Impacts of pesticides used in Quebec (Canada) corn fields on honeybee colonies

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Economic value of pollinators in Quebec

| Culture | Taux de dépendance aux pollinisateurs Références | | | | | Valeur de la culture | | | | Valeur attribuable aux pollinisateurs |
	Pouvreau[1]	Morse et Caldrone[2]	Agri. Agro. Canada[3]	deOliveira[4]	Moyenne	Superficie Qc/Ha	Produit brut/ha	Références	Valeur brute	
Bleuets		1	1	0,89	0,96	12 400	1 995	5 et 6	24 738 000 $	23 830 940 $
Canneberge		1	1	0,80	0,93	1 619	24816	9	40 177 104 $	37 498 630 $
Canola/Colza	0,10		0,20	0,46	0,25	21 000	982	5 et 6	20 622 000 $	5 224 240 $
Citrouille		0,90	1	1,00	0,97	647	12 150	5 et 8	7 861 050 $	7 599 015 $
Concombre		0,90	1	0,60	0,83	809	10 636	5 et 7	8 604 524 $	7 170 437 $
Courge Zucchini		0,90	1		0,95	647	20 930	5 et 6	13 541 710 $	12 864 625 $
Fraise	0,80	0,20	0,30	0,36	0,42	1 477	30 627	5 et 6	45 236 079 $	18 772 973 $
Framboise			0,90	0,38	0,64	526	24 206	5 et 6	12 732 356 $	8 148 708 $
Poivrons		0,20		0,65	0,43	587	25 200		14 792 400 $	6 286 770 $
Pomme	0,70	1	1	1	0,93	4 961	8 361	5 et 6	41 478 921 $	38 368 002 $
Raisins		0,1			0,10	301	12 600	1et 2	3 792 600 $	379 260 $
Total									233 576 744 $	166 143 599 $

[1] Pouvreau, A. 2004. Les insectes pollinisateurs. Eds. Delachaux et Niestlé, Paris189 p.

[2] Morse, R. et Calderone, N,. 2000. The Value of Honey Bees as Pollinators of U.S. Crops in 2000. http://www.beeculture.com/beeculture/pollination2000/pg1.html

[3] Agriculture et Agroaliemtaire Canada - 2001. The Value of Honeybee Pollination in Canada. http://www.honeycouncil.ca/users/folder.asp?FolderID=5174

[4] deOliveira, D. 2005. Évaluation économique de l'abeille domestique, en 2005, au Québec. Congrès SEQ 2005

[5] Évolution des superficies cultivées en fruits et légumes au Québec de 2002 à 2008 nouveauté

[6] Références économiques du CRAAQ

[7] La Financière agricole :

[8] Adgex 1987* prix marché MTL oct 2008

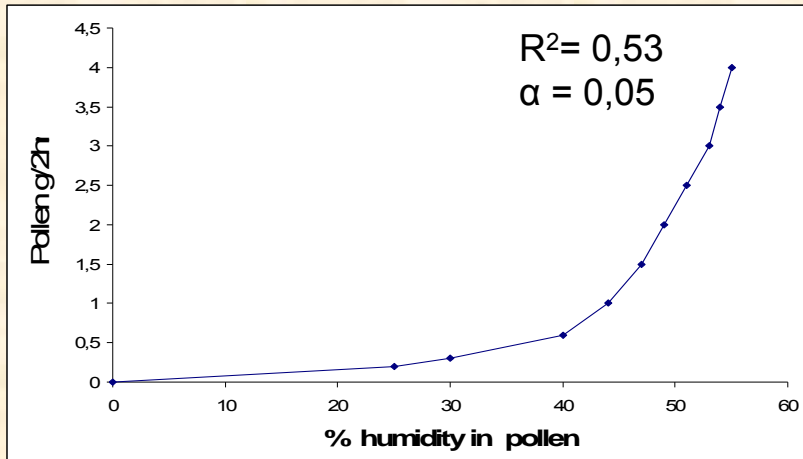[9] Jacques Painchaud MAPAQ Centre du Québec

Corn, especially sweet corn is a source of pollen, but also a risk of poisoning by pesticides

By pollen analysis,
It is possible to quantify
 presence of honeybees in
a crop

Honeybees forage on corn

Pollen g/2h vs % humidity in pollen

$R^2 = 0,53$
$\alpha = 0,05$

When pollen reaches 30% to 40% humidity (requiered to form pellets ?)

When other pollen ressources are poor

- - - - - - - MUSTARD

············· CLOVER

——— CORN

July   August
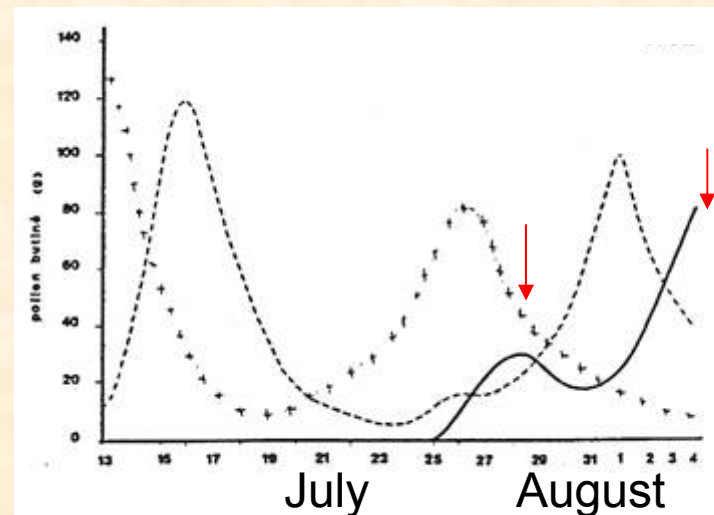
Increasing land use for corn crops in Quebec

Superficie des terres agricoles utilisées à des fins de culture du maïs
1966-2001

(Tiré de Statistique Canada, 2001)
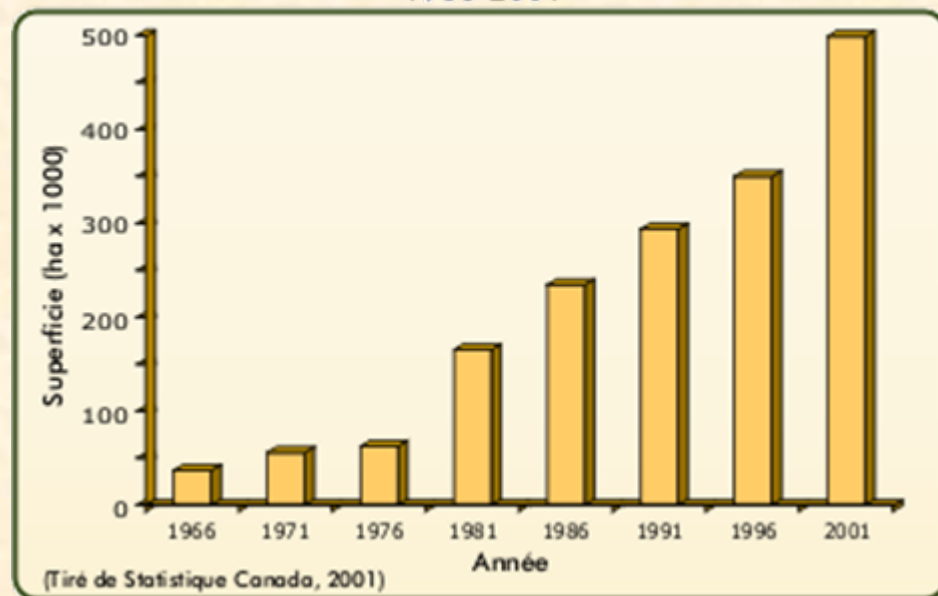
Culture du maïs au Québec par région administrative

Maïs
Superficies cultivées (ha)
< 100
100 à 10 000
10 000 à 50 000
50 000 à 200 000
> 200 000

Données : Statistique Canada, 2001
Ministère de l'Environnement, 2004

Europeen corn borer
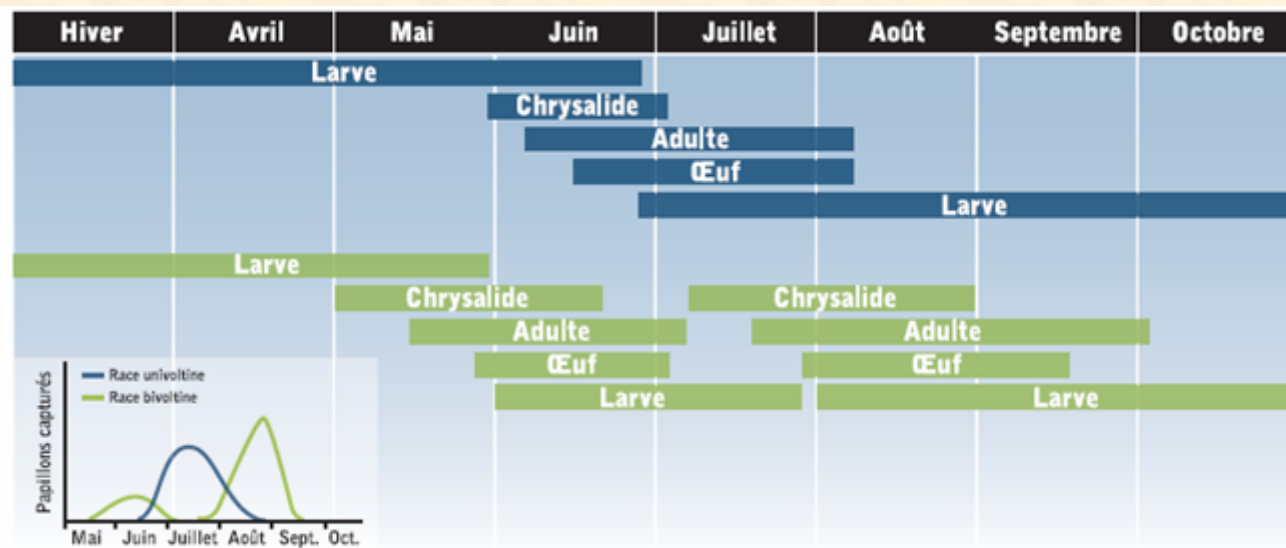
Les périodes d'apparition des stades de la pyrale du maïs peuvent varier selon la situation géographique et les conditions climatiques.

Distribution des races univoltine et bivoltine de la pyrale du maïs
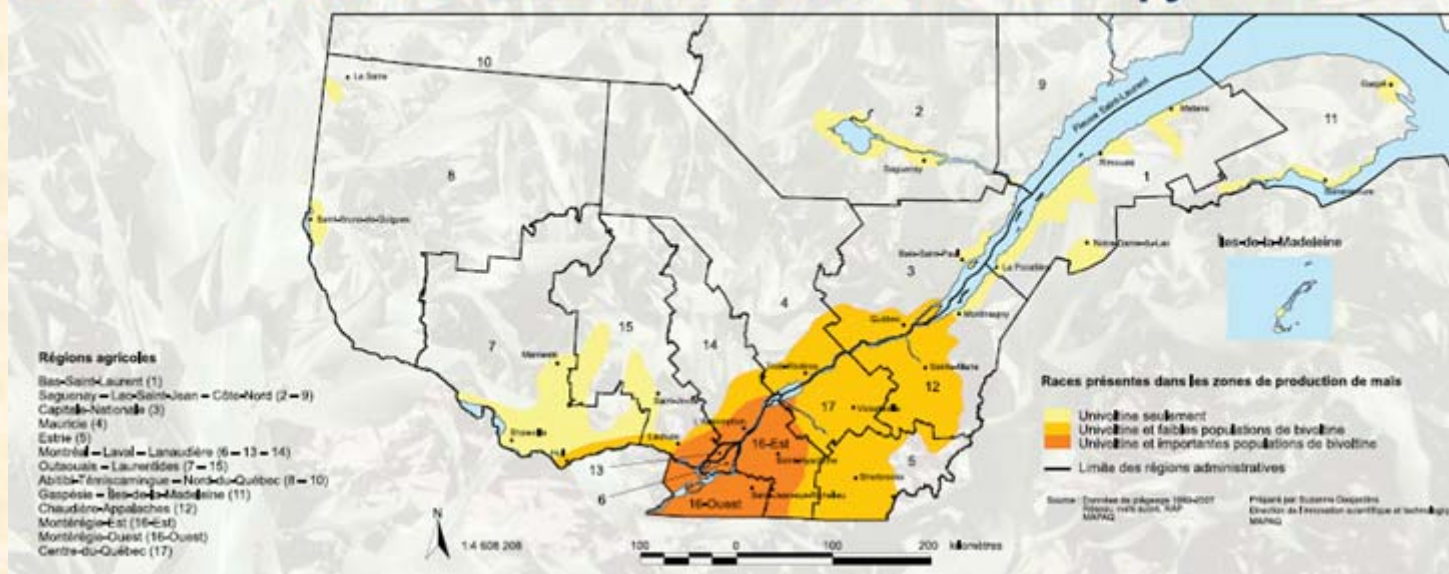
Aerial spaying in Sweet corn
TWO ways for Honeybees of getting poisoned

1: The bees are directly spayed

2: Insectides drift in the next field and in border plants

Carbamates	Crabaryl (Sevin XLR)
	Carborufan (Furadan 480F)

Insecticides that are highly toxic to bees and may have a residual hazard longer than 8 hours

échantillon	Volume d'eau	Q injectée µg/mi pour 10 ml	Carbofurane (µg/mi)	Carbofurane absorbé/abeille (µg) **	XDL$_{50}$a b. ***
	3,3	48,2	146	7,3	912
2	1,0	11,1	111	5,5	693
3	1,3	7,7	59	2,9	368
4	1,3	14,2	109	5,5	681
5	2,8	41,9	149	7,5	931
6	1,6	14,5	91	4,5	568

** si une abeille s'y abreuvait , charge moyenne (jabot= 50 µg)

*** DL$_{50}$ = 0,16 µg /abeille

Accumulation and concentration
of insecticide in little pools formed in the
leaves nods (ramification) of the maize plant

Work done with Suzanne Pion and Domingos deOliveira

Use of Honeybees as bioindicators

Experimental design

Saint-Damase

Saint-Jude/Saint-Barnabé

Saint-Pie/Saint-Dominique
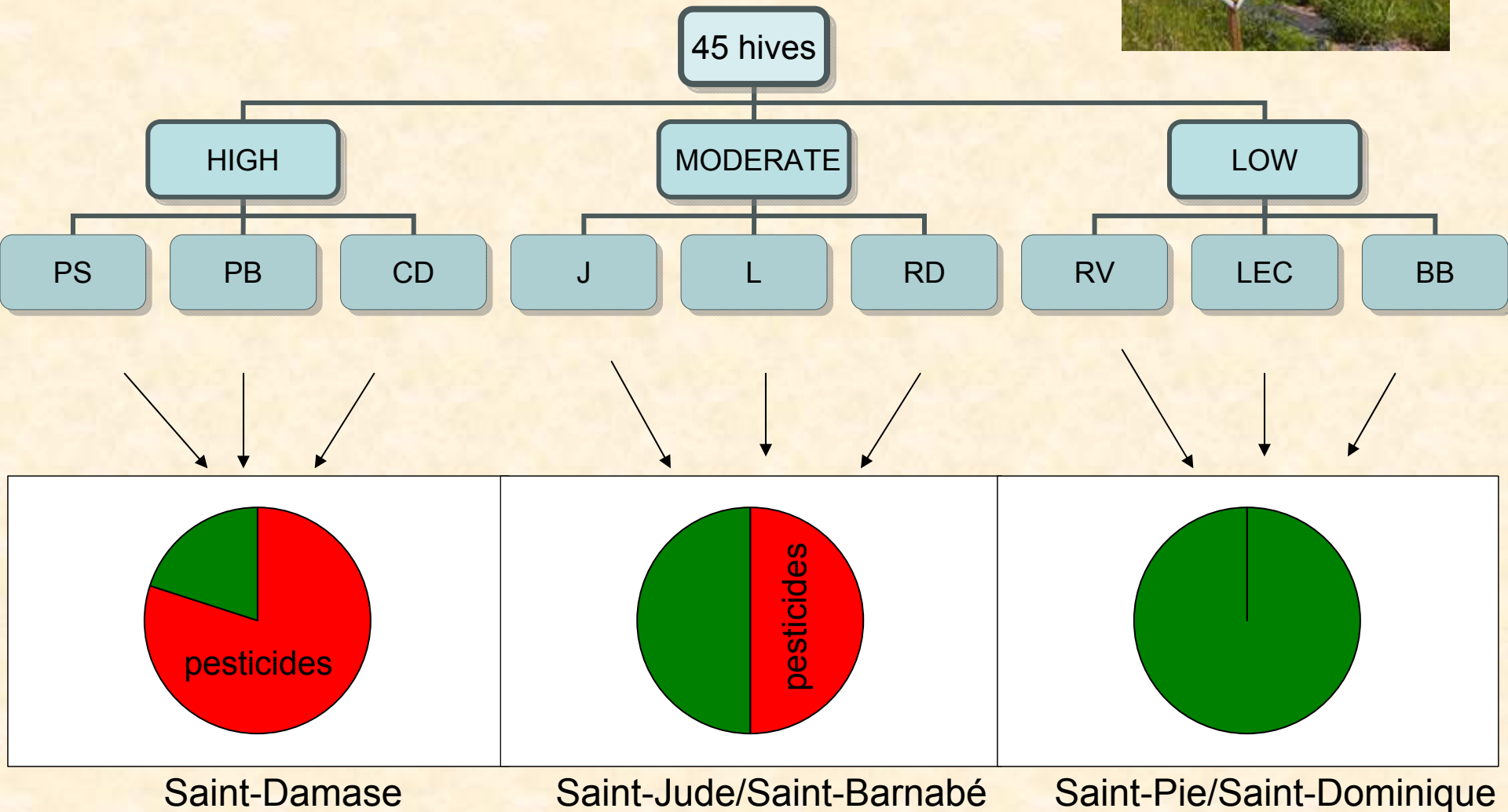
Variables mesured

1. Weight of hives

2. Dead honeybee count

3. Problems with queens
    - Loss
   - Interruption of egg laying


4. Brood development

RESULTS

GLOBAL HIVE PERFORMANCE vs PESTICIDE USE IN THE ENVIRONNEMENT

	High	Moderate	Low
Queenless hive Queen stops laying eggs	9 hives on 15*	7 hives on 15	1 hive on 15**
Percent of dead honeybees collected during the study	68 %	27 %	5 %
Number of time more than 100 dead honeybees were found	11	2	0
Hive weight gain(kg)	+ 32.09	+ 48.91	+ 44.55
Gain in brood cells	-6967	-4232	+ 8075

MULTIVARIATE ANALYSIS
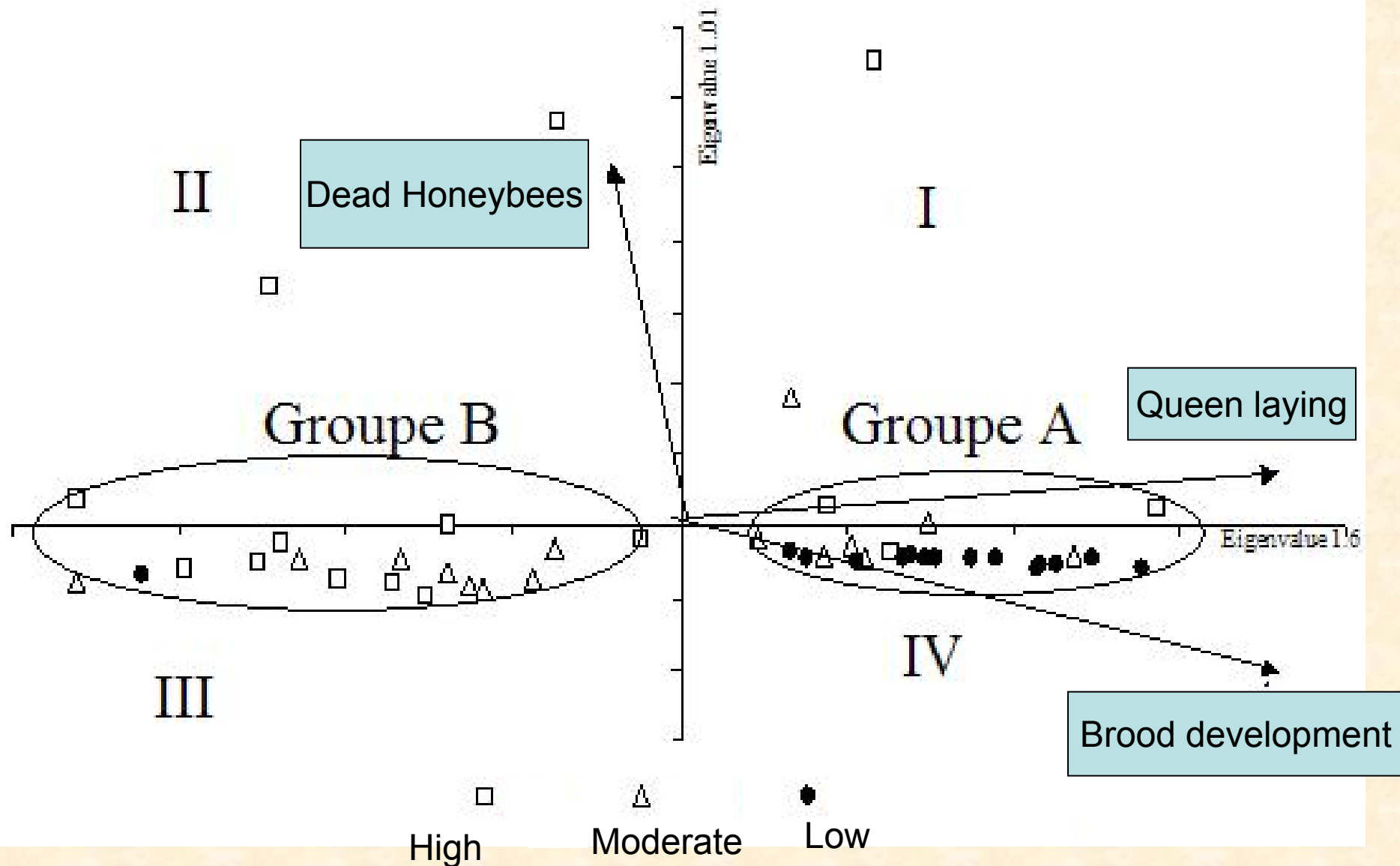
Follow up on native wild bees : species acculumation curves
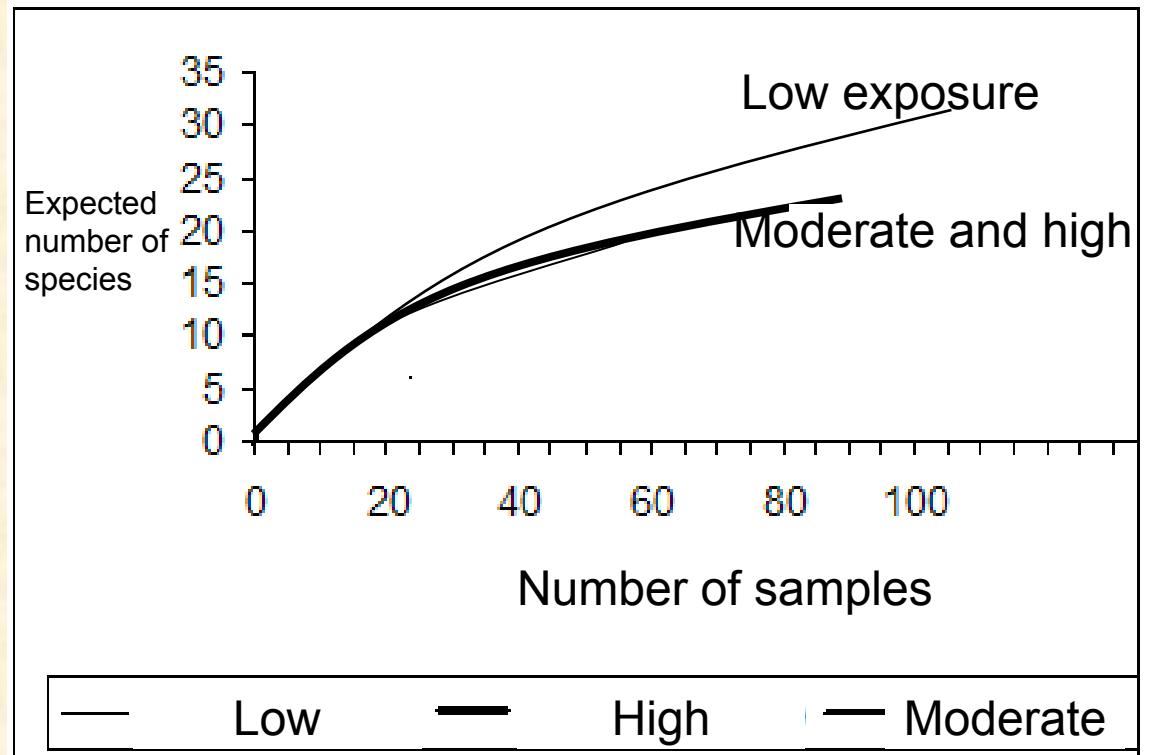
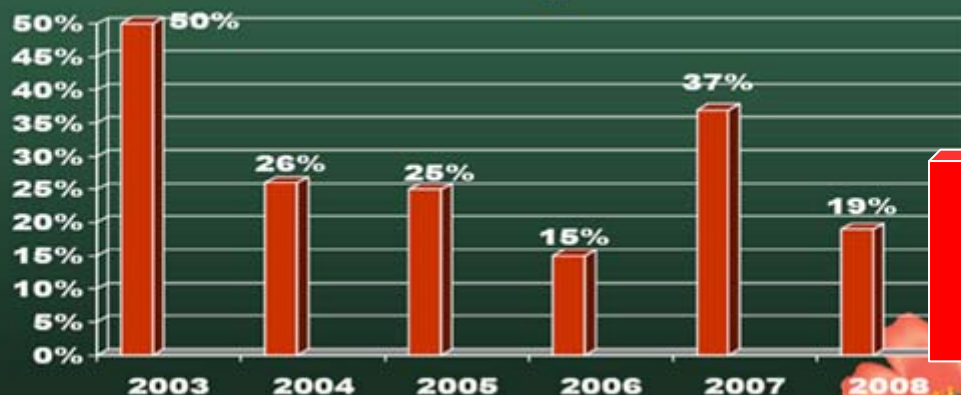Wild bee are also prolific pollinators.

2003

Arrival of the varroa mite

Qu'en est-il au Québec....

- Taux de mortalité à l'hivernage anormalement élevé
  - Dans le passé (pré-varroa) = moyenne de 10-15%
  - Depuis l'arrivée du varroa = moyenne ↑↑↑ (avec des extrêmes de 0-100%)
  - Cause: VARROA et ....?

Mortalité hivernale de colonies au Québec depuis 2003
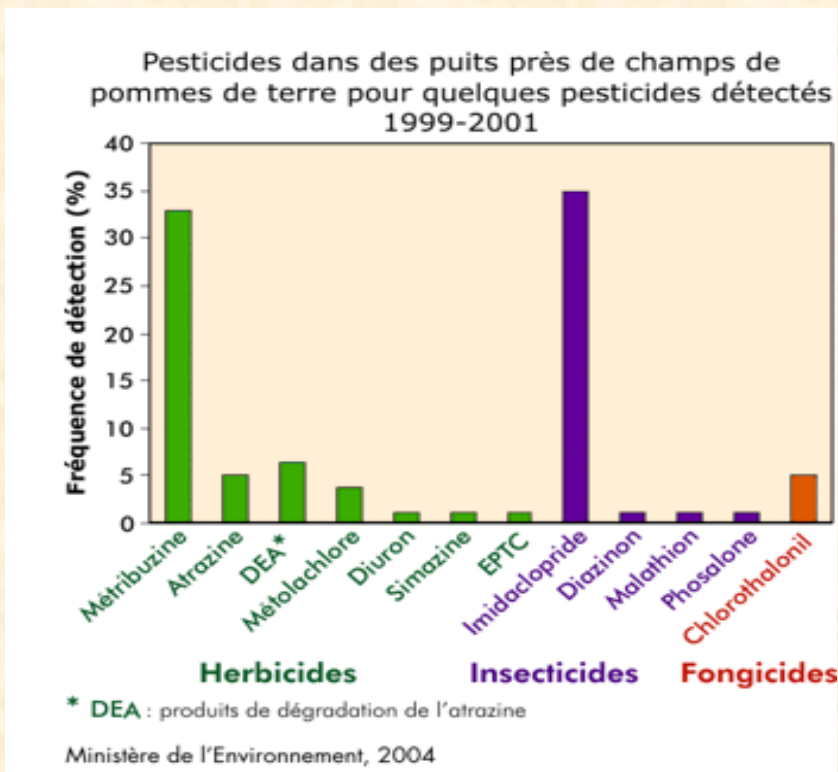

2009: 30%

Tiré d'une présentation de Claude Boucher mv MAPAQ

Many other causes are possible (or a combination of these)

- Pathogenes

- Parasites

- Food ressource quality

- Pesticides

SOIL

Candian studies have showen that the half-life of this insecticide in bare soil can go from 282 to 366 days, in soil covered with grass from 224 to 257 days and in soil planted with potatoes, from 266 à 457 days (PMRA, 1997).

Pesticides dans des puits près de champs de pommes de terre pour quelques pesticides détectés 1999-2001

Herbicides   Insecticides   Fongicides

* DEA : produits de dégradation de l'atrazine

Ministère de l'Environnement, 2004

WATER

The ministery of environement detected Imidaclopride in 35 % of the wells sampled near potato feilds (up to 6,4 µg/l)

Systemic Insecticides

Seed coating (néonicotinoïde)

LD_{50} **contact**

Clothianidine (PONCHO®)　　0,003 µg/bee (3 ng)

Thiaméthoxame (CRUISER®)　　0,005 µg/bee (5 ng)

Imidaclopride (GAUCHO®)　　0,004 µg/bee (4 ng)

(SAgE pesticide)

Acétylcholine Inhibitor (neurotransmission)

Chemical communication
Disruption of temperature regulation
Affectation wing muscles

A study was recently initiated to assess the current large scale use of new systemic pesticides (neonicotinoids) in corn as one of the multifactorial causes of observed honeybee losses.

SUPERFICIES ASSURÉES EN MAIS-GRAIN PAR MUNICIPALITÉ EN 2007
(individuel + collectif)

La Financière agricole
Québec

CORN

Légende

Centres de services
Municipalités
HECTARES ASSURÉS
< 1000 ha
1000 - 3000 ha
> 3000 ha

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In Quebec 95 to 100% of canola, soya or corn seeds plated were treated with either
''Poncho'' (clothianidin) - Bayer

Or
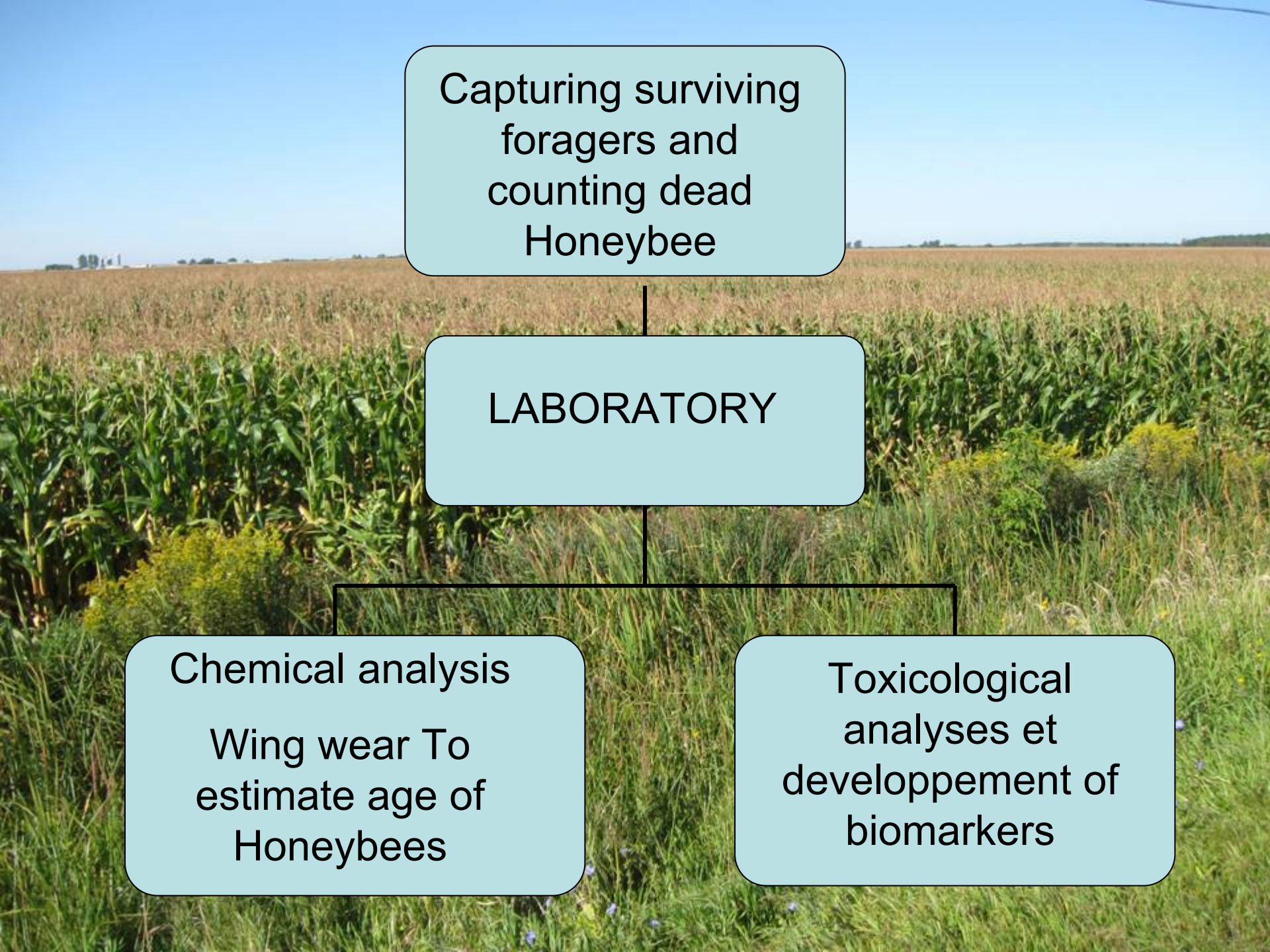
''Cruiser'' (thiamethoxam) - Syngenta.

3 Québec régions

Saint- Eustache | Saint-Hyacinthe | Sainte-Marie

Control
Lachute

Expérimental
St-André

Control
St-Francois

Expérimental
Pierreville

Control
St-Étienne

Expérimental
St-Lambert
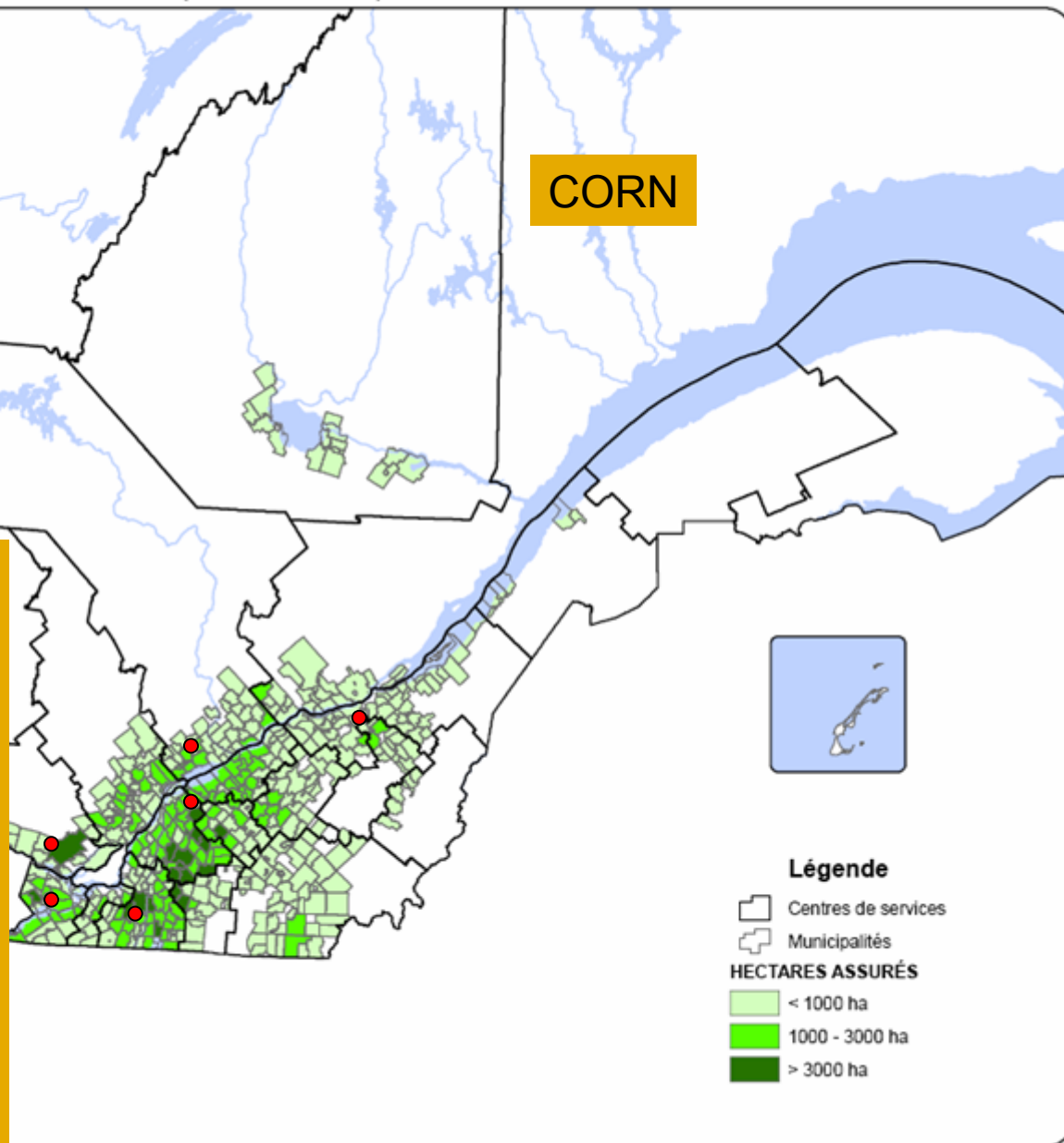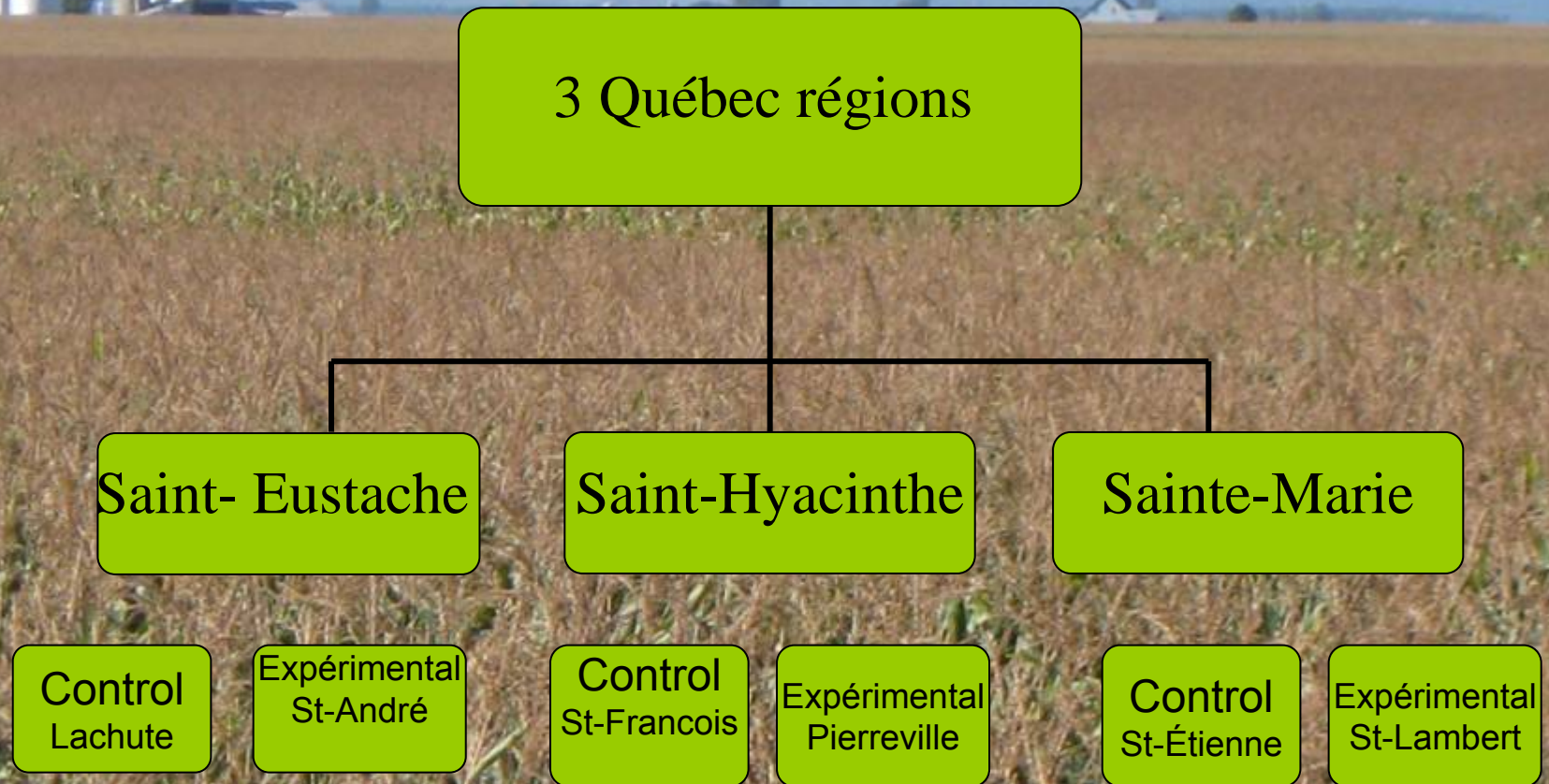
Capturing surviving foragers and counting dead Honeybee

LABORATORY

Chemical analysis

Wing wear To estimate age of Honeybees

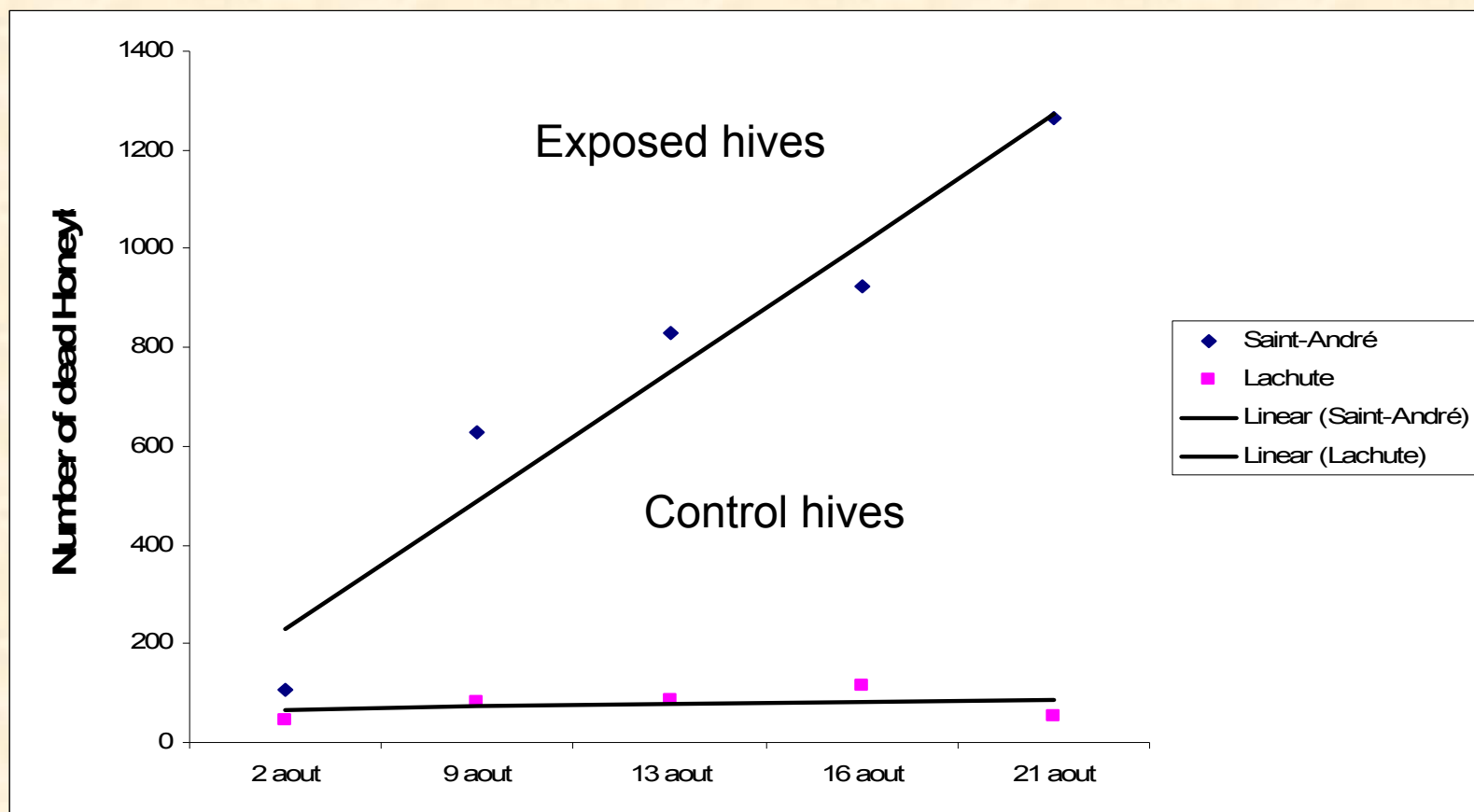Toxicological analyses et developpement of biomarkers

High mortality of bees showing symptoms of the Chronic Bee Paralysis Virus was observed in exposed hives while control hives remained healthy

SYMPTOMS OBSERVED

•paralysis
•abnormal wobbly movements
•spinning on the back
•fighting and confusion at the hive entrance

Results on Honeybee mortality

- Queenless hives

- Severely weakened or queenless colonies that did not survive the following winter.

- Honeybees displaying symptomes of viral paralysis disease (symptoms that may be confused with bee poisoning).

High morality in foragers causes worker bee to leave hive : advancing their foraging role
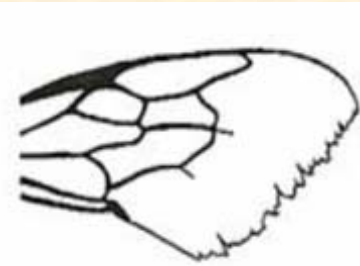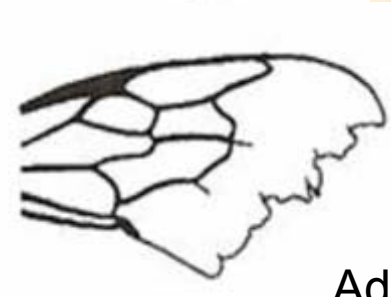
Estimation of wing wear
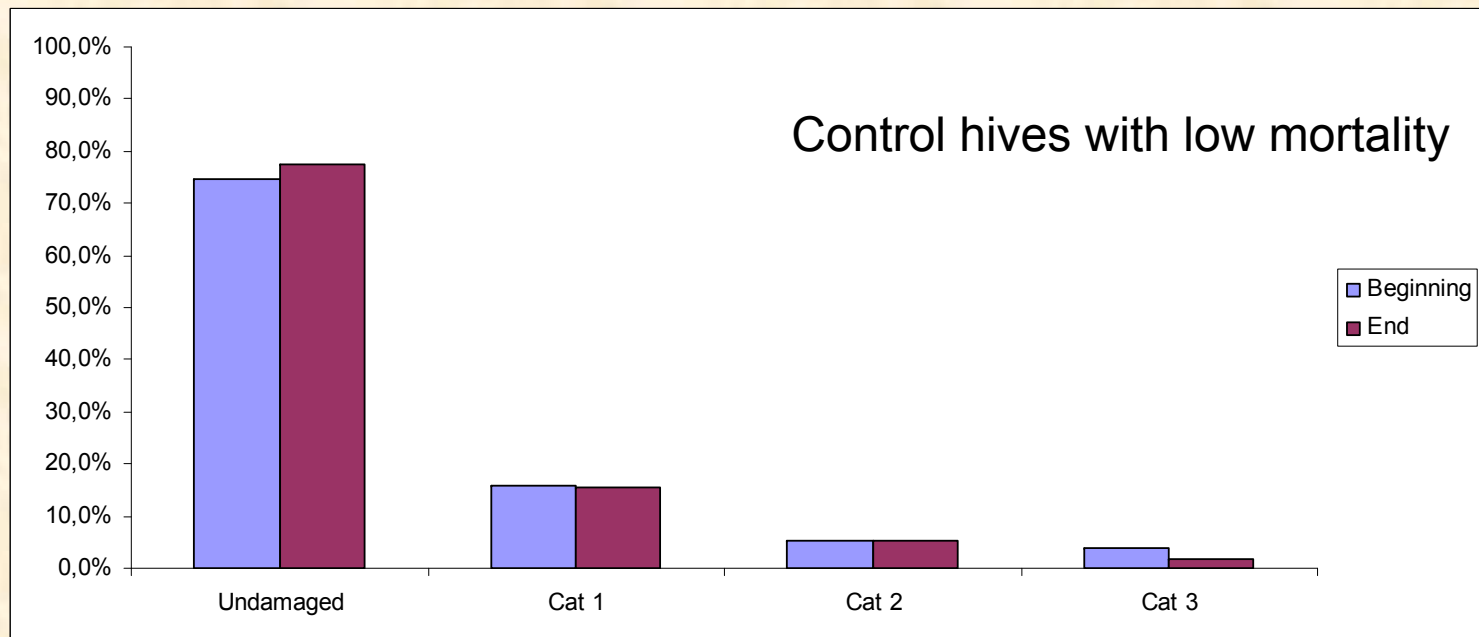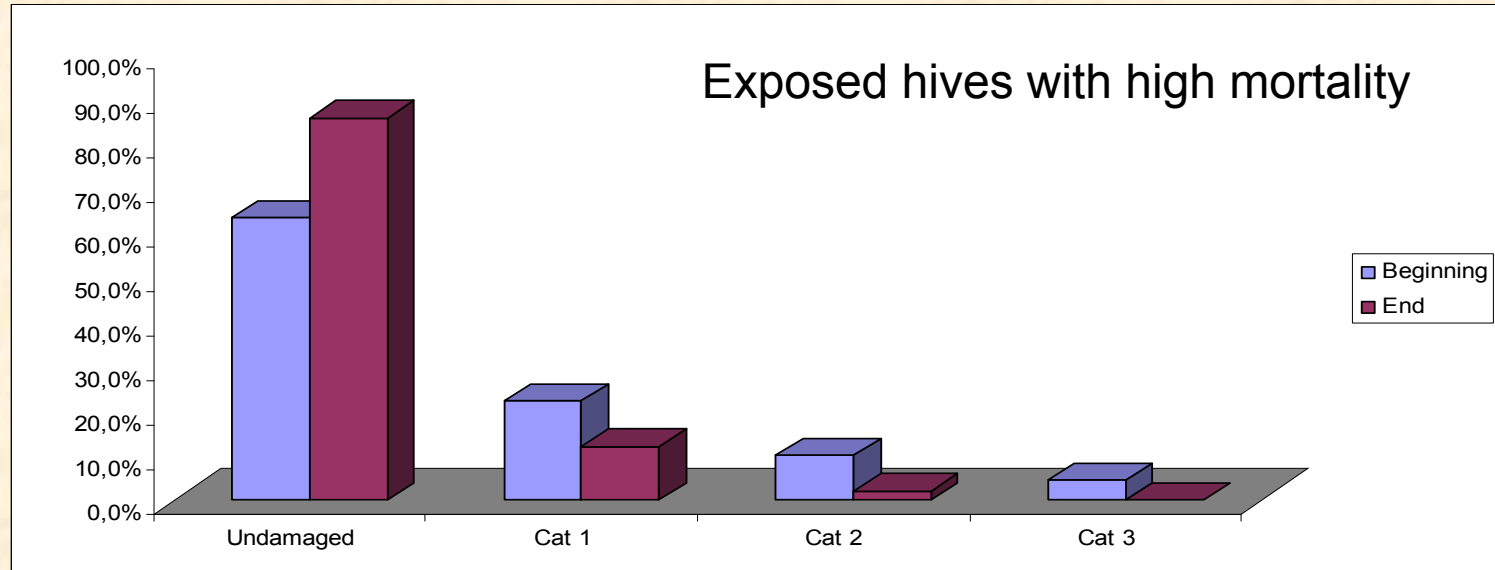

Undamaged
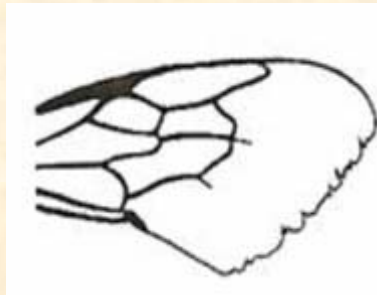
Category 1

Category 2

Category 3

Adapted from Mueller & Mueller 1993

First year results on wing wear

Ectoxicology – UQAM/TOXEN

(Madeleine Chagnon, Monique Boily et Geneviève Beaunoyer)

Developement of biomarkers to evaluatate the impacts of Honeybee (*Apis mellifera*)*exposition to pesticides used in large corn field environnements*

Dosage of bee head acetylcholinesterase (AChE) using microplate spectrofluorometry

Expected results: a decrese in acetylcholinesterase as an indicator of exposure to an antiholinesterase pesticide (This enzymatic essay is not capable of distinguishing between diffrent pesticides)

First results : The AChE increase in surviving Honeybees showed that AChE activity might be used as biomarker to reveal an exposure to pesticides (overcompensation).

The pesticides used are constantly changing as well as their mode of action: Example - Movento

We are now working on the developement of certain tests that can help us to judge Honeybee health, including its immune system

- Weakened immune systems can facilitate the spreading viral infections.
- This hypothysis has been largely suggested for the varroa mite

Ongoing work

Dosage of vitamine A and enzymes playing a rôle in the immune system of the Honeybee

The enzymes phénol oxydase (PO) and glucose déshydrogénase (GLD) play a critical role in cellulare response (Xiaolong et al., 2005)

These levels of the immunity-related enzymes are thus priorised