Monitoring with Pheromone Traps and Trap Catch Interpretation

James F. Campbell

USDA ARS

GMPRC
GRAIN MARKETING AND PRODUCTION RESEARCH CENTER

Questions Monitoring can Address

- What insects are present?
- Where are they located?
- How are numbers changing over time?
- Where are important infestation sources?
- How effective are management tools?

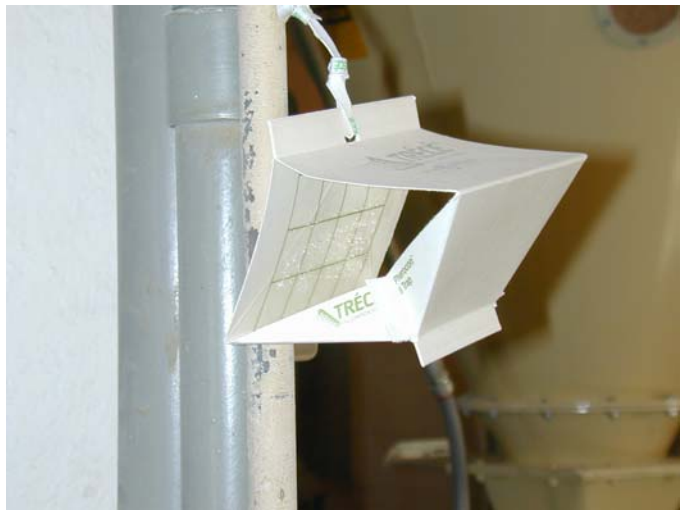
Ways to Monitor Pests

- Direct Sampling

  Populations in food patches (e.g., food packages, bins, spillage, cracks)

- Indirect Sampling

  Insects moving between patches of food



Direct Sampling

Visual inspection of…

- Cracks and crevices
- Spillage
- Packaged commodities
- Tailings or product stream samples
- Equipment

Indirect Sampling

- Device to capture moving insects
- Often use an attractant
- Capture influenced by pest biology, environment, and trap type and placement
- What is relationship between trap capture and product infestation or economic impact?

Sticky Cards

- Primarily used for monitoring cockroaches
- Also widely used for greenhouse and orchard pests
- Can be used for capturing flying or walking stored-product insects
- Many insects will not walk onto sticky cards
- Nonspecific capture

Light Traps

Gilbert MODEL 605 "Night Eagle"
Electrocuting light trap

Gilbert MODEL 747GT "Sticky Bear"
Glue board light trap

- Two types: sticky cards and electrocuting
- Used primarily for fly and night flying insect control
- Can capture stored-product insects, but not often used for monitoring
- Not all species respond
- Nonspecific capture

Food Baits

- Measures potential for product infestation
- Primarily a research tool
- Labor and time intensive
- Can contribute to pest problems if not replaced in a timely manner

Pheromone and Food Attractant Traps

- Most widely used method for monitoring outside bulk grain
- Pheromone and/or food odor
- Wide range of trap and lure types commercially available

Components of a monitoring program

- Trap and attractant type
- Trap placement
- Checking traps and collecting information
- Visualization and interpretation of results

Pheromones

- Chemicals emitted by an individual to send a message to other individuals of the same species
- Many types of pheromones, but only two are important for pest management
  - sex pheromones
  - aggregation pheromones

Pheromone Traps

Advantages

- Sample continuously
- Large active space for some attractants
- Early detection
- Species specific
- Relatively easy to use
- Quick results
- Can be used to target monitoring and management

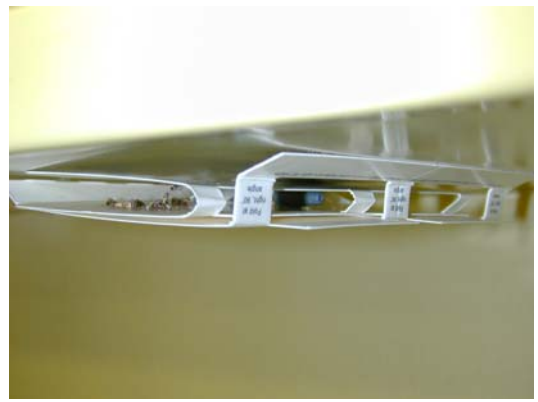
Disadvantages

- Only capture receptive insects
- Pheromones not available for all species
- Small active space for some species
- Multiple lures/traps to monitor multiple species
- Expense
- Visibility
- How to use results?

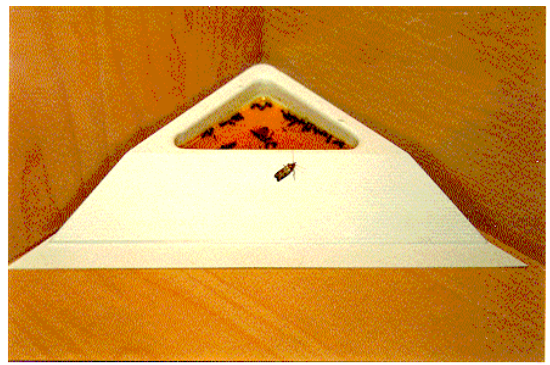
Pheromones

Insect	Pheromone type	Sex that produces pheromone	Commercially available
Beetles			
Cigarette Beetle	sex	female	yes
Lesser grain borer	aggregation	male	yes
Cowpea weevil	sex	female	no
Flat grain beetle	aggregation	male	no
Foreign grain beetle	aggregation	male	no
Rusty grain beetle	aggregation	male	no
Merchant grain beetle	aggregation	male	no
Sawtoothed grain beetle	aggregation	male	no
Granary weevil	aggregation	male	no
Rice weevil	aggregation	male	yes
Maize weevil	aggregation	male	yes
Warehouse beetle	sex	female	yes
Yellow mealworm	aggregation	male	no
Red flour beetle	aggregation	male	yes
Confused flour beetle	aggregation	male	yes
Moths			
Angoumois grain moth	sex	female	yes
Almond moth	sex	female	yes
Tobacco moth	sex	female	yes
Mediterranean flour moth	sex	female	yes
Indianmeal moth	sex	female	yes

Some Traps for Flying Insects



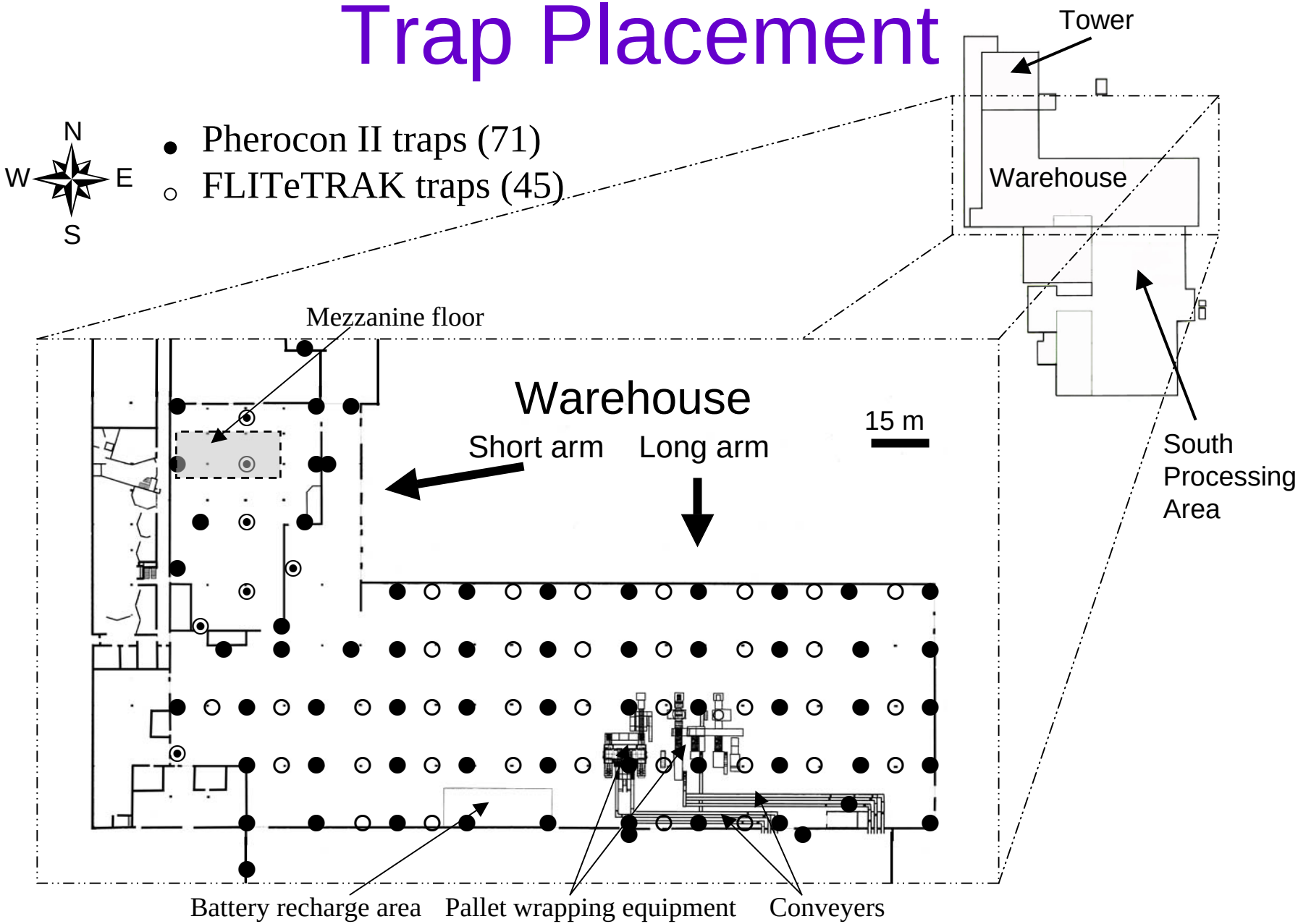
Some Traps for Walking Insects



Trap Placement

- A balance of practical and scientific considerations on trap number and placement
- Grid pattern is generally best
- Start with high density grid and then reduce number or focus the sampling based on initial results and monitoring goals
- Outside trapping is also useful

Trap Placement

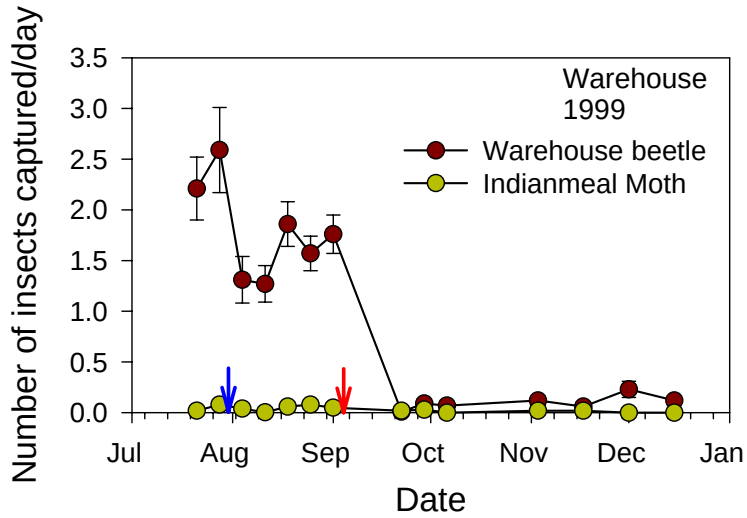


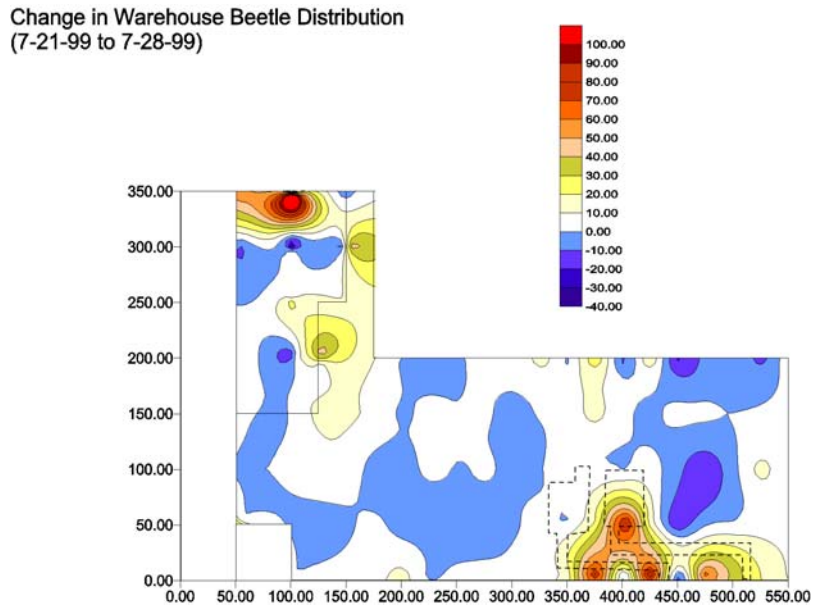
Checking Traps

- Traps checked every one to two weeks
- Captured insects removed, identified and counting
- Pheromone lures replaced as per manufacturer recommendations
- Sticky traps replaced when saturated with dust or insect scales
- Reusable traps kept clean
- Observations made of conditions near traps

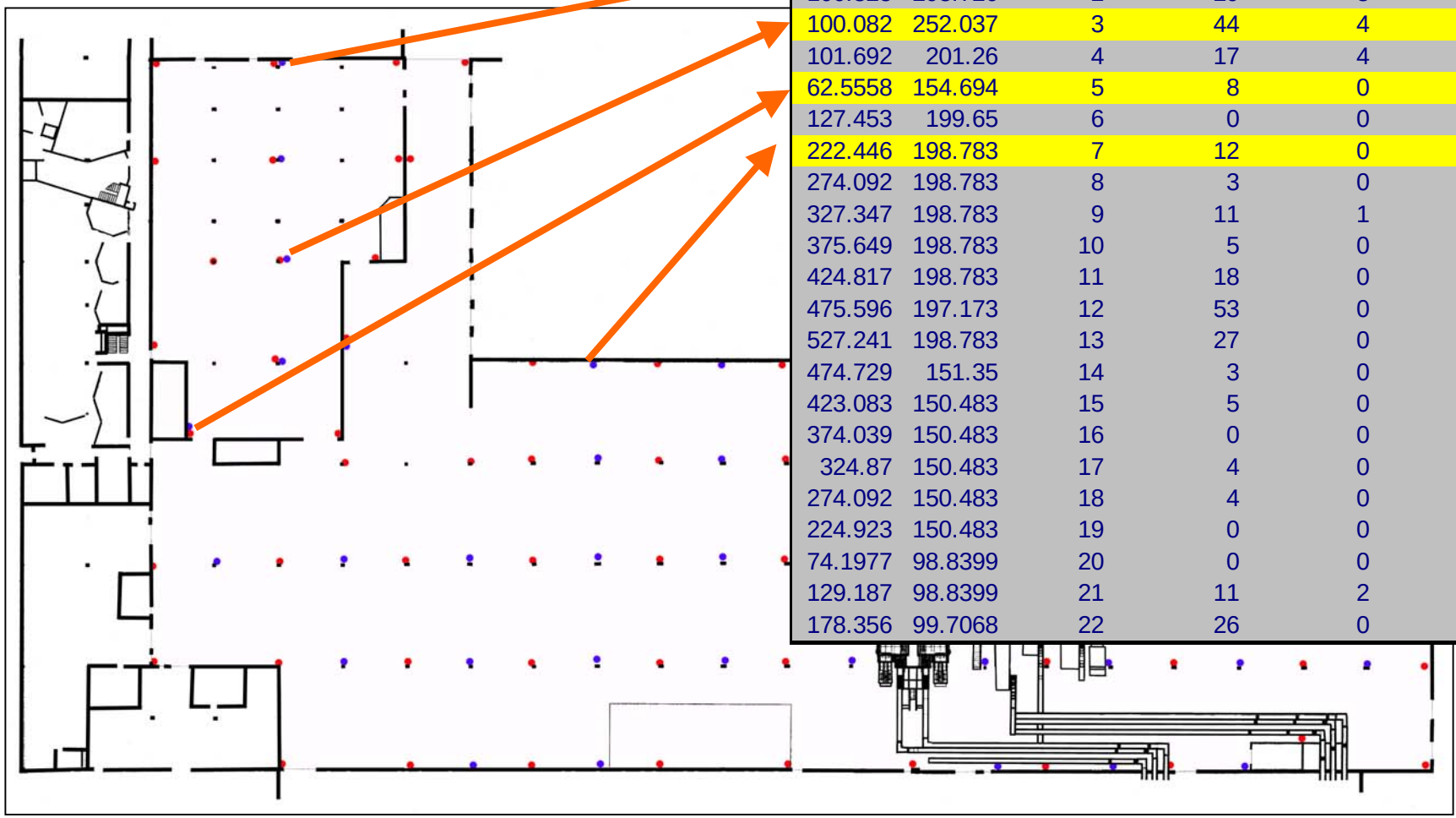
Visualization and Interpretation

- Graph averages over time to look at population trends and response to treatment
- Look at the spatial distribution of insects to target pest management





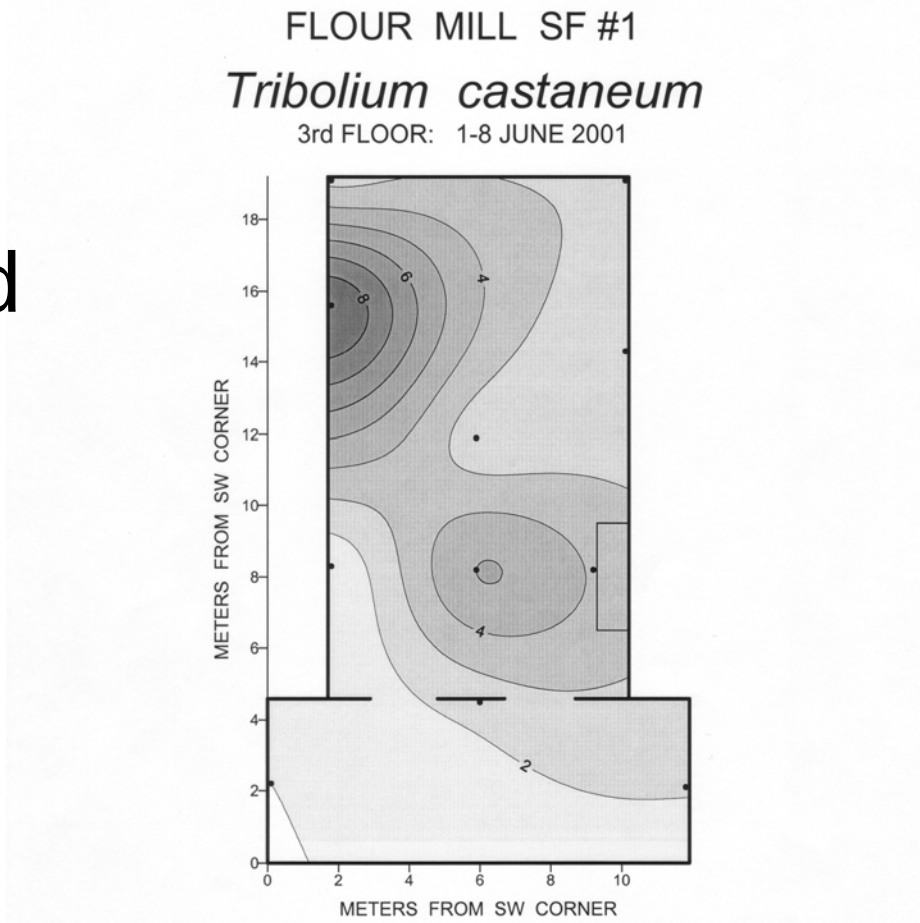
Create a data sheet



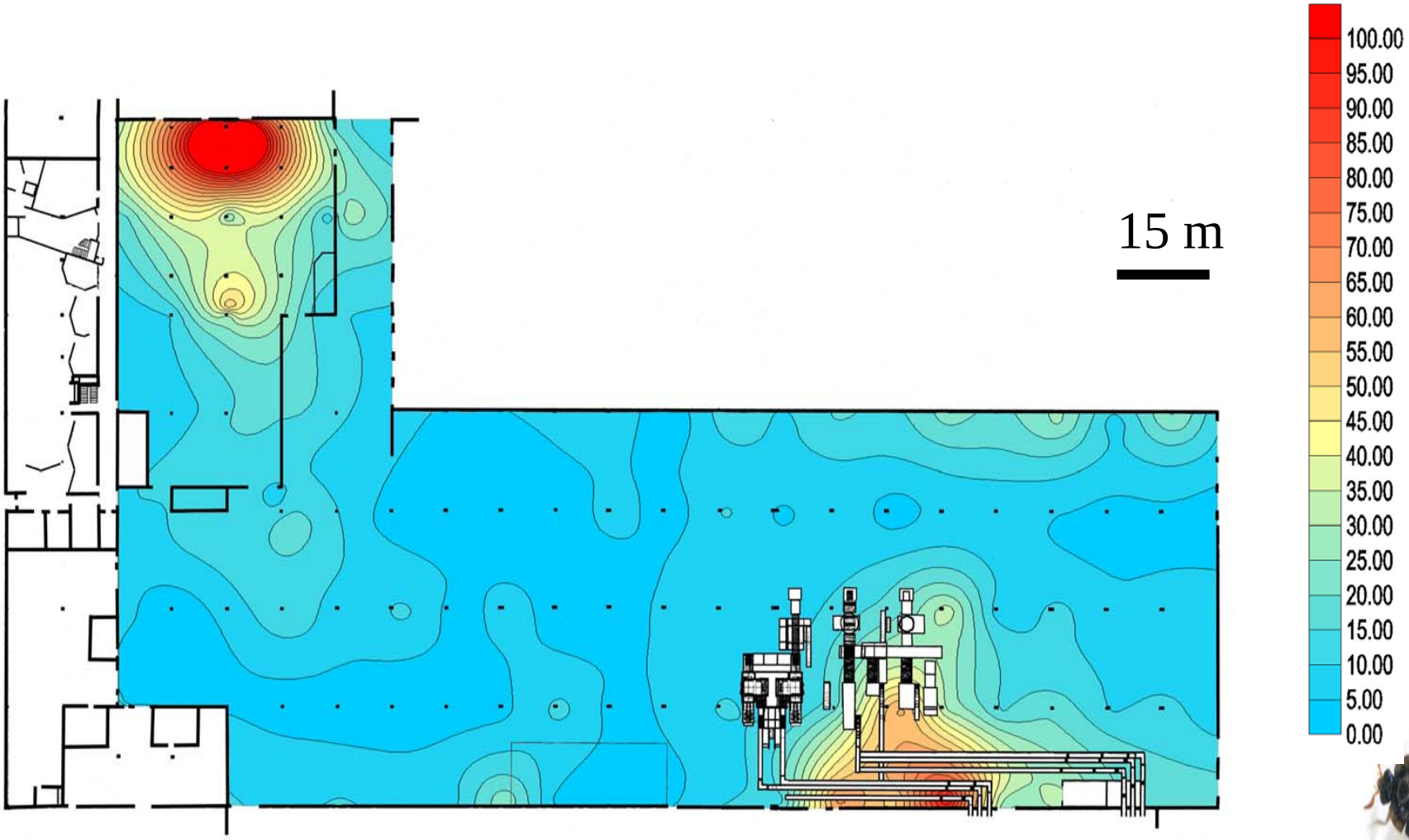
X-axis	Y-axis	Trapno	WB072299	CB072299	FB072299
100.825	347.893	1	228	2	1
100.825	298.726	2	29	3	3
100.082	252.037	3	44	4	5
101.692	201.26	4	17	4	4
62.5558	154.694	5	8	0	0
127.453	199.65	6	0	0	0
222.446	198.783	7	12	0	2
274.092	198.783	8	3	0	2
327.347	198.783	9	11	1	1
375.649	198.783	10	5	0	3
424.817	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

Spatial Mapping

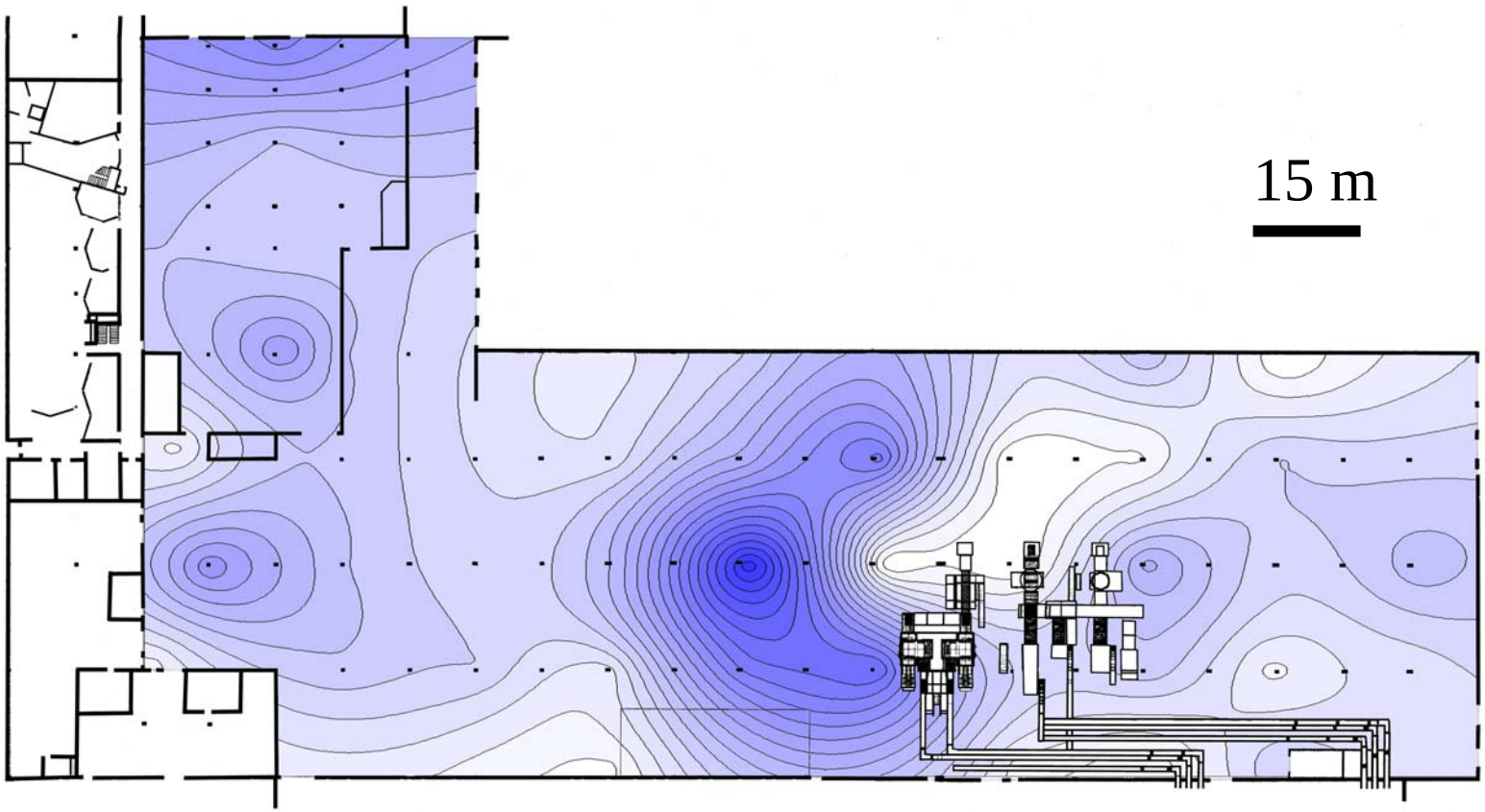
- Mathematical model to estimate the values at unsampled points
- Different estimation procedures are available
- Generate contour maps of distribution



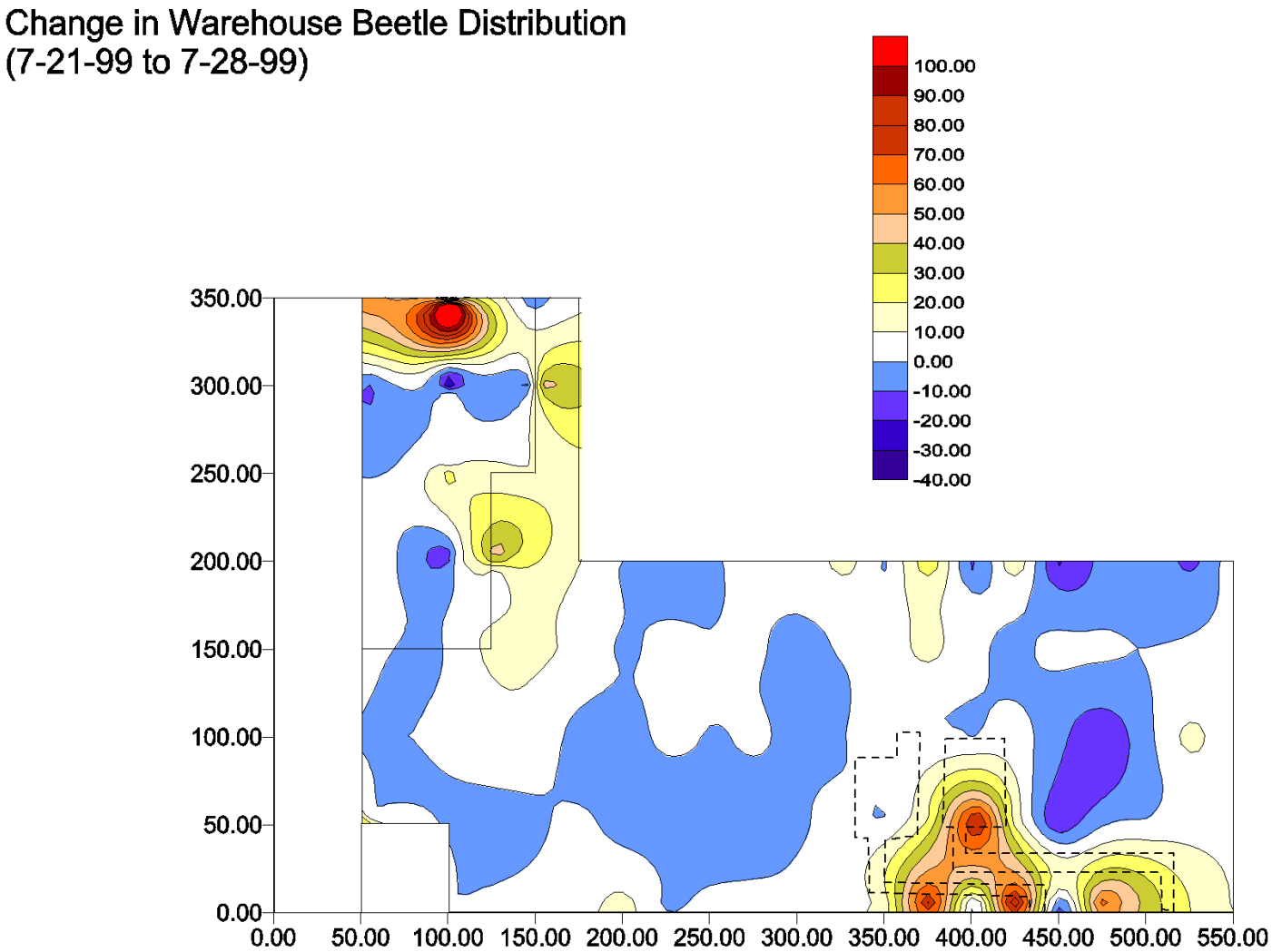
Trogoderma variabile distribution in warehouse



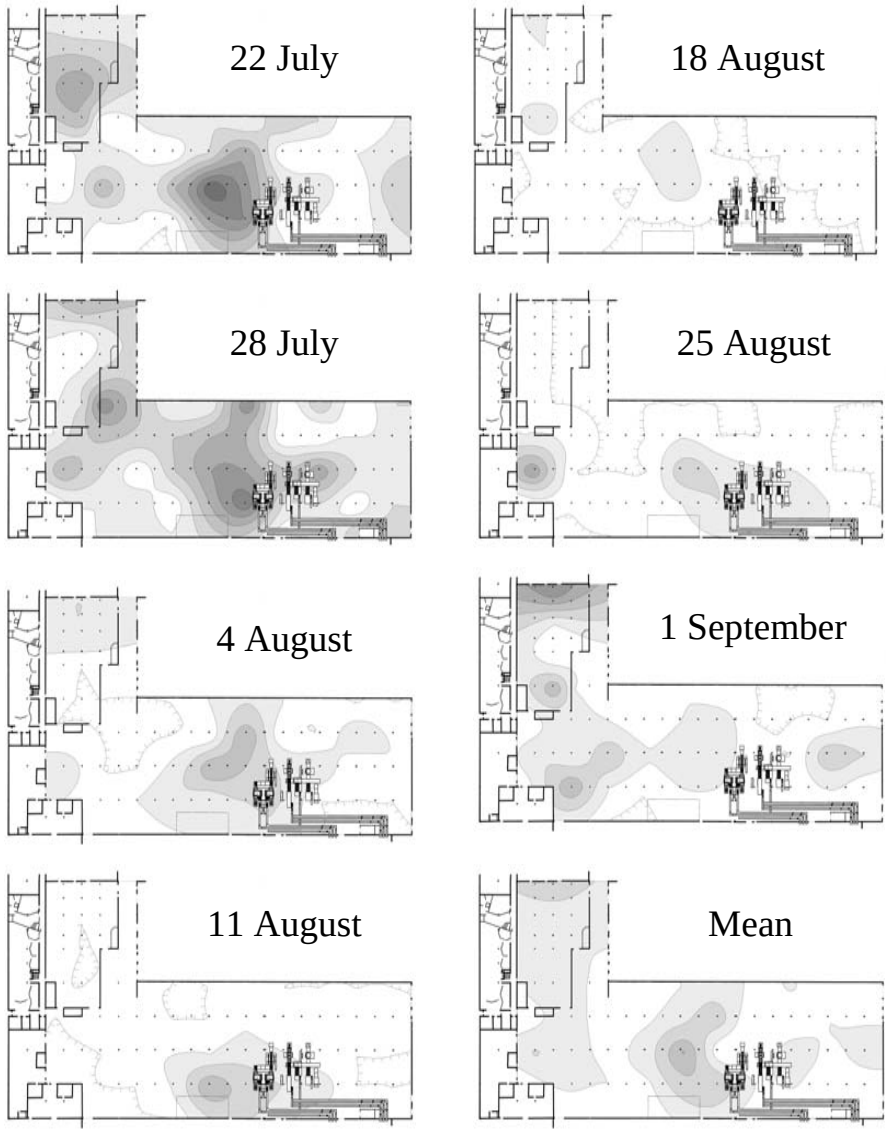
Tribolium castaneum distribution in warehouse



Change in trap catch

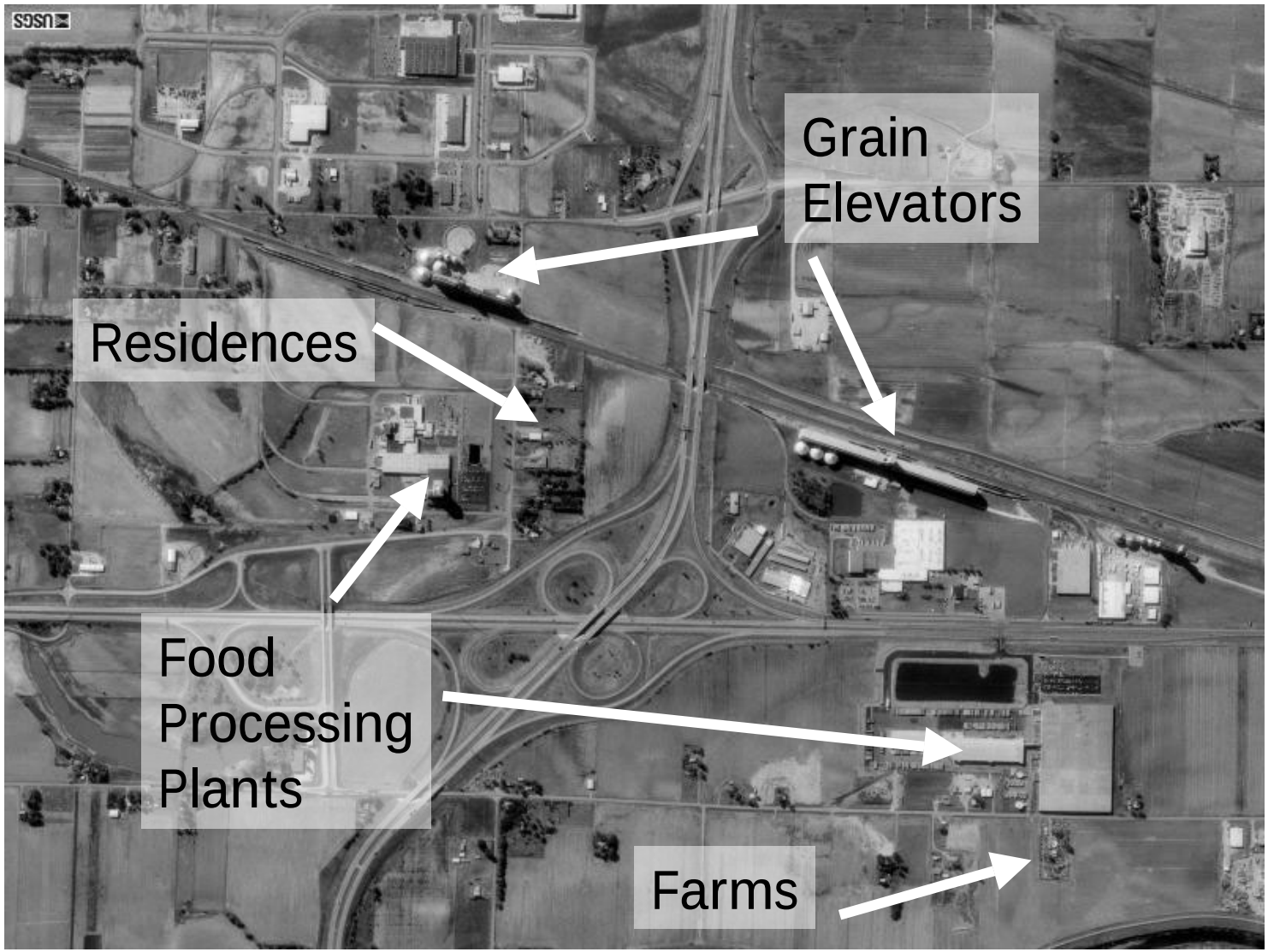


Foci of trap captures move from place to place and expand and contract

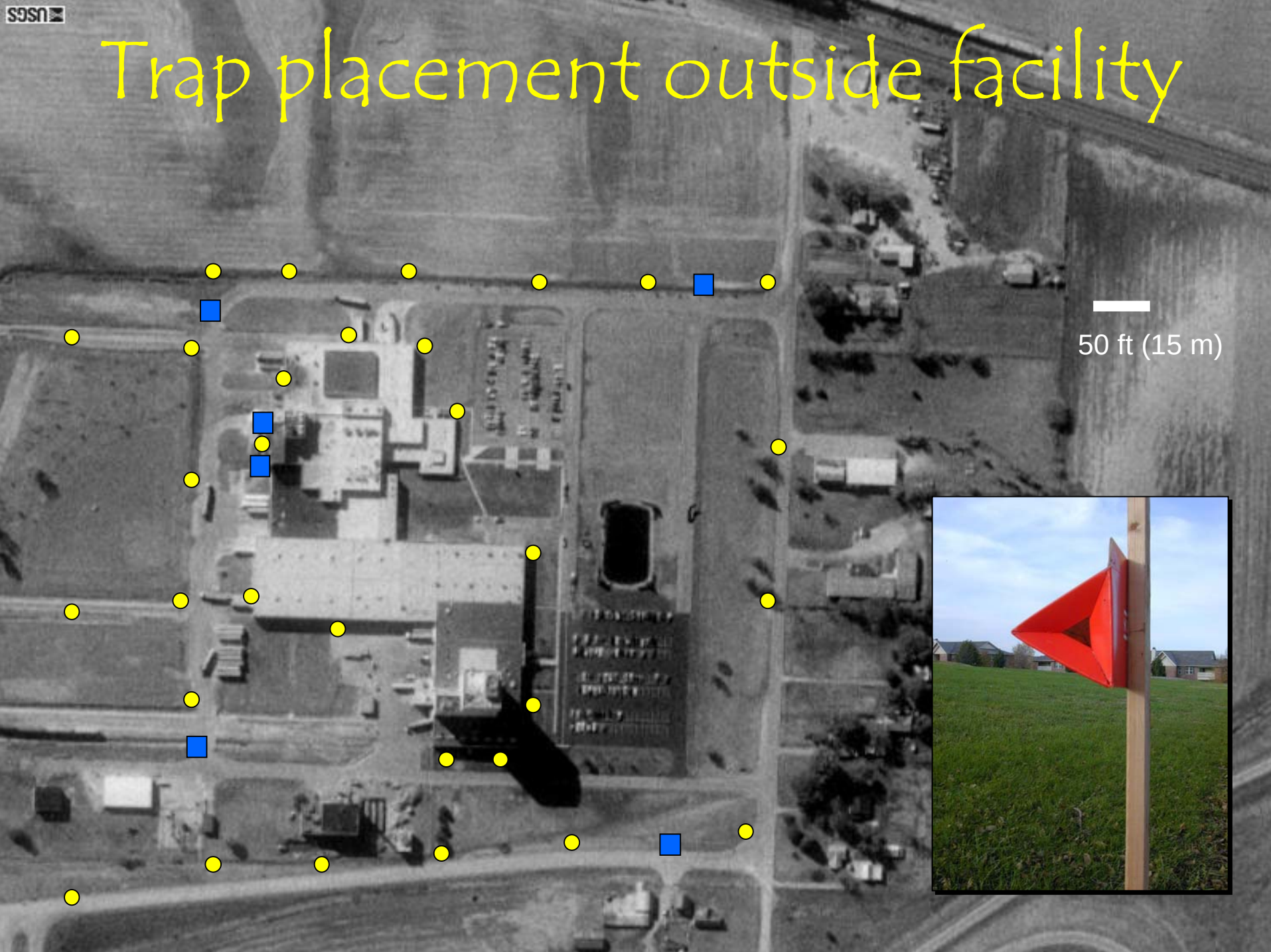


Tribolium castaneum pheromone trap captures in warehouse

Outside sources of infestation



Trap placement outside facility



Outside Spatial Distribution

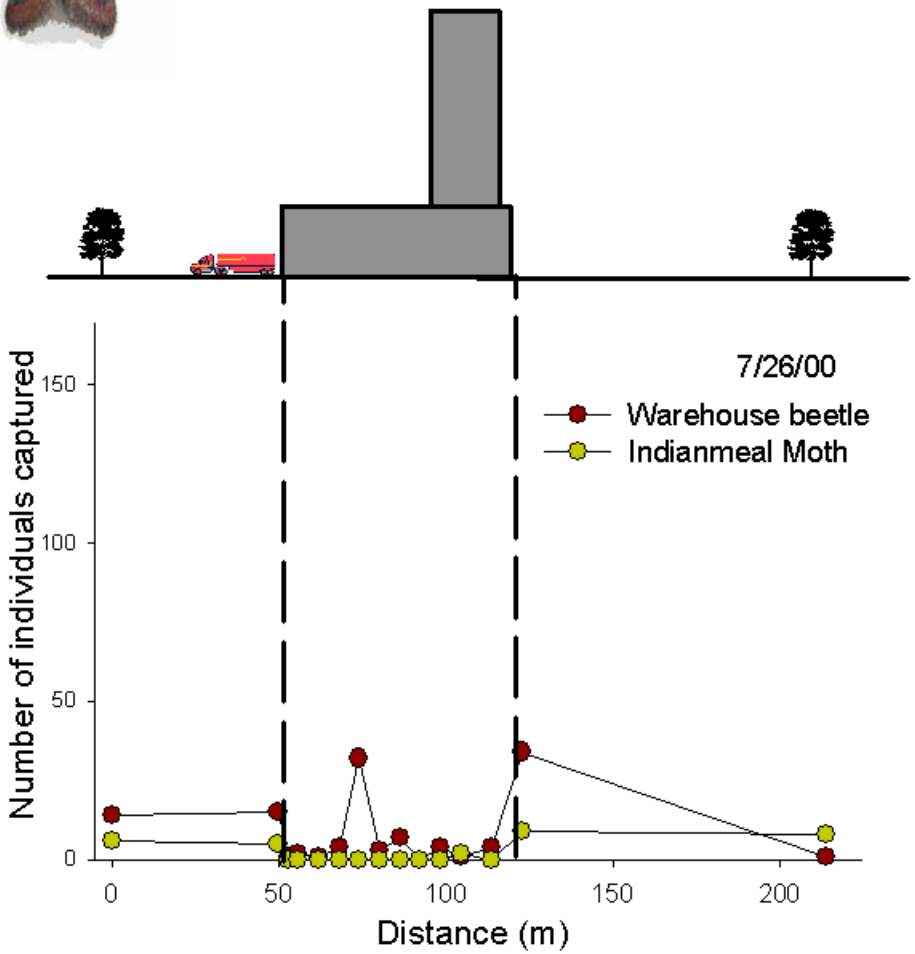
Warehouse Beetle

Indianmeal moth

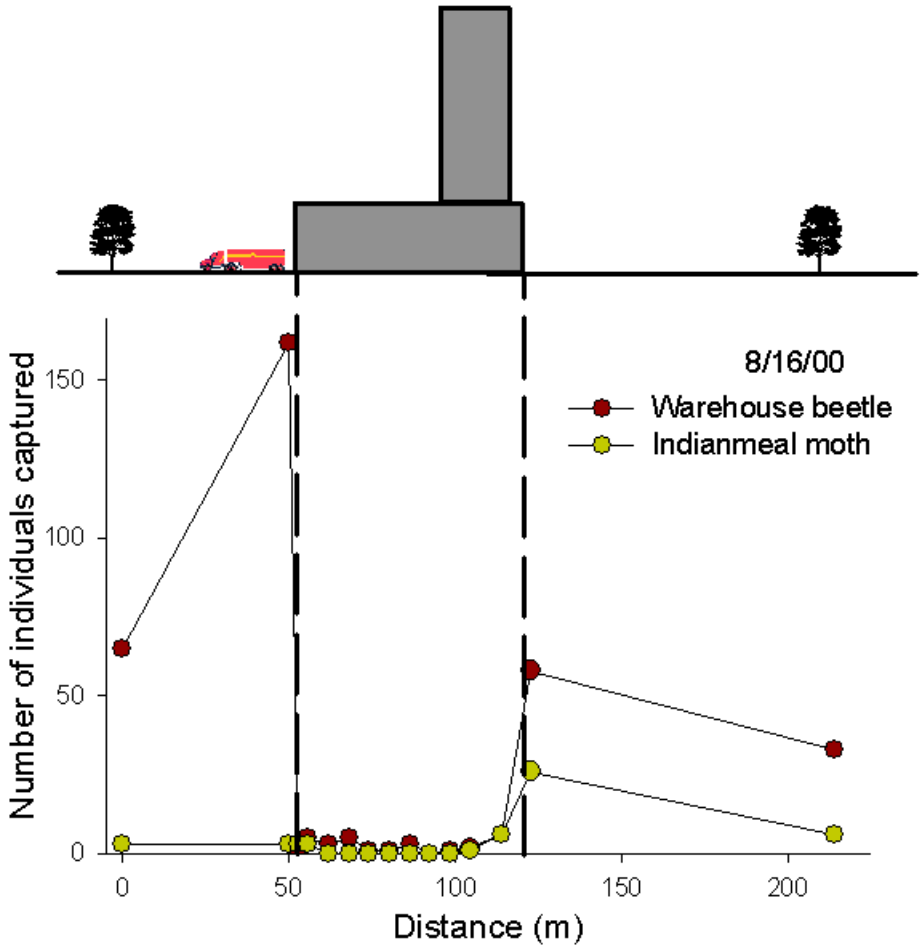
Average daily capture rate from 6/7/00 to 10/11/00

Impact on Pest Management

Before fumigation



After fumigation

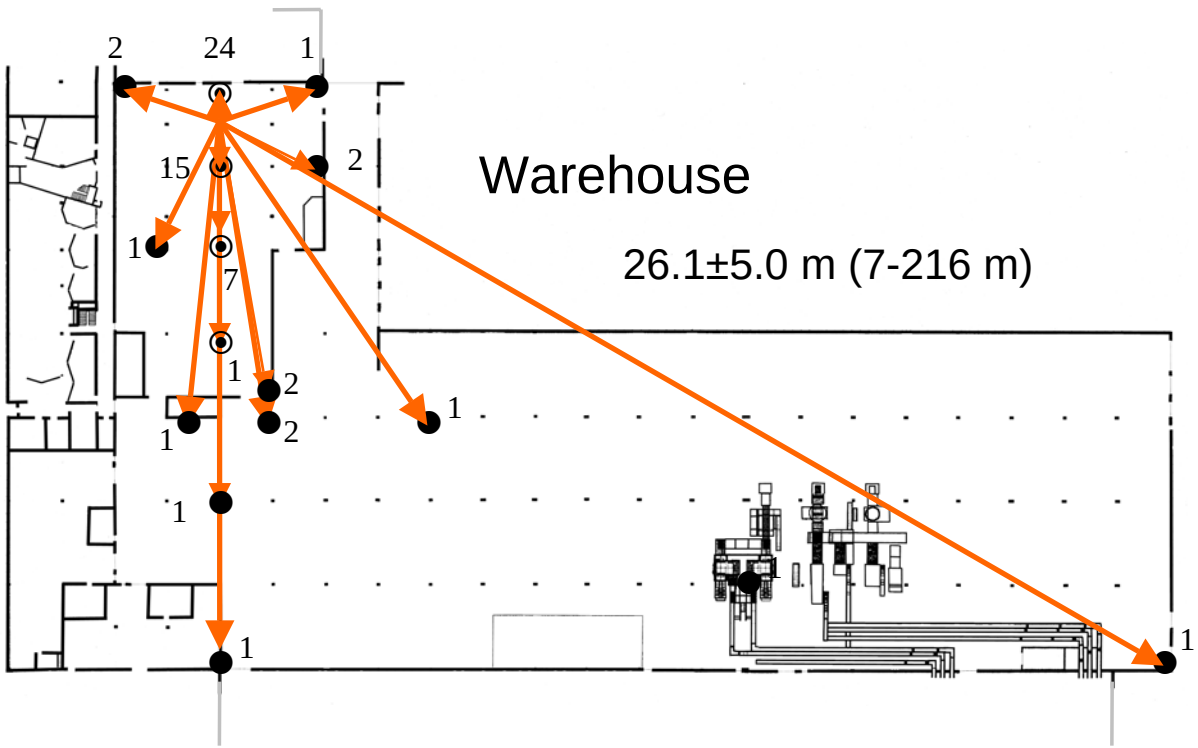


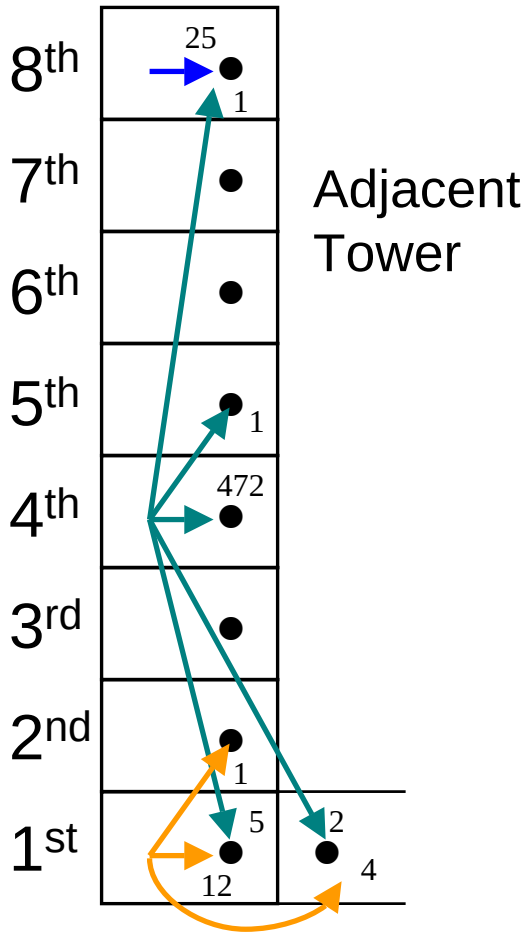
'Self-marking' Stations

- Modified pheromone traps so insects do not get trapped
- Insects get marked with fluorescent powder during visit
- Some marked individuals are captured in pheromone traps

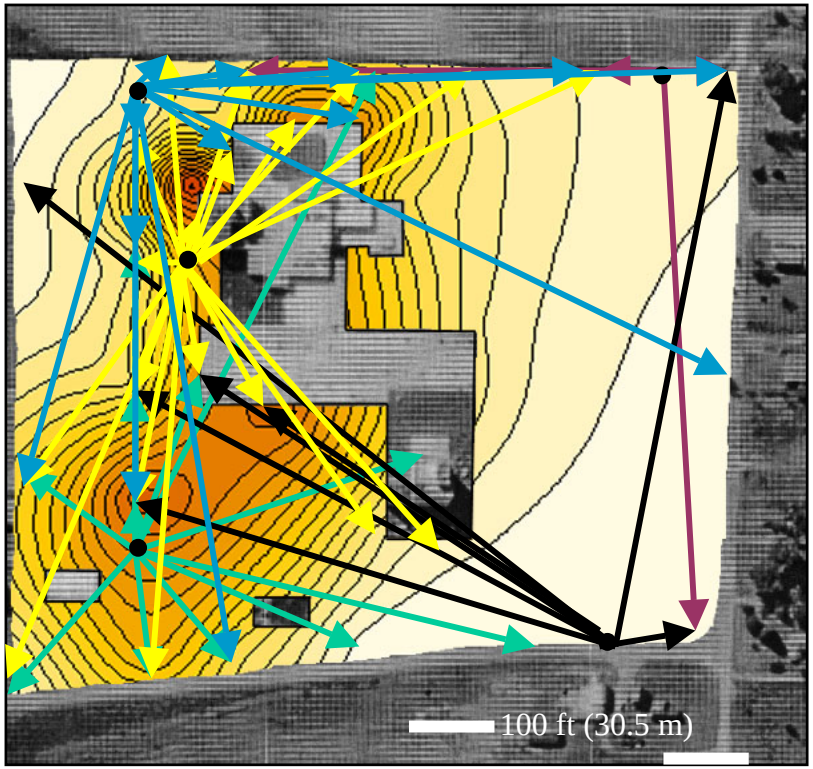
Warehouse beetle (*Trogoderma variabile*) movement patterns

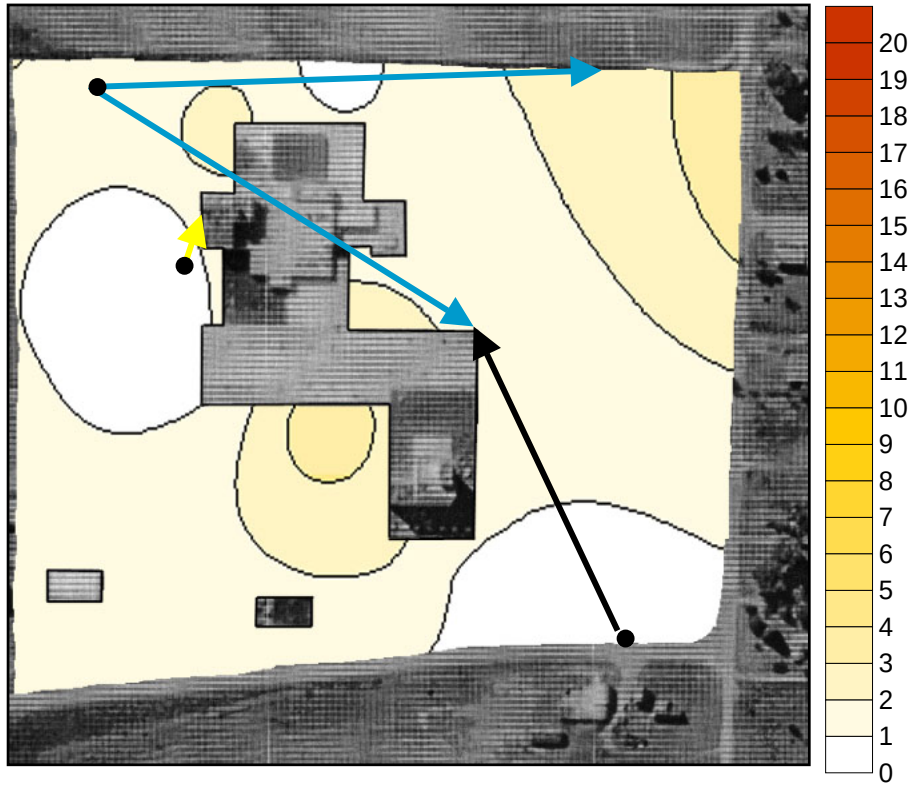
Trogoderma variabile male movement





Outside Movement Patterns





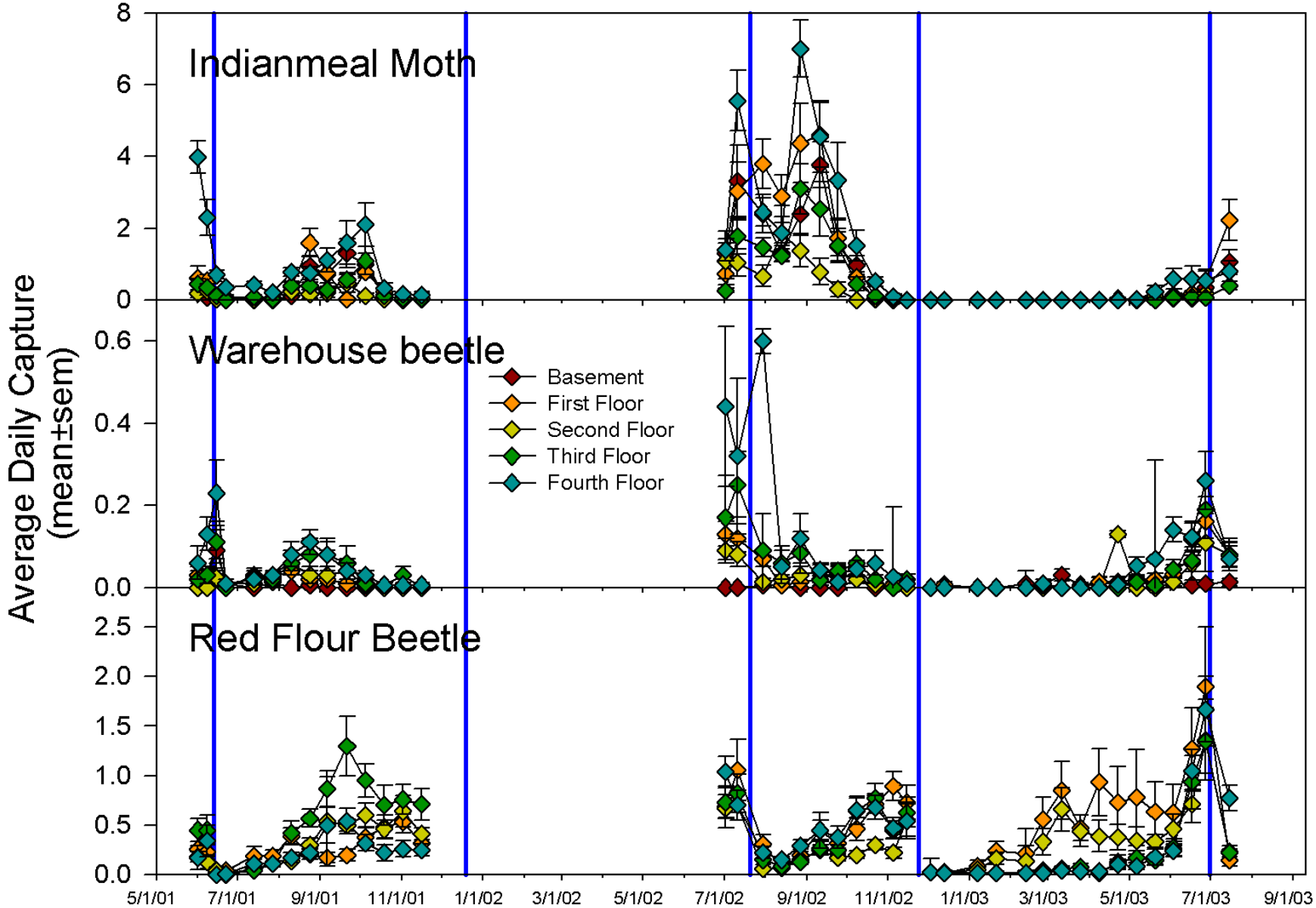
Warehouse Beetle

WB captured: 19420
Marked WB captured: 203
Percent of total capture: 1.04%
Average distance: 75 m (range 21-508 m)

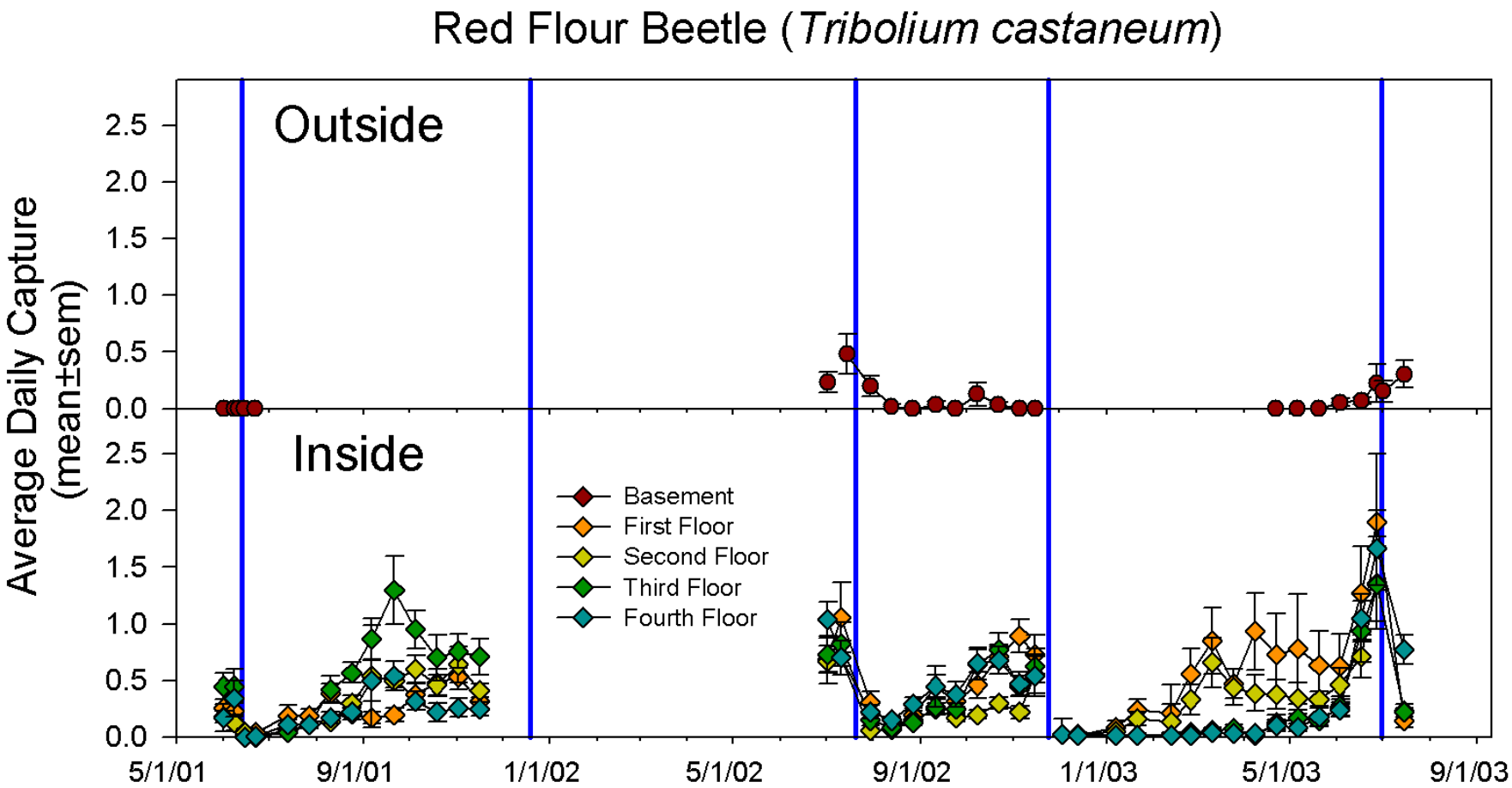
Indianmeal moth

IMM captured: 4433
Marked IMM captured: 6
Percent of total capture: 0.13%
Average distance: 136 m (range 21-276 m)

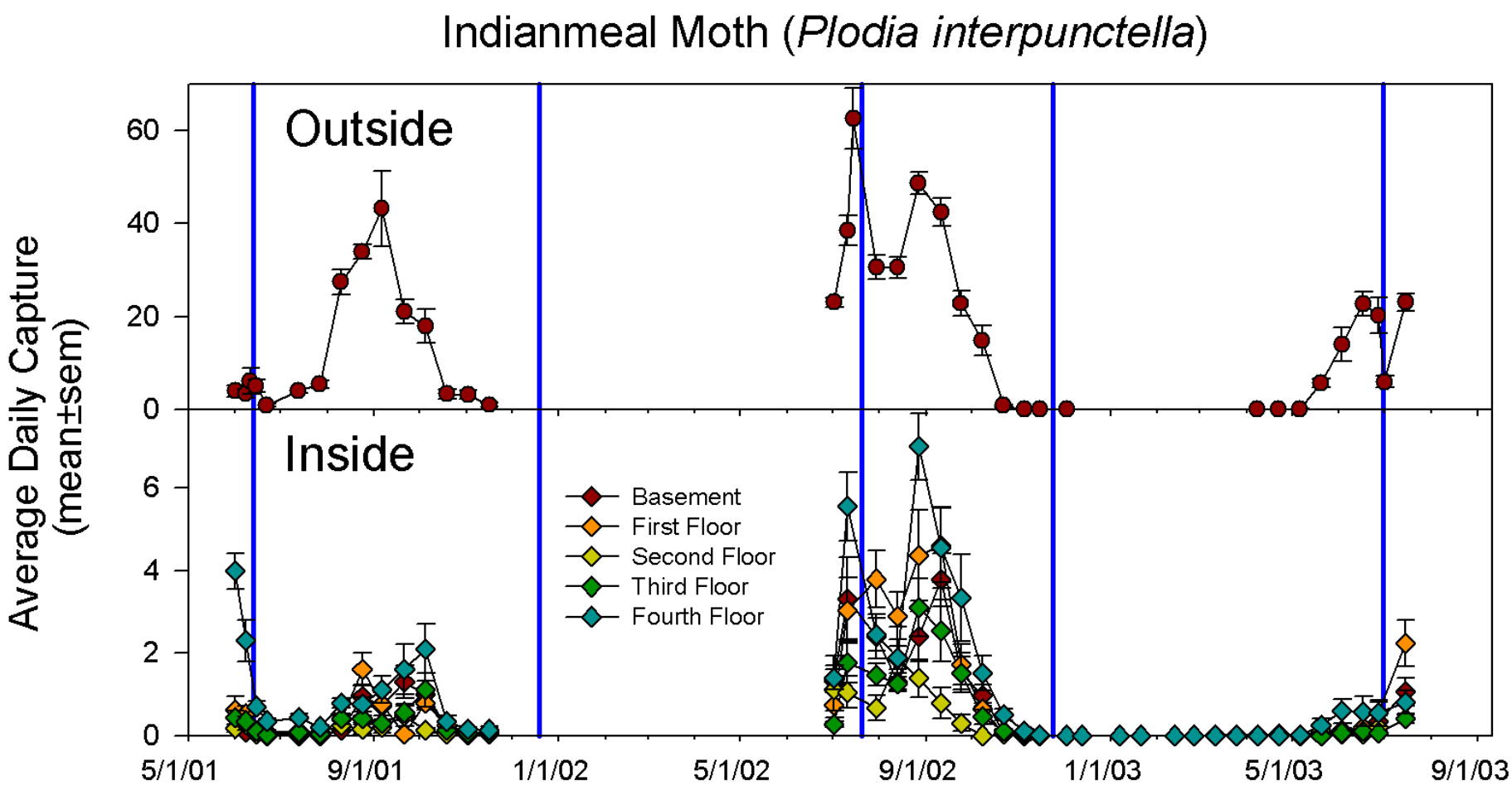
Population Trends over Time



Population Trends over Time



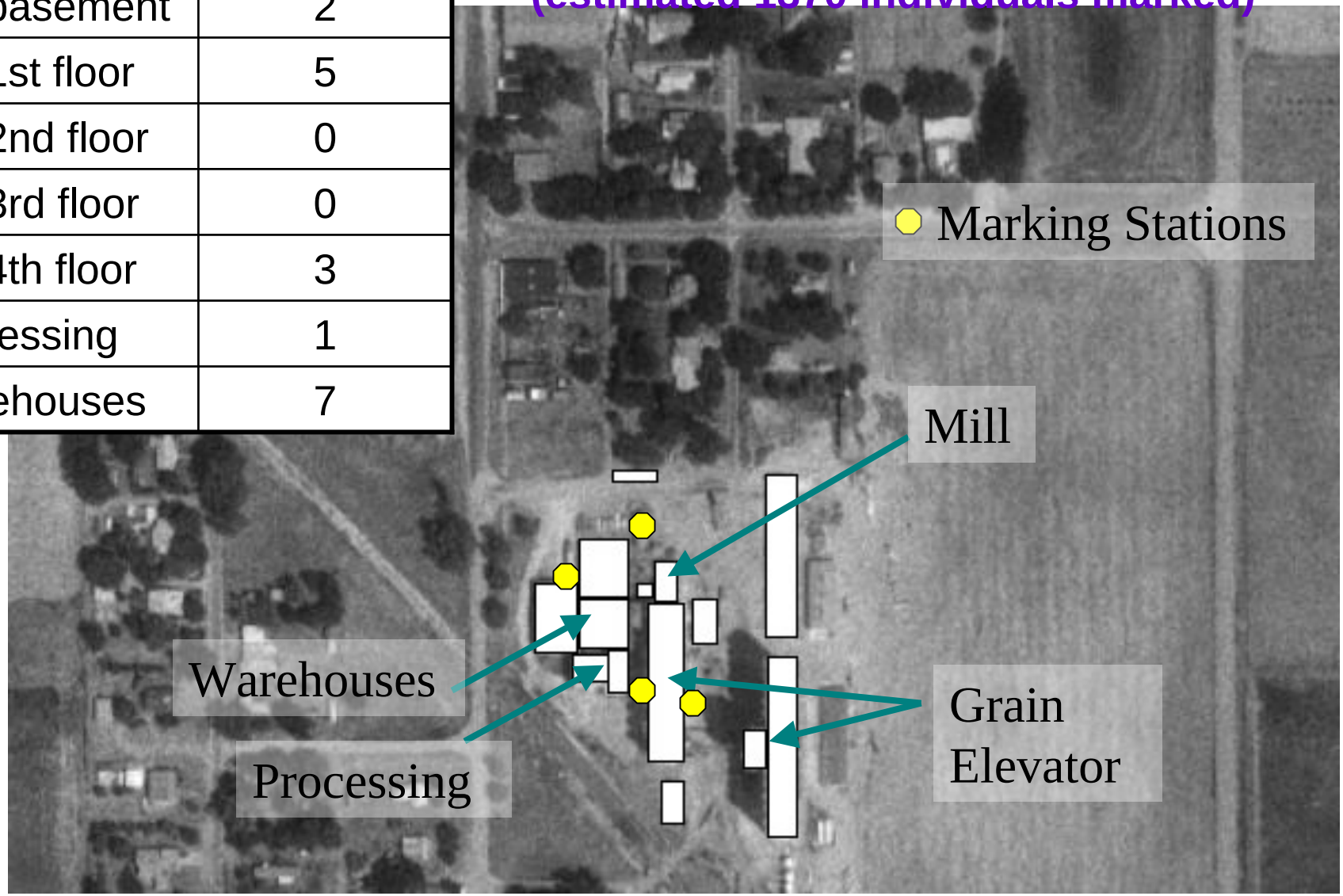
Population Trends over Time



Indianmeal Moth Self Mark-Recapture

(estimated 1370 individuals marked)

Location	Recaptured
Outside	50
Mill basement	2
Mill 1st floor	5
Mill 2nd floor	0
Mill 3rd floor	0
Mill 4th floor	3
Processing	1
Warehouses	7



Trap capture interpretation

- Pheromone monitoring is a powerful tool, but it is only one component in a pest monitoring program
- High trap captures can indicate:
  - proximity of infested material
  - Vulnerability to infestation
  - Routes of insect movement
- Follow up using more monitoring or direct inspection is needed for interpretation