Central Ohio. Redwings, cowbirds, and starlings represent 65%, 15%, and 15% of the local population, respectively. Shaded area represents unknown grackle diet, 5% of the total population. I=injurious animal matter, B=beneficial animal matter, U=unclassified animal matter, UP=unidentified plant matter, NA=non-agricultural matter, and OA=other agricultural matter.

Comparisons With Previous Studies. The food preferences of red-winged blackbirds and brown-headed cowbirds in north-central Ohio differed from those of other areas. Although plant matter has, according to other studies, constituted a consistently high proportion of the redwing diet (Hintz and Dyer 1970, Meanley 1961, Mott *et al* 1972, and Stockdale 1959), the relative importance of particular items has varied tremendously, depending on geographic and cultural practices. The higher corn consumption by redwings found in this study was comparable to that found in other studies in Ohio and Ontario (Hintz and Dyer 1970, Stockdale 1959) and could be attributed to intensive farming practices near roosting and breeding habitats and consequent reduction in alternative foods, chiefly weeds. In South Dakota, where alternate food types were readily available, Mott and co-authors (1972) reported that bristlegrass (*Seteria* spp.) was found in 94% of all samples and contributed up to 41% of the diet during the period of corn damage, suggesting that availability of this weed reduced feeding on corn.

Differences among cowbird studies (Friedmann 1929, Goddard 1969, Stebler, in Goddard 1969) have indicated that local variations in cowbird diets also may be considerable. Since cowbirds in Ohio were frequently observed in corn fields and since the analysis of their stomach contents confirmed that a significant part of their diet came from the crop itself and not from the associated pests and weeds, the cowbird should be of economic concern.

Data from other food studies of starlings (Kalmbach 1922, 1928; Kalmbach and Gabrielson 1921, Russell 1971) generally has shown a similarity to that found in this study and has indicated that starlings consumed a high proportion of insects, most of which were injurious. Kalmbach (1922, 1928) additionally reported that fruit crops (*e.g.*, grapes, cherries, and apples) received the only significant agricultural pressures and that cultivated grains were of relatively low importance in the starling diet, except when birds congregated in livestock areas and fed on the exposed grains usually in the autumn and winter when natural food supplies were low. The amount of wheat in the late summer and early fall diet of the starling found during this study suggested similar preferences in Ohio.

The dietary trends documented in this study suggested that the food preferences of red-winged blackbirds, brown-headed cowbirds, and European starlings in this 10 week period may differ greatly. Comparing these findings with similar stomach content analyses of these species also suggested that diets, with the possible exception of that of the starling, may vary substantially depending on the geographic location, time of year, and local environmental conditions affecting food availability.

Relative to agricultural depredation in north-central Ohio, this study documented from a seasonal ecological, food-habits perspective that these birds do exert an economic pressure on local agricultural production, particularly corn. However, the overall significance of this depredatory pressure is not yet fully understood since other ecological questions still remain unanswered. Many ecological relationships, both among and within the species as well as between the individual species and their immediate and overall environments, still need to be investigated. We must continue to evaluate feeding habitat utilization, feeding behavior, flocking behavior, temporal and spatial food preferences, and bioenergetics relative to the different species as well as age and sex within individual species. Only through these continued research efforts might we be able to reasonably analyse the positive and negative effects of these birds on both agricultural and non-agricultural environments so that we might someday reasonably predict economic impacts on agricultural production and reduce such depredation pressures.

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