



Agriculture and  
Agri-Food Canada

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Agroalimentaire Canada



# Measuring Efficacy of Treatments in Flour Mills: An International Perspective.

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Canada

**Did it work?**

**Did it work**

**as well as MB?**



# Overview

- **Treatments**
- **Bioassays**
- **Pheromone Traps**
- **Sample While You Clean**
- **Rebolt Sifter Tailings**



# Efficacy Trials in Flour Mills

- Mills from Canada, Germany and Italy
- Methyl bromide
- Sulfuryl fluoride (ProFume)
- Phosphine, (ECO<sub>2</sub>FUME) heat and CO<sub>2</sub>
- Heat
- IPM / Sanitation



# MB and SF fumigations





# Phosphine, Heat and Carbon Dioxide

- Carbon dioxide at 3-6%
- Heat at 30-40°C
- Phosphine at 100 ppm,  
ECO<sub>2</sub>FUME
- Sensitive equipment:  
remove or seal



# Heat: Portable Steam Heaters



Armstrong International Inc  
Mill 3, June 2006



Roo Can Inc.  
Mill 2, September 2003





# Heat Treatments in Germany

[www.thermonox.de](http://www.thermonox.de)



[www.biotech.at](http://www.biotech.at)







Two mills, 14 floors  
+ packaging unit,  
approx. 42,000 m<sup>3</sup>



# How Many Insects?





# Flour Mills are Complex Structures



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# Stage specific toxicity for various fumigants.

Gas	Insect	CT to kill 95% of the population (g-h/m <sup>3</sup> )				Reference
		Egg	Larvae	Pupae	Adult	
sulfuryl fluoride	confused flour beetle	<b>1125</b>	-	-	<b>55</b>	Kenga 1957
	granary weevil	<b>794</b>	<b>14</b>	<b>14</b>	<b>15</b>	Kenga 1957
methyl bromide	confused flour beetle*	-	-	<b>90</b>	<b>60</b>	Heseltine & Thompson 1974
	confused flour beetle*	<b>65</b>	<b>98</b>	<b>251</b>	-	Bell et al. 1988
	rice weevil	<b>37</b>	<b>10</b>	<b>44</b>	<b>27</b>	Krohne & Lindgren 1958
phosphine	Indian meal moth*	<b>77</b>	<b>1</b>	<b>1</b>	-	Bell 1976
	confused flour beetle	<b>2</b>	<b>0.1</b>	<b>0.3</b>	<b>0.3</b>	Lindgren & Vincent 1966

\* complete kill.



## Insect bioassay

- 20 red flour beetle adults on flour for 4 d before fumigation
- variable # of eggs and young larvae
- total of 25 locations per date



# German Heat Treatments

- 50 samples placed around mill
- *Rhizopertha dominica*, 50 adults + dev.stgs.
- Half with data loggers







# German Heat Treatments

- 60 samples placed around mill:
  - E. kuehniella* 50 eggs, 50 larvae
  - R. dominica*, 30 adults + 30 ml dev. stages
  - T. confusum* 30 adults + 30 ml dev. stages
- All samples with data loggers



# Insect Bioassays: Methyl Bromide

Mill	Date	Treatment	Conc.-Time (g-h/m <sup>3</sup> )	Mortality (%)	
				Adult	Immatures
3	July 2003	MB	334	100	-
4a	Nov. 2004	MB	377	100	-
4a	May 2005	MB	274	100	98.8
6a	Nov. 2005	MB	-	100	100
7	June 2006	MB	242	100	100
6b	July 2006	MB	210	100	100
6ab	Nov. 2006	MB	-	100	-



# Insect Bioassays: Phosphine, Heat and Carbon Dioxide

Mill	Date	Treatment	Maximum Temperature (°C)	Mortality (%)	
				Adult	Immatures
6b	Nov. 2005	PH3 combo	32	100	99
6a	Nov. 2005	MB	27	100	100
6a	July 2006	PH3 combo	37	100	99
6b	July 2006	MB	40	100	100



# Insect Bioassays: Sulfuryl Fluoride

Mill	Date	Treatment	Conc.-Time (g-h/m <sup>3</sup> )	Mortality (%)	
				Adult	Immatures
4a	Dec. 2004	SF	457	100	64
4a	Oct. 2005	SF	1096	100	96
8	July 2006	SF	832	100	99.6
5	Aug. 2006	SF	1280	100	99.7
10	Aug. 2008	SF	675	100	75
11	Sep. 2008	SF	750	100	81
12	Sep. 2008	SF	652	100	96
13	Oct. 2008	SF	768	100	93





# Insect Bioassays: Heat

Mill	Date	Treatment	Maximum Temperature (°C)	Mortality (%)	
				Adult	Immatures
1	Aug. 2003	Heat: forced air*	64	100	99.6
1	Aug. 2006	Heat: forced air*	56	100	100
7	Sept. 2006	Heat: forced air*	57	100	100
2	Sept. 2003	Heat: steam**	55	87	89
3	June 2006	Heat: steam***	57	94	99.6

\* Temp-Air

\*\* Roo Can portable heaters

\*\*\* Armstrong International portable heaters



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# Pheromone Traps

- pheromone baited
- 5-10 traps/floor
- sifter and roll floors
- weekly counts
- expressed as % of pre treatment populations



# *Tribolium* Traps



Dome trap - Trécé

Pheromone = 4R,8R-dimethyldecanal

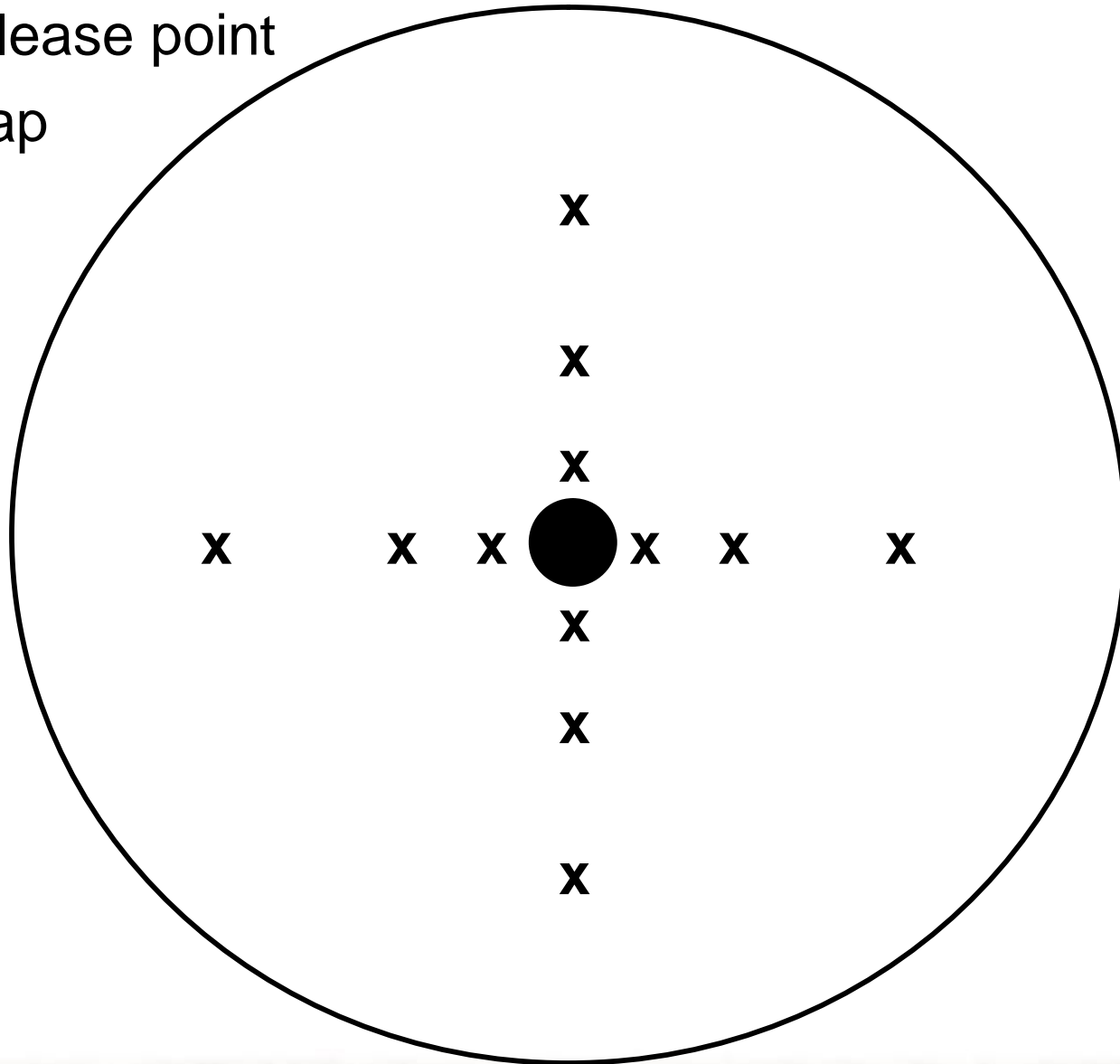
Food bait = cereal oil





**x** = release point

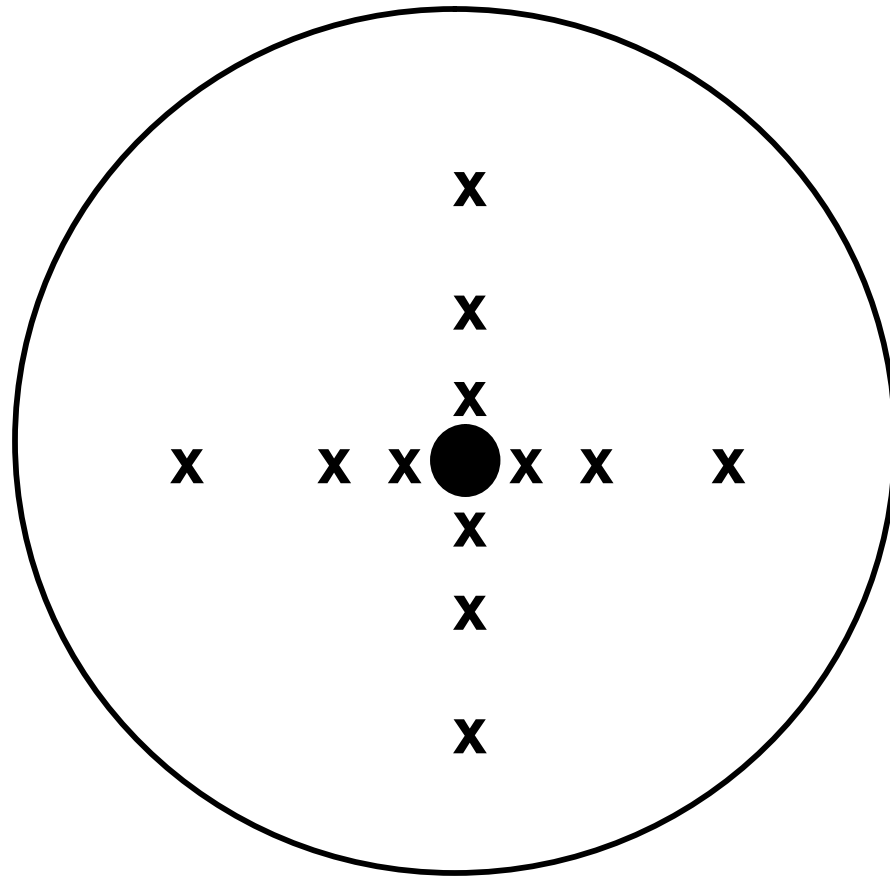
● = trap



$r = 100$  cm, release points = 10, 30, 60 cm

# Bullseye Study

- Males released
- Timed until
  - Exited bullseye
  - Caught in trap
  - 10 minutes up



$r = 100$  cm

release points = 10, 30, 60 cm

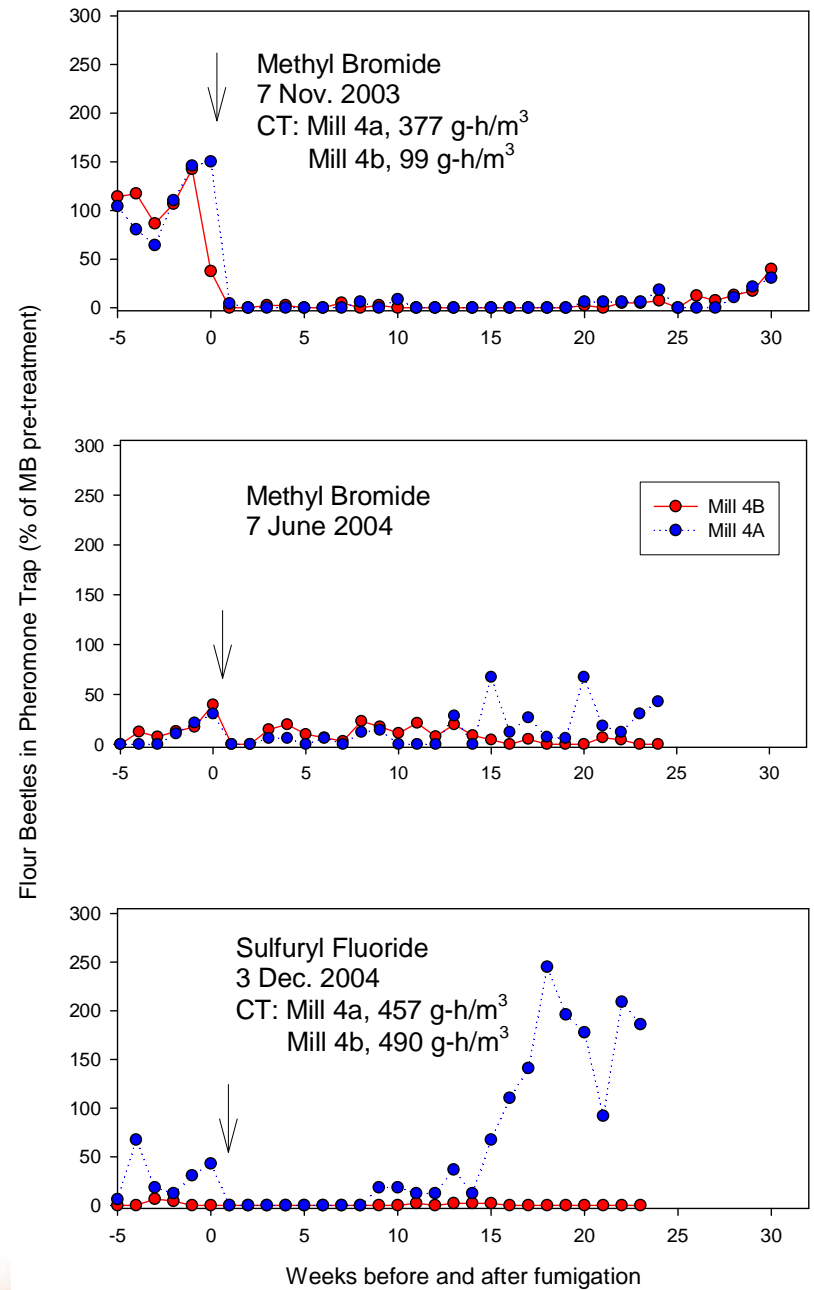


# Bullseye Study

Treatment	Not in trap	In trap
Pheromone (n=132)	130	2



# Pheromone Traps





# Italian Flour Mills

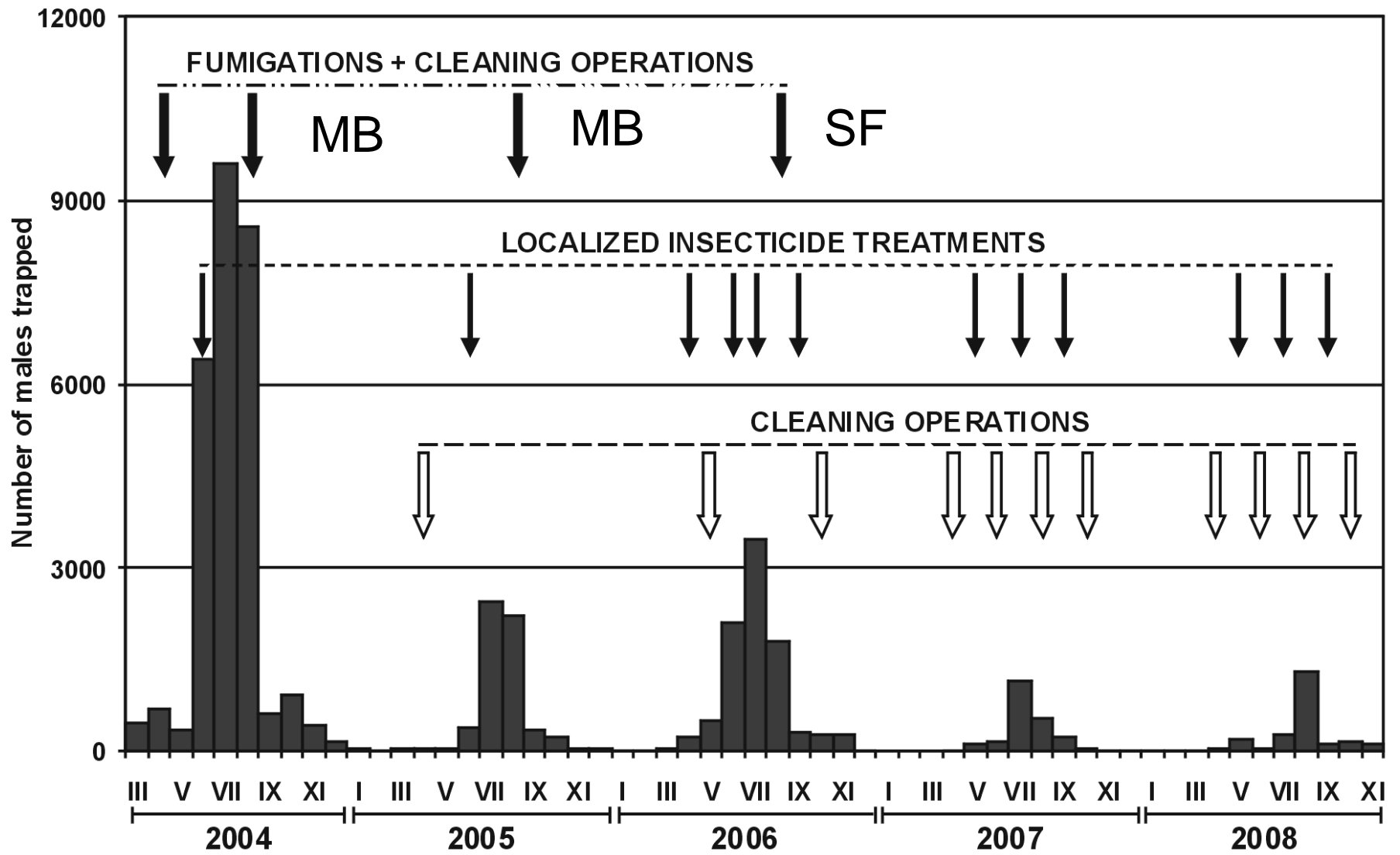


Mediterranean flour moth, *Ephestia kuehniel*



# Pheromone Mass Trapping





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## **During Cleaning**

- **When cleaning equipment, sifters, roll stands, etc...**
- **Note number of insects,**
  - **None = 0 insects**
  - **Low = 1-10 insects**
  - **Medium = 10-20 insects**
  - **High = 20+**
- **Document, follow trends over time**



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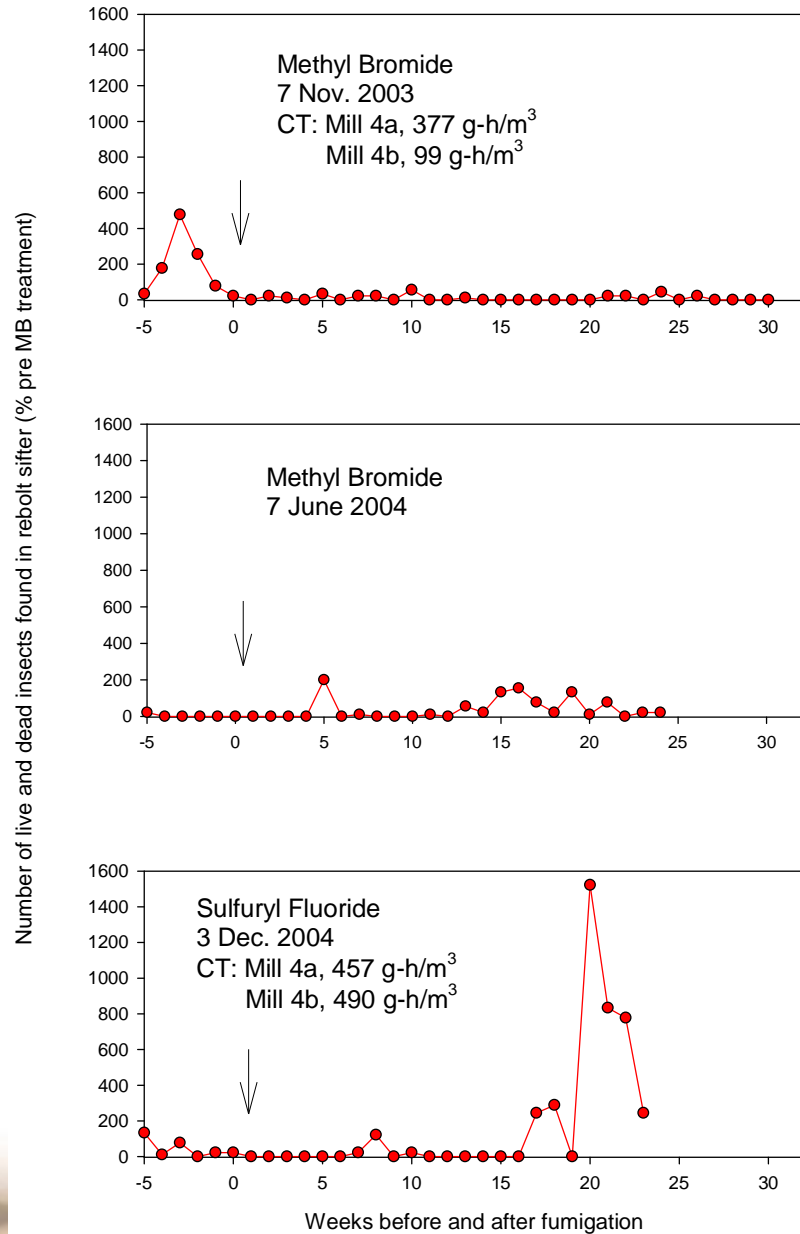


# Rebolt Sifter Tailings

- Pulls insects from flour stream
- Usually just before load out bins
- May show similar trend as traps
- Every load, once a day, 3x/wk
- Take subsample, or count all
- Choose system, be consistent

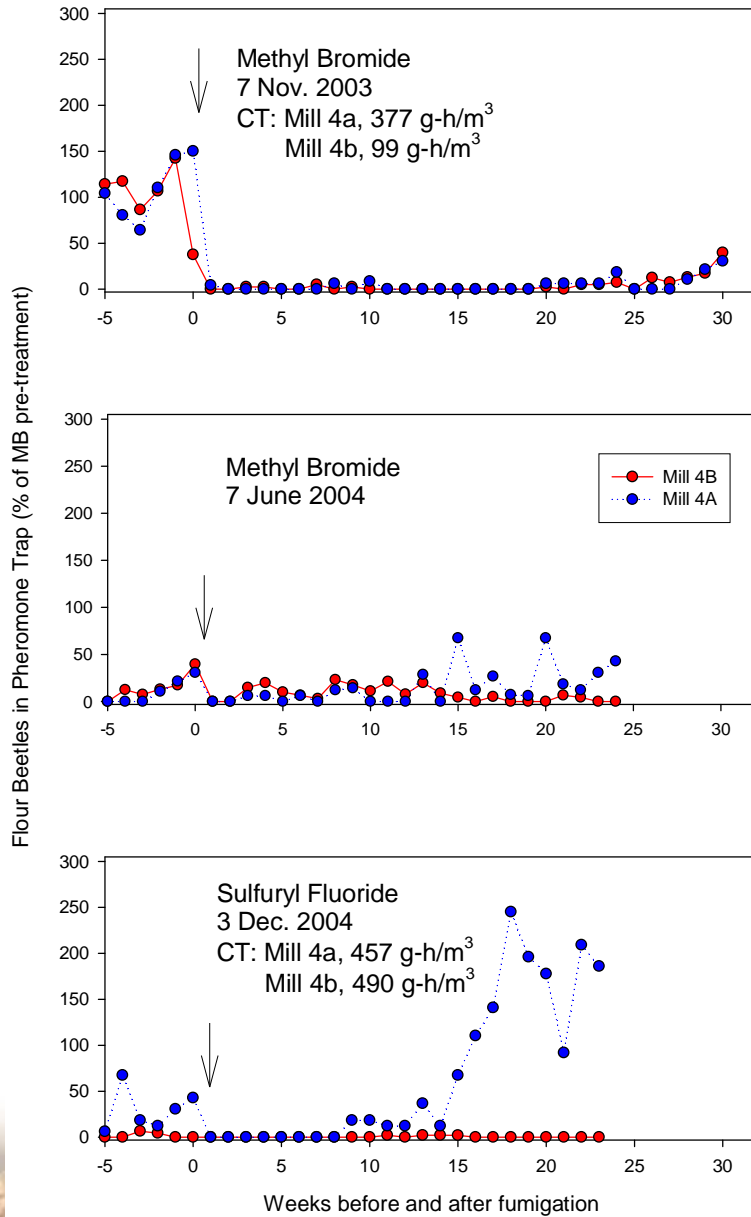


# Insects in Rebolt Sifter Tailings

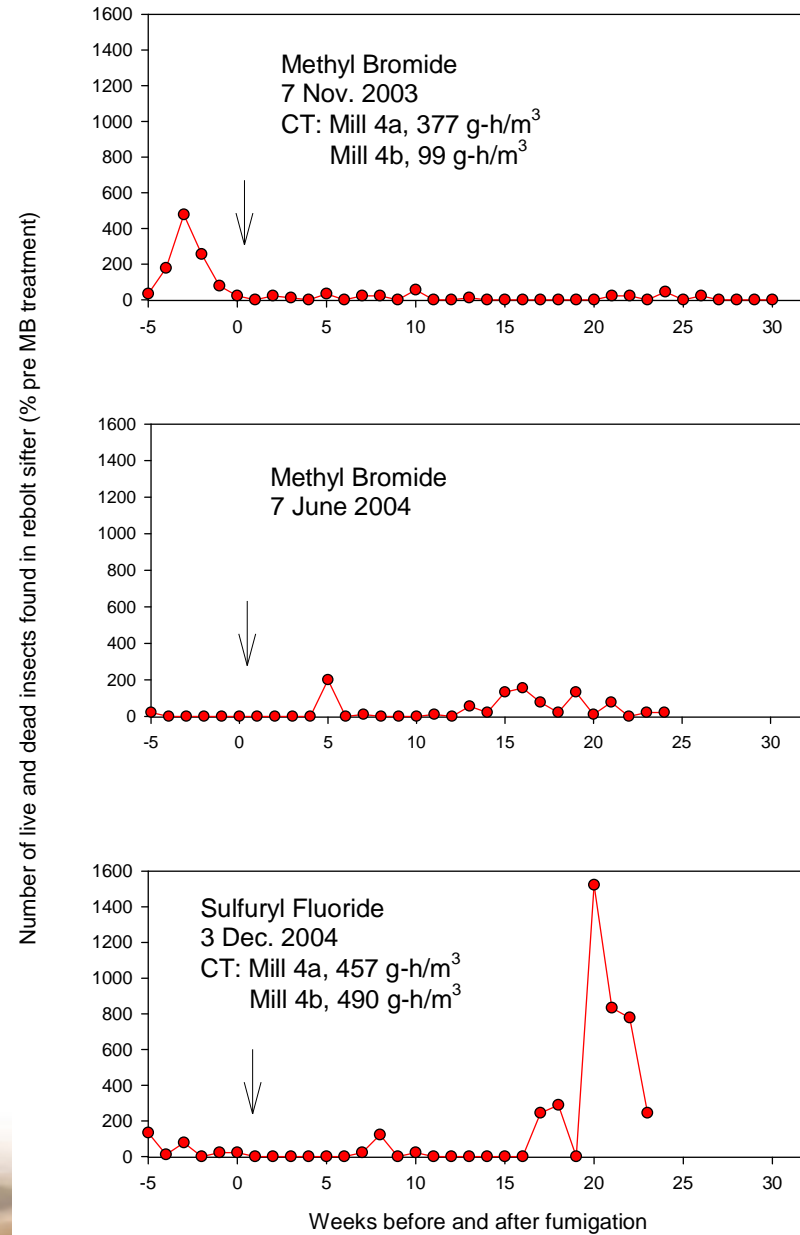




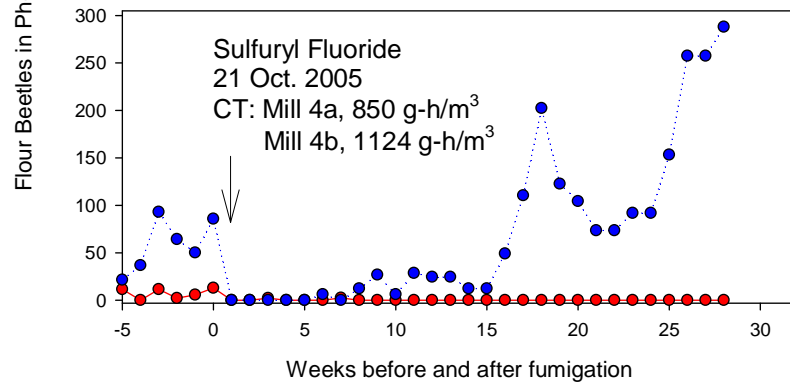
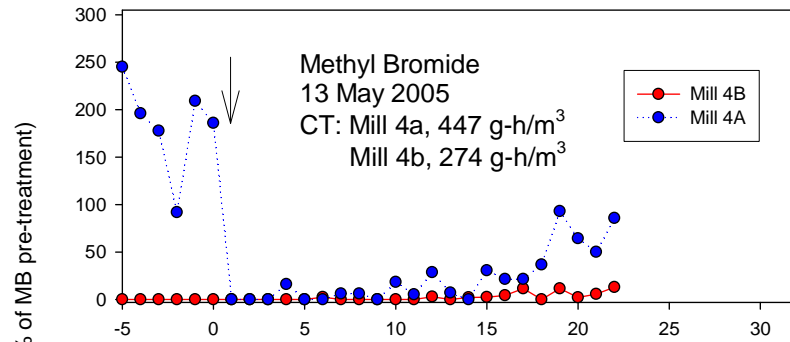
# Pheromone Trapping



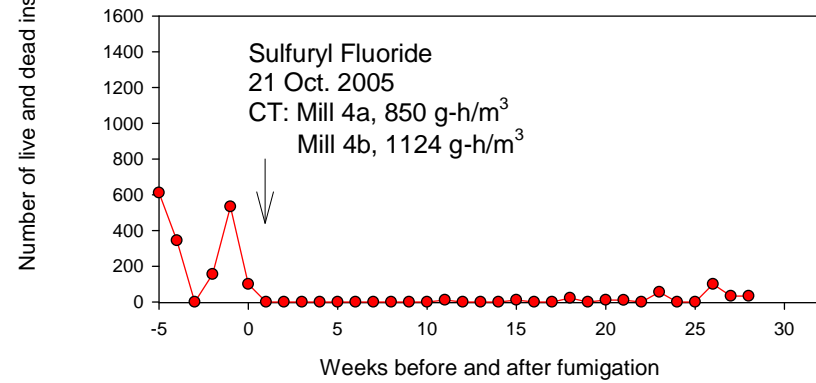
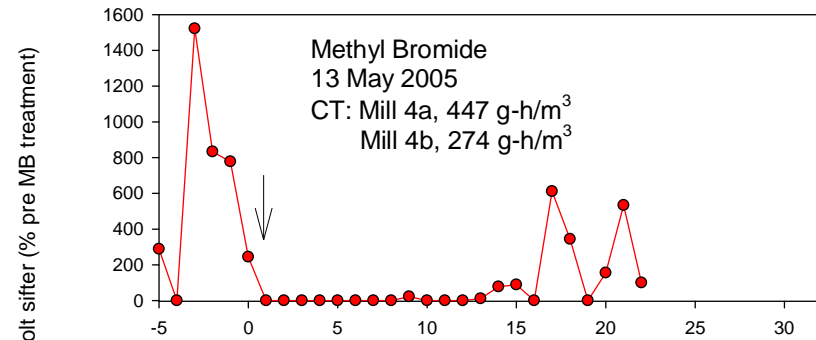
# Rebolt Sifter Tailings



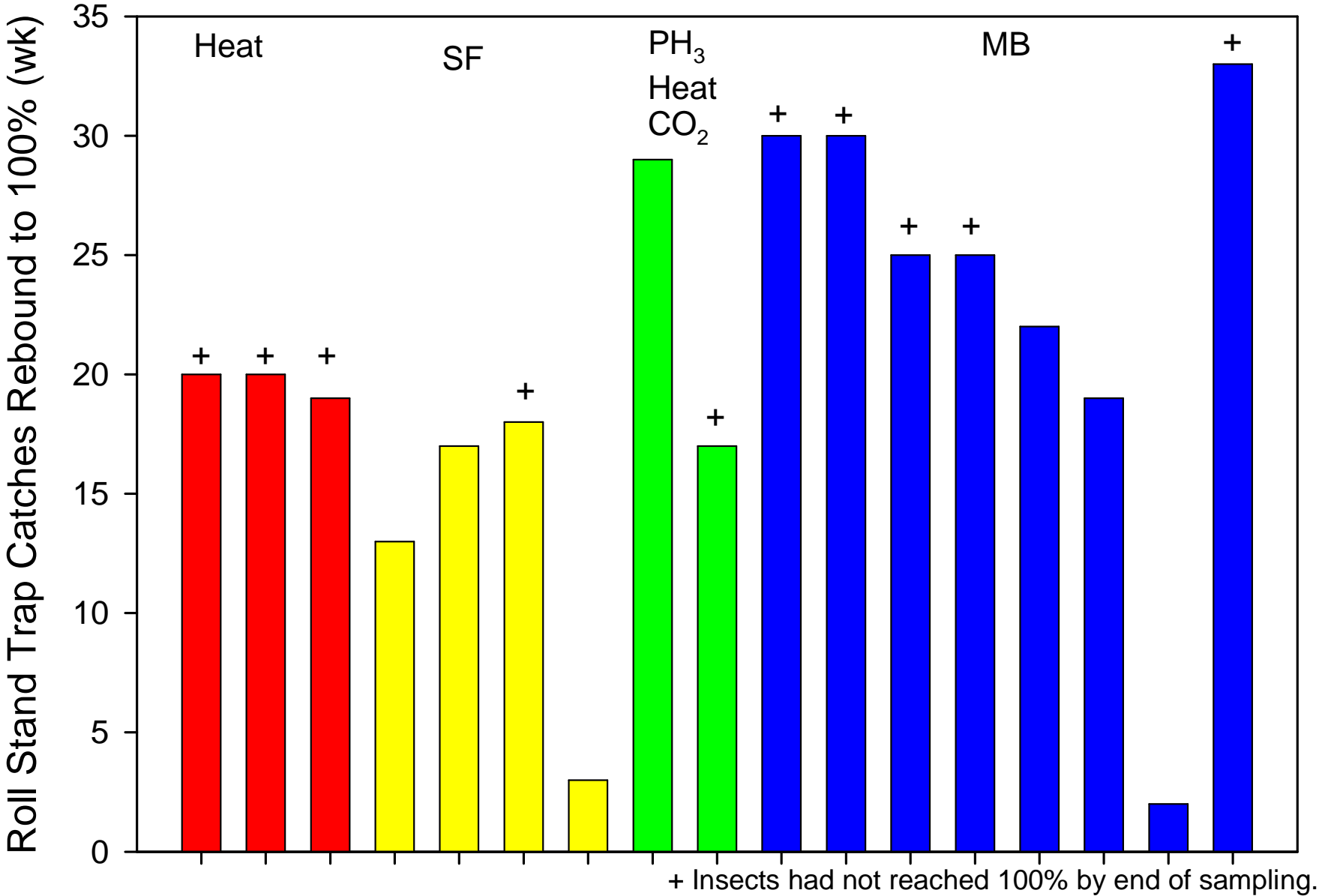
# Pheromone Trapping



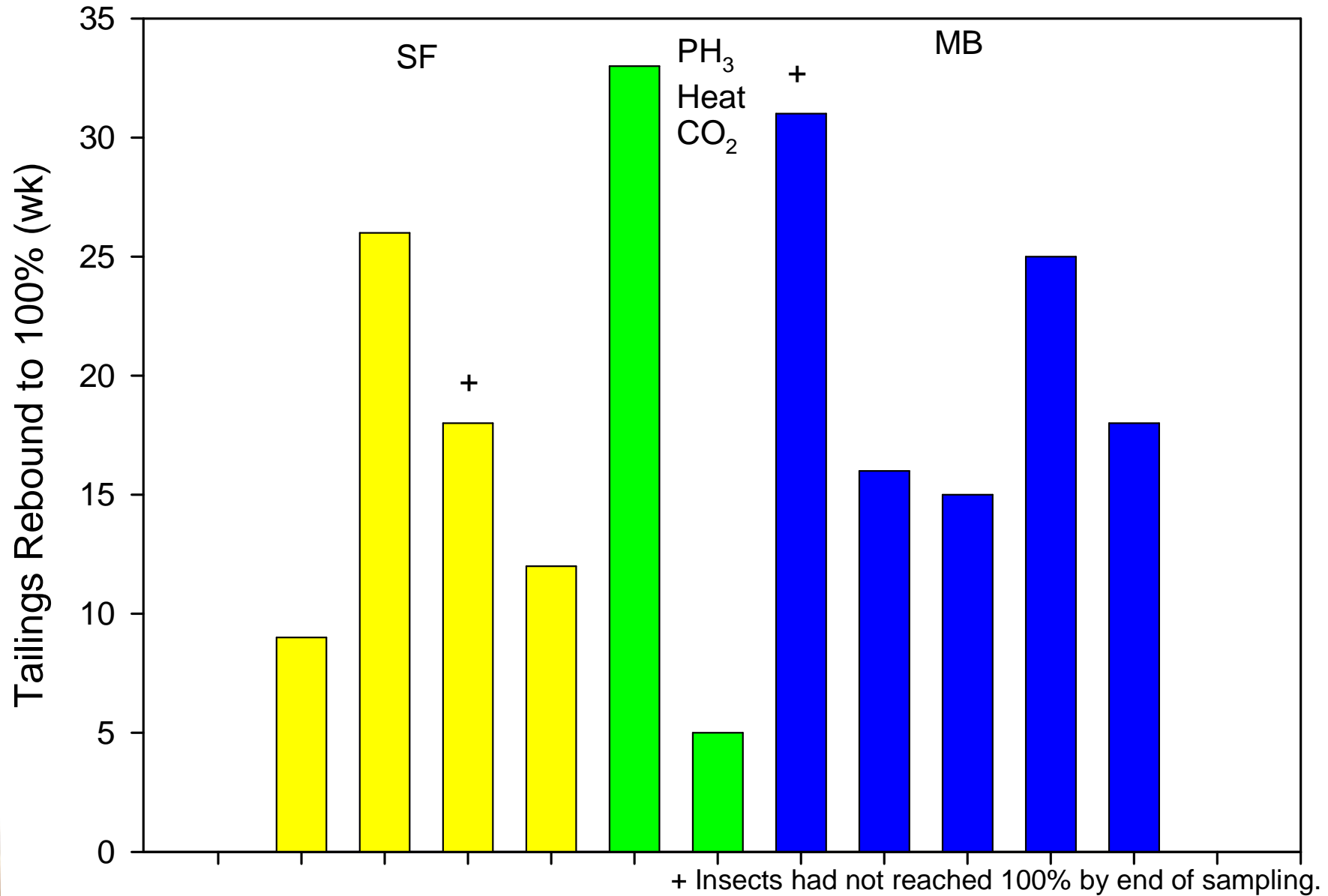
# Rebolt Sifter Tailings



# Conclusions: Traps



# Conclusions: Tailings



## Mills Difficult to Sample

- **Mills: large, complex structures.**
- **Replication is problematic.**
- **Treatments at different times of year difficult to compare.**
- **Treatments in different facilities difficult to compare.**





## Take Home Message

- **Adults in vials easy to kill**
- **Pheromone trapping gives numbers**
- **Rebolt sifter tailings variable**
- **Important to be consistent over time**



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