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**BIRD USE OF CROPS IN SOUTHERN ONTARIO:
IMPLICATIONS FOR ASSESSMENT OF PESTICIDE RISK**

**C. Boutin¹, K. E. Freemark¹, D.V. Weseloh², G.M. Donaldson¹, M. Csizy³,
P.A. Martin⁴, A. Wormington⁵, J. McCracken⁶, D. Shepherd⁷**

¹*Canadian Wildlife Service, National Wildlife Research Centre, Hull, Québec, Canada, K1A 0H3*

²*Canadian Wildlife Service, Box 5050, Burlington, Ontario, Canada, L7R 4A6*

³*1274 Kingston Avenue, Ottawa, Canada, K1Z 8K6*

⁴*rr #8, Site 40-9, Lethbridge, Alberta, Canada, T1J 4P4*

⁵*rr #1, Leamington, Ontario, Canada, N8H 3V4*

⁶*Long Point Bird Observatory, PO Box 160, Port Rowan, Ontario, Canada, N0E 1M0*

⁷*285 Pisley Road, Guelph, Ontario, Canada, N1H 2P8*

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* Copies may be obtained from:

C. Boutin, PhD
Research Scientist
Canadian Wildlife Service
National Wildlife Research Centre
100 Gamelin Boulevard
Hull, Québec, Canada
K1A 0H3

TEL: (819) 997-6075
FAX: (819) 953 6612
e-mail: CELINE.BOUTIN@EC.GC.DOE.CA

ABSTRACT

A thorough survey of bird use of cropfields has never been performed in southern Ontario where agriculture is intensive and noncrop habitats are dwindling. The knowledge of bird use of cropfields is critical for a finer evaluation of pesticide risk incurred by birds breeding in or migrating through this area. From July to mid-September 1987 birds were inventoried in six corn and soybean fields in Essex county, in five to six cornfields and apple orchards in Norfolk (Haldimand-Norfolk), and in six cornfields and grape vineyards in Niagara county. In 1988 bird inventories were done from May to mid-September in Essex and Norfolk but could not be carried out in Niagara county. Fields surveyed were approximately 16 hectares in size. Birds were recorded using a combination of point counts and transects. The objectives were to measure the extent of bird use of field interiors versus edges, to assess crop preferences, and to record bird main activities in or near cropfields.

A total of 138 species was observed in the three counties over the two year period. Twenty-five species were seen at least 50% of the time in at least one crop during any given month. An additional 16 species were seen occasionally (50% > frequency \geq 25%) in at least one crop during one month. The majority of these species were ground or low canopy omnivores. Mean bird abundance and species richness were generally lower in Essex than in Norfolk and Niagara counties. This may be attributed to a lower availability of habitats in Essex at proximal and regional levels or to differences in crops planted.

Song Sparrow¹ was the most frequent species in corn and was observed engaged in territorial activity. Common Grackle, American Robin and Barn Swallow were also commonly seen in May corresponding to the period of pesticide use in corn. Common Grackle, Horned Lark and Song Sparrow were the most frequently observed species feeding and occupying territories in soybean fields. Chipping Sparrows were most often detected in apple orchards, also feeding or engaged in territorial activities. American Goldfinch, American Robin and Savannah Sparrow were the most common birds in vineyards.

A comparison of the crops preferred by the most common species revealed that Red-winged Blackbird and Barn Swallow were observed significantly more often in corn whereas Song Sparrow exhibited a marked preference for both corn and soybean fields. In contrast, apple orchard was the crop of choice for American Crow, Chipping Sparrow, Eastern Bluebird and Mourning Dove. Significantly more insectivores were found in or near cornfields than in other crops throughout the seasons. Not surprisingly, during the harvest season, frugivores were encountered in significant numbers in apple orchards whereas omnivores and granivores were more frequent in corn. In corn and soybean, birds were seen significantly more often in field edges whereas, in orchards and vineyards, species were distributed more randomly. Nevertheless a large number of species were observed foraging at least once inside fields, especially in cornfields and apple orchards.

¹ Latin names of the 138 species inventoried in this study are listed in Appendix C

Information on pesticide use was gathered and this, combined with the bird survey data, provided a basis for assessing pesticide impacts on birds using the four selected crops. Birds most at risk from pesticide poisoning are those using fields for breeding and feeding during applications of toxic insecticides. This corresponds to May for corn, May-June for soybean, and from May to September in apple orchards and vineyards. Species most at risk were Blue Jay, American Crow, American Goldfinch, American Robin, Brown-headed Cowbird, Common Grackle, Eastern Kingbird, Eastern Bluebird, European Starling, Horned Lark, Killdeer, Red-winged Blackbird, Chipping, Savannah, Song and Vesper Sparrow and Yellow Warbler. Several of these species show signs of population decline according to data gathered independently on a long term basis. It is not possible, however, with the current data, to conclusively link species decline with pesticide use. Other causes such as habitat loss, nest predation and parasitism as well as conditions prevailing in wintering areas may constitute important factors of some bird population decline. The simplification of remaining habitats and reduction of food sources due to herbicide use may be responsible for the low productivity of some species in farmland mosaics. Nonetheless, some steps could be taken and are recommended to reduce pesticide risk for birds in agriculture.

RÉSUMÉ

Un inventaire exhaustif de l'utilisation par les oiseaux des champs en culture n'avait jamais été effectué pour le sud de l'Ontario là où l'agriculture est intensive et les habitats non cultivés sont en déclin. La connaissance de l'utilisation par les oiseaux des champs en culture est cruciale pour une estimation améliorée du risque encouru par les oiseaux nicheurs et migrateurs dû à l'utilisation des pesticides. De juillet à la mi-septembre 1987 les oiseaux ont été inventoriés dans six champs de maïs et de soya situés dans le comté d'Essex, dans cinq ou six champs de maïs et vergers de pommes du comté de Norfolk (Haldimand-Norfolk) et dans six champs de maïs et plantation de vignes du comté de Niagara. En 1988 l'inventaire des oiseaux a été fait de mai à la mi-septembre dans les comtés d'Essex et de Norfolk mais n'a pu être effectué dans le comté de Niagara. La taille des champs inventoriés était approximativement de 16 hectares. Les oiseaux ont été répertoriés en utilisant une combinaison de la méthode d'inventaire ponctuel de même que des transects. Les travaux avaient pour but de mesurer l'étendue de l'utilisation par les oiseaux des champs par rapport aux bordures des champs, d'établir quelles cultures sont préférées par les oiseaux ainsi que de déterminer les activités principales des oiseaux dans les champs ou près de ceux-ci.

Un total de 138 espèces a été observé dans les trois comtés au cours des deux années. Vingt-cinq espèces ont été vues au moins 50% du temps dans au moins une culture et un mois. Seize espèces additionnelles ont été vues de façon occasionnelle ($50\% > \text{fréquence} \geq 25\%$) dans au moins une culture et un mois. La majorité de ces espèces étaient des oiseaux omnivores habitant près du sol ou les strates arborescentes basses. L'abondance moyenne des oiseaux et la richesse spécifique étaient généralement plus basses dans le comté d'Essex que dans les comtés de Norfolk et de Niagara. Ceci peut être attribué à une disponibilité moins élevée des habitats aux niveaux proximal et régional ou à des différences dans les cultures plantées.

Le Bruant chanteur² fut l'espèce la plus fréquente dans le maïs et a été observé engagé dans des activités territoriales. Le Quiscale bronzé, le Merle d'Amérique et l'Hirondelle des granges ont été vus fréquemment en mai, ce qui correspond à la période d'utilisation des pesticides dans le maïs. Le Quiscale bronzé, l'Alouette cornue et le Bruant chanteur ont été les espèces observées le plus fréquemment à se nourrir et à occuper des territoires dans les champs de soya. Le Bruant familier a été détecté dans les vergers de pommes également en train de se nourrir ou impliqué dans des activités territoriales. Le Chardonneret jaune, le Merle d'Amérique et le Bruant des prés étaient les espèces les plus communes dans les vignobles.

Une comparaison des cultures préférées par les espèces les plus communes a révélé que le Carouge à épauettes et l'Hirondelle des granges ont été observés significativement plus souvent dans le maïs et que le Bruant chanteur montrait une préférence marquée pour les cultures de maïs et de soya. Par contre, les vergers de pommes sont la culture préférée de la Corneille d'Amérique, du Bruant familier, du Merlebleu de l'Est et de la Tourterelle triste. Davantage d'insectivores ont été détectés dans les

²Les noms latins des 138 espèces inventoriées dans cette étude sont énumérés à l'annexe C

champs de maïs et près de ceux-ci que dans les autres cultures au cours des saisons, ceci de façon significative. Il n'est pas étonnant de constater que les frugivores furent observés en nombre significativement élevé dans les vergers de pommes mais que les omnivores et les granivores furent plus fréquents dans le maïs. Dans le maïs et le soya, les espèces étaient vues significativement plus souvent au bord des champs mais dans les vergers de pommes et les vignobles, les espèces étaient distribuées de façon plus aléatoire. Un grand nombre d'espèces a tout de même été observé au moins une fois à l'intérieur des champs, particulièrement dans les champs de maïs et dans les vergers de pommes.

De l'information sur l'utilisation des pesticides a été rassemblée et avec l'inventaire des oiseaux, cela a formé la base permettant d'estimer les impacts des pesticides sur les oiseaux qui utilisent les quatre cultures étudiées. Les oiseaux les plus à risque dû à l'empoisonnement aux pesticides étaient ceux qui utilisaient les champs pour nicher et se nourrir durant les applications de pesticides toxiques. Ceci correspond au mois de mai pour le maïs, mai et juin pour le soya et aux mois de mai jusqu'à septembre pour les vergers de pommes et les plantations de vignes. Les espèces les plus à risque sont le Geai bleu, la Corneille d'Amérique, le Chardonneret jaune, le Merle d'Amérique, le Vacher à tête brune, le Quiscale bronzé, le Tyran tritri, le Merlebleu de l'Est, l'Étourneau sansonnet, l'Alouette cornue, le Pluvier kildir, le Carouge à épaulettes, les Bruants familier, des prés, chanteur et vespéral et la Paruline jaune. Plusieurs de ces espèces montrent des signes de baisse de leurs populations selon certaines données à long terme rassemblées indépendamment. Il n'est cependant pas possible, avec les données présentées ici, de relier de façon certaine, le déclin d'espèces avec l'utilisation des pesticides. D'autres causes, par exemple la perte d'habitats, la prédation et le parasitisme des nids de même que les conditions qui prévalent dans les aires d'hivernage, constituent probablement des facteurs importants de la diminution de certaines populations d'oiseaux. La simplification des habitats non cultivés qui restent et la réduction des sources de nourriture dues à l'utilisation d'herbicides peuvent être responsable de la productivité réduite de certaines espèces retrouvées dans les milieux agricoles. Il reste que plusieurs mesures pourraient être prises et sont recommandées lesquelles pourraient permettre de réduire, chez les oiseaux, le risque relié à l'utilisation des pesticides en agriculture.

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INTRODUCTION

In the Mixed-Wood-Plain ecozone of the Great Lakes region (i.e. southern Ontario) 75% of the land is used for agriculture (Statistics Canada 1987). Because of the extent of the land devoted to agriculture, and owing to extensive habitat fragmentation and the constant decrease in uncultivated habitats (e.g. hedgerows, vegetated ditchbanks, woodlots), that has resulted from the modernization of agriculture (Yahner 1983, Clark and Weatherhead 1986, Statistics Canada 1987, Merriam 1988, Mineau and McLaughlin 1997), many birds and other wildlife must use agricultural land to forage for food, to search for cover, as nesting sites or as passageway to reach preferred habitats. The propensity to make use of agricultural features has admittedly expanded greatly for some species, e.g. Brown-headed Cowbird (Robinson et al. 1995). In addition to loss of terrestrial habitats, large areas of wetland have been drained in southern Ontario to be converted to cropfields, reducing further non-agricultural habitats (Canada's Green Plan 1991).

Pesticides are an integral part of modern agriculture. In southern Ontario in 1986 approximately one million hectares (60% of the total farmland) were treated at least once with herbicides, and a quarter of a million hectares were treated at least once with insecticides and/or fungicides (Statistics Canada 1987). Many insecticides, and to a lesser extent fungicides, are acutely toxic to birds (White et al. 1979, Hill and Fleming 1982, Balcomb 1983, Thomson 1987, 1989), while most herbicides may adversely impact wildlife through reduction of food sources and cover needed to survive and reproduce (Potts 1977, 1986, Altieri and Letourneau 1982, Sotherton et al. 1988, Freemark and Boutin 1995). By using agricultural fields, birds and other wildlife are exposed to pesticides, and thus may be directly or indirectly at risk from pesticide use.

Risk posed by a pesticide is a function of its inherent toxicity and the exposure encountered by birds and other wildlife. Inherent toxicity and environmental chemistry and fate of any pesticide are known for a few species at the time of registration. Information is lacking, however, on the frequency and range of farmland use by birds (and other wildlife), required to adequately evaluate risk posed by pesticide use in agriculture. As well, information is needed on the extent birds utilize and spend time inside fields as opposed to edges, what crops are preferred by which species and at what period of the cropping season. This paper will focus on birds as representative species of wildlife use of croplands.

A literature review of bird use of cropland in Ontario (Freemark et al. 1991) revealed that small fruit crops were eminently attractive to several bird species. Ironically, this was revealed by the numerous studies completed on means of controlling bird species in these crops. American Robin, European Starling and Northern Oriole were observed as major depredators of grapes in the Niagara Peninsula (Stevenson and Virgo 1971, Brown 1974). Other species which feed on grapes include Cedar Waxwing, Gray Catbird, Northern Cardinal, Song Sparrow and Swainson's Thrush (Jubb and Cunningham 1976). It was confirmed that birds feed extensively on blueberries and cherries, and for this reason means of restricting them was forcefully sought (Bollengier et al. 1973, Dolbeer et al. 1973, Guarino et al. 1974, Conover 1985). Apple orchards were similarly visited by several species with documented damage to apples and crabapples during fruit maturation by Blue Jays (Mitterling 1965). Other species recorded foraging in apple orchards included American Crow, American Robin, Cedar Waxwing, European Starling, Northern Oriole and Purple Finch (Mitterling 1965, Brown 1974, Johnson et al. 1976, Fischl and Caccamise 1985, Pietz and Pietz 1987, Graham et al. 1990).

Other studies reported that birds consume insects that feed on mature seeds in

cropfields or on berries and fruits, especially during the breeding season. MacLellan (1959) found that Downy and Hairy Woodpeckers fed extensively on codling moths in orchard apples but not at sufficient rate to circumvent the use for chemical insecticides when density was high. Blackbirds were recorded as using cornfields for insect (Quiring and Timmins 1988, Dolbeer 1990) and weed seed food early in the season while feeding on maturing corn in the fall (Johnson and Caslick 1982) (see also Kirk et al. (1997) for a thorough review of the role of birds as predators of insect pests in temperate agriculture).

Corn seemed the crop of choice for several bird species (Johnson and Caslick 1982, Rodenhouse and Best 1983, Castrale 1985, Gard and Hooper 1995, Freemark et al. 1991 and references therein). Only a few studies have assessed how edge habitats adjacent to cornfields influence bird species composition and abundance in cornfields (Rodenhouse and Best 1983, Best et al. 1990). In contrast to corn, soybean fields do not appear to be used so widely by birds (Warnock and Joselyn 1964, Gottfried and Franks 1975, Rodenhouse and Best 1983, Castrale 1985), although O'Connor and Boone (1991) found significant associations between birds and soybeans, albeit not always positive correlations (see also Rodenhouse et al. 1993, 1995). Freemark et al. (1991) asserted that in the Great Lakes-St. Lawrence region, more species were found in corn than in soybean fields, yet these numbers could be misleading because they do not take into account availability of each crop and sampling differences.

Several species use newly planted fields to extract seeds and sprouts or may search bare fields for grit (Ingram et al. 1973), both situations with potentially high associated risk. Before the recent cancellation of granular carbofuran in cornfields, birds were especially at risk when ingesting granules coated with this highly toxic insecticide (Balcomb et al. 1984a and 1984b, Mineau 1993, Stinson et al. 1994,

Gard and Hooper 1995). Some fields may attract birds for dust-bathing in potentially contaminated soils or for consumption of contaminated water.

The objectives of this study were to inventory bird use of four major crops in southern Ontario, corn, soybean, apple and grape; to measure the extent of use of fields versus edges in these crops, and to assess bird crop preference. This was done for birds using the fields and for food and foraging bird guilds. The risk incurred by birds from pesticide use was qualitatively estimated.

METHODS

Description of study area

Birds were surveyed in two different crops in each of three southern Ontario counties in 1987 and in two counties in 1988 (Niagara was only surveyed in 1987). Corn was common to all areas; a second representative crop was chosen for each region on the basis of crop coverage and of potential high risk to birds due to pesticide use³. These were grapes in Niagara county, soybeans in Essex county, and apples in Haldimand-Norfolk county (hereafter referred to as Norfolk county). Location of study areas (counties) in southern Ontario are shown in Figure 1. Table 1 presents the area reported for each crop in Ontario and in the three counties studied (Statistics Canada 1987).

Study fields

Six fields in each of two crop types per county were selected to typify fields of approximately 16 hectares in size with a square or rectangular shape. An example is presented in Figure 2 for corn and soybean fields in Essex county in 1987.

³In collaboration with pesticides officer of the Ontario Ministry of Agriculture and Food and a search of the Ontario Pesticide Registry, four crops were chosen for which cultivation and pesticide use were extensive.

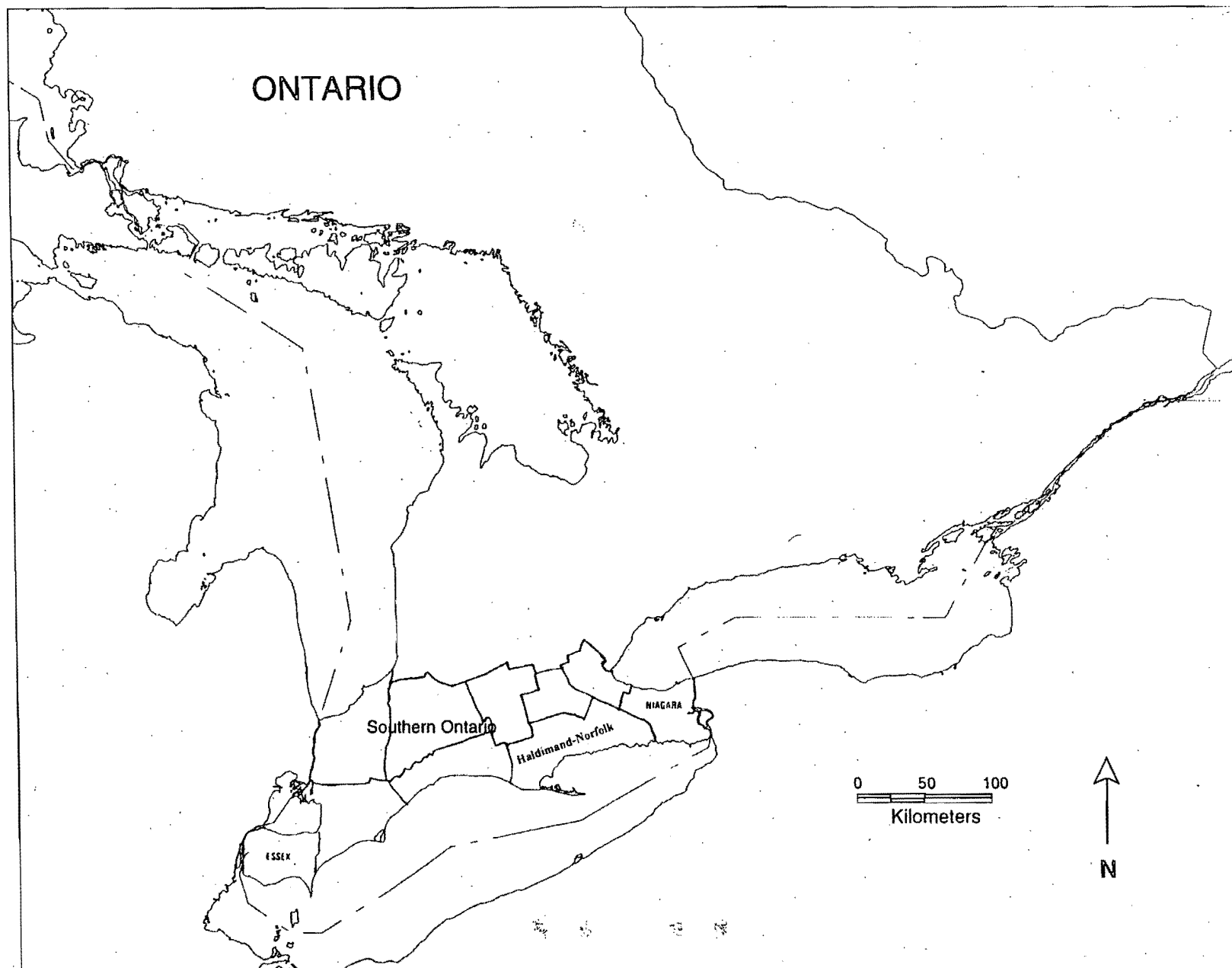


Figure 1. Counties in southern Ontario, Essex, Haldimand-Norfolk, Niagara, studied for bird use of cropland.

Table 1. Area sown (ha) in corn, soybean, apple and grape in southern Ontario and in Essex, Norfolk and Niagara counties based on farmer surveys (from Statistics Canada 1987). Number of farms reporting is given in parentheses. Numbers in bold refer to the area sown in counties surveyed in this study

Crop	AREA SOWN (HA)			
	SOUTHERN ONTARIO	ESSEX county	NIAGARA county	NORFOLK county
Corn (grain)	405,374 (11,567)	22,817 (914)	12,486 (426)	32,361 (1,148)
Corn (silage)	46,667 (3,588)	1,202 (106)	2,584 (246)	3,398 (293)
Soybean	320,293 (9,777)	60,781 (1,754)	3,104 (105)	17,724 (777)
Apples	6,110 (1,695)	1,005 (209)	745 (795)	1,378 (124)
no. bearing trees	1,451,389	218,459	230,540	215,503
no. non-bearing trees	565,736	84,705	69,915	106,224
Grapes				
no. bearing plants	8,154 (949)	234 (29)	7,332 (792)	3 (11)
no. non-bearing plants	x ¹ (1,100)	276 (38)	8,343 (909)	6 (12)

¹ Confidential data

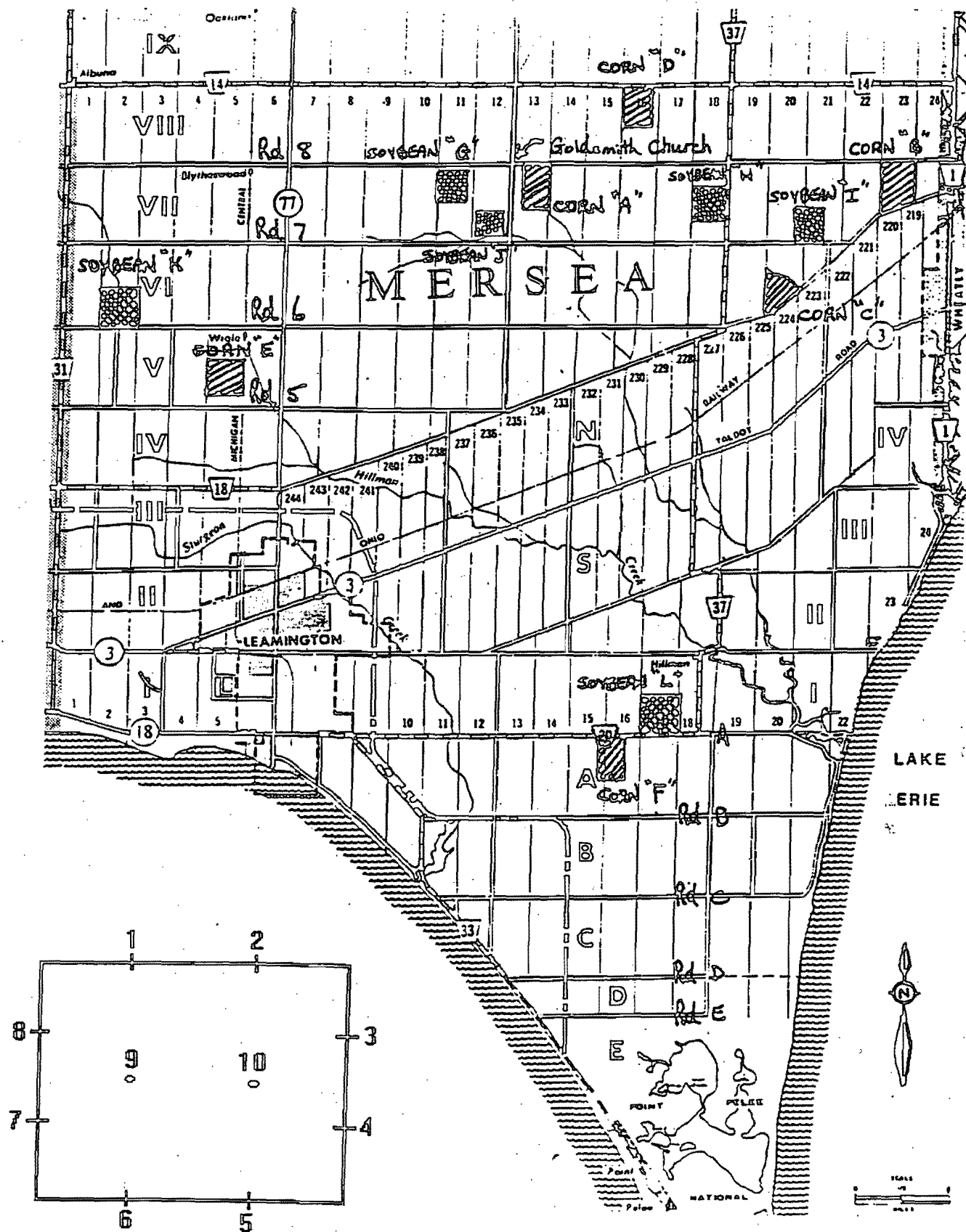




Figure 2: Map of Mersea Township in Essex County showing the location of corn  and soybean  fields in 1987. Inset shows the location of stops, numbered 1 to 10, where observations were made in each field.

Except in one case, different fields had to be selected in 1987 and 1988 for corn and soybean due to crop rotation practiced in the region; the same fields could be surveyed in the case of apple orchards. Vineyards were only surveyed in 1987.

Surrounding edge habitat was described for each field surveyed (Table 2, Appendix A). Field edges were defined as non-crop areas or areas with a different crop which extended from the field perimeter to the nearest significant habitat feature (road, woodlot, adjacent field, etc.), up to 10 metres.

Avian survey techniques

Birds were surveyed using a combination of point counts and transects. At each field, a total of ten points was established, eight along the field perimeter (two along each of four sides) and two in the field centre (Figure 2). Points were spaced approximately 200 m apart.

Three-minute point counts were conducted, during which all species and individuals seen or heard were recorded. Point counts were alternated with inter-point transect surveys. During transect counts all new individuals/species seen or heard were registered. Experienced surveyors assured that double counting of individuals was minimal. Bird counts were performed by the same surveyor in each county both years in Essex and Norfolk; different surveyors were used between counties. All birds registered on a field were combined to give total numbers per visit.

Bird surveys were conducted five days a week in July, August, and mid-September 1987 during three daily visits; in the morning (0445-0945 hrs); at noon (0946-1400 hrs), and in the evening (1401-2200 hrs). Surveyors followed a three-day rotational schedule for the six fields/crop/county to minimize time of day effects.

Table 2. Percent fields and percent sides (within bracket) surrounded with different habitat types within 10 m of field edges surveyed in 1987 and 1988 in Essex, Niagara and Norfolk counties. Fields were planted with a) corn and with b) soybean, grape and apple. See Appendix A for description of habitats.

a) Corn	All Counties			Essex			Niagara	Norfolk		
	Total	1987	1988	Total	1987	1988	1987	Total	1987	1988
Crop fields	89(73)	89(67)	92(81)	100(98)	100(96)	100(100)	100(71)	70(45)	67(33)	83(63)
unspecified	46(21)	56(24)	42(23)	17(4)	33(8)	-	67(38)	70(33)	67(25)	83(46)
soybean	46(29)	33(21)	58(38)	100(67)	100(63)	100(71)	-	10(3)	-	17(4)
corn	57(23)	56(25)	58(19)	67(31)	67(38)	67(25)	67(29)	40(10)	33(8)	50(13)
wheat	25(8)	11(3)	42(15)	58(19)	33(8)	83(29)	-	-	-	-
tomato	7(2)	6(1)	8(2)	17(4)	17(4)	17(4)	-	-	-	-
cucumber	-	-	-	-	-	-	-	-	-	-
fallow	4(1)	6(1)	-	8(2)	17(4)	-	-	-	-	-
clover	4(1)	6(1)	-	8(2)	17(4)	-	-	-	-	-
hay	4(1)	6(1)	-	-	-	-	17(4)	-	-	-
Pasture	7(2)	6(1)	8(2)	8(2)	-	17(4)	17(4)	-	-	-
Orchard	11(3)	11(3)	(4)17	8(2)	17(4)	-	-	20(5)	17(4)	33(8)
Vineyard	-	-	-	-	-	-	-	-	-	-
Farmstead	7(2)	6(1)	8(2)	17(4)	17(4)	17(4)	-	-	-	-
Residential	11(3)	11(3)	16(4)	-	-	-	17(4)	20(5)	17(4)	33(8)
Railway	4(1)	6(1)	-	8(2)	17(4)	-	-	-	-	-
Laneway	7(2)	11(3)	-	8(2)	17(4)	-	-	10(3)	17(4)	-
Road	89(32)	94(35)	83(27)	92(31)	83(25)	100(38)	100(42)	80(28)	100(38)	67(17)
Ditch	46(21)	44(21)	50(23)	67(27)	67(29)	67(25)	33(8)	30(20)	33(25)	33(21)
Wetland	25(8)	33(10)	17(6)	-	-	-	83(25)	20(8)	17(4)	33(13)
Hedgerow	46(18)	33(10)	58(27)	67(25)	67(17)	67(33)	17(4)	40(18)	17(8)	50(21)
Woodlot	29(8)	22(6)	48(10)	-	-	-	50(13)	50(15)	17(4)	67(21)
Other wooded	14(4)	17(4)	17(4)	-	-	-	17(4)	30(8)	33(8)	33(8)
Commercial/ industrial	7(2)	11(3)	-	-	-	-	-	20(5)	33(8)	-
Number of sides	112	72	48	48	24	24	24	40	24	24
Number of fields	28	18	12	12	6	6	6	10	6	6

Table 2 (cont.)

b)	Essex Soybean			Niagara Grape	Norfolk Apple		
	Total	1987	1988	1987	Total	1987	1988
Crop fields	100(100)	100(100)	100(100)	100(54)	86(25)	83(25)	83(25)
unspecified	8(2)	-	17(4)	100(58)	86(25)	83(25)	83(25)
soybean	100(65)	100(63)	100(67)	-	-	-	-
corn	25(8)	33(13)	17(4)	-	-	-	-
wheat	67(23)	33(8)	100(38)	-	-	-	-
tomato	50(17)	67(25)	33(8)	-	-	-	-
cucumber	8(2)	17(4)	-	-	-	-	-
fallow	-	-	-	-	-	-	-
clover	8(2)	17(4)	-	-	-	-	-
hay	-	-	-	-	-	-	-
Pasture	-	-	-	-	-	-	-
Orchard	-	-	-	-	86(61)	83(63)	100(71)
Vineyard	-	-	-	33(13)	-	-	-
Farmstead	25(8)	33(13)	17(4)	50(13)	29(7)	33(8)	33(8)
Residential	-	-	-	17(4)	14(7)	17(8)	-
Railway	-	-	-	-	-	-	-
Laneway	42(19)	50(25)	33(13)	67(21)	14(4)	17(4)	17(4)
Road	75(19)	67(17)	83(21)	100(58)	57(18)	50(17)	50(13)
Ditch	67(25)	67(25)	67(25)	50(17)	-	-	-
Wetland	-	-	-	-	-	-	-
Hedgerow	83(27)	83(21)	83(33)	33(8)	-	-	-
Woodlot	25(8)	17(4)	33(13)	67(33)	-	-	-
Other wooded	8(2)	-	17(4)	33(8)	14(4)	17(4)	-
Commercial/ industrial	-	-	-	17(4)	-	-	-
Number of sides	12	6	6	6	7	6	6
Number of fields	48	24	24	24	28	24	24

Table 3 provides a summary of surveys conducted by county, crop and month for both years examined. Budgetary and time constraints precluded data collection in May and June 1987 for all crops. Further, due to the inability to obtain a surveyor for the 1988 season, vineyards and corn fields in Niagara county were surveyed in 1987 only. Appendix B presents the cumulative number of species seen as a function of the number of visits for a subset of the data. In general, less than 15 visits were sufficient to record 80% of the species with two notable exceptions: apple orchards in July 1987 and corn fields in August/September 1987. The latter may be due to an increasing number of migrants passing through southern Ontario at that time of the year. Additional information collected at the time of the surveys included the date, survey start and end time, field location and number, crop type, and weather conditions such as percent cloud cover, wind speed and precipitation.

In 1988, evening survey visits were eliminated due to time constraints, and in order to standardize the times of daily visits among surveyors. To justify this, 1987 survey data was first examined. Data were grouped into 20-day blocks beginning in July 1987, by county, crop, and time of visit. The cumulative number of species recorded during morning visits and during morning and noon visits for each 20-day interval was tallied and compared to the total mean number of species for all three visits (morning, noon, afternoon) for all fields (Table 4).

Evening visits yielded on average an additional five to nine new species, with generally only a few individuals detected for each species (Table 5). Thus, although some information was lost, it was considered that a representative bird sample was obtainable from two daily visits, and the evening visits were eliminated in 1988. Morning and noon visits to fields were kept alternating to minimize time of day effects.

Table 3. Record of visits to corn and soybean fields, grape vineyards and apple orchards. Time periods were characterised as follows, 1: 0443-0945 hrs.; 2: 0946-1400 hrs.; 3: 1401-2200 hrs. Weather conditions recorded were mean percent cloud cover (C), mean wind speed (km/hr) (W), and percent visits without precipitation (P). For corn and soybean different fields were surveyed in 1987 and 1988.

Crop	Month/ year	Number of fields visited	Total number of visits	Number of visits/ time period			Mean length of visit (min)	Weather		
				1	2	3		C	W	P
Corn (Essex County)	July 87	6	38	9	15	14	77	43	11	100
	Aug 87	6	35	10	13	12	76	42	12	100
	Sept 87	6	29	8	11	10	77	47	9	100
	May 88	4	8	5	3	0	72	8	10	100
	June 88	6	22	7	15	0	73	44	13	90
	July 88	6	14	6	8	0	75	28	6	100
	Aug 88	6	29	15	14	0	79	46	7	97
	Sept 88	6	12	5	7	0	77	11	12	100
Corn (Niagara County)	July 87	6	18	6	6	6	76	25	11	100
	Aug 87	6	26	9	9	8	86	36	15	96
	Sept 87	6	57	19	18	20	90	54	11	71
Corn (Norfolk County)	July 87	5	27	12	9	6	75	26	10	86
	Aug 87	6	58	22	21	15	67	41	16	91
	Sept 87	6	23	6	9	8	61	30	17	100
	May 88	6	24	13	11	0	74	43	15	98
	June 88	6	29	12	17	0	71	43	23	100
	July 88	6	32	18	14	0	74	33	9	96
	Aug 88	6	35	15	20	0	75	55	13	98
	Sept 88	6	12	8	4	0	73	19	11	100

Table 3 (cont.)

Crop	Month/ year	Number of fields visited	Total number of visits	Number of visits/ time period			Mean length of visit (min)	Weather		
				1	2	3		C	W	P
Soybean (Essex County)	July 87	6	36	8	13	15	75	34	12	73
	Aug 87	6	35	10	13	12	76	39	12	86
	Sept 87	6	31	7	13	11	75	57	9	97
	May 88	4	8	5	3	0	70	7	10	100
	June 88	6	29	15	14	0	72	27	11	100
	July 88	6	16	5	11	0	75	34	12	88
	Aug 88	6	27	13	14	0	78	43	7	96
	Sept 88	6	12	7	5	0	79	13	16	100
Grape (Niagara County)	July 87	6	35	12	12	11	71	22	12	97
	Aug 87	6	31	13	11	7	65	34	13	91
	Sept 87	6	22	8	7	7	61	74	5	93
Apple (Norfolk County)	July 87	6	61	18	25	18	74	51	12	84
	Aug 87	6	52	18	18	16	72	48	9	85
	Sept 87	6	15	4	4	7	87	40	13	70
	May 88	6	24	16	8	0	67	60	14	100
	June 88	6	36	18	18	0	67	21	12	100
	July 88	6	38	14	24	0	67	55	11	94
	Aug 88	6	37	20	17	0	66	34	10	99
	Sept 88	6	8	4	4	0	63	17	10	100

Table 4. Cumulative percent of total number of species observed per day block (5 blocks of 20 days from mid June to September 1987) recorded at morning and noon in corn, soybean, apple and grape fields in Essex, Niagara and Norfolk counties. Species flying over and seen outside fields are included but were later deleted (see text).

County	Time	Block 1	Block 2	Block 3	Block 4	Block 5	Mean	Total
Corn								
Essex (n=6)	AM (%)	68	74	69	61	44	63.2	61.9
	AM + Noon (%)	89	88	94	88	94	90.6	88.9
	Total # spp.	28	34	36	41	18		63
Niagara (n=6)	AM (%)	67	64	79	78	69	71.4	80.9
	AM + Noon (%)	88	77	91	93	93	88.4	91.0
	Total # spp.	33	44	43	69	54		89
Norfolk (n=6)	AM (%)	84	90	82	69	-	81.3	86.9
	AM + Noon (%)	91	96	94	92	-	93.3	94.0
	Total # spp.	32	50	67	48	-		84
Average (n=18)	AM (%)	73	76	77	69	57	70.4	82.8
	AM + Noon (%)	89	87	93	91	94	90.8	91.8
Soybean								
Essex (n=6)	AM	57	73	77	61	48	63.2	72.5
	AM + Noon	91	85	97	92	84	89.8	92.8
	Total # spp.	35	41	39	49	25		69
Grape								
Niagara (n=6)	AM (%)	-	85	87	60	-	77.3	79.7
	AM + Noon (%)	-	96	93	67	-	85.3	85.5
	Total # spp.	-	47	45	43	-		69
Apple								
Norfolk (n=6)	AM (%)	74	92	84	69	-	79.8	80.9
	AM + Noon (%)	86	96	94	81	-	89.3	91.2
	Total # spp.	43	48	51	42	-		68

Table 5. Bird species seen only in the afternoon/evening in or adjacent to corn, soybean, grape and apple fields in Essex, Niagara and Norfolk Counties in Jul.-Sept. 1987.

	CORN			SOYBEAN	GRAPE	APPLE
	Essex	Niagara	Norfolk	Essex	Niagara	Norfolk
No. field	6	6	6	6	6	6
No. visits	102	101	108	105	88	128
% total species	11	9	6	7	14	9
No. species	7	8	5	5	9	6
Sharp-shinned Hawk			x	x		
Pectoral Sandpiper		x				
Spotted Sandpiper			x		x	x
Solitary Sandpiper						x
Lesser Yellowlegs*					x	
Double Crested Cormorant					x	
Blue-winged Teal		x				
Mallard			x			
Canada Goose*			x			
Belted Kingfisher					x	
Common Nighthawk				x		
Red-headed Woodpecker						x
Willow Flycatcher	x					x
Eastern Phoebe		x				
Rough-winged Swallow*	x					
Bank Swallow					x	
Chimney Swift		x		x		
White-breasted Nuthatch					x	
Gray Catbird	x					
Red-eyed Vireo				x		
Yellow-throated Vireo						x

Table 5 (cont.)

	CORN			SOYBEAN	GRAPE	APPLE
	Essex	Niagara	Norfolk	Essex	Niagara	Norfolk
Warbling Vireo		x				
Bay-breasted Warbler	x					
Cape May Warbler					x	x
Wilson's Warbler					x	
Common Yellowthroat					x	
Magnolia Warbler				x		
Palm Warbler			x			
Ovenbird	x					
American Redstart		x				
Eastern Meadowlark		x				
Dark-eyed Junco	x					
Lincoln's Sparrow		x				
Purple Finch	x					

* Seen flying over or outside fields. Deleted from further analyses.

The location of each individual inside, outside, flying over or in field edges was recorded based on its location at initial sighting (e.g. individuals flushed from the field edge into the field interior, were considered 'edge' detections, and vice versa). Individuals observed or heard outside field and edge boundaries were designated as "outside". It was decided, however, to discard all outside and fly-over records because their use of fields or edges could not be established. However, species observed feeding in flight low above fields, such as swallows or swifts were considered to be using the interior of fields.

Surveyors were asked to identify and describe the activity/age of individuals as precisely as possible. Evidence of breeding was based on criteria outlined in the Ontario Breeding Bird Atlas (Cadman et al. 1987). Since descriptions were highly variable among surveyors, activities/ages were grouped into six broad categories: nesting, presence of fledged young, territorial behaviour, calling, feeding, and other (including unknown activities).

The nesting category included sightings of a nest with eggs/young, agitation by adult with eggs/young, sightings of one/both parents entering or flushed from a nest with eggs and/or chicks, or an adult carrying food or faecal sac. Pre-nesting activities such as singing, agitation, distraction or courtship displays constituted territorial behaviour. Bird activities/ages which could not be identified such as birds that were flushed, or nondirected behaviour such as perching and roosting were classified as "other".

Pesticide use regimes

Tables 6a-b present a compilation of the recommendation for pesticide use in corn and soybean, with date of planting and harvest (Ontario Ministry of Agriculture and Food 1987, 1988). The information was cross-referenced with authorities at the

Table 6. Calendar of recommended pesticide use for a) Essex, Niagara and Norfolk corn, b) Essex county soybean, c) Norfolk apple (fruit bearing trees), and d) Niagara grape. xxx= application period, 3-4x=3 or 4 applications, ppi/pre/post= pre-planted incorporated/pre-emergence/post-emergence. Derived from: 1989-90 Field Crop Recommendations, OMAF 1988, 1988 Fruit Production Recommendations, OMAF 1987, and Guide to Weed Control, OMAF 1986.

a) corn	April	May	June	July	August	Sept	Oct	Nov
Planting	XXXXXX							
Herbicide	XXXXXX ppi/pre XXXXXXXXXXXXX post							
Insecticide	XXXXXX granulars ¹				XXXX ²			
Fungicide	XXXXXX seed coated							
Harvest	XXXXXXXXXXXXXXXXXXXX							

b) soybean	April	May	June	July	August	Sept	Oct	Nov
Planting	XXXXXXXXXX							
Herbicide	XXXXXXXXXXXXXXXXX ppi/pre XXXXXXXXXXXXXXXXX ³ XXXXXXXXXXXXX post							
Insecticide	XXXXXXXXXXXXX seed coated							
Fungicide	XXXXXXXXXXXXX seed coated							
Harvest	XXXXXXXXXXXXXXXXX							

Table 6 (cont.)

c) apple	March	April	May	June	July	August	Sept	Oct
Herbicide	XXXXXXXXXXXX XXXXXXXX							
Insecticide	XXXX XXXX ⁴ XX XXX XXX XX ⁵							
Fungicide	XX <div> 3-4x 1-2x 2-3x 2-8x </div>							
Aphicide	XXXXXXXXX XXXXXXXX ⁴							
Miticide	XXXXXXX XXXXXX							
Harvest	XXXXXXXXXXXXXXXXXXXXXXXXXXXX							

d) grape	March	April	May	June	July	August	Sept	Oct
Herbicide				XXXX <u>1-2x</u>				
Insecticide				xxx	xx⁶	xx	xxx	
Fungicide			xxxxxxx <u>2x</u>	xx xx	xx xxx <u>1-2x</u>	xx xxx xxxx	xxxxxxxxx <u>1-2x</u>	
Harvest							xxxxxxxxx	

¹ granular= formulation² sprayed <5% of acreage, uncommon, seed corn variety only

³ Uncommon

⁴ sprayed 10-15% of acreage only⁵ 50% of acreage

⁶ 10% of acreage

Ontario Ministry of Agriculture and Food. Planting of corn and soybean in these regions usually occurs in late April until mid-May for corn and the third week of June for soybean. The information compiled from farmers of the fields surveyed showed that herbicides were applied pre-plant incorporated, pre-emergence or post-emergence (Table 7). Atrazine was the most used herbicide, frequently in a tank mix with metolachlor (Dual) or pre-mixed (Primextra). Other herbicides identified were EPTC (Eradicaine), bromoxynil (Pardner), 2,4-D, cyanazine (Bladex), bentazon (Basagran), chloramben (Amiben) and metribuzin (Lexone). No information could be obtained for four cornfields in Niagara although herbicides were probably applied. Only in one cornfield in Essex was there no application of pesticides. No insecticide was sprayed in these fields but seeds were probably coated with both fungicides and insecticides.

Pesticide use in apple orchards and vineyards was far more extensive than in field crops (Table 7). Several insecticides (e.g. diazinon, carbaryl, some pyrethroids), fungicides (captan, folpet, myclobutanil, sulfur), mancozeb + dinocap (Dikar) which has fungicidal and miticidal proprieties, and herbicides (paraquat, glyphosate, simazine) were used in vineyards. In apple orchards, up to 20 applications of different products (unidentified by farmers) were done in one season. This is in accordance with the information gathered from the Ontario Ministry of Agriculture and Food (Tables 6c-d)

Data analyses

To coincide with crop cultivation and pesticide application regimes, analyses were conducted by county, crop and month. Data were analyzed separately for 1987 and 1988 since often different fields were used and because of differences in the number and time of surveys. The following analyses were carried out:

Table 7. Pesticide used by farmers in 1987 and 1988 in fields surveyed in Essex, Niagara, Norfolk planted with corn, soybean, grapes and apple trees. H= herbicide, I= insecticide, F= fungicide, M= miticide; ppi=preplanted incorporated, pre=preemergence, post=postemergence.

Corn 1987					
Field no.	Pesticides used	Field no.	Pesticides used	Field no.	Pesticides used
Essex A	(H) Atrazine & metolachlor, at planting Bromoxynil, post	Niagara A	Information non-available	Norfolk A	(H) Unknown herbicide, ppi
Essex B	(H) Metolachlor, ppi 2,4-D, post	Niagara B	Information non-available	Norfolk B	(H) Atrazine & metolachlor
Essex C	(H) Metolachlor, ppi Atrazine, post	Niagara C	Information non-available	Norfolk C	(H) Unknown herbicide, ppi
Essex D	(H) Atrazine & metolachlor, ppi Bromoxynil, post	Niagara D	Information non-available	Norfolk D	(H) Eradicane, ppi
Essex E	(H) Cyanazine & metolachlor, pre	Niagara E	(H) Atrazine, post	Norfolk E	(H) Atrazine, ppi
Essex F	None	Niagara F	(H) Unknown herbicide	Norfolk F	(H) Unknown herbicides, ppi

Corn 1988					
Field no.	Pesticides used	Field no.	Pesticides used	Field no.	Pesticides used
Essex A	(H) Atrazine & metolachlor, at planting Bromoxynil, post	Niagara A	Not done in 1988	Norfolk A	(H) Atrazine & metolachlor, timing unknown
Essex B	(H) Atrazine & metolachlor, ppi Metribuzin, ppi	Niagara B		Norfolk B	(H) Unknown herbicide, ppi
Essex C	(H) Metolachlor & atrazine, ppi	Niagara C		Norfolk C	(H) Unknown herbicide, ppi
Essex D	(H) Atrazine & metolachlor, ppi	Niagara D		Norfolk D	(H) Unknown herbicide, ppi
Essex E	(H) Atrazine, ppi & post	Niagara E		Norfolk E	(H) Atrazine, ppi
Essex F	(H) Atrazine, post	Niagara F		Norfolk F	(H) Unknown herbicides at planting

Table 7 (cont.)

Soybean 1987		Grape 1987		Apple 1987	
Field no.	Pesticides used	Field no.	Pesticides used	Field no.	Pesticides used (unidentified) ¹
Essex A	(H) Metolachlor & metribuzin, ppi Bentazon, spot treatment	Niagara A	(H) Paraquat, simazine, glyphosate (1x) (I) Diazinon (2x) (F, M) Dikar, captan, folpet, myclobutanil (spray), sulfur	Norfolk A	Insecticides (10-12x) + pyrethroid (1x) Fungicides (6-7x) Miticide (1x)
Essex B	(H) Trifluralin, ppi Linuron, pre Bentazon, post	Niagara B	(H) Glyphosate, simazine (I) Carbaryl (several times) (F, M) Dikar, sulfur (several times)	Norfolk B	Insecticides (10-12x) + pyrethroid (1x) Fungicides (6-7x) Miticide (1x)
Essex C	(H) Metolachlor, ppi Bentazon, post	Niagara C	(H) Glyphosate, simazine (I) Carbaryl (several times) (F, M) Dikar, sulfur (several times)	Norfolk C	Insecticides (3x) Fungicides (8-10x) Miticide (2x)
Essex D	(H) Chloramben & metribuzin, ppi	Niagara D	(H) Glyphosate, simazine (I) Carbaryl (several times) (F, M) Dikar, sulfur (several times)	Norfolk D	Insecticides (3x) Fungicides (8-10x) Miticide (2x)
Essex E	(H) Metolachlor & metribuzin, ppi	Niagara E	(H) Glyphosate, simazine (I) Carbaryl (several times) (F, M) Dikar, sulfur (several times)	Norfolk E	Herbicides (spray as needed, May-Sept) Insecticides (2x) Fungicides (10-12x) Miticide (2-3x)
Essex F	None	Niagara F	(H) Simazine, ppi (I) Carbaryl (F, M) Dikar	Norfolk F	Insecticides (4x) Fungicides (7x) Miticide (2x)

¹ Possible candidate insecticides were: organophosphates = parathion, azinphos methyl, demeton, dimethoate, diazinon, methidathion, phosalone and phosnet; carbamates = formetanate, methomyl, oxamyl and primicarb; pyrethroids = cypermethrin, deltamethrin, fenvalerate and permethrin. Possible candidate fungicides and/or miticides were: captan, dodine, dikar, benlate, dithane, morestan, streptomycin and zineb (derived from: 1988 Fruit Production Recommendations, OMAF 1987).

Table 7 (cont.)

Soybean 1988				Apple 1988	
Field no.	Pesticides used	Field no.	Pesticides used	Field no.	Pesticides used (unidentified) ¹
Essex A	(H) Metolachlor & metribuzin, ppi	Niagara A	Not done in 1988	Norfolk A	Insecticides (10-12x) + pyrethroid (1x) Fungicides (6-7x) Miticide (1x)
Essex B	(H) Metolachlor & metribuzin, ppi	Niagara B		Norfolk B	Insecticides (10-12x) + pyrethroid (1x) Fungicides (6-7x) Miticide (1x)
Essex C	(H) Metribuzin, timing unknown	Niagara C		Norfolk C	Insecticides (3x) Fungicides (8-10x) Miticide (2x)
Essex D	(H) Metribuzin, timing unknown	Niagara D		Norfolk D	Insecticides (3x) Fungicides (8-10x) Miticide (2x)
Essex E	(H) Metolachlor & metribuzin, ppi	Niagara E		Norfolk E	Insecticides (3x) Fungicides (8-10x) Miticide (2x)
Essex F	(H) Metolachlor & metribuzin, ppi Unknown herbicide, spot treatment	Niagara F		Norfolk F	Insecticides (4x) Fungicides (7x) Miticide (2x)

¹ Possible candidate insecticides were: organophosphates = parathion, azinphos methyl, demeton, dimethoate, diazinon, methidathion, phosalone and phosnet; carbamates = formetanate, methomyl, oxamyl and primicarb; pyrethroids = cypermethrin, deltamethrin, fenvalerate and permethrin. Possible candidate fungicides and/or miticides were: captan, dodine, dikar, benlate, dithane, morestan, streptomycin and zineb (derived from: 1988 Fruit Production Recommendations, OMAF 1987).

- 1) The mean number of individual birds per visit was calculated for each year in each crop per county by month for individuals recorded inside fields and at field edges. The variance in abundance within a field among visits, and among fields was calculated. The corresponding total and mean number of species per field were also calculated based on cumulative species number seen during visits.
- 2) Species frequency of occurrence (F) measured as percent of total visits to each crop (across counties) each month⁴ in 1987 and 1988 for individuals detected inside fields and at field edges. Species were then assigned to four frequency (F) classes as follows: recurrent, $F \geq 75\%$; regular, $75\% > F \geq 50\%$; occasional, $50\% > F \geq 25\%$; and uncommon, $F < 25\%$.
- 3) The mean number of individuals per field for those species detected inside fields and/or at edges of fields on at least one half of visits each month, was calculated for each crop (across counties) by month and year. The within and among field variance in abundance and the proportion of individuals within the six activity classes (see above) were also calculated for these species.
- 4) The percentage of total species observed inside fields and feeding in fields at least once was calculated for each crop type by month.
- 5) Analyses of variance (ANOVA) tests were carried out on the most common species to test the main effect of crop type on bird numbers (General Linear Models Procedure, SAS 1988). For this analysis, bird numbers were combined over edge and interior habitat to give total number per field. Crop and county were the model

⁴ Since only the first two weeks in September were surveyed, data for August and September were pooled. This also served to combine all fall migrants into one time interval. Pooling was also justified on the basis that pesticides were applied similarly during the two months.

main effects. County was included to account for variation that might result from geographic and observer differences. The interaction term of the two variables could not be tested, as corn was the only crop common to all counties. Means comparisons among crops were carried out using LSMEANS tests, which tests for all differences among weighted means; this test is useful when sample sizes are unbalanced as in this case where the number of census dates varied among fields (see Table 3). Significance was determined using Sidak inequality (Sidak 1967) setting the main effect comparisonwise error rate at $P < 0.05$, assuming six and three comparisons in 1987 and 1988 respectively.

6) To test the preference of birds for the edge habitat or the field interior, t-tests of randomness of distribution among the two types of habitat were conducted. The hypotheses tested was based on the assumption that the spatial coverage for observations in the field (16 ha or 160,000 m²) was greater than in the edge (400 m edge X 10 width margin X 4 = 1,600 m²) with a ratio 160,000:1,600 m² (10:1). This is a conservative estimate as for larger fields, the calculated ratio would be even more skewed towards the field interior. This hypothesis does not take into account the intensity of surveying i.e. that eight sample points were on the perimeter of the field, while only two were on the interior of the field (ratio 8:2).

7) Species were classified by food type and food substrate during the breeding season according to DeGraaf et al. (1985) (see Appendix C). The number of birds within each food type and food substrate guild was calculated for each crop by month (across counties and years) for species detected inside fields at least once. ANOVAs were conducted on each guild using models identical to those described above.

RESULTS

Characteristics of study fields

Except in Norfolk County, all of the fields surveyed were bounded by other crop fields, and usually on at least three of four sides (Table 2). Of the crop types specified, soybean and corn were adjacent to about half of the corn fields surveyed. All the soybean fields surveyed were bounded on all sides by other soybean fields. Soybean was also prevalent as a habitat bounding corn fields in Essex County (all fields, 63-71% of sides). In Essex County wheat was the adjacent crop of 25% of corn and 67% of soybean fields surveyed. A variety of other crops was specified as edge habitat in Essex County but, except for tomato adjacent to soybean fields, not very often. Pasture was identified as a field edge habitat only for corn in Essex and Niagara counties. Orchard was most prevalent as a field edge habitat in Norfolk County (for corn, 20% of fields, 5% of sides; for apple, 86% of fields, 61% of sides). Vineyard was identified as a field edge habitat only in Niagara County.

Only a few corn and soybean fields but from a third to half of the apple and grape fields surveyed were adjacent to human habitations (farmsteads or rural residences). Most fields were bounded by a road, on at least one side (apple somewhat less so). Drainage ditches were most prevalent as edge habitat in Essex County (67% of both corn and soybean fields) compared to Niagara County (33% of corn and 50% of grape fields) and particularly Norfolk County (30-33% of corn and no apple fields). Wetlands were only identified as edge habitat for corn fields in Niagara (83% of fields, 25% of sides) and Norfolk (20% of fields, 8% of sides).

At least half of the corn and grape fields surveyed in Niagara and Norfolk abutted woodlots (but usually only on one side) although Norfolk had a substantial

difference for corn fields between 1987 (17% of fields, 4% of sides) and 1988 (67% of fields, 21% of sides). In Essex, woodlot and other wooded habitat were not identified next to corn fields and only at 25% or less of soybean fields. In contrast, hedgerows were most prevalent in Essex for both corn (67% of fields and 25% of sides; some variability in percent sides between years) and soybean (83% of fields, 27% of sides; similar between years).

Bird mean abundance and species richness

A summary of bird species abundance and richness per field per visit reported for each county and survey month is found for each year separately in Table 8.

Corn

In Essex county bird mean abundance/field was two to three times higher in 1988 than in 1987 (Table 8) despite the fact that more surveys were completed in 1987 (Table 3). Flocking was not evident in either survey year. Bird mean abundance/field was notably high in July 1988. However the total number of birds and species was generally lower in Essex county than in either Norfolk and Niagara.

Fields in Niagara county were only surveyed in 1987. The number of birds and species was highest in September (Table 8) with evidence of a flocking effect partly due to migrants.

The total number of species in Norfolk corn fields varied among survey months and years (Table 8). No general pattern was discernible except that the highest number of species was observed in August both years, coinciding with the start of fall migration. While the mean number of species/field declined between May and September 1988, and between July and September in 1987, bird mean abundance/field generally increased except in September 1988. This trend may be

Table 8. Number of individuals (ind) and species of birds seen in total and per field per visit (mean \pm standard error) in the corn, soybean, apple and grape fields in 1987 and 1988.

County/ year		May	June	July	Aug	Sept
Corn						
Essex/ 1987	ind	n/a	n/a	20.7 \pm 7.5	20.0 \pm 6.47	14.19 \pm 3.9
	species	n/a	n/a	7.9 \pm 1.2	7.4 \pm 0.8	6.1 \pm 1.4
	total sp	n/a	n/a	37	38	41
Essex/ 1988	ind	28.5 \pm 8.0	30.2 \pm 9.0	65.4 \pm 83.1	44.0 \pm 43.6	41.6 \pm 25.4
	species	11.4 \pm 3.1	9.0 \pm 1.4	9.3 \pm 2.7	9.8 \pm 3.2	10.0 \pm 4.6
	total sp	31	30	30	52	42
Niagara/ 1987	ind	n/a	n/a	74.2 \pm 43.6	134.0 \pm 104.0	244.1 \pm 145.2
	species	n/a	n/a	13.4 \pm 1.7	13.5 \pm 2.1	15.8 \pm 3.2
	total sp	n/a	n/a	47	44	74
Norfolk/ 1987	ind	n/a	n/a	119.1 \pm 45.7	219.8 \pm 176.4	1876.2 \pm 3815.4
	species	n/a	n/a	5.3 \pm 1.1	9.8 \pm 2.0	7.2 \pm 2.4
	total sp	n/a	n/a	44	66	46
Norfolk/ 1988	ind	67.3 \pm 20.7	85.4 \pm 40.2	154.9 \pm 97.7	403.2 \pm 270.7	132.0 \pm 152.6
	species	19.2 \pm 2.5	17.2 \pm 2.1	17.7 \pm 2.3	15.7 \pm 2.2	13.6 \pm 4.3
	total sp	62	58	51	69	50
Total/ 1987	ind	n/a	n/a	75.5 \pm 75.99	124.6 \pm 143.9	711.5 \pm 2355.1
	species	n/a	n/a	10.4 \pm 2.7	10.2 \pm 3.0	9.7 \pm 5.0
	total sp	n/a	n/a	61	73	89
Total/ 1988	ind	51.8 \pm 25.4	57.8 \pm 40.2	110.2 \pm 101.2	223.6 \pm 264.3	87.8 \pm 118.3
	species	16.1 \pm 4.7	13.1 \pm 4.5	13.5 \pm 4.9	12.7 \pm 4.1	11.8 \pm 4.8
	total sp	65	59	55	78	42

Table 8 (cont.)

County/ year		May	June	July	Aug	Sept
Soybean						
Essex/ 1987	ind	n/a	n/a	31.6±9.4	28.2±9.1	17.8±10.0
	species	n/a	n/a	10.4±2.4	9.1±2.4	7.2±1.9
	total sp	n/a	n/a	43	41	46
Essex/ 1988	ind	36.8±7.7	40.8±16.3	47.6±26.3	38.8±17.6	43.9±22.8
	species	12.6±3.3	12.3±3.9	12.6±3.6	13.0±5.1	15.8±6.0
	total sp	31	46	38	63	59
Grape						
Niagara/ 1987	ind	n/a	n/a	63.2±22.6	56.8±34.7	41.8±28.6
	species	n/a	n/a	9.7±3.6	9.7±2.8	6.4±2.0
	total sp	n/a	n/a	40	48	36
Apple						
Norfolk/ 1987	ind	n/a	n/a	43.3±9.7	81.5±37.6	71.6±58.6
	species	n/a	n/a	12.2±1.7	11.2±2.1	10.0±3.6
	total sp	na/	n/a	52	53	35
Norfolk/ 1988	ind	37.8±10.0	49.1±26.1	55.0±24.3	91.5±52.9	44.3±24.6
	species	12.3±2.4	12.4±2.2	12.4±1.7	13.1±1.1	10.0±3.7
	total sp	45	53	48	59	30

explained by flocking behaviour in a few species, such as Red-winged Blackbirds and European Starlings. The variability in bird numbers observed between years may be due to the sampling of different fields both years or, for September, to a reduced number of visits in 1988.

Table 8 also presents a summary of number of individuals and species of birds in all cornfields pooled separately for 1987 and 1988. A total of 89 species was inventoried in September 1987 possibly due to the passing of birds in Niagara county (74 species recorded) during fall migration.

Soybean

Birds in soybean fields were surveyed in Essex county (Table 8). Between 31 and 63 species were identified with the highest numbers in August or September, although no flocking is apparent in either years.

Apple

The same orchards were surveyed in 1987 and 1988. The total number of species recorded ranged from 35 to 53 in 1987, and from 30 to 59 in 1988 (Table 8). Total species number was highest in August and lowest in September both years. The August peaks in mean abundance and total species coincided with the dispersal of young and post-breeding adults, the arrival of fall migrants, and an increase in food availability in orchards at this time of year. In September the number of surveys was much lower which could explain the reduced total number of species identified (see Appendix B) although it may also be related to the departure of several migrant species.

Grape

Vineyards were only surveyed in 1987 in the Niagara county (Tables 3 and 8).

More species were seen in August than in any other month. A steady decline in species number and abundance per field was recorded from July to September probably related to autumn dispersal and migration.

Species frequency of occurrence

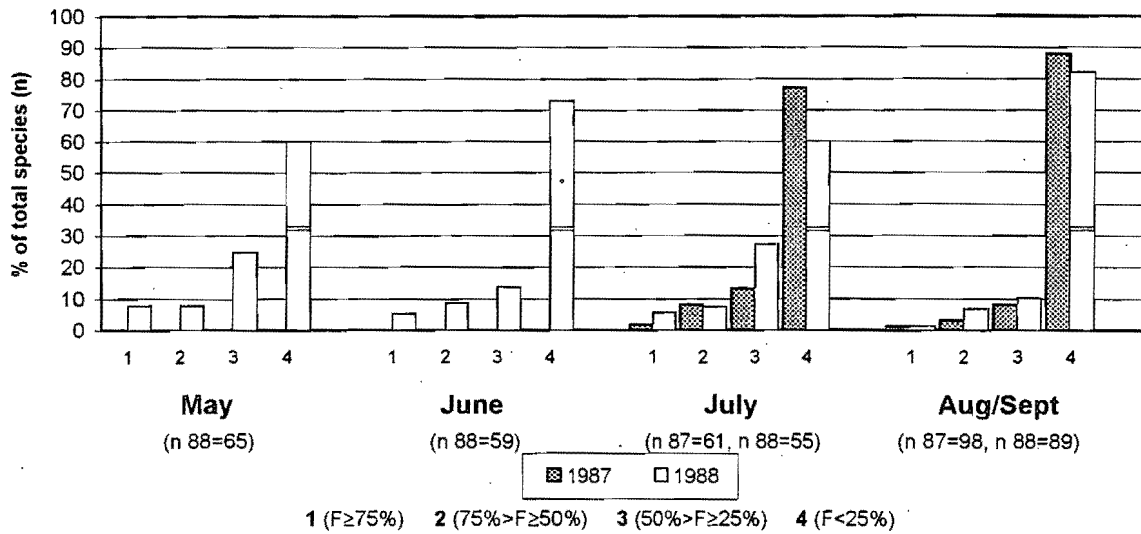
Species frequency of occurrence was calculated for each month surveyed in 1987 and 1988, based on proportion of total visits (Figure 3, Appendix D). Since only the first two weeks of September were surveyed, data for August and September were pooled. This also served to combined fall migrants into one time interval.

A total of 138 bird species was detected in the surveyed fields (119 in 1987 and 118 in 1988) although the majority of species occurred uncommonly (frequency < 25%) (Figure 3). Twenty-five species occurred during at least 50% of field visits (recurrent and regular species) in one or more crops at one or more periods (Appendix D) and a further 16 species occurred occasionally (50% > frequency ≥ 25%) in at least one crop. The recurrent and regular bird species account for a total of approximately 7-15% of species recorded each month in corn, 9-36% in soybean, 12-20% in apple orchards and 5-20% in vineyards. The highest proportion of uncommon species (frequency < 25%) was generally seen in August/September, at the time of fall migration.

Activity/age breakdown of bird species

Bird activity/age inside field and in field edge was examined for species occurring on at least 50% of visits during each month. Table 9 lists recurrent and regular visitors, their mean abundance per visit per field and associated variances, and whether they were denoted as inside fields and/or field edges. A breakdown of species activity/age, expressed as percent individuals detected is also summarized.

a) CORN



b) SOYBEAN

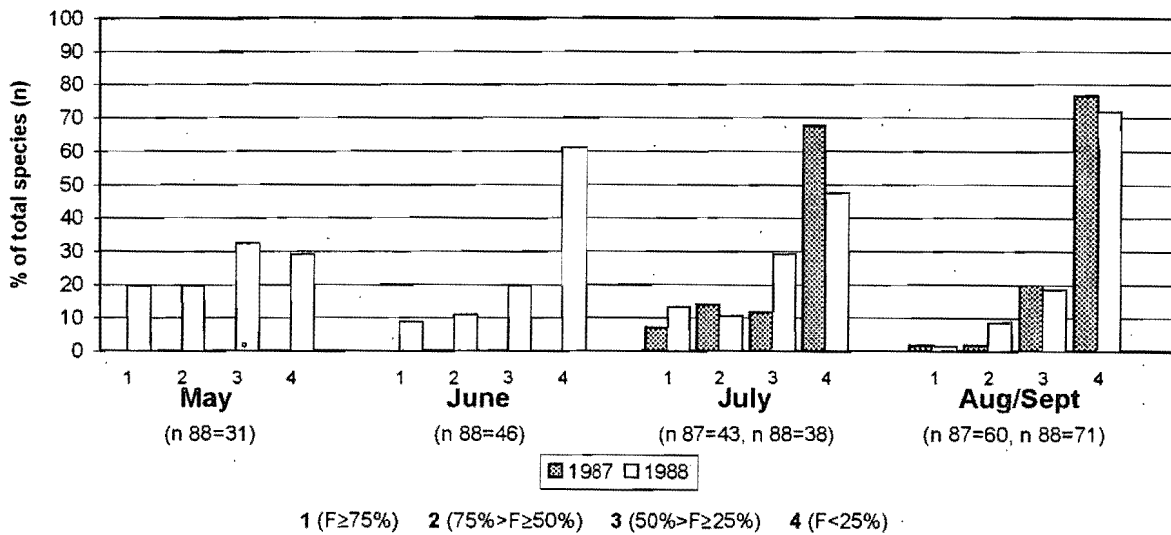
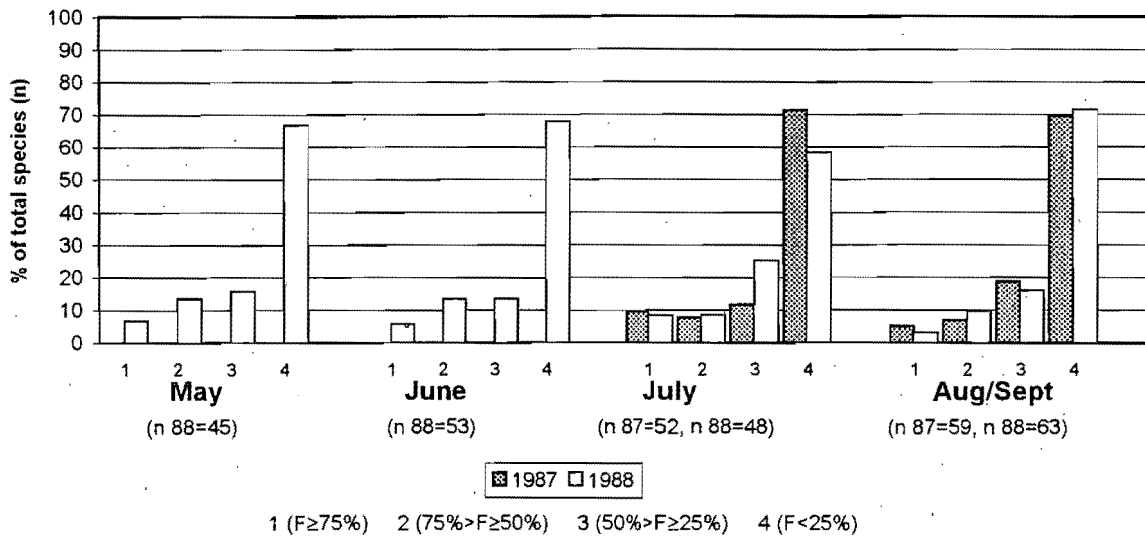


Figure 3. Percent total number of species recorded in May, June, July and August/September 1987 and 1988, by frequency of occurrence (F) as % of visits in a) corn fields b) soybean fields c) apple orchards, and d) vineyards.

c) APPLE



d) GRAPE

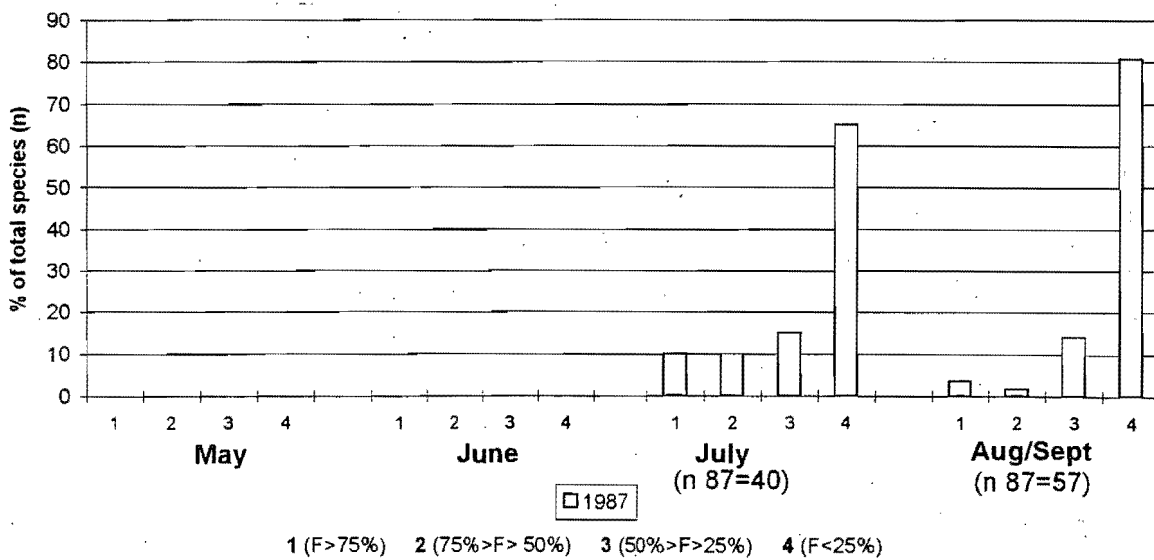


Figure 3 (cont.)

Table 9a. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to corn fields (all counties) in May 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-Feeding; O-other. The main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Robin (AMRO)	Inside and Edge	88	88	3.00	6.0	4.3	3.7	1.9	14.8	7.4	64.8	7.4
Barn Swallow (BARS)	Inside and Edge	88	83	3.78	9.8	6.3	0.0	0.0	0.0	0.0	99.3	0.7
Brown-headed Cowbird (BHCO)	Inside and Edge	88	68	2.22	2.6	5.6	0.0	0.0	28.8	2.5	57.5	11.2
Common Grackle (COGR)	Inside and Edge	88	85	4.97	15.5	24.1	1.7	1.1	0.6	8.9	73.2	14.5
European Starling (EUST)	Inside and Edge	88	68	3.97	27.0	12.7	0.7	0.0	2.8	1.4	89.5	5.6
Horned Lark (HOLA)	Inside and Edge	88	78	2.06	2.3	5.6	0.0	0.0	39.2	1.4	27.0	32.4
Killdeer (KILL)	Inside and Edge	88	73	1.06	1.0	0.5	0.0	0.0	28.9	21.1	42.1	7.9
Red-winged Blackbird (RWBL)	Inside and Edge	88	70	5.06	29.0	23.4	0.0	0.0	20.3	22.0	46.7	11.0
Song Sparrow (SOSP)	Inside and Edge	88	90	4.28	29.0	23.4	0.6	0.0	61.7	16.2	5.2	16.2
Yellow Warbler (YWAR)	Edge Only	88	58	2.19	2.1	8.8	0.0	0.0	82.3	13.9	1.3	2.5

Table 9b. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to corn fields (all counties) in June 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Robin (AMRO)	Inside and Edge	88	65	2.22	3.0	3.1	1.8	0.0	8.8	12.4	61.1	15.9
Barn Swallow (BARS)	Inside and Edge	88	69	3.77	12.7	11.7	0.0	0.0	0.0	0.0	98.4	1.6
Brown-headed Cowbird (BHCO)	Inside and Edge	88	57	1.71	5.2	1.9	0.0	0.0	31.0	4.6	43.7	20.7
Common Grackle (COGR)	Inside and Edge	88	70	5.43	67.8	27.1	0.0	0.0	1.8	5.4	63.5	29.2
European Starling (EUST)	Inside and Edge	88	74	10.1	263.2	108.9	0.0	0.0	0.8	0.6	83.9	14.8
Horned Lark (HOLA)	Inside and Edge	88	77	2.88	4.6	6	0.0	0.7	29.3	1.4	10.9	57.8
Red-winged Blackbird (RWBL)	Inside and Edge	88	77	13.5	365.0	203.7	0.0	0.0	6.4	16.6	52.1	24.9
Song Sparrow (SOSP)	Inside and Edge	88	94	5.12	3.7	7.9	0.4	0.4	60.2	19.5	2.3	17.2

Table 9c. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species bird species detected on at least half of visits (freq \geq 50%) to corn fields (all counties) in July 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visit)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Goldfinch (AMGO)	Inside and Edge	87	52	1.12	1.9	3.3	0.0	0.0	16.0	5.0	19.0	60.0
American Robin (AMRO)	Inside and Edge	87	74	4.26	86.5	143	0.0	0.0	3.4	6.6	28.8	61.2
		88	94	5.65	26.6	25	0.8	0.0	4.2	15.0	54.6	25.4
Barn Swallow (BARS)	Inside and Edge	87	68	3.17	21.6	13.7	0.0	0.0	0.4	0.0	98.6	1.1
		88	85	6.65	24.8	17.7	0.0	0.0	0.0	0.0	96.4	3.6
Horned Lark (HOLA)	Inside and Edge	88	56	1.17	1.6	1.9	1.9	0.0	5.6	3.7	40.7	48.1
House Sparrow (HOSP)	Inside and Edge	88	54	1.5	8.0	10.2	0.0	0.0	0.0	24.6	47.8	27.5
Indigo Bunting (INBU)	Inside and Edge	87	54	0.85	0.9	0.6	0.0	1.3	78.9	6.6	3.9	9.2
		88	66	1.37	0.7	1.4	3.2	0.0	71.4	17.5	0.0	7.9
Red-winged Blackbird (RWBL)	Inside and Edge	87	56	22.32	3957.0	1618	0.1	0.0	1.1	1.0	18.0	80.7
		88	68	40.4	4616.0	3913	0.0	0.0	0.7	1.8	49.8	47.7
Song Sparrow (SOSP)	Inside and Edge	87	94	5.12	8.7	16.7	0.0	3.1	50.9	6.1	2.9	37.1
		88	97	7.35	9.6	12.7	0.6	0.0	53.0	17.2	5.6	23.7

Table 9d. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for species detected on at least half of visits (freq \geq 50%) to corn fields (all counties) in August and September 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Goldfinch (AMGO)	Inside and Edge	87	62	4.25	37.0	32.8	0.1	0.4	1.2	1.8	7.7	88.8
		88	51	1.17	1.9	0.7	0.0	0.0	2.9	16.5	10.7	69.9
American Robin (AMRO)	Inside and Edge	87	60	2.02	8.3	2.5	0.0	0.0	2.8	7.0	3.3	87.0
		88	73	2.72	8.2	2.4	0.0	0.0	0.0	9.6	69.0	21.3
Barn Swallow (BARS)	Inside and Edge	88	64	3.38	18.7	7.3	0.0	0.0	0.0	0.0	98.0	2.0
European Starling (EUST)	Inside and Edge	88	52	8.83	357.0	97.6	0.0	0.0	0.0	0.0	71.4	28.6
House Sparrow (HOSP)	Inside and Edge	87	58	11	346.0	139.0	0.0	0.0	0.1	1.1	19.7	79.1
Mourning Dove (MODO)	Inside and Edge	88	74	3.01	33.4	7.3	0.0	0.0	2.6	0.0	58.9	38.5
Red-winged Blackbird (RWBL)	Inside and Edge	88	57	128.2	68189.0	31233.0	0.0	0.0	0.0	0.0	79.8	20.1
Song Sparrow (SOSP)	Inside and Edge	87	83	5.63	11.3	17.7	0.0	0.5	13.5	6.3	1.6	78.0
		88	80	3.51	10.1	4.9	0.0	0.0	28.8	18.8	20.4	32.0

Table 9e. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq $\geq 50\%$) to Essex County soybean fields in May 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. Main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Crow (AMCR)	Inside and Edge	88	63	0.92	3.6	2.2	0.0	0.0	0.0	0.0	90.9	9.1
American Robin (AMRO)	Edge Only	88	100	1.42	2.1	0.1	0.0	0.0	17.6	11.8	29.4	41.2
Barn Swallow (BARS)	Inside and Edge	88	50	1.67	0.63	0.9	0.0	0.0	0.0	0.0	100.0	0.0
Chipping Sparrow (CHSP)	Edge Only	88	63	0.50	0.5	0.2	0.0	0.0	100.0	0.0	0.0	0.0
Common Grackle (COGR)	Inside and Edge	88	75	3.50	25.5	30.9	0.0	0.0	28.6	2.4	42.9	26.2
European Starling (EUST)	Edge Only	88	50	1.00	3.2	3.2	0.0	0.0	25.0	0.0	0.0	75.0
Horned Lark (HOLA)	Inside and Edge	88	88	4.42	7.1	20.9	0.0	0.0	39.6	0.0	13.2	47.2
House Sparrow (HOSP)	Inside and Edge	88	50	0.58	0.6	0.7	0.0	0.0	0.0	0.0	42.9	57.1
Killdeer (KILL)	Inside and Edge	88	88	0.92	0.6	0.6	0.0	0.0	45.5	9.1	9.1	36.4
Red-winged Blackbird (RWBL)	Inside and Edge	88	50	0.75	3.1	0.4	0.0	0.0	33.3	0.0	22.2	44.4
Song Sparrow (SOSP)	Inside and Edge	88	88	1.83	4.0	2.9	0.0	0.0	63.6	0.0	0.0	36.4
Vesper Sparrow (VESP)	Inside and Edge	88	88	1.00	0.5	0.3	0.0	0.0	50.0	0.0	0.0	50.0

Table 9f. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Essex County soybean fields in June 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities for each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Robin (AMRO)	Inside and Edge	88	65	1.41	1.7	0.3	0.0	0.0	7.3	4.9	46.3	41.5
Barn Swallow (BARS)	Inside Only	88	76	2.48	1.9	8.1	0.0	0.0	0.0	0.0	100.0	0.0
Chipping Sparrow (CHSP)	Inside and Edge	88	54	1.24	1.1	2.5	0.0	0.0	50.0	8.3	19.4	22.2
Common Grackle (COGR)	Inside and Edge	88	59	5.17	29.0	23.4	0.0	0.0	1.3	0.0	56.7	42.0
Horned Lark (HOLA)	Inside and Edge	88	86	4.14	6.0	4.8	0.0	0.0	25.8	0.0	13.3	60.8
House Sparrow (HOSP)	Inside and Edge	88	76	2.41	3.8	1.4	0.0	0.0	0.0	22.9	15.7	61.4
Red-winged Blackbird (RWBL)	Inside and Edge	88	61	3.03	42.7	16.2	0.0	0.0	29.5	2.3	53.4	14.8
Song Sparrow (SOSP)	Inside and Edge	88	80	4.97	5.8	16.6	0.0	0.0	60.4	7.6	2.8	29.2
Vesper Sparrow (VESP)	Inside and Edge	88	51	0.69	0.7	0.2	0.0	0.0	80.0	0.0	0.0	20.0

Table 9g. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq $\geq 50\%$) to Essex County soybean fields in July 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of each species is in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Robin (AMRO)	Inside and Edge	87	66	1.86	3.9	1.9	1.5	1.5	7.5	17.9	29.9	41.8
		88	84	2.44	6.7	1.0	0.0	0.0	5.1	7.7	43.6	43.6
Barn Swallow (BARS)	Inside and Edge	87	79	2.58	5.4	4.2	0.0	0.0	0.0	0.0	84.9	15.1
		88	92	5.63	32.2	28.2	0.0	0.0	0.0	0.0	0.0	100.0
Chipping Sparrow (CHSP)	Inside and Edge	88	83	1.69	1.5	0.7	3.7	0.0	25.9	3.7	40.7	25.9
European Starling (EUST)	Edge Only	87	52	2.17	8.8	8.4	0.0	0.0	3.8	2.6	69.2	24.4
Horned Lark (HOLA)	Inside and Edge	87	56	1.19	2.1	0.2	2.3	0.0	0.0	0.0	4.7	93.0
		88	67	3.38	9.4	9.7	0.0	0.0	3.7	0.0	55.6	40.7
House Sparrow (HOSP)	Inside and Edge	87	82	3.61	13.8	7.7	0.0	0.8	1.5	46.9	11.5	39.2
		88	67	4.75	12.1	11.4	0.0	0.0	0.0	21.1	26.3	52.6
Indigo Bunting (INBU)	Edge Only	87	60	0.97	0.3	0.0	0.0	0.0	80.0	20.0	0.0	0.0
		88	54	1.56	0.7	3.6	0.0	0.0	64.0	4.0	20.0	12.0
Purple Martin (PUMA)	Inside and Edge	87	57	1.14	1.5	0.5	0.0	0.0	2.4	0.0	97.6	0.0
		88	79	3.13	8.0	6.2	0.0	0.0	0.0	0.0	88.0	12.0

Table 9g. continued

Song Sparrow (SOSP)	Inside and Edge	87	89	6.56	6.3	13.1	0.4	0.0	49.6	9.3	1.3	39.4
		88	83	5.56	5.0	12.3	0.0	0.0	52.8	10.1	11.2	25.8
Vesper Sparrow (VESP)	Inside and Edge	87	57	1.06	1.1	0.5	2.6	0.0	63.2	0.0	5.3	28.9
		88	57	0.94	1.0	0.3	6.7	0.0	46.7	0.0	26.7	20.0

Table 9h. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Essex County soybean fields in August and September 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Robin (AMRO)	Inside and Edge	88	68	1.95	2.9	5.1	0.0	0.0	1.3	9.2	80.3	9.2
Barn Swallow (BARS)	Inside and Edge	87	53	2.05	7.2	0.6	0.0	0.0	0.0	0.0	96.3	3.7
		88	87	4.44	36.8	7.1	0.0	0.0	0.0	0.0	97.7	2.3
European Starling (EUST)	Inside and Edge	88	62	4.69	39.5	5.6	0.0	0.0	0.0	0.5	11.5	88.0
House Sparrow (HOSP)	Inside and Edge	88	65	3.08	10.4	3.2	0.0	0.0	0.0	13.3	22.5	64.2
Mourning Dove (MODO)	Inside and Edge	88	61	2.33	23.8	6.4	0.0	0.0	2.2	0.0	35.2	62.6
Northern Cardinal (NOCA)	Inside and Edge	88	51	0.72	0.4	0.4	0.0	0.0	0.0	42.9	46.4	10.7
Song Sparrow (SOSP)	Inside and Edge	87	83	3.91	6.4	4.5	0.0	0.0	24.0	22.1	0.4	53.5
		88	64	2.44	4.7	2.9	0.0	0.0	20.0	11.6	50.5	17.9

Table 9i. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq $\geq 50\%$) to Norfolk County apple orchards in May 1988. VW and VA are mean variances within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Crow (AMCR)	Inside and Edge	88	71	1.13	1.2	0.1	0.0	3.7	0.0	44.4	25.9	25.9
American Robin (AMRO)	Inside and Edge	88	71	2.79	3.7	5.5	0.0	0.0	26.9	16.4	44.8	11.9
Barn Swallow (BARS)	Inside and Edge	88	58	1.58	2.4	1.1	0.0	0.0	0.0	0.0	100.0	0.0
Blue Jay (BLJA)	Inside and Edge	88	50	0.79	0.3	0.7	0.0	0.0	0.0	73.7	5.3	21.1
Brown-headed Cowbird (BHCO)	Inside and Edge	88	71	1.67	2.6	0.1	0.0	0.0	57.5	2.5	17.5	22.5
Chipping Sparrow (CHSP)	Inside and Edge	88	100	7.17	9.4	11.3	0.0	0.0	54.1	26.7	8.1	11.0
European Starling (EUST)	Inside and Edge	88	63	5.00	14.3	37	1.7	0.0	5.0	0.8	67.5	25.0
Savannah Sparrow (SAVS)	Inside and Edge	88	92	4.3	4.6	5.1	1.0	0.0	61.5	14.4	8.7	14.4
Song Sparrow (SOSP)	Inside and Edge	88	79	2.7	2.2	3.9	0.0	0.0	69.2	15.4	3.1	12.3

Table 9j. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Norfolk County apple orchards in June 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Crow (AMCR)	Inside and Edge	88	67	1.89	3.9	0.2	0.0	0.0	0.0	44.1	30.9	25.0
American Robin (AMRO)	Inside and Edge	88	56	1.47	2.3	1.9	0.0	3.8	28.3	18.9	39.6	9.4
Barn Swallow (BARS)	Inside Only	88	64	1.53	2.8	1.3	0.0	0.0	0.0	0.0	100.0	0.0
Brown-headed Cowbird (BHCO)	Inside and Edge	88	58	1.42	3.0	0.4	0.0	0.0	43.1	9.8	29.4	17.6
Chipping Sparrow (CHSP)	Inside and Edge	88	100	6.58	8.2	3.5	1.7	0.0	48.5	39.2	3.0	7.6
Eastern Bluebird (EABL)	Inside and Edge	88	56	1.36	2.0	0.9	0.0	28.6	10.2	34.7	18.4	8.2
European Starling (EUST)	Inside and Edge	88	64	15.4	395.0	581	0.5	0.0	0.5	1.6	91.0	6.3
Mourning Dove (MODO)	Inside and Edge	88	61	1.56	3.1	0.8	0.0	0.0	28.6	0.0	25.0	46.4
Savannah Sparrow (SAVS)	Inside and Edge	88	95	5.81	7.1	9.2	0.5	0.0	68.9	17.2	5.3	8.1
Song Sparrow (SOSP)	Inside and Edge	88	78	2.78	1.0	10.1	0.0	0.0	70.0	22.0	2.0	6.0

Table 9k. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq $\geq 50\%$) to Norfolk County apple orchards in July 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Crow (AMCR)	Inside and Edge	87	51	1.59	2.3	3.5	0.0	3.1	0.0	7.2	13.4	76.3
		88	58	1.92	4.4	0.6	0.0	0.0	0.0	38.4	43.8	17.8
American Goldfinch (AMGO)	Inside and Edge	87	55	1.20	1.7	0.8	0.0	0.0	17.8	1.4	0.0	80.8
		88	86	1.84	1.2	0.7	2.9	0.0	7.1	65.7	4.3	20.0
American Robin (AMRO)	Inside and Edge	87	89	4.18	33.1	5.3	0.0	0.0	12.2	2.4	26.3	59.2
		88	65	3.66	56.6	19.3	0.7	0.0	5.8	14.4	64.7	14.4
Barn Swallow (BARS)	Inside and Edge	87	92	4.10	9.9	6.0	0.0	0.0	0.0	0.0	99.6	0.4
		88	58	1.34	2.3	0.5	0.0	0.0	0.0	0.0	100.0	0.0
Cedar Waxwing (CEDW)	Inside and Edge	87	76	1.38	1.6	0.3	0.0	0.0	0.0	0.0	2.4	97.6
Chipping Sparrow (CHSP)	Inside and Edge	87	98	7.15	11.8	15.8	0.0	8.0	54.6	21.1	5.7	10.6
		88	100	15.0	597.8	349.4	0.2	0.9	20.4	15.1	31.1	32.5
Mourning Dove (MODO)	Inside and Edge	87	91	3.69	17.2	2.6	0.4	0.0	21.8	0.4	23.6	53.8
		88	83	2.90	4.9	3.1	0.0	0.0	19.1	0.9	23.6	56.4
Savannah Sparrow (SAVS)	Inside and Edge	87	62	2.38	3.7	6.0	0.0	0.0	57.2	17.9	13.8	11.0
		88	81	4.58	39.1	16.6	1.1	0.0	42.5	19.0	5.2	32.2
Song Sparrow (SOSP)	Inside and Edge	87	58	2.03	2.7	10.7	0.0	5.6	70.2	8.9	7.3	8.1
		88	65	2.47	3.0	11.8	1.1	0.0	60.6	29.8	1.1	7.4

Table 91. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Norfolk County apple orchards in August and September 1987 and/or 1988. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of each species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Crow (AMCR)	Inside and Edge	87	53	1.36	2.7	0.6	0.0	0.0	0.0	24.2	20.9	54.9
		88	75	2.09	3.9	0.6	0.0	0.0	0.0	26.6	34.0	39.4
American Goldfinch (AMGO)	Inside and Edge	87	54	1.16	2.3	0.8	7.7	0.0	2.6	6.4	15.4	67.9
		88	70	1.67	2.5	1.0	0.0	0.0	4.0	57.3	13.3	25.3
American Robin (AMRO)	Inside and Edge	88	59	2.47	45.0	4.0	0.0	0.0	0.0	12.6	68.5	18.9
Bank Swallow (BANS)	Inside and Edge	87	51	16.8	996.7	572.0	0.0	0.0	0.0	0.0	100.0	0.0
Barn Swallow (BARS)	Inside and Edge	87	70	6.12	44.6	8.9	0.0	0.0	0.0	0.0	98.8	1.2
		88	68	2.36	7.6	0.6	0.0	0.0	0.0	0.0	100.0	0.0
Cedar Waxwing (CEDW)	Inside and Edge	87	87	2.87	6.8	1.3	1.6	0.5	0.0	3.6	18.2	76.0
		88	72	3.89	38.5	5.3	0.0	0.0	0.0	21.1	33.7	45.1
Chipping Sparrow (CHSP)	Inside and Edge	87	95	17.4	429.3	260.1	0.0	1.8	1.1	8.7	45.8	42.5
		88	95	31.5	1326.1	998.6	0.2	0.1	2.0	8.1	62.4	27.2
Eastern Bluebird (EABL)	Inside and Edge	88	57	2.60	7.2	3.3	0.0	3.4	0.0	14.5	72.6	9.4
Mourning Dove (MODO)	Inside and Edge	87	91	5.63	42.9	32.2	0.0	0.0	7.2	0.0	31.8	61.0
		88	81	3.71	14.2	7.6	0.0	0.0	4.8	0.0	29.3	65.9

Table 9m. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Niagara County grape vineyards in July 1987. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. Main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Goldfinch (AMGO)	Inside and Edge	87	92	4.60	8.7	10.0	0.0	0.0	28.6	0.0	12.4	59.0
American Robin (AMRO)	Inside and Edge	87	95	7.51	43.2	14.7	0.0	0.4	14.1	0.0	17.5	68.1
Chipping Sparrow (CHSP)	Inside and Edge	87	94	8.06	1.8	0.4	0.0	0.0	0.0	0.0	50.0	50.0
Eastern Kingbird (EAKI)	Inside and Edge	87	64	1.46	1.3	1.2	0.0	0.0	33.3	0.0	3.9	62.7
Killdeer (KILL)	Inside and Edge	87	70	1.83	2.6	2.2	0.0	0.0	76.6	0.0	6.2	17.2
Red-winged Blackbird (RWBL)	Inside and Edge	87	56	6.34	222	19.6	0.0	0.0	0.9	0.0	55.4	43.7
Savannah Sparrow (SAVS)	Inside and Edge	87	62	2.69	8.4	5.8	0.0	10.6	24.5	0.0	12.8	52.1
Song Sparrow (SOSP)	Inside and Edge	87	86	3.17	5.0	2.7	0.0	3.6	46.8	0.0	4.5	45.0

Table 9n. Mean number of individuals per field and the proportions of individuals involved in each of six breeding and feeding activities for bird species detected on at least half of visits (freq \geq 50%) to Niagara County grape vineyards in August and September in 1987. VW and VA are mean variance within and among fields, respectively. N-nesting; FY-fledged young; T-territorial; C-calling; F-feeding; O-other. The main activities of the species are in bold print.

Species	Location in Field	Year	Freq (% visits)	Individuals/Field			Activity (% individuals)					
				mean	VW	VA	N	FY	T	C	F	O
American Goldfinch (AMGO)	Inside and Edge	87	81	2.81	6.1	0.4	0.7	0.7	31.5	0.0	12.1	55.0
American Robin (AMRO)	Inside and Edge	87	77	10.9	161	53.8	0.0	0.2	1.9	0.0	2.6	95.3
Chipping Sparrow (CHSP)	Inside and Edge	87	69	2.85	10.1	4.2	0.7	4.0	16.6	0.0	10.6	68.2

Corn

A total of 14 species was recorded during more than 50% of visits in all corn fields (Tables 9a-d). May corresponds to the interval of pesticide treatment in these cropfields (Table 6) and thus the period where birds are likely to be exposed when feeding or nesting inside or nearby fields. Territorial species may be also at risk since individuals spend much time in or near cropfields.

The Song Sparrow occurred most frequently every month (80-97%) with between 3.5 and 7.3 individuals recorded per field per visit through the seasons. The species was observed in territorial activity throughout the breeding season. Common Grackle, Common Grackle, American Robin and Barn Swallow were also common in May. American Robin, Brown-headed Cowbird and Horned Lark, although not very numerous, were seen frequently all summer.

Evidence of nesting was found for the American Goldfinch, American Robin, Common Grackle, European Starling, Horned Lark, Indigo Bunting, Red-winged Blackbird and Song Sparrow. The American Robin and Common Grackle had already produced fledged young by May whereas presence of fledglings was detected later in the case of the American Goldfinch, Horned Lark, Indigo Bunting and Song Sparrow. By far the most common activity recorded in May and June was feeding either inside or near cornfields. For species such as American Robin, Barn Swallow, Brown-headed Cowbird, Common Grackle, European Starling and Red-winged Blackbird, feeding was the predominant activity in May and June. Territorial behaviour was also notable for the Horned Lark, Indigo Bunting, Song Sparrow and Yellow Warbler from May to July.

The mean abundance per field of European Starlings and Red-winged Blackbirds

increased considerably in June. Associated variances were also very high in June, indicating a high degree of movement among and within fields in relatively large numbers of flocks. This was particularly characteristic of later months. In July and August/September, new species were found to occupy fields more frequently, e.g. the American Goldfinch and Indigo Bunting made use of fields and edges for nesting and feeding whereas the House Sparrow and Mourning Dove was found feeding in or near cornfields. Conversely, the Killdeer and Yellow Warbler were observed less regularly (<50%) after May (Appendix D).

Soybean

Sixteen species were regularly detected inside or in the vicinity of soybean fields (Tables 9e-h). In the case of soybean, May and June coincide with pesticide application (Table 6), therefore twelve species are more at risk. Common Grackle, Horned Lark and Song Sparrow were the most numerous species in those two months.

None of the 16 most numerous bird species were seen nesting during May and June inside or near soybean fields although several species were engaged in territorial displays. Feeding was the other main activity recorded in May and June. Evidence of nesting was exclusively noticed in July for the American Robin, Chipping Sparrow, Horned Lark, Song Sparrow, and Vesper Sparrow, and only fledged young of the American Robin, and House Sparrow were observed associated with soybean fields. The Killdeer was only seen on more than 50% of the visits in May as in cornfields (Tables 9a-d). Four new species were observed using soybean fields during the later months of July through September for feeding and activities associated with breeding such as territoriality and calling; these species were Indigo Bunting, Mourning Dove, Northern Cardinal and Purple Martin. Large increase in number of species and individuals was not noticed in late summer

and fall in soybean fields indicating that this crop is less attractive than corn as a major feeding source for flocks of blackbirds.

Apple

A total of 14 species occurred during at least 50% of visits in apple orchards (Tables 9i-l). All species were seen both inside fields and field edges. In apple orchards pesticides were applied regularly from late March to the end of August (Table 6), therefore birds are subject to exposures the entire period they spend in the orchard during and after the breeding season.

The Chipping Sparrow was the most frequently detected species (95-100%) regularly seen in relatively large numbers (6.6-31.5) (Tables 9i-l). Other sparrows were commonly observed, e.g. the Savannah Sparrow and Song Sparrow, also nesting in orchards.

Several species were observed foraging in the studied orchards. This was the main activity of the American Robin, Barn Swallow and European Starling in May and June, and of the Bank Swallow, Chipping Sparrow and Eastern Bluebird later in the season. Territory establishment was a commonly noted activity for several species, including the Brown-headed Cowbird, Chipping Sparrow, Savannah Sparrow, Song Sparrow for which it was the main activity recorded at the onset of the season. Of the 14 major species recorded, ten nested or produced fledged young, among them the Cedar Waxwing, Eastern Bluebird and Mourning Dove.

Blue Jays, frequently seen in May, were detected at fewer than 25% of visits in orchards during June and July, and were only occasional visitors during the last two months of the survey (Tables 9i-l, Appendix D). Savannah and Song Sparrows had dispersed by August and were no longer frequently observed at orchards. The

American Goldfinch and Cedar Waxwing were seen nesting later in the season i.e. from July to early fall. Bank Swallows, which were rare in the spring and early summer were seen during more than 51% of visits in 1987 (only 35% of visits in 1988).

Evidence of flocking was seen for the European Starling in June (very large variances within and among fields) as well as later in the season for the Bank Swallow and Chipping Sparrow, and to a lesser extent for the American Robin, Barn Swallow, Cedar Waxwing, Mourning Dove and Savannah Sparrow.

Grape

Eight species were recorded during at least one half of visits in vineyards, all of which were detected both within the field and in edges (Tables 9m-n). Assuming that the risk of contact with pesticides is directly related to how often birds were seen in or near vineyards, risk of exposure was highest for the American Goldfinch, American Robin, Chipping and Song Sparrows, all of which produced fledged young. Fledged young were also seen for the Savannah Sparrow. Flocking was observed for the Red-winged Blackbird and American Robin.

All species were seen engaged in territorial behaviour during the season although evidence of nesting was recorded for only two species. Conversely, all species used the vineyard for feeding in July and August/September.

Bird crop preference

Common species

Results of analyses of variance for the most common species in at least one crop (recurrent or regular birds, inside or in field edge combined) is given in Table 10. In early spring (May, Table 10a) abundances of Barn Swallow, Common Grackle,

Table 10a. Mean (Standard Error) number of individuals of bird species observed in at least 50% of visits to fields of at least one of three common crops in southern Ontario during May, 1988 (n = 5-6 fields for soybean and apples and 12 fields for corn [6 per county]). Species showing significant differences are in bold print.

SPECIES	CROP						EFFECT			
	Corn		Soybean		Apple		Crop		County	
	mean	SE	mean	SE	mean	SE	F	P	F	P
American Crow	0.61	0.29	0.92	0.78	1.13	0.31	1.12	0.35	0.43	0.52
American Robin	3	1.1	1.42	0.64	2.79	1.91	1.12	0.35	8.57	0.008
Barn Swallow	3.78^a	1.38	1.67^{ab}	1.3	1.58^b	0.87	4.51	0.02	4.78	0.04
Brown-headed Cowbird	2.22	1.22	0.33	0.35	1.67	0.28	1.95	0.17	9.27	0.006
Blue Jay	0.47	0.2	0	0	0.79	0.68	0.14	0.87	3.31	0.08
Chipping Sparrow	0.61^a	0.36	0.50^a	0.32	7.17^b	2.75	19.7	0.0001	0.42	0.53
Common Grackle	4.97^a	2.53	3.50^{ab}	2.94	1.21^b	1.34	3.55	0.048	3.4	0.08
European Starling	3.97	1.84	1	0.91	5	4.96	0.06	0.94	4.13	0.06
Horned Lark	2.06	1.09	4.42	2.84	0.13	0.25	0.85	0.44	1.17	0.29
House Sparrow	0.53	0.29	0.58	0.46	0	0	1.36	0.28	1.08	0.31
Killdeer	1.06^a	0.34	0.92^a	0.53	0.17^b	0.25	5.45	0.013	1.39	0.25
Red-winged Blackbird	5.06^a	2.43	0.75^b	0.44	0.13^b	0.17	15.7	0.0001	19.3	0.0003
Savannah Sparrow	0.97^a	0.77	0.92^a	0.83	4.33^b	1.84	5.76	0.01	1.24	0.28
Song Sparrow	4.28	1.35	1.83	1.12	2.71	1.61	2.04	0.16	1.8	0.19
Vesper Sparrow	0.44	0.4	1	0.52	0.29	0.27	0.32	0.73	8.65	0.008
Yellow Warbler	2.19^a	1.51	0^b	0	0.04^b	0.08	5.93	0.01	8.1	0.01

^{abc} means followed by a different superscript are significantly different (P < 0.017, Sidak equality test; P < 0.05, ANOVA).

Table 10b. Mean (Standard Error) number of individuals of bird species observed in at least 50% of visits to fields of at least one of three common crops in southern Ontario during June, 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Species showing significant differences are in bold print.

SPECIES	CROP						EFFECT			
	Corn		Soybean		Apple		Crop		County	
	mean	SE	mean	SE	mean	SE	F	P	F	P
American Crow	0.20 ^a	0.15	0.79 ^b	0.51	1.89 ^c	0.49	28.2	0.0001	0.01	0.93
American Robin	2.22	1.07	1.41	0.52	1.47	1.37	2.03	0.16	4.24	0.053
Barn Swallow	3.77 ^a	2.11	2.48 ^a	2.78	1.53 ^b	1.13	5.42	0.01	9.48	0.006
Brown-headed Cowbird	1.71	0.83	0.83	0.72	1.42	0.62	0.96	0.4	2.81	0.11
Chipping Sparrow	0.49 ^a	0.43	1.24 ^a	1.45	6.58 ^b	1.88	29.7	0.0001	0.66	0.43
Common Grackle	5.43 ^a	3.15	5.17 ^a	4.23	0.64 ^b	0.69	5.46	0.013	3.89	0.06
Eastern Bluebird	0.16 ^a	0.3	0 ^a	0	1.36 ^b	0.96	4.97	0.018	0.5	0.49
European Starling	10.1	6.5	3.41	4.31	15.4	24.1	0.02	0.98	1.02	0.32
Horned Lark	2.88	1.46	4.14	1.9	0.03	0.07	1.66	0.22	4.76	0.04
House Sparrow	0.84 ^b	0.52	2.41 ^a	1.06	0.06 ^b	0.14	8.47	0.002	0.73	0.4
Mourning Dove	1.47	0.9	1.41	1.26	1.56	0.92	0.24	0.79	1.22	0.28
Red-winged Blackbird	13.5 ^a	8.88	3.03 ^a	3.34	0.06 ^b	0.14	10.9	0.0006	12.29	0.002
Savannah Sparrow	1.78	1.96	0.9	0.89	5.81	3.04	2.29	0.13	0.85	0.37
Song Sparrow	5.12	1.72	4.97	3.88	2.78	3.17	1.64	0.22	0.96	0.34
Vesper Sparrow	0.65	0.44	0.69	0.45	0.36	0.22	0.21	0.81	0.38	0.54

^{abc} means followed by a different superscript are significantly different ($P < 0.017$, Sidak equality test; $P < 0.05$, ANOVA).

Table 10c. Mean (Standard Error) number of individuals of bird species observed in at least 50% of visits to fields of at least one of three common crops in southern Ontario during July, 1987 (n = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 per county]) and July 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Species showing significant differences are in bold print.

SPECIES		CROP								EFFECT			
		Corn		Soybean		Apple		Grape		Crop		County	
		mean	SE	mean	SE	mean	SE	mean	SE	F	P	F	P
American Crow	87	0.15	0.13	0.22	0.42	1.59	2.41	0.17	0.16	2.4	0.09	0	1
	88	0.30^a	0.29	0.88^{ab}	0.83	1.92^b	0.79			9.06	0.002	0.77	0.39
American Goldfinch	87	1.12	0.79	0.39	0.43	1.2	1.16	4.6	3.16	0.68	0.57	6.4	0.01
	88	0.78	0.43	0.63	0.55	1.84	0.85			2.59	0.1	2.65	0.12
American Robin	87	4.26	4.9	1.86	1.31	4.18	3.1	7.51	3.75	1.05	0.39	5.2	0.01
	88	5.65	3.35	2.44	0.61	3.66	4.92			0.78	0.47	1.07	0.31
Barn Swallow	87	3.17^a	1.62	2.58^a	2.19	4.10^a	3.05	0.60^b	0.97	4.88	0.01	3.6	0.04
	88	6.63^a	2.36	5.63^a	3.15	1.34^b	0.73			10.3	0.001	5.57	0.03
Cedar Waxwing	87	0.29^{ab}	0.27	0.53^{bc}	0.58	1.38^c	0.78	0.06^a	0.14	6.22	0	1.2	0.32
Chipping Sparrow	87	0.35^a	0.3	0.86^a	1.13	7.15^b	4.91	8.06^b	2.78	16.7	0	0	0.99
	88	1.09	0.7	1.69	0.54	15	18.9			3.04	0.07	0.01	0.92
Eastern Kingbird	87	0.39	0.47	0.03	0.06	0.28	0.38	1.46	1.09	0.11	0.95	6.8	0
European Starling	87	7.01	13.56	2.17	2.62	2.97	5.05	10.2	10.6	0.86	0.47	1.3	0.3
Horned Lark	87	0.91	0.56	1.19	0.41	0	0	0.8	0.91	1.3	0.29	1.9	0.16
	88	1.17	0.69	3.38	2.13	0.42	1.02			0.94	0.41	0.85	0.37
House Sparrow	87	2.72	2.18	3.61	2.79	0.8	1.79	7.54	15.6	0.11	0.95	0.9	0.42
	88	1.5	1.18	4.75	2.03	0.18	0.4			3.04	0.07	0.06	0.81
Indigo Bunting	87	0.85^a	0.4	0.97^a	0.94	0.11^b	0.33	0.09^b	0.2	3.51	0.03	0.4	0.67
	88	1.37	0.67	1.56	1.28	0.4	1.03			1.81	0.19	0.4	0.53
Kildeer	87	0.29	0.23	0.25	0.18	0.15	0.18	1.83	1.44	2.73	0.06	0.6	0.53
Mourning Dove	87	0.88^a	0.49	0.44^a	0.37	3.69^b	2.2	1.11^a	1.27	9.21	0	1	0.39
	88	0.98^a	0.55	1.06^{ab}	0.59	2.90^b	1.84			3.61	0.05	0.63	0.44
Purple Martin	87	0.48	0.31	1.14	0.75	0.25	0.25	0	0	1.19	0.33	2.7	0.08
	88	1.26	1.01	3.13	1.86	1	1.55			1.36	0.28	0.21	0.65
Red-winged Blackbird	87	22.32^a	20.1	1.47^a	1.58	0.02^b	0.06	6.34^{ab}	4.27	6.24	0	7.1	0
	88	40.4^a	30.8	6.19^{ab}	4.99	0^b	0			4.17	0.03	2.38	0.14
Savannah Sparrow	87	1.36	1.43	0.69	0.85	2.38	3.12	2.69	2.39	0.09	0.97	0.8	0.45
	88	2.35	2.44	0.75	0.63	4.58	4.1			0.28	0.76	1.21	0.28
Song Sparrow	87	5.12^{ab}	2.05	6.56^a	3.43	2.03^c	4.06	3.17^b	1.64	4.73	0.01	4.1	0.03
	88	7.35^a	2.06	5.56^{ab}	1.95	2.47^b	3.48			5.97	0.009	1.66	0.21
Vesper Sparrow	87	0.42	0.27	1.06	0.67	0.48	0.76	0.34	0.74	1.09	0.37	0.1	0.9
	88	0.52	0.48	0.94	0.31	0.32	0.33			1.19	0.32	16.2	0.001

^{abc} means followed by a different superscript are significantly different (P < 0.008, Sidak equality test; P < 0.05, ANOVA).

Table 10d. Mean (Standard Error) number of individuals of bird species observed in at least 50% of visits to fields of at least one of three common crops in southern Ontario during the autumn staging and migration period (August and September) 1987 (n = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 per county]) and 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Species showing significant differences are in bold print.

SPECIES		CROP								EFFECT			
		Corn		Soybean		Apple		Grape		Crop		County	
		mean	SE	mean	SE	mean	SE	mean	SE	F	P	F	P
American Crow	87	0.16 ^a	0.2	0.03 ^a	0.1	1.36 ^b	1.02	0.04 ^a	0.1	14	0	1.2	0.32
	88	0.28 ^a	0.55	0.39 ^a	0.57	2.09 ^b	0.83			9.11	0.002	1.92	0.18
American Goldfinch	87	4.25 ^a	4.9	0.55 ^b	0.7	1.16 ^{ab}	1.22	2.81 ^{ab}	1	3.2	0.04	12	0
	88	1.17	0.68	0.85	1.18	1.67	1.1			0.23	0.8	6.34	0.02
American Robin	87	2.02 ^a	1.4	1.50 ^a	2.4	1.84 ^a	3.57	10.9 ^b	8.8	6.8	0	0.1	0.92
	88	2.72	1.23	1.95	2.29	2.47	2.15			0.58	0.57	0.52	0.48
Bank Swallow	87	5.75 ^b	1.7	0.71 ^b	0.3	16.81 ^a	4.53	0.02 ^b	0	6.9	0.001	15	0.001
Barn Swallow	87	2.53 ^a	1.4	2.05 ^a	1	6.12 ^b	4.11	2.15 ^a	3.6	4.8	0.01	1.2	0.33
	88	3.38	2.11	4.44	2.86	2.36	0.84			2.42	0.11	2.47	0.13
Cedar Waxwing	87	0.83	1	1.06	1.6	2.87	1.57	0.06	0.1	2.6	0.07	3.1	0.06
	88	1.16	1.81	0.82	0.83	3.89	2.53			0.68	0.52	7.07	0.015
Chipping Sparrow	87	0.48 ^a	0.5	0.61 ^a	1.1	17.4 ^b	23.03	2.85 ^a	2.4	6.7	0	0	0.99
	88	0.53 ^a	0.47	0.56 ^a	1.05	31.5 ^b	37			5.31	0.01	0	0.97
Eastern Bluebird	88	0 ^a	0	0 ^a	0	2.60 ^b	2.01			12.9	0.001	0	1
European Starling	88	8.83	7.94	4.69	2.48	16.6	29.2			0.18	0.84	0.46	0.51
House Sparrow	87	11.0 ^a	9.9	3.20 ^{ab}	5.8	0.78 ^b	1.49	5.98 ^{ab}	16	3.4	0.03	7.4	0
	88	3.59	4	3.08	1.89	0.58	0.96			0.81	0.46	2.81	0.11
Mourning Dove	87	2.70 ^{ab}	3.6	1.20 ^{bc}	1	5.63 ^a	7.99	0.98 ^c	0.8	3.8	0.02	4.6	0.02
	88	3.01	2.17	2.33	2.61	3.71	3.04			0.02	0.98	0.39	0.54
Northern Cardinal	88	0.41	0.53	0.72	0.67	0.27	0.2			0.86	0.44	0.26	0.62
Red-winged Blackbird	88	128.2 ^a	138.5	1.51 ^a	1.89	0.40 ^b	1.14			8.22	0.003	14.2	0.001
Song Sparrow	87	5.63 ^a	3.5	3.91 ^a	2.8	0.93 ^b	1.84	0.77 ^c	0.7	20	0	23	0
	88	3.51	1.75	2.44	1.76	1.38	2.82			3.09	0.07	2.2	0.15

^{abc} means followed by a different superscript are significantly different (P < 0.008, Sidak equality test; P < 0.05, ANOVA).

Killdeer, Red-winged Blackbird and Yellow Warbler stand out as being significantly higher in cornfields, whereas Chipping Sparrow and Savannah Sparrow were highest in apple orchards. Differences were similar in June for the Chipping Sparrow (Table 10b). The Barn Swallow, Common Grackle and Red-winged Blackbird were still common in cornfields in June with the addition that they were also found in large numbers in soybean, together with the American Crow and House Sparrow. The American Crow and Eastern Bluebird were present in significantly higher numbers in apple orchards.

During mid-summer (July) of both years (Table 10c) Red-winged Blackbird numbers were very high in cornfields. Barn Swallow was recorded in high numbers associated with field crops both years and was also registered in high numbers in apple orchards in 1987. Song Sparrows and Indigo Bunting preferred soybean and corn fields both years. American Crow numbers were highest in orchards, although this was significant only in 1988. Chipping Sparrow were significantly higher in both orchards and vineyards than in the field crops in 1987. Similarly, Cedar, Waxwings (in 1987) and Mourning Doves (both in 1987 and 1988) were highest in orchards.

During the staging and migration period in late summer and early fall (Table 10d), numbers of Red-winged Blackbird were extremely high and variable in cornfields in 1988, but they were rarely seen in the other crops. American Goldfinch and House Sparrow were high in corn fields with significant differences apparent only in 1987. The Song Sparrow was also frequently observed in soybean fields. American Crow, Bank Swallow, Barn Swallow, Chipping Sparrow, Eastern Bluebird and Mourning Dove were highest in apple orchards in at least one year whereas American Robins preferred vineyards.

A few significant differences occurred between counties for individual species for average numbers of birds.

Feeding/foraging guilds - all species

Results of the analyses of variances for crop preference of foraging guilds are given in Table 11. Most notable are the significantly higher numbers of aerial and tree-foraging insectivores at most seasons in corn fields. Barn Swallows were highest in corn in May and June 1988 and July 1987 and 1988 in the individual species analyses. The cause of their preference for corn fields may also be responsible for the attractiveness to other members of the aerially foraging community, including several other species of swallows (e.g. Bank, Cliff and Tree Swallow) that were also included in the guild analysis. Similarly, the attraction of Yellow Warblers, classified as low-canopy insectivores, to corn, as indicated in the individual species analysis, may indicate some property of corn fields that is generally attractive to the other warblers, vireos, chickadees and nuthatches that were also include in the guild analysis. Numbers of ground-foraging omnivores, including blackbirds, sparrows and most finches, were not unexpectedly high in corn fields during late summer and early fall, but were so variable that the difference was significant only in fall 1988 (Table 11d).

The greater use of apple orchards by such species as American Crows, Chipping Sparrows and Eastern Bluebirds may be a function of their habit of nesting in trees, rather than any foraging preferences.

In all crops ground feeders were most prevalent (Figure 4), and this is especially apparent in vineyard (Figure 4d).

Table 11a: Mean (Standard Error) numbers of birds of different foraging/feeding guilds observed in fields of three common crops in southern Ontario during May, 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Guilds showing significant differences are in bold print.

GUILD ^d	CROP						EFFECT			
	Corn		Soybean		Apple		Crop		County	
	mean	SE	mean	SE	mean	SE	F	P	F	P
AQ	0.28	0.23	0.08	0.12	0	0	1.59	0.23	0.16	0.70
CA	0.06	0.07	0	0	0.21	0.24	1.61	0.23	0.12	0.73
FR	0.03	0.04	0.25	0.24	0.13	0.25	1.20	0.32	0.07	0.79
FRT	0.11	0.16	0	0	1.83	2.99	1.22	0.32	0.02	0.90
GR	1.33	0.50	1.25	0.93	0.75	0.55	1.48	0.25	1.42	0.25
HE	0.44	0.47	0	0	0	0	2.06	0.15	2.75	0.11
INA	11.4^a	5.48	4.25^{ab}	2.23	3.13^b	0.99	6.64	0.006	8.98	0.007
ING	1.83	0.86	0.92	0.53	0.92	0.63	2.03	0.16	2.38	0.14
INT	3.31^a	1.79	0.08^b	0.12	0.46^b	0.35	10.7	0.0007	17.23	0.0005
OMA	0.03	0.04	0	0	0	0	1.00	0.39	1.33	0.26
OMG	31.0	8.60	16.8	7.84	29.3	8.24	1.83	0.19	14.63	0.001
OMT	0.78	0.38	0.50	0.58	0.46	0.40	0.56	0.58	0.13	0.72
VE	0	0	0	0	0	0				

^{abc} means followed by a different superscript are significantly different ($P < 0.017$, Sidak equality test; $P < 0.05$, ANOVA).

^d See Appendix C for major species in each guild.

Table 11b. Mean (Standard Error) numbers of birds of different foraging/feeding guilds observed in fields of three common crops in southern Ontario during June, 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Guilds showing significant differences are in bold print.

GUILD ^d	CROP						EFFECT			
	<u>Corn</u>		<u>Soybean</u>		<u>Apple</u>		<u>Crop</u>		<u>County</u>	
	<i>mean</i>	<i>SE</i>	<i>mean</i>	<i>SE</i>	<i>mean</i>	<i>SE</i>	<i>F</i>	<i>P</i>	<i>F</i>	<i>P</i>
AQ	0.08	0.08	0.86	1.02	0.03	0.07	2.60	0.10	0.03	0.87
CA	0.08	0.07	0.17	0.20	0.17	0.26	0.61	0.55	0.03	0.86
FR	0.10	0.15	0.17	0.20	0.75	1.60	0.71	0.50	0.09	0.76
FRT	0.47	0.29	0	0	0.58	0.52	0.91	0.42	16.2	0.0007
GR	2.31	1.12	3.86	1.99	1.61	0.95	3.23	0.06	1.58	0.22
HE	0.28	0.52	0	0	0	0	1.15	0.33	1.80	0.20
INA	7.31^a	4.49	5.52^a	4.86	3.39^b	2.34	4.98	0.02	9.39	0.006
ING	1.35	0.80	0.83	0.74	1.44	1.02	0.33	0.72	3.54	0.075
INT	3.02^a	2.54	0.52^b	0.83	1.11^b	0.65	5.36	0.01	13.2	0.002
OMA	0	0	0	0	0	0
OMG	46.1	18.7	27.5	9.82	38.9	27.8	1.65	0.22	6.5	0.02
OMT	0.82	0.49	1.21	1.12	0.33	0.59	1.00	0.38	0.09	0.77
VE	0	0	0	0	0	0

^{abc} means followed by a different superscript are significantly different ($P < 0.017$, Sidak equality test; $P < 0.05$, ANOVA).

^d See Appendix C for major species in each guild.

Table 11c. Mean (Standard Error) numbers of birds of different foraging/feeding guilds observed in fields of four common crops in southern Ontario during July, 1987 (n = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 in each county]) and 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 in each county]). Guilds showing significant differences are in bold print.

Guild ^d		CROP								EFFECT			
		Corn		Soybean		Apple		Grape		Crop		County	
		mean	SE	mean	SE	mean	SE	mean	SE	F	P	F	P
AQ	87	0.14	0.19	0.11	0.20	0.02	0.06	0.20	0.40	0.32	0.81	0.91	0.41
	88	0.02	0.04	0	0	0.03	0.07			0.78	0.47	0.06	0.81
CA	87	0.05	0.07	0.03	0.07	0.05	0.07	0.17	0.21	0.37	0.77	0.77	0.47
	88	0.02	0.04	0	0	0.03	0.07			0.01	0.99	0.62	0.44
FR	87	0.02	0.03	0.14	0.17	0.12	0.29	3.43	4.69	2.11	0.12	0.00	0.99
	88	0.52	0.42	0.50	0.36	0.76	1.24			0.27	0.76	1.61	0.22
FRT	87	0.29^{ab}	0.27	0.53^{bc}	0.58	1.38^c	0.78	0.06^a	0.14	6.22	0.002	1.18	0.32
	88	1.35	0.76	0.31	0.40	0.84	0.75			3.11	0.07	10.1	0.005
GR	87	3.71	2.49	4.06	3.02	4.49	2.73	8.66	16.1	0.21	0.89	1.24	0.30
	88	2.48	1.49	5.81	2.42	3.11	1.71			1.83	0.19	0.05	0.82
HE	87	0	0	0	0	0	0	0.11	0.27	0.70	0.56	0.00	1.00
	88	0	0	0	0	0	0						
INA	87	11.09^a	6.45	4.08^b	3.05	8.23^b	4.71	2.11^b	1.71	3.93	0.02	7.41	0.002
	88	28.4 ^a	17.1	11.6 ^a	7.52	3.95 ^b	2.54			7.33	0.01	7.79	0.01
ING	87	0.33^a	0.25	0.36^{ab}	0.40	1.75^b	1.88	2.34^b	2.02	3.00	0.05	0.25	0.78
	88	0.35 ^a	0.27	0.75 ^{ab}	0.69	1.71 ^b	1.34			4.48	0.03	0.03	0.86
INT	87	1.24^a	0.57	0.72^a	0.62	1.31^a	1.4	0.29^b	0.59	3.33	0.03	3.22	0.05
	88	6.20 ^a	3.72	0.44 ^a	0.44	1.55 ^b	1.57			7.36	0.01	11.2	0.003
OMA	87	0.01	0.02	0	0	0.02	0.06	0	0	0.20	0.90	1.38	0.27
	88	0	0	0	0	0.03	0.06			1.22	0.32	0.00	1.00
OMG	87	47.0	33.7	20.0	6.31	24.2	6.2	45.7	7.88	2.60	0.07	4.59	0.02
	88	78.3	40.3	27.4	9.48	42.0	24.5			2.9	0.08	4.4	0.05
OMT	87	1.26^a	0.81	1.11^a	1.13	0.23^a	0.36	0.17^b	0.21	3.48	0.03	1.56	0.23
	88	1.96	0.95	1.81	1.56	0.45	1.00			3.07	0.07	1.28	0.27
VE	87	0.03	0.10	0	0	0	0	0	0	1.32	0.29	2.39	0.11
	88	0	0	0	0	0	0						

^{abc} means followed by a different superscript are significantly different ($P < 0.008$, Sidak equality test; $P < 0.05$, ANOVA).

^d See Appendix C for major species in each guild.

Table 11d. Mean (Standard Error) numbers of birds of different foraging/feeding guilds observed in fields of four common crops in southern Ontario during the autumn staging and migration period (August and September), 1987 (n = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 per county]) and 1988 (n = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]). Guilds showing significant differences are in bold print.

Guild ^d	CROP									EFFECT			
	Corn		Soybean		Apple		Grape		Crop		County		
	mean	SE	mean	SE	mean	SE	mean	SE	F	P	F	P	
AQ	87	0.03	0.04	0.06	0.09	0.05	0.15	0.06	0.07	0.90	0.45	1.04	0.37
	88	0.19	0.23	0.26	0.34	0.07	0.13			0.24	0.79	0.09	0.76
CA	87	0.23	0.13	0.17	0.15	0.09	0.15	0.19	0.19	1.45	0.25	4.94	0.01
	88	0.13	0.07	0.23	0.25	0.13	0.26			0.81	0.46	0.26	0.62
FR	87	0.02	0.04	0.18	0.30	0.10	0.30	4.87	10.7	2.20	0.11	0.00	0.99
	88	0.11 ^a	0.17	0.08 ^a	0.21	1.09 ^b	1.14			4.15	0.03	0.46	0.50
FRT	87	0.83	0.96	1.06	1.60	2.87	1.57	0.06	0.13	2.63	0.07	3.08	0.06
	88	1.60	1.81	0.82	0.83	3.89	2.53			0.68	0.52	7.07	0.02
GR	87	14.0 ^a	12.2	4.39 ^b	6.13	6.40 ^b	9.23	6.96 ^b	16.3	4.17	0.01	11.08	0
	88	6.60	5.18	5.41	2.61	4.29	3.66			0.40	0.68	0.72	0.41
HE	87	0	0	0	0	0	0	0	0				
	88	0	0	0	0	0	0						
INA	87	11.5	11.6	4.85	4.26	24.2	37.4	2.49	3.50	0.12	0.95	2.92	0.07
	88	20.8 ^a	23.2	8.59 ^b	5.05	8.00 ^b	7.38			3.66	0.04	9.19	0.01
ING	87	0.58 ^a	0.88	0.32 ^a	0.38	2.40 ^b	2.80	1.38 ^a	1.89	3.03	0.05	1.25	0.30
	88	1.57	1.59	0.69	0.43	2.69	1.91			0.30	0.74	0.97	0.34
INT	87	2.06 ^a	1.52	0.85 ^a	0.66	1.55 ^a	0.84	0.57 ^b	0.85	3.99	0.02	5.21	0.01
	88	3.83	2.02	3.05	3.22	3.56	1.62			2.31	0.13	11.4	0.01
OMA	87	0.04	0.09	0	0	0.13	0.28	0	0	0.33	0.80	0.70	0.50
	88	0.50 ^a	0.47	0 ^b	0	0.09 ^b	0.19			15.2	0.01	35.4	0.01
OMG	87	260	521.7	11.3	7.02	42.4	44.7	30.4	19.6	1.40	0.26	2.40	0.11
	88	157 ^a	149.0	18.3 ^b	7.23	62.4 ^b	54.9			5.8	0.01	14.8	0.01
OMT	87	0.78	0.62	0.58	0.80	0.21	0.35	0.60	0.74	1.58	0.21	4.33	0.02
	88	1.25	0.80	1.31	1.25	0.31	0.60			2.53	0.11	0.86	0.37
VE	87	0.01	0.03	0	0	0	0	0	0	1.97	0.1	2.85	0.07
	88	0.01	0.03	0	0	0	0			1.00	0.38	1.9	0.18

^{abc} means followed by a different superscript are significantly different (P < 0.008, Sidak equality test; P < 0.05, ANOVA).

^d See Appendix C for major species in each guild.

CORN

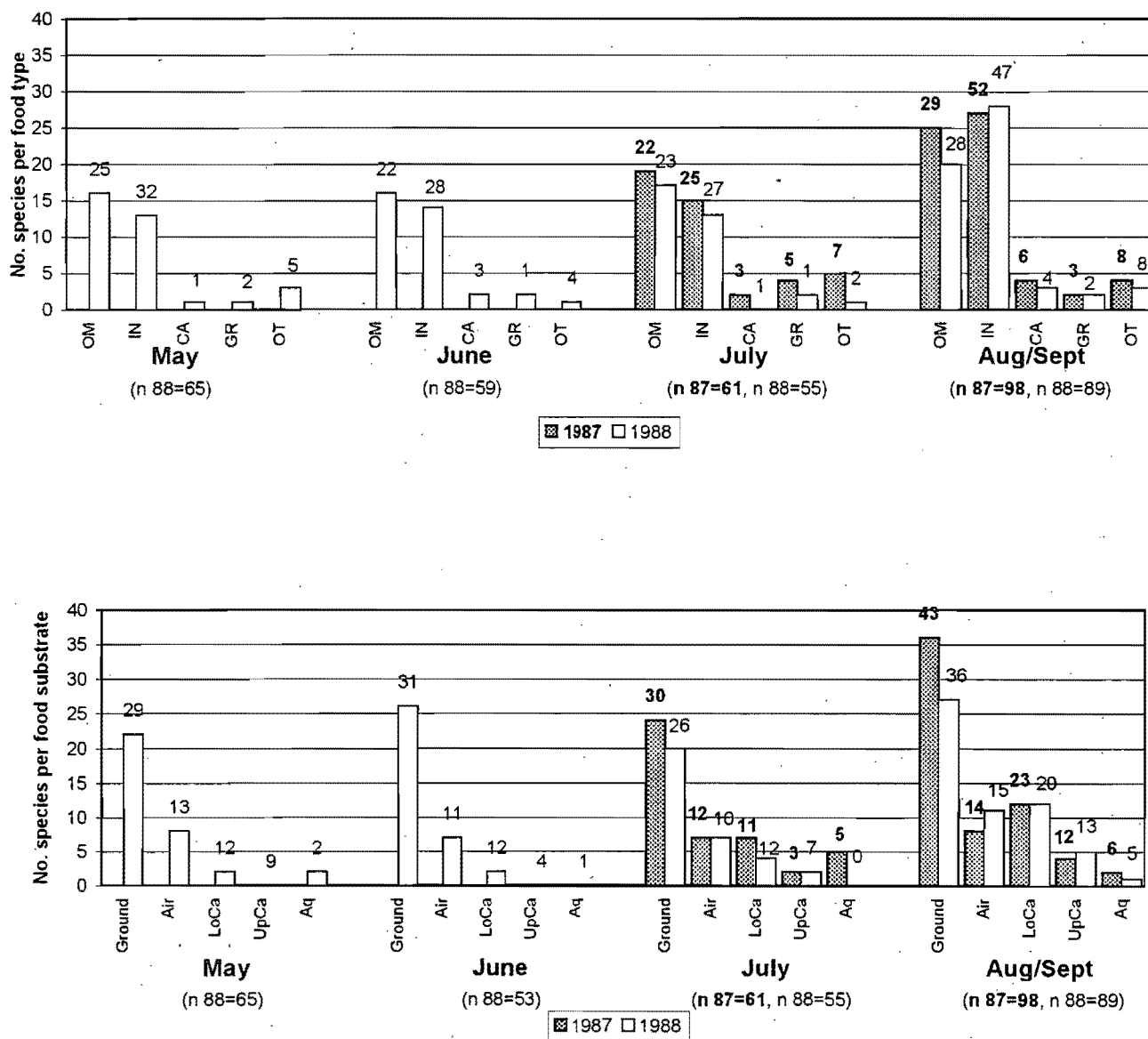


Figure 4a. Number of species by food type (OM = omnivorous, IN = insectivorous, CA = carnivorous, GR = granivorous species, OT, others) and food substrate (LoCa = low canopy, UpCa = Upper Canopy, Aq = aquatic) guild observed at least once inside corn fields in May, June, July, and August/September in 1987 and/or 1988. The total number of species is shown above each bar.

SOYBEAN

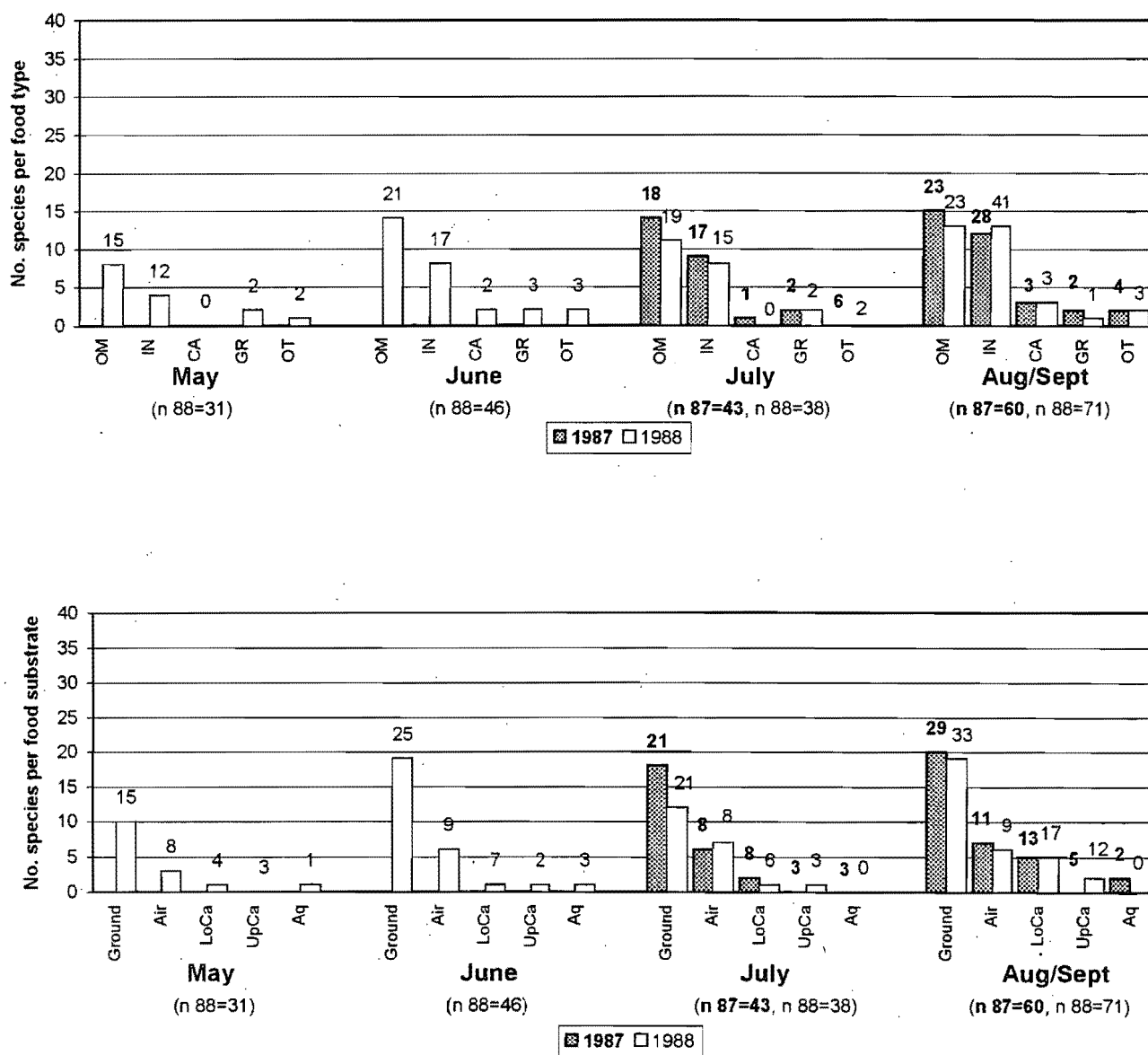


Figure 4b. Number of species by food type (OM = omnivorous, IN = insectivorous, CA = carnivorous, GR = granivorous species, OT, others) and food substrate (LoCa = low canopy, UpCa = Upper Canopy, Aq = aquatic) guild observed at least once inside soybean fields in May, June, July, and August/September in 1987 and/or 1988. The total number of species is shown above each bar.

APPLE

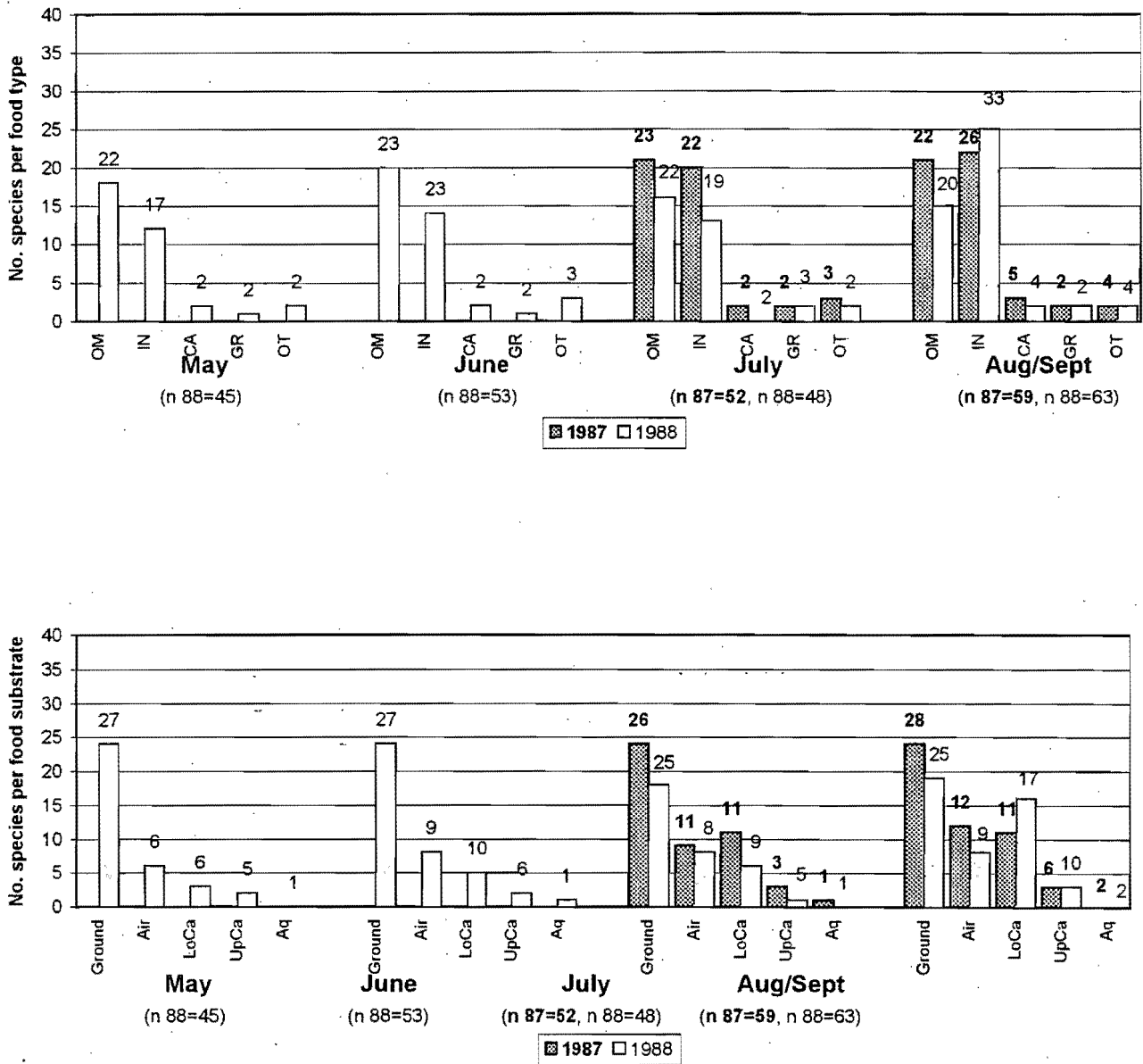


Figure 4c. Number of species by food type (OM = omnivorous, IN = insectivorous, CA = carnivorous, GR = granivorous species, OT, others) and food substrate (LoCa = low canopy, UpCa = Upper Canopy, Aq = aquatic) guild observed at least once inside apple orchards in May, June, July, and August/September in 1987 and/or 1988. The total number of species is shown above each bar.

GRAPE

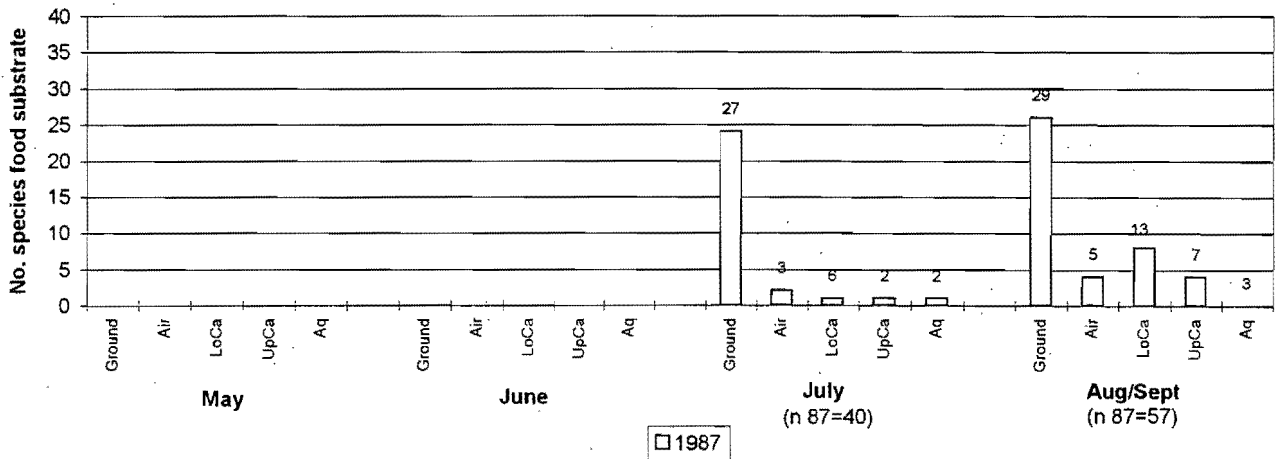
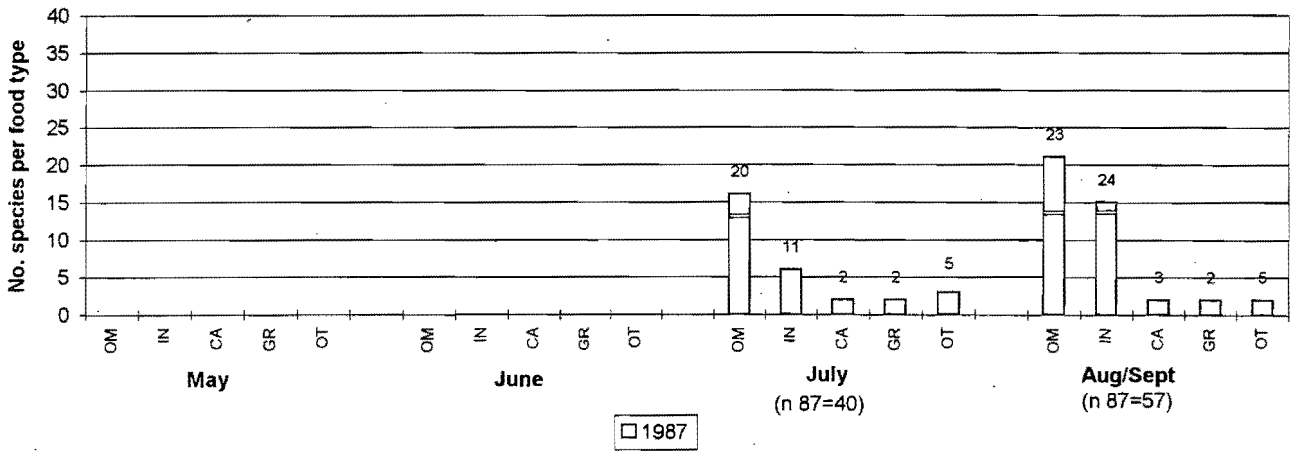


Figure 4d. Number of species by food type (OM = omnivorous, IN = insectivorous, CA = carnivorous, GR = granivorous species, OT, others) and food substrate (LoCa = low canopy, UpCa = Upper Canopy, Aq = aquatic) guild observed at least once inside vineyards in May, June, July, and August/September in 1987 and/or 1988. The total number of species is shown above each bar.

Preference of birds for field edge or interior

Table 12 summarizes the results of t-tests of randomness of bird distribution within fields versus edge habitats, and tabulates the proportion of birds observed in the two habitats for the most common species (recurrent and regular species). In all seasons, most birds in corn and soybean fields occurred significantly more often in the edge habitat than would be expected, with mean percent of observations in edge habitat frequently falling between 50 and 100% in each crop type. In contrast, this proportion is considerably smaller in vineyards and orchards, and the distribution of observations of most species was random in these crops in most seasons. Barn Swallow occurred more frequently than predicted in the field interior than edge. Horned Lark and Purple Martin were sometimes found significantly more frequently in the field than in the edge of cropfields.

Nevertheless several species were found foraging inside cropfields at least once during the surveys (Figure 5). Consistently more than 50% of species were observed using or feeding inside corn fields and apple orchards at least once (Figure 5a). This proportion was lower in soybean fields, especially for species feeding in those fields. In the fall, at the time of potential avian crop depredation, soybean fields and vineyards were used by only 31 to 45% of species for feeding, as compared to cornfields (51-61%) and apple orchards (57-59%).

DISCUSSION

A total of 138 species was recorded with 25 species seen more than 50% of the time in one or more crops and a further 16 occasional species observed at frequencies ranging from 25% to 50% in at least one crop. A total of 124 species was associated with cornfields (81 in Essex, 106 in Norfolk and 85 in Niagara), including data from the three counties over two years, and 89 species in or near

Table 12a. Mean (Standard Error) percent of birds (species seen in at least 50% of visits) observed in edge habitat of three common crops in southern Ontario during May 1988 (total fields censused = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]).

SPECIES	CROP								
	Corn			Soybean			Apple		
	% in edge	n ^a	P ^b	% in edge	n	P	% in edge	n	P
American Crow	-----	--	-----	50 (50)	3	0.30	24 (20)	6	0.16 +
American Robin	59 (31)	10	0.0008 +	100 (0)	4	. +	14 (13)	6	0.47
Barn Swallow	0.5 (0.2)	9	0.0001 -	-----	--	-----	6.4 (16)	6	0.60
Brown-headed Cowbird	66 (35)	8	0.003 +	-----	--	-----	27 (31)	6	0.25
Blue Jay	-----	--	-----	-----	--	-----	33 (45)	5	0.32
Chipping Sparrow	-----	--	-----	100 (0)	4	. +	25 (7.7)	6	0.005 +
Common Grackle	41 (36)	10	0.02 +	56 (49)	3	0.24	-----	--	-----
European Starling	48 (36)	9	0.01 +	100 (0)	2	.	22 (44)	5	0.59
Horned Lark	6.6 (8.5)	9	0.27	2.5 (2.9)	4	0.015 -	-----	--	-----
House Sparrow	-----	--	-----	67 (58)	3	0.23	-----	--	-----
Killdeer	22 (24)	9	0.16	31 (38)	4	0.34	-----	--	-----
Red-winged Blackbird	66 (20)	7	0.0003 +	75 (50)	4	0.08	-----	--	-----
Savannah Sparrow	-----	--	-----	-----	--	-----	9.5 (9.9)	6	0.90
Song Sparrow	96 (5.1)	9	0.0001 +	91 (11)	4	0.0006 +	53 (39)	6	0.04 +
Vesper Sparrow	-----	--	-----	38 (43)	4	0.29	-----	--	-----
Yellow Warbler	100 (0)	6	. +	-----	--	-----	-----	--	-----

^a Number of fields in which the species was seen, from which the percentages were calculated.

^b Significance of t-test of the number of birds occurring on the edge of the field, compared to the number expected assuming random distribution between field edge and interior (ratio of 1:10 based on relative area of edge:interior). + or - indicate that the proportion of birds found in edge habitat is either greater or lesser, respectively, than that expected. Where the proportion is either 100 or 0%, and the species was seen in > 2 fields, distribution was arbitrarily deemed significant.

Table 12b. Mean (Standard Error) percent of birds (species seen in at least 50% of visits) observed in edge habitat of three common crops in southern Ontario during June, 1988 (total fields censused = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]).

SPECIES	CROP								
	Corn			Soybean			Apple		
	% in edge	n ^a	P ^b	% in edge	n	P	% in edge	n	P
American Crow	-----	--	-----	-----	--	-----	32 (37)	6	0.20
American Robin	75 (19)	11	0.0001 +	87 (16)	6	0.0001 +	28 (23)	5	0.15
Barn Swallow	3.8 (10)	11	0.07	0 (0)	6	.-	0 (0)	6	.-
Brown-headed Cowbird	81 (27)	10	0.0001 +	-----	--	-----	20 (18)	6	0.23
Chipping Sparrow	-----	--	-----	89 (20)	6	0.0002 +	25 (9.9)	6	0.01 +
Common Grackle	58 (27)	10	0.0003 +	46 (36)	5	0.09	-----	--	-----
Eastern Bluebird	-----	--	-----	-----	--	-----	21 (39)	6	0.51
European Starling	77 (32)	12	0.0001 +	-----	--	-----	14 (20)	4	0.71
Horned Lark	16 (14)	11	0.21	1.9 (3.3)	6	0.002 -	-----	--	-----
House Sparrow	-----	--	-----	93 (11)	6	0.0001 +	-----	--	-----
Mourning Dove	-----	--	-----	-----	--	-----	35 (3.6)	6	0.0001 +
Red-winged Blackbird	77 (23)	10	0.0001 +	78 (36)	5	0.01 +	-----	--	-----
Savannah Sparrow	-----	--	-----	-----	--	-----	17 (15)	6	0.32
Song Sparrow	96 (4.5)	12	0.0001 +	96 (4.6)	6	0.0001 +	53 (41)	5	0.08
Vesper Sparrow	-----	--	-----	9	5	0.12	-----	--	-----

^a Number of fields in which the species was seen, from which the percentages were calculated.

^b Significance of t-test of the number of birds occurring on the edge of the field, compared to the number expected assuming random distribution between field edge and interior (ratio of 1:10 based on relative area of edge:interior). + or - indicate that the proportion of birds found in edge habitat is either greater or lesser, respectively, than that expected. Where the proportion is either 100 or 0%, and the species was seen in > 2 fields, distribution was arbitrarily deemed significant.

Table 12c Mean (Standard Error) percent of birds (species seen in at least 50% of visits) observed in edge habitat of four common crops in southern Ontario during July, 1987 (total fields censused = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 in each county] and 1988 (total fields censused = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]).

CROP													
SPECIES	Corn				Soybean			Apple			Grape		
	% in edge	n ^a	P ^b	% in edge	n	P	% in edge	n	P	% in edge	n	p	
American Crow	87	----	--	----	--	----	32 (25)	6	0.09	----	--	----	
	88	----	--	----	--	----	20 (12)	6	0.10				
American Goldfinch	87	61 (38)	16	0.0007 +	----	--	4.5 (7.6)	6	0.19	12 (11)	6	0.73	
	88	----	--	----	--	----	17 (13)	6	0.26				
American Robin	87	62 (22)	17	0.0001 +	98 (3.1)	6	0.0001 +	13 (6.7)	6	0.27	15 (7.2)	6	0.10
	88	71 (22)	12	0.0001 +	73 (16)	6	0.0002 +	27 (29)	6	0.22			
Barn Swallow	87	7 (23)	16	0.66	5.1 (12)	6	0.38	4.8 (12)	6	0.32	----	--	----
	88	4.7 (9.3)	12	0.07	0 (0)	6	--	0 (0)	6	--			
Cedar Waxwing	87	----	--	----	--	----	7.9 (6.9)	6	0.50	----	--	----	
Chipping Sparrow	87	----	--	----	--	----	14 (9.1)	6	0.36	16 (7.1)	6	0.10	
	88	----	--	----	67 (42)	5	0.04 +	25 (8.5)	6	0.008 +			
Eastern Kingbird	87	----	--	----	--	----	----	--	----	80 (23)	6	0.0006 +	
European Starling	87	----	--	----	100 (0)	6	+	----	--	----	--	----	
Horned Lark	87	----	--	----	40 (35)	6	0.08	----	--	----	--	----	
	88	28 (32)	11	0.09	31 (14)	0	0.053	----	--	----			
House Sparrow	87	----	--	----	80 (20)	6	0.0003 +	----	--	----	--	----	
	88	75 (38)	10	0.0005 +	88 (18)	5	0.0007 +	----	--	----			
Indigo Bunting	87	78 (26)	15	0.0001 +	100 (0)	5	+	----	--	----	--	----	
	88	86 (22)	10	0.0001 +	100 (0)	4	+	----	--	----			

Table 12c (cont.)

Kildeer	87	----	--	----	----	--	----	----	--	----	35 (30)	6	0.09
Mourning Dove	87	----	--	----	----	--	----	18 (15)	6	0.25	----	--	----
	88	----	--	----	----	--	----	21 (18)	6	0.18			
Purple Martin	87	----	--	----	0 (0)	6	----	----	--	----	----	--	----
	88	----	--	----	5.0 (7.8)	6	0.18	----	--	----			
Red-winged Blackbird	87	37 (28)	15	0.002 +	----	--	----	----	--	----	14 (19)	5	0.66
	88	48 (33)	10	0.005 +	----	--	----	----	--	----			
Savannah Sparrow	87	----	--	----	----	--	----	5.3 (6.3)	5	0.17	18 (19)	6	0.33
	88	----	--	----	----	--	----	18 (23)	6	0.43			
Song Sparrow	87	65 (18)	17	0.0001 +	76 (15)	6	0.0001 +	35 (26)	6	0.06	42 (20)	6	0.01 +
	88	83 (13)	12	0.0001 +	92 (5.7)	5	0.0001 +	42 (31)	6	0.06			
Vesper Sparrow	87	----	--	----	66 (34)	6	0.009 +	----	--	----	----	--	----
	88	----	--	----	63 (22)	5	0.005 +	----	--	----			

^a Number of fields in which the species was seen, from which the percentages were calculated.

^b Significance of t-test of the number of birds occurring on the edge of the field, compared to the number expected assuming random distribution between field edge and interior (ratio of 1:10 based on relative area of edge:interior). + or - indicate that the proportion of birds found in edge habitat is either greater or lesser, respectively, than that expected. Where the proportion is either 100 or 0%, and the species was seen in > 2 fields, distribution was arbitrarily deemed significant.

Table 12d. Mean (Standard Error) percent of birds (species seen in at least 50% of visits) observed in edge habitat of four common crops in southern Ontario during the autumn staging and migration period (August and September), 1987 (total fields censused = 5-6 fields for soybean, apple and grape and 18 fields for corn [6 per county]) and 1988 (total fields censused = 5-6 fields for soybean and apple and 12 fields for corn [6 per county]).

SPECIES	CROP											
	Corn			Soybean			Apple			Grape		
	% in edge	n ^a	P ^b	% in edge	n	P	% in edge	n	P	% in edge	n	P
American Crow	87	----	--	----	--	----	38 (25)	6	0.04 +	----	--	----
	88	----	--	----	--	----	28 (38)	6	0.30			
American Goldfinch	87	61 (27)	18	0.0001 +	----	--	27 (19)	6	0.08	36 (15)	6	0.009 +
	88	79 (23)	11	0.0001 +	----	--	25 (14)	6	0.05 +			
American Robin	87	58 (29)	17	0.0001 +	----	--	----	--	----	32 (9.2)	6	0.002 +
	88	78 (17)	12	0.0001 +	84 (14)	5	0.0003 +	31 (29)	6	0.13		
Barn Swallow	87	----	--	----	3.8 (9.2)	6	0.16	6.0 (15)	6	0.53	----	--
	88	1.2 (2.9)	12	0.0001 -	1.8 (2.9)	6	0.0009 -	0 (0)	6	-		
Cedar Waxwing	87	----	--	----	----	--	33 (21)	6	0.04 +	----	--	----
Bank Swallow	87	----	--	----	----	--	1(3)	6	0.001	----	--	----
	88	----	--	----	----	--	28 (28)	6	0.18			
Chipping Sparrow	87	----	--	----	----	--	19 (14)	6	0.017 +	25 (11)	6	0.02 +
	88	----	--	----	----	--	13 (7.5)	6	0.34			
European Starling	88	88 (22)	11	0.0001 +	100 (0)	6	+	----	--	----		
House Sparrow	87	52 (35)	17	0.0002 +	----	--	----	--	----	----	--	----
	88	----	--	----	91 (13)	6	+	----	--	----		
Mourning Dove	87	----	--	----	----	--	30 (17)	6	0.04 +	----	--	----
	88	69 (25)	12	0.0001 +	89 (17)	6	0.0001 +	20 (12)	6	0.10		
Northern Cardinal	88	----	--	----	98 (5.6)	5	0.0001 +	----	--	----		
Red-winged Blackbird	88	30 (30)	11	0.054	----	--	----	--	----			
Song Sparrow	87	71 (13)	18	0.0001 +	81 (9.3)	5	0.0001 +	----	--	----		
	88	30 (15)	18	0.0001 +	89 (10)	5	0.0001 +	----	--	----		

^a Number of fields in which the species was seen, from which the percentages were calculated.

^b Significance of t-test of the number of birds occurring on the edge of the field, compared to the number expected assuming random distribution between field edge and interior (ratio of 1:10 based on relative area of edge:interior). + or - indicate that the proportion of birds found in edge habitat is either greater or lesser, respectively, than that expected. Where the proportion is either 100 or 0%, and the species was seen in > 2 fields, distribution was arbitrarily deemed significant.

Corn

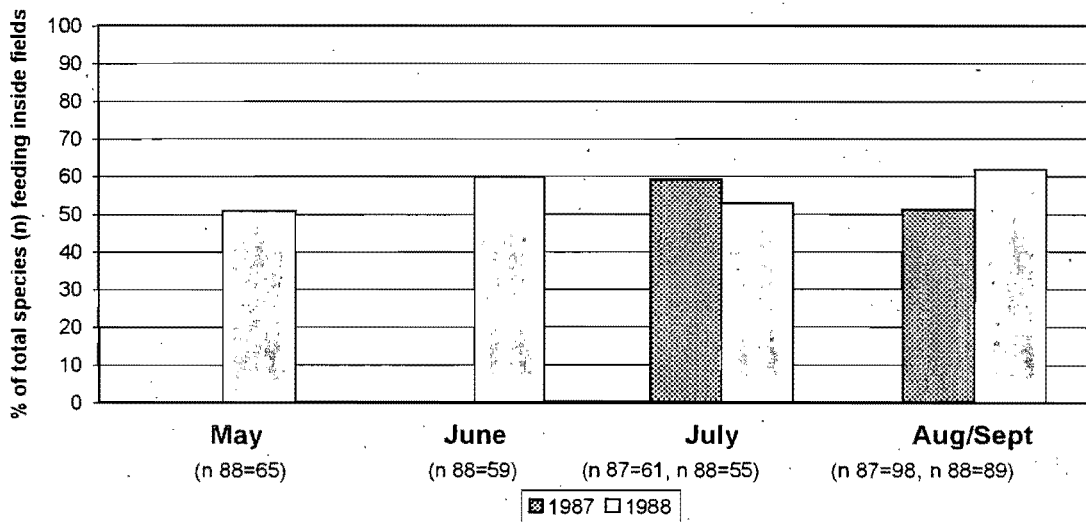
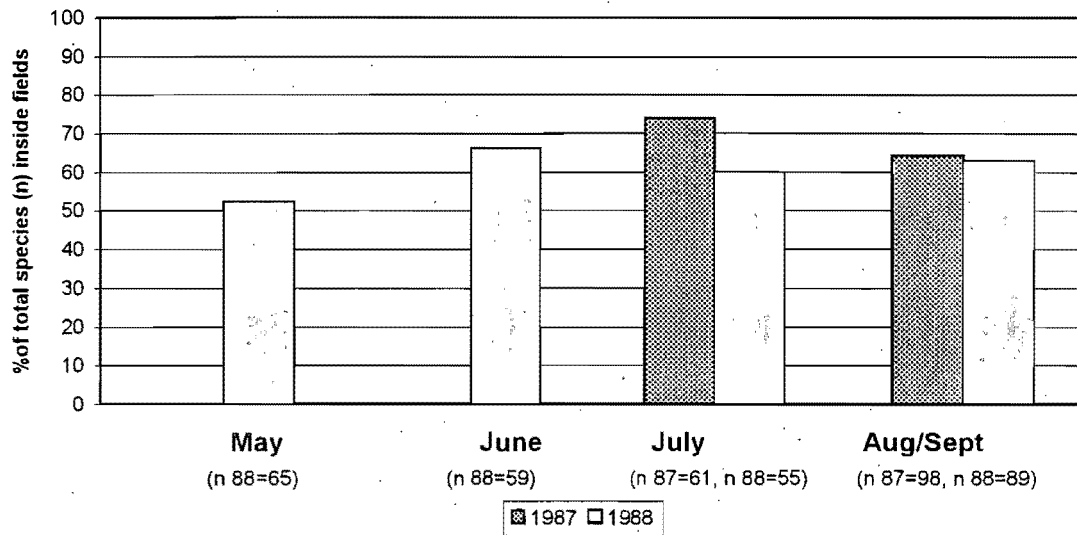


Figure 5a. Percent total number of species using the inside of, and feeding inside of corn fields.

SOYBEAN

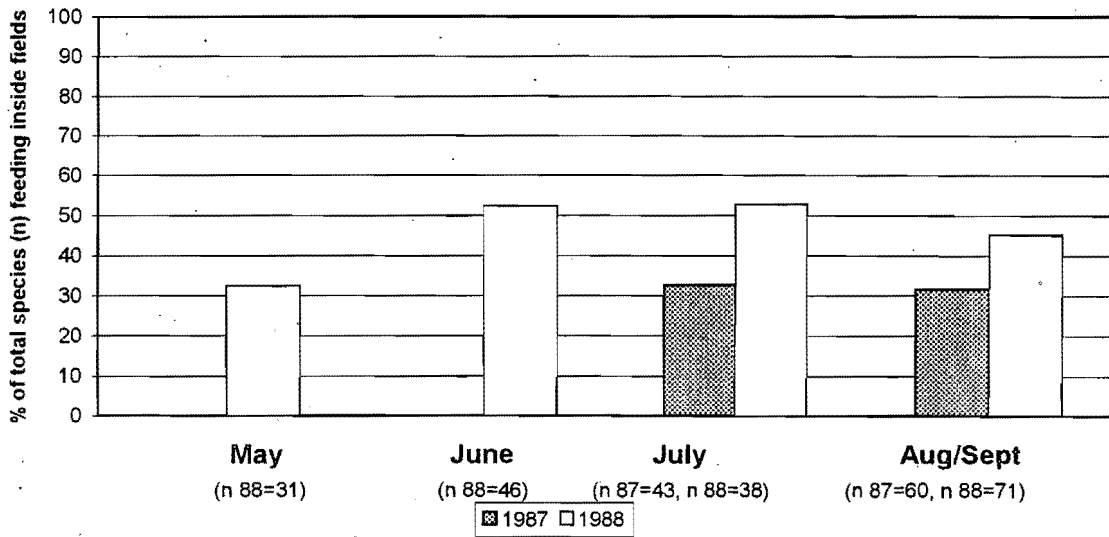
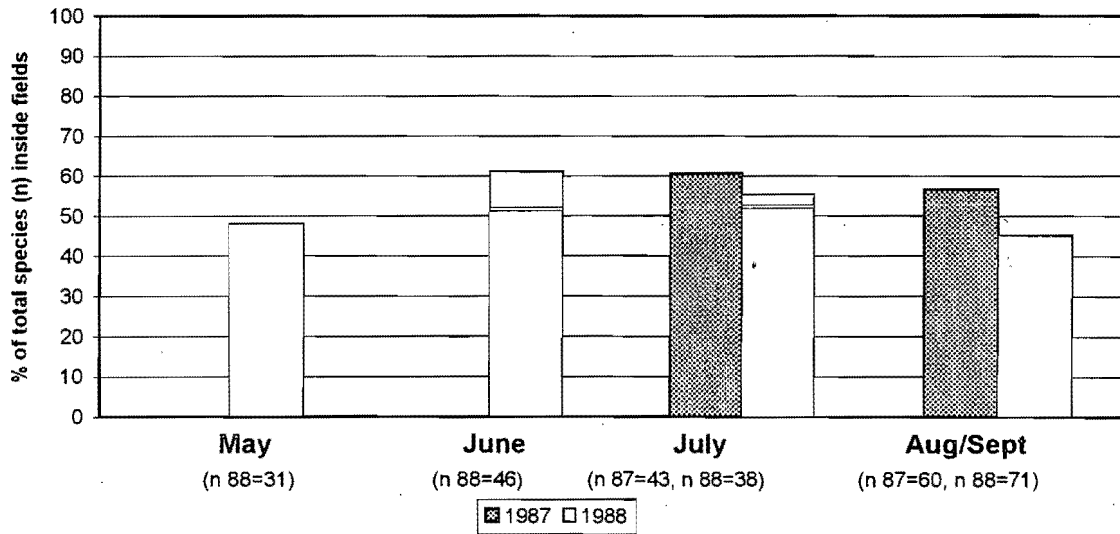


Figure 5b. Percent total number of species using the inside of, and feeding inside of vineyards.

APPLE

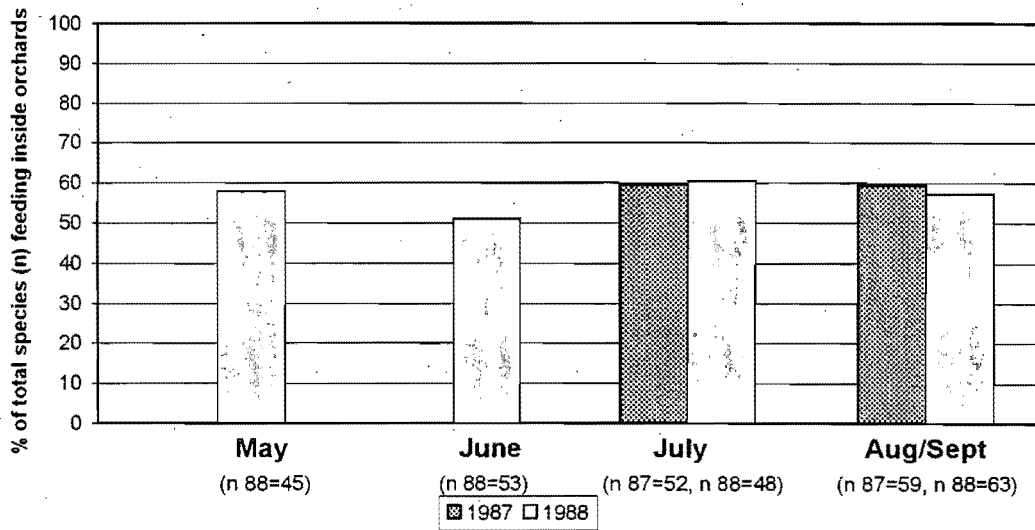
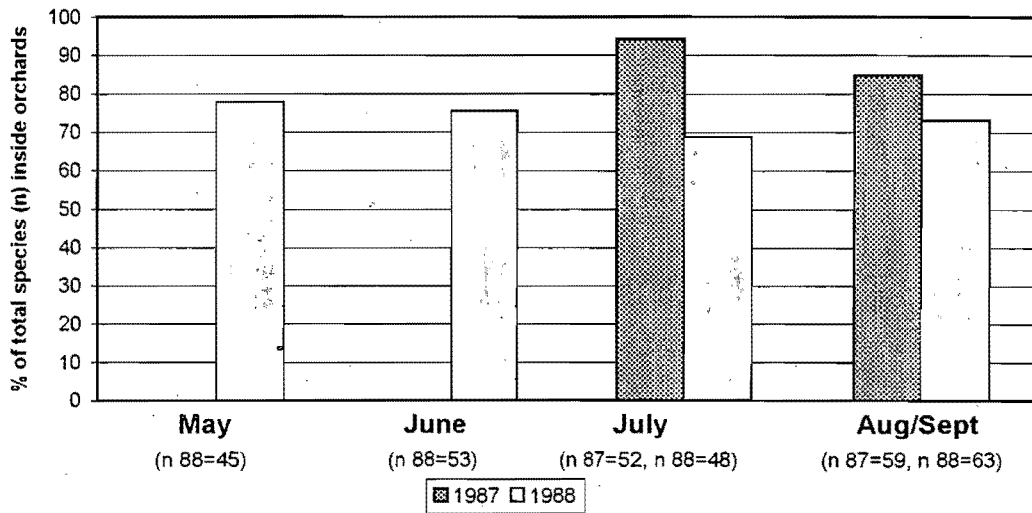


Figure 5c. Percent total number of species using the inside of, and feeding inside of soybean fields.

GRAPE

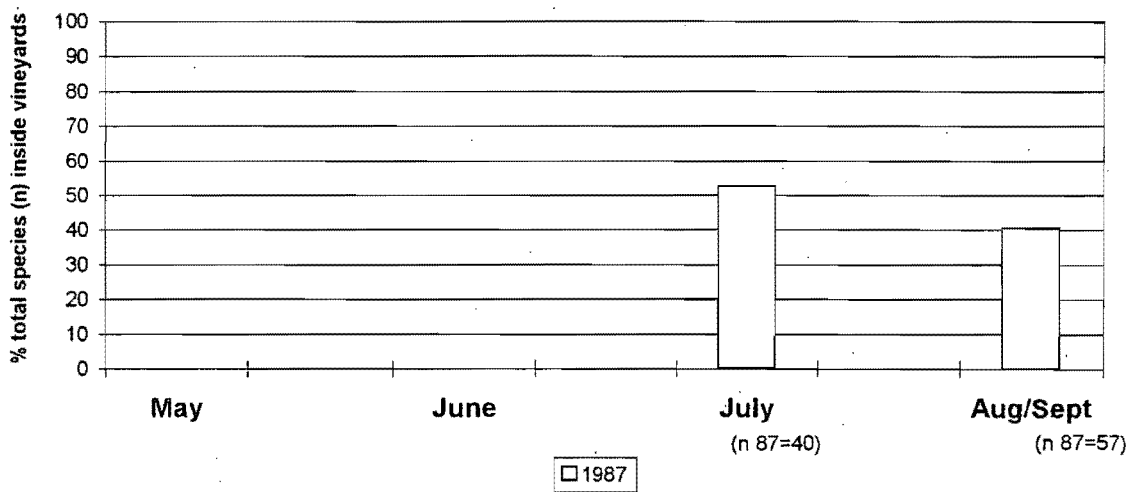
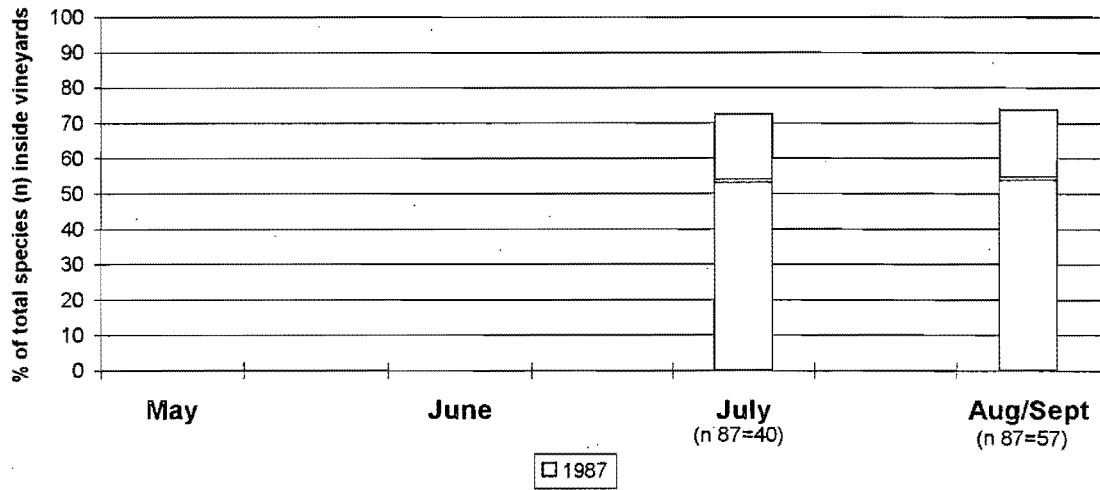


Figure 5d. Percent total number of species using the inside of, and feeding inside of apple orchards.

soybean fields in Essex county. This exceeds the 68 and 44 species reported by Freemark et al. (1991) in corn and soybean fields respectively, and the 93 species described by Best et al. (1995) in their literature review for corn in Iowa. The number of species seen in apple orchards (91) and vineyards (61) also exceeds numbers previously reported for those fruit crops (Freemark et al. 1991). The current study takes into account birds seen during the whole breeding season and most of the fall migrating period; a study of this magnitude has not been realized in previous investigations performed in the same area.

The size of fields surveyed (16 ha) was small by today's standard; field sizes between 5 to 10 hectares were typical a few decades ago whereas they now commonly range from 25 to 50 hectares (Baldwin and Johnson 1986). There is a positive relationship between the ratio of edge to field area and the number of species observed (Best et al. 1990, Ratti and Scott 1991, Rodenhouse and Best 1994). In accordance with previous reports, many more bird species were observed in the perimeter of the fields than in the centre, especially for corn and soybean fields (Table 12). Notable exceptions were the Barn Swallow and Purple Martin seen feeding above fields and the Horned Lark predominately observed within fields. Nevertheless, a large number of species utilized the inside of fields for feeding at least once during the survey (Figure 5).

Thirty-five species were only recorded in August/September (Figure 3, Appendix D), amongst these 18 have not been registered breeding in any of the three counties that were surveyed (Peck and James 1983, 1987). The areas studied, that is, the Niagara Peninsula situated between the Lake Ontario and Lake Erie, Essex county with Point Pelee and Haldimand-Norfolk with Long Point Bird Observatory both advancing deeply into Lake Erie, constitute corridors for bird migrating south in the fall. This is certainly the case for a few northern breeders, e.g. the Blackpoll

Warbler, Gray-cheeked Thrush, Lincoln's Sparrow, Merlin, Wilson's Warbler and Yellow-bellied Flycatcher, or species nesting in the Canadian shield, e.g. Olive-sided Flycatcher and Osprey. Some of these species may once have been resident breeders that have retreated north due to agriculture and loss of wetland or forested habitats, e.g. Dark-eyed Junco, Black and White Warbler, Black-throated Blue Warbler, Cooper's Hawk, Swainson's Thrush, White-throated Sparrow, Palm Warbler, Ruffed Grouse and Rusty Blackbird.

In the present study the close association of bird species with the type of habitats adjacent to fields inventoried was not investigated, albeit *a posteriori* data were collected (Table 2, Appendix A), nor was information collected on the size and proximity of habitat patches at the regional level, which has been established in the literature as important to birds in agricultural areas (Morgan and Gates 1982, Yahner 1988). Although the region was quite homogeneous, a few species may have been associated with particular attributes of the landscape, e.g. small marshes, small woodlots or permanent grassy stretches. Consistently more species and individuals (Table 8), were inventoried in Norfolk (total 106) than in Essex (total 81), both areas having been censused in 1987 and 1988. Less than 4% natural area can be found in Essex county whereas 25% of Norfolk county, particularly in the south, is still forested, although somewhat fragmented (Friesen 1994). Essex county appeared to be the most intensively cropped county and had the least amount of native habitat adjacent to crop fields; remaining woody vegetation was restricted to hedgerows (Table 2). Norfolk County appeared to have the most diverse mix of crop and noncrop habitats adjacent to crop fields. Niagara was intermediate between the two.

Arnold (1983) in Britain found that the number of species increased from six to nine when croplands were interspersed or bordered by ditches, hedges and woodlands.

Best (1983) documented greater bird abundance in wooded versus herbaceous hedgerows. In a monocultural rowcrop landscape, Best et al. (1995) asserted that a maximum of 18 species could be accommodated in a quarter section of land (64 hectares) in Iowa in the United States; conversely in a landscape where cropland diversity prevails, that is, where some perennial crops were planted, more bird species could breed, and the presence of a marshland area doubled the number of species and the addition of wooded habitats increased by a further 40 the number of species.

Differences between counties in bird diversity may also be ascribed to regional variation in cropland. Norfolk county produces nearly one quarter of all apples in southern Ontario (Statistics Canada 1987). The geographical proximity of Niagara county, which produced up to 90% of southern Ontario grapes in 1987 may also have had a similar and significant effect on bird distribution in this region.

Pesticide risk - acute toxicity

Information on pesticide use in the surveyed fields was gathered in two ways: from pesticide use profiles (Table 6) and *a posteriori* investigation with farmers (Table 7). This provided a basis for bird survey data treatment with respect to an impact assessment of pesticides on birds using the four selected crops. First, we identified pesticide types in terms of target organisms, which in turn indicated potential acute effects or reduction in food resources for birds. Secondly, our analyses provided an indication of use intensity, contributing information on the potential routes (ingestion, skin surface) and degree of exposure for birds. Finally, pesticide use calendars provided an indication of timing of agrochemical use that may aid in determining when (and which) birds are most susceptible to exposure.

Any bird species using croplands and contiguous habitats may be exposed to

agricultural pesticides. Birds most at risk from pesticide poisoning, however, are those using fields where acutely toxic insecticides are applied, namely organophosphates or carbamates (Grue et al. 1991). These two groups of insecticides are inhibitors of acetyl cholinesterase, the enzyme responsible for the removal of acetyl choline after the transmission of an impulse between nerve synapses. If this enzyme is inhibited by the binding of an organophosphate (OP) or a carbamate (CA), the nervous system will become and remain excited, causing trembling, convulsions and eventually death. Bird mortality due to insecticide exposure has been reported in several studies or through reported kill incidents (Mineau 1993). Diazinon, an organophosphate that was used on grapes (Table 7), has been reported to cause mortality in geese and other bird species (Frank et al. 1991, Augspurger et al. 1996). Unfortunately data on the precise use of specific pesticides were not provided during the course of this study for apple orchards; what is known is that a maximum of 10 to 12 insecticide spray events were performed in apple orchard, excluding pyrethroids. Among the possible candidates were some OPs (parathion, azinphos methyl, demeton, dimethoate, diazinon, methidathion, phosalone, phosnet) and CAs (formetanate, methomyl, oxamyl, primicarb) (Ontario Ministry of Agriculture and Food 1987); most of these compounds are acutely toxic to birds if taken with their food or as grit, with LD50s ranging from less than 1.0 mg per kg body weight for parathion to a few mg for others such as demeton, diazinon, oxamyl, etc (A. Baril, Canadian Wildlife Service, pers. comm.). Toxicity levels are also species dependant and species will be affected differently by different compounds. Several pyrethroids were also used in apple orchards, and the likely products were cypermethrin, deltamethrin, fenvalerate and permethrin. These latter insecticides, although less acutely toxic to birds ($LD50 > 1000$), have broad spectrum toxicity to invertebrates and may cause depletion of important avian food resources.

Two important activities that may be linked with high pesticide exposure are nesting (including territoriality and calling) and feeding, since risk of contact with chemicals is directly related to the proximity and fidelity of birds to fields. Thus, birds most at risk in apple orchards would be, among the most common species, Blue Jay, American Crow, Eastern Bluebird, American Robin, European Starling, Chipping, Song and Savannah Sparrows, Brown-headed Cowbird and American Goldfinch (Tables 9i-l). In vineyards, Killdeer, Eastern Kingbird, Chipping and Song Sparrows and Red-winged Blackbird would be most likely exposed to insecticides (Tables 9m-n). As pesticides are regularly applied from May to September in these crops, birds are continuously exposed to toxic chemicals (Table 6). Between 30 and 59 species were recorded each month in these two fruit crops during the course of the investigation and could potentially have been affected by pesticides (Table 8, Appendix D).

Corn and soybean seeds are regularly treated, including the use of insecticides, to reduce damage by seed maggots and for protection against wireworms (Ontario Ministry of Agriculture and Food 1988). In cornfields granular insecticides may have been used at planting (Table 6). Birds ingesting granules or corn seeds planted in May and soybean seeds sowed in May-June (Table 6) could be exposed to toxic chemicals such as diazinon or lindane (LD50 ranging from 1.1 to 2000 mg-ai/kg body weight, depending on the species). Species most at risk could be the Killdeer, Horned Lark, American Crow, American Robin, European Starling, Yellow Warbler, Vesper, Chipping and Song Sparrows, Red-winged Blackbird, Brown-headed Cowbird and Common Grackle (Tables 9a-b, 9e-f). Between 31 and 65 species were observed each month in or near corn and soybean fields during the seeding period in spring (Table 8, Appendix D).

Furthermore, in 1988 apple orchards were the preferred crop for the Chipping and

Savannah Sparrows in May, for the Chipping Sparrow and Eastern Bluebird in June, for the American Crow from June to August/September, for the Mourning Dove in July, and for the Chipping Sparrow and the Eastern Bluebird at the end of the breeding season (Table 10). In 1987 several species elected apple orchards or vineyard as their crop of choice, e.g. Barn Swallow, Cedar Waxwing, Chipping Sparrow, Mourning Dove, American Crow, American Robin, and Barn and Bank Swallows. In May and June six species selected corn and/or soybean fields as their crop of predilection (Tables 10a-b). Most of the above species were involved in nesting or feeding activities and, overall were exposed to additional risk from use of toxic pesticides. Undoubtedly the Chipping Sparrow may have been further at risk since it was gathering in flocks of substantial numbers in apple orchards from July to September (Tables 9k-l). The Killdeer and Horned Lark which nest and feed inside fields may also be especially at risk of using corn and soybean fields.

Several bird species have decreased between 1980 and 1994 in the mixed wood plains ecozone which corresponds to the southern part of Ontario along Lakes Huron, Erie, Ontario of the Great Lakes and the plains along the St. Lawrence River (Downes and Collins 1996). Among the 41 recurrent, regular and occasional species observed (Appendix D) 20 species show sign of reduction of their populations. The Killdeer, Horned Lark, Barn Swallow, Purple Martin, Savannah Sparrow, Brown-headed Cowbird, House Sparrow, Northern Flicker and Bobolink underwent significant declines while the Eastern Kingbird, Bank Swallow, Vesper Sparrow, Red-winged Blackbird, Common Grackle, Chimney Swift, House Wren, Gray Catbird, Common Yellowthroat, Field Sparrow and Northern Oriole display a negative but not significant trend. In general, according to Askins (1993) many grassland species exhibit alarming signs of decline in the US; among those are the Vesper and Savannah Sparrows, Eastern Meadowlark and Bobolink (the latter not significantly).

Omnivorous and insectivorous ground feeders comprised the bulk of the species encountered in this study (Figure 4, Appendix C). In the fall, aerial and low canopy feeders were also frequently recorded in cornfields and apple orchards. Of the 17 nesters (excluding the Brown-headed Cowbird) recorded by Yahner (1983) in seven shelterbelts in Minnesota, almost all were generalists feeding on the ground. Best et al. (1990) found that most bird species that commonly used the inside of cornfields were omnivorous ground-feeders. Falardeau and DesGranges (1991) ascertained in their study that five of the six species declining in agricultural land of Québec were omnivorous species feeding on the ground in fields: Brown-headed Cowbirds, Vesper Sparrow, European Starling, Common Grackle and Savannah Sparrow. Barn Swallow was the only aerial insectivorous species of the group. Similarly Freemark et al. (1991) in their literature review noticed that 33 of the 49 most abundant species foraged on the ground or in very low vegetation during the breeding season. Quite expectedly in the current study none of the 25 most common species and only two of the occasional species (Northern Oriole and House Finch) were species feeding in the upper canopy. This is no doubt largely due to the rarity of tree species in nearby marginal habitats. Seventy percent of the declining species were ground or low canopy feeders, mostly omnivorous.

Pesticide risk - indirect effect

At present it is difficult to firmly link the decrease of any bird species in agricultural areas to the use of acutely toxic pesticides, despite the demonstration of heavy losses of some species, e.g. the endangered Burrowing Owl in the Canadian Prairies (Fox et al. 1989), and songbirds in Ontario cornfields (Mineau 1988). Growing inimical conditions due to habitat loss and simplification of remaining habitats, an ongoing situation in southern Ontario, undoubtedly contributes to the increasing rarity of some species. Hay pasture and old field habitats have diminished progressively with intensification of agriculture and populations of Bobolink and

Eastern Meadowlark have simultaneously declined (, Frank et al. 1991, Downes and Collins 1996); alfalfa fields which have largely replaced hay fields as forage crop, are avoided by the Bobolink (Bollinger and Gavin 1992). High rates of nest parasitism by Brown-headed Cowbirds and nest predation which prevail in small habitat patches, constitute two important factors of low productivity for several species in farmland mosaics (Laurance and Yensen 1991). Wintering conditions of non-resident species may have contributed to the decline of some other species (Askins 1993).

Herbicides eliminate weeds - primarily broad-leaved species - in already impoverished monotypic rowcrop cultures. A community of plants composed largely of grass crops (corn, wheat, barley) and grass weeds (*Bromus*, *Elytrigia*, *Setaria*, *Echinochloa*, *Poa*, *Panicum*, etc) has become the norm with modernization of agriculture. Modification in plant species composition of noncrop field edges sprayed with herbicides has recently been documented by Jobin et al. (1997); more annual species and more grasses were inventoried in habitats adjacent to herbicide treated fields. This may have a marked effects on invertebrate populations (Lagerlöf et al. 1992) with consequences for vertebrate wildlife. In Britain extensive studies performed on the Grey Partridge (*Perdix perdix*) have thoroughly documented the link between plant diversity, invertebrate richness and abundance and survival of partridge chicks (Potts 1970, 1985, Sotherton 1990). In North America a few studies have linked bird diversity and abundance to plant and arthropod richness (Dennis and Fry 1992, Rodenhouse and Best 1994). Fortunately the seeds of some crops are valuable food sources for birds (Martin et al. 1951, Freemark and Boutin 1994) without any documented detrimental effects on yield except for some blackbird species in sweetcorn fields during the fall (Potvin et al. 1976).

Conclusion

Forest dwelling bird species have retreated from large parts of southern Ontario following the disappearance of the Carolinian forest (Peck and James 1983, 1987). Grassland species are decreasing dramatically with the transformation of agriculture from a diversified mixture of pasture land, perennial and annual crops (Askins 1993) to more homogeneous landscapes. The intensification of agriculture, typified by monocultures planted in increasingly larger fields, the destruction or simplification of marginal habitats and the extensive use of agro-chemicals, is creating landscapes that have been qualified as ecological deserts (Ratti and Scott 1991). In the current investigation, several species have been observed within these landscapes; however, the commonest are generalists that are adaptable and can be accommodated in disturbed human-made habitats.

A few steps could be undertaken to reduce risk for birds in agricultural landscapes. Crucial to this is the elimination of the most toxic insecticides for which there is usually less destructive alternatives available (Sheehan et al 1987, Mineau 1988, Fox et al. 1989). If relatively poisonous pesticides must be used, liquid formulations appear to present less of a risk to birds than granular forms, that can be taken as grit. The creation of buffer zones at the perimeter of cropfields free of toxic chemical spray should be indicated on the label and enforced for the most toxic pesticides since it was seen in this study and others (Best et al. 1990) that birds use hedges and margins of field preferably to the field centre. Birds typically travel using noncrop habitats (Wegner and Merriam 1979). Field margins, linear and patchy habitats should be retained and maximized, especially those with woody elements; in addition to sheltering beneficial invertebrates they provide home for many bird species that may also contribute to the control of pest insects (Kirk et al. 1997). Other agricultural practices can be slightly modified to accommodate birds and other wildlife in general. Mowing of hayfields could be delayed to provide for

safe nesting of species such as the Bobolink or Eastern Meadowlark. The use of no-till cultivation promote invertebrate diversity and consequently greater use of fields by many species, particularly for the Horned Lark and Killdeer (Basore 1986).

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Appendix A: Description of habitats within 10 m of edge of fields surveyed in 1987 and 1988 in Essex, Niagara and Norfolk counties planted with corn, soybean, grape and apple

Definition of habitats identified within 10m of field edges

Crop fields(f)	cultivated; crops listed when known, tabled as unspecified when not; fallow is cultivated but not seeded
Pasture	area grazed by livestock
Orchard	type not specified
Vineyard	grapes
Farmstead	house with farm buildings, usually treed; includes old farmsteads (i.e. abandoned)
Residential	rural residential developments and houses without farm buildings; includes lawns
Railway	railroad bed and right-of-way, usually woody
Laneway	includes grassy and sandy lanes with and without trees
Road (r)	gravel and paved roads; includes the verge which is usually grassy and adjacent grassy banks
Ditch (d)	drainage ditches with at least intermittent water flow; usually alongside a road; herbaceous/weedy to shrub/sparse trees
Wetland	includes ponded creek, flooded area, marsh, creek, stream, gully
Hedgerow	fencerow with continuous to sparse shrubs/trees
Woodlot	farmland forest
Other wooded	includes parkland with trees, shrubland, young pine plantation, old field with regenerating woody vegetation, isolated trees
Commercial/ industrial	golf driving range, packing plant, sewage plant

Description of habitats. N,E,S,W refer to cardinal points

Corn 1987					
Field no.	Habitats	Field no.	Habitats	Field no.	Habitats
Essex A	N: f(corn,soybean) , r E:hedgerow, f(soybean) S:d, f W:f(soybean)	Niagara A	N: woodlot,f E:f S:houses,flooded area,f W:f(corn),r	Norfolk A	N:d,f,r E:house,d,f S:marsh,d W:f(corn)
Essex B	N:farmstead,f(corn,soybean) , r E:hedgerow, f(corn) S:d, f(wheat,corn), r W:grassy lane, f(corn,soybean)	Niagara B	N:r E:ponded creek,f S:woodlot,f W:r	Norfolk B	N:shrubland E:hedgerow S:r W:hedgerow
Essex C	N:d,f(soybean) E:d,f(soybean) S:d,f(tomato),r W:f	Niagara C	N:creek,f E:r S:f(corn) W:creek,f	Norfolk C	N:d,r E:golf driving range S:d,r W:d,r
Essex D	N:f(soybean),r E:f(corn) S:f(corn,soybean) W:hedgerow,f(corn)	Niagara D	N:f(corn),r E:f(corn),r S:f(corn) W:stream,creek	Norfolk D	N:r E:woodlot S:f W:r
Essex E	N:f(soybean) E:railway,f(corn,wheat,clover) S:f(soybean) W:orchard,f(fallow,soybean)	Niagara E	N:shrubland, creek,f E:f,r S:d,r W:hedgerow,pasture	Norfolk E	N:f,r E:f S:parkland,trees W:orchard
Essex F	N:hedgerow, d, r E:d,f(soybean) S:f(soybean) W:f(soybean)	Niagara F	N:f(corn) E:woodlot,d,f(hay) S:f(corn),r W:r	Norfolk F	N:f(corn) E:grassy lane, trees S:r, packing plant W:f

(cont.)

Corn 1988					
Field no.	Habitats	Field no.	Habitats	Field no.	Habitats
Essex A	N:f(soybean) E:hedgerow,f(tomato) S:d,f(soybean,wheat),r W:hedgerow,f(soybean)	Niagara A	Not done in 1988	Norfolk A	N:f(soybean) E:grassy bank,r S:f,hedgerow W:woodlot, hedgerow,f
Essex B	N:f(soybean),r E:f(soybean) S:f(soybean) W:hedgerow,f(corn)	Niagara B		Norfolk B	N:f(corn) E:woodlot, hedgerow,f S:marsh,d W:d,f
Essex C	N:old farmstead,f(soybean),r E:hedgerow,f(wheat) S:hedgerow,f(soybean) W:hedgerow,f(soybean,wheat)	Niagara C		Norfolk C	N:d,f,r E:house,d,f S:marsh,d W:f(corn)
Essex D	N:f(soybean) E:f(soybean) S:d,f(corn,soybean),r W:f(corn,wheat),r	Niagara D		Norfolk D	N:f,r,shrubland E:hedgerow,f S:f(corn) W:hedgerow,woodlot,f
Essex E	N:d,f(wheat),r E:d,f(soybean),r S:pasture,f(corn) W:d,f(corn,,soybean)	Niagara E		Norfolk E	N:f,r E:f S:parkland with trees W:orchard
Essex F	N:hedgerow,f(soybean) E:f(soybean),r S:d,f(corn,soybean,wheat),r W:hedgerow,f(wheat)	Niagara F		Norfolk F	N:woodlot E:orchard S:residential W:woodlot, gully

(cont.)

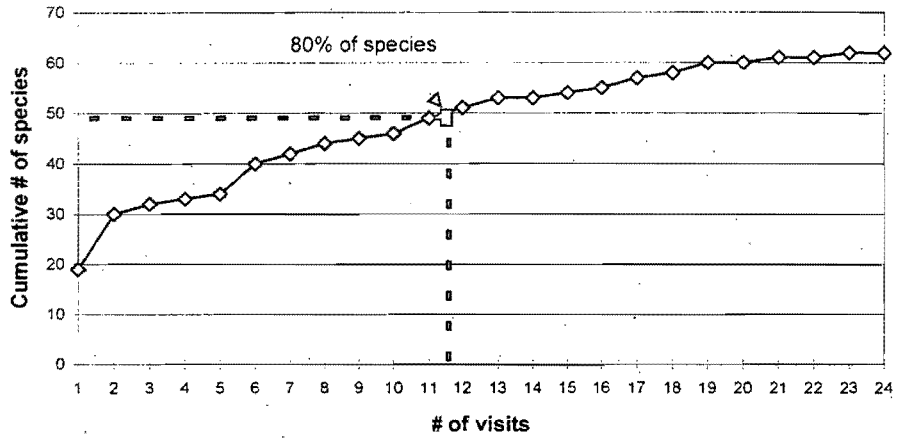
Soybean 1987		Grape 1987		Apple 1987	
Field no.	Habitats	Field no.	Habitats	Field no.	Habitats
Essex A	N:sandy lane,f(soybean) E:f(wheat, clover) S:sandy lane,f(tomato) W:sandy lane,f(corn, tomato)	Niagara A	N:woodlot E:farmstead,f S:houses,r W:hedgerow, woodlot,f,r	Norfolk A	N:orchard E:orchard,r S:orchard W:orchard
Essex B	N:woodlot,hedgerow,f(soybean) E:f(soybean),r S:f(wheat) W:sandy lane,trees,f(tomato)	Niagara B	N:d,f,r E:f S:farmstead,r W:d,r	Norfolk B	N:f E:orchard S:orchard,farmstead W:f
Essex C	N:f(soybean) E:f(soybean) S:d,f(tomato),r W:hedgerow,f(soybean)	Niagara C	N:laneway,f E:f S:d,f,r W:shrubland,f,r	Norfolk C	N:orchard,farmstead E:f S:orchard W:orchard
Essex D	N:f(corn,cucumber) E:farmstead,f(corn,soybean) S:farmstead,d,f(soybean) W:hedgerow,f(soybean)	Niagara D	N:f E:hedgerow,r S:woodlot,r W:laneway,trees,f	Norfolk D	N:orchard E:r S:orchard W:orchard,f
Essex E	N:sandy lane,f(tomato) E:sandy lane,f(tomato) S:hedgerow,f(soybean),r W:d,f(soybean)	Niagara E	N:laneway,vineyard,sewage plant E:woodlot,laneway,f S:woodlot,d,f,r W:r,vineyard	Norfolk E	N:lawn,r E:lawn,r S:young pine plantation W:pine trees,f
Essex F	N:hedgerow,f(soybean) E:d,f(soybean) S:farmstead,d,f(soybean),r W:d,f(soybean)	Niagara F	N:laneway,woodlot,vineyard E:woodlot,f,r S:r W:woodlot,farmstead,f,r	Norfolk F	N:orchard E:laneway,f S:orchard W:orchard

(cont.)

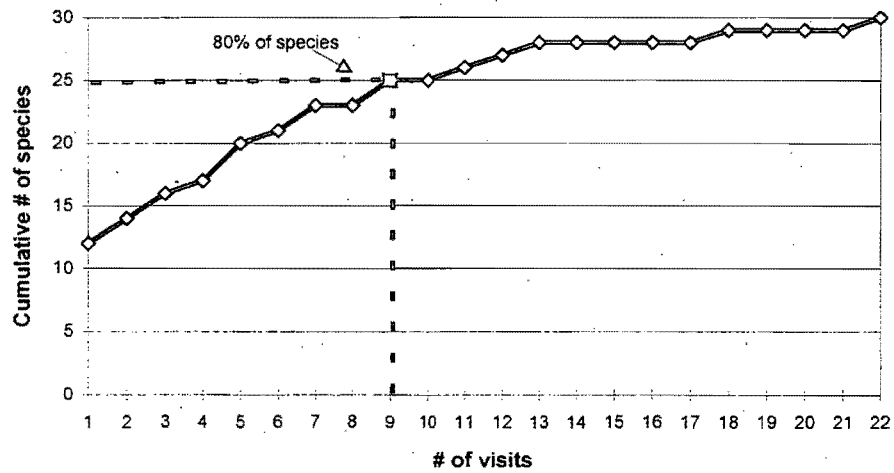
Soybean 1988				Apple 1988	
Field no.	Habitats	Field no.	Habitats	Field no.	Habitats
Essex A	N:f(tomato,soybean) E:sandy lane,f(wheat) S:hedgerow,farmstead,f(soybean),r W:d,f(soybean)	Niagara A	Not done in 1988	Norfolk A	N:orchard E:orchard,r S:orchard W:orchard
Essex B	N:sandy lane,f(soybean) E:laneway,f(soybean,tomato) S:f(wheat) W:f(soybean)	Niagara B		Norfolk B	N:f E:orchard S:orchard,farmstead W:f
Essex C	N:hedgerow,d,f(wheat),r E:d,f(soybean) S:f(wheat) W:d,f(wheat)	Niagara C		Norfolk C	N:orchard,farmstead E:f S:orchard W:orchard
Essex D	N:f(soybean,wheat),r,d E:hedgerow,f S:woodlot,hedgerow,f(soybean) W:hedgerow,f(soybean)	Niagara D		Norfolk D	N:orchard E:r S:orchard W:orchard,f
Essex E	N:f(soybean,wheat),r E:hedgerow,f(soybean) S:d,f(wheat) W:f(soybean)	Niagara E		Norfolk E	N:orchard E:f S:orchard W:r
Essex F	N:f(corn),r E:woodlot,old field,f(soybean) S:hedgerow,f(soybean,wheat) W:woodlot,hedgerow,f(soybean)	Niagara F		Norfolk F	N:orchard E:laneway,f S:orchard W:orchard

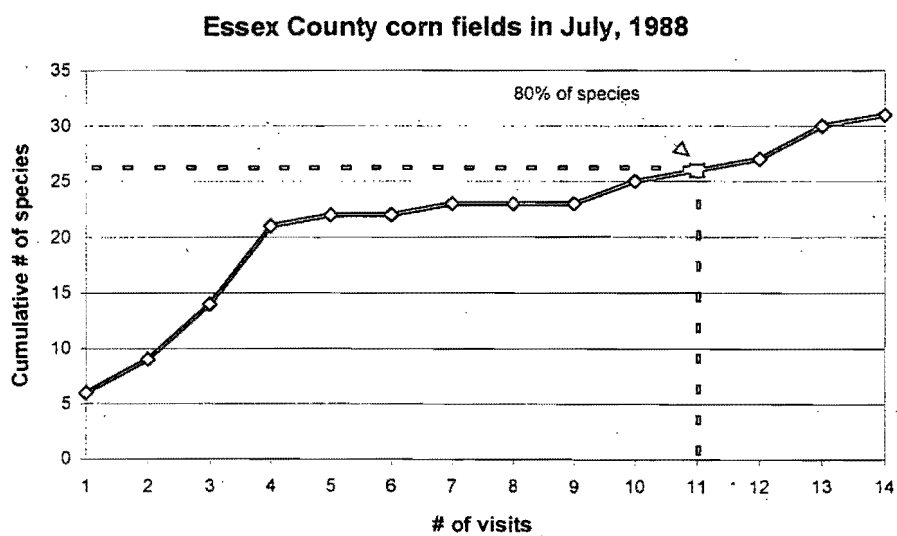
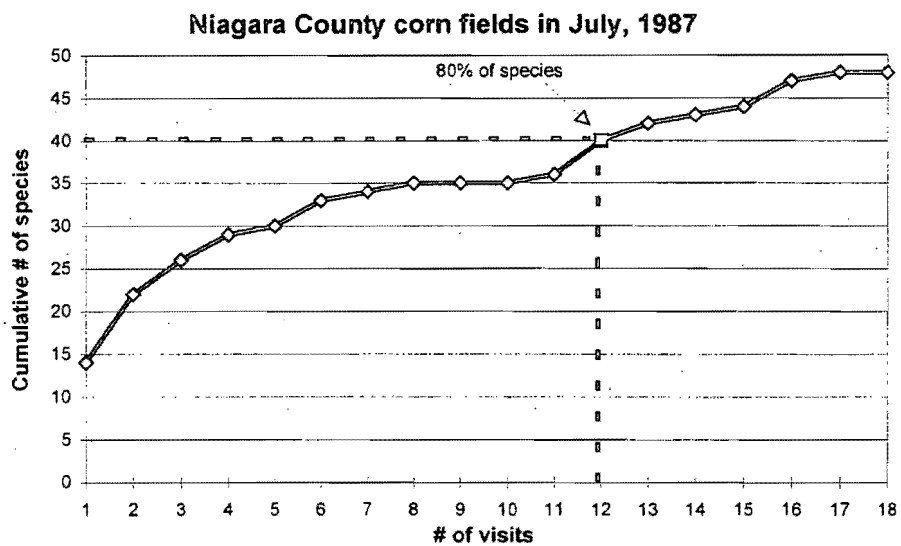
**Appendix B: Cumulative number of species as a function of the number of visits for a
sample of the data**

Norfolk County corn fields in May, 1988

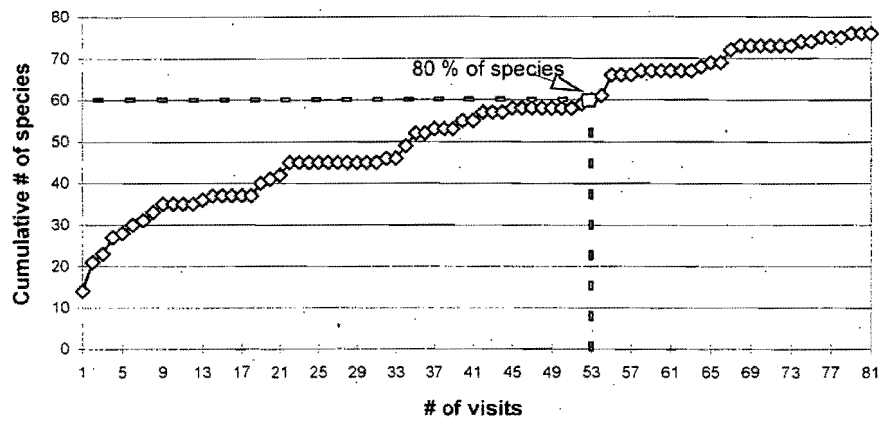


Essex County corn fields in June, 1988

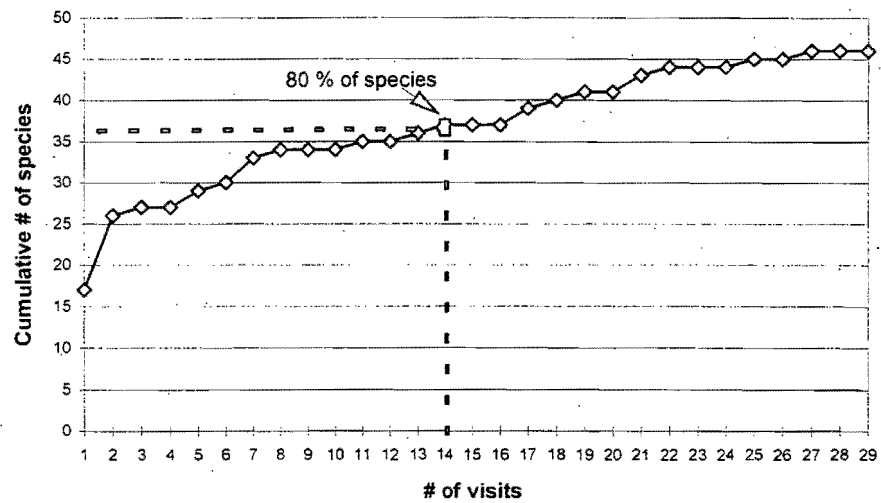




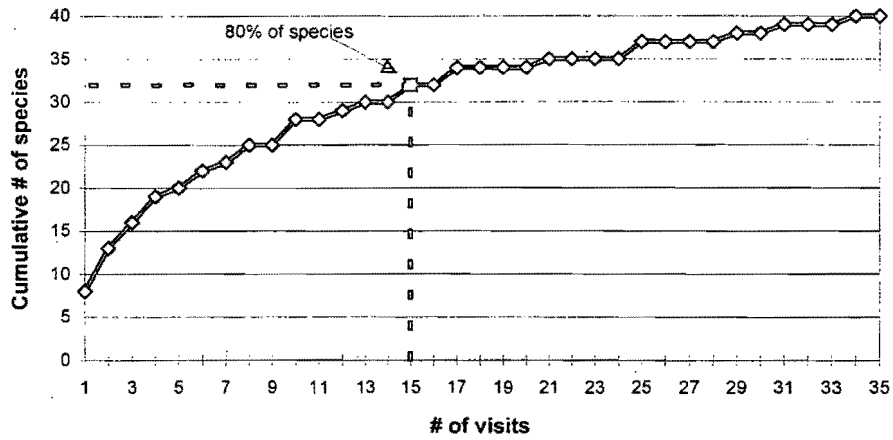
Norfolk County corn fields in August and September, 1987



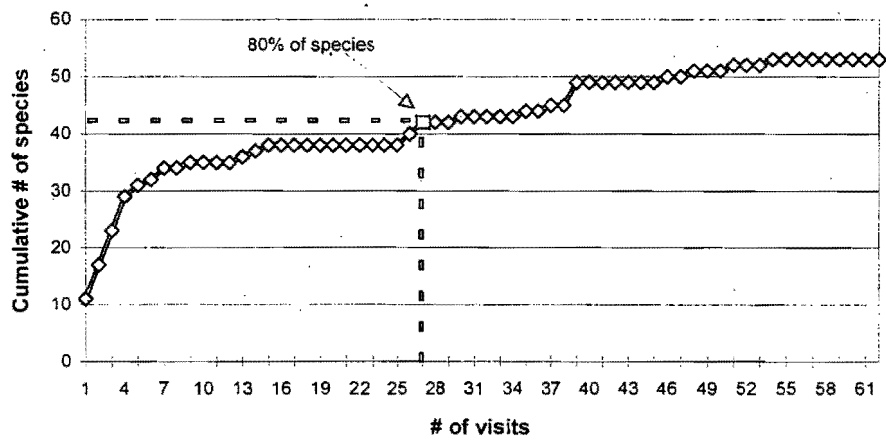
Essex County soybean field in June, 1988



Niagara County vineyards in July, 1987



Norfolk apple orchards in July, 1987



**Appendix C: English, French and Latin names, mnemonic codes, feeding and foraging
guilds of the 138 species inventoried in corn and soybean fields, apple
orchards and vineyards in 1987 and 1988**


ENGLISH NAMES	FRENCH NAMES	LATIN NAMES	MEMORIC	FEEDING	FORAGING
			CODES	GUILDS	GUILDS
Ciconiiformes					
Great Blue Heron	Grand Héron	Ardea herodias	GTBH	Aquatic	
Great Egret	Grande Aigrette	Casmerodius albus	GREG	Aquatic	
Green-backed Heron	Héron vert	Butorides striatus	GNBH	Aquatic	
Black-crowned Night-Heron	Bihoreau à couronne noire	Nycticorax nycticorax	BCNH	Aquatic	
Anseriformes					
Canada Goose	Bernache du Canada	Branta canadensis	CAGO	Herbivore	Ground
American Black Duck	Canard noir	Anas rubripes	ABDU	Aquatic	
Mallard	Canard colvert	Anas platyrhynchos	MALL	Aquatic	
Blue-winged Teal	Sarcelle à ailes bleues	Anas discors	BWTE	Aquatic	
Falconiformes					
Turkey Vulture	Urubu à tête rouge	Cathartes aura	TUVU	Carnivore	Ground
Osprey	Balbusard	Pandion haliaetus	OSPR	Aquatic	
Bald Eagle	Pygargue à tête blanche	Haliaeetus leucocephalus	BAEA	Carnivore	Ground
Northern Harrier	Busard Saint-Martin	Circus cyaneus	NOHA	Carnivore	Ground
Sharp-shinned Hawk	Epervier brun	Accipiter striatus	SSHA	Carnivore	Ground
Cooper's Hawk	Epervier de Cooper	Accipiter cooperii	COHA	Carnivore	Ground
Red-shouldered Hawk	Buse à épaulettes	Buteo lineatus	RSHA	Carnivore	Ground
Broad-winged Hawk	Petite Buse	Buteo platypterus	BWHA	Carnivore	Ground
Red-tailed Hawk	Buse à queue rousse	Buteo jamaicensis	RTHA	Carnivore	Ground
American Kestrel	Crécerelle d'Amérique	Falco sparverius	AMKE	Insectivore	Ground
Merlin	Faucon émerillon	Falco columbarius	MERL	Carnivore	Ground
Galliformes					
Ring-necked Pheasant	Faisan de chasse	Phasianus colchicus	RNPH	Omnivore	Ground
Ruffed Grouse	Gélinotte huppée	Bonasa umbellus	RUGR	Omnivore	Ground
Gruiformes					
Sandhill Crane	Grue du Canada	Grus canadensis	SACR	Omnivore	Ground
Charadriiformes					
Black-bellied Plover	Pluvier argenté	Pluvialis squatarola	BBPL	Aquatic	
Killdeer	Pluvier kildir	Charadrius vociferus	KILL	Insectivore	Ground
Lesser Yellowlegs	Petit Chevalier	Tringa flavipes	LEYE	Aquatic	
Solitary Sandpiper	Chevalier solitaire	Tringa solitaria	SOSA	Aquatic	
Spotted Sandpiper	Chevalier branlequeue	Actitis macularia	SPSA	Aquatic	
Upland Sandpiper	Maubèche des champs	Bartramia longicauda	UPSA	Insectivore	Ground
Pectoral Sandpiper	Bécasseau à poitrine cendrée	Calidris melanotos	PESA	Aquatic	
American Woodcock	Bécasse d'Amérique	Scolopax minor	AMWO	Vermivore	Ground
Ring-billed Gull	Goeland à bec cerclé	Larus delawarensis	RBGU	Insectivore	Ground
Columbiformes					
Rock Dove	Pigeon biset	Columba livia	RODO	Omnivore	Ground
Mourning Dove	Tourterelle triste	Zenaidura macroura	MODO	Granivore	Ground
Cuculiformes					
Black-billed Cuckoo	Coulicou à bec noir	Coccyzus erythrophthalmus	BBCU	Insectivore	Low canopy
Yellow-billed Cuckoo	Coulicou à bec jaune	Coccyzus americanus	YBCU	Insectivore	Low canopy
Strigiformes					
Great Horned Owl	Grand-duc d'Amérique	Bubo virginianus	GHOW	Carnivore	Ground
Caprimulgiformes					
Common Nighthawk	Engoulevent d'Amérique	Chordeiles minor	CONI	Insectivore	Aerial
Apodiformes					
Chimney Swift	Martinet ramoneur	Chaetura pelagica	CHSW	Insectivore	Aerial
Ruby-throated Hummingbird	Colibri à gorge rubis	Archilochus colubris	RTHU	Omnivore	Aerial
Coraciiformes					
Belted Kingfisher	Martin-pêcheur d'Amérique	Ceryle alcyon	BEKI	Aquatic	

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

Piciformes					
Red-headed Woodpecker	Pic à tête rouge	Melanerpes erythrocephalus	RHOW	Insectivore	Low canopy
Downy Woodpecker	Pic mineur	Picoides pubescens	DOWO	Insectivore	Low canopy
Hairy Woodpecker	Pic chevelu	Picoides villosus	HAWO	Insectivore	Low canopy
Northern Flicker	Pic flamboyant	Colaptes auratus	YSFL	Insectivore	Ground
Passeriformes					
Olive-sided Flycatcher	Moucherolle à côtes olive	Contopus borealis	OSFL	Insectivore	Aerial
Eastern Wood-Pewee	Pioui de l'Est	Contopus virens	EAWP	Insectivore	Aerial
Yellow-bellied Flycatcher	Moucherolle à ventre jaune	Empidonax flaviventris	YBFL	Insectivore	Aerial
Alder Flycatcher	Moucherolle des aulnes	Empidonax alnorum	ALFL	Insectivore	Aerial
Willow Flycatcher	Moucherolle des saules	Empidonax traillii	WIFL	Insectivore	Aerial
Least Flycatcher	Moucherolle tchébec	Empidonax minimus	LEFL	Insectivore	Aerial
Eastern Phoebe	Moucherolle phébi	Sayornis phoebe	EAPH	Insectivore	Aerial
Great Crested Flycatcher	Tyrann huppé	Myiarchus crinitus	GCFL	Insectivore	Aerial
Eastern Kingbird	Tyrann tritri	Tyrannus tyrannus	EAKI	Insectivore	Aerial
Horned Lark	Alouette cornue	Eremophila alpestris	HOLA	Omnivore	Ground
Purple Martin	Hirondelle noire	Progne subis	PUMA	Insectivore	Aerial
Tree Swallow	Hirondelle bicolore	Tachycineta bicolor	TRES	Insectivore	Aerial
Northern Rough-winged Swallow	Hirondelle à ailes hérisssées	Stelgidopteryx serripennis	NRWS	Insectivore	Aerial
Bank Swallow	Hirondelle de rivage	Riparia riparia	BANS	Insectivore	Aerial
Cliff Swallow	Hirondelle à front blanc	Hirundo pyrrhonota	CLSW	Insectivore	Aerial
Barn Swallow	Hirondelle des granges	Hirundo rustica	BARS	Insectivore	Aerial
Blue Jay	Geai bleu	Cyanocitta cristata	BLJA	Omnivore	Ground
American Crow	Corneille d'Amérique	Corvus brachyrhynchos	AMCR	Omnivore	Ground
Black-capped Chickadee	Mesange à tête noire	Parus atricapillus	BCCH	Insectivore	Low canopy
Red-breasted Nuthatch	Sittelle à poitrine rousse	Sitta canadensis	RBNU	Insectivore	Upper Canopy
White-breasted Nuthatch	Sittelle à poitrine blanche	Sitta carolinensis	BWNU	Insectivore	Upper Canopy
Carolina Wren	Troglodyte de Caroline	Thryothorus ludovicianus	CARW	Insectivore	Low canopy
House Wren	Troglodyte familier	Troglodytes aedon	HOWR	Insectivore	Low canopy
Winter Wren	Troglodyte des forêts	Troglodytes troglodytes	WIWR	Insectivore	Ground
Golden-crowned Kinglet	Roitelet à couronne dorée	Regulus satrapa	GCKI	Insectivore	Low canopy
Ruby-crowned Kinglet	Roitelet à couronne rubis	Regulus calendula	RCKI	Insectivore	Upper Canopy
Blue-gray Gnatcatcher	Gobe-moucheron gris-bleu	Poliophtila caerulea	BGGN	Insectivore	Upper Canopy
Eastern Bluebird	Merle-bleu de l'Est	Sialia sialis	EABL	Insectivore	Ground
Veery	Grive fauve	Catharus fuscescens	VEER	Omnivore	Ground
Gray-cheeked Thrush	Grive à joues grises	Catharus minimus	GCTH	Omnivore	Ground
Swainson's Thrush	Grive à dos olive	Catharus ustulatus	SWTH	Omnivore	Ground
American Robin	Merle d'Amérique	Turdus migratorius	AMRO	Omnivore	Ground
Gray Catbird	Moqueur chat	Dumetella carolinensis	GRCA	Omnivore	Ground
Northern Mockingbird	Moqueur polyglotte	Mimus polyglottus	NOMO	Omnivore	Ground
Brown Thrasher	Moqueur roux	Toxostoma rufum	BRTH	Omnivore	Ground
Cedar Waxwing	Jaseur des cèdres	Bombicilla cedrorum	CEDW	Frugivore	Low canopy
European Starling	Etourneau sanzonnet	Sturnus vulgaris	EUST	Omnivore	Ground
Yellow-throated Vireo	Viréo à gorge jaune	Vireo flavifrons	YTVI	Insectivore	Upper Canopy
Warbling Vireo	Viréo mélodieux	Vireo gilvus	WAVI	Insectivore	Upper Canopy
Philadelphia Vireo	Viréo de Philadelphie	Vireo philadelphicus	PHVI	Insectivore	Upper Canopy
Red-eyed Vireo	Viréo aux yeux rouges	Vireo olivaceus	REVI	Insectivore	Upper Canopy
Blue-winged Warbler	Paruline à ailes bleues	Vermivora pinus	BWWA	Insectivore	Low canopy
Tennessee Warbler	Paruline obscure	Vermivora peregrina	TEWA	Insectivore	Upper Canopy
Nashville Warbler	Paruline à joues grises	Vermivora ruficapilla	NAWA	Insectivore	Low canopy
Yellow Warbler	Paruline jaune	Dendroica petechia	YWAR	Insectivore	Low canopy
Chestnut-sided Warbler	Paruline à flancs marron	Dendroica pensylvanica	CSWA	Insectivore	Low canopy
Magnolia Warbler	Paruline à tête cendrée	Dendroica magnolia	MAWA	Insectivore	Low canopy
Cape May Warbler	Paruline tigrée	Dendroica tigrina	CMWA	Insectivore	Upper Canopy

Black-throated Blue Warbler	Paruline bleue à gorge noire	<i>Dendroica caerulescens</i>	BTBW	Insectivore	Low canopy
Yellow-rumped Warbler	Paruline à croupion jaune	<i>Dendroica coronata</i>	MYWA	Insectivore	Low canopy
Black-throated Green Warbler	Paruline verte à gorge noire	<i>Dendroica virens</i>	BTNW	Insectivore	Upper Canopy
Blackburnian Warbler	Paruline à gorge orangee	<i>Dendroica fusca</i>	BLBW	Insectivore	Upper Canopy
Pine Warbler	Paruline des pins	<i>Dendroica pinus</i>	PIWA	Insectivore	Low canopy
Palm Warbler	Paruline à couronne rousse	<i>Dendroica palmarum</i>	WPWA	Insectivore	Ground
Bay-breasted Warbler	Paruline à poitrine baie	<i>Dendroica castanea</i>	BBWA	Insectivore	Upper Canopy
Blackpoll Warbler	Paruline rayée	<i>Dendroica striata</i>	BLPW	Insectivore	Upper Canopy
Black-and-white Warbler	Paruline noir et blanc	<i>Mniotilta varia</i>	BAWW	Insectivore	Low canopy
American Redstart	Paruline flamboyante	<i>Setophaga ruticilla</i>	AMRE	Insectivore	Low canopy
Ovenbird	Paruline couronnée	<i>Seiurus aurocapillus</i>	OVEN	Insectivore	Ground
Northern Waterthrush	Paruline des ruisseaux	<i>Seiurus noveboracensis</i>	NOWA	Aquatic	
Mourning Warbler	Paruline triste	<i>Oporornis philadelphia</i>	MOWA	Insectivore	Ground
Common Yellowthroat	Paruline masquée	<i>Geothlypis trichas</i>	COYE	Insectivore	Low canopy
Wilson's Warbler	Paruline à calotte noire	<i>Wilsonia pusilla</i>	WIWA	Insectivore	Low canopy
Canada Warbler	Paruline du Canada	<i>Wilsonia canadensis</i>	CAWA	Insectivore	Low canopy
Scarlet Tanager	Tangara écarlate	<i>Piranga olivacea</i>	SCTA	Insectivore	Upper Canopy
Northern Cardinal	Cardinal rouge	<i>Cardinalis cardinalis</i>	NOCA	Omnivore	Ground
Rose-breasted Grosbeak	Cardinal à poitrine rose	<i>Pheucticus ludovicianus</i>	RBGR	Omnivore	Upper Canopy
Indigo Bunting	Passerin indigo	<i>Passerina cyanea</i>	INBU	Omnivore	Low canopy
Dickcissel	Dickcissel	<i>Spiza americana</i>	DICK	Omnivore	Ground
Rufous-sided Towhee	Tohi à flancs roux	<i>Pipilo erythrophthalmus</i>	RSTO	Omnivore	Ground
Chipping Sparrow	Bruant familial	<i>Spizella passerina</i>	CHSP	Omnivore	Ground
Clay-colored Sparrow	Bruant des plaines	<i>Spizella pallida</i>	CCSP	Omnivore	Ground
Field Sparrow	Bruant des champs	<i>Spizella pusilla</i>	FISP	Omnivore	Ground
Vesper Sparrow	Bruant vespéral	<i>Poocetes gramineus</i>	VESP	Omnivore	Ground
Savannah Sparrow	Bruant des prés	<i>Passerculus sandwichensis</i>	SAVS	Omnivore	Ground
Song Sparrow	Bruant chanteur	<i>Melospiza melodia</i>	SOSP	Omnivore	Ground
Lincoln's Sparrow	Bruant de Lincoln	<i>Melospiza lincolni</i>	LISP	Omnivore	Ground
Swamp Sparrow	Bruant des marais	<i>Melospiza georgiana</i>	SWSP	Omnivore	Ground
White-throated Sparrow	Bruant à gorge blanche	<i>Zonotrichia albicollis</i>	WTSP	Omnivore	Ground
White-crowned Sparrow	Bruant à couronne blanche	<i>Zonotrichia leucophrys</i>	WCSP	Omnivore	Ground
Dark-eyed Junco	Junco ardoisé	<i>Junco hyemalis</i>	SCJU	Omnivore	Ground
Bobolink	Goglu	<i>Dolichonyx oryzivorus</i>	BOBO	Omnivore	Ground
Red-winged Blackbird	Carouge à épaulettes	<i>Agelaius phoeniceus</i>	RWBL	Omnivore	Ground
Eastern Meadowlark	Sturnelle des prés	<i>Sturnella magna</i>	EAME	Insectivore	Ground
Rusty Blackbird	Quiscale rouilleux	<i>Euphagus carolinus</i>	RUBL	Insectivore	Ground
Brewer's Blackbird	Quiscale de Brewer	<i>Euphagus cyanocephalus</i>	BRBL	Omnivore	Ground
Common Grackle	Quiscale bronzé	<i>Quiscalus quiscula</i>	COGR	Omnivore	Ground
Brown-headed Cowbird	Vacher à tête brune	<i>Molothrus ater</i>	BHCO	Omnivore	Ground
Orchard Oriole	Oriole des vergers	<i>Icterus spurius</i>	OROR	Insectivore	Upper Canopy
Northern Oriole	Oriole du Nord	<i>Icterus galbula</i>	BAOR	Omnivore	Upper Canopy
Purple Finch	Roselin pourpré	<i>Carpodacus purpureus</i>	PUFI	Granivore	Ground
House Finch	Roselin familial	<i>Carpodacus mexicanus</i>	HOFI	Frugivore	Upper Canopy
American Goldfinch	Chardonneret jaune	<i>Carduelis tristis</i>	AMGO	Omnivore	Ground
House Sparrow	Moineau domestique	<i>Passer domesticus</i>	HOSP	Granivore	Low canopy


Appendix D: **Summary table for the 138 species recorded in the study.**
Location of the species inside, at the edge of fields or both,
frequency and maximum abundance at any one time
are given separately for each crop, county and year

Example: **E** **E = edge of fields**
  **Frequency < 25%**
 3 **Maximum abundance**

Location of birds **E = edge of fields**
 I = inside
 B = both

Frequency  **> 75%**
  **50% - 74%**
  **25% - 49%**
  **< 25%**


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Great Blue Heron (GTBH)	1987								E 2				E 1												
	1988				E 1																				
Great Egret (GREG)	1987																								
	1988														E 1										
Green- backed Heron (GNBH)	1987																								
	1988																	I 1		E 1					
Black- crowned Night-heron (BCNH)	1987								I 1																
	1988																								

E=outside fields


I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Canada Goose (CAGO)	1987																							I 4	
	1988					B 11	I 12																		
American Blackduck (ABDU)	1987												E 2												
	1988																								
Mallard (MALL)	1987						E 1					I 8	E 21												
	1988													E 1				E 1		E 1					
Blue- winged Teal (BWTE)	1987											I 2									E 2				
	1988																								

E=outside fields


I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Turkey Vulture (TUVU)	1987								<div>B</div> <div>1</div>				<div>I</div> <div>1</div>												<div>E</div> <div>2</div>
	1988																								
Osprey (OSPR)	1987																								
	1988								<div>E</div> <div>1</div>																
Bald Eagle (BAEA)	1987																								
	1988						<div>E</div> <div>2</div>																		
Northern Harrier (NOHA)	1987			<div>I</div> <div>1</div>	<div>I</div> <div>4</div>				<div>I</div> <div>1</div>				<div>B</div> <div>1</div>			<div>I</div> <div>1</div>	<div>I</div> <div>1</div>			<div>B</div> <div>1</div>	<div>E</div> <div>1</div>			<div>I</div> <div>1</div>	<div>I</div> <div>2</div>
	1988	<div>I</div> <div>1</div>	<div>I</div> <div>1</div>		<div>I</div> <div>1</div>	<div>E</div> <div>1</div>	<div>E</div> <div>1</div>		<div>B</div> <div>1</div>						<div>I</div> <div>2</div>		<div>I</div> <div>1</div>	<div>B</div> <div>2</div>			<div>E</div> <div>1</div>				

E=outside fields

I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Sharp-shinned Hawk (SSHA)	1987				B 1				B 1				I 1				I 1				B 1				
	1988				E 1		I 1		B 1								I 1	B 1			I 1				
Cooper's Hawk (COHA)	1987																				I 1				
	1988								B 1												E 1				
Red-shouldered Hawk (RSAH)	1987																								
	1988																			E 1					
Broad-winged Hawk (BWAH)	1987																				E 1				
	1988														I 1										

E=outside fields


I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Red-tailed Hawk (RTHA)	1987											E 1	B 2				I 1			I 1	I 1			B 1	B 1
	1988				E 1												I 1		B 1	E 1	B 1				
American Kestrel (AMKE)	1987			E 1	B 2								B 2			E 2	B 2			I 1	B 1			E 1	E 2
	1988	I 1		B 2	B 1		I 1	E 1	B 1								B 1								
Merlin (MERL)	1987								E 1																
	1988																								
Ring-necked Pheasant (RNPH)	1987			E 2	I 1												I 1								
	1988			I 1	B 4	E 1									B 12	E 8	E 5								

E=outside fields

I =inside

B=both

 > 75%


 50% - 74%

 25% -

Frequency

 <25%

Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Ruffed Grouse (RUGR)	1987																				I 1				
	1988								E 3																
Sandhill Crane (SACR)	1987																								
	1988						E 1																		
Black-bellied Plover (BBPL)	1987																								
	1988	I 1							E 4																
Killdeer (KILL)	1987			E 1				B 3	E 14			B 3	B 9			B 2	E 2			B 3	E 1			B 10	B 9
	1988	B 4	B 3	B 3	E 1	B 3	B 4	B 2	B 10					B 3	B 4	B 2	B 2	B 2	B 2	B 3					

E=outside fields


I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Lesser Yellowlegs (LEYE)	1987											I 1													
	1988																								
Solitary Sandpiper (SOSA)	1987																	E 1			B 1	E 1			
	1988																	E 1							
Spotted Sandpiper (SPSA)	1987							I 4				I 1				E 2	I 1			I 1				E 4	
	1988	I 2	E 1			B 3	B 1							I 1	B 1										
Upland Sandpiper (UPSA)	1987								E 1																
	1988																	E 1							

E=outside fields


I =inside

B=both

 > 75%


 60% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Pectoral Sandpiper (PESA)	1987											I 1													E 1
	1988																								
American Woodcock (AMWO)	1987				B 1							B 3	I 1												
	1988								E 1																
Ring-billed Gull (RBGU)	1987																								
	1988	I 1			B 12	I 22	B 4		B 25							E 4	E 3								
Rock Dove (RODO)	1987																	E 1	B 3				B 19		
	1988					I 2	I 1							I 2				E 2		E 1					

E=outside fields


I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%



Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Mourning Dove (MODO)	1987			B 7	B 11			B 4	B 13			B 10	B 46			B 4	B 8			B 20	B 40			B 11	B 8
	1988	E 1	B 9	E 2	B 16	B 6	B 10	B 9	B 50					B 3	B 6	B 5	B 25	B 5	B 7	B 11	B 23				
Black-billed Cuckoo (BBCU)	1987			B 2	E 1				E 1			E 1	E 1			E 2	E 2								
	1988			E 1	E 2	E 1	E 1		E 2							E 1	B 5			E 1	I 1				
Yellow-billed Cuckoo (YBCU)	1987								E 1																
	1988			E 1			E 1		E 1					E 2	E 1				E 1						
Great Horned Owl (GHOW)	1987												E 1												
	1988							E 1											I 1						



E=outside fields

I =inside


B=both

 > 75% 50% - 74%

Frequency

 25% - 49% <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Common Nighthawk (CONI)	1987																I 4				I 10				
	1988																								
Chimney Swift (CHSW)	1987								I 1				I 1				I 1			I 3	B 23				I 2
	1988	I 2				I 1			I 1							I 4		I 2		I 4					
Ruby-throated Hummingbird (RTHU)	1987							E 1	E 2				E 1							I 1	I 2				
	1988					E 1			B 8											I 1	I 1				
Belted Kingfisher (BEKI)	1987				E 1								E 1			E 1									E 1
	1988				E 1																				

E=outside fields


I =inside

B=both

 > 75%


























































 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Red-headed Wood- pecker (RHWO)	1987								E  4											I  1				E  1	
	1988								E  1																
Downey Wood- pecker (DOWO)	1987			E  2	B  1			B  3	B  1			B  1	B  3			E  1	E  2			B  2	B  2			E  1	B  1
	1988			E  1	E  1		E  1	E  2	B  2						E  3	E  1	E  2	I  1	B  3	B  4	B  5				
Hairy Wood- pecker (HAWO)	1987								E  1				E  1							I  1	I  1				E  1
	1988																								
Northern Flicker (yellow- shafted) (YSFL)	1987							E  1	B  3			E  1	B  2			B  2	E  2			B  4	B  5			B  3	B  6
	1988		B  1		E  1		E  3	B  3	B  6	B  3						E  1	E  2	E  1	B  2	B  3	B  4	B  4			

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Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Olive-sided Flycatcher (OSFL)	1987																								
	1988								E 1																
Eastern Wood- peewee (EAWP)	1987							E 2	E 1				E 2				E 1			E 1	B 1			E 1	B 2
	1988	E 1			I 1	E 1	E 1	E 1	E 1					E 4			E 1		E 1		E 1				
Yellow- bellied Flycatcher (YBFL)	1987								E 1																
	1988																								
Alder Flycatcher (ALFL)	1987																								
	1988		E 1						E 1					E 1											

E=outside fields


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 > 75%






































 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Willow Flycatcher (WIFL)	1987				E  2				E  1								E  1			I  1					
	1988					E  1	E  2	E  2	B  2					E  3	E  4										
Least Flycatcher (LEFL)	1987				E  1				B  3			E  2	E  2			E  2	E  1								
	1988				B  2	E  1		E  1	B  1								E  3								
Eastern Phoebe (EAPH)	1987											E  1													
	1988																								
Great Crested Flycatcher (GCFL)	1987							E  1	E  1											B  2	I  1				
	1988					E  2	E  2		E  1					E  1	E  1		E  1	B  3	B  3	B  2	B  1				

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 > 75%

 50% - 74%


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Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Eastern Kingbird (EAKI)	1987			E 1	E 5			E 1	B 3			B 5	B 4			E 1	E 51			B 3	B 14			B 5	B 2
	1988				B 5	B 3	B 2	B 5	B 3						E 4	E 4	B 5	B 2	I 3	B 2	B 1				
Horned Lark (HOLA)	1987			B 8	B 6			B 4	E 2			B 3	B 11			B 5	B 4							B 8	B 19
	1988	B 8	B 12	B 5	E 13	B 7	B 9	B 6	B 2					B 14	B 10	B 15	B 9	B 3	E 1	E 14					
Purple Martin (PUMA)	1987			B 6	I 3			I 2	E 10			I 6	I 2			I 5	I 5			I 2	B 1				
	1988	I 2	I 6	B 5	I 4	I 4	I 4	B 14	I 5					I 8	B 9	B 12	B 16	I 5	I 7	I 6	I 5				
Tree Swallow (TRES)	1987				I 4			B 98	B 162			B 11	B 30			I 1				B 6	I 4				
	1988		I 1			B 5	B 11	B 27	B 15						I 1	B 7	B 1	I 1	I 2	I 2	I 1				



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I =Inside


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 > 75% 50% - 74%

Frequency

 25% - 49% <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Northern Rough- winged Swallow (NRWS)	1987			I 2				B 11								I 2	I 1			E 2	I 2				
	1988	I 3	B 2	I 1			I 2	I 1	E 4					E 3	B 2	I 1			I 2	I 1					
Bank Swallow (BANS)	1987			I 15	I 59			B 150	B 258				B 60			I 2	I 16			B 73	B 194				E 1
	1988	I 1		I 4	I 3	I 64	I 25	B 189	B 415					I 3	B 9	B 14	I 22	I 4	I 2	I 7	I 114				
Cliff Swallow (CLSW)	1987			I 1	I 2			I 3	I 4							I 1	I 2				I 1				
	1988				I 1	I 2	I 9	I 6	B 4						I 2	I 1	I 2								
Barn Swallow (BARS)	1987			B 13	I 9			B 18	B 20			I 34	B 31			B 13	B 13			B 15	B 27			I 11	B 40
	1988	I 7	B 6	B 17	B 10	B 16	B 22	B 21	B 30					I 8	I 10	I 19	B 36	B 5	I 8	I 6	I 14				

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 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Swallow Species (SWsp)	1987			I 1																					
	1988																								
Blue Jay (BLJA)	1987			E 2	B 5			B 5	B 2			B 2	B 5							B 3	B 2				B 7
	1988	E 1	E 2	E 1	E 5	B 4	E 2	E 2	E 2						E 1	E 1	E 4	B 3	B 2	B 2	B 3				
American Crow (AMCR)	1987			E 3				B 2	E 8			E 3	E 7			E 4	E 2			B 7	B 7			B 2	B 1
	1988	I 4	B 2			B 4	I 3	E 5	B 11					B 6	B 3	B 6	E 8	B 4	B 6	B 8	B 10				
Black capped Chickadee (BCCH)	1987							E 2	B 4			B 4	B 11							B 6	B 7			E 4	B 6
	1988					E 1		E 2	B 8									B 2	B 4	B 6	B 10				


E=outside fields

I =inside


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 > 75% 50% - 74%

Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Red-breasted Nuthatch (RBNU)	1987				E 1																				
	1988				E 1												E 2			E 2	E 1				
White-breasted Nuthatch (WBNU)	1987								E 1											B 1	E 1				E 1
	1988							E 2	E 1									E 1	E 1	E 1	E 5				
Carolina Wren (CAWR)	1987							E 1																	
	1988																								
House Wren (HOWR)	1987								E 1			E 1	E 1			E 1	E 1			B 4	B 2			E 2	B 4
	1988				E 1	E 1	E 1	E 4	E 5						E 4	E 2	B 2		B 2	B 2	B 1				

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Frequency

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 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Winter Wren (WIWR)	1987								I 1																
	1988																								
Golden-crowned Kinglet (GCKI)	1987												E 2												
	1988																								
Ruby-crowned Kinglet (RCKI)	1987												E 3												
	1988				E 1																				
Blue-gray Gnatcatcher (BGGN)	1987																								
	1988					E 1														E 1					

E=outside fields


I =inside

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 > 75%
























 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Eastern Bluebird (EABL)	1987											E  1								B  10	B  13			B  4	B  5
	1988					B  1	B  6												B  4	B  5	B  7	B  10			
Veery (VEER)	1987								E  3																
	1988																E  1				E  1				
Gray- cheeked Thrush (GCTH)	1987																								E  1
	1988																								
Swainson's Thrush (SWTH)	1987				E  1				E  1								E  1								I  1
	1988				E  1				E  1								E  4								

E=outside fields


I =inside

B=both

 > 75%














































































 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.
American Robin (AMRO)	1987			B  8	B  5			B  12	B  12			B  102	B  29			B  9	B  18			B  41	B  27			B  33	B  65
	1988	B  4	B  6	B  11	B  7	B  11	B  9	B  39	B  13					E  4	B  4	B  8	B  11	B  10	B  7	B  43	B  35				
Gray Catbird (GRCA)	1987			E  2			B  2	B  3			E  1	B  2			B  1	E  1			B  1	E  1			B  2	B  2	
	1988	E  1	E  2	E  2	E  3	B  5	B  3	B  4	B  4						E  1	B  3	E  1	E  2	B  2	E  2					
Northern Mockingbird (NOMO)	1987																							I  1	I  2
	1988																	I  1	I  1						
Brown Thrasher (BRTH)	1987							E  1	E  1			E  1	B  2			I  2	B  1			I  1				E  1	
	1988		E  1	E  2	E  2	E  1	B  2	B  3							E  1		I  1	B  1	B  2	E  2					

E=outside fields

I =inside






























































B=both

 > 75% 50% - 74%

Frequency

 25% - 49% <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Cedar Waxing (CEDW)	1987			E  1	E  3			E  3	E  27			E  6	B  6			E  4	E  11			B  5	B  16			E  2	B  1
	1988			E  1	E  2	E  2	E  5	E  6	B  31							E  2	E  5	B  18	B  4	B  4	B  34				
European Starling (EUST)	1987			B  26	B  7			B  490	B  1980			B  14	B  108			E  16	B  18			B  40	B  144			B  128	B  88
	1988	B  2	B  26	B  18	B  80	B  17	B  85	B  80	B  115					E  6	B  42	E  28	E  22	B  23	B  112	B  105	B  219				
Yellow-throated Vireo (YTVI)	1987																								
	1988																		E  1						
Warbling Vireo (WAVI)	1987												E  1												E  1
	1988					E  2	E  1	B  2	E  1								E  1								

E=outside fields


I =inside

B=both

 > 75%


 60% - 74%

Frequency

 25% - 49%

 <25%

Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Philadelphia Vireo (PHVI)	1987																								
	1988																E 1								
Red-eyed Vireo (REVI)	1987								E 1								E 1				E 1				
	1988				E 1	E 1	E 1	E 1	E 1					E 1		E 1	E 4	E 1	E 3	E 1	E 1				
Blue-winged Warbler (BWWA)	1987								E 1				E 1				E 1								
	1988				E 1	E 1			E 1								E 1				I 1				
Tennessee Warbler (TEWA)	1987			I 1	B 2				B 1				E 1			E 1	E 1								
	1988			E 1	B 2				E 2								B 1				I 1				

E=outside fields


I =Inside


B=both

 > 75%

















































 50% - 74%

Frequency

 25% - 49%

 <25%



Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Nashville Warbler (NAWA)	1987				B  1				E  2				B  1												
	1988				E  1				B  1								E  1				I  1				
Yellow Warbler (YWAR)	1987			B  5	B  3			B  4	B  6			B  4	B  3			B  4	B  2			I  1				I  1	
	1988				B  2	E  13	B  14	B  22	B  19						E  1		B  2	E  1	E  1		I  1				
Chestnut-sided Warbler (CSWA)	1987				E  1				E  1				B  1							I  1				E  1	
	1988							E  1	E  1								E  3	E  1	E  1	E  1	E  1				
Magnolia Warbler (MAWA)	1987				B  2								B  2				E  1				I  1				
	1988				E  2				B  3								E  4				I  1				


E=outside fields

I =inside


B=both

 > 75% 50% - 74%

Frequency

 25% - 49% <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Cape May Warbler (CMWA)	1987								B 5				B 3								I 2				E 1
	1988				E 1				B 6								E 2				B 1				
Black-throated Blue Warbler (BTBW)	1987				E 1				E 1																
	1988								E 1								E 1				I 1				
Yellow-rumped Warbler (MYWA)	1987								B 1				B 5				B 1								
	1988				E 1	E 1			B 1												I 1				
Black-throated Green Warbler (BTNW)	1987																								
	1988				E 1	E 1											E 2								

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I =inside

B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Blackburnian Warbler (BLBW)	1987																								
	1988																E 1								
Pine Warbler (PIWA)	1987								E 1				E 1								I 10				
	1988					E 1	E 1											E 1	E 1	B 3					
Palm Warbler (WPWA)	1987				I 1				I 1				E 2				I 1								
	1988				B 6												B 2				I 2				
Bay-breasted Warbler (BBWA)	1987				E 1				E 1				E 2												I 1
	1988					E 1			E 2								E 1				E 1				

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B=both

 > 75%


 50% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit.

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Blackpoll Warbler (BLPW)	1987				E 1												E 1								
	1988				B 4												E 4								
Black and White Warbler (BAWW)	1987				E 1				E 1								E 2								E 1
	1988																E 2								
American Redstart (AMRE)	1987							E 1	B 3				E 2				E 1								
	1988				E 1	E 1	E 1	E 1	B 3								E 4				I 1				
Ovenbird (OVEN)	1987				E 1				B 1				E 1												
	1988								B 1								E 2				E 1				


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B=both

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Frequency

 25% - 49% <25%



Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Northern Waterthrush (NOWA)	1987				E  1				B  1							E  1	B  1								
	1988								B  2																
Mourning Warbler (MOWA)	1987								E  1				I  1												
	1988																E  1								
Common Yellow- throat (COYE)	1987				B  2			B  3	B  3			I  1	E  3			E  2	B  1							B  1	
	1988				E  2	B  6	B  12	B  7	B  7					E  1	E  1		E  2				B  4				
Wilson's Warbler (WIWA)	1987								B  1				B  1												I  1
	1988				E  1				B  1								E  1								


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
















B=both

 > 75% 50% - 74%

Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Canada Warbler (CAWA)	1987												E  1												
	1988						E  1		E  1								E  1								
Warbler Species (WAsp)	1987				B 7				B 7				E 4				B 2				I 1				I 1
	1988				B 2				E 2								B 12				B 2				
Scarlet Tanager (SCTA)	1987																								
	1988																	E  1	E  1						
Northern Cardinal (NOCA)	1987			E  1	E  1			B  6	B  3			B  2	B  3			B  1	E  1			B  1	B  2			E  1	B  2
	1988	E  2	E  1		B  4	E  3	B  3	E  3	B  4							E  1	B  2	B  3	E  1	B  3	B  2	B  2			


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Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Rose-breasted Grosbeak (RBGR)	1987												B 6							B 2	B 2				I 1
	1988				E 1	E 2		E 4	E 1												E 1				
Indigo Bunting (INBU)	1987			B 3	B 6			B 5	B 4			B 3	B 4			E 3	B 4			B 2	B 1			E 1	E 1
	1988	B 3	B 5	B 3	B 5	E 1	E 3	B 5	B 7					E 2	E 4	E 6	B 8	E 3	B 3	B 4	B 1				
Dickcissel (DICK)	1987																								
	1988				E 1																				
Rufous-sided Towhee (RSTO)	1987																			B 3	B 2				
	1988																	B 4	B 2	E 2	E 2				

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


















































Frequency

 25% - 49%

 <25%




Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Chipping Sparrow (CHSP)	1987			B  2	B  14			B  5	B  5			B  2	B  4			B  5	B  7			B  22	B  142			B  26	B  13
	1988	E  1	E  1	B  7	B  3	B  4	B  4	B  6	B  6					E  2	B  7	B  4	B  3	B  18	B  13	B  164	B  217				
Clay-coloured Sparrow (CCSP)	1987																								
	1988				E  1																				
Field Sparrow (FISP)	1987							I  1	E  1			E  1	B  5				I  2			B  7	B  38			B  3	I  4
	1988							E  1											B  3	E  2	B  7	B  8			
Vesper Sparrow (VESP)	1987			B  3	B  5			I  4	B  4			B  2	B  6			B  4	B  2			B  4	B  2			B  4	B  3
	1988	B  4	B  4	B  4	B  2	B  1	B  4	B  1						B  2	B  4	B  3	B  5	B  2	B  2	B  2	B  2				


E=outside fields

I =inside



































































B=both

 > 75% 50% - 74%

Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Savannah Sparrow (SAVS)	1987			B 	B 			B 	B 			B 	B 			B 	B 			B 	B 			B 	B 
	1988	I 	B 	B 	B 	B 	B 	B 	B 					B 	B 	B 	B 	B 	B 	B 	B 				
Song Sparrow (SOSP)	1987			B 	B 			B 	B 			B 	B 			B 	B 			B 	B 			B 	B 
	1988	B 	B 	B 	B 	B 	B 	B 	B 					B 	B 	B 	B 	B 	B 	B 					
Lincoln Sparrow (LISP)	1987								B 				E 				I 								
	1988																								
Swamp Sparrow (SWSP)	1987								B 				B 												
	1988					E 	E 	B 	B 																


E=outside fields

I =inside











B=both

 > 75% 50% - 74%

Frequency

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
White-throated Sparrow (WTSP)	1987				E  1								B  12				E  1								
	1988				E  1													E  2							
White-crowned Sparrow (WCSP)	1987																								
	1988					E  1												E  2							
Sparrow Species (SPsp)	1987								I 2			I 1	B 6							B 14	B 99				I 2
	1988				E 1		E 1	I 2									I 1	I 1	I 7	B 34					
Slate-coloured Junco (SCJU)	1987				I  1								E  2												
	1988																								

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



















































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Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara				
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	
Bobolink (BOBO)	1987			E  11				B  12	B  18			B  2	B  56			B  20	B  11			B  20	I  1				I  5	
	1988	B  2	B  7		E  1	B  2	E  1	B  8	B  21					I  1	E  2	E  6	B  2	B  6		B  1						
Red-winged Blackbird (RWBL)	1987			B  17	B  5			B  372	B  28960			B  125	B  1014			B  18	B  4			E  1				B  69	B  6	
	1988	E  3	B  14	B  181	B  250	B  32	B  106	B  384	B  156					B  4	B  37	B  48	E  30	B  2	B  1		I  18					
Eastern Meadow- lark (EAME)	1987											I  1	E  1											I  3	B  2	
	1988						I  1	E  1							I  1				I  1							
Rusty Blackbird (RUBL)	1987												I  1													
	1988																									

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Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
Brewer's Blackbird (BRBL)	1987																								
	1988																I 1								
Common Grackle (COGR)	1987			B 19	B 4			B 100	B 30			B 36	B 110			B 15	I 1			B 3	I 200			B 8	B 3
	1988	B 10	B 26	I 31	B 80	B 23	B 39	B 58	B 152					B 20	B 21	E 2	B 45	B 6	B 4	B 14					
Brown- headed Cowbird (BHCO)	1987			E 1	B 1			I 4	E 100			B 7	B 10			B 5	E 2			B 4	B 2			B 2	B 1
	1988	E 2	E 7	E 3	E 1	B 9	B 10	B 7	B 30					E 3	B 6	E 2	B 2	B 5	B 6	E 7	I 6				
Orchard Oriole (OROR)	1987																			E 1					
	1988					E 1																			


E=outside fields

I =inside















































































B=both

 > 75% 50% - 74%

Frequency

 25% - 49% <25%


Maximum abundance: maximum number of individuals per field at any one visit


		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.	May	June	July	Aug./Sept.
Northern Oriole (BAOR)	1987				B 			B 	B 			B 	B 			E 	E 			I 	B 			E 	B 
	1988		E 	E 	E 	E 	B 	E 	B 					E 	E 	B 	E 	B 	I 	E 	E 				
Purple Finch (PUFI)	1987			I 																					
	1988																								
House Finch (HOFI)	1987			E 				E 	E 				E 			E 	E 			B 	I 			B 	B 
	1988					E 	E 	B 	B 					E 	B 	E 	B 	B 	B 	B 	B 				
American Goldfinch (AMGO)	1987			B 	B 			B 	B 			B 	B 			B 	E 			B 	B 			B 	B 
	1988	E 	E 	B 	B 	E 	E 	B 	B 					E 	B 	E 	B 	B 	B 	B 	B 				

E=outside fields


I =inside

B=both

 > 75%





























 60% - 74%

Frequency

 25% - 49%

 <25%


Maximum abundance: maximum number of individuals per field at any one visit

		CORN - Essex				CORN - Norfolk				CORN - Niagara				SOYBEAN - Essex				APPLE - Norfolk				GRAPE - Niagara			
SPECIES	Year	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.	May	June	July	Aug./ Sept.
House Sparrow (HOSP)	1987			B  6	B  38			B  19	B  215			B  55	B  74			B  22	B  53			B  10	B  14			B  46	B  59
	1988	E  3	B  3	B  11	B  64	E  3	B  6	B  18	B  12					B  2	B  7	B  12	B  12		E  2	I  3	B  19				
	1987																								
	1988																								
	1987																								
	1988																								
	1987																								
	1988																								
	1987																								
	1988																								


E=outside fields

I =inside

B=both

 > 75% 50% - 74%

Frequency

 25% - 49% <25%

Maximum abundance: maximum number of individuals per field at any one visit