

HERBICIDES, BEETLES, AND THE DECLINE OF INSECTIVOROUS BIRDS



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Background information

- Few entomologists study a group of insects over 50 to 60 years in a given region.
- Three groups of insects families have been observed over long periods. They are ground beetles (Carabidae), sawflies (11 families), and “Proctos” (8 families). This represents a total of about 1700 species (described or not).

Ground beetles data is based on field work (1961-2016) in addition to data in collections going back to the 1930s.

Sawflies data is based on field work (1978-2016) in addition to data in collections going back to the 1930s.

The Proctos data is from L. Masner & is based almost entirely on his field work (1969-2016).

Images of insects considered here

Ground beetles: one family with about 250 species in the region - [80 species considered here]



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**Sawflies: 11 families and about 300 species - [54
species considered here]**



Images of insects considered here

Ground beetles: one family with about 250 species in the region - [90 species considered here]

Sawflies: 11 families and about 300 species - [54 species considered here]

Proctos: 8 families and about 1200 species - [48 species considered here]



The Proctos decline

Ground Scelionidae are cricket and spider egg parasitoids.

A massive collapse of populations of the above species happened between 1984 and 1989. No recuperation thereafter at least until 2010. The number of captures per species range from common (hundreds or thousands of specimens) to 0 or 1 specimen per year).

The most observed group are species of the genus *Idris* (parasitoids of spider eggs). The best spots are the Pinhey Sand Dunes and Gatineau Park. They have 15 species at each site.



The Sawfly decline

Among sawflies adults of *Tenthredo* are very unusual as they are predators like tiger beetles & their larvae are herbivorous. Adults visit flowers for nectar and pollen before hunting.

A massive collapse of populations of the above species happened between 1982 and 1989. No recuperation thereafter until at least 2010. The number of captures per species ranges from common (100-200 specimens) to 0 specimen per year).

Away from Ottawa, like Sudbury and Manitoulin Island, no collapse was observed.





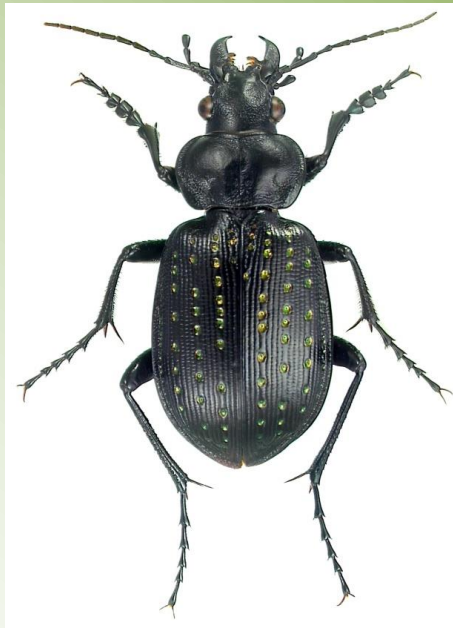
The Ground beetle decline

About 80 species of ground beetles are associated with agricultural sites, fallow places and other open sites. Adults are predators, scavengers or seed eaters.

A massive collapse of populations of many species happened probably during the 1980s. I recorded my data during the 1990s. So I missed the beginning of the decline. There has been no recuperation since the 1990s. The number of captures per species ranges from common (200-1000s specimens) to as low as 0 specimen per year.

Away from Ottawa, like Sudbury and Manitoulin Island, I found no evidence of collapsing populations.

Common species that have disappeared or almost





What is behind the decline of these insects? Part 1

Before 1969, the dairy farming around Ottawa and southern Quebec represents most of the agricultural land. Their main source of crops were **alfalfa** and **hay fields**.

After 1980 in the same area, dairy farming still represents most of the agricultural land. Their main source of crops were **alfalfa** (much less common), **hay fields**, **corn** and **soybean**.

Between 1969 and 1980, a new crop, corn, became widespread. It was followed by another new crop, soybean. Corn and soybean are often use in rotation.

What is behind the decline of these insects? Part 2

Here is a brief history of corn as I was privileged to witness.

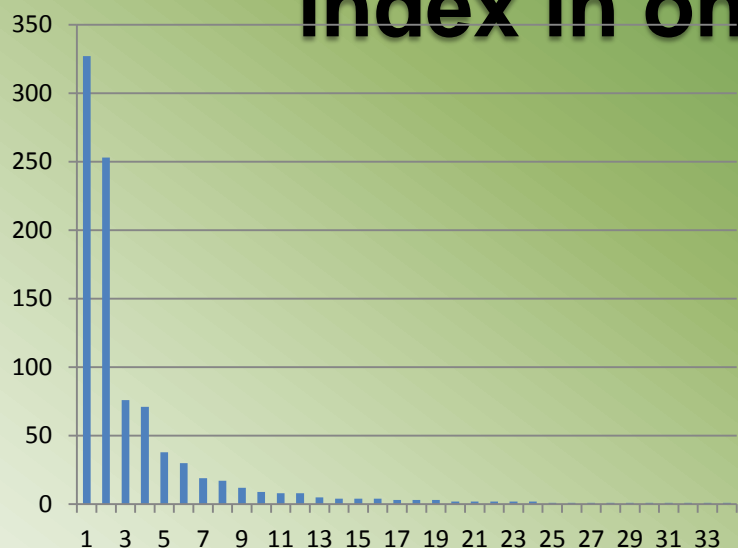
During the 1960s new varieties adapted for our region were developed at the Experimental Farm (Ottawa) and at Macdonald College of McGill University (Montreal). The first varieties released were greatly in need of day degrees - a measure of heating or cooling. To gain day degrees, herbicides were recommended for weed control and early seeding to avoid disking, which delayed planting for a week or two.

In 1969, Agriculture students at MacDonald College were shown the first field of this new crop for our region. By 1978, corn occupied a large portion of the agricultural land, having replaced most of the alfalfa. Unknown to me at the time was the use of herbicides.

Impact of herbicides on ground beetles in sprayed and unsprayed fields

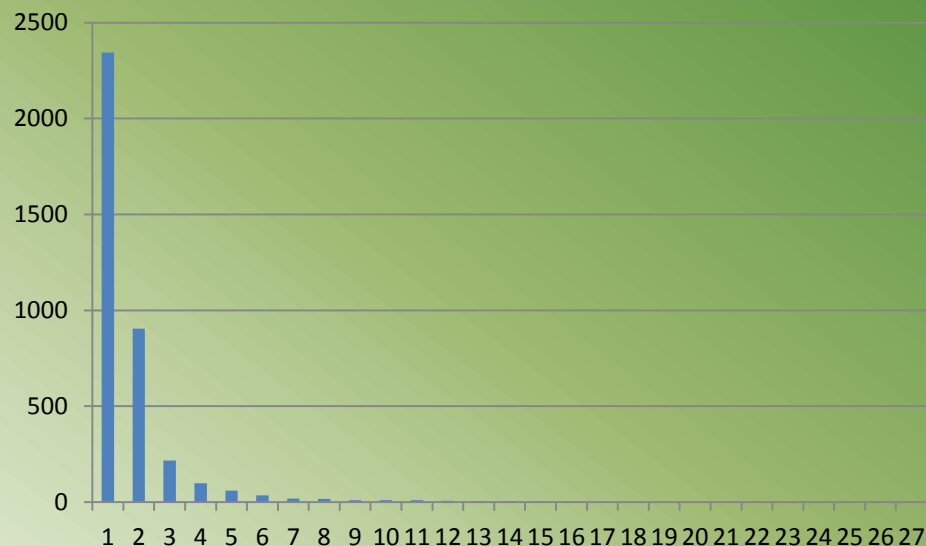
- A. Impact of spraying on the total diversity of ground beetles and the evenness index
- B. Impact on the total diversity of ground beetles in relation to nearby sites
- C. Impact on the abundance of captured specimens between spring- and summer-breeding ground beetles

A) The impact of spraying on the total diversity of ground beetles and evenness index in one growing season

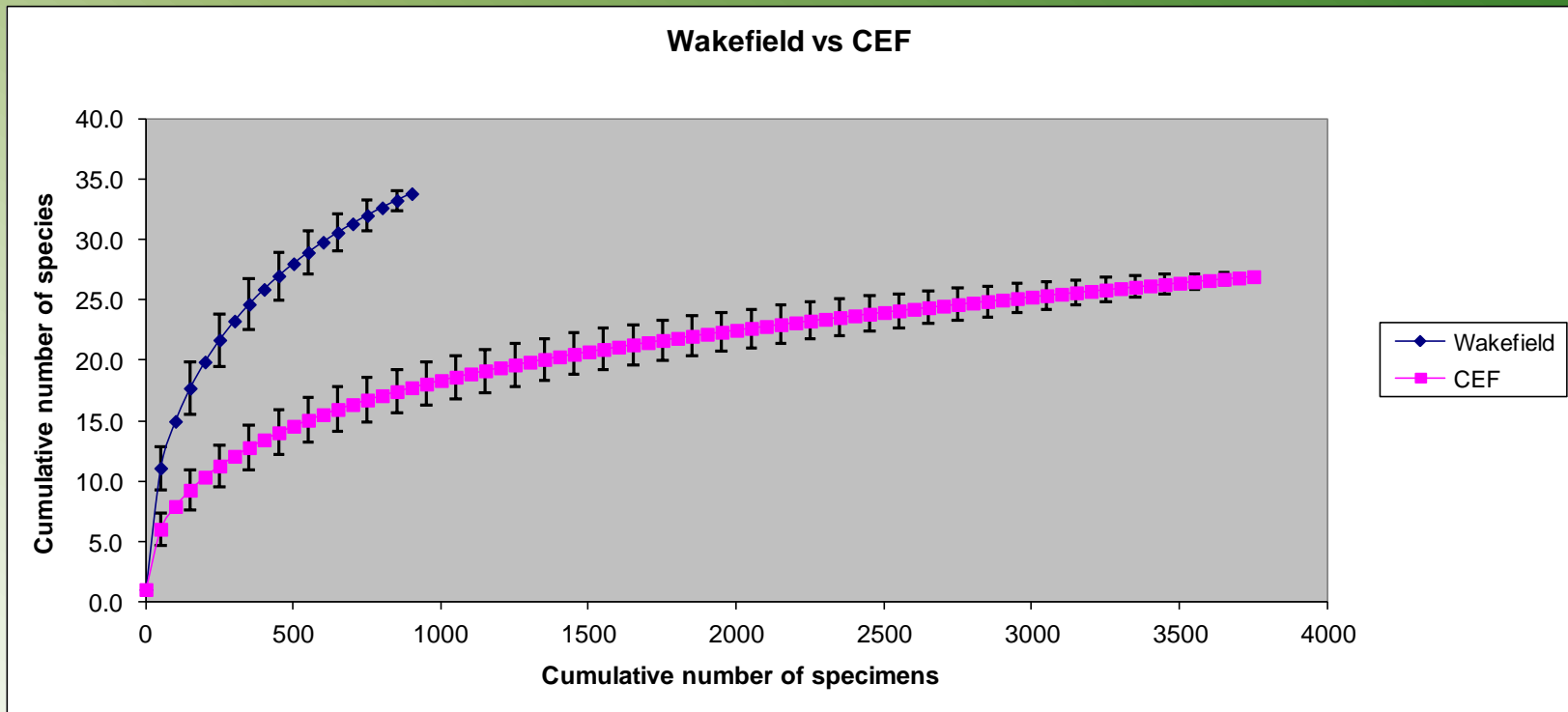


- Unsprayed site and all around the valley east of Wakefield, QC
- Shannon diversity index: 2.06
- Evenness index = 0.57
- Number of species : 34 or 28 normal
- Number of specimens: 914

- Sprayed every year at the Central Experimental Farm
- Shannon index of diversity: 1.18
- Evenness index: 0.36
- Number of species: 27 normal
- Number of specimens: 3767

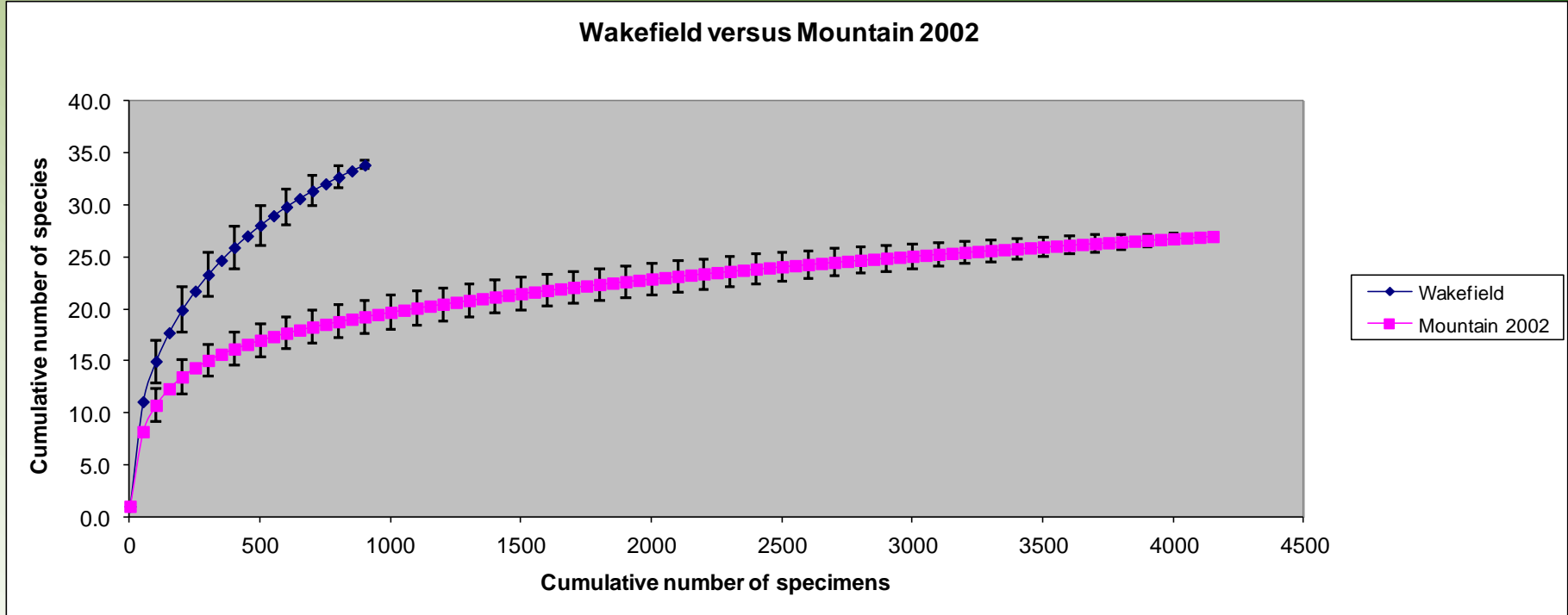


Rarefaction diversity curves between sprayed and unsprayed sites



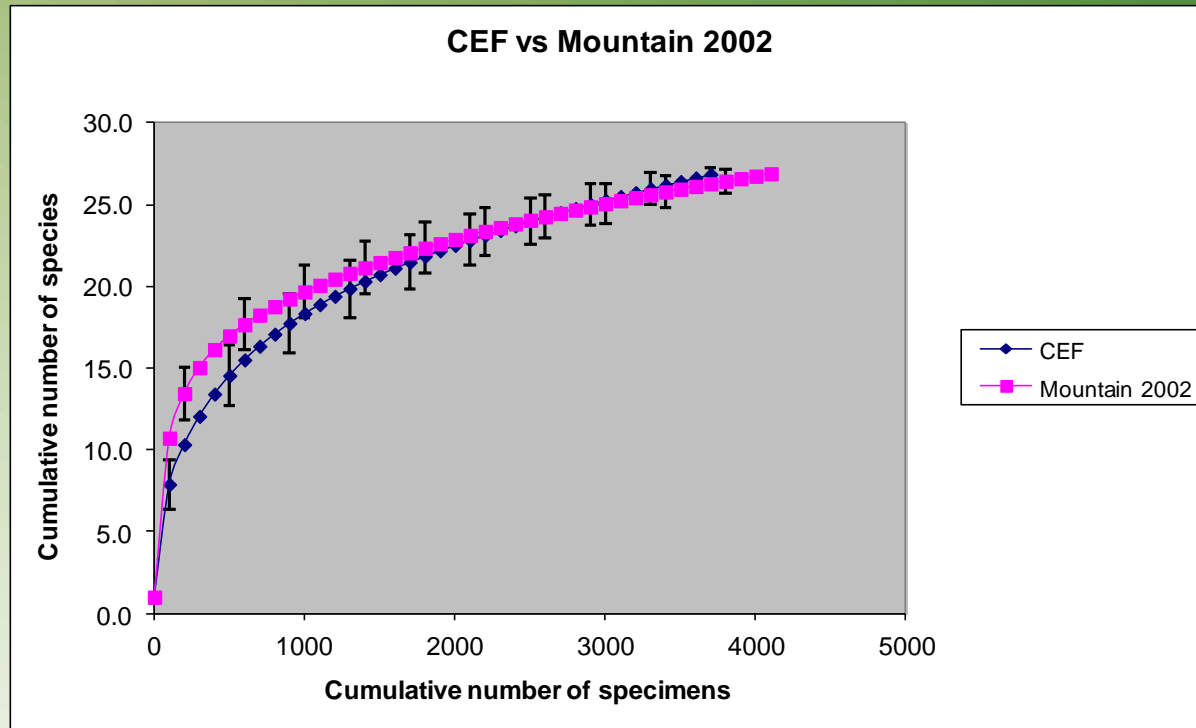
Despite a small sample (914), the unsprayed site is much more diverse than the much larger sample (3767) site, sprayed yearly. The two are significantly different.

Rarefaction diversity curves between two unsprayed sites



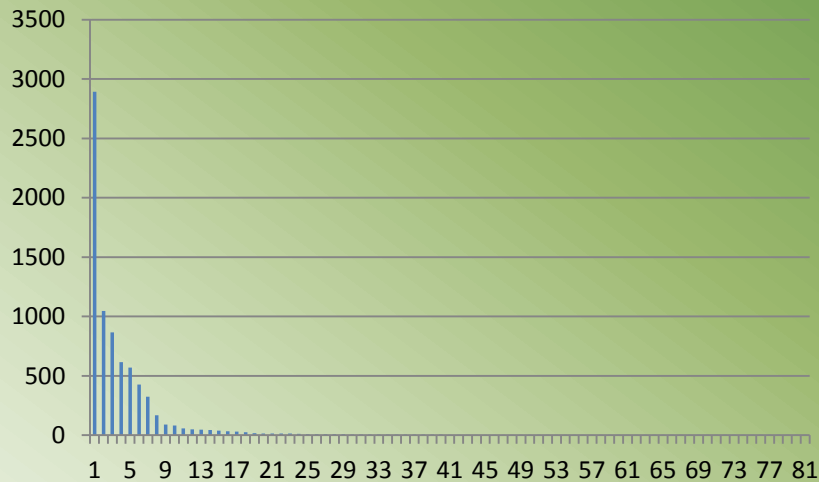
Despite a small sample (914), the Wakefield unsprayed site is much more diverse than the Mountain site, also unsprayed (3767). The two are highly significantly different. WHY?

Rarefaction diversity curves between a sprayed and unsprayed but surrounded by sprayed sites



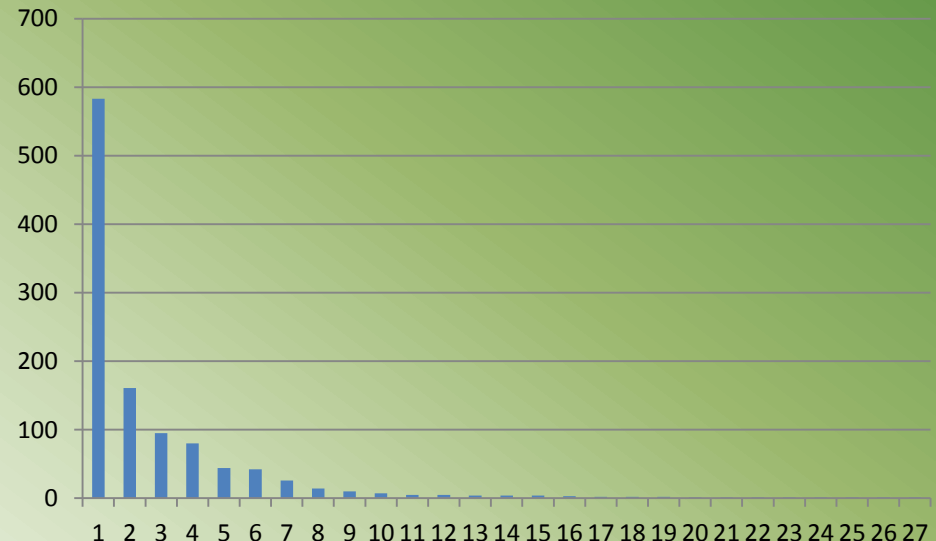
The Mountain site, though unsprayed, is between two sprayed corn fields. Its diversity is as reduced and its curve is very similar to that of Central Experimental Farm. Therefore, nearby sprayed sites have a very significant impact on the organic site as the beetles can move between fields.

B) The impact on the total diversity of ground beetles in relation to nearby sites

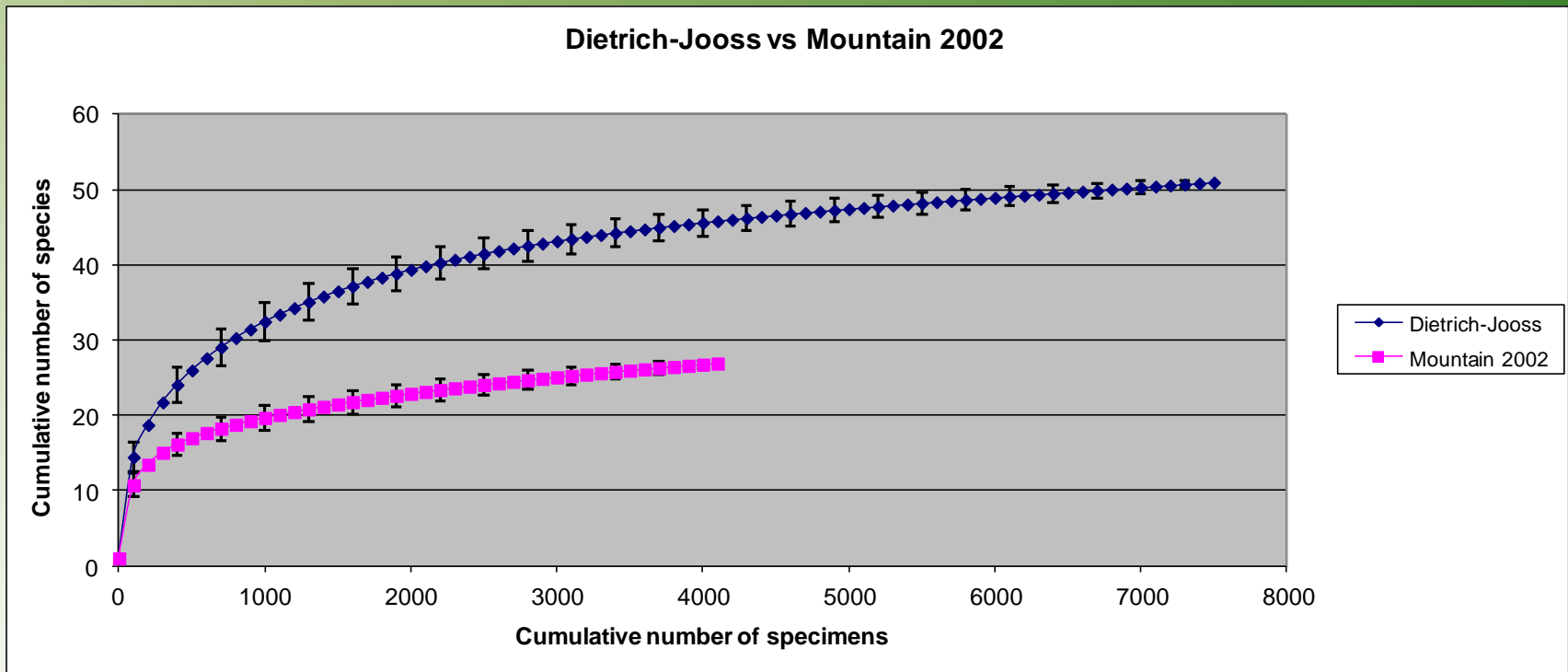


This sprayed vineyard diversity on the left was completely improved by a large unsprayed fallow site near it. The very low diversity of the organic fields below (Mountain, ON) was greatly reduced by sprayed corn fields on both sides.

- Small sprayed vineyard along fallow site near Iberville, QC
- Shannon diversity index: 2.22
- Evenness index = 0.51
- Number of species : 81 & 54 normal
- Number of specimens: 7659



The impact on the total diversity of ground beetles in relation to nearby sites



This vineyard diversity (Dietrich-Jooss) was markedly improved by an unsprayed fallow site near it. The diversity of an organic field (Mountain, ON) was greatly reduced by sprayed corn fields on both sides.

C) The impact on the abundance of captured specimens between spring and summer breeding ground beetles

Spraying	# of specimens	% spring	% summer
Unsprayed	914	70	30
Unsprayed	305	87	13
Sprayed yearly	7367	14	86
Sprayed site improved by an unsprayed fallow field, but fallow field affected by sprayed corn	7535	46	54
Organic corn field between 2 sprayed corn fields	2700	23	77
As above in organic wheat	1101	31	69

Unsprayed sites are dominated by spring-breeding ground beetles, but in sprayed sites or those near sprayed sites, most of the population of spring breeding beetles is markedly reduced. This is coincidental with herbicidal spray in late May or early June at the peak of breeding.

Impact of herbicides outside sprayed field

A) Insects exposed to insecticides do not go very far and basically they become immobilized on the spot. The impact on predatory insects or birds may not be that great as it is in an agricultural habitat with reduced diversity, with low bird densities.

B) Insects exposed to herbicides are not immobilized but can fly away, usually eastward, following the predominant winds when active.

Impact of herbicides outside sprayed field



The dispersal of contaminated insects extends far away from sprayed sites. This dispersal from sprayed a site is probably the most important factor in relation to the bird or insect decline.

Impact of herbicides outside sprayed fields

Herbicides are sprayed over thousands of square kilometers of corn and soybean in our region. Therefore, billions upon billions of insects during and after a spray become contaminated and many if not most move away from the site to a wide range of habitats. How far do they spread is not clear, but at least one kilometer would be a very conservative value.

How do contaminated insects feel after a while is not known. It could range from not feeling good, being unbalanced or awkward, dying, or even becoming unable to reproduce (research is required here).

Impact of herbicides outside sprayed field

As contaminated insects spread, they are probably becoming quite easily preyed upon by insects such as *Tenthredo*, spiders such as *Geolycosa*, and, not least, by birds. These animals, after much consumption, become poisoned. Birds are nesting at the time. They feed on the contaminated insects and feed contaminated insects to their nestlings.

Herbivorous insects such as caterpillars, though not involved feeding on contaminated insects, may be eating leaves on which contaminated insects walked. This probably happened on the forested hills south of Montreal. There was indeed a massive collapse of numerous species of Lepidoptera recorded there in the mid-2000s (Louis Handfield, pers. comm.).

Parasitic wasps of the genus *Idris* do not consume contaminated insects, but their host, the spiders, do, in May and June. The spider populations collapsed followed by the fast decline of *Idris*, their egg parasitoids (they ran out of spider eggs), and of their predators, the Pompilidae or spider wasps (they ran out of adult spiders). This was all recorded at the Pinhey Sand Dunes from 1984 to 2016.

Impact of banning herbicides in Ottawa and public private places

It is very nice to complain, but I like to be positive under the deluge of pesticide pollution and to end up on an hopeful note

In 2016, we sampled five sites with Malaise traps from May to October (Mer Bleue: near the boardwalk and east of the ridge; Stony swamp; Fletcher Garden; a private home).

At four of the sites we captured many specimens of *Tenthredo* and a few species of the parasitoid *Idris*, after obtaining almost none in more than two decades of collecting. In short, the ban on herbicides and other pesticides in Ottawa and Gatineau (around 2006-2007) is beneficial. There were no sawflies or parasitoids at the Fletcher Garden as it is near a sprayed corn field at the Experimental Farm.

Conclusions

The populations of some insects groups collapsed between 1980 and 1989, and herbicides were suspected.

Within a crop with a yearly spray of herbicides, the population of many species are greatly diminished compared with sites with no herbicides anywhere near.

Within a crop with a yearly spray of herbicides, nearby fallow places act as a source area and help in re-establishing the lost diversity.

Within an organic crop between two adjacent fields with a yearly spray of herbicides, its diversity is similar to that of sprayed sites. The sprayed site affect the diversity of the unsprayed site.

Conclusions

Insects exposed to herbicides are not killed on the spot as with insecticides. Insects of a herbicide-sprayed field become contaminated and spread out. Other insects prey on them in late May and early June.

Contaminated insects from a spray site will disperse, mainly to the East. They are consumed by predatory insects and insectivorous birds and their nestlings.

The amount of contaminated insects is enormous during the spray period because the proportion of sprayed corn and soya is over 30% of the land around Ottawa.

With repeated sprays over the years, populations of insects collapse, affecting probably the amount of insects available to birds. Continued exposure of contaminated insects no doubt has an impact beyond the decline of insectivorous birds.

References

Goulet, H., LeSage, L., Bostanian, N., Vincent, C., and Lasnier, J. 2004. Diversity and seasonal activity of ground beetles (Coleoptera: Carabidae) in two vineyards of Southern Quebec, Canada. *Annals of the Entomological Society of America* 97(6): 1263-1272. [Most of the data presented on ground beetles is from this paper. The rarefaction and evenness curves were not illustrated and no comparisons were presented between abundance of spring breeding and summer breeding beetles.]

Peck, S. B. and Cook, J. 1992. Use of 'car-nets' to sample flying micro-Coleoptera. *The Canadian Entomologist* **124** (5): 745-749. [This sampling technique allows a precise estimate of the density of insects per cubic meter of air going through sampling nets in front of the car at a comfortable speed of 40-60 Kph.]

