Interpreting Trap Capture Data

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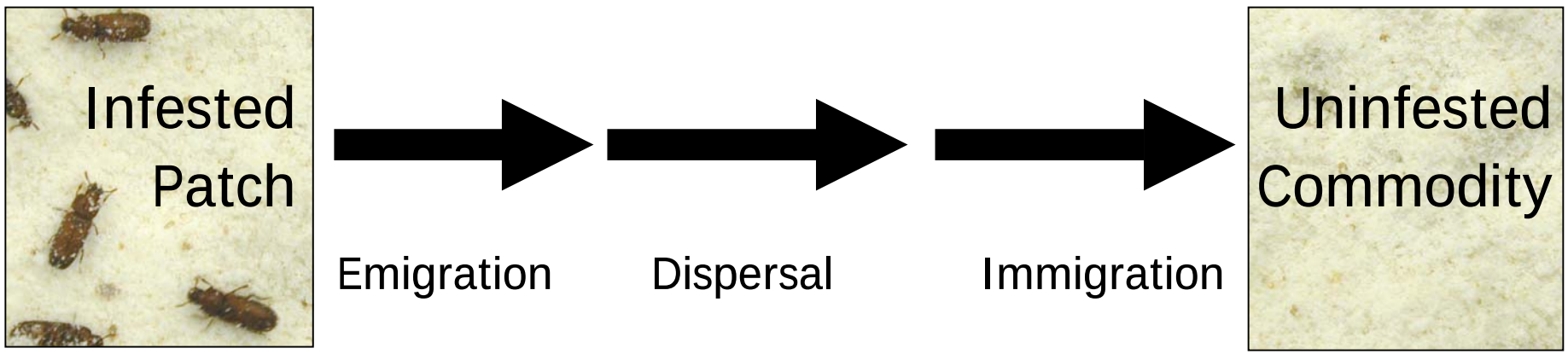
Monitoring Questions

- What pests are present?
- Are numbers increasing?
- Where are they located?
- Where did they come from?
- What is the best response?
- How effective was treatment?

The Challenges

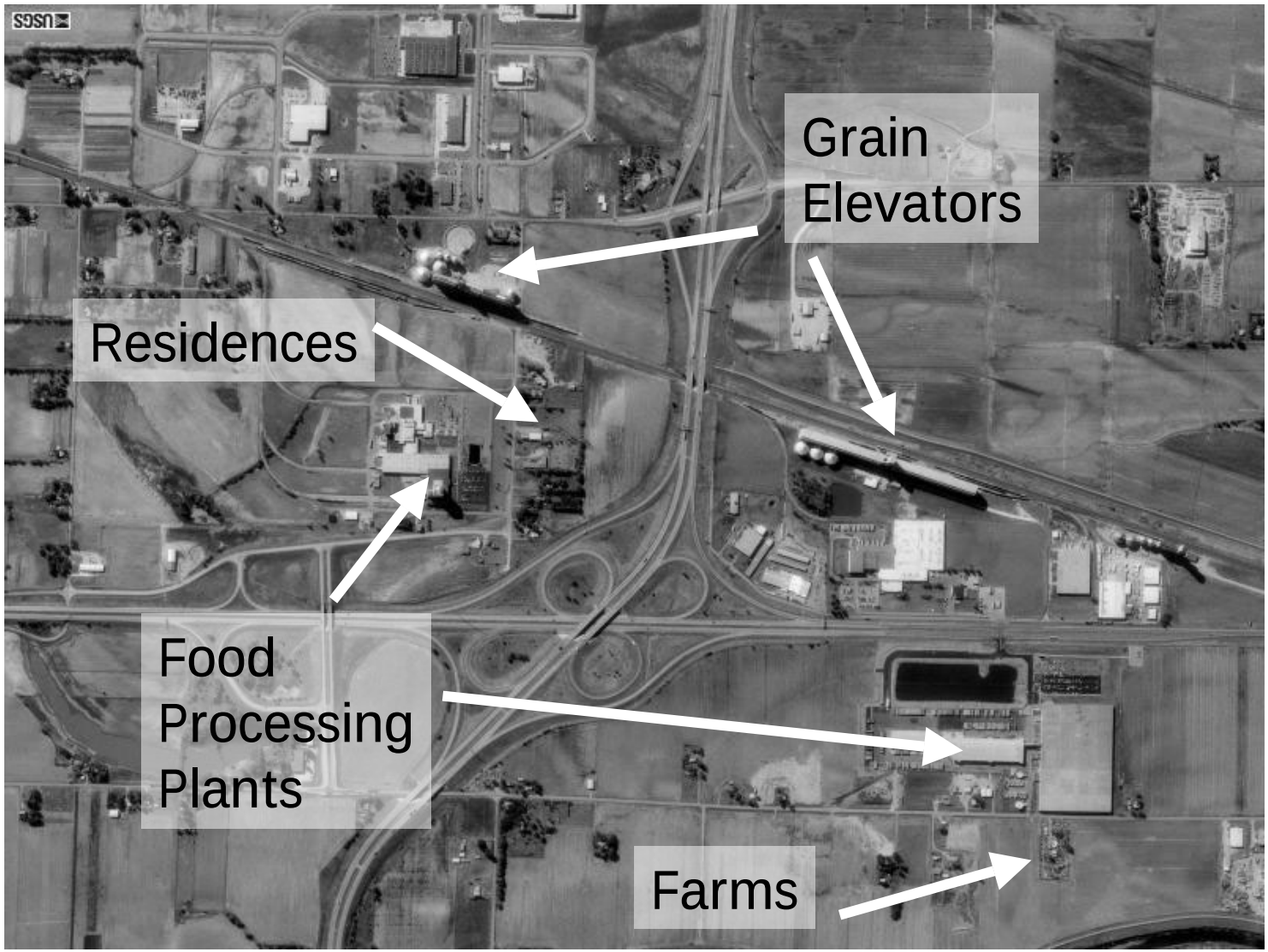
- Stored-product insects are adapted to live in and around human structures
- High degree of diversity among sites
- Hide in locations that are difficult to access
- Dynamic environments:
  - human movement of pests
  - active insect dispersal

Stored-product pests actively move among patches of resource in search of food, mates or places to lay eggs



Resource Patches

Resource Patches



Potential IPM Implications

Sanitation
Fumigation/Heat
Crack & Crevice
Biological Control
Structural Modification

Fumigation/Heat
Surface/Spot Treatments
Fogging
Structural Barriers
Attracticides

Barriers
Resistant Packaging
Repellents
Product Management

Emigration

Dispersal

Immigration

Direct Sampling

Pheromone Monitoring

Direct Sampling

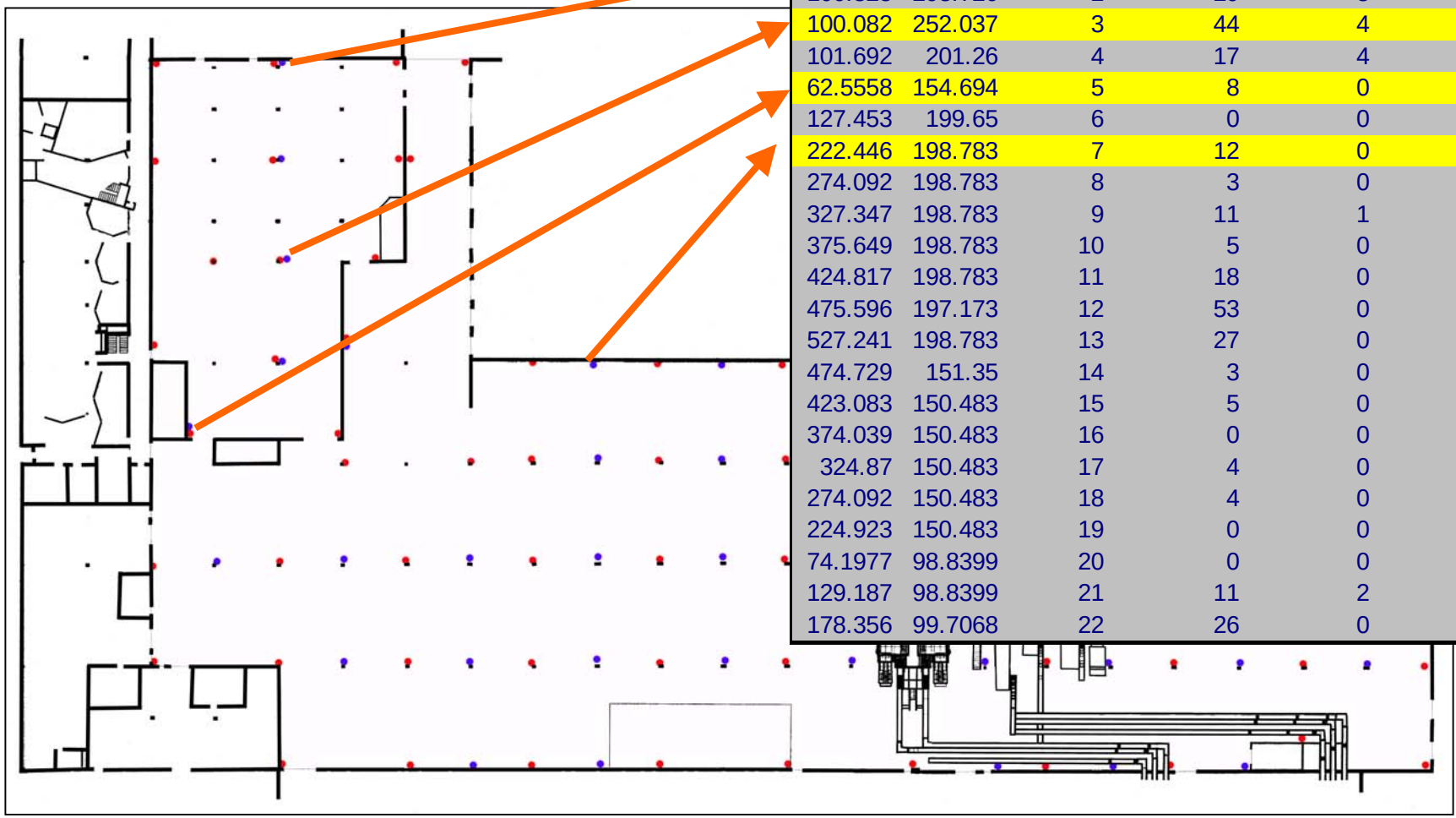
To more effectively monitor and target pest management, need to understand stored-product pest behavior and ecology in and around food facilities

Trap Interpretation

Trap capture interpretation

- High pheromone trap captures can indicate:
  - Proximity of infested material
  - Vulnerability to infestation
  - Routes of insect movement
- Trap capture also influenced by factors other than just pest density
- Follow up using additional monitoring or direct inspection is often needed

Create a data sheet



X-axis	Y-axis	Trapno	WB072299	CB072299	FB072299
100.825	347.893	1	228	2	1
100.825	298.726	2	29	3	3
100.082	252.037	3	44	4	5
101.692	201.26	4	17	4	4
62.5558	154.694	5	8	0	0
127.453	199.65	6	0	0	0
222.446	198.783	7	12	0	2
274.092	198.783	8	3	0	2
327.347	198.783	9	11	1	1
375.649	198.783	10	5	0	3
424.817	198.783	11	18	0	2
475.596	197.173	12	53	0	0
527.241	198.783	13	27	0	1
474.729	151.35	14	3	0	1
423.083	150.483	15	5	0	0
374.039	150.483	16	0	0	0
324.87	150.483	17	4	0	5
274.092	150.483	18	4	0	2
224.923	150.483	19	0	0	0
74.1977	98.8399	20	0	0	0
129.187	98.8399	21	11	2	4
178.356	99.7068	22	26	0	1

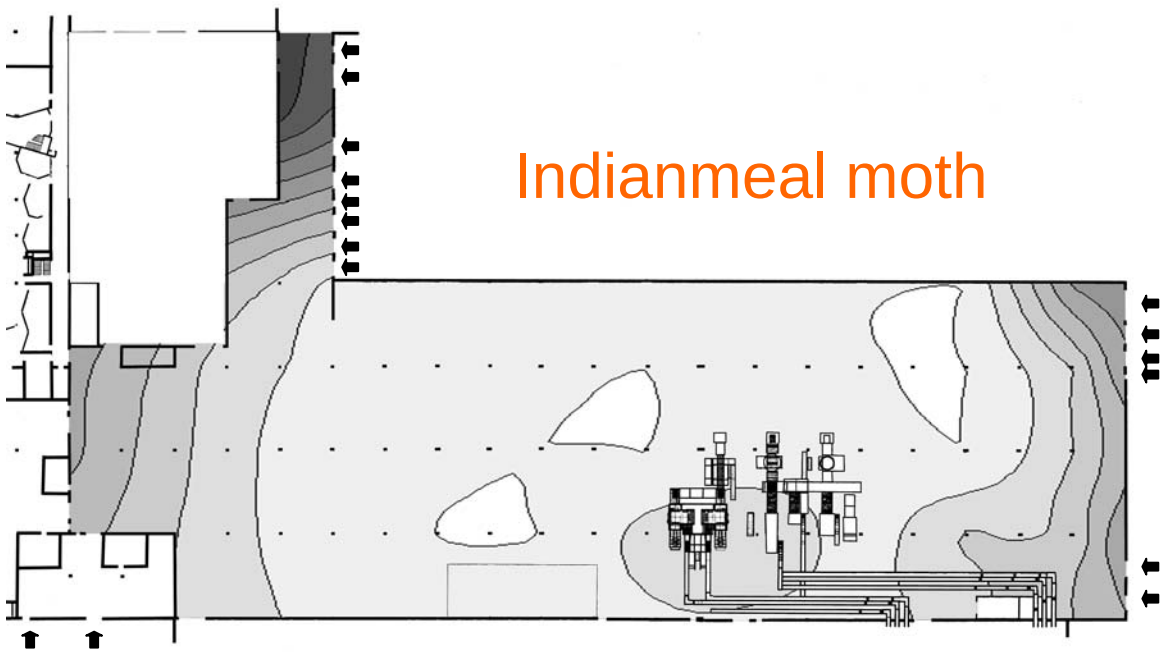
Visualization and Interpretation

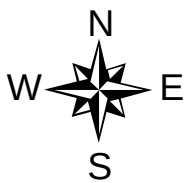
- Graph averages over time to look at population trends and response to treatment
- Look at the spatial distribution of insects to target additional monitoring and pest management
- Evaluate population trends in different locations to identify potential pest sources

Visualization of spatial distribution

- Spatial mapping of trap data has been used in a variety of stored-product situations
- Contour or 3D surface mapping and bubble plots
- A number of computer programs that can be used to visualize XYZ data. For example…
  - Surfer (Golden Software) is relatively easy to use software for contour mapping
  - ArcView and ArcGIS (ESRI) are more complex programs for spatial analysis
  - Many graphing programs can generate bubble plots (e.g., Excel (Microsoft), SigmaPlot (SPSS))

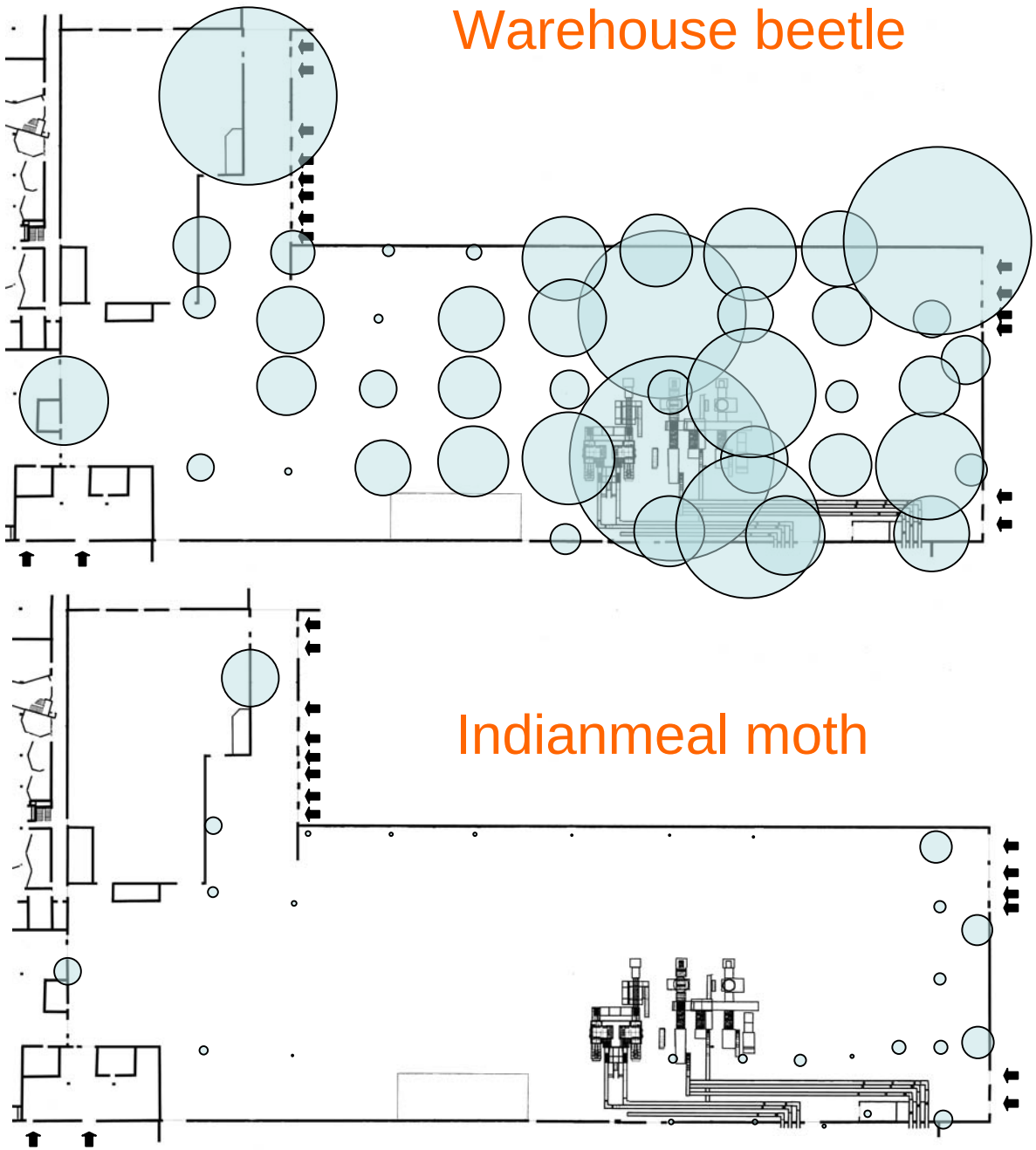
Spatial Distribution of trap capture data: Contour maps





15 m

Spatial Distribution of trap capture data: Bubble plots

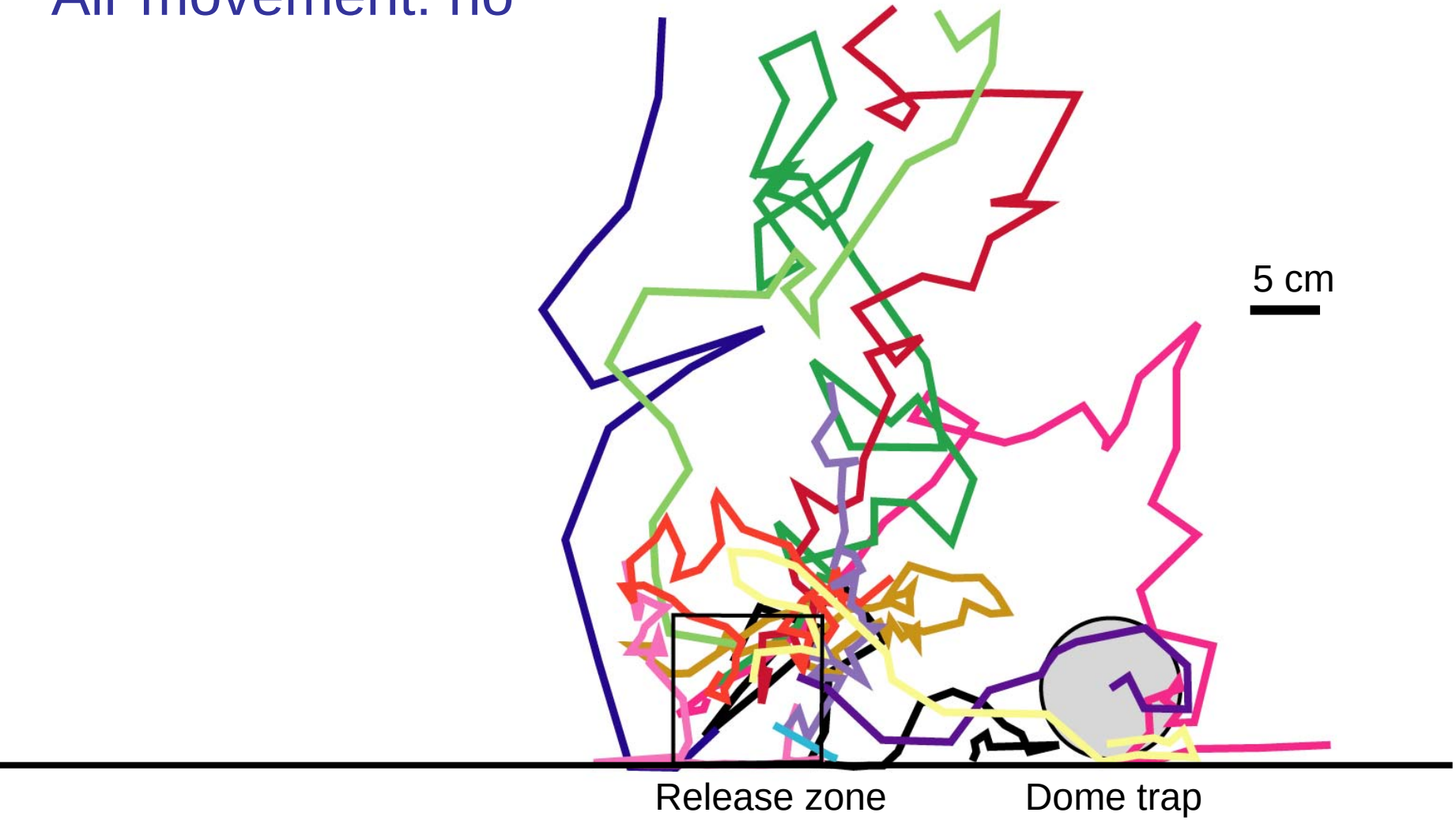


Environmental Influences on Pheromone Trap Capture

- Factors other than insect density also influence trap capture number
  - Type of trap
  - Structures around the trap
  - Amount and direction of air movement
- Example: Red flour beetle response to pitfall (walking insect) traps such as the Dome trap
- Questions have been raised about the effectiveness of these traps/attractants at capturing beetles

Species: *T. castaneum* (Lab strain)
Sex: female
Attractant: pheromone/food oil
Air movement: no

Each colored line represents the movement path of a single beetle



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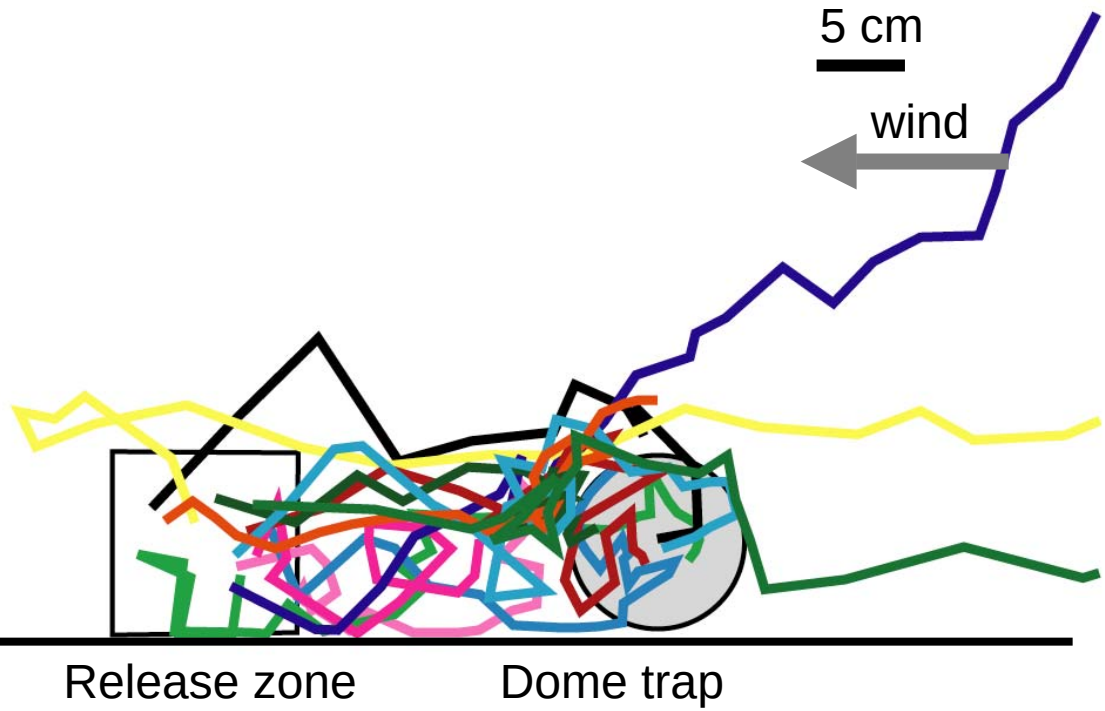


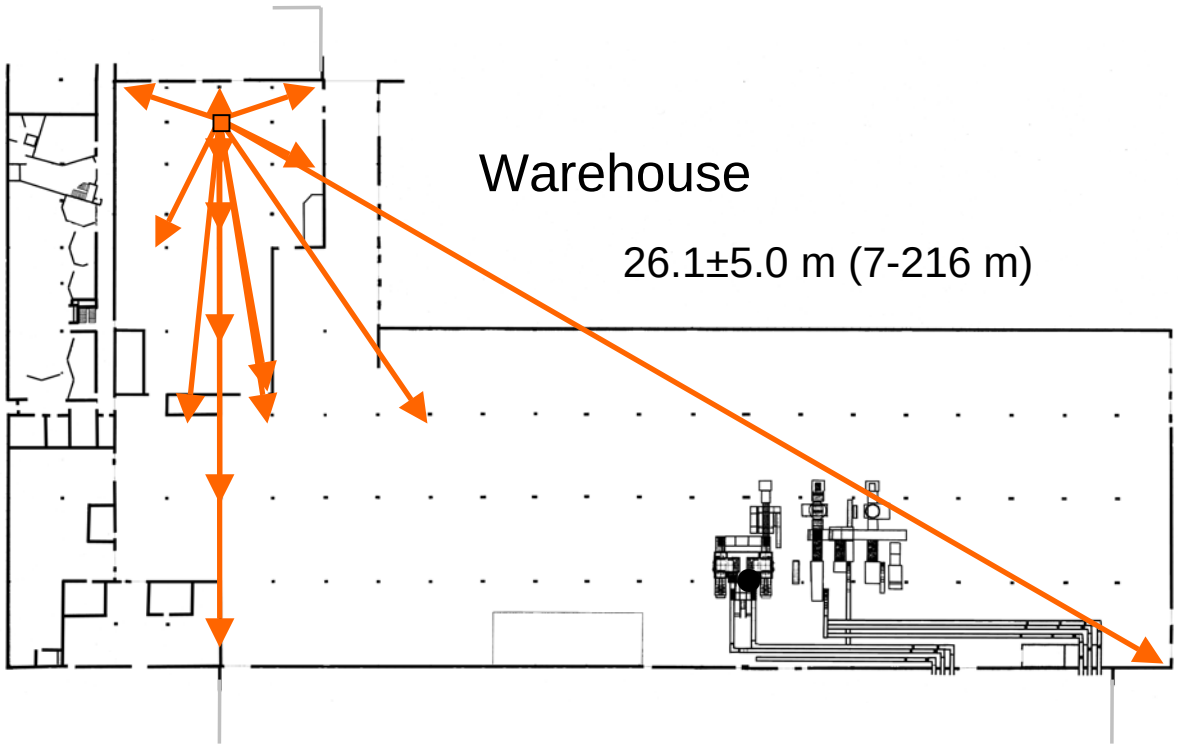
Insect Movement Patterns

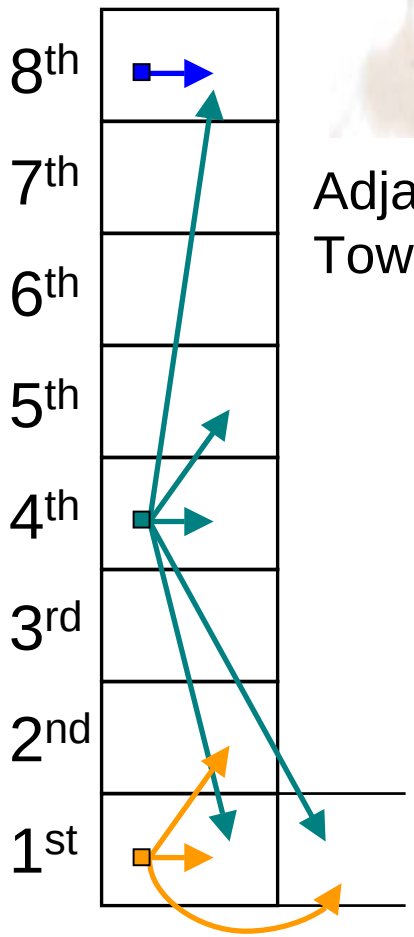
- Insect movement before being captured in a trap impacts interpretation of the results
- Species differences in mobility
- For many species dispersal distances and movement patterns are not well understood
- Sources may be inside or outside facility
- Follow-up (additional trapping, visual inspection, self-mark recapture) is needed to determine source(s) of insects captured in traps

Mark-Recapture

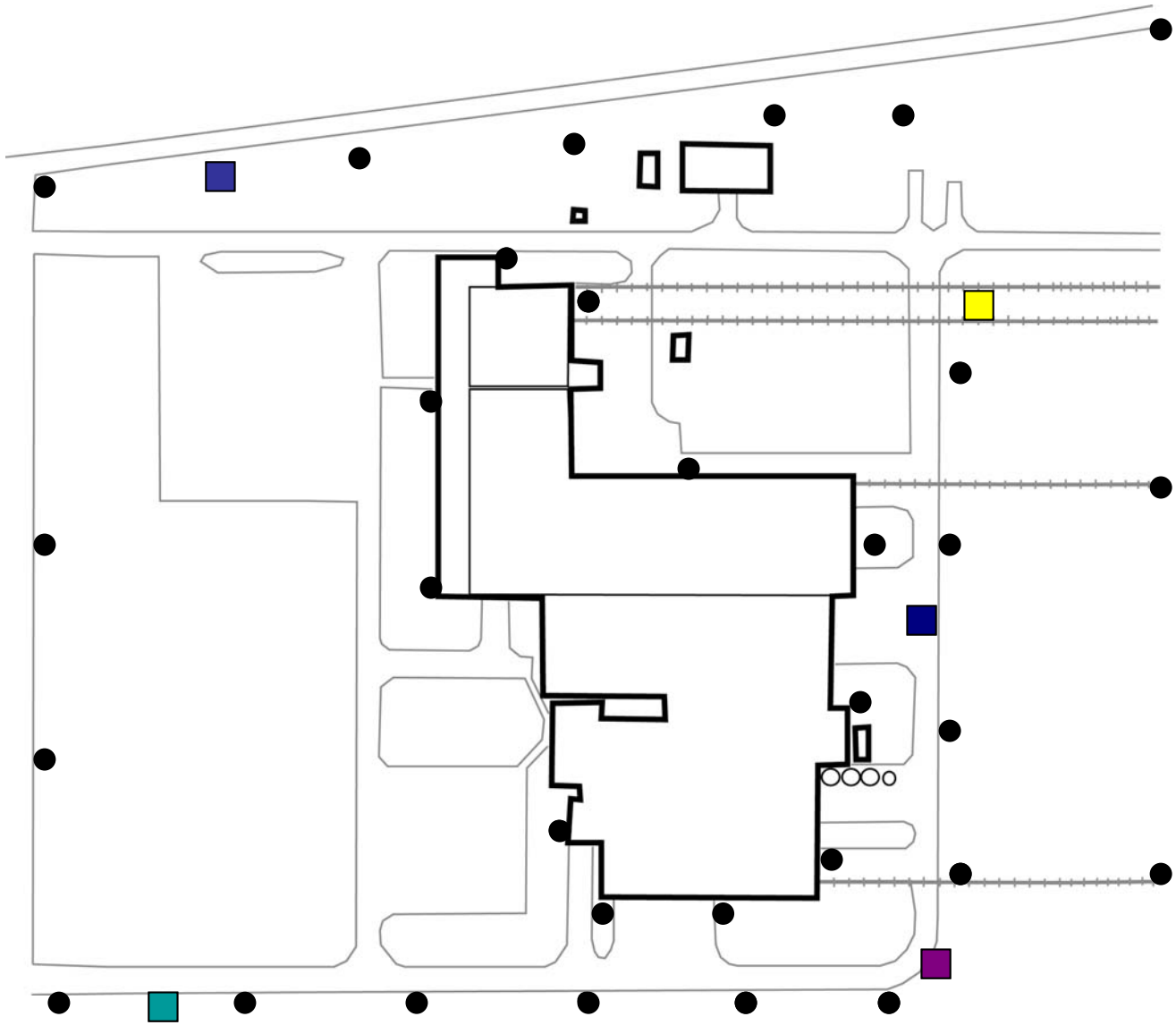
- Self-mark/recapture
- Evaluate movement and immigration
- Self-marking stations contain pheromone lures and fluorescent powder
- Marked insects -
  - Leave station
  - Recaptured in pheromone traps
  - Detected using an ultraviolet lamp

Warehouse beetle movement patterns in a food processing facility



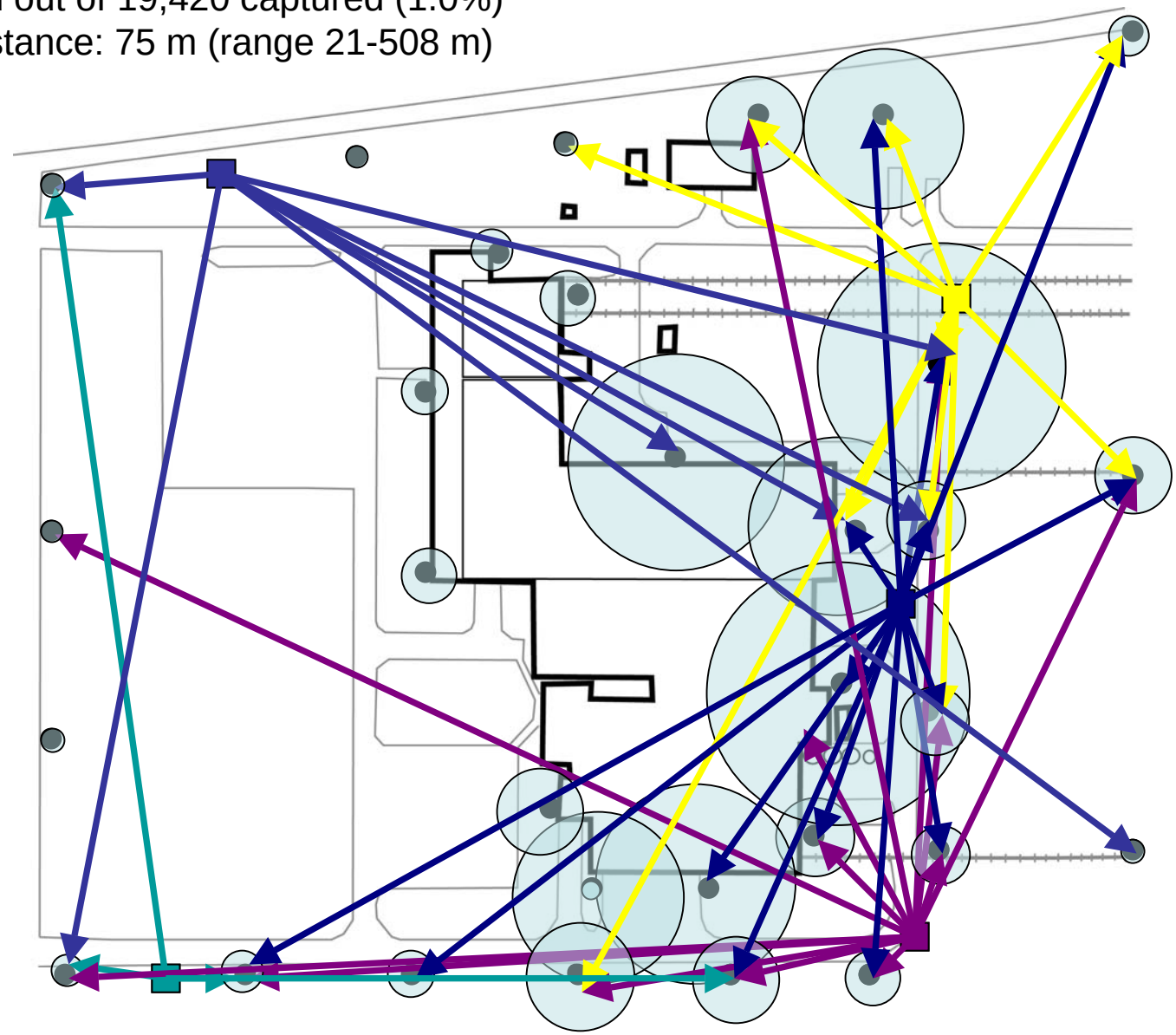


Traps and Marking Stations



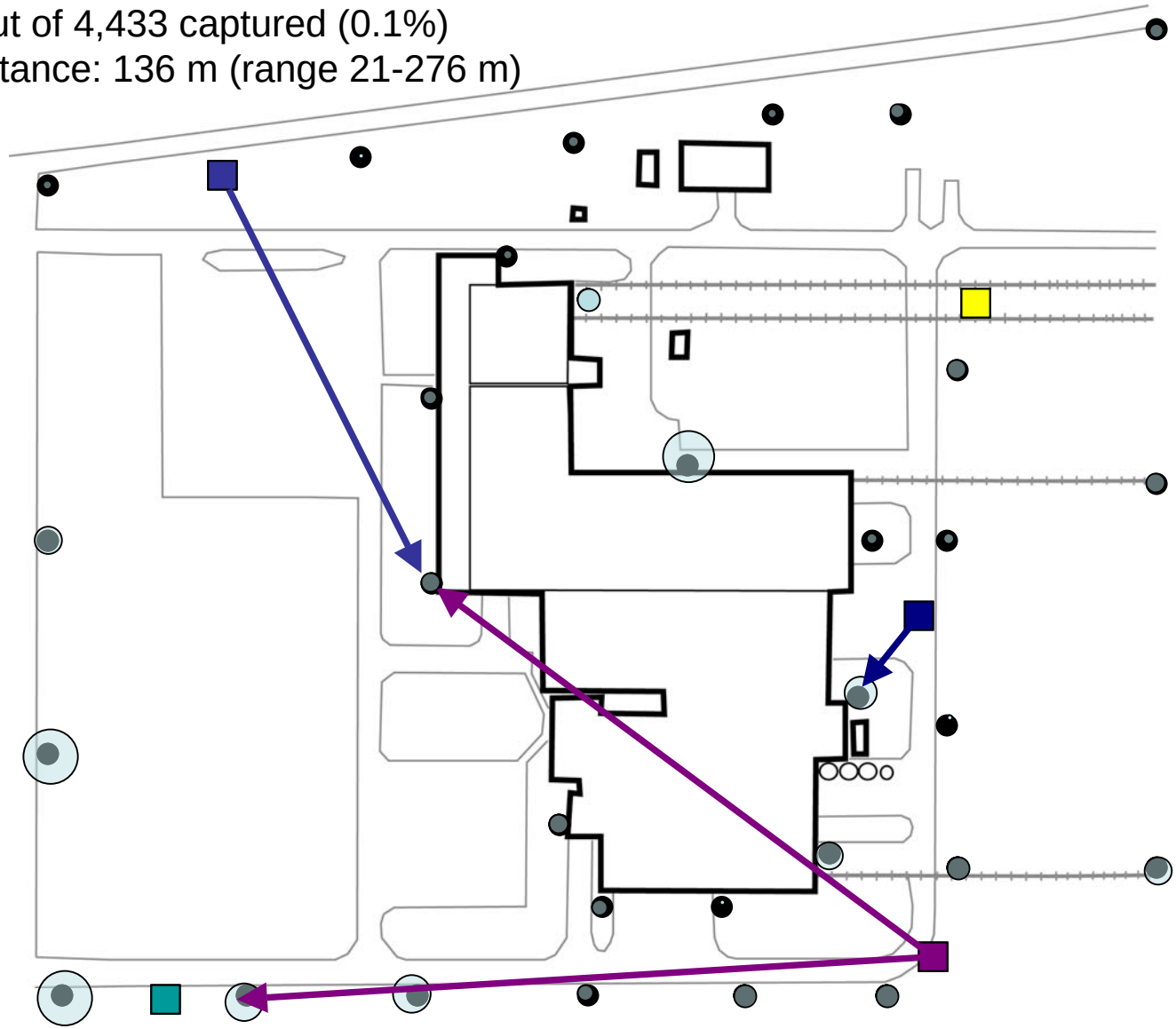
Warehouse beetle

203 marked out of 19,420 captured (1.0%)
Average distance: 75 m (range 21-508 m)

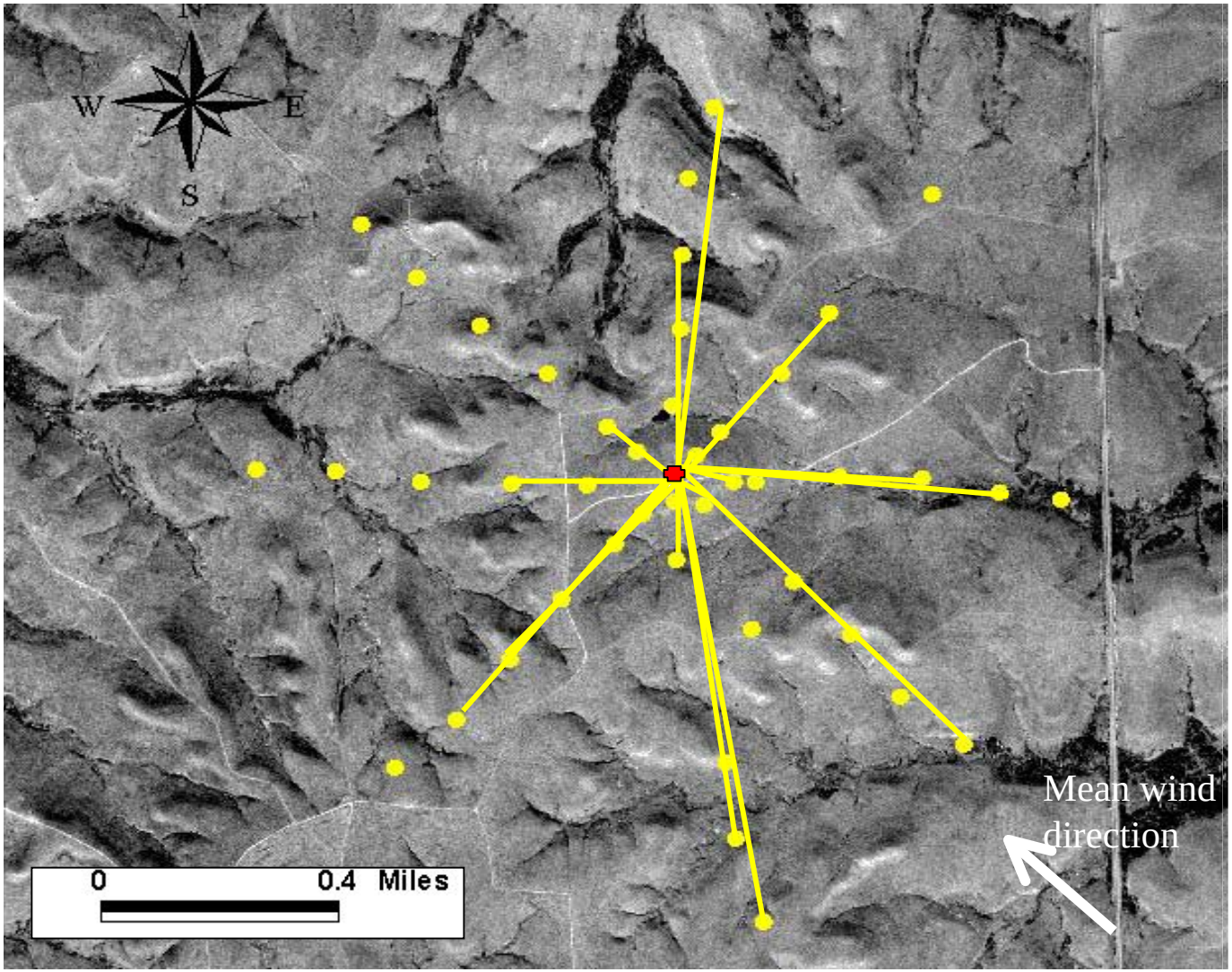


Indianmeal moth

6 marked out of 4,433 captured (0.1%)
Average distance: 136 m (range 21-276 m)



Lesser Grain Borer Dispersal



Number of marked beetles

- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 8

Mean distance: 446 ± 318 m (range 50-1000)

No significant directionality in dispersal

Recapture sex ratio: approximately 50:50

No difference between the sexes in dispersal distance

Movement between indoors and outdoors can be important

Some species captured around openings:

Indianmeal moth > foreign grain beetle > hairy fungus beetle > warehouse beetle > rusty grain beetle > lesser grain borer

Flour Mill Case Study

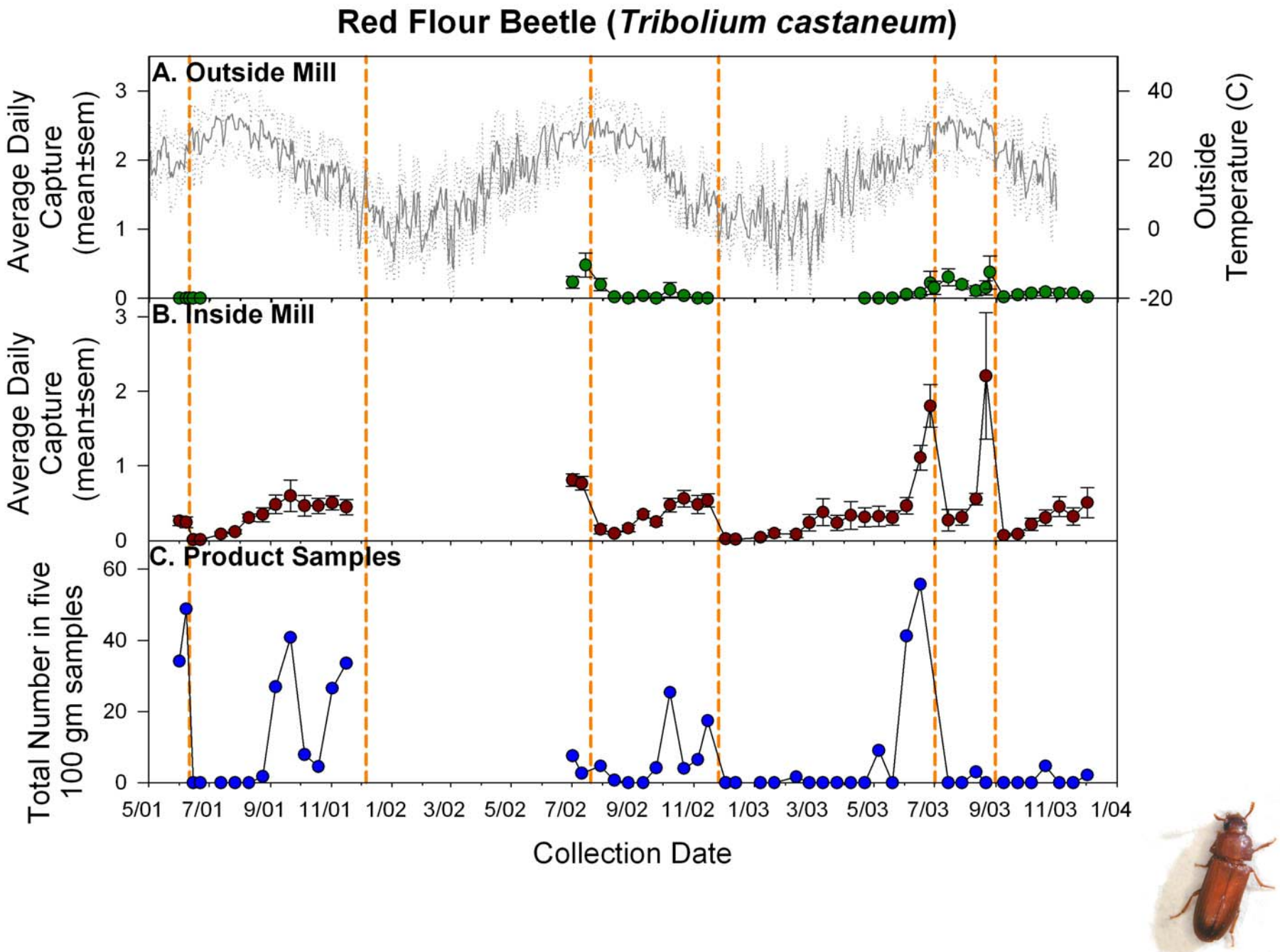
Flour Mill Study Site

- Five floor flour mill in Kansas
- The mill was monitored from:
  - June 2001 until November 2001
  - July 2002 until October 2003
- Six fumigations were performed
- Eleven trap locations on each floor
- Eight trap locations around the outside of the building
- Product samples collected at five locations (5 mids, 6 mids, 7 mids, purifiers, trash bucket)

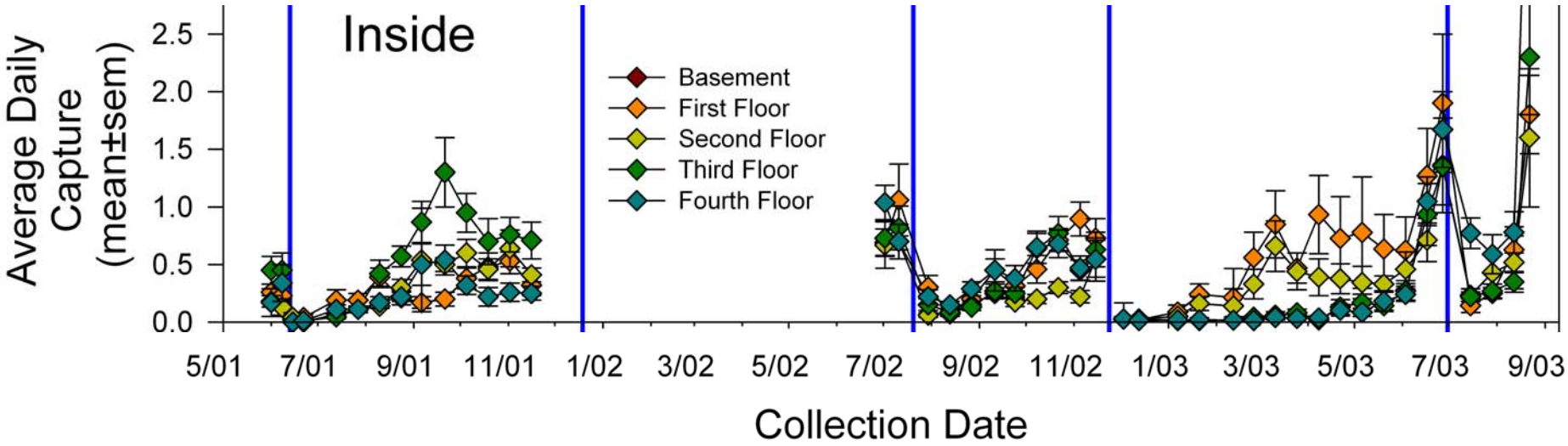

Flour Mill Study Site
Mill
Warehouses
Grain Elevators
Processing

Pheromone Monitoring

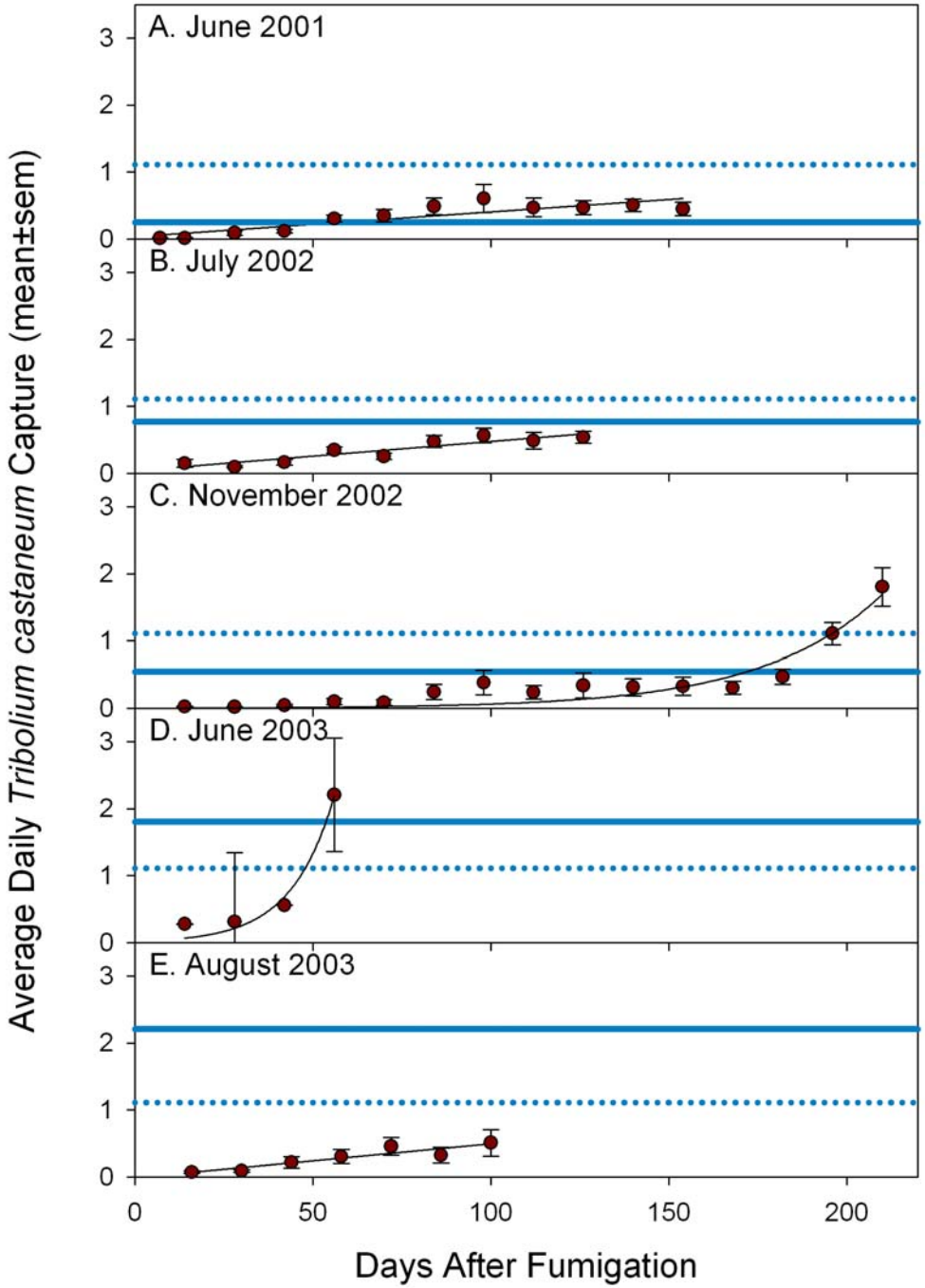
- Red flour beetle (*Tribolium castaneum*)
- Warehouse beetle (*Trogoderma variabile*)
- Indian meal moth (*Plodia interpunctella*)

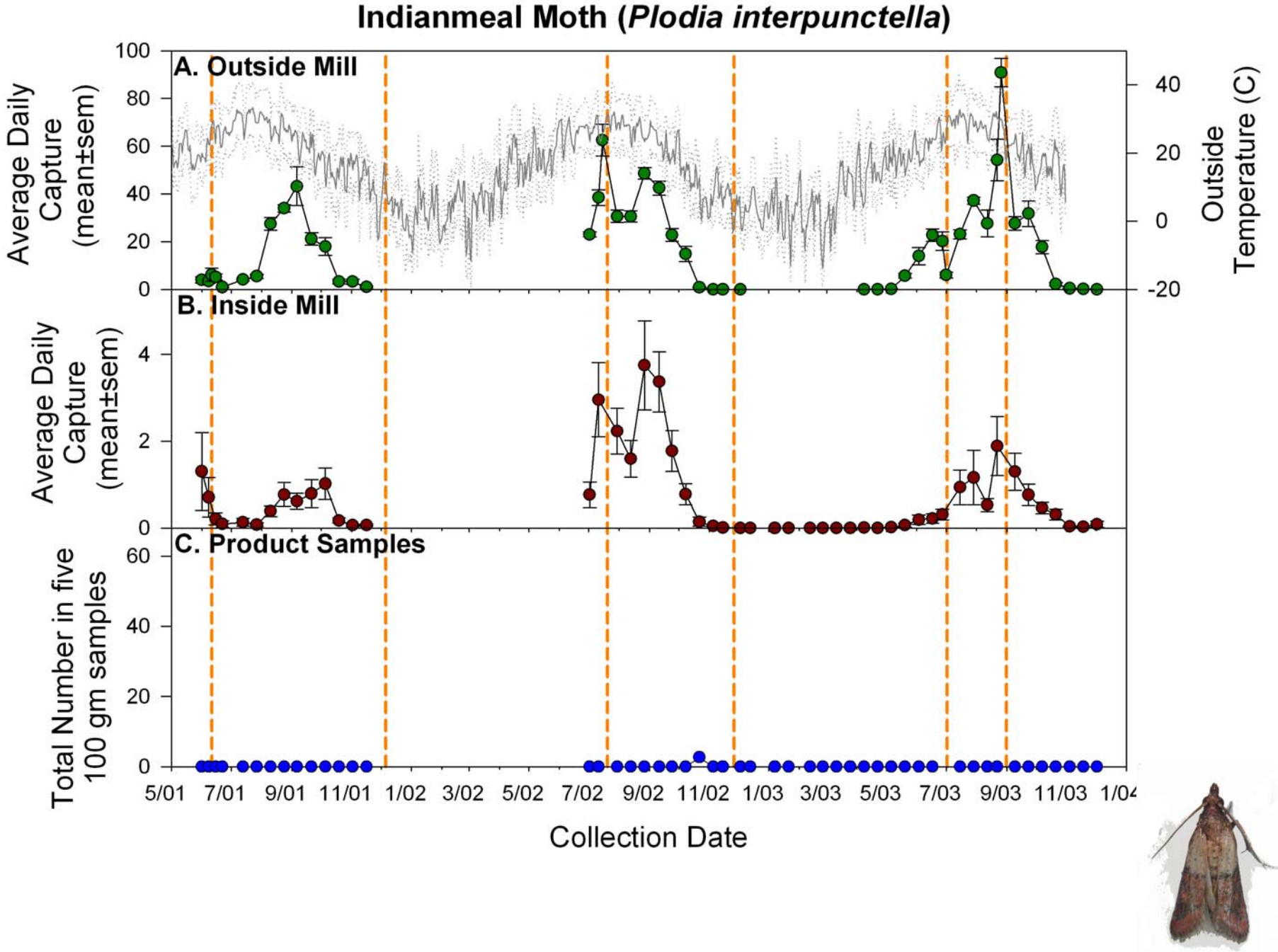

Red Flour Beetle (*Tribolium castaneum*)
A. Outside Mill
B. Inside Mill
C. Product Samples
Average Daily Capture (mean±sem)
Outside Temperature (C)
Total Number in five 100 gm samples
Collection Date
5/01
7/01
9/01
11/01
1/02
3/02
5/02
7/02
9/02
11/02
1/03
3/03
5/03
7/03
9/03
11/03
1/04

Red flour beetle (*Tribolium castaneum*)

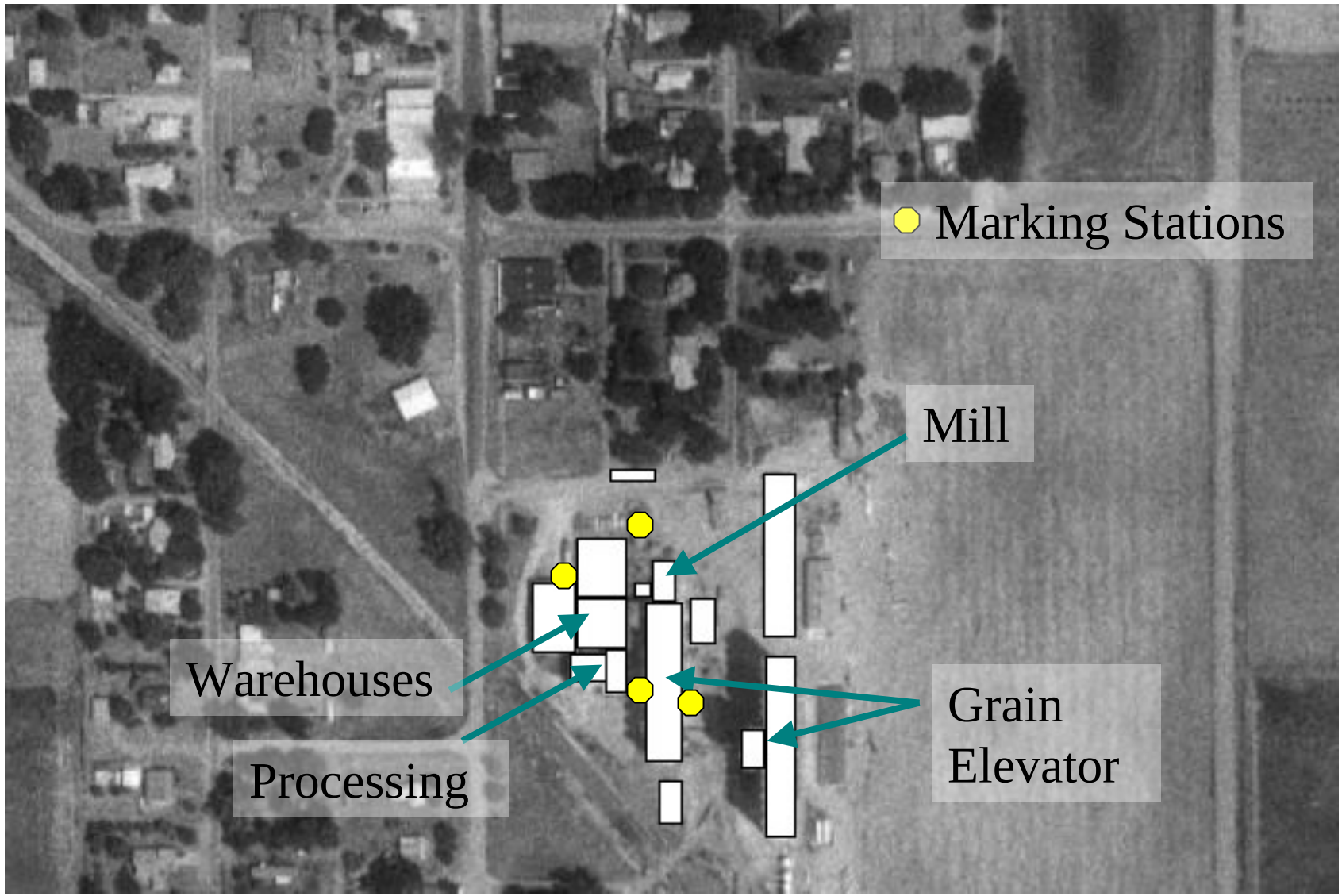


Red flour beetle: resurgence after treatment



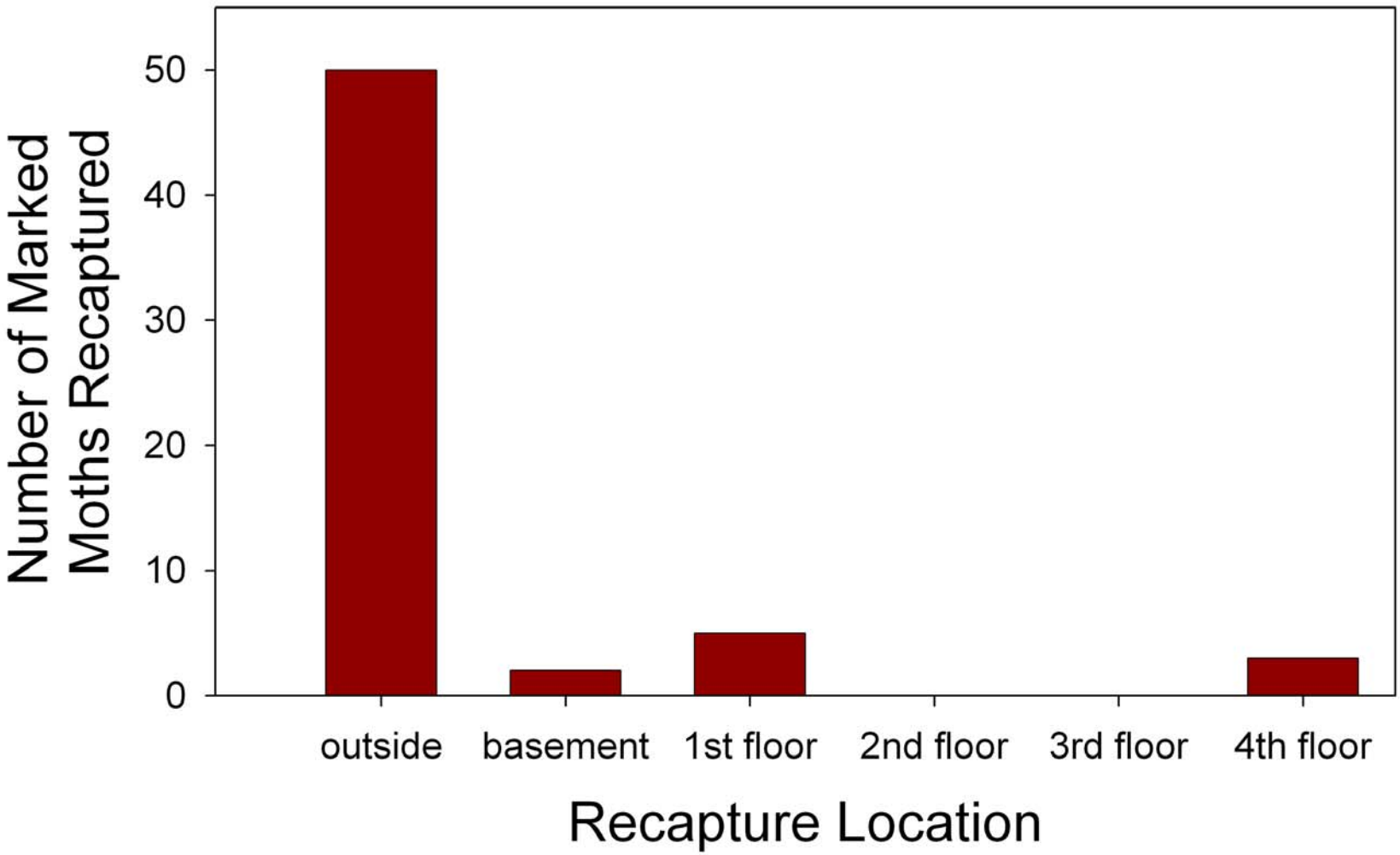

Indianmeal Moth (*Plodia interpunctella*)
A. Outside Mill
B. Inside Mill
C. Product Samples
Average Daily Capture (mean±sem)
Average Daily Capture (mean±sem)
Total Number in five 100 gm samples
Outside Temperature (C)
100
80
60
40
20
0
4
2
60
40
20
0
40
20
0
-20
5/01
7/01
9/01
11/01
1/02
3/02
5/02
7/02
9/02
11/02
1/03
3/03
5/03
7/03
9/03
11/03
1/04
Collection Date

Self-Marking Station Locations

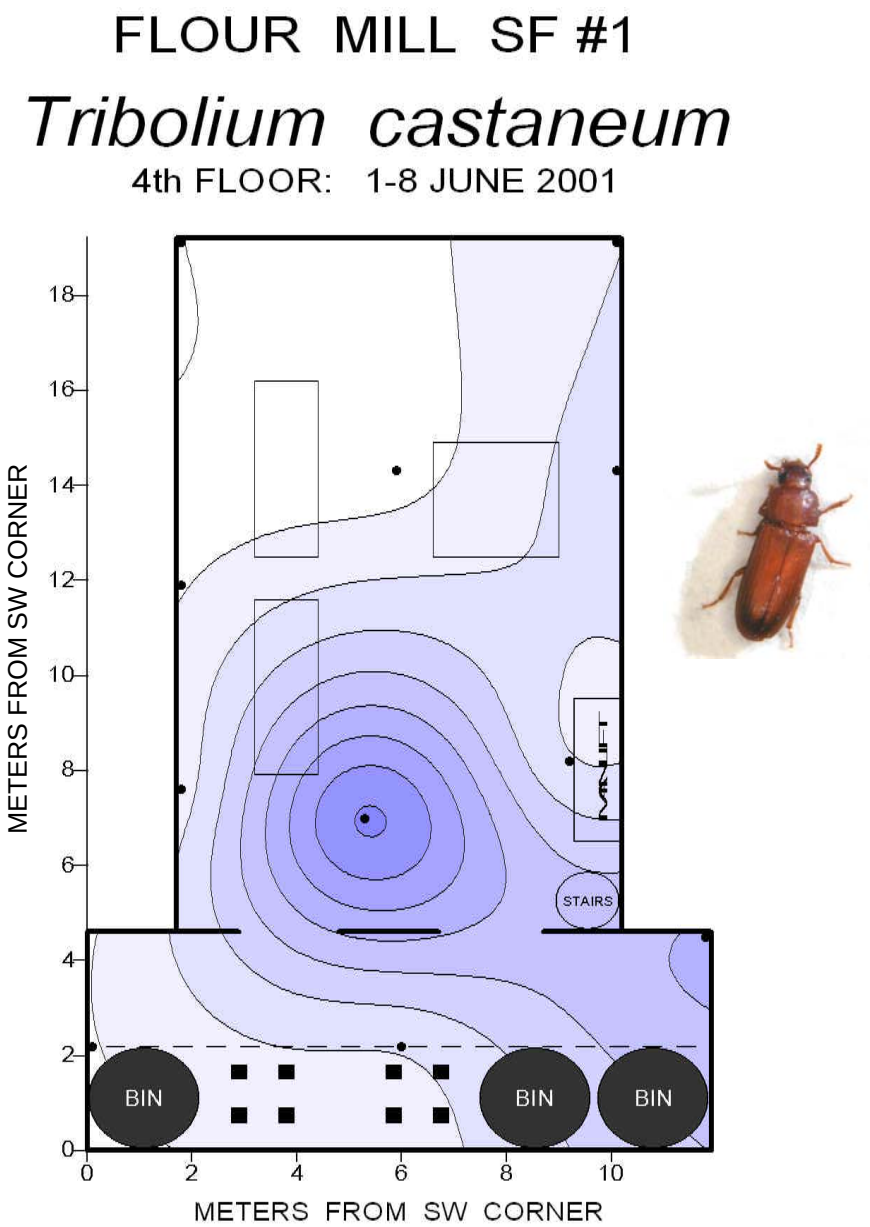


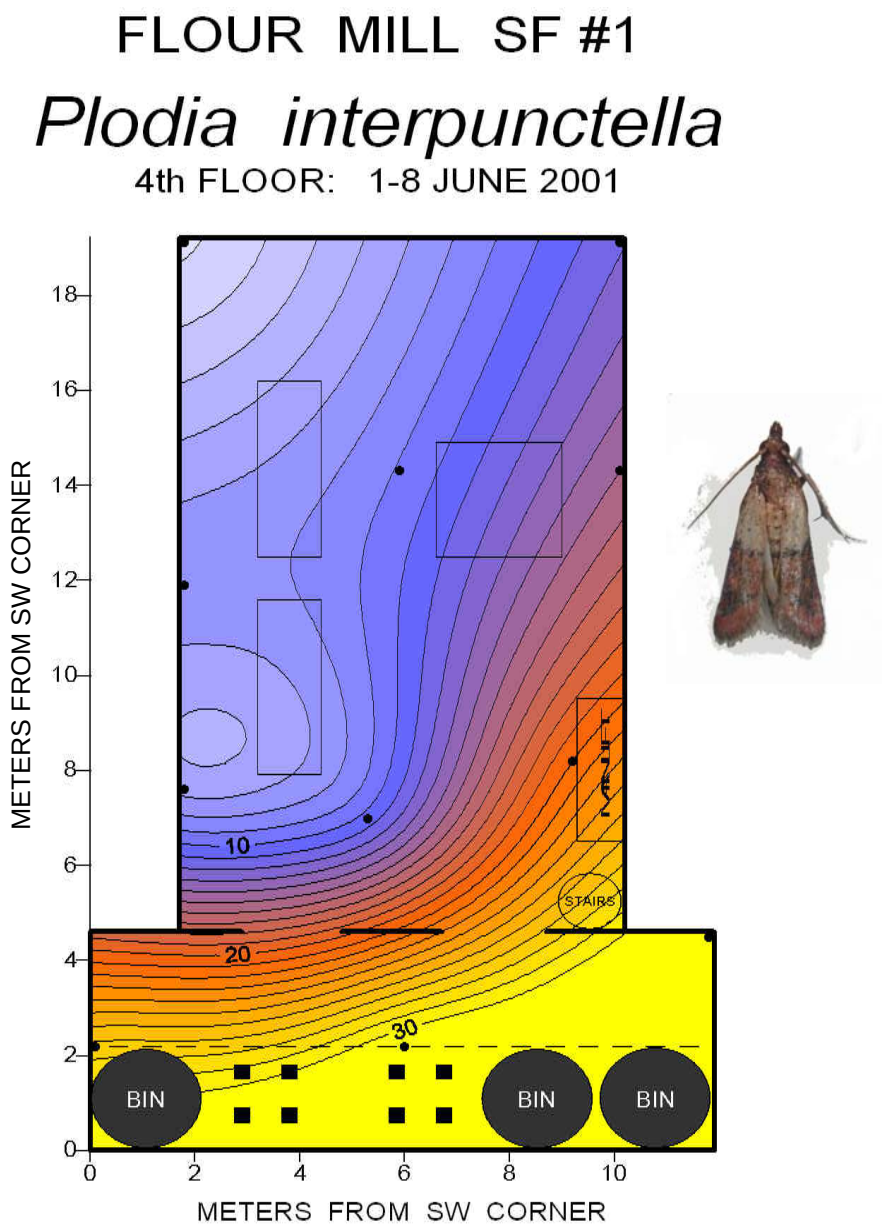
Indian Meal Moth Self Mark-Recapture

(estimated 1370 individuals marked)

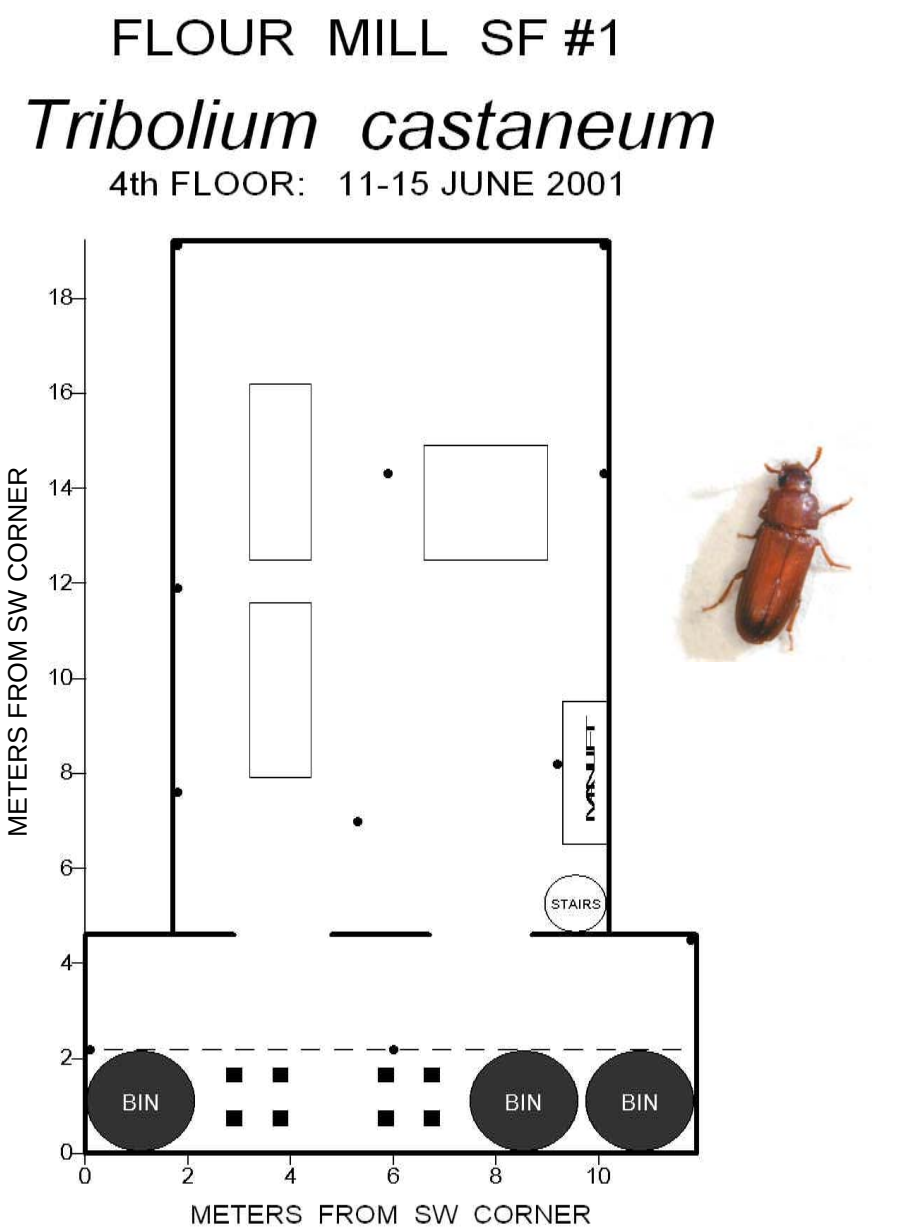


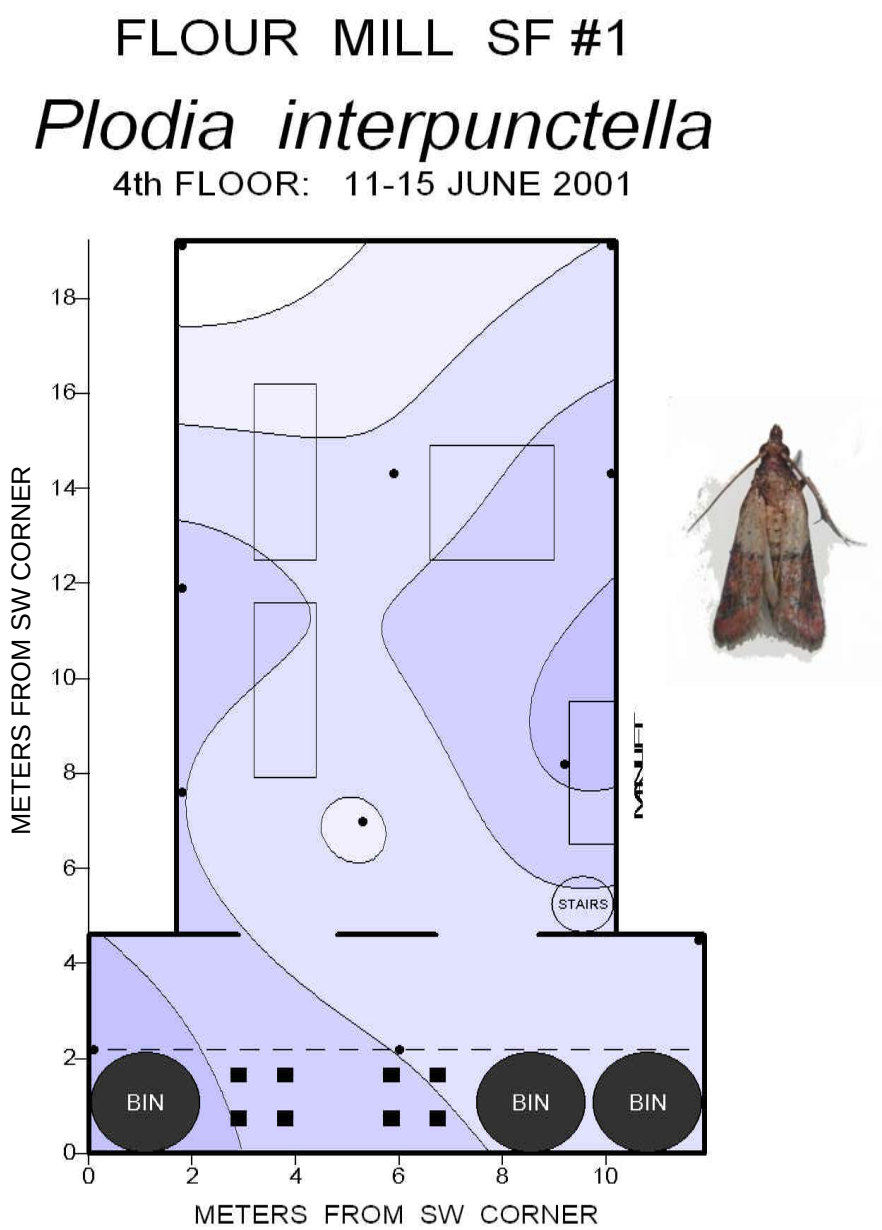
Week before fumigation





Week after fumigation

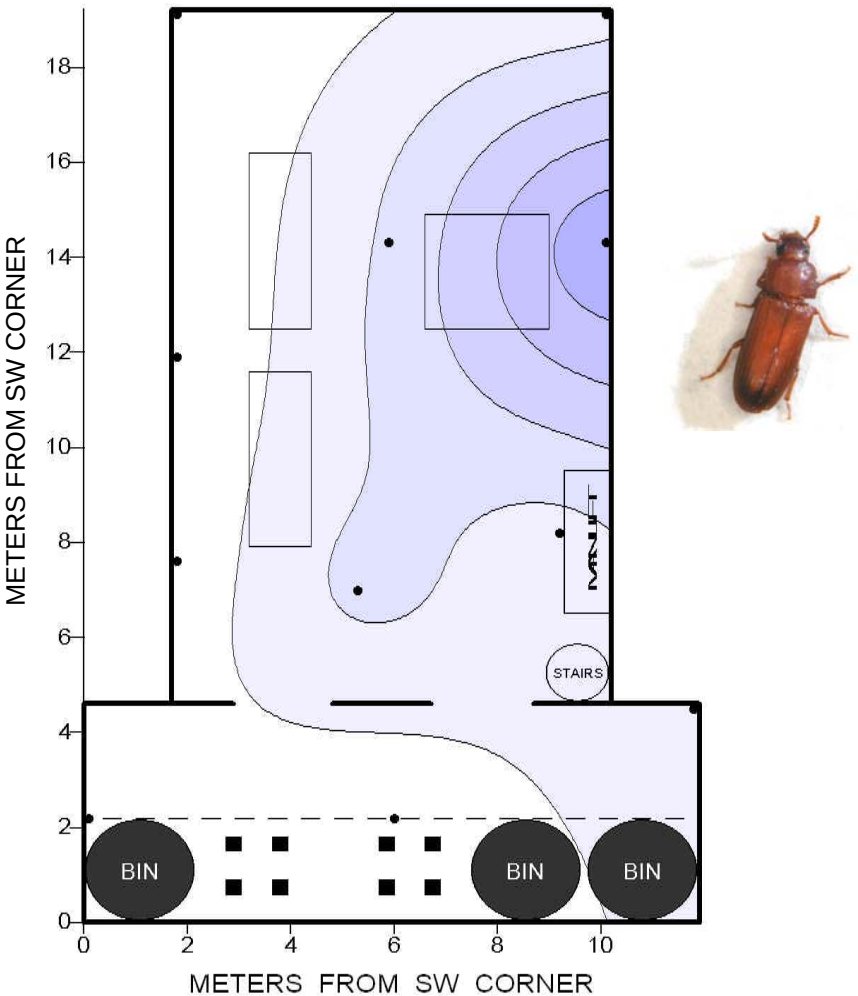




FLOUR MILL SF #1

Tribolium castaneum

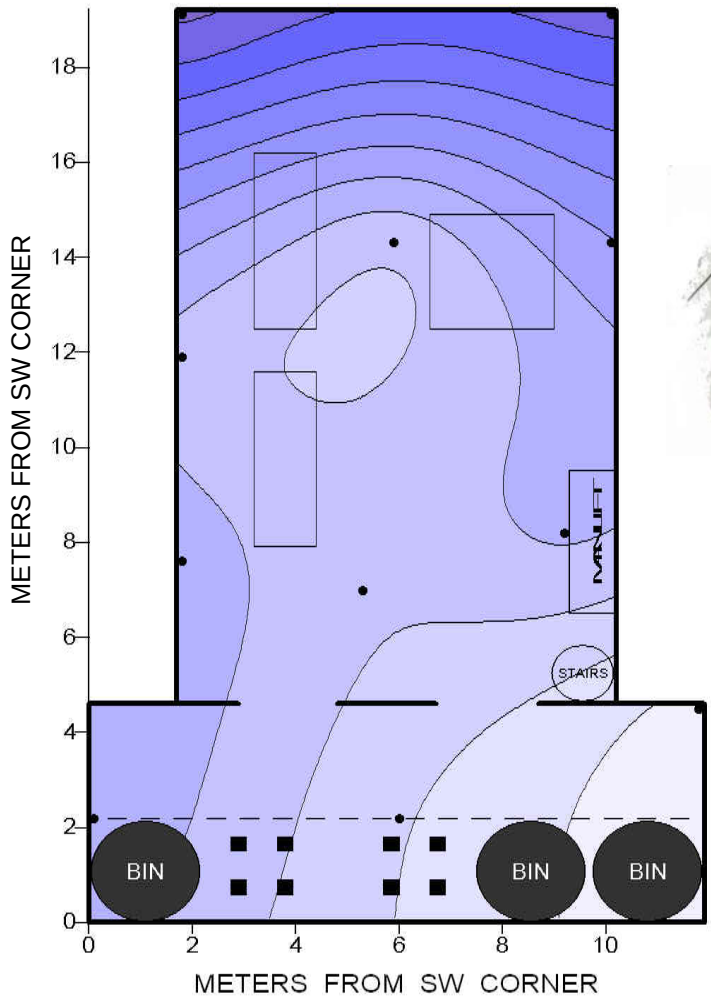
4th FLOOR: 29 JUNE - 13 JULY 2001



FLOUR MILL SF #1

Plodia interpunctella

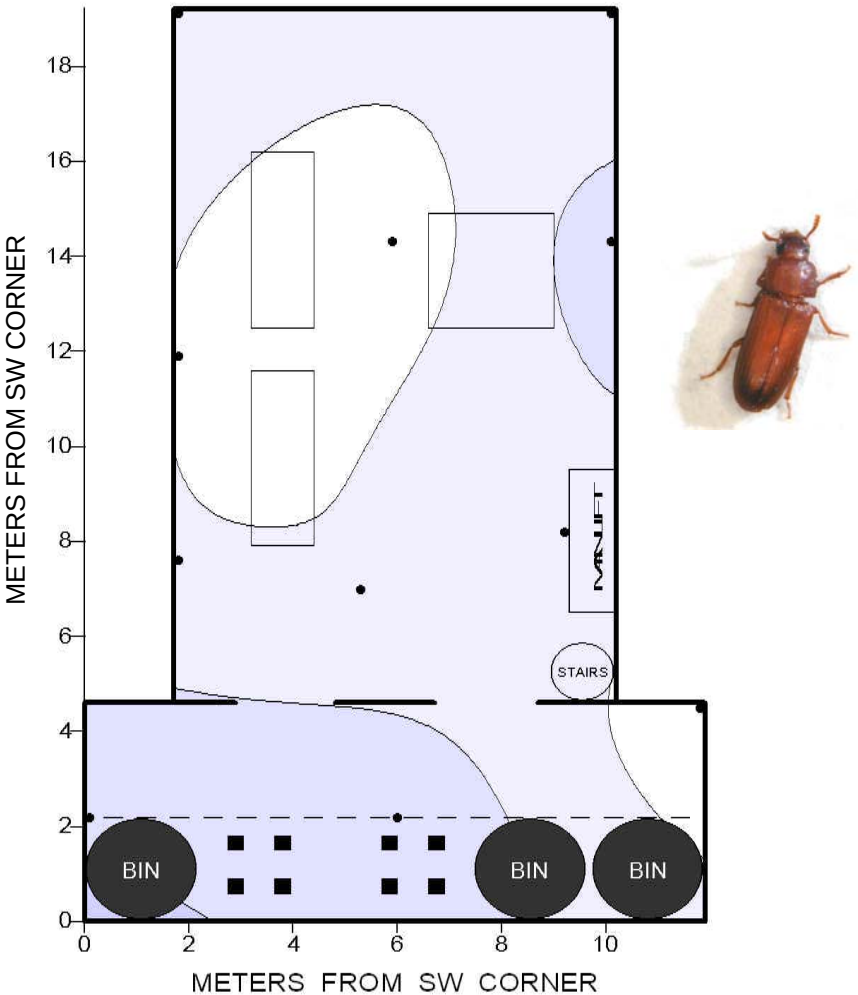
4th FLOOR: 29 JUNE - 13 JULY 2001



FLOUR MILL SF #1

Tribolium castaneum

4th FLOOR: 13-27 JULY 2001



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Plodia interpunctella

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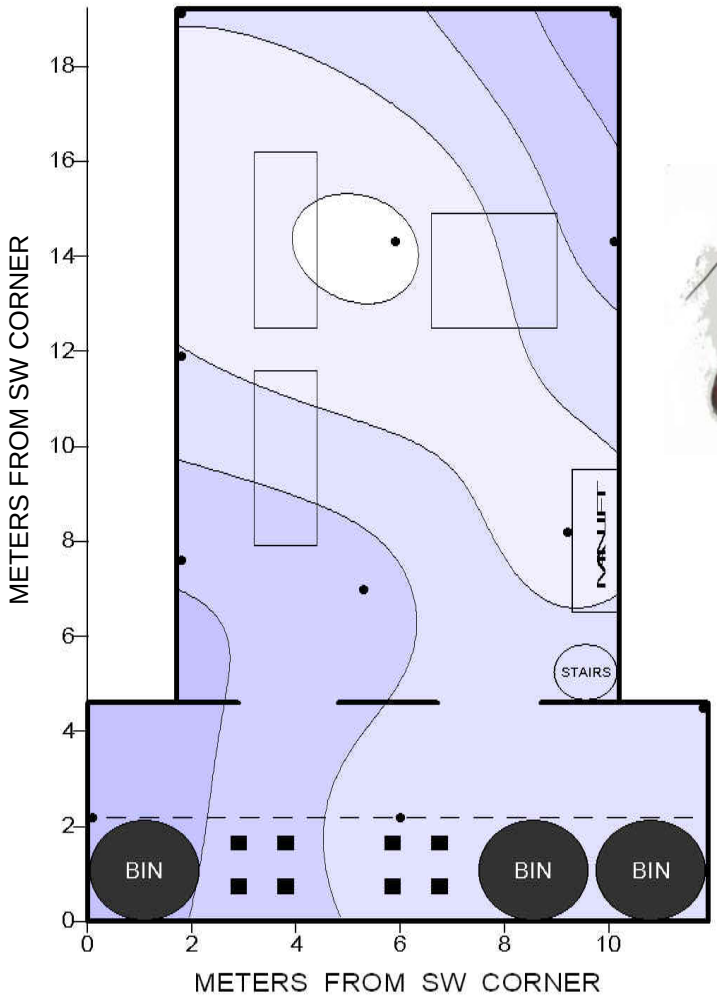
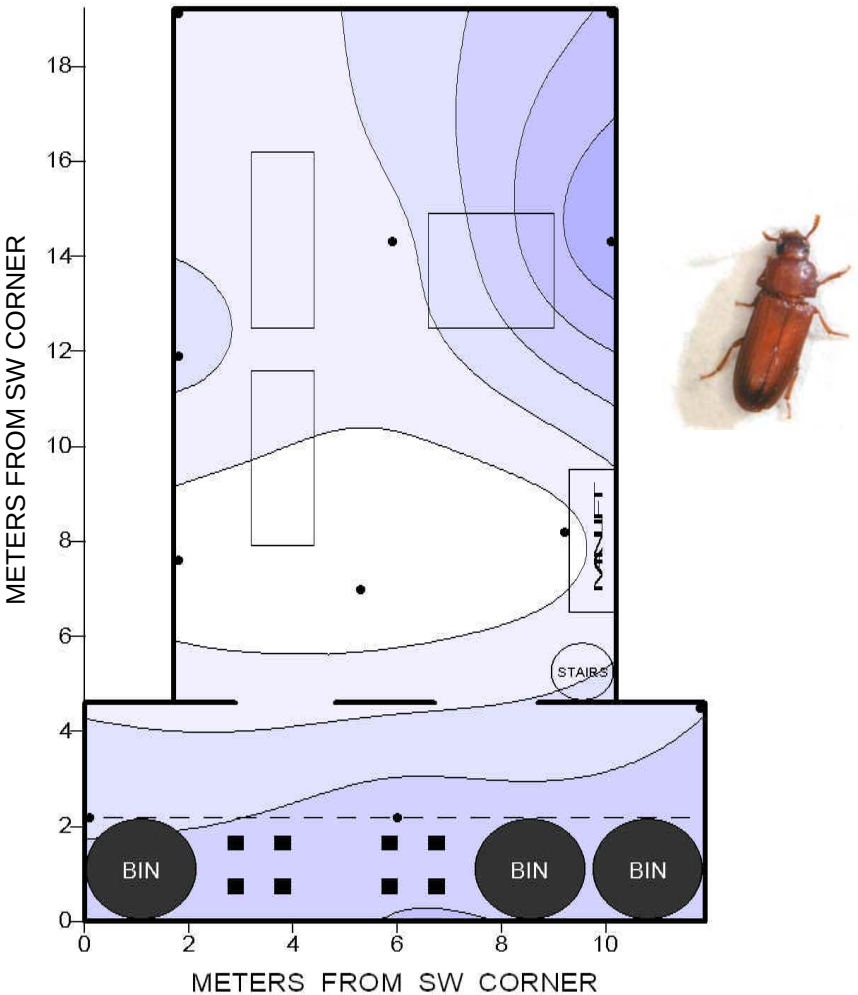


FLOUR MILL SF #1

Tribolium castaneum

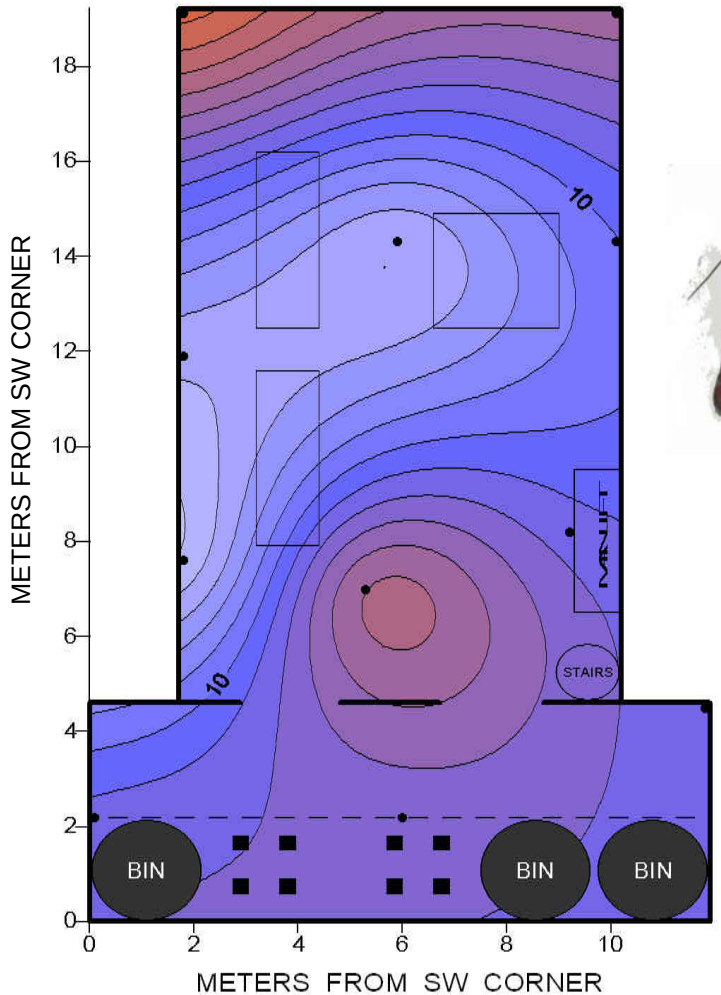
4th FLOOR: 27 JULY - 10 AUGUST 2001



FLOUR MILL SF #1

Plodia interpunctella

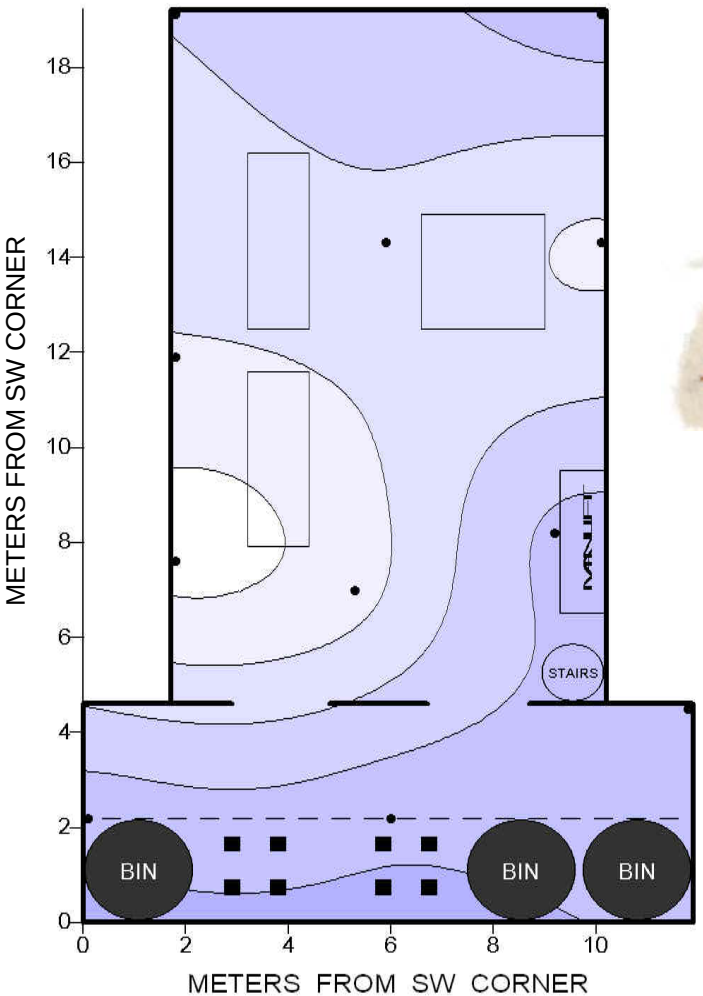
4th FLOOR: 27 JULY - 10 AUGUST 2001



FLOUR MILL SF #1

Tribolium castaneum

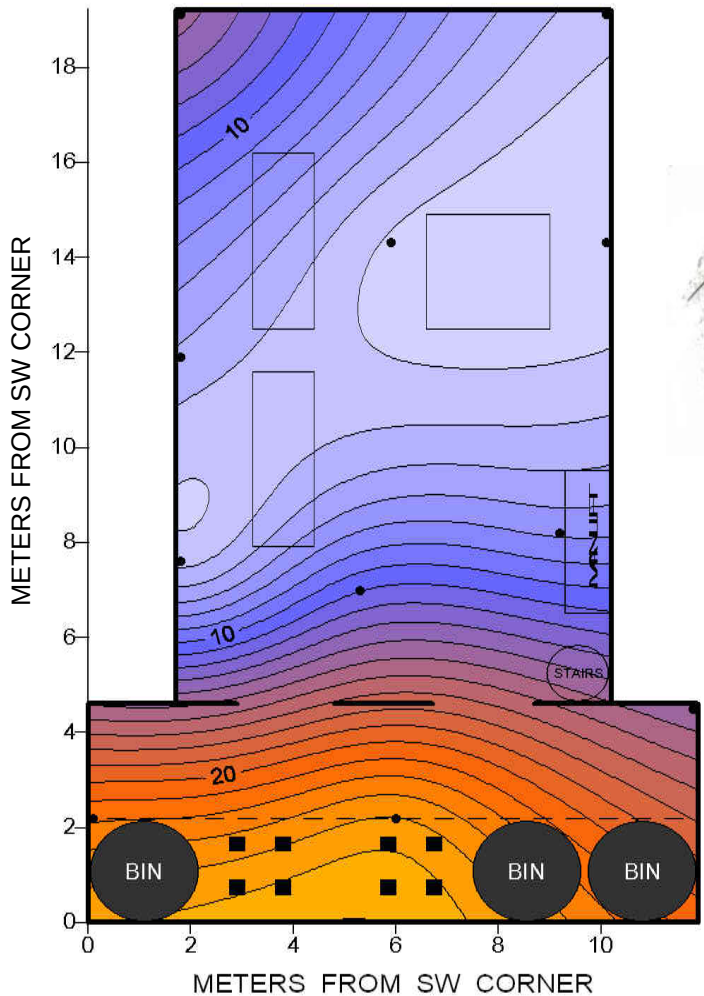
4th FLOOR: 10-24 AUGUST 2001



FLOUR MILL SF #1

Plodia interpunctella

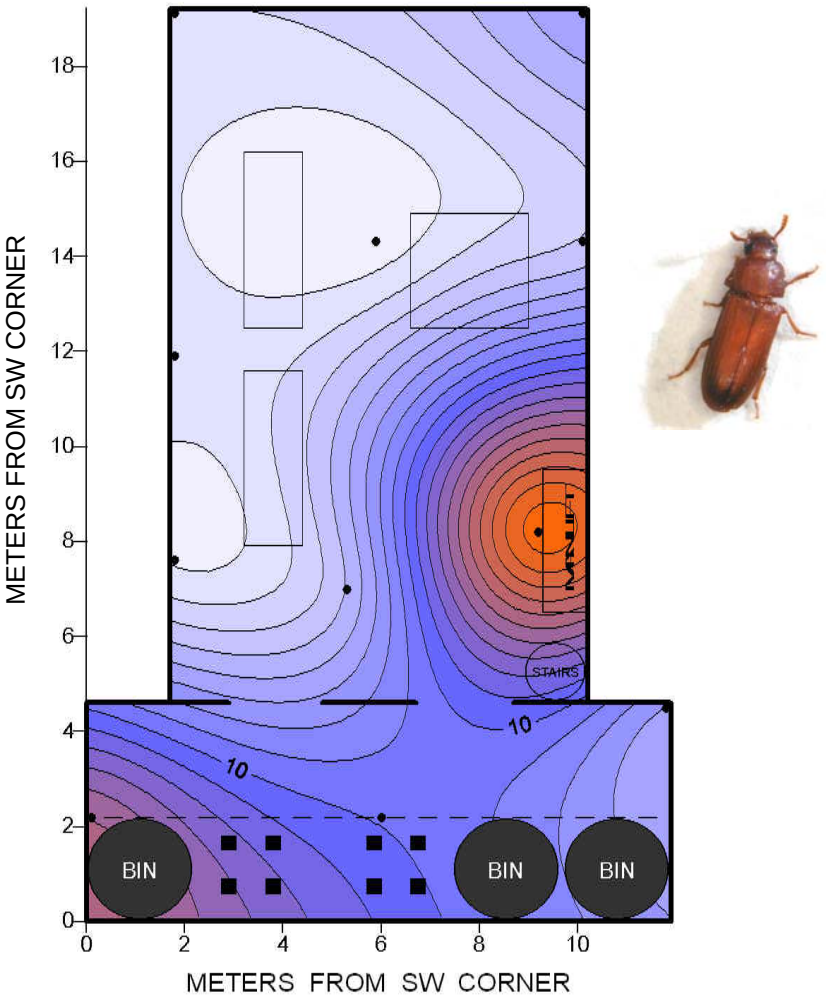
4th FLOOR: 10-24 AUGUST 2001



FLOUR MILL SF #1

Tribolium castaneum

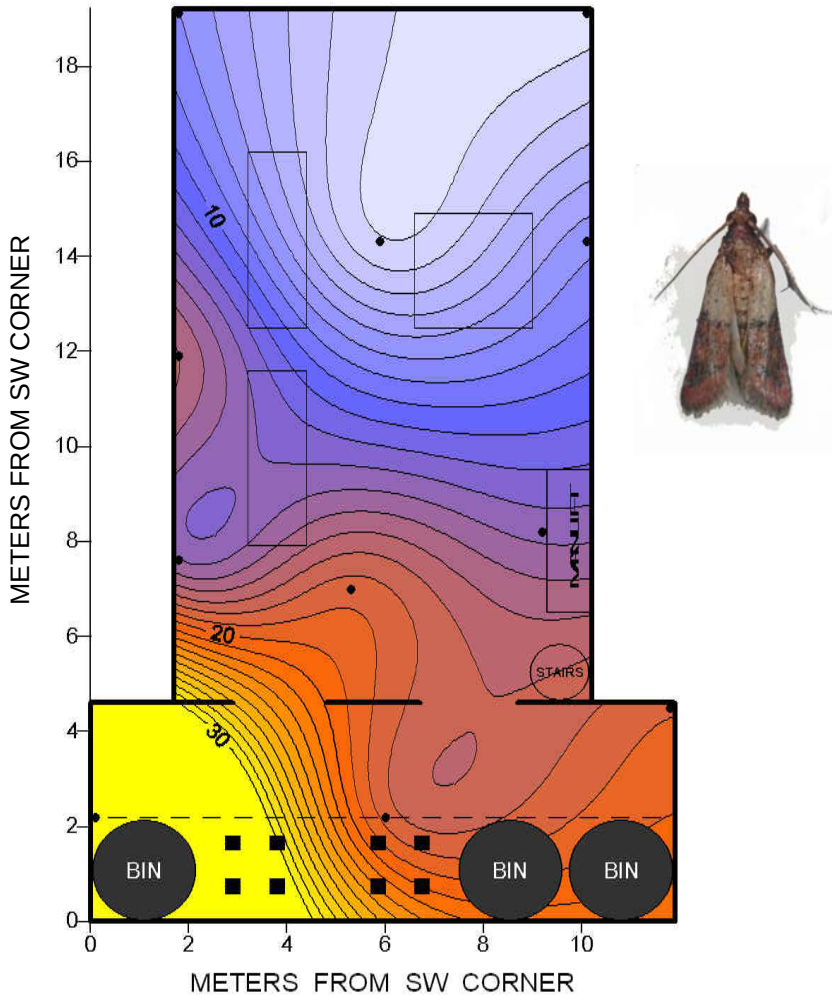
4th FLOOR: 24 AUGUST - 7 SEPTEMBER 2001



FLOUR MILL SF #1

Plodia interpunctella

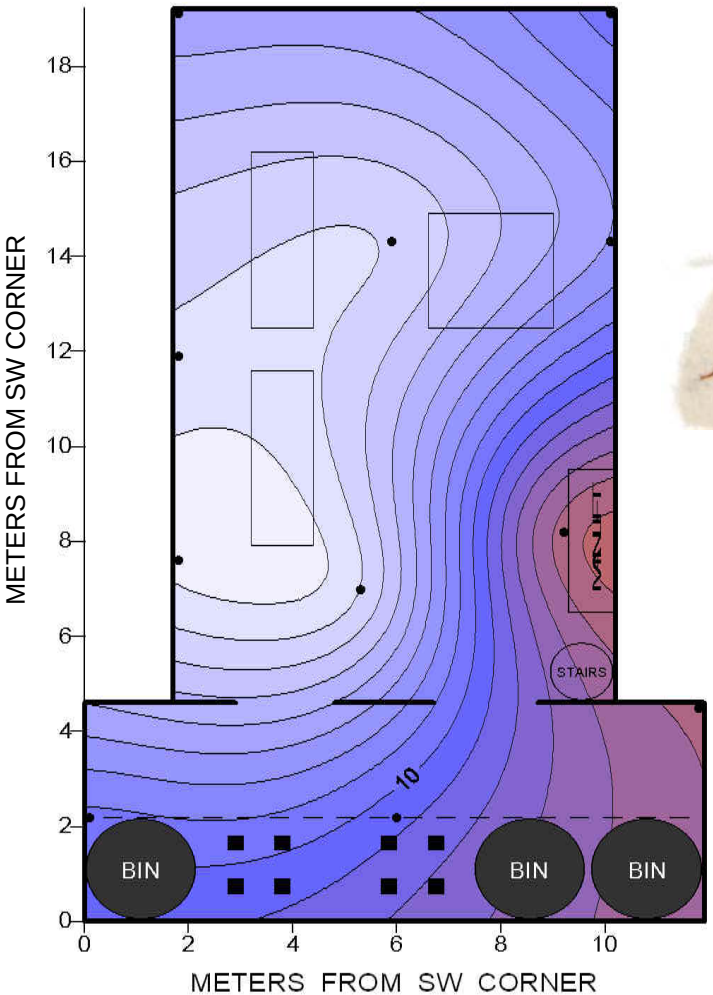
4th FLOOR: 24 AUGUST - 7 SEPTEMBER 2001



FLOUR MILL SF #1

Tribolium castaneum

4th FLOOR: 7-21 SEPTEMBER 2001



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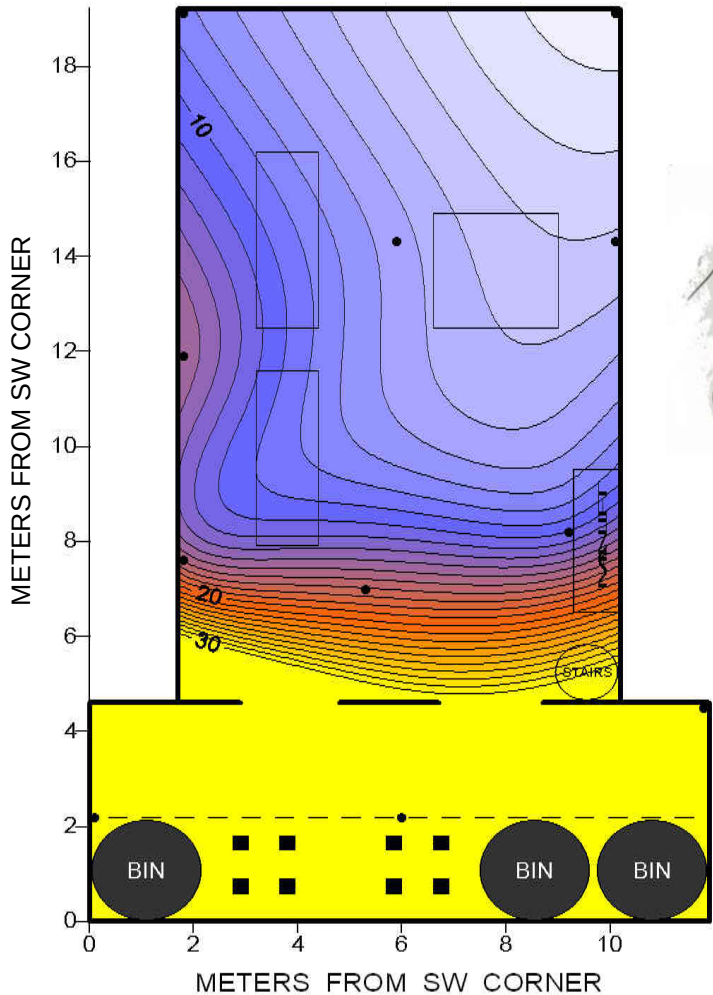
Plodia interpunctella

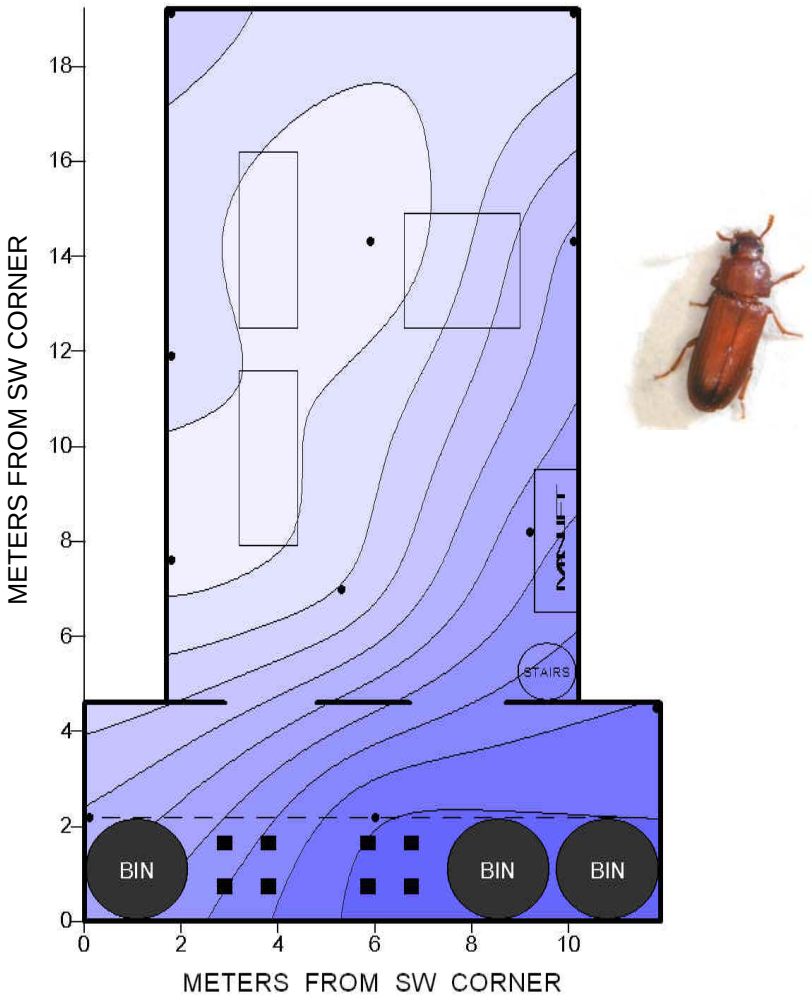
4th FLOOR: 7-21 SEPTEMBER 2001



FLOUR MILL SF #1

Tribolium castaneum

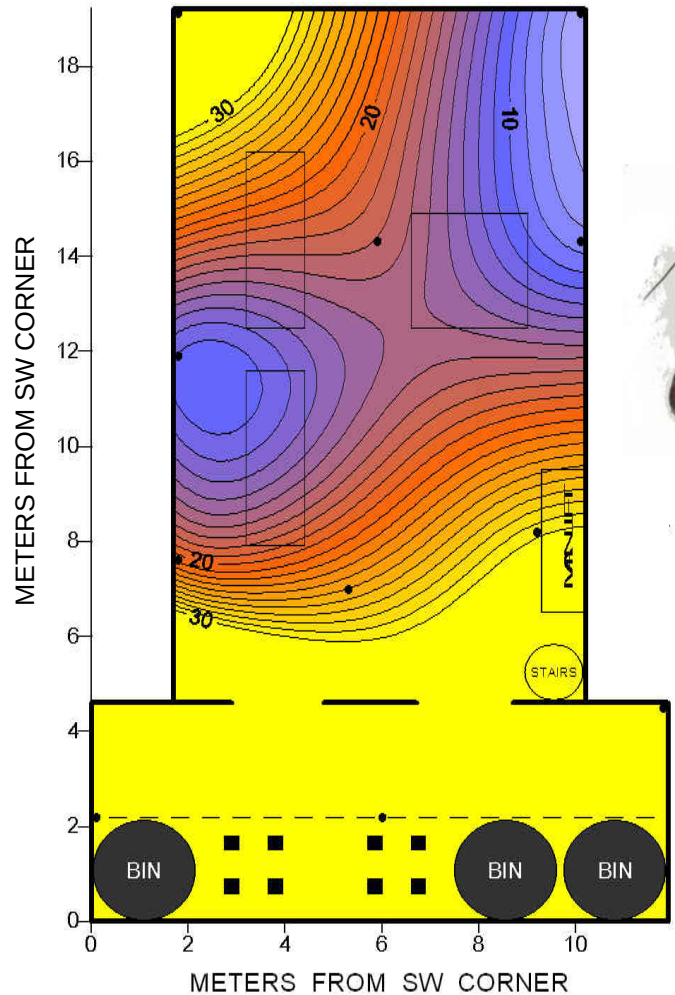
4th FLOOR: 21 SEPTEMBER - 5 OCTOBER 2001



FLOUR MILL SF #1

Plodia interpunctella

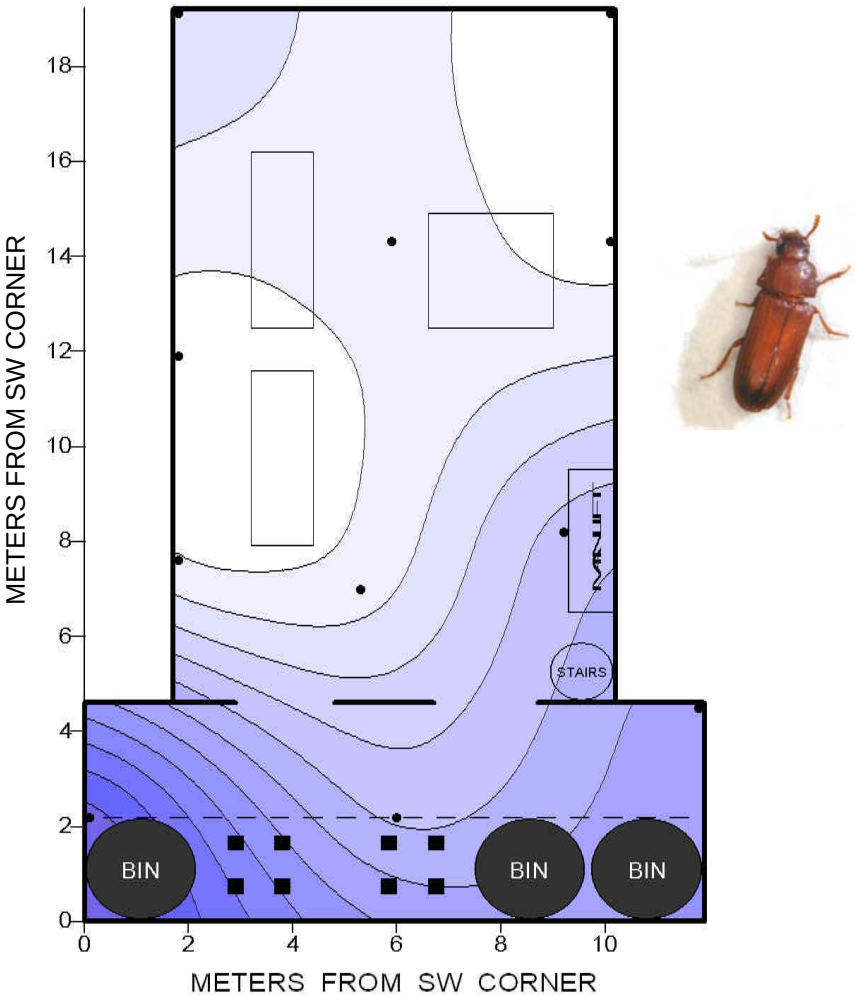
4th FLOOR: 21 SEPTEMBER - 5 OCTOBER 2001



FLOUR MILL SF #1

Tribolium castaneum

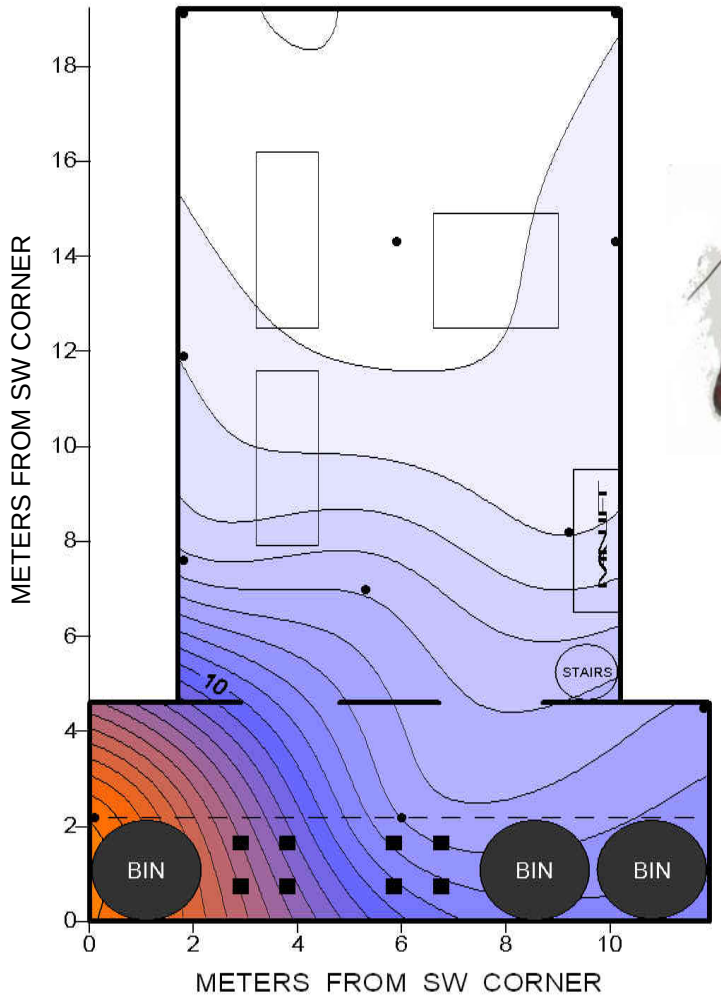
4th FLOOR: 5-19 OCTOBER 2001



FLOUR MILL SF #1

Plodia interpunctella

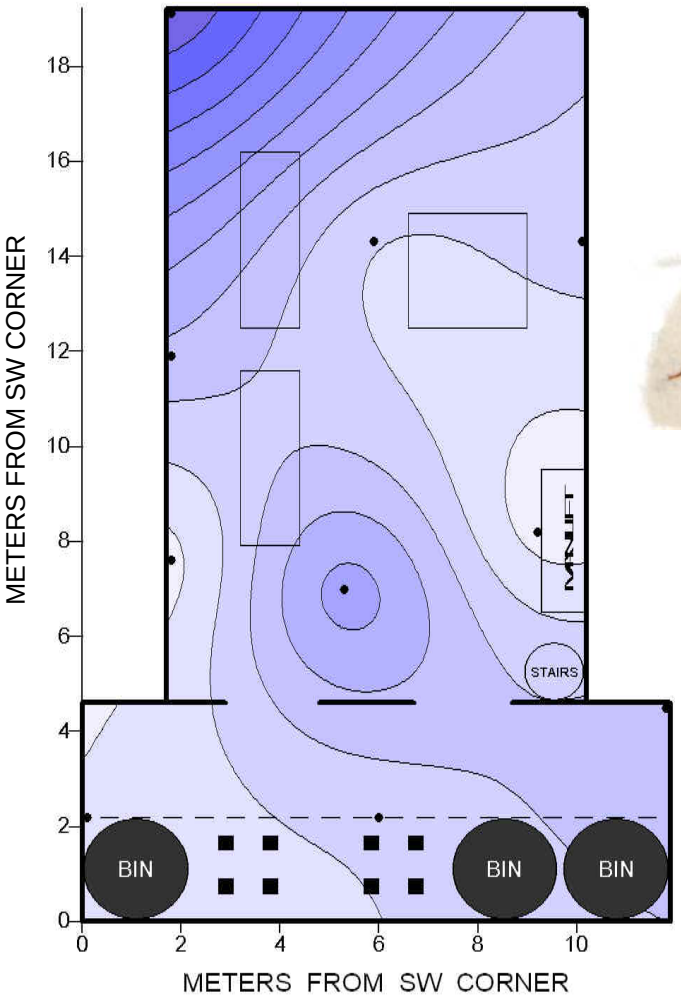
4th FLOOR: 5-19 OCTOBER 2001



FLOUR MILL SF #1

Tribolium castaneum

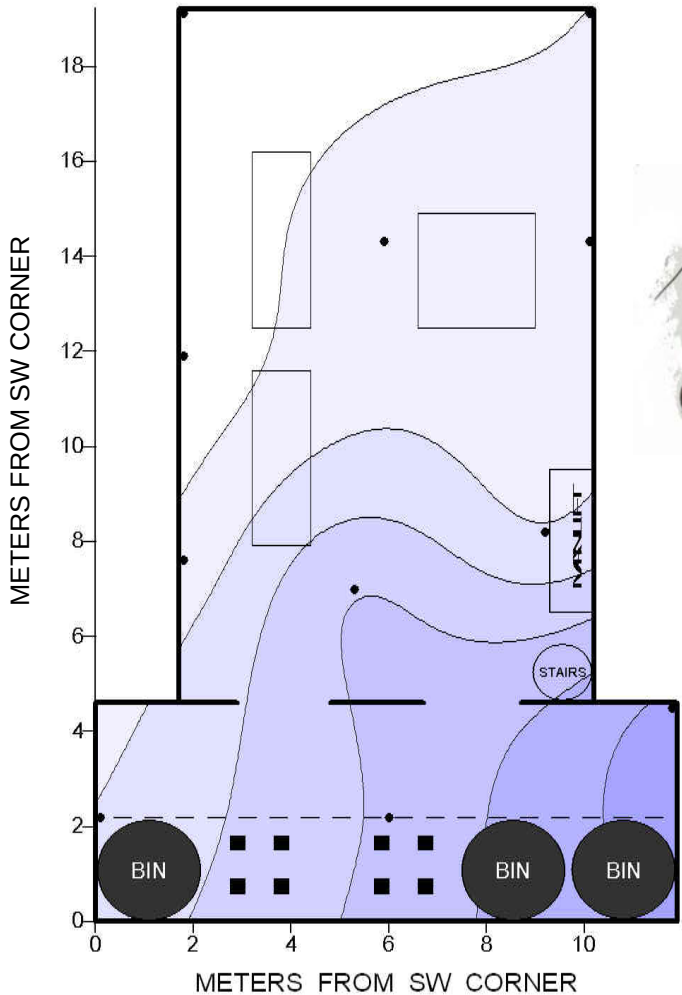
4th FLOOR: 19 OCTOBER 2 NOVEMBER 2001



FLOUR MILL SF #1

Plodia interpunctella

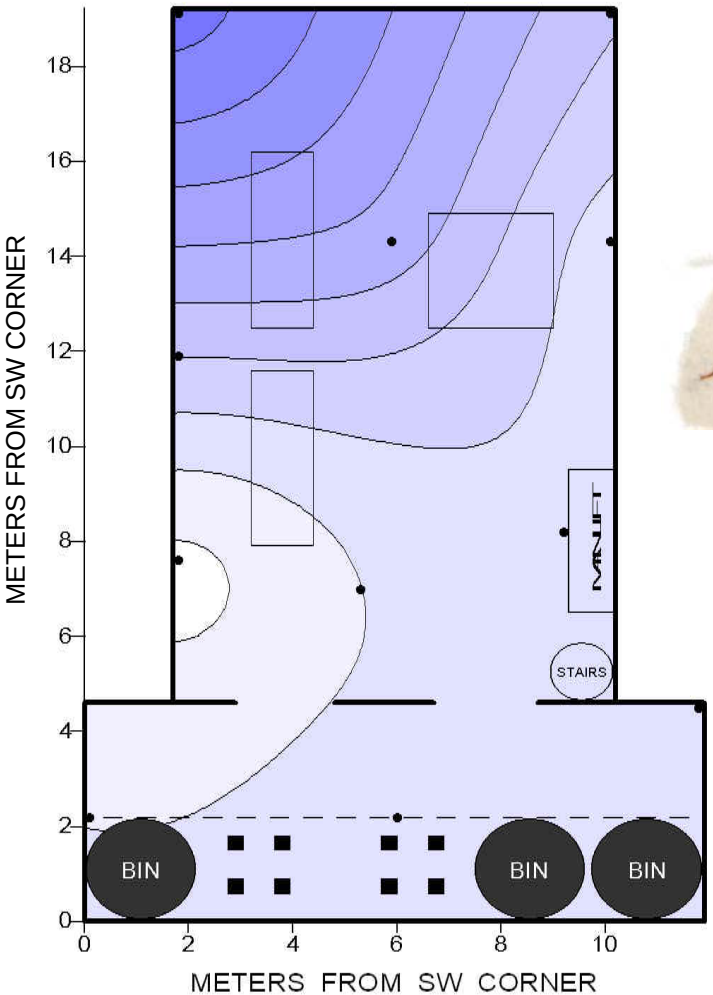
4th FLOOR: 19 OCTOBER - 2 NOVEMBER 2001



FLOUR MILL SF #1

Tribolium castaneum

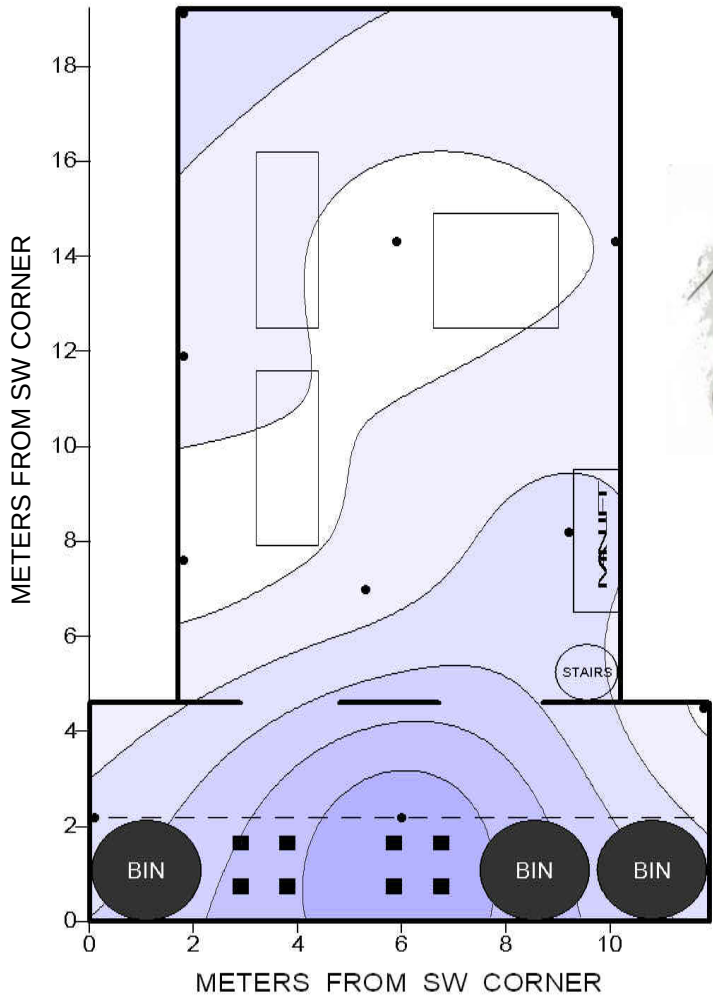
4th FLOOR: 2-16 NOVEMBER 2001



FLOUR MILL SF #1

Plodia interpunctella

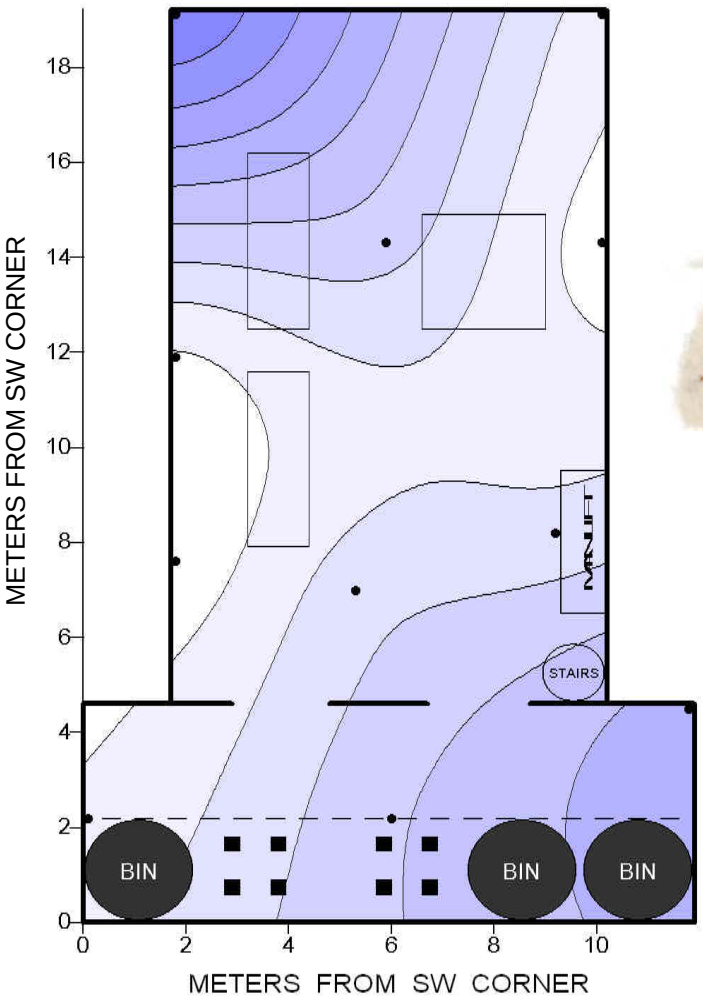
4th FLOOR: 2-16 NOVEMBER 2001



FLOUR MILL SF #1

Tribolium castaneum

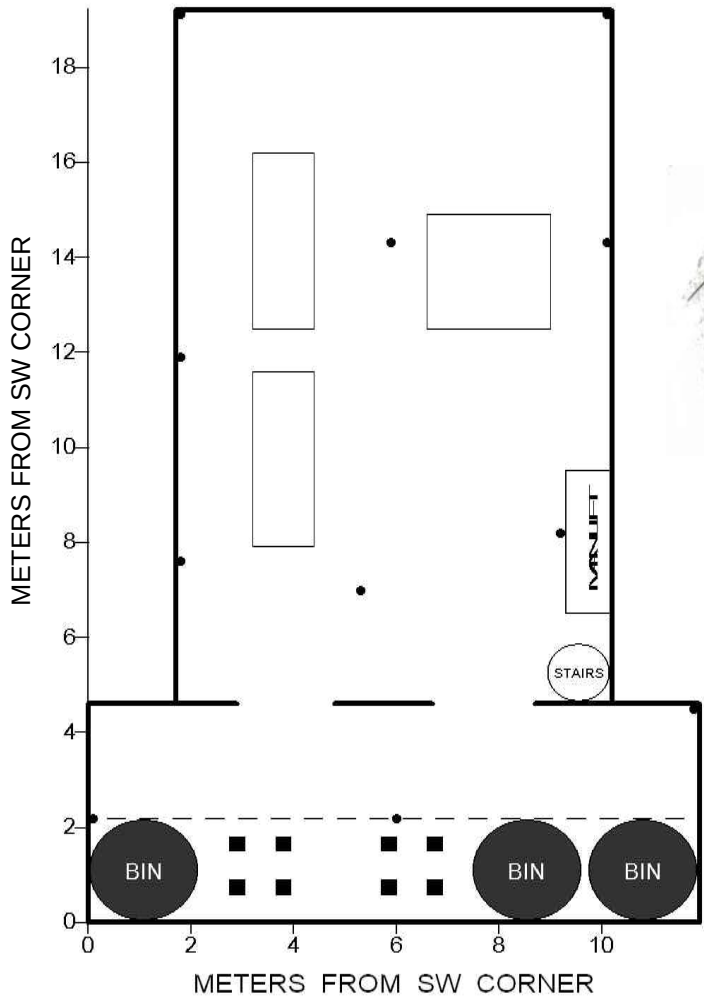
4th FLOOR: 16-30 NOVEMBER 2001



FLOUR MILL SF #1

Plodia interpunctella

4th FLOOR: 16-30 NOVEMBER 2001



Conclusions

- Pheromone/food baited trapping can provide useful information on which to make management decisions
- Interpretation is not always straightforward and involves follow up investigation
- Long term monitoring data both inside and outside provides insight into type of problem and best response

Conclusions

- Each facility likely has unique characteristics that need to be determined to develop and interpret an effective monitoring program
- Understanding pest ecology and behavior within food facility landscapes is critical, but we still have a lot to learn