# A FEASIBILITY STUDY COMPARING BIRDS FROM ORGANIC AND CONVENTIONAL (CHEMICAL) FARMS IN CANADA

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## PREFACE

The Canadian Wildlife Service is responsible for protecting and managing migratory bird species in Canada. To fulfill this mandate, field studies are needed to assess the impact of modern agricultural practices (particularly use of pesticides, but also habitat alteration and use of chemical fertilizers) on birds and their habitat. The study reported here was conducted in 1989 to investigate the feasibility of comparing birds between organic and conventional (chemical) farms in Canada, as a novel approach for assessing these effects. Since then, more extensive field studies have been conducted in Ontario, Saskatchewan and Quebec. The current report provides the background information used to justify the implementation of and specific design for those studies. The preliminary findings reported here, that the use of chemical pesticides and/or fertilizers contribute to a reduction in the number and variety of farmland birds, has been corroborated by analyses of the more extensive sample from Ontario. Results from regional studies will be published elsewhere as they become available.

## PRÉFACE

Le Service canadien de la faune est responsable de la protection et de la gestion des espèces d'oiseaux migrateurs au Canada. Pour réaliser ce mandat, il faut effectuer des études sur le terrain pour évaluer l'impact des pratiques agricoles modernes (particulièrement l'utilisation de pesticides, mais aussi la modification des habitats et l'utilisation d'engrais chimiques) sur les oiseaux et leurs habitats. L'étude résumée ici, une nouvelle approche pour évaluer ces effets, a été effectuée en 1989 dans le but d'examiner la possibilité de comparer entre les oiseaux de deux types d'établissements agricoles canadiens : biologiques et conventionnels (chimiques). Depuis, des études plus approfondies ont été effectuées en Ontario, en Saskatchewan et au Québec. Ce rapport présente l'information de base utilisée pour justifier la réalisation et la conception particulière de ces études. Les conclusions initiales qui rapportent que l'utilisation de pesticides ou d'engrais chimiques contribue à la réduction du nombre et de la variété d'oiseaux sur les terres agricoles ont été confirmées par les analyses d'échantillons plus importants provenant de l'Ontario. Les résultats des études régionales seront publiés ailleurs quand ils seront disponibles.

## SUMMARY

We conducted a study in 1989 to evaluate the feasibility of comparing birds on organic versus conventional farms as a way of assessing impacts of agricultural practices (particularly pesticides) on wildlife in Canada. Information on alternative agricultural practices and Canadian organic farming organizations was reviewed to summarize recent trends and to quantify the number of organic farms in different regions of Canada. Based on certification statistics, good potential for establishing organic study sites exists in Ontario, Saskatchewan, Quebec and the Maritimes.

A field study was conducted in Ontario to assess the comparability of organic and conventional farms and to evaluate a variety of bird survey methods. Ten pairs of study sites were established on 3 pairs of organic/conventional farms near Ottawa. Five unpaired study sites were also established among farms. Organic study sites were at least 100m from the farm boundary to minimize potential contamination from adjoining farms through spray drift, etc. All conventional study sites were a minimum of 500m from organic farms. Study sites were paired between farms so as to minimize differences in landscape characteristics such as geographic location, crop type, proximity to farmsteads/water/woodland, and the nature and extent of field-edge habitats. Habitat features within a 200m semicircle of survey sites were quantified from aerial photographs. Empirical analyses indicated a high degree of similarity between pairs of survey sites. On conventional farms, 60% of survey sites were treated with herbicides and/or chemical fertilizers during the field study. All organic farms were certified (i.e. have not applied commercial pesticides or fertilizers for at least 3 years). Other aspects of farm operation, such as time of planting, did not appear to differ within farm pairs.

Birds were surveyed by point count and search (walk-about) methods. Point counts were conducted from field edges at all study sites and from field centres at seven of the study sites paired between farm types. Point counts of 5-minutes duration were used representing a compromise between greater detection efficiency for both numbers of species and individuals associated with point counts of longer duration and total time required each day to complete point counts at all study sites on the farm pair. One farm pair was surveyed on each day to minimize weather effects, and each farm pair was surveyed 3 times between June 13 and July 7. On alternate visits, the order of visitation was reversed for the farms in the pair and for the study sites on each farm to minimize effects related to time of day. Point counts were conducted between dawn and 9:00 in good weather only. Bird registrations were recorded such that they could be separated into 180° or 360°, and limited (100m radius) or unlimited distance (but still on farm). Abundance for each species was interpreted from the territorial status and simultaneous observation of individuals. Search surveys for additional species and individuals were conducted in study sites and in noncrop habitats on each farm following point counts for the farm pair.

A total of 64 bird species were observed during farm surveys. Forty-six species (72%) were recorded during field-edge point counts paired between farm types. An additional 2 species (3%) were recorded only during unpaired field-

edge point counts; 1 (2%) additional species was recorded only during field-centre point counts. No additional species and few birds were noted during search surveys of study sites. Fifteen species (23%) were noted only during search surveys of farmsteads, woodlots or wetlands. Numbers of species and individuals were not significantly different between 7 pairs of field-edge and field-centre point counts; most of the bird activity occurred near the field edge. For field-edge point counts paired between farm types, numbers of species and individuals were similar for limited-distance, 180° and 360° counts, and unlimited-distance, 180° and 360° point counts. Of the 46 species observed in the 360°, unlimited-distance range, 91% were observed in the 180°, unlimited distance range. Many more species and individuals were recorded in the unlimited-distance than in the limited-distance point counts. Fifteen species were recorded only beyond 100m. Numbers of species observed during point counts continued to increase over the 3 survey dates; mean numbers of individuals were relatively similar.

Statistical analyses of survey data for 180°, unlimited-distance point counts paired between farm types indicated that the avifauna differed significantly between organic survey sites and their conventional twins. Detrended correspondence analysis (DECORANA) was used to generate study site scores based on species composition and abundance data. Multiway analysis of variance of DECORANA site scores indicated that bird patterns were significantly related to farm pair and farm type, but not crop type or point-pair within farm-pair. Significantly more species and birds were observed at organic sites than at their conventional twins. Analyses by species were inconclusive because of small sample sizes.

Our results indicated that a fairly robust study could be devised for comparing birds on organic and conventional (chemical) farms to assess the impact of modern agricultural practices on wildlife and that further research was warranted. Recommendations for further studies include:

- Selection of additional study sites, particularly in the intensively farmed areas of southwestern Ontario, to increase sample size. Other studies could be implemented in Saskatchewan, Quebec and the Maritimes.
- The need to match and quantify habitat features. Habitat analyses could be enhanced by more intensive surveys of plant species composition, weed seed and invertebrate/insect abundance within fields and/or by analyses at the scale of study farms or larger. More quantitative analyses need to be explored.
- Use of field-edge, 180-degree point counts with observations recorded within or beyond 100m (but still on farm). All species seen or heard should be recorded and every effort made to avoid double-counting of individuals. Conservative estimates of abundance should be employed during interpretation of field data and analysis.
- Increasing point count duration to 10 minutes per survey to improve sampling efficiency while still accommodating time constraints on total survey time each field day.
- Expansion of bird surveys to at least 4 times during May and June (preferably 2 per month) to encompass more of the breeding season and to balance the study design.
- Continuation of the survey schedule used to minimize effects related to weather and time of day.

. A calendar of farm operations to characterize/quantify practices used at each study site (e.g. pesticide/fertilizer use, tillage practices).


## RÉSUMÉ

En 1989, nous avons effectué une étude pour connaître la possibilité de comparer les oiseaux des fermes biologiques avec ceux des fermes conventionnelles afin d'évaluer les effets des pratiques agricoles (particulièrement des pesticides) sur la faune au Canada. L'information sur les pratiques agricoles alternatives et les organismes agricoles biologiques canadiens a été étudiée pour résumer les tendances récentes et pour connaître le nombre de fermes biologiques dans les différentes régions du Canada. En se fondant sur les statistiques relatives aux certificats, il existe une bonne possibilité d'établir des sites d'études biologiques en Ontario, en Saskatchewan, au Québec et dans les Maritimes.

On a effectué une étude sur le terrain, en Ontario, afin de comparer les fermes biologiques et conventionnelles et d'évaluer diverses méthodes de recensement des oiseaux. Dix sites d'échantillonnage pairés ont été établis dans 3 établissements agricoles biologiques-conventionnels pairés près d'Ottawa. Cinq sites isolés ont aussi été choisis parmi les fermes. Les sites biologiques étaient situés à au moins 100 m des limites de la ferme pour diminuer les possibilités de contamination dues à la proximité des fermes où il y a pulvérisation, etc. Tous les sites expérimentaux conventionnels étaient situés à au moins 500 m des fermes biologiques. Les sites étaient regroupés par fermes afin de diminuer les différences dans les caractéristiques topographiques telles que la situation géographique, le type de culture, la proximité des fermes, de l'eau, de la forêt, et la nature et l'étendu des habitats le long des champs. Les particularités des habitats dans un demi-cercle de 200 m de sites de recensement ont été comptées à partir de photographies aériennes. Des analyses empiriques ont indiqué un niveau élevé de similitude entre les sites pairés. Dans les fermes conventionnelles, 60 % des sites ont été traités avec des herbicides et (ou) des engrais chimiques au cours de l'étude sur le terrain. Toutes les fermes biologiques ont été certifiées (c.-à-d. pendant au moins trois ans, aucun pesticide ou engrais commercial n'a été utilisé). Les autres aspects du fonctionnement d'une ferme, comme la période des semences, ne semblaient pas varier parmi les fermes regroupées.

Les oiseaux ont été recensés par la méthode d'indice ponctuel d'abondance (IPA) et la méthode de recherche de validation. Les IPA ont été effectués le long des champs de tous les sites et à partir du centre du champs pour sept des sites regroupés parmi les types de fermes. Des IPA d'une durée de cinq minutes ont été effectués, ce qui représente un compromis entre une plus grande efficacité de détection pour le nombre d'espèces et d'individus associés au dénombrement d'une plus longue durée et le temps nécessaire chaque jour pour effectuer les dénombrements dans tous les sites. Chaque jour, on a recensé un groupe de fermes pairées pour diminuer les effets de la température, et chaque paire a été recensée trois fois entre le 13 juin et le 7 juillet. Concernant les visites alternées, l'ordre a été renversé dans chaque paire et parmi les sites d'étude dans chaque établissement agricole

afin de réduire les effets reliés à la période de la journée. Les IPA ont été effectués entre l'aube et 9 heures, dans de bonnes conditions climatiques seulement. Les enregistrements des oiseaux ont été inscrits de façon à ce qu'ils puissent être divisés en 180° ou 360°, et à une distance limitée (cercle de 100 m) ou illimitée (mais toujours sur la ferme). L'abondance de chaque espèce a été interprétée à partir du type de territoire et de l'observation simultanée d'individus. Après les IPA dans la ferme pairée, les recherches de validation pour d'autres espèces et individus ont été effectuées dans les sites d'échantillonnage et dans les habitats non cultivés sur chaque ferme.

En tout, 64 espèces d'oiseaux ont été observés pendant le recensement sur les fermes. Quarante-six espèces (72 %) ont été inscrites lors des IPA le long des champs pairés entre les types de fermes. Seulement deux autres espèces (3 %) ont été inscrites pendant les IPA le long des champs non pairés; seulement une autre espèce (2 %) a été inscrite pendant les IPA au centre des champs. Aucune autre espèce n'a été inscrite, mais quelques oiseaux l'ont été pendant les recherches de validation dans les sites expérimentaux. Seulement 15 espèces (23 %) ont été inscrites pendant les recherches de validation sur les terres agricoles, les terres boisées et les terres humides. Le nombre d'espèces et d'individus n'était pas très différents dans 7 paires avec IPA le long et au centre des champs; la plupart des activités des oiseaux ont eu lieu le long du champ. Pour les IPA le long des champs regroupés en paires entre les types de fermes, le nombre d'espèces et d'individus était semblable sur une distance limitée, un IPA à 180° et à 360°, et une distance illimitée, IPA à 180° et à 360°. Sur les 46 espèces observées dans 360°, distance illimitée, 91 % ont été observées dans 180°, distance illimitée. Beaucoup plus d'espèces et d'individus ont été inscrits avec un IPA à distance illimitée qu'avec une IPA à distance limitée. Quinze espèces seulement ont été inscrites au delà de 100 m. Le nombre d'espèces observées pendant les IPA a continué d'augmenter après les trois dates de relevés; en moyenne, les nombres d'individus étaient relativement semblables.

Les analyses statistiques des données de l'IPA à 180°, distance illimitée, regroupées selon le type de ferme ont indiqué qu'il y avait une différence considérable entre l'avifaune des sites biologiques et leurs sites jumeaux. L'analyse de correspondance qui efface la tendance centrale (DECORANA) a été utilisée pour produire des pointages par sites d'échantillonnage fondés sur les données sur la composition et l'abondance des espèces. Les analyses multidimensionnelles de la variance des pointages obtenus dans chaque site DECORANA indiquent que les habitudes des oiseaux étaient reliées de façon significative aux paires et aux types de fermes, mais n'étaient pas reliées aux types de cultures ou aux sites pairés dans les fermes pairées. Il y a eu beaucoup plus d'espèces et d'oiseaux observés dans les sites biologiques que dans leurs sites jumeaux. Les analyses par espèces ont été moins concluantes en raison de la petite taille des échantillons.

Nos conclusions ont indiqué qu'une étude passablement plus solide pourrait être conçue pour comparer les oiseaux des fermes biologiques et des fermes conventionnelles (chimiques) afin d'évaluer l'impact des pratiques agricoles modernes sur la faune, et qu'une recherche plus poussée était justifiée. Les recommandations relatives à de futures études incluent les suivantes :

- La sélection de sites d'étude additionnels, particulièrement dans les régions très agricoles du sud-ouest de l'Ontario, pour augmenter la taille de l'échantillon. D'autres études pourraient être mises en oeuvre en Saskatchewan, au Québec et dans les Maritimes.

- Le besoin d'assortir et de quantifier les caractéristiques des habitats. Les analyses d'habitats pourraient être améliorées par plus de recensements intensifs de la composition des espèces de flore, de l'abondance des mauvaises herbes et des insectes-invertébrés dans les champs et (ou) par des analyses à l'échelle des fermes d'étude ou à plus grande échelle. Des analyses plus quantitatives doivent être examinées.

- L'utilisation d'indices ponctuels d'abondance (IPA) le long des champs, à 180°, dont les observations sont inscrites dans des limites de 100 m ou au delà (mais toujours sur la ferme). Toutes les espèces observées ou entendues devraient être inscrites et tous les efforts devraient être faits pour éviter de compter deux fois le même individu.

- Augmenter la durée de l'IPA à 10 minutes par recensement pour améliorer l'efficacité de l'échantillonnage tout en continuant de tenir compte des contraintes de temps sur la période de recensement totale d'une journée.

- L'extension des recensements d'oiseaux à au moins 4 fois en mai et juin (de préférence 2 par mois) pour inclure une plus grande saison de reproduction et pour équilibrer la conception de l'étude.

- La continuité de l'horaire du recensement, utilisée pour diminuer les effets reliés à la température et à la période de la journée.

- Un calendrier des opérations agricoles pour caractériser et (ou) quantifier les pratiques utilisées dans chaque site d'étude (ex. : utilisation de pesticides ou d'engrais, pratiques de labour)

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## CHAPTER 1: INTRODUCTION

Each year, commercially synthesized pesticides and fertilizers are applied to vast tracts of farmland. In 1986, in Canada alone, approximately 22.9 million ha (34% of total farmland) were treated at least once with herbicides and 4.6 million ha (7% of total farmland) were treated at least once with insecticides (Statistics Canada 1986). Similarly, in 1980, approximately 17.9 million ha of farmland were treated at least once with commercial fertilizers (Statistics Canada 1951-1986). It is likely that these agricultural chemicals have been used even more extensively in recent years. The area of land treated with herbicides and insecticides in 1986 represented 169% and 188% increases respectively over the areas treated in 1981 (Statistics Canada 1986), and the area of land treated with fertilizers in 1980 represented a 167% increase over the area treated in 1970 (Statistics Canada 1951-1986).

This extensive use of toxic chemicals could have significant implications for wildlife associated with agricultural habitats. Accordingly, in keeping with its mandate, the Canadian Wildlife Service (CWS) is developing methods of identifying and evaluating the impact of agricultural chemicals on wildlife (migratory birds in particular) and wildlife habitat.

Some time ago, the CWS recognized that the current trend in agriculture, from chemical practice to ecologically sustainable alternatives, could provide the opportunity to develop a comparative field study for evaluating the ecotoxicological impact of agricultural chemicals. A study conducted in Denmark indicated the potential utility of this approach (Brae et al. 1988). The main conclusions of that study were that organic and conventional chemical farms in Denmark support similar complements of avian species but that, for many species, there are fewer individuals on conventional farmland than on organic farmland. This difference was attributed specifically to the use of pesticides, not through acute toxic effects, but rather through a reduction in the quality and quantity of food available to the birds. The value of conducting similar research, in Canada, to substantiate these conclusions is apparent. Consequently, the CWS initiated a feasibility study on comparing avifauna on organic and conventional chemical farms in Canada.

This report consists of a review of recent trends in alternative agricultural practices in Canada, a summary of the 1989 field study undertaken in Ontario and recommendations for future studies.

## CHAPTER 2: RECENT TRENDS IN ALTERNATIVE AGRICULTURE IN CANADA

In Canada, agriculture has rapidly evolved from a modest lifestyle into a highly competitive business (Agriculture Canada 1979; Agriculture Canada 1986; de Zeeuw 1988; Eijsackers 1988; McEwen and Stephenson 1979). In the 1930s, and even the 1940s, the most common practice was subsistence farming: a system in which all or nearly all the goods required by the farm family were produced on the farm, and very little surplus was produced for sale. Today, as a result of countless technological developments (including mechanization, chemical additives and genetic manipulation), the most common practice is industrial farming: a system characterized by intense productivity (yield per acre), high off-farm inputs (cash, energy, commercial chemicals, stock) and commercial scale, highly specialized production (e.g., continuous monocultural cropping on extensive tracts of land).

Modern agriculture must be credited of course, with the tremendous quality, quantity and variety of food that is produced today. However, there is increasingly widespread concern among farmers and consumers alike, that chemical (industrial) methods of food production are jeopardising human health and are contributing to the destabilization of the global ecosystem (Table 1).

In the wake of growing environmental awareness, alternative forms of sustainable agriculture, such as organic, ecological and biodynamic farming, are experiencing pronounced revitalization. In its most sophisticated form, organic agriculture employs principles of ecology to address the disbenefits of conventional chemical agriculture. More specifically, production is optimized and assured over the long term by maintaining or enhancing the quality of air, water and soil, and by stimulating natural cycles that are associated with the flow of nutrients and energy through the ecosystem. Production of environmental pollutants and consumption of non-renewable resources are minimized through farm management and design (for example, diverse operation permits recycling of animal and vegetable "wastes" and reduces or eliminates requirement for off-farm inputs such as commercial feeds and fertilizers). Furthermore, environmental degradation via contamination with toxic agricultural chemicals is averted since pest, weed and disease problems are addressed primarily through agro-system design and management (such as judicious timing of all farm operations and selection of robust seed or stock varieties which are adapted to local conditions), and secondarily through use of "environmentally friendly" substances, biological, cultural and mechanical controls.

There is, at present, some confusion regarding the exact definition of organic agriculture. Consequently, in November 1988, a fundamental code of practice was developed, by and for the organic foods industry in Canada, to clarify terms such as "organic practice" and "organic produce".[1] Moreover to prevent misuse of these terms, accredited certification agencies have established specific organic production and processing standards and permit compliant farmers to market their produce under an official seal.[2] On-farm compliance with agency standards is ascertained by affidavits (i.e., declarations written under oath) provided by the farmer, attesting to the truth of all information furnished to the agency and adherence to agency standards. Compliance is further verified on routine, random and, in suspicious cases, supplementary bases, by third party farm inspection.

Naturally, production standards vary in detail among certification

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[1] The following code of practice is included in "Food Guidelines, Section 36" of the 1988 "Guide for Food Manufacturers and Advertisers" published by Consumers and Corporate Affairs of Canada:

> The description "organic", "organically grown", "organically raised", "organically produced", and "certified organic", or other variations of, or use of the word "organic" shall only apply to those food and health products which meet the following definition, as elaborated and specified by independent organic certification agencies:
>
> Organic farming is a system of farm design and management practices that seek to create ecosystems which achieve sustainable productivity through a diverse mix of mutually dependent life forms.
>
> Management practices which achieve this sustainable productivity, and which provide weed and pest control, and maintain soil productivity and tilth, include recycling plant and animal residues, crop selection and rotation, water management, and tillage and cultivation. Soil fertility is maintained and enhanced by a system which optimizes soil biological activity as a means to provide nutrients for plant and animal life and conserve soil resources.
>
> In keeping with soil health and environmental considerations, pest and disease management is attained by encouraging a balanced host/predator relationship through augmentation of beneficial insect populations, biological and cultural controls, and mechanical removal of pests and affected plant parts.
>
> Organic livestock is raised under conditions of minimal stress including reasonable freedom of movement, lack of crowding, and access to sunshine and fresh air. All grains, forages and protein supplements used as feed must be organically grown. Animal health must be maintained without the use of antibiotics, synthetic growth promoters or similar drugs. Slaughtering and processing must be done under humane and sanitary conditions.
>
> Organic foods and health products and their ingredients are processed, packaged, transported and stored to retain maximum nutritional value. All packaging must be non-reactive with its contents.
>
> If a production unit has been farmed conventionally, a minimum three year transition period is required to achieve organic status. During the transition period from conventional to organic farming, the production unit must adhere to strict organic practices.
>
> All enterprises selling organic food or health products must maintain an accurate and comprehensive audit trail of production and handling, with records retained for a period of three years for all products that are sold as organically produced. This audit trail is further strengthened by independent third party verification of growing, processing, packaging, transportation, warehousing, and retailing procedures.
>
> Organic food production systems prohibit the use of highly soluble or synthetically compounded mineral fertilizers, synthetically compounded pesticides, fungicides, herbicides, plant and animal growth regulators, antibiotics, hormones, preservatives, colouring or artificial additives, ionizing irradiation and recombinant genetic manipulation of plants and animals.
>
> Specific standards for production, processing and storage of organic products may be obtained from independent organic certification agencies.

[2] It is important to recognize that the organic seal indicates only that the product has been grown and processed organically, according to agency standards. In view of the sensitivity of modern pesticide residue testing procedures and the multitude of potential sources of contamination -e.g, air or water borne contaminants- the seal cannot guarantee that the product is free of pesticide residues.

agencies, and all represent a compromise between ideals and the current state of biotechnology. In Canada, there are over a dozen certification agencies, but the two dominant and most stringent are the Organic Crop Improvement Association (OCIA) and the Mouvement Pour L'Agriculture Biologique (MAB). (Production and processsing standards for these agencies are outlined in Appendix 1.)

The idea of growing food in an environmentally sustainable manner is appealing to the imagination and intellect of ever increasing numbers of farmers and consumers.[3] Promotional and educational organizations, certifying agencies, coordinating and networking bodies (Appendix 2) are originating and evolving at tremendous speed. Canadian academic institutions (for example MacDonald College of McGill University, University of Guelph, and University of Laval) are initiating courses, programs and degrees in organic agriculture. The demand for organic food is increasing daily and has already surpassed the supply (Kramer 1989). It is estimated that about 4000 farms in Canada (about 1% of all Canadian farms) are organic or are in transition from chemical to organic (Boutkatem and White 1989). Although relatively few (i.e., less than 20%) of these farms are certified[4], the number of certified organic farms is dramatically increasing each year (Table 2). In Canada, organic agriculture appears to have taken strongest hold in Quebec (Table 3) and predictions by the Union des Producteurs Agricoles au Quebec suggest that 40% of the farms in Quebec will be organic within 20 years (Boutkatem and White 1989). In short, the organic food industry is experiencing spectacular growth.

This trend toward organic agriculture is creating considerable unease within farming communities, as well as within academic and industrial sectors. Perhaps reflecting the comparative ease of research, the rapidity at which effects can be detected and the potential for financial gain, researchers and advisors in both public and private sectors have traditionally emphasized the development and use of chemical technology (Oelhaf 1978). Consequently, many livelihoods and many deeply held convictions are at stake.

As can be seen in almost any topical literature, critics and proponents of organic agriculture are diametrically opposed (e.g., McEwen and Stephenson 1979, Oelhaf 1978, Vyn 1989, Zettel 1989). Contemporary critics interpret the growing concern over conventional agricultural practices as a product of hysteria fuelled by an uninformed media. Furthermore, they claim that organic agriculture is a throwback to our forefathers' agricultural techniques, which were both ineffective and inefficient, relative to modern techniques. Accordingly these sceptics claim that organic methods are economically infeasible and that proponents thereof are naive. Conversely, proponents of organic agriculture claim that organic techniques are not merely a throwback

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[3] This movement appears to have begun in Europe (more specifically, in Germany, Switzerland, the United Kingdom and France). Today there are approximately 11,000 organic farmers in Europe, of which 6,800 are certified (Boutkatem and White 1989).

[4] Apparently many farmers are using organic techniques, but are opting to sell into conventional markets for convenience (Boutkatem and White 1989), or are finding it unnecessary to certify their farms since they can hardly meet the demand for their (unlabelled) organic produce (Zakreski 1989).

to traditional ways but are, instead, a refinement of them. They argue that organic techniques have tremendous potential because they concur with fundamental ecological principles. Furthermore, they claim that, although the techniques are relatively "unproven" at present, they will be gradually refined and improved as organic practice becomes more common and the resources of modern science and technology are applied to the problems. Finally, proponents of organic agriculture denounce conventional chemical agriculture, stating that it is non-sustainable (and thus irresponsible) because it maximizes immediate financial returns at the expense of non-renewable resources and the natural environment. Needless to say, the dispute between proponents of organic agriculture or of conventional chemical agriculture is heated and unresolved.

In the context of this controversy, it is important to recognize the dilemma that confronts farmers and other people that could be part of, or could be affected by, the trend toward organic agriculture. The primary factors that impede conversion to organic farming can be broadly categorized as mindset, economic constraints, confusion, and logistics (Table 4). However, the reasons for practising organic agriculture most frequently cited by farmers include concern for health, satisfaction associated with independence from commercial suppliers and harmony with nature, philosophical change involving higher reverence for life (human and otherwise) and, finally, moral obligation to future generations for stewardship of the natural environment (Fraser et. al. 1988; pers. obs.).

Clearly, the controversy associated with organic versus conventional chemical farming will not be resolved in the near future. Little comparative research on organic and chemical farming has been conducted to date (Altieri 1987). Furthermore, comparison of these particular forms of agriculture is confounded by the number of variables involved and by the fact that the full potential of organic farming will not be realized until natural cycles become firmly established (this may require years) and cannot be realized if the organic farm is surrounded by chemical farms (due to large negative externalities resulting from surrounding chemical farms and due to lack of positive externalities that would arise if there were adjacent organic farms).

According to the limited research that has been done, it appears that the profit margins of the organic and conventional chemical farms may converge since the economic costs of production differ (Altieri 1987; Anon. 1989a; Zakreski 1989). For example, capital inputs for materials, fuel and machinery associated with application of commercial pesticides and fertilizers are lower on organic farms, but costs associated with tillage and manual labour may be higher. Furthermore, the retail value of organic foods is higher than conventional, but the costs associated with processing are higher for organic products (primarily due to transportation and processing costs related to the economy of scale). Finally, under favourable growing conditions, conventional yields tend to average approximately 10% higher than organic yields but, under less favourable conditions, the discrepancy decreases (Altieri 1987). In any case, ultimate success in any form of agriculture is strongly dependent on the physical resources of the farm, the knowledge, talent and commitment of the farmer, the availability of support from government, academia and professional agriculture advisors and, of course, chance.

## CHAPTER 3: THE 1989 ONTARIO FIELD STUDY

Conventional and organic agriculture differ in many respects. However, for the purposes of this study, the most important distinction between them is related to the use of commercial chemicals. In chemical practice, commercial fertilizers are used to nourish plants, and commercial pesticides (i.e., herbicides, insecticides, fungicides, rodenticides etc.) are used to control insects, weeds and diseases which threaten crops and livestock. In organic agriculture commercially synthesized chemicals are not employed.

If commercially-synthesized chemicals have significant impact on wildlife in agricultural habitats, it follows that there should be a significant difference in the wildlife associated with conventional farmland and that associated with organic farmland. This difference may be manifest in species variety, composition or abundance. Birds may be particularly useful indicators of the (potential) impact of agricultural chemicals since birds feed on a variety of food resources, are visible in farmland habitat, and are geographically widespread.

The design employed for the Ontario field study was modelled after the Danish study by Brae et. al. (1988) who compared avifauna on survey points on organic farms that were paired with survey points on conventional chemical farms that had similar habitat. Although, in the english translation of their report, it is not entirely clear how species abundance data were determined or how data were analyzed to eliminate habitat effects, it was concluded that the populations of many avian species were significantly lower in conventionally-farmed areas than in organically-farmed areas. This effect was attributed specifically to the use of commercial pesticides (as opposed to habitat differences or the use of chemical fertilizers) which reduced the food available to the birds.

### METHODS

#### Selection of study sites

In Canada, at present, certified organic farms are well outnumbered by conventional chemical farms. Accordingly, initial efforts to locate study sites involved the identification of organizations associated with organic agriculture. Certified organic farmers in Ontario were identified primarily through the Ottawa Chapter of the Canadian Organic Growers (COG). A few farmers responded to a notice which was published in the COG-Ottawa newsletter, but most were identified through the Organic Food Register (Anon. 1988) and the COG-Ottawa Producers List (Anon. 1989b).

The organic farmers were initially contacted by telephone in May 1989. The farms of willing individuals were characterized with respect to operation and landscape by way of a 15 to 30 minute interview. The organic farmers' suggestions regarding conventional (chemical) farms in their vicinity, that might serve as paired study sites, were followed up with similar telephone interviews.

Organic and conventional (chemical) farms which sounded well matched were visited in late May and early June. Farm pairs were selected so as to minimize differences in geographic location and farm operation (e.g. crops grown). In order to minimize the possibility of chemical contamination from adjoining farms (through spray drift, etc.), all study sites on organic farms were located at least 100m from the outer boundaries of the farm. To ensure that birds recorded at conventional points were typical of conventionally-farmed areas, all conventional study sites were located a minimum of 500m from the boundaries of organic farms.

Three or four study sites were paired between farms in each pair to minimize differences in habitat features such as crop type, field edges and proximity to farmsteads, roads, water and woodland. Habitat matching between site pairs was most stringent within 100m of point count locations at field edges. One or two unpaired study sites were also established on most farms.

### Habitat survey

A habitat survey was conducted at each study site. A semi-circle of 200m radius (parallel to the field edge) was surveyed which encompassed the 180° range (i.e., the area in which most birds were observed). The survey consisted of gross structural measurements of point features (e.g., isolated trees), linear features (e.g., hedgerows and hydrolines), and features measured by area (ha) (e.g., cropland, woodlots and settlements). Quantitative measurements were obtained using an electronic digitizer and 1:15,000 scale aerial photographs. These measurements were supplemented by information derived from field notes and Ontario Base Maps and were verified with ground truthing.

### Avian survey

Birds were surveyed using both point count and search (walk-about) methods. Point counts of field propers were conducted from field edges at all study sites. Point counts were repeated from the centre of fields for a sample of study sites at which field-edge counts were also done.

One farm pair was surveyed on a given day and each farm pair was surveyed 3 times between June 13 and July 7 (although a few point counts were done only twice). All surveys were conducted by the senior author. On alternate visits to a farm pair, the order of visitation was reversed both for the farms in the pair and for the study sites on each farm. On each visit, the following were recorded: primary direction of observation, date, time, temperature, sky conditions, wind velocity and crop stage.

Point counts were conducted between dawn and 09:00 hours in good weather only (i.e., no precipitation and wind less than Beaufort 3). A total of five trial surveys were conducted at 4 study sites to evaluate point count duration. Five-minute counts represented a reasonable compromise between greater detection efficiency associated with point counts of longer duration (Figure 1) and total time required each day to complete point counts at all study sites on the farm pair. All bird registrations were mapped such that data could be separated into 180° (i.e., the field in front of the observer) or 360° (i.e., including the field(s) behind the observer) and limited (100m radius) or unlimited distance (but still on farm). During each point count, all species seen or heard were recorded, with individuals counted only once as far as possible. The abundance of each species was interpreted from the territorial status of individuals (e.g., a singing male counted as two birds, a bird calling or seen counted as one) and simultaneous observation of individuals. Conservative estimates were employed when interpreting abundance from field data to further minimize double counting of individuals.

Search (walk-about) surveys for additional species and individuals were conducted in study sites and in noncrop habitat on each farm following point counts for the farm pair. Only species not observed during point counts were recorded.

### Calendar of farm operations

To establish a chronology of operations for the 1989 season, the farmers on all of the study farms were again interviewed by telephone in late October. The information gathered at this time included field use with respect to crops and livestock; cultivation, planting and harvest dates; compound names, rates and dates of application for all pesticides and fertilizers applied.

### Statistical analysis of avifauna data

Assemblage level patterns in the distribution of avifauna across sites were investigated using detrended correspondence analysis (DECORANA[5]). This technique is particularly useful because it is designed to analyze ecological data which has been collected as species abundances in different samples. Accordingly, this technique permitted the bird assemblages observed at each study site to be analyzed simultaneously with respect to the variety of species present and the abundance (mean number) of each species. Theoretical variables that best explained the variation in the data were established and represented by a series of axes of ordination.

Multiway analysis of variance was then used to investigate the patterns of dispersion of DECORANA scores for each study site along the axes of ordination. This procedure tests for correlations between study site scores and factors of ecological significance. In this case, DECORANA scores for each study site on each ordination axis were tested with farm pair (1, 2 or 3), farm type (organic or conventional), study site within farm pair (1, 2, 3 or 4) and principal crop at each study site (barley, corn, hay, pasture or soybean).

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[5] DECORANA is a computer program in the Cornell Ecology Progam series which was developed by the Department of Ecology and Systematics at Cornell University. The procedure is well outlined by Jongman et. al. (1987).

The Wilcoxon Matched Pair Signed Rank Test (a non-parametric analysis based on pairwise comparisons of results for each organic study site and its conventional twin) was used to determine whether numbers of species or birds differed at study sites paired between organic and conventional chemical farms. The number of species at each study site was calculated by accumulating species over point counts. The number of individuals for each study site was calculated by averaging over point counts.

McNemar's Test for Discrepancy (Sokal and Rohlf 1969) was applied to presence/absence data for each species, to determine if species were differentially associated with organic or conventional study sites.

## RESULTS

### Study sites

In practice, the selection of study sites was relatively difficult. Although over 40 organic farms (approximately 25% of which were certified) were registered in the Ottawa area by the Canadian Organic Growers, most of these were not considered for this study because they differed little from their conventional counterparts with respect to use of commercial pesticides (e.g., many of these were beef farms which consisted primarily of hay and pasture; others were maple sugar producers; all of these operations involved "crops" to which few pesticides are applied, regardless of farming practice). In all, 27 organic farmers and 15 conventional farmers were interviewed, while 11 organic farms and 7 conventional farms were visited.

The pairing of study sites was also complicated by a number of inherent differences between organic and conventional farms. These differences are associated with the scale and diversity of operation, the selection of crops grown and the availability of proximal habitat. However, for the pilot study, 10 pairs of survey sites (3 or 4 per farm) were established on 3 pairs of farms. Farm size averaged 87 ha (SD= 38.6). Field size at these study sites averaged 15.6 ha (SD=13.9). On average, the study sites were a minimum of 464 m apart (range 150-1410). Five additional survey sites were unpaired between farm types.

All of the farms included in the pilot study are located in Ontario, within 200 km of Ottawa. All of the organic study farms are currently certified by the OCIA and, accordingly, have not applied commercially synthesized pesticides or fertilizers to their land for at least 3 years. All of the conventional study farms have recently made use of agricultural chemicals. During the 1989 field season, 60% of the conventional study sites were treated with commercial herbicides (Table 5) and/or fertilizers (Table 6). No insecticides, fungicides or vertebrate control products were used at any of the study sites. Other aspects of farm operation (e.g., time of planting) did not appear to differ significantly within pairs.

**Habitat survey**

Habitats varied considerably between study site pairs but relatively little within study site pairs (Table 7). Habitat features of areal extent had greatest influence in determining the general character of each study site. Pairwise comparison indicated these features (i.e., cropland (corn, soybean, barley/wheat, pasture and hay combined), oldfield, woodland, settlement), differed (+/-) within site pairs on average by 15%, 11%, 5% and 10%, respectively, and at most by 39%, 20%, 9% and 14%, respectively. Linear habitat features (i.e., road, hydroline, fence, hedge, ditch, water) and point features (i.e., tree) define the character of each study site at a more detailed level. Pairwise comparison of these features indicated that, in general, they varied little within study site pairs. In almost every instance where differences appeared to be more sizable, compensating factors could be cited. Often times, where a feature was less common in one study site than the other in a pair, the feature occurred at the greatest possible distance from the location from which the field-edge point count was conducted. In some cases, the feature was present just beyond the boundary of the study site which appeared to have less, or the relative difference in occurrence (as opposed to the quoted absolute difference) was small. In the remaining cases, differences between study sites within a pair may have been of little biological significance. For example, differences in the length of road contained within study sites, may be of little consequence because "road" (which, to a large extent, was private laneway and farm track or relatively quiet paved road) may have provided habitat of equivocal value.

On a geographic scale, the local rural landscape which formed the context of each study farm, differed little within farm pairs, but varied considerably among farm pairs. In series, the landscape contexts of the farm pairs may represent a progression from intensely developed (pair 1), through moderately developed (pair 2), to relatively undeveloped (pair 3).

Avian survey methodolgy

Over the course of the breeding season, 64 species of birds (from 27 families) were observed during farm surveys (Table 8). Forty-six (72%) of these species were recorded during field-edge point counts paired between farm types. An additional two (3%) species were recorded only during unpaired field-edge point counts; one (2%) additional species was recorded only during field-centre point counts. No additional species and few birds were noted during search surveys of study sites. Fifteen (23%) species were noted only during search surveys of farmsteads, woodlots or wetlands.

Numbers of species and individuals were not significantly different (Wilcoxon Matched Pair Signed Rank Test, $p>.05$) between paired field-edge and field-centre point counts for comparable observation ranges (Table 9). However, most of the bird activity recorded during these point counts was in the vicinity of field edges.

Similar numbers of species (Fig. 2) and individuals (Fig. 3) were observed during limited-distance, 180° and 360° and unlimited-distance, 180°

and 360° point counts conducted from field edges of study sites paired between farm types. Of the 46 species in the 360° unlimited-distance range (Table 8), 91% were observed in the 180° unlimited-distance range (Table 10).

Many more species (Fig. 2) and individuals (Fig. 3) were observed during unlimited-distance 180° or 360° point counts than limited-distance 180° or 360° point counts. Furthermore, 15 species (33% of the species observed during paired, 360°, field-edge point counts) were recorded only beyond the limited-distance radius of 100m (Table 8).[6] In practice, an "unlimited" distance was equivalent to about 250m.

Numbers of species observed during field-edge point counts at study sites paired between farm types increased with the number of surveys conducted during the study period (Fig. 2). Mean numbers of individuals were relatively constant (Fig. 3).

## Avifauna

All statistical analyses on avifauna were based on data collected over 3 surveys at each study site, during 180-degree, unlimited-distance point counts. A total of 42 bird species were observed; 37 on organic and 33 on conventional farms (Table 10).

DECORANA indicated significant dispersion of the transformed data points along the first 3 axes of ordination (Table 11). Each eigenvalue represents the (maximized) dispersion of the DECORANA plot scores on the ordination axis, and thus indicates the relative importance of the axis (Jongman et. al. 1987). The assemblage of birds observed at study sites reflected significant differences in farm pair and farm type, but not crop type or study site within farm pair (Table 12). Site scores were represented graphically on the axes along which they showed maximum dispersion for farm pair and farm type (Fig. 4). The sites associated with each farm pair formed a fairly discrete cluster, reflecting differences in the variety and abundance of species among the 3 farm pairs. Within each farm pair, points representing organic study sites tended to be situated above points representing the corresponding conventional study sites, reflecting differences in species composition and abundance. In the 2 exceptions to this pattern (points 2a and 2b), the conventional site scores may have reflected the presence of a river nearby.

Significantly more species and birds were observed at organic sites than at their conventional twins (Wilcoxon Matched Pair Signed Rank Test, $p<.05$; Table 13). No species was significantly more likely to occur at organic than at conventional sites (McNemar's Test for Discrepancy, $p>.05$), but analyses were limited by small sample size. The following 6 species tended to occur more often on organic sites: Bobolink ($p<.07$), Great Crested Flycatcher ($p<.12$), Red-tailed Hawk ($p<.25$), Upland Sandpiper ($p<.25$) and Yellow Warbler ($p<.25$).

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[6] In the more extensive 1990 Ontario study (see Chapter 4), 9 of 68 species observed (13%) were recorded only beyond the limited-distance radius of 100m.

## CHAPTER 4: RECOMMENDATIONS FOR FUTURE STUDIES

Our review and field study indicated that a fairly robust experiment could be devised using organic and conventional (chemical) farms to assess the impact of modern agricultural practices on wildlife, and that further research is warranted.

### Selection of study sites

Additional certified organic farms and "matching" conventional chemical farms should be identified in order to augment sample size. Additional organic farms can be identified from the membership listings acquired from the Organic Crop Improvement Association (OCIA) and the Ecological Farmers Association of Ontario. Study sites should be established in southwestern Ontario since this area is recognized as a belt of intensive farming[7]. Available literature on organic farming indicates that there may also be good potential for study sites in Saskatchewan[8], Quebec[9], and the Maritimes. Given the trend toward organic agriculture, it should become progressively easier to establish well-matched pairs of farms. Moreover, almost invariably, the farmers contacted to date have expressed enthusiasm for the study and have been receptive to the idea of their property being used. The outlook for locating and accessing a sufficient number of study sites is promising.

Telephone interviews are useful for determining whether a farmer is willing to participate in the study, and are also an efficient way of characterizing potential study sites. It is important, however, to note that if an organic farmer does not feel that his farm can be well paired with any of the nearby conventional farms, it may be possible to pair points on the organic farm with points on several different conventional farms.

A personal visit to each potential study site is essential for selecting points prior to the field season. When telephoning farmers to arrange visits, it is useful to ask them to have a map of their property. The map orients the researcher on the farm and makes efficient use of both the farmer's and the researcher's time.

### Habitat survey

The methodology employed in the habitat survey appears appropriate.

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[7] In 1990, an additional 7 pairs of organic/chemical farms in southwestern Ontario were included in the study.

[8] Ten pairs of organic/chemical farms near Saskatoon were subsequently selected for study under contract to CWS Western & Northern Region (D.Forsyth). Bird surveys were conducted in 1990 under contract to NWRC.

[9] In 1990, a study was initiated in Quebec to select suitable farms and to compare point counts to a more intensive survey method through a NWRC contract to University of Sherbrooke (A.Cyr). Bird surveys were conducted in 1991 under a similar contract.

Derivation of habitat features from aerial photographs is feasible and efficient, but definitely should be augmented with first hand information from farm maps and field notes.

The habitat analysis indicated that the study sites selected for the Ontario field study were well matched in terms of gross structure. Accordingly, the assumption that structural habitat effects within site pairs are negligible, should be valid. With a larger sample of study sites, more quantitative statistical analyses, such as multiple linear regression (Jongman et al. 1987), should be used to assess habitat similarity.

Characterization of habitat features could be supplemented by more intensive surveys. A species-specific vegetation survey would permit a more sophisticated assessment of habitat similarity at paired study plots. Cover from crop residue, weed seed and invertebrate/insect abundance within fields could also be measured. Detailed surveys could provide insight or help explain possible differences in the avifauna associated with organic and conventional (chemical) farmland (e.g., differential occurrence of important food resources or cover) and, thus, would allow more definitive conclusions regarding the effects of pesticides and chemical fertilizers. Information on habitat use by birds could be derived from bird surveys if observations were made on field sheets showing the spatial characteristics at the survey point (i.e. observations in the field proper vs. the edge, or beyond, etc.).

Quantitative analyses of habitat at the spatial scale of study farms or larger could provide additional insight into avifaunal composition.

### Avian survey

Unlimited-distance, 180° point counts conducted from field edges and oriented toward the field proper appear to provide reasonable measures of species number, composition and abundance of cropland birds based on comparisons with other types of point counts and search surveys of study sites. Since avian activity is greatest at the field edge, it can be monitored most readily from this vantage point, particularly when field sizes are relatively small. In addition, there is minimal damage of crop plants and avian activity may be less disrupted by an observer who is less prominent in the landscape compared to when point counts are conducted from the centre of fields.

In the open environment of adjoining fields, it is difficult to monitor 360° reliably, given the large proportion of visual versus aural cues. In the field proper, individuals of many species are difficult to monitor because of vegetative cover and because they are cryptically coloured and seldom call. Where hedgerows or other shrubby vegetation exist at field edges, sounds are muffled and vision is obscured beyond the 180°. With 180° counts, there is also greater flexibility in locating study sites on farms and matching between farm types.

Unlimited-distance point counts generate a more "complete" data set, particularly for some species which are observed only beyond 100m of the observer. Observations can be recorded within and beyond 100m of the observer to generate a more restricted sample which can be used for density estimates. In practice, an unlimited distance will span approximately 250m. Only individuals within the boundaries of the study farm should be recorded. Individuals sighted from more than 1 survey site should be noted and counted at only one site if data are analyzed by farm.

On organic farms, the outer boundaries of the study sites should be located a minimum of 100m from the outer boundaries of the farm, in order to minimize the possibility of contamination from adjoining conventional farms through spray drift, etc. Conventional study sites should be located at least 500m from the boundaries of organic farms in order to ensure that birds observed on these sites are representative of chemically-farmed land.

Avian surveys on study farms should be conducted over a longer seasonal interval. Ideally, they should begin in the first week of May and continue until the latter part of June (after which time fledglings complicate data interpretation). It may be valuable to conduct surveys in April as well, since information on transient or migrant use of conventional and organic farmland and patterns of territory establishment would complement the information gathered during peak breeding season. At a minimum, each study site should be surveyed at least 4 times during May and June (preferably twice per month) to provide a better representation of the assemblage of birds associated with each study site[10]. An even number of surveys also balances the study design with respect to number of surveys conducted on each farm at each time of day, and facilitate statistical analyses.

Paired farms should be surveyed on the same day in order to minimize weather effects, and in order to increase the number of surveys that can be collected during the season. The order in which farms and survey sites are surveyed should be reversed on alternate visits to the farm pair, in order to minimize effects related to time of day.

All species seen or heard should be recorded because the response to agricultural practices may be species-specific, and because the goal of the study is to discern assemblage-level response. So far as possible, individual birds should be tracked throughout the duration of the point count in order that they be counted only once. Similarly, conservative estimates of numbers should be employed when interpreting abundance from field data and during analysis. These practices will preclude overestimates of abundance and will tend to reduce data variance which arises when the (apparent) abundance of a species reflects repeated observations of certain individuals.

Point counts should be conducted between dawn and 10:00 hrs. Point count duration could be lengthened to 10 minutes to improve sampling

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[10] In the more extensive 1990 Ontario study, mean no. of individuals/site stabilized by the fourth survey. No. of species/site was still increasing after the fourth survey suggesting that a greater number of surveys, or possibly a longer duration per point count, is required to sample bird species composition more completely.

efficiency while still accommodating time constraints on total time required for each survey. Point counts should be conducted only in fair weather (i.e., no precipitation and wind less than Beaufort 3). Prior to counting, the following should be noted: time of day, temperature, sky conditions, wind velocity, humidity, crop stage and vigour. Depending on time contraints, search surveys could be useful for confirming the location and identity of individuals which were difficult to see or recognize during point counts, serve as a check on detection efficiency, and provide additional information on species using noncrop habitats on study farms.

### Calendar of farm operations

The calendar of farm operations is an essential component of the study since it will provide the additional information needed to interprete the avian data (e.g., effects related to habitat vs. chemical use vs. tillage practices). A telephone interview conducted at the close of the growing season appears to be a good way of establishing a calendar of farm operations for each study farm. At this time there is little uncertainty regarding dates and activities during the season, particularly if farmers are asked to keep a log from the beginning of the study.

### Conclusions

Although small sample size dictates caution in interpreting the results, our data on three pairs of organic and conventional (chemical) farms in Ontario suggest that the use of chemical pesticides and/or fertilizers contribute(s) to a reduction in the number and variety of farmland birds. These results could and should be substantiated by further research.

The current trend towards alternative forms of agriculture provides an unprecedented opportunity for field research on the implications of modern agricultural practices for wildlife. The farmland bird project could be developed into a highly integrated, nationally-coordinated study. The information generated by such a study could be used to improve CWS advice and recommendations, to regulatory agencies such as Agriculture Canada, as well as to the farming and conservation communities, in order to encourage sustainable agricultural practices, and to prevent or mitigate adverse impacts on wildlife and their habitats from practices currently used in Canada.

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Table 1. Characterization of conventional (chemical) agriculture as currently practiced.[1]

<u>Intense Productivity</u>

. Economy of scale achieved through single ownership of large tracts of land, thus fewer privately-owned farms

. Immediate enhancement of profits at expense of non-renewable resources and natural environment

. Biological impoverishment as habitat diversity diminishes when woodlots, wetlands, hedgerows and other semi-natural habitats or marginal lands are brought into production with advent of modern technology such as fertilizers, tile drainage, and irrigation

. Biological impoverishment due to diminished feeding opportunities resulting from increasingly rapid and efficient machinery which compresses time that food is available and reduces spillage

. Biological impoverishment as environment becomes increasingly unstable due to rapid technological evolution which outpaces biological adaptation

. Livestock welfare compromised; quality of life declines as animals are regarded as production units, which in turn enhances need for off-farm inputs as animals' health declines in absence of space, exercise, exposure to fresh air and sunlight

<u>Large-scale, Highly-specialized Production</u>

. Fewer, but larger farms; higher debt load and thus higher economic risk

. Continuous and/or monocultural cropping resulting in depletion of soil moisture and nutrients, loss of soil structure and eventually soil erosion

. Monocultural cropping enhances vulnerability to pests and disease

. Loss and/or fragmentation of natural and semi-natural habitat as fields enlarged to accommodate machinery; incremental threat to wildlife survival and thus biodiversity

Continued ...

Table 1 continued ...

Off-farm Inputs

. Increased dependence on commercial sector, thus less independence and reduced profit margin due to transaction costs

. Increased capital required to support operation of larger farms, machinery and commercial supplies; increased debt load or cash turnover which may increase financial risk

. Energy (fuel) required for chemical production and application

. Seed and livestock
  - decline of genetic diversity, thus increased vulnerability to dynamic climate and evolving pests and diseases
  - false sense of security due to reliance on ubiquitous cultivars that are susceptible to pests and disease
  - increased dependence on chemical additives since genetic selection based on yield, appearance and nutritive value under "chemical umbrella", rather than survival under adverse conditions, thus selection for biological weaklings which cannot achieve "full" potential in absence of chemical additives

. Commercial chemicals
  - use of non-renewable resources (energy and materials)
  - toxic contamination of water and land with chemical products
  - environmental accumulation of byproducts associated with production of chemical products
  - toxic effects on human, livestock and wildlife health through direct or secondary exposure; acute poisoning, cancer, genetic mutation, illness, reproductive impairment
  - disruption of natural energy and nutrient cycles
  - biological impoverishment due to loss of vegetative cover and food sources including invertebrates, green vegetation and grain, seeds and fruit
  - decline of soil fertility since commercial fertilizers toxic to soil organisms and trace elements not restored
  - selection for chemical tolerant species and individuals which accentuates initial pest problem and disrupts predator-prey relationships
  - reduction of crop yield due to imperfect specificity of toxic pesticides

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[1] Information based on personal observations, conversations with farmers and the following references: Altieri (1987), Anon. (1989a), Bates (1989), Cook (1989), de Snoo and Canters (1988), de Zeeuw (1988), Eijsackers (1988), Fraser et. al. (1988), Hay (1988), Kramer (1989), McEwen and Stephenson (1979), O'Connor and Shrubb (1986), Oelhaf (1978), Sutton and Tittensor (1988), van der Werff and Nauta (1988), Vereijken (1989), Zakreski (1989) and Zettel (1989).

Table 2. Number of organic farms certified by the Organic Crop Improvement Association in Ontario since 1986.[1]

| Year | Number of certified farms | Absolute increase over previous year |
|---|---|---|
| 1986 | 16 | - |
| 1987 | 44 | 28 |
| 1988 | 84 | 40 |
| 1989 | 120 | 36 |
| 1990 | 200[2] | 80[2] |

[1] Pers. Comm. Lendhart (OCIA Secretary)

[2] Number predicted by OCIA

Table 3. Number of organic farms certified by the Organic Crop Improvement Association across Canada in 1989.[1,2]

| Province | Number of certified farms |
|---|---|
| Ontario | 120 |
| Quebec | 200[3] |
| Nova Scotia, New Brunswick & Prince Edward Island | 50 |
| Saskatchewan | 50 |

[1] Pers. com. Lendhart (OCIA secretary)

[2] Although OCIA does not have a chapter in British Columbia, there are a number of certification agencies there (Boutkatem and White 1989).

[3] Combined total for farms certified by OCIA or Mouvement pour l'agriculture biologique au Quebec

Table 4. Impediments to adoption of organic agriculture.[1]

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Mindset

. Scepticism

. Need for a philosophy to harmonize with nature rather than to conquer it, since organic farming is generally associated with reverence for life (human and otherwise) and stewardship of the natural environment

. Need to develop a sophisticated knowledge of ecological principles and an appreciation of the physical and biological interrelations among soil, water, flora and fauna

. Need to accept financial and social risks associated with adoption of new and "unproven" technology

. Flexibility to accept greater financial vicissitudes (chemical umbrella tends to stabilize production from year to year and may also contribute to higher yields)

. Reliance on the convenience associated with use of commercial chemicals

Confusion Associated With The Organic Food Industry

. Confusion regarding the precise definition of "organic"

. Complicated infrastructure; labyrinth of marketing agencies, regulatory boards and municipal bylaws

. Disorganization typical of an infant industry scrambling to catch up to a runaway market

. Inadequate access to reliable information and advice since little conclusive research has been done and since networks are not yet established

. Lack of expertise since many aspects of organic practice are "new" and since most practitioners are novices

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Continued ...

Table 4 continued ...

Economic Considerations

- Farm incomes are seldom "high" and are relatively unstable from one year to the next so farmers may not have opportunity to trade off "excess" income for other values (such as environmental concerns)

- Organic management strategy involves minimizing economic and environmental costs while achieving sustainable yield, whereas traditional management strategy has been to minimize productions costs while increasing yield; accordingly, conventional farmers may have competitive edge over organic farmers

- Natural balance in soil disrupted by conventional techniques (chemical inputs, heavy machinery, monocultural and continuous cropping) may take several years to become reestablished upon changeover from conventional to organic practice, so interim yields may be low

- Transition difficult because transitional farmers cannot charge premium associated with organic produce

- Societal structure favours conversion to conventional farming not reverse (e.g., governmental policies, bank loans, advertising, funding for agricultural lobbies and organizations)

Logistical Difficulties

- Difficulty in networking with consumers/farmers/suppliers

- Expense of adversely biased industry (e.g., transportation, storage, processing, advertising)

- Benefits of scale unrealized: lack of continuity in supply and demand; high transportation, processing and marketing costs

- Fickle markets (consumers generally put low value on avoiding ill effects which will not occur until distant future, especially if the link between cause and effect is difficult to establish)

- Lack of concerted will for sustainable development

[1] Information based on personal observations, conversations with farmers and the following references: Altieri (1987), Anon. (1989a), Bates (1989), Cook (1989), de Snoo and Canters (1988), de Zeeuw (1988), Eijsackers (1988), Fraser et. al. (1988), Hay (1988), Kramer (1989), McEwen and Stephenson (1979), O'Connor and Shrubb (1986), Oelhaf (1978), Sutton and Tittensor (1988), van der Werff and Nauta (1988), Vereijken (1989), Zakreski (1989) and Zettel (1989).

Table 5. Pesticide use at conventional study sites during the 1989 field season in Ontario.

| Farm pair/ Site | Crop | Pesticide (active ingredient) | Application Rate |
|---|---|---|---|
| 1A | hay | None | - |
| 1B | corn | None | - |
| 1C | corn | Bladex herbicide (cyanazine) | 1.12 kg/ha |
| 1D | soybean | Dual herbicide (metolachlor) | 2.47 l/ha |
| | | Sencor herbicide (metribuzin) | 0.85 l/ha |
| 2A | barley | Embutox herbicide (2,4-DB) | 1.98 l/ha |
| | | MCPA herbicide (MCPA) | 0.10 l/ha |
| 2B | pasture | None | - |
| 2C | hay | None | - |
| 3A | soybean | Edge herbicide (ethalfluralin) | 1.24 kg/ha |
| 3B | soybean | Edge herbicide (ethalfluralin) | 1.24 kg/ha |
| 3C | barley | Embutox herbicide (2,4-DB) | 1.98 l/ha |

Table 6. **Fertilizer use at conventional study sites during the 1989 field season in Ontario.**

| Farm pair/ Site | Crop | Fertilizer | Application Rate (kg/ha) |
|---|---|---|---|
| 1A | hay | None | - |
| 1B | corn | 8-35-9[1]<br>ammonium nitrate | 168<br>224 |
| 1C | corn | 8-35-9<br>ammonium nitrate | 168<br>224 |
| 1D | soybean | None | - |
| 2A | barley | 18-46-0 | 168 |
| 2B | pasture | None | - |
| 2C | hay | None | - |
| 3A | soybean | 5-20-20 | 224 |
| 3B | soybean | 5-20-20 | 224 |
| 3C | barley | 18-18-18 | 224 |

1 %nitrogen:% phosphorus:% potassium

Table 7. Habitat comparisons for field-edge study sites paired between organic and conventional farms in Ontario in 1989.[1,2]

| Habitat Feature | Farm/Site pair 1A | 1B | 1C | 1D | 2A | 2B | 2C | 3A | 3B | 3C |
|---|---|---|---|---|---|---|---|---|---|---|
| corn | -14 | **-17** | **-19** | x | x | x | x | x | x | x |
| soybean | 15 | x | 16 | **2** | x | x | x | -7 | -13 | -10 |
| barley/wheat | x | 4 | x | x | **-15** | -34 | x | x | -7 | 28 |
| pasture | x | x | x | x | 12 | 39 | x | -9 | x | x |
| hay | **-22** | x | x | x | x | -7 | 9 | 8 | x | x |
| oldfield | x | x | x | x | x | x | x | x | 20 | 2 |
| woodland | 1 | x | x | x | 5 | 2 | -8 | x | 6 | -9 |
| settlement | 14 | x | x | x | x | -7 | x | -12 | -10 | -6 |
| road | 389 | 0 | 12 | 0 | -389 | -194 | -389 | -239 | -487 | -397 |
| hydroline | x | x | 121 | 389 | -204 | -194 | -213 | x | x | x |
| fence | 86 | 0 | 170 | 0 | 76 | 218 | 0 | -478 | -342 | -153 |
| hedge | -3 | x | -37 | x | x | -100 | x | 873 | 143 | 382 |
| ditch | x | 98 | 147 | x | x | x | x | x | x | x |
| water | x | x | x | x | x | x | x | x | -257 | x |
| tree | 0 | x | 2 | x | 1 | 11 | 0 | -11 | 0 | -15 |

[1] Values indicate difference (organic - conventional) quoted in:
1) proportion (%) of study site for corn, soybean, barley/wheat, pasture, hay, oldfield, woodland and settlement
2) length (m) for road, hydroline, fence, hedge, ditch and water
3) # for "tree"

Margin of error for any given value is approximately 5%.

[2] Values in bold type indicate principal crop at each site pair.
Underlined values indicate feature present in only 1 site of the pair.
Value "x" indicates feature not present in either site of the pair.

Table 8. **Bird species and observation patterns for organic/conventional farms in the 1989 Ontario field study.**

| Species Common Name | Scientific Name | Farm[1] Org | Farm[1] Con | Survey PC[2] | Survey S[3] |
|---|---|---|---|---|---|
| American Bittern | *Botaurus lentiginosus* | | * | | r |
| Great Blue Heron | *Ardea herodias* | | * | | r |
| Red-tailed Hawk | *Buteo jamaicensis* | * | | e+ | |
| American Kestrel | *Falco sparverius* | * | | e+ | |
| Ruffed Grouse | *Bonasa umbellus* | * | | | w |
| Killdeer | *Charadrius vociferus* | * | * | e | |
| Spotted Sandpiper | *Actitis macularia* | * | * | e+ | |
| Upland Sandpiper | *Bartramia longicauda* | * | * | e | |
| Common Snipe | *Gallinago gallinago* | * | * | e+ | |
| American Woodcock | *Scolopax minor* | * | | c | |
| Ring-billed Gull | *Larus delawarensis* | * | | e+ | |
| Rock Dove | *Columba livia* | * | * | e | |
| Mourning Dove | *Zenaida macroura* | * | * | e | |
| Black-billed Cuckoo | *Coccyzus erythropthalmus* | * | * | e+ | |
| Yellow-bellied Sapsucker | *Sphyrapicus varius* | | * | e+ | |
| Hairy Woodpecker | *Picoides villosus* | | * | | w |
| Northern Flicker | *Colaptes auratus* | * | * | e | |
| Eastern Wood-pewee | *Contopus virens* | * | * | e | |
| Least Flycatcher | *Empidonax minimus* | * | * | e+ | |
| Eastern Phoebe | *Sayornis phoebe* | * | * | e+ | |
| Great Crested Flycatcher | *Myiarchus crinitus* | * | | e+ | |
| Eastern Kingbird | *Tyrannus tyrannus* | * | * | e | |
| Horned Lark | *Eremophila alpestris* | * | * | e | |
| Tree Swallow | *Tachycineta bicolor* | * | * | e | |
| Barn Swallow | *Hirundo rustica* | * | * | e | |
| Blue Jay | *Cyanocitta cristata* | * | * | e | |
| American Crow | *Corvus brachyrhynchos* | * | * | e | |
| Black-capped Chickadee | *Parus atricapillus* | * | | | w,f |
| Red-breasted Nuthatch | *Sitta canadensis* | * | * | | w |
| White-breasted Nuthatch | *Sitta carolinensis* | * | * | | w |
| Brown Creeper | *Certhia americana* | * | | | w |
| House Wren | *Troglodytes aedon* | * | | e+ | |
| Eastern Bluebird | *Sialia sialis* | * | | | f |
| Veery | *Catharus fuscescens* | | * | e+ | |
| Hermit Thrush | *Catharus guttatus* | * | | | w |
| Wood Thrush | *Hylocichla mustelina* | * | * | | w |
| American Robin | *Turdus migratorius* | * | * | e | |
| Gray Catbird | *Dumetella carolinensis* | * | | | w |
| Brown Thrasher | *Toxostoma rufum* | * | * | e+ | |

Continued ...

Table 8 continued ...

| Species Common Name | Scientific Name | Farm[1] Org | Con | Survey PC[2] | S[3] |
|---|---|---|---|---|---|
| Cedar Waxwing | *Bombycilla cedrorum* | | * | e | |
| European Starling | *Sturnus vulgaris* | * | * | e | |
| Warbling Vireo | *Vireo gilvus* | | * | u | |
| Red-eyed Vireo | *Vireo olivaceus* | * | * | e | |
| Yellow Warbler | *Dendroica petechia* | * | * | e | |
| Chestnut-sided Warbler | *Dendroica pensylvanica* | * | * | e | |
| Black-throated Green Warbler | *Dendroica virens* | | * | | w |
| Black-and-white Warbler | *Mniotilta varia* | * | | e | |
| Ovenbird | *Seiurus aurocapillus* | | * | e | |
| Mourning Warbler | *Oporornis philadelphia* | | * | e+ | |
| Common Yellowthroat | *Geothlypis trichas* | * | * | e | |
| Northern Cardinal | *Cardinalis cardinalis* | * | | u | |
| Rufous-sided Towhee | *Pipilo erythrophthalmus* | | * | | w |
| Chipping Sparrow | *Spizella passerina* | * | * | e+ | |
| Savannah Sparrow | *Passerculus sandwichensis* | * | * | e | |
| Song Sparrow | *Melospiza melodia* | * | * | e | |
| White-throated Sparrow | *Zonotrichia albicollis* | * | * | | w |
| Bobolink | *Dolichonyx oryzivorus* | * | * | e | |
| Red-winged Blackbird | *Agelaius phoeniceus* | * | * | e | |
| Eastern Meadowlark | *Sturnella magna* | * | * | e | |
| Common Grackle | *Quiscalus quiscula* | * | * | e | |
| Brown-headed Cowbird | *Molothrus ater* | * | * | e | |
| Northern Oriole | *Icterus galbula* | * | * | e | |
| American Goldfinch | *Carduelis tristis* | | * | e | |
| House Sparrow | *Passer domesticus* | * | * | e | |

1 farm type where species was observed:
Org = organic
Con = conventional

2 Unlimited-distance, 360° point count survey:
e = paired field-edge
c = field-centre
u = unpaired field-edge
+ = paired field-edge >100m only

3 Search (walkabout) survey:
r = near river
w = woodlot
f = farmstead

Table 9. Numbers of species and individuals for field-edge and field-centre point counts paired within farms in the 1989 Ontario field study. Based on 3 surveys of each study site (except where noted).

| Farm Type[1] | Study Site | Location in Field | No. Species L180 | No. Species L360 | No. Species U180 | No. Species U360 | Mean No. Individuals L180 | Mean No. Individuals L360 | Mean No. Individuals U180 | Mean No. Individuals U360 |
|---|---|---|---|---|---|---|---|---|---|---|
| Conv | 1B | Edge | 4 | 5 | 7 | 9 | 7.0 | 10.7 | 11.0 | 15.3 |
| | | Centre | 4 | 4 | 9 | 11 | 3.7 | 5.0 | 13.0 | 19.3 |
| Org | 2B[2] | Edge | 6 | 6 | 11 | 12 | 10.5 | 13.5 | 16.5 | 20.5 |
| | | Centre | 7 | 7 | 11 | 11 | 11.0 | 11.0 | 15.5 | 15.5 |
| Org | 2C | Edge | 4 | 5 | 8 | 11 | 9.7 | 10.3 | 15.7 | 17.0 |
| | | Centre | 3 | 4 | 5 | 10 | 5.0 | 6.3 | 10.0 | 16.0 |
| Conv | 2C[2] | Edge | 2 | 4 | 4 | 7 | 4.0 | 6.0 | 5.5 | 25.0 |
| | | Centre | 1 | 2 | 6 | 6 | 5.0 | 8.0 | 10.5 | 13.0 |
| Org | 3A | Edge | 8 | 8 | 11 | 11 | 8.3 | 10.3 | 15.0 | 16.3 |
| | | Centre | 6 | 7 | 9 | 10 | 8.0 | 11.0 | 11.7 | 17.7 |
| Conv | 3A | Edge | 8 | 8 | 11 | 11 | 8.7 | 8.7 | 14.7 | 16.7 |
| | | Centre | 8 | 11 | 11 | 14 | 6.7 | 10.3 | 10.7 | 15.0 |
| Conv | 3C | Edge | 6 | 11 | 8 | 13 | 7.3 | 10.7 | 11.0 | 14.3 |
| | | Centre | 10 | 10 | 15 | 16 | 8.7 | 10.0 | 15.0 | 17.7 |
| | MEAN | Edge | 5.4 | 6.7 | 8.6 | 10.6 | 7.9 | 10.0 | 12.8 | 17.9 |
| | | Centre | 4.3 | 6.4 | 9.4 | 11.1 | 6.9 | 8.8 | 12.3 | 16.3 |
| | S.D. | Edge | 2.2 | 2.4 | 2.6 | 2.0 | 2.1 | 2.3 | 3.9 | 3.7 |
| | | Centre | 2.8 | 3.3 | 3.4 | 3.2 | 2.5 | 2.4 | 2.2 | 2.1 |

[1] Conv = conventional Org = organic
[2] Based on 2 surveys

Table 10. **Bird species composition and abundance for sites paired between organic/conventional farms in the 1989 Ontario field study.** See Table 8 for species scientific names.

| Species Common Name | % Occurrence[1] Org | Conv | Abundance[2] Org | Conv |
|---|---|---|---|---|
| Red-tailed Hawk | 30 | - | 0.400 | - |
| American Kestrel | 20 | - | 0.133 | - |
| Killdeer | 70 | 70 | 0.767 | 1.067 |
| Upland Sandpiper | 40 | - | 0.267 | - |
| Common Snipe | 10 | 10 | 0.067 | 0.133 |
| Ring-billed Gull | 20 | - | 0.500 | - |
| Rock Dove | 20 | 10 | 0.100 | 0.300 |
| Mourning Dove | 30 | 10 | 0.100 | 0.033 |
| Black-billed Cuckoo | 10 | - | 0.067 | - |
| Yellow-bellied Sapsucker | - | 20 | - | 0.067 |
| Northern Flicker | 20 | 10 | 0.067 | 0.033 |
| Eastern Wood-pewee | 10 | - | 0.067 | - |
| Least Flycatcher | 10 | 10 | 0.067 | 0.067 |
| Eastern Phoebe | 10 | 10 | 0.067 | 0.067 |
| Great Crested Flycatcher | 40 | - | 0.267 | - |
| Eastern Kingbird | 30 | 10 | 0.333 | 0.067 |
| Horned Lark | 20 | 10 | 0.133 | 0.067 |
| Tree Swallow | 30 | 30 | 0.267 | 0.167 |
| Barn Swallow | 30 | 40 | 0.233 | 0.600 |
| Blue Jay | 20 | 10 | 0.100 | 0.033 |
| American Crow | 50 | 70 | 0.333 | 0.483 |
| House Wren | 10 | - | 0.133 | - |
| Veery | - | 10 | - | 0.200 |
| American Robin | 60 | 70 | 0.800 | 0.633 |
| Brown Thrasher | 10 | 10 | 0.067 | 0.133 |
| Cedar Waxwing | - | 20 | - | 0.133 |
| European Starling | 10 | 20 | 0.033 | 0.100 |
| Red-eyed Vireo | 20 | 20 | 0.133 | 0.200 |
| Yellow Warbler | 30 | - | 0.267 | - |
| Mourning Warbler | - | 10 | - | 0.067 |
| Common Yellowthroat | 10 | 10 | 0.067 | 0.067 |
| Chipping Sparrow | 20 | 10 | 0.133 | 0.067 |
| Savannah Sparrow | 90 | 70 | 2.967 | 1.767 |
| Song Sparrow | 70 | 70 | 1.133 | 1.400 |
| Bobolink | 70 | 10 | 0.833 | 0.033 |
| Red-winged Blackbird | 80 | 80 | 3.167 | 2.433 |
| Eastern Meadowlark | 50 | 20 | 0.800 | 0.200 |
| Common Grackle | 10 | 20 | 0.133 | 0.200 |
| Brown-headed Cowbird | 10 | 20 | 0.100 | 0.133 |
| Northern Oriole | 10 | 10 | 0.133 | 0.067 |
| American Goldfinch | - | 10 | - | 0.067 |
| House Sparrow | 10 | 20 | 0.133 | 0.800 |

1 No. of study sites = 10   Org = organic   Conv = conventional

2 Number of individuals observed during field-edge, 180°, unlimited-distance point counts at study sites paired between farm types, averaged over the season by study site, then averaged within farmtypes. Org = organic   Conv = conventional

**Table 11. Eigenvalues for Detrended Correspondence Analysis axes.** Axes derived from bird species composition by abundance and listedin order of importance. Significance shown by * .

| Axis | Eigenvalue |
|---|---|
| 1 | 0.568* |
| 2 | 0.316* |
| 3 | 0.154* |
| 4 | 0.071 |

**Table 12. Factors influencing farmland birds at 1989 Ontario study sites.** Based on Multiway Analysis of Variance of DECORANA site scores.

| <u>MODEL 1</u>: | axis | $R^2$ | factor | significance |
|---|---|---|---|---|
| | 1 | .792 | farmpair | * |
| | | | farmtype | NS |
| | | | plot(farmpair) | NS |
| | 2 | .652 | farmpair | NS |
| | | | farmtype | NS |
| | | | plot(farmpair) | NS |
| | 3 | .718 | farmpair | NS |
| | | | farmtype | * |
| | | | plot(farmpair) | NS |

| <u>MODEL 2</u>: | axis | $R^2$ | factor | significance |
|---|---|---|---|---|
| | 1 | .768 | farmpair | NS |
| | | | farmtype | NS |
| | | | crop | NS |
| | 2 | .606 | farmpair | NS |
| | | | farmtype | * |
| | | | crop | NS |
| | 3 | .604 | farmpair | NS |
| | | | farmtype | * |
| | | | crop | NS |

* p<.05

**Table 13.** **Numbers of species and individuals for study sites paired between organic/conventional farms in the 1989 Ontario field study.** Based on 3 surveys (except where noted) of unlimited-distance, 180°, field-edge point counts.

| Study Site | ---- No. Species ---- | | -- Mean No. Individuals -- | |
|---|---|---|---|---|
| | Organic | Conventional | Organic | Conventional |
| 1A | 10 | 8 | 14.3 | 13.7 |
| 1B | 8 | 7 | 16.7 | 11.0 |
| 1C | 15 | 8 | 20.7 | 11.0 |
| 1D | 9 | 6 | 17.3 | 8.7 |
| 2A | 13 | 13 | 13.3 | 12.7 |
| 2B | 13 | 7 | 16.7 | 16.7 |
| 2C[1] | 7 | 4 | 16.5 | 5.5 |
| 3A | 11 | 11 | 15.0 | 14.7 |
| 3B | 10 | 11 | 11.0 | 14.0 |
| 3C | 12 | 8 | 13.0 | 11.0 |
| Mean | 10.8 | 8.3 | 15.5 | 11.9 |
| SD | 2.5 | 2.7 | 2.7 | 3.2 |

[1] Based on 2 surveys

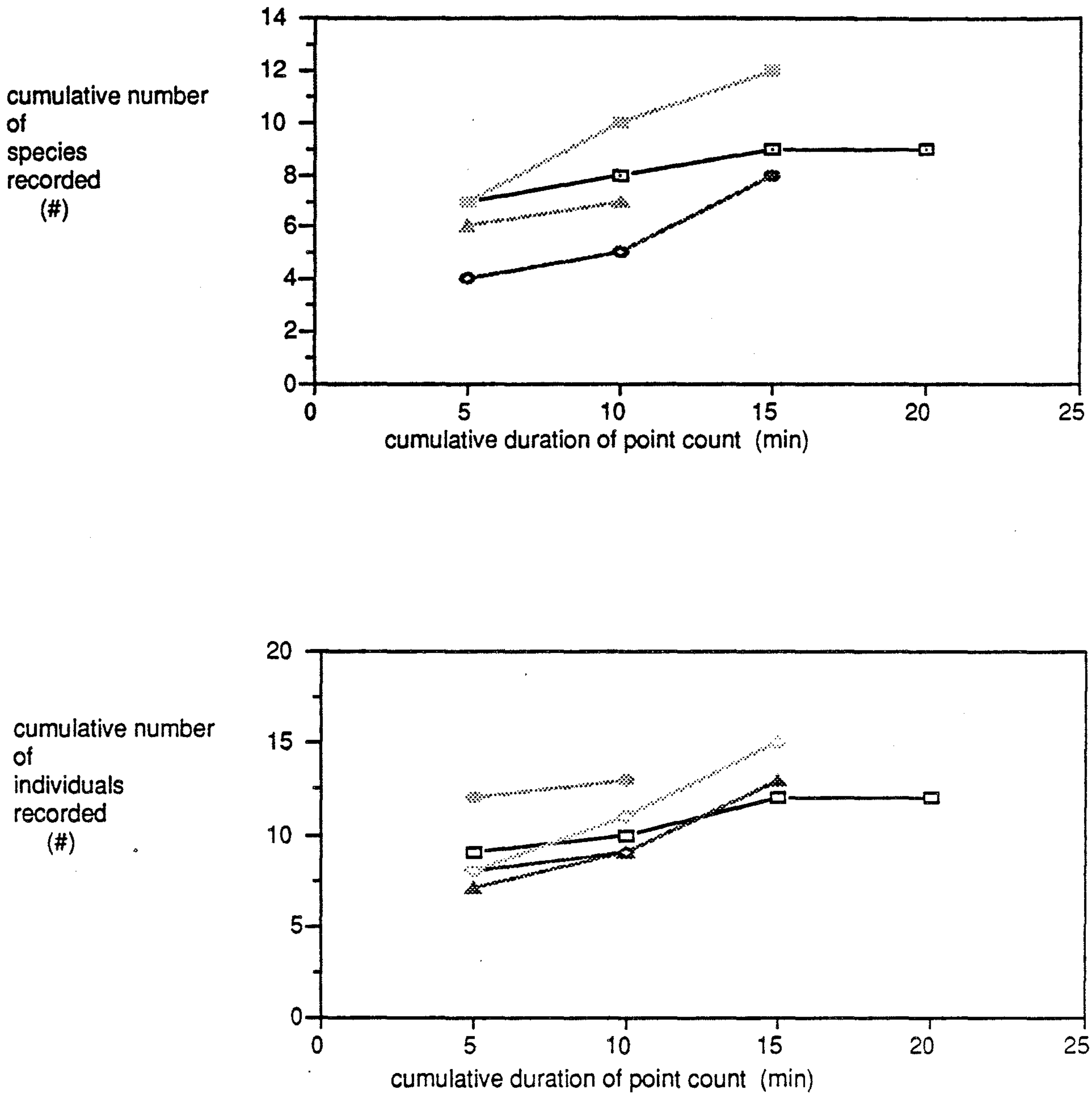


Figure 1. **Calibration curves for point count duration.** Based on a trial survey of five, 360°, unlimited-distance, field-edge point counts at four study sites on one study farm.

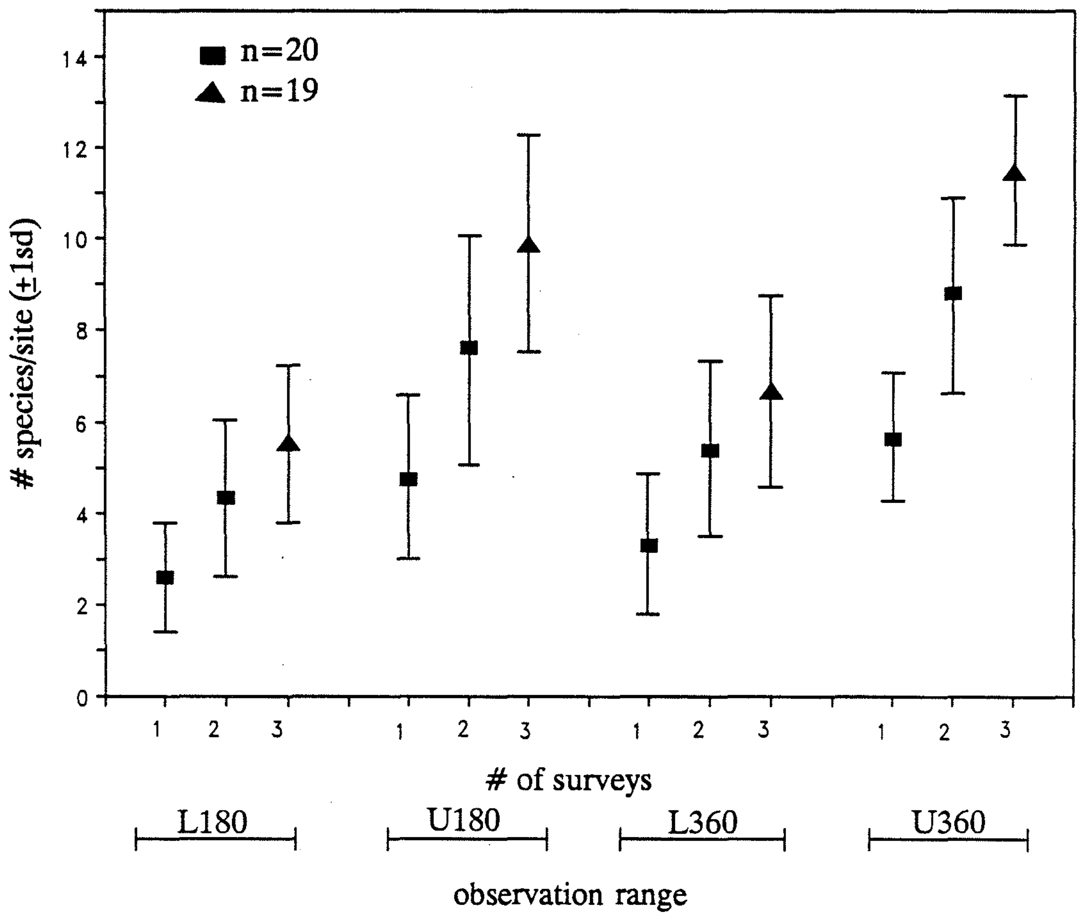


Figure 2. **Number of species recorded during point counts in limited (L) and unlimited (U) distance, 180° and 360° observation ranges.** Number of species cumulated within each study site over 1,2 or 3 surveys and averaged across field-edge study sites paired between organic and conventional farms in the 1989 Ontario field study

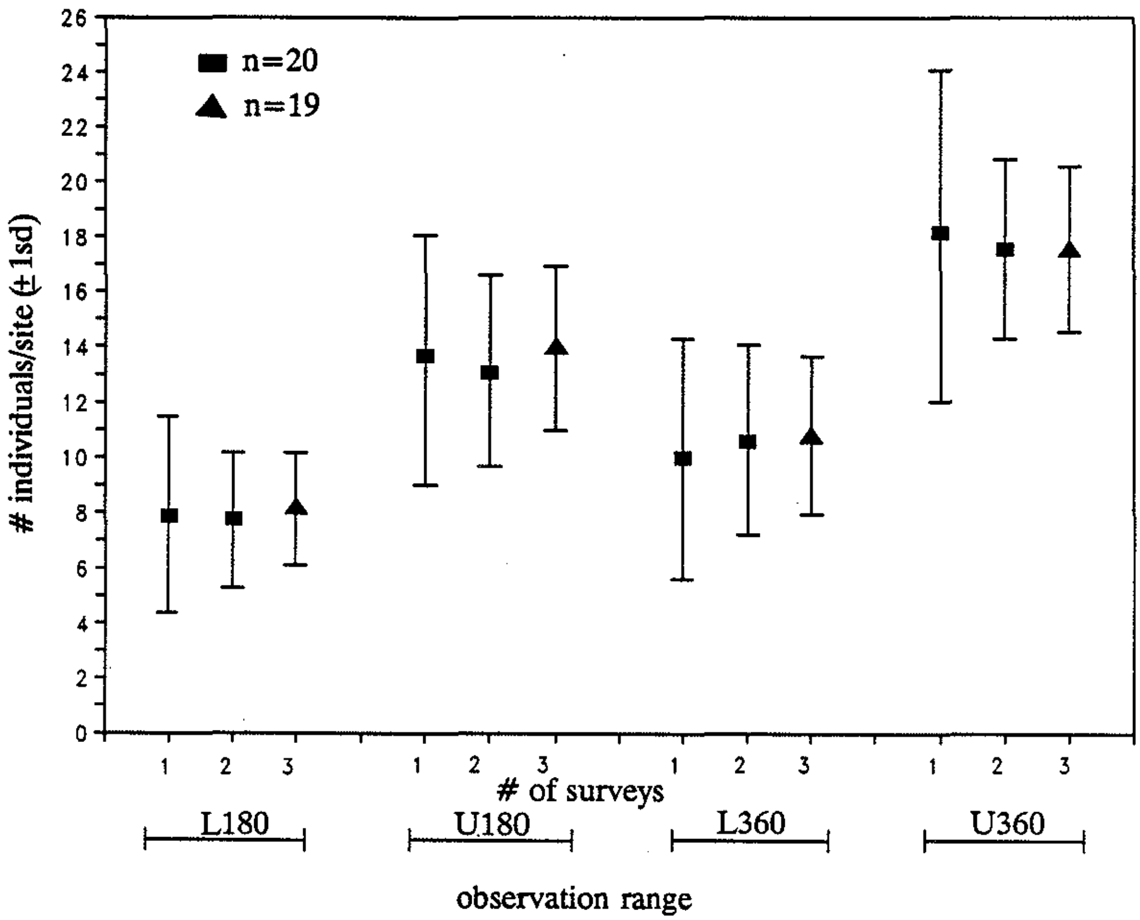


Figure 3. **Number of individuals recorded during point counts in limited (L) and unlimited (U) distance, 180° and 360° observation ranges.** Number of individuals at each study site averaged over 1,2 or 3 surveys and averaged across all field-edge study sites paired between organic and conventional farms in the 1989 Ontario field study.

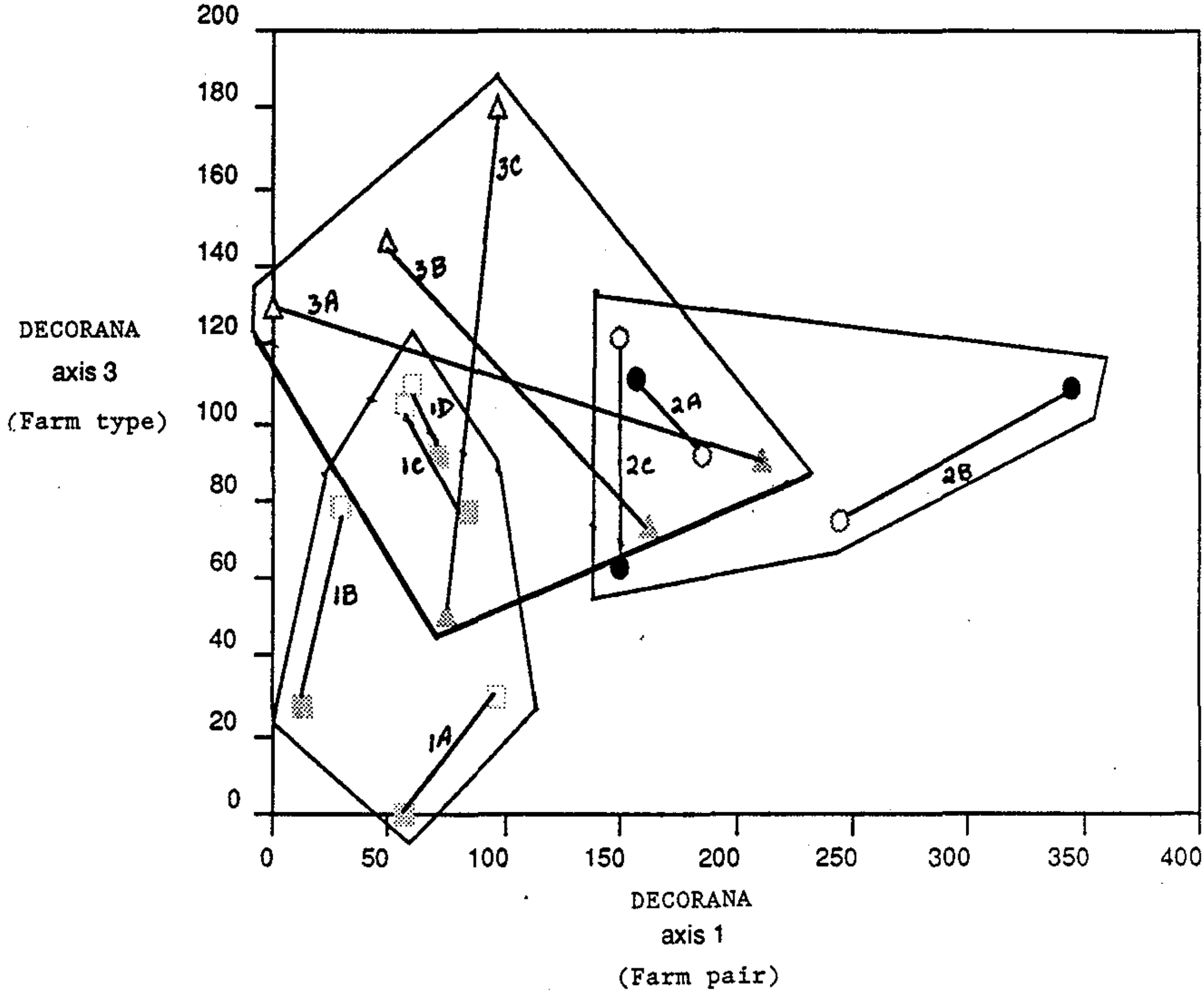


Figure 4. Detrended Correspondence Analysis (DECORANA) site scores of bird species by abundance among 1989 organic/conventional farm pairs in Ontario. Each farm pair (1-squares, 2-circles, 3-triangles) is enclosed by a polygon. Matched study sites (A, B, C or D) within each farm pair are connected by a labelled line. Farm type is shown as organic (open shape) or conventional (closed shape).

Appendix 1. Excerpts of Standards of the Organic Crop Improvement Association (Ontario) and Mouvement pour l'agriculture biologique au Quebec

ORGANIC CROP IMPROVEMENT ASSOCIATION
(ONTARIO) INC.

# PRODUCTION AND PROCESSING STANDARDS

January 09, 1989

ORGANIC CROP IMPROVEMENT
ASSOCIATION (ONTARIO) INC.

P.O. BOX 8000

LINDSAY, ONTARIO

K9V 5E6

1-705-324-9144
1-705-324-2709

**MAB STANDARDS (1989)**

Standards and procedures for the certification of organic production, storage and packaging methods for crops, meat, dairy products, and eggs

Mouvement pour l'agriculture biologique au Québec Inc
4545 Pierre de Coubertin Ave
PO Box 1000, Station M
Montreal, Quebec
H1V 3R2

Telephone: (514) 252-3039

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**Appendix 2. Principle organic organizations in Ontario and Quebec.** See Boutkatem and White (1989) for a more complete listing and description of organizations across Canada.

**Canadian Organic Growers Inc. (COG)**

- national, non-profit, voluntary association
- promotes organic farming by serving as a network, an information source and a forum for organic farmers, food processors and consumers
- current membership is approximately 2000 individuals and includes producers, processors and consumers
- activities include:
  COGnition - national quarterly magazine
  Organic Foods Register- catalogue of Ont. producers
  Lending Library - assemblage of relevant books, journals, articles ...
  Local Chapter -meetings, speakers, workshops, tours, newsletter, reference series ...
  Directory of Organic Agriculture - national listing of producers, processors, retailers, consultants, organizations ...

Contact: Anne Macey
Canadian Organic Growers (Ottawa Chapter)
R.R. 1, Lanark, Ontario K0G 1K0
(613) 259-2967

**Organic Crop Improvement Association Inc. (OCIA)**

- international, non-profit association
- supports organic farming through provision of technical knowledge, skills and organizational aids
- certifies organic farm products which have been grown and processed according to clearly defined standards (note: certification is subject to approval by a 3rd party inspector and must be updated annually; farmers must provide detailed production records which describe the farm's operation and provide audit trail for all produce from field to table as well as a notarized or sworn affidavit attesting to the truth of information furnished and adherence to specified standards)
- OCIA registered seal is currently recognized in North, Central and South America, as well as in Europe and Japan

Contact: Larry Lendhart, Secretary
Organic Crop Improvement Association (Ontario) Inc.
P.O. Box 8000, Lindsay, Ontario K9V 5E6
(705) 324-9144 or (705) 324-2709

**Society for Biodynamic Farming and Gardening in Ontario**

- local chapter of international, non-profit association
- founded on <u>Agriculture's Course</u> by Rudolf Steiner (1924)
- promotes agricultural production consistent with environmentally responsible stewardship of the Earth
- certifies agricultural foods which have been grown and processed according to defined standards (trademarks: "DEMETER" and "Biodyn")

Contact: Irene Smedley, Secretary
So. for Bio-Dynamic Farming and Gardening in Ontario
R.R. 3, Acton, Ontario
(519) 833-2029

**The Organic Foods Production Association of North America (OFPANA)**

- continent-wide, non-profit trade association
- represents organic foods processors, private companies, distributors, organizations, consultants
- discusses and creates organic foods policy (drafted "Guidelines for the Organic Foods Industry" 1985)
- promotes consistent definition for certified organic foods in the marketplace

Contact: Lorri King, Marketing Committee Chairperson
Organic Foods Production Assoc. of North America
c/o Alternatives Natural Food Market
453 Reynolds Ave., Oakville, Ontario L6J 3M6

**Ecological Farmers Association of Ontario (EFAO)**

- provincial, non-profit organization for the advancement of ecological agriculture
- educates farmers with respect to ecologically sound agricultural practices
- activities include:
  -biannual conferences
  -courses regarding all basic aspects of organic farming
  -on-farm consultation service
  -quarterly newsletter
  -public farm tours
  -seed exchange

Contact: Ted Zettel
Public Relations Director
Ecol. Farmers Assoc. of Ont.
Chepstow, Ontario N0G 1K0
(519) 366-9982

or

Lawrence Andres
c/o Anbros Farms Inc.
R.R. 1, Tiverton,
Ontario N0G 2T0
(519) 368-7417

**Mouvement Pour L'Agriculture Biologique au Quebec Inc. (MAB)**

- provincial non-profit association
- founded in 1974; certification programme initiated in 1985
- promotes the principles and practice of organic agriculture through public education and facilitation of interactions among individuals, corporations and institutions
- certifies organic farm products which have been grown and processed according to clearly specified standards (note: producers pledge by written contract and are under oath to respect the standards)
- membership includes producers, processors, distributors, consumers, home gardeners, teaching professionals ...
- activities include:
  -magazine (Humus)
  -newsletter
  -bookshop
  -information centre
  -courses in organic agriculture and gardening
  -workshops, conferences
  -certification program

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