



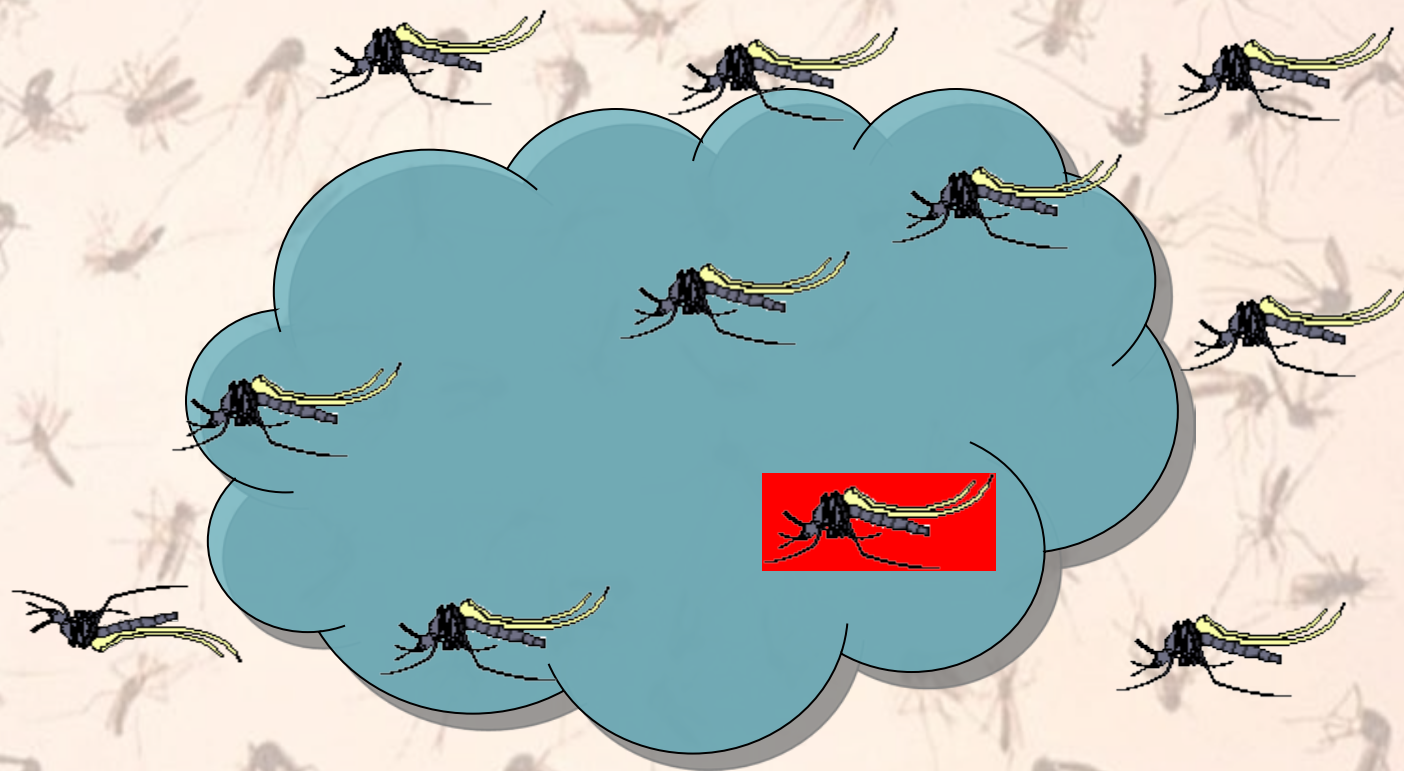
# Overview of Insecticide Resistance

Janet McAllister, CDC Ft. Collins, CO

# Spray a population



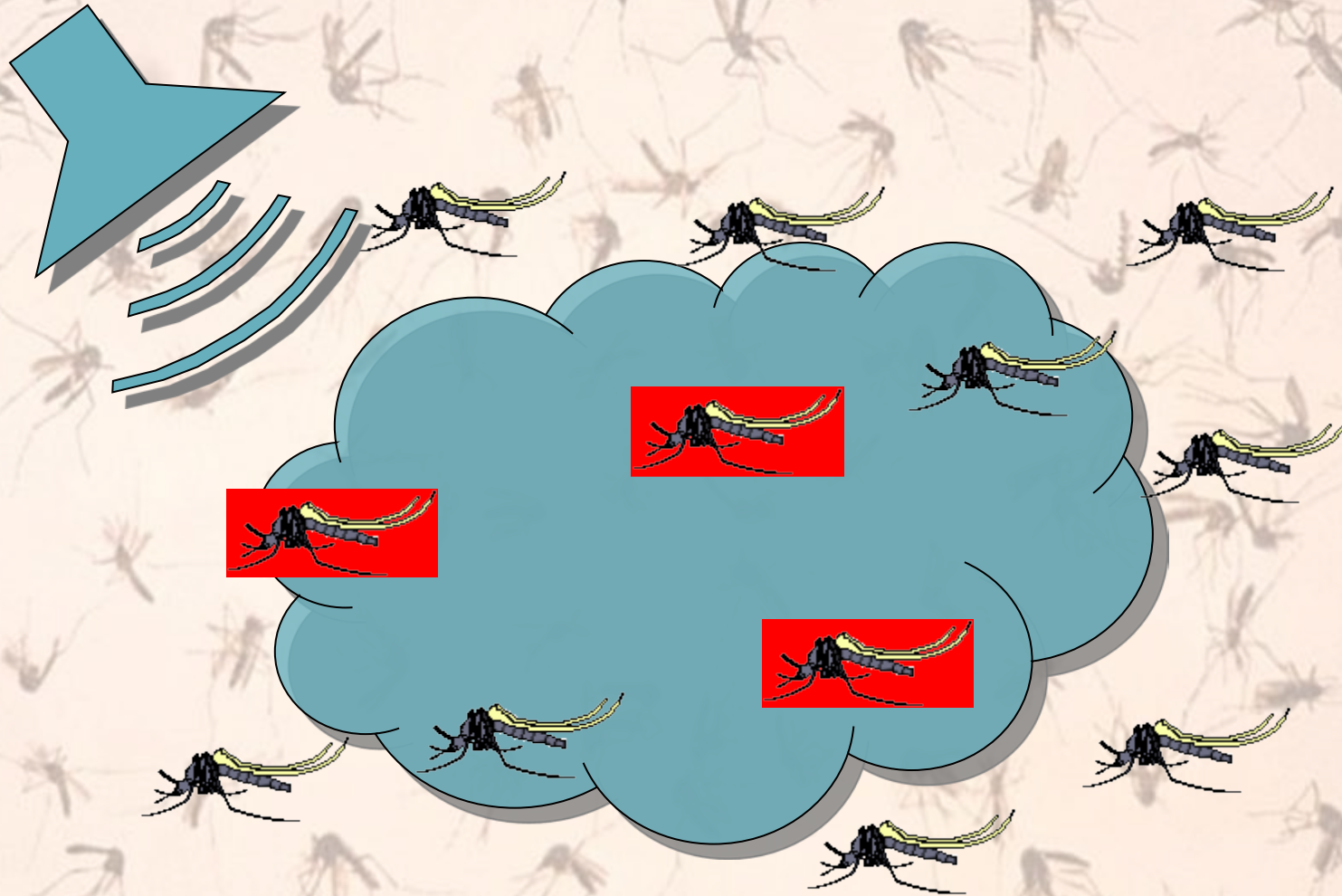
# Survivor with “something special”



# Offspring of the survivor



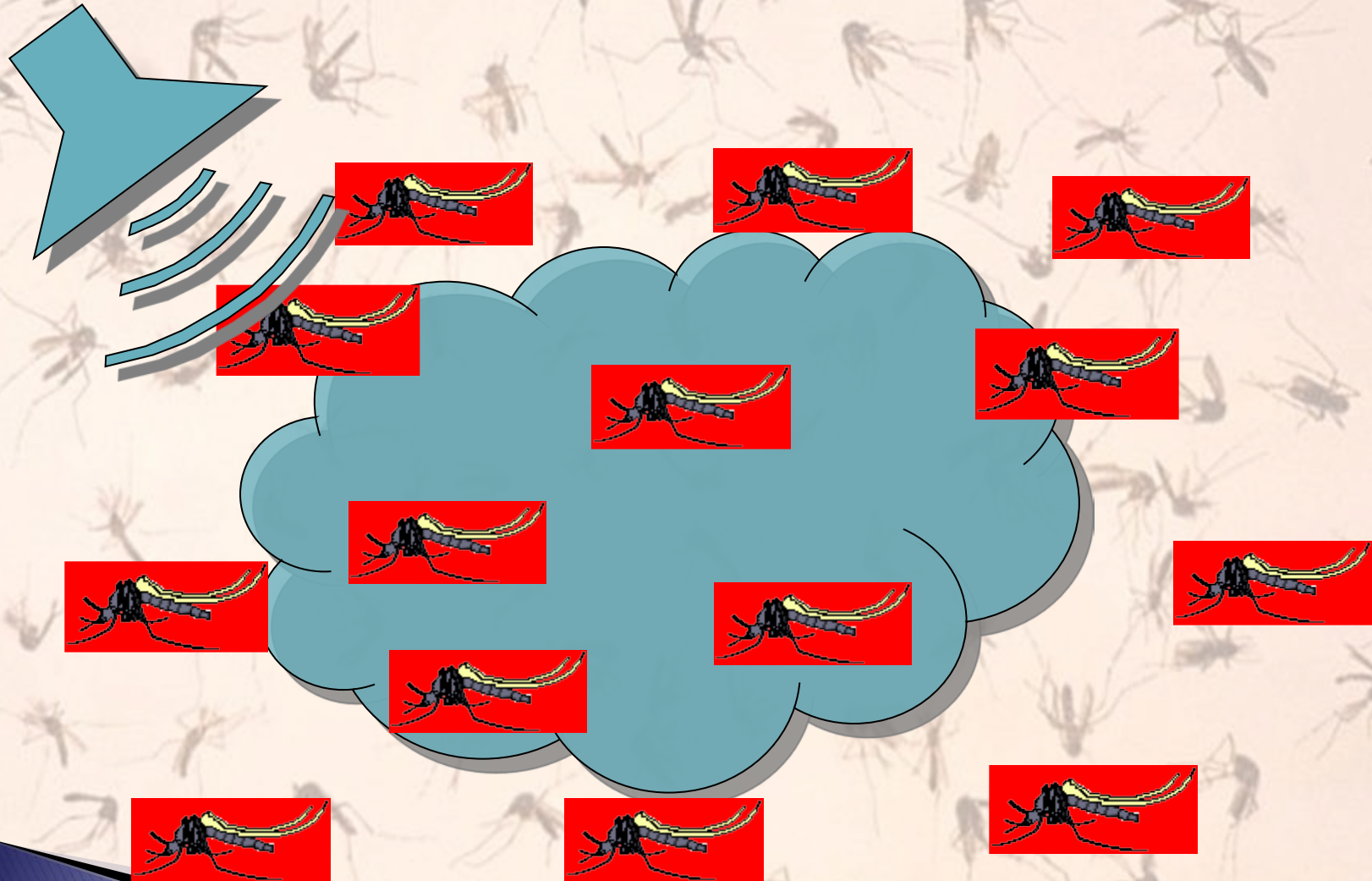
# Spray again – more survivors



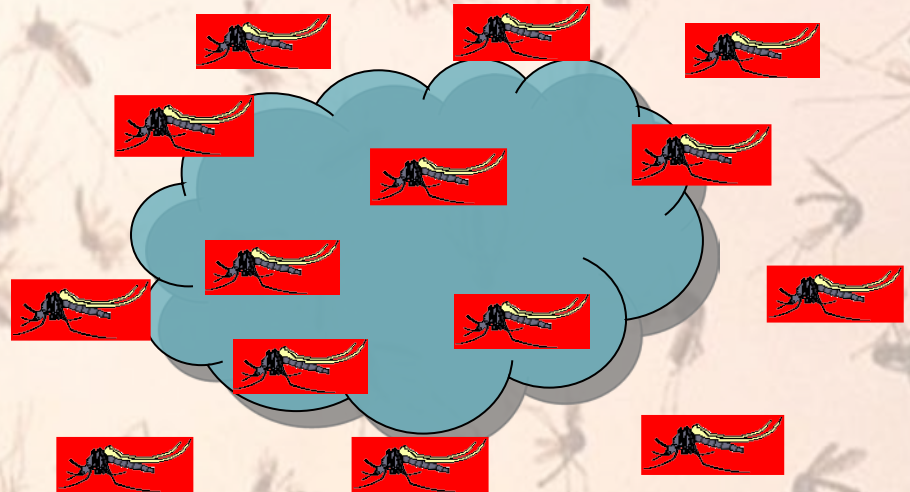
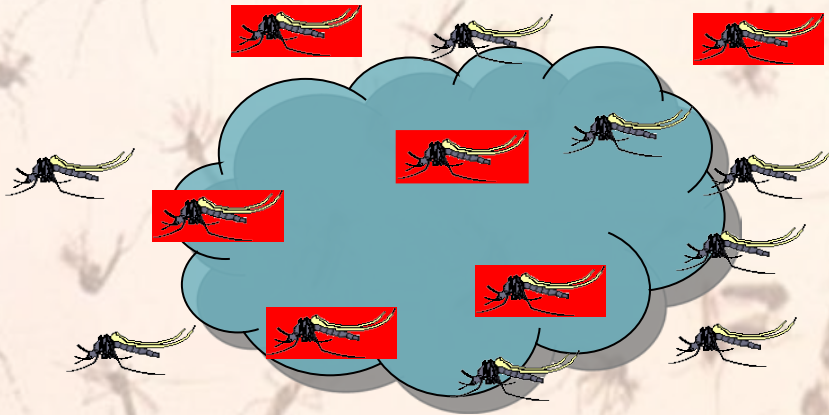
# Spray again – more survivors



# Spray again – more survivors



At what point do you have a resistant population?



# Definition

**Insecticide Resistance** is a genetic change in response to selection by toxicants that may impair control in the field. (Sawicki, 1987)

# How to develop Insecticide Resistance in Vectors

- ▶ single class of insecticide
- ▶ long-residual action
- ▶ slow-release formulation
- ▶ apply to all life states, all generations
- ▶ treat all habitat where pest occurs

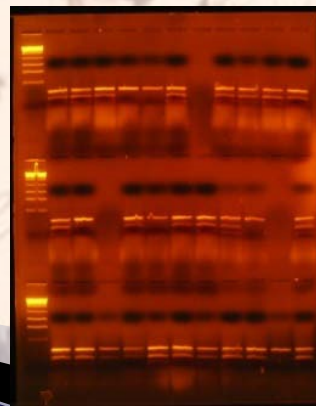
# Mechanisms of Resistance

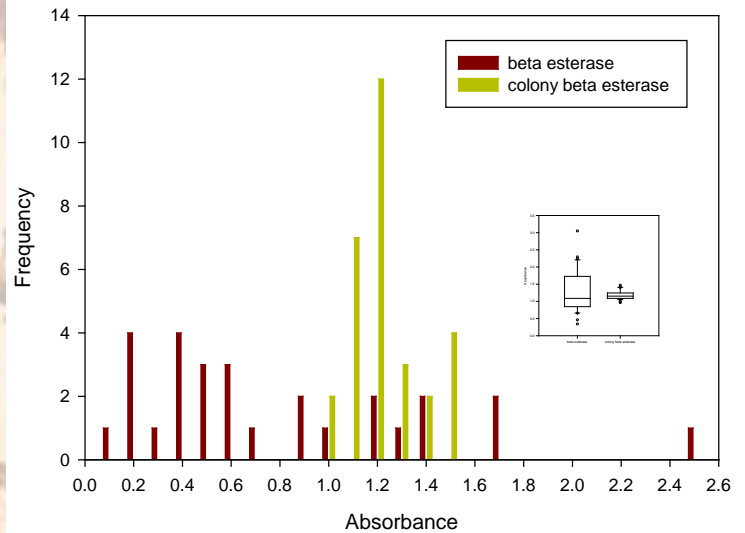
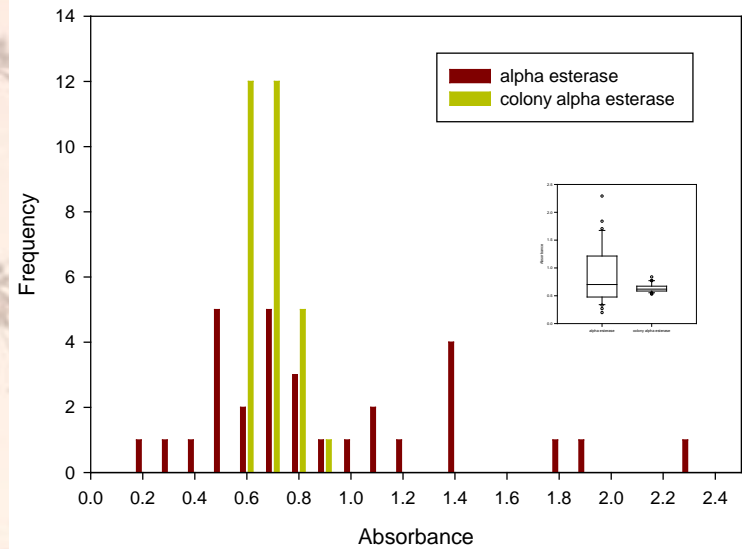
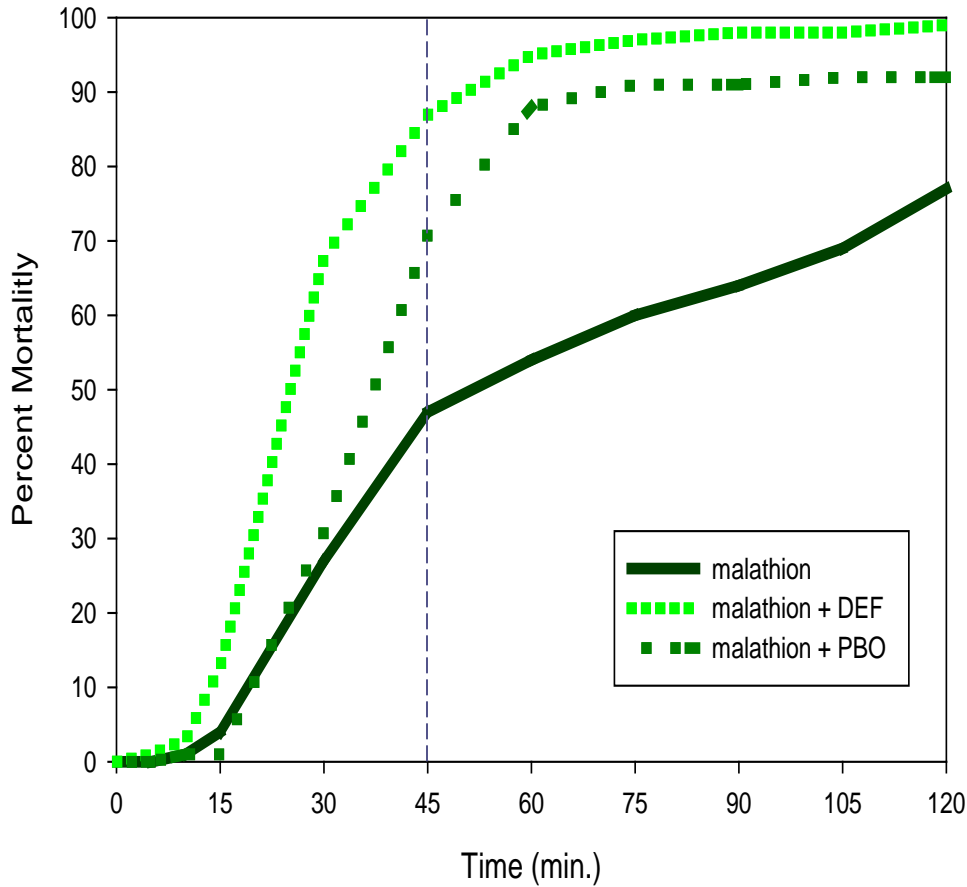
- ▶ Behavioral
- ▶ Reduced Penetration
- ▶ Metabolic
- ▶ Altered Target Site

So which mechanism gets selected?

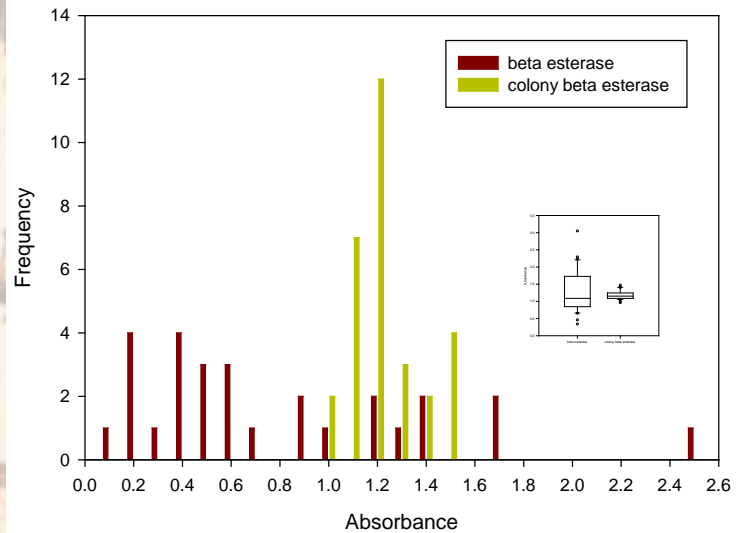
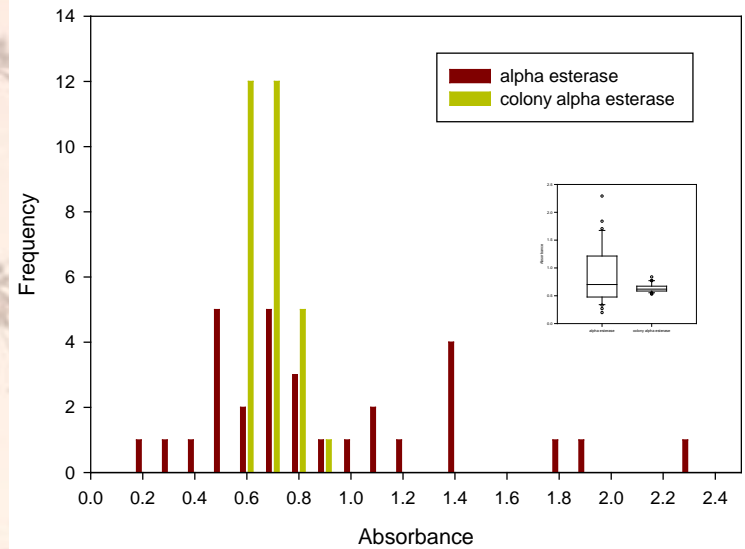
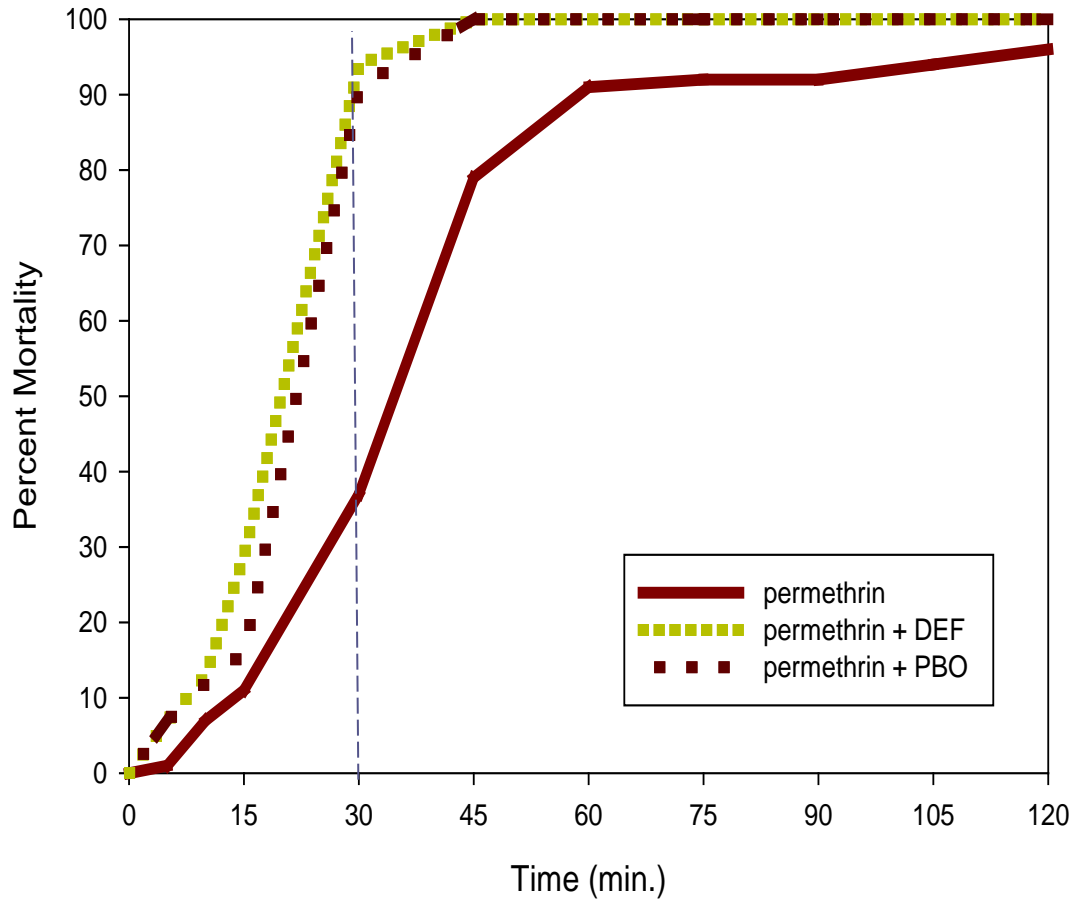
# Strategies for Detecting Resistance

- ▶ WHO Larval Test
- ▶ WHO Adult Test
- ▶ Bottle Bioassay – adults
- ▶ Topical Applications – adults
  - Wind Tunnel, Microliter syringes etc.
- ▶ Biochemical Assays – both
- ▶ Molecular Tools – both
- ▶ Field Tests – both

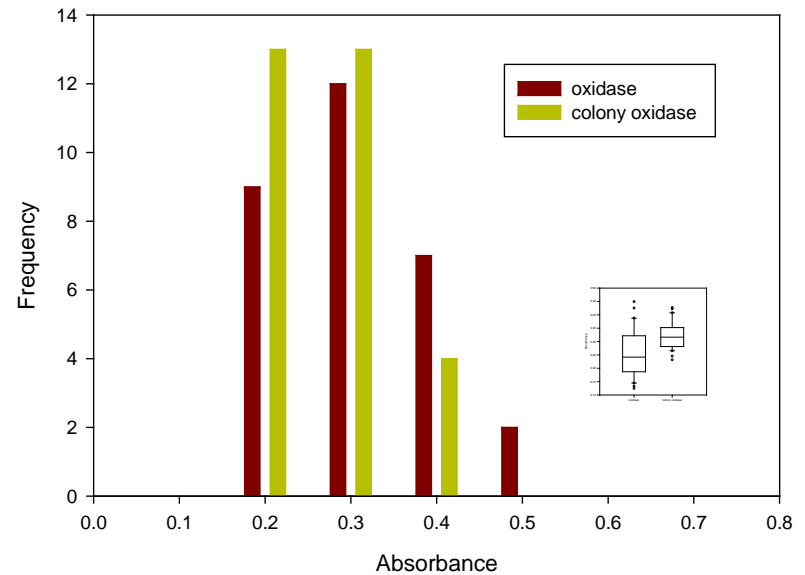
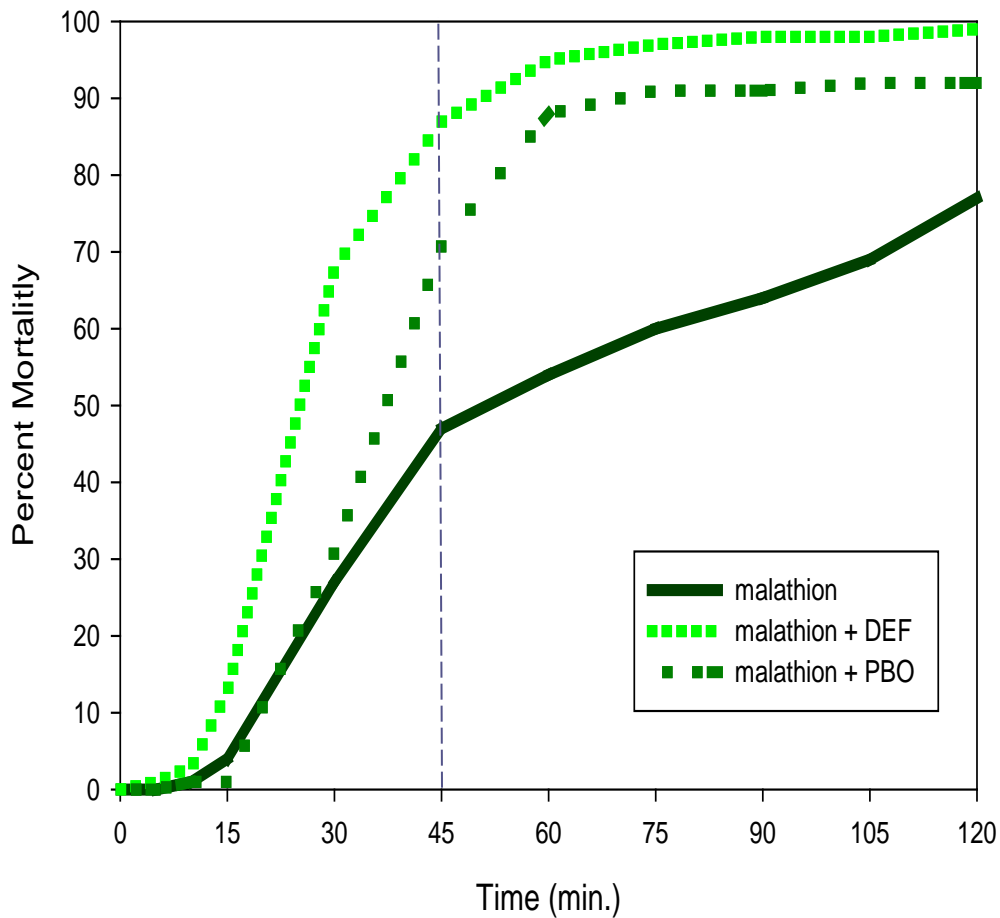




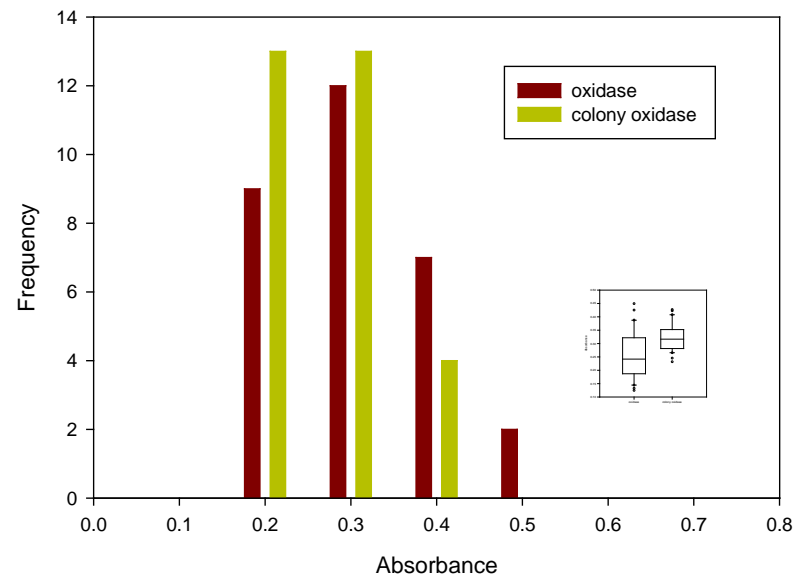
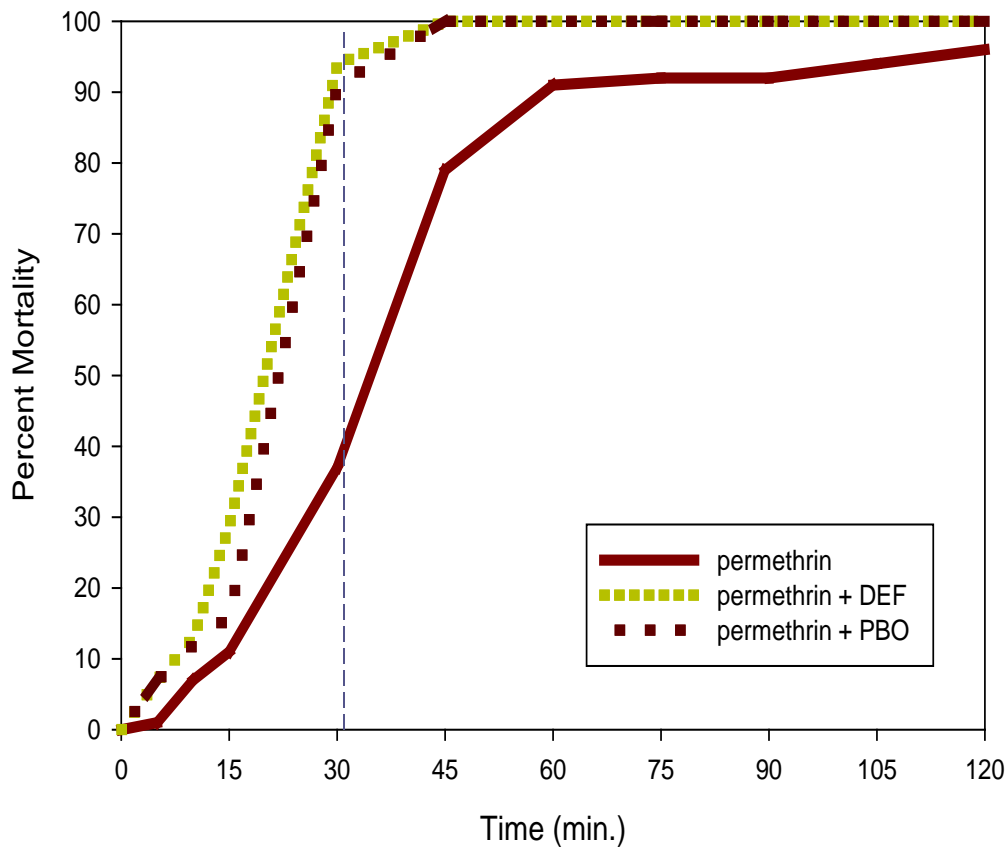
Phenotypic expression of resistance mechanisms for *Cx. quinquefasciatus* from Maricopa Co AZ 2010 using bottle bioassays



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Phenotypic expression of resistance mechanisms for *Cx. quinquefasciatus* from Maricopa Co AZ 2010 using bottle bioassays

24 March 2000  
Vol. 287, No. 5461  
Pages 2105-2364 58

# Science

**The  
Drosophila  
Genome**

# *Anopheles gambiae* 111 P450 genes

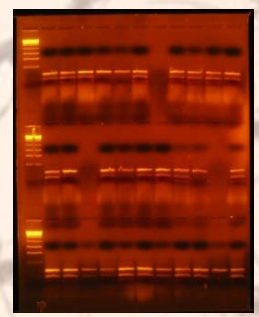
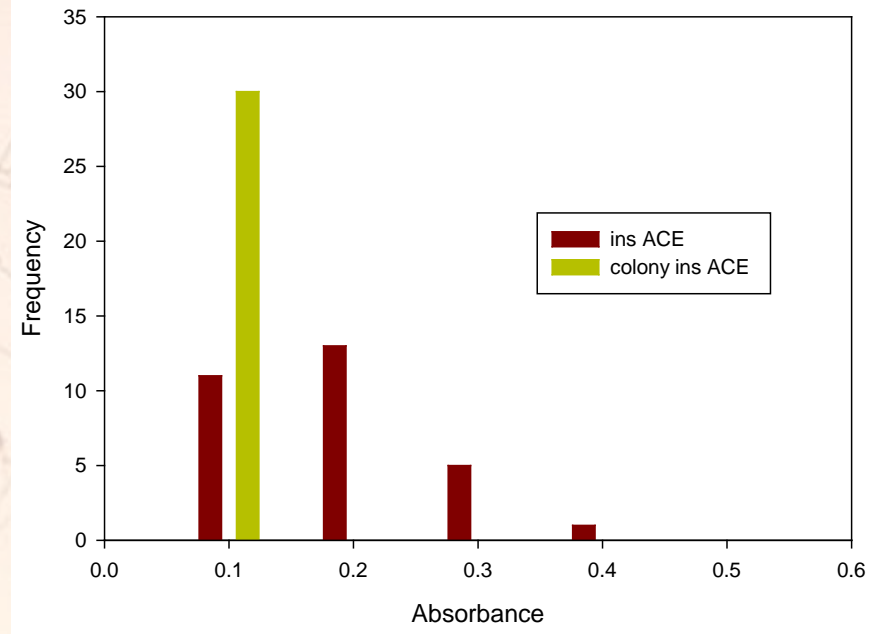
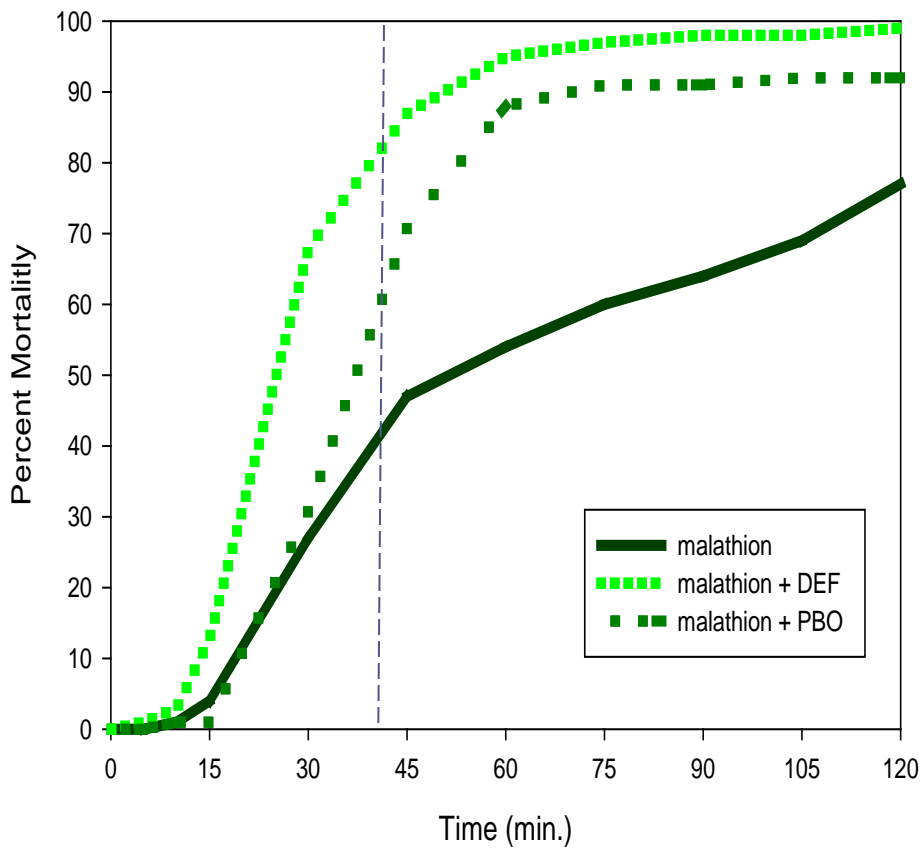
4 October 2002  
Vol. 298 No. 5591  
Pages 1-310 \$10

# Science

THE MOSQUITO GENOME  
*Anopheles gambiae*

*Drosophila*  
80 P450 genes

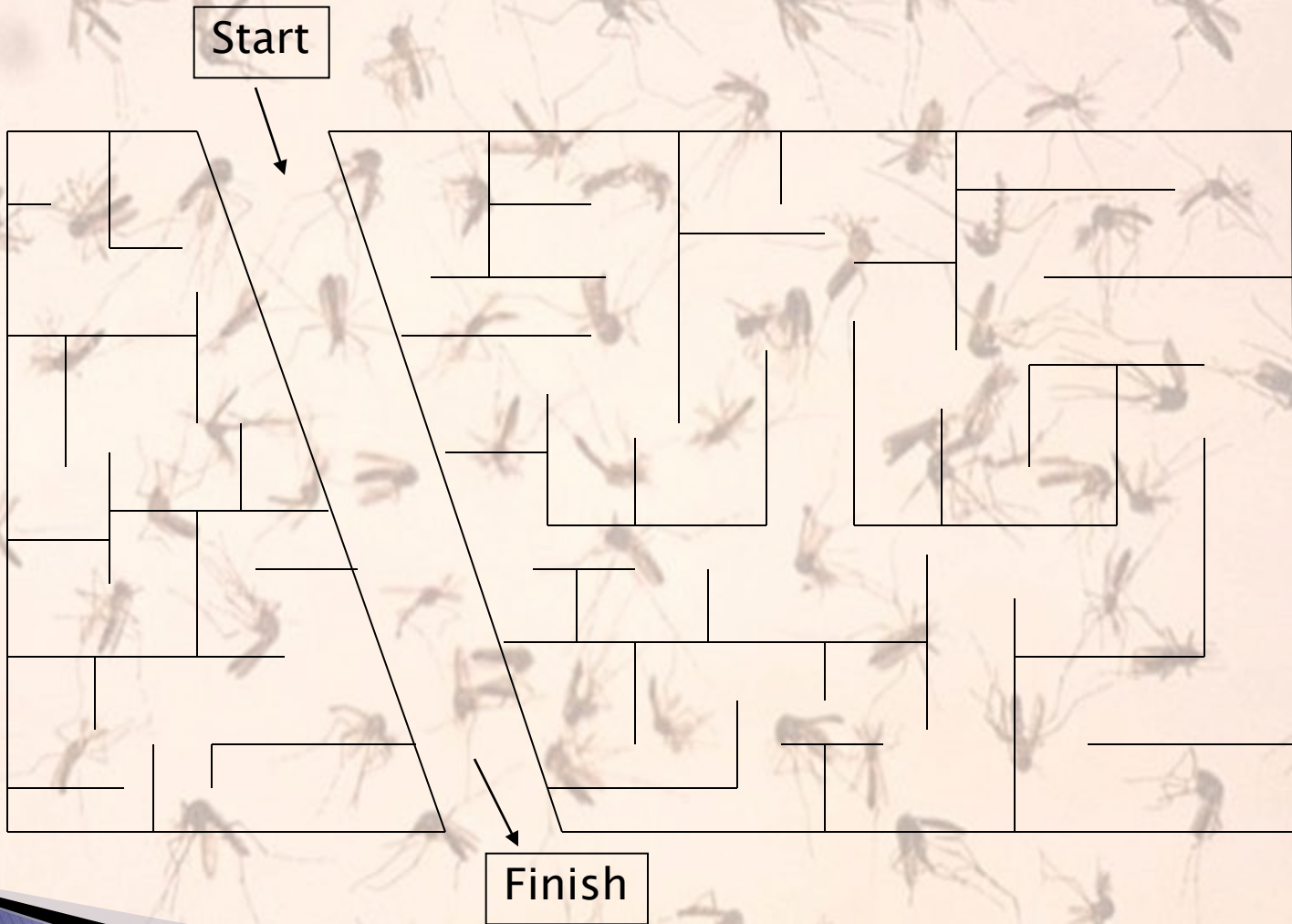
*Culex pipiens* – 52 P450 genes thus far.



Altered-target site is a minor resistance mechanisms for *Cx. quinquefasciatus* from Maricopa Co AZ 2010 using bottle bioassays



# To this?



# Resistance Management Issues

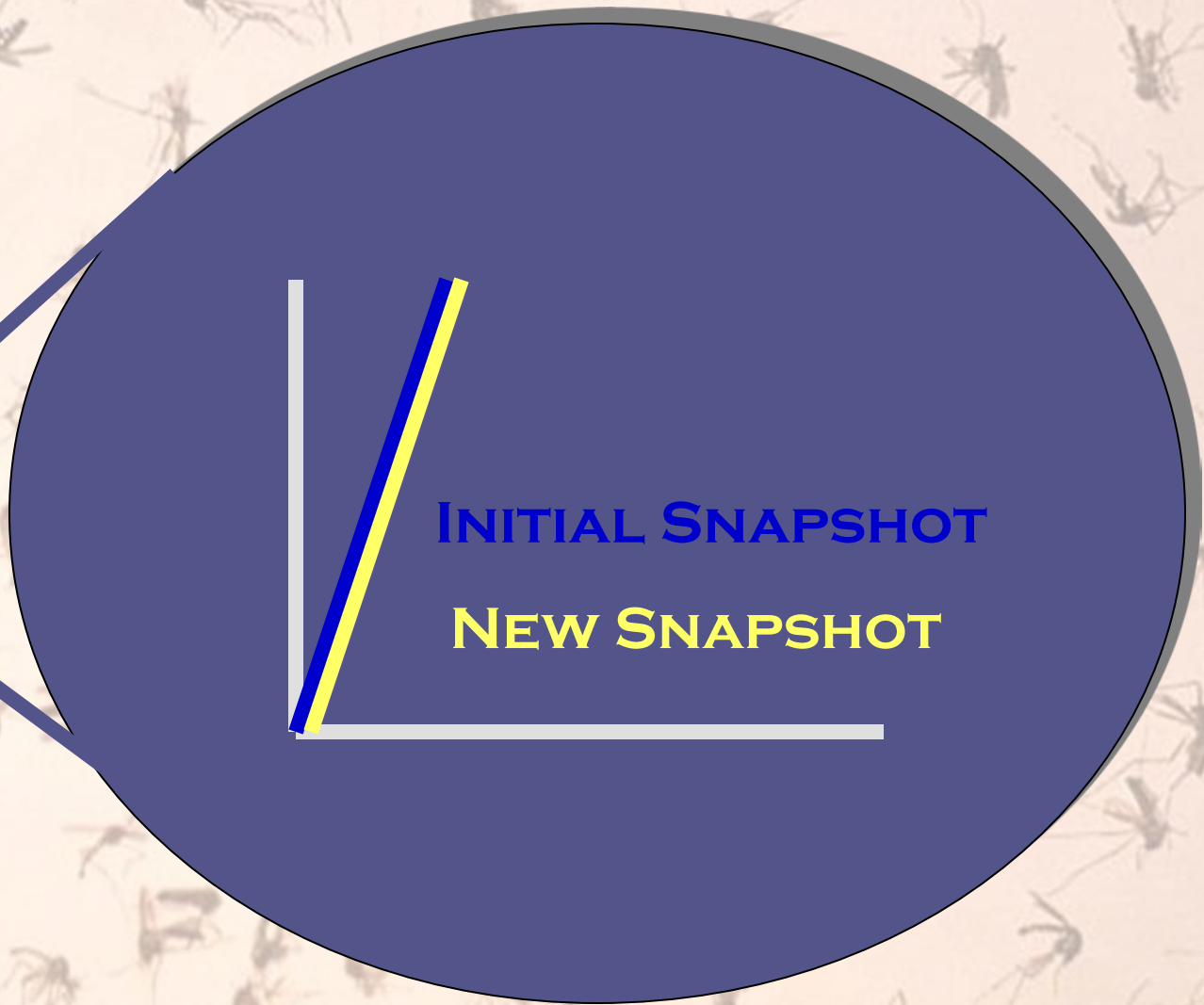
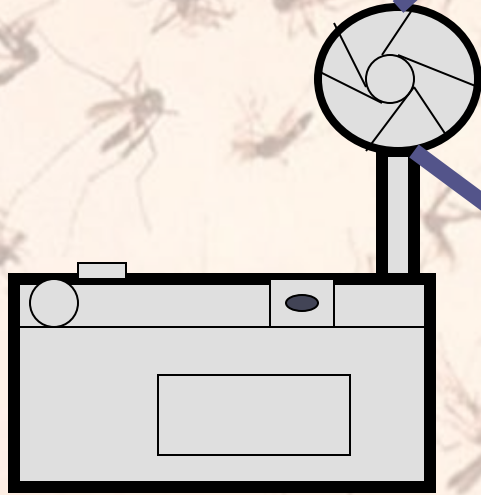
- ▶ What is it?
- ▶ When will it arrive?
- ▶ Once it's here is that it for using for the chemical?
- ▶ How do I know I have it?
- ▶ What do I do?
- ▶ What roles do outside forces play in selection for resistance?
- ▶ Where do I go for help?

# Surveillance for Resistance

**Detection**

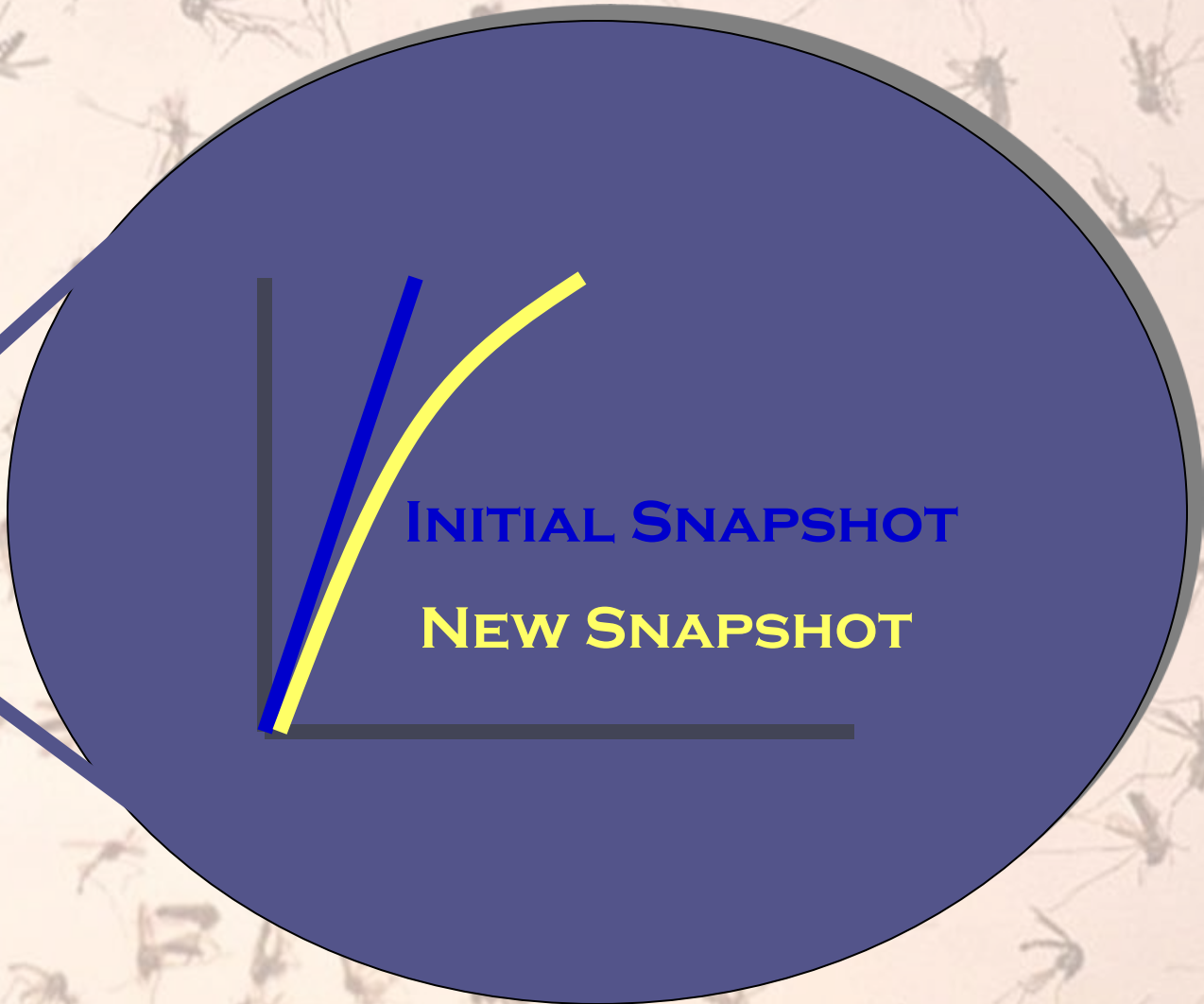
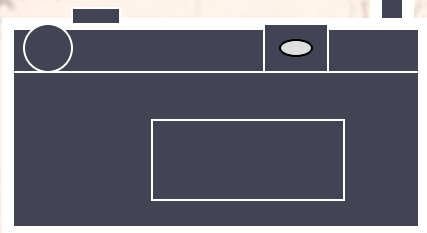
Action

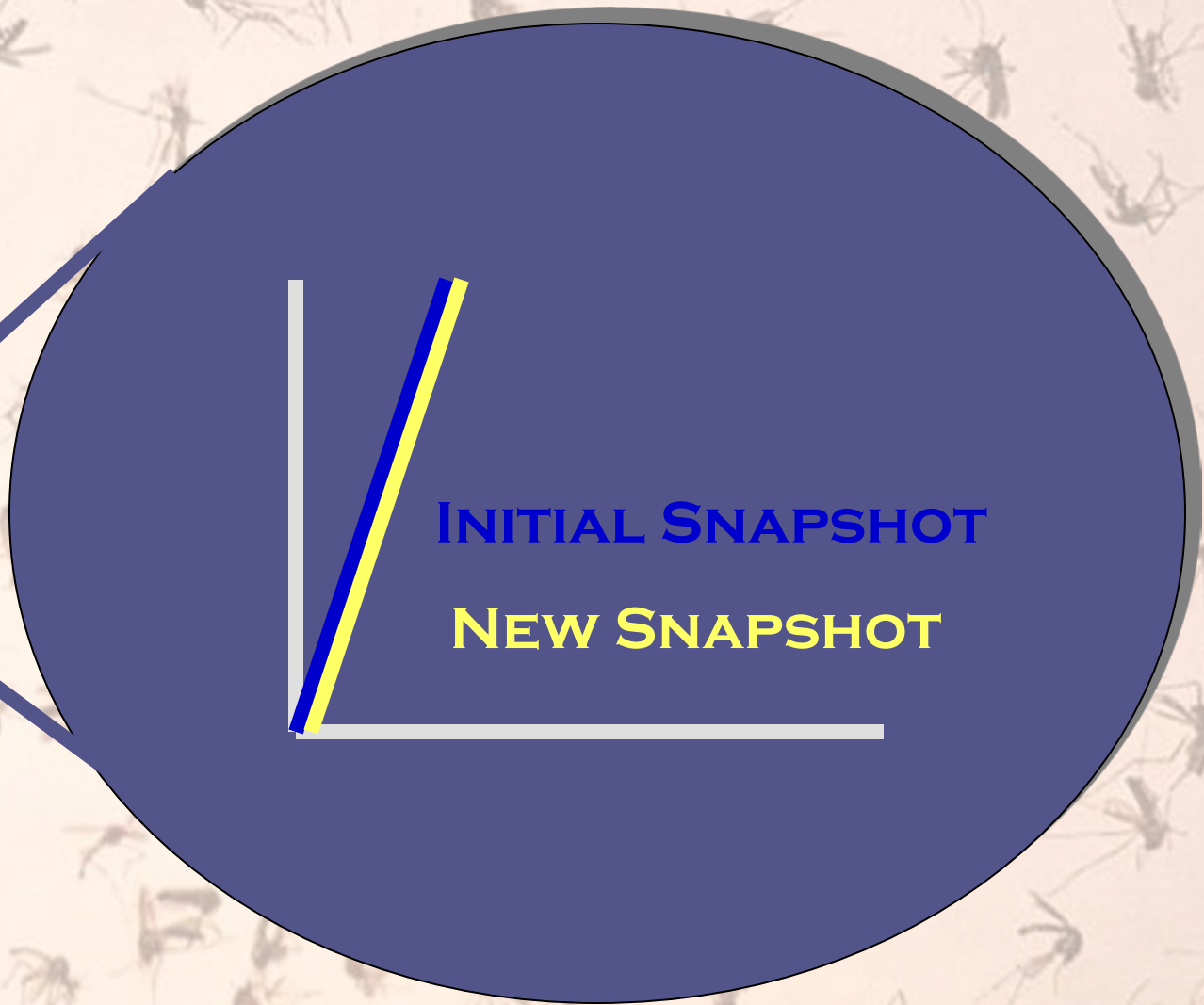
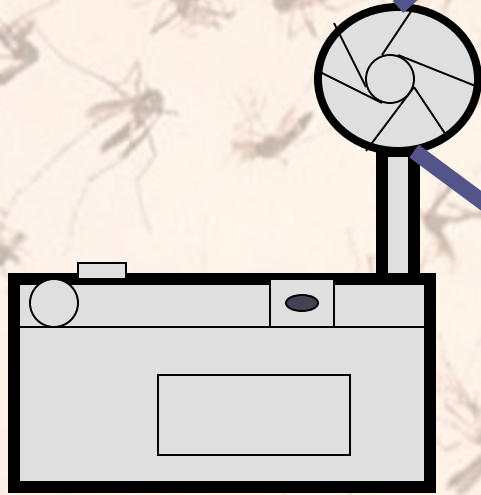
Evaluation



**INITIAL SNAPSHOT**

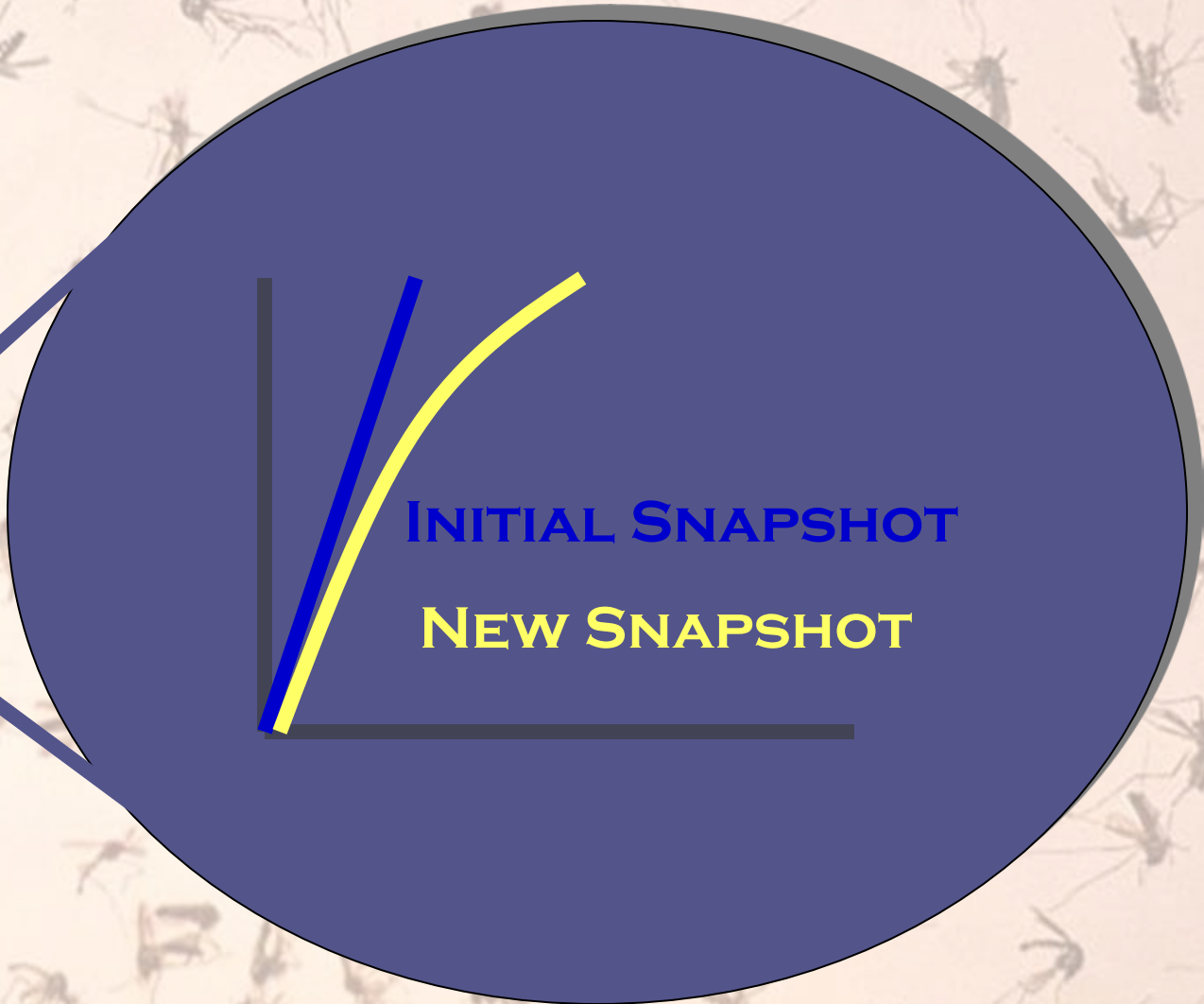
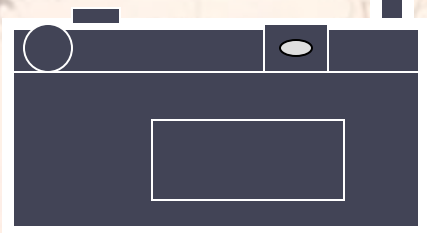
**NEW SNAPSHOT**

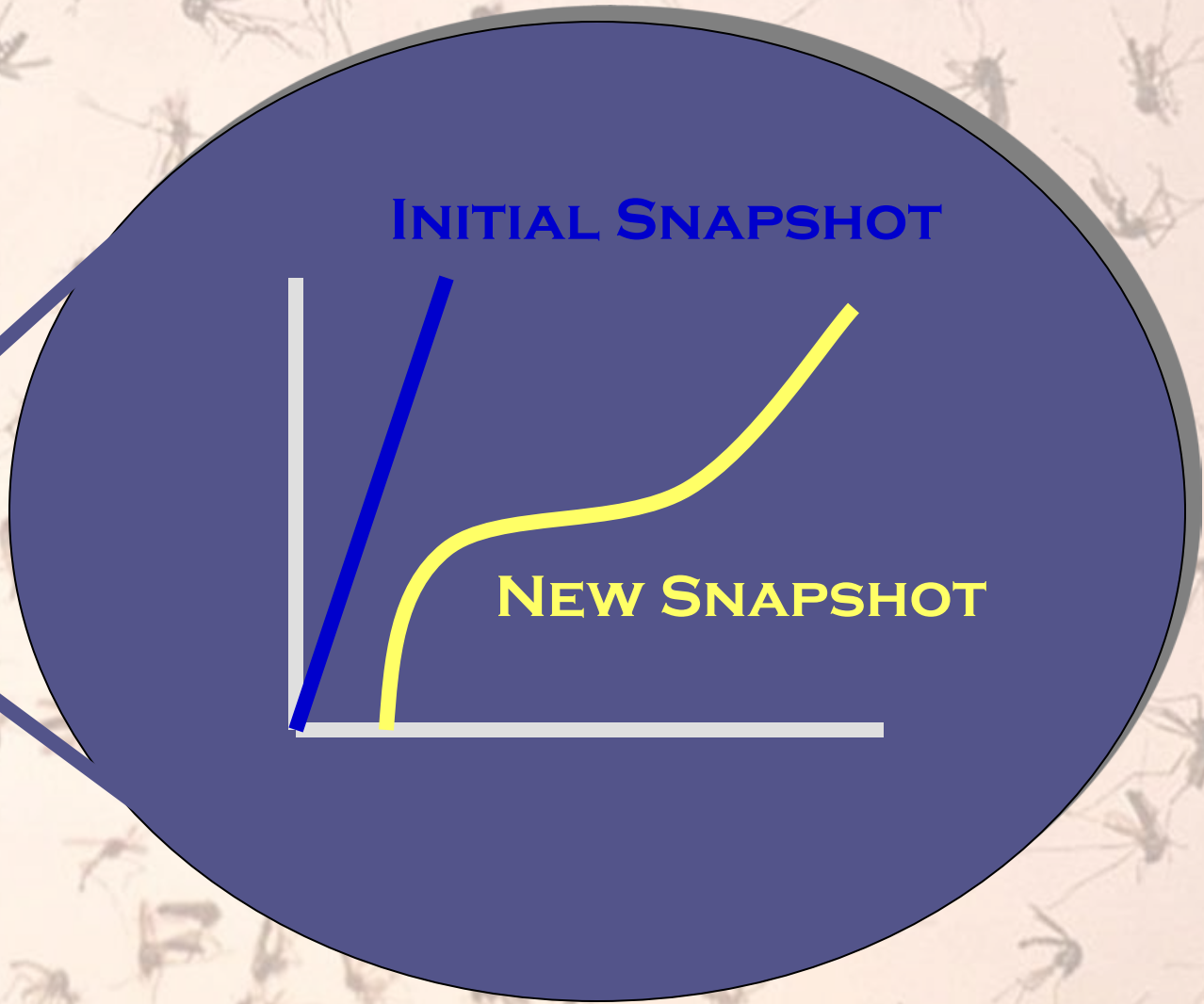
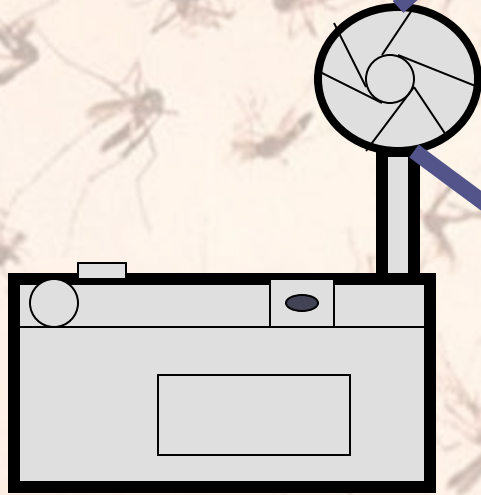




**INITIAL SNAPSHOT**

**NEW SNAPSHOT**



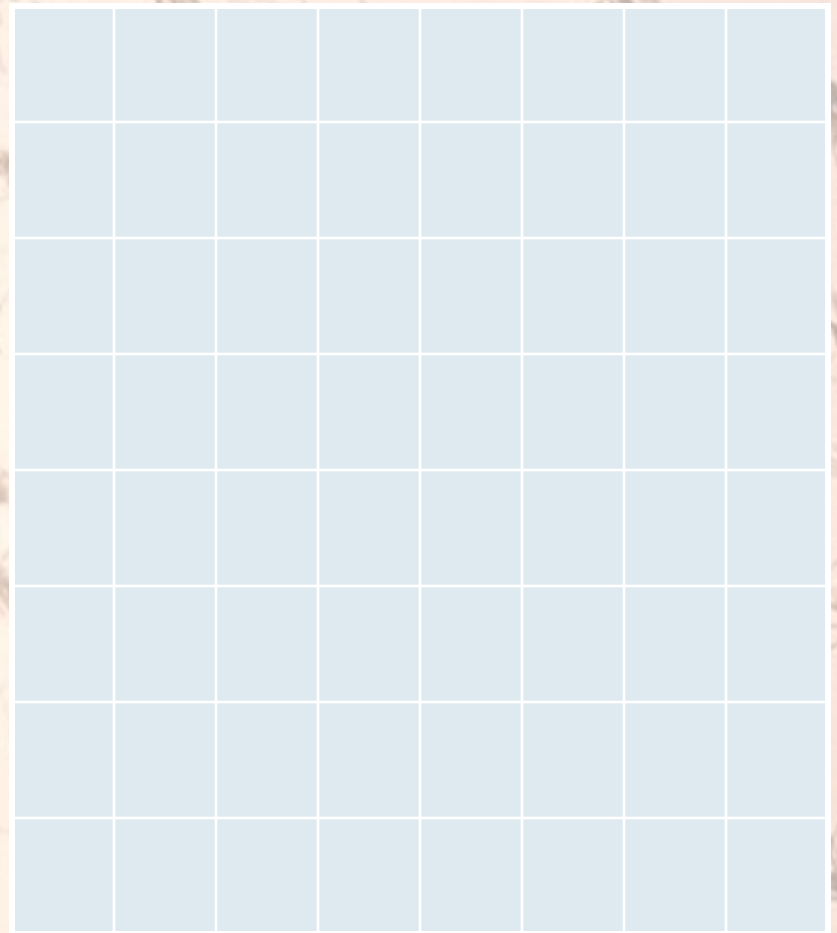
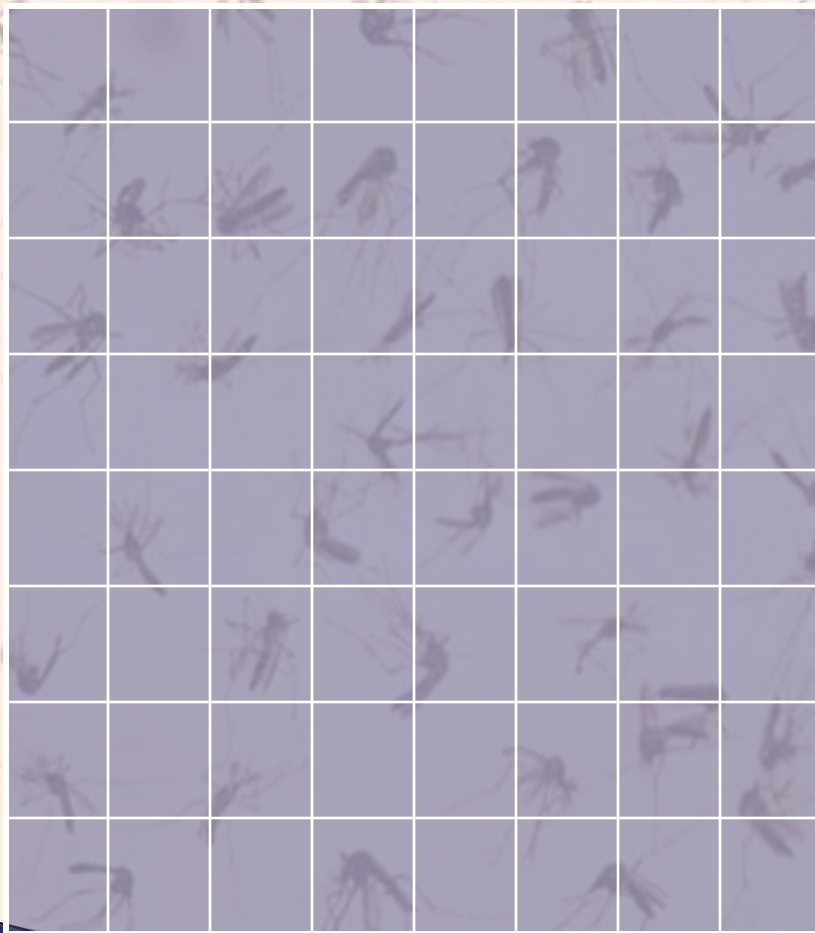


# What do I do if I find it?

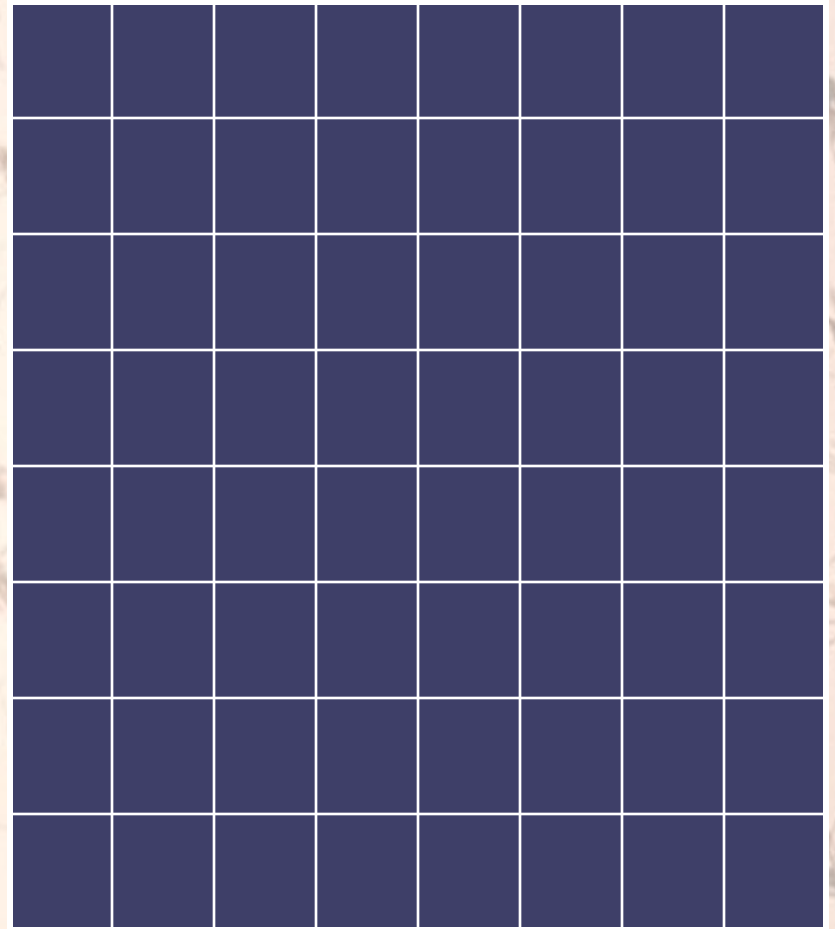
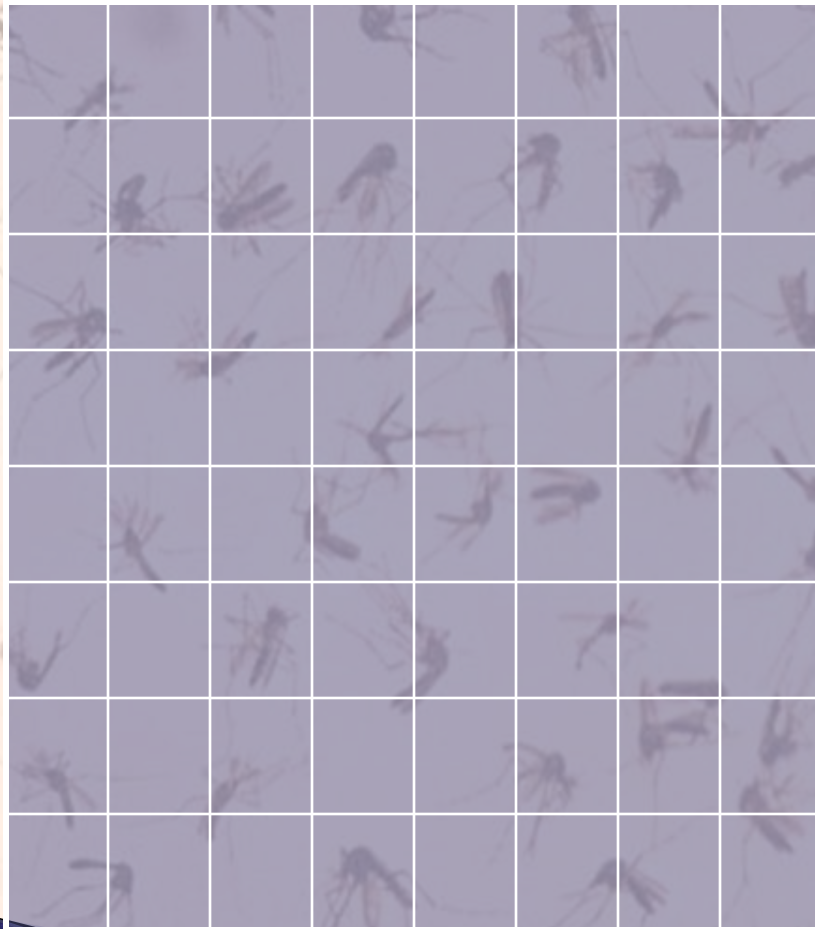
## ASK MORE QUESTIONS

- ▶ What class is the insecticide?
- ▶ Are other members of this class also less effective?
- ▶ What mechanism is the likely cause?
- ▶ What do I know of the spray history of my population?
- ▶ What level of control can I live with?

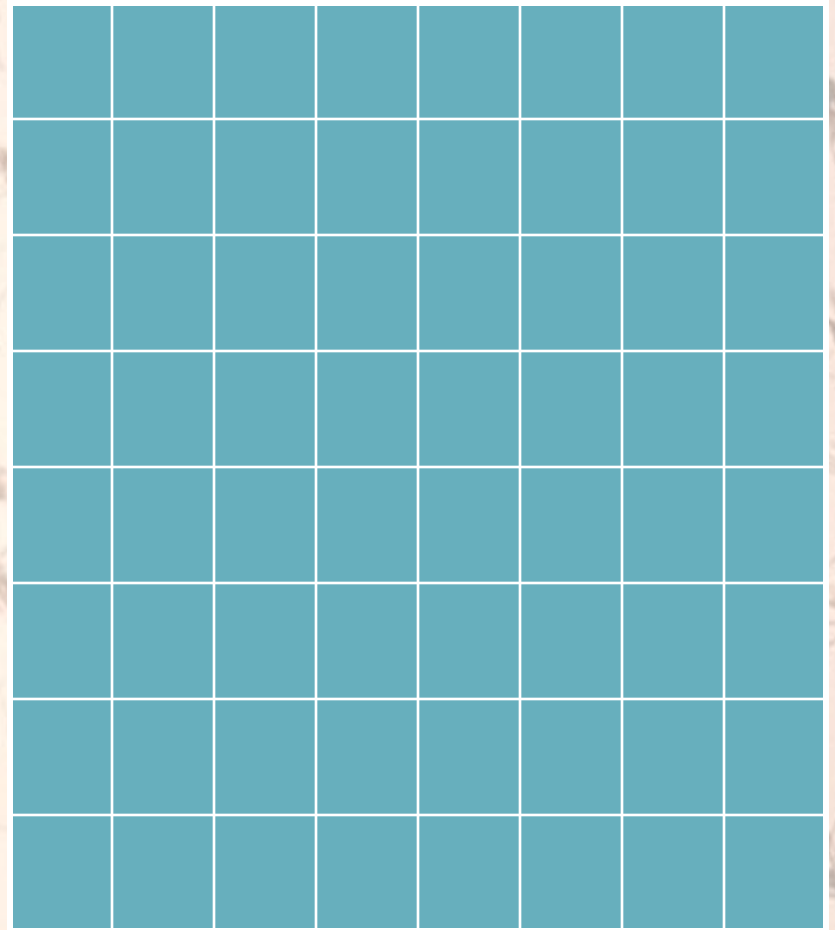
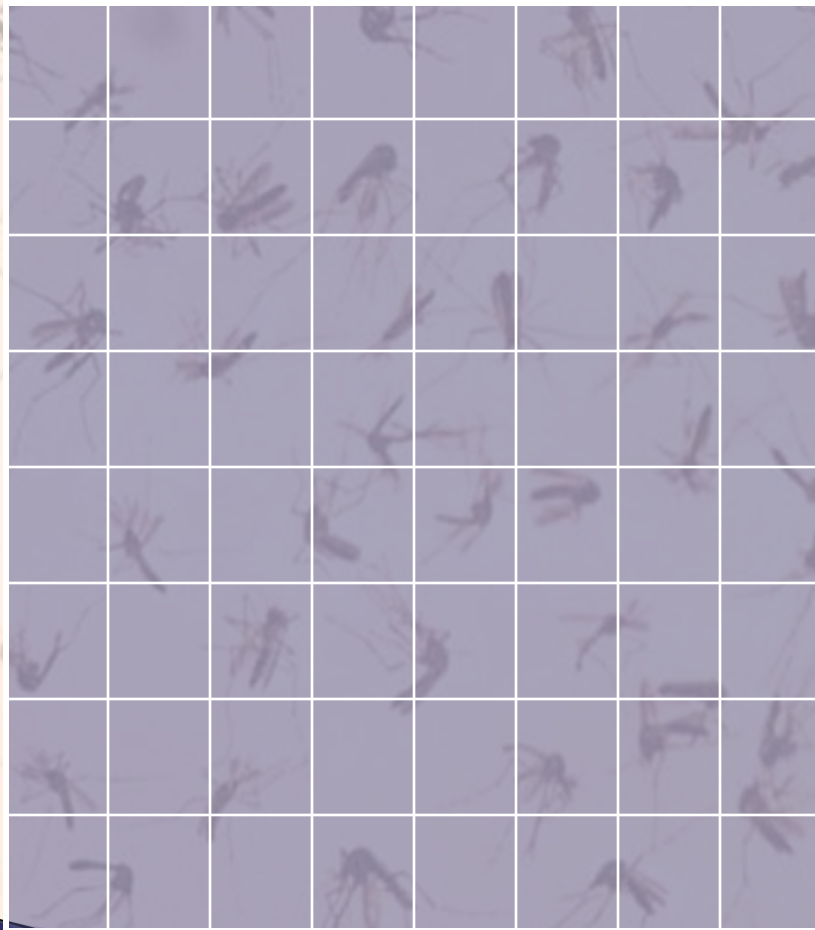
# Management schemes – stop spraying and rely on other control methods



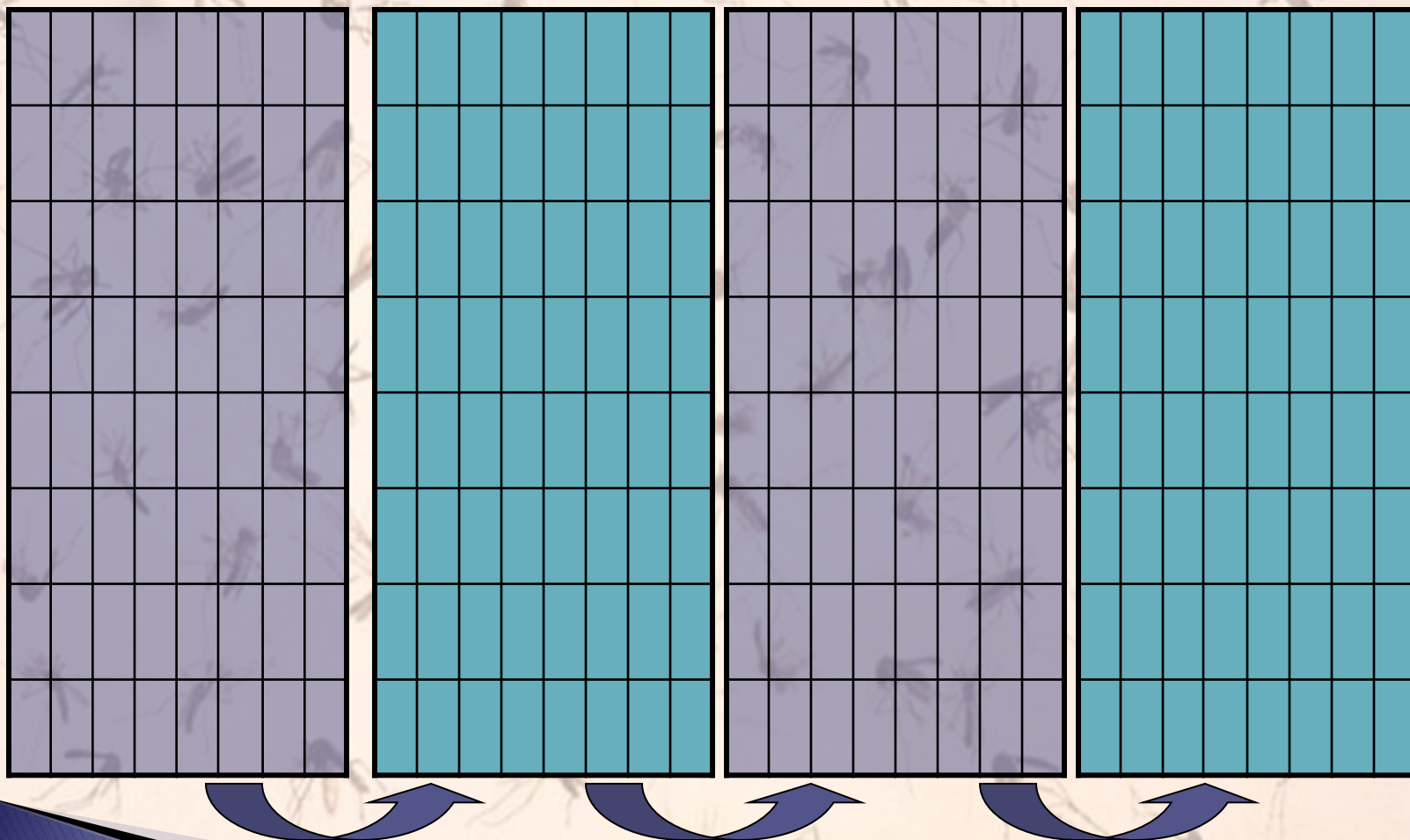
# Management schemes - increase doseage



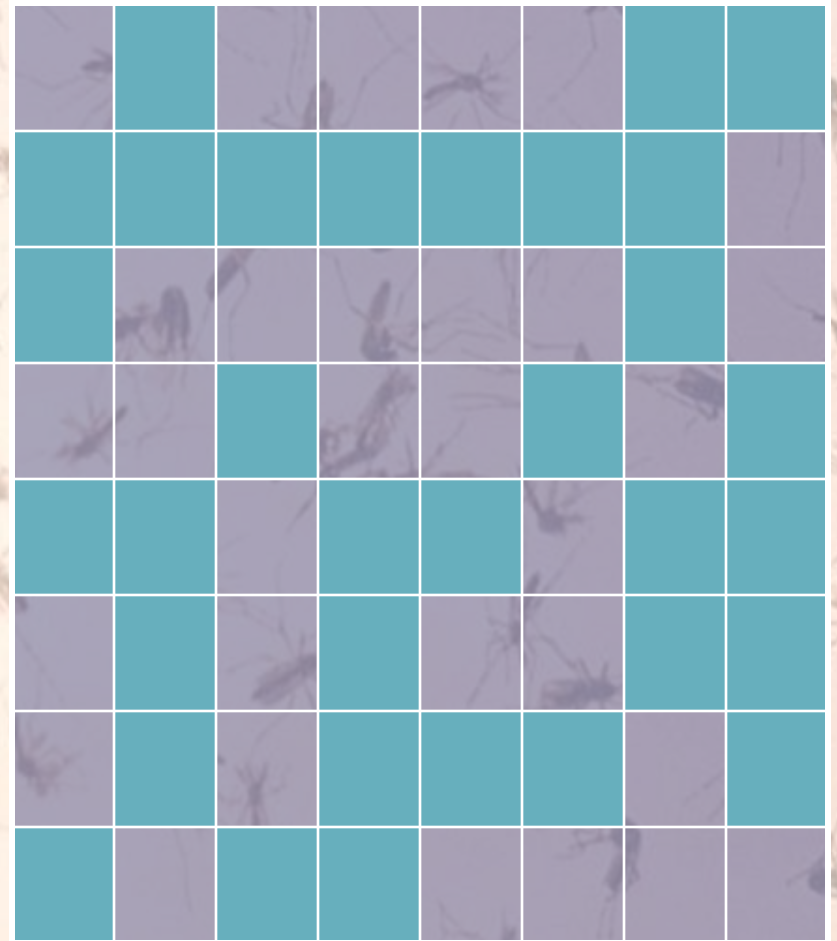
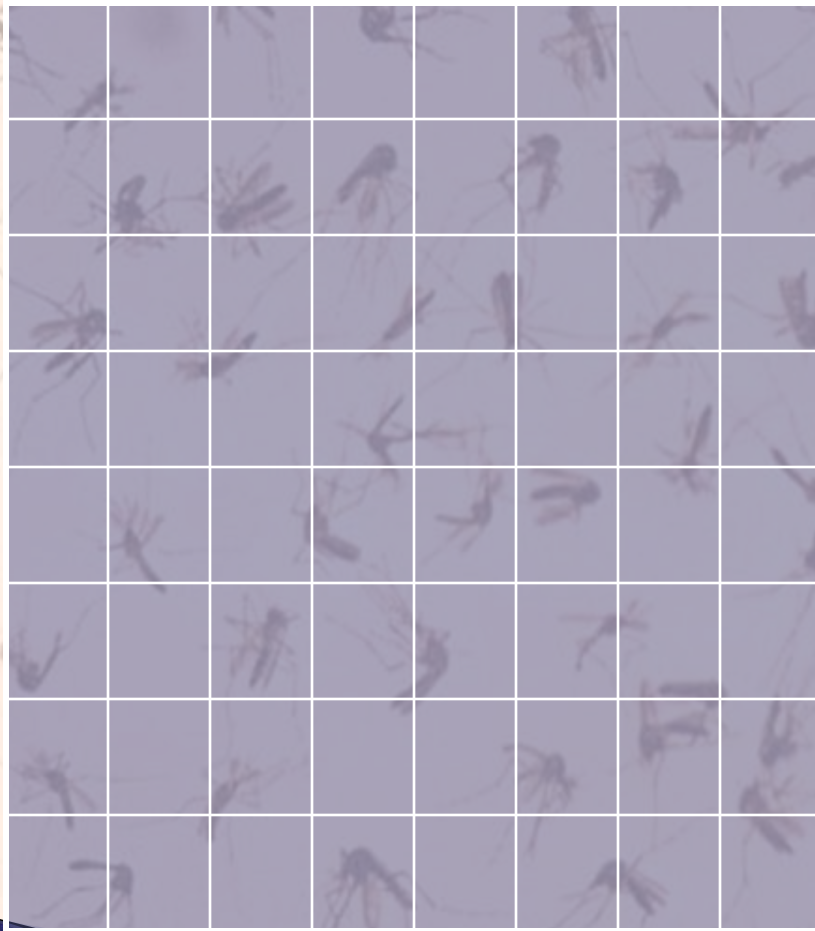
# Management schemes - switch chemical



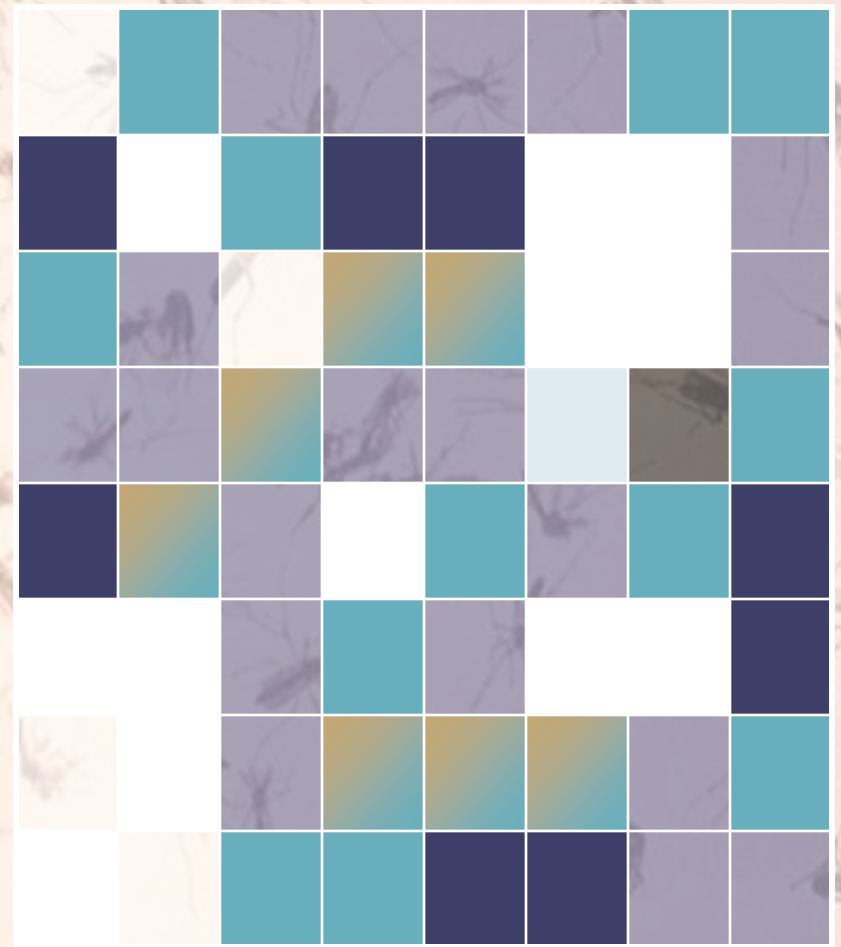
# Management schemes - rotate chemicals



# Management schemes - mosaic



# Reality is you may rely on more than one method



# What are my alternatives ?

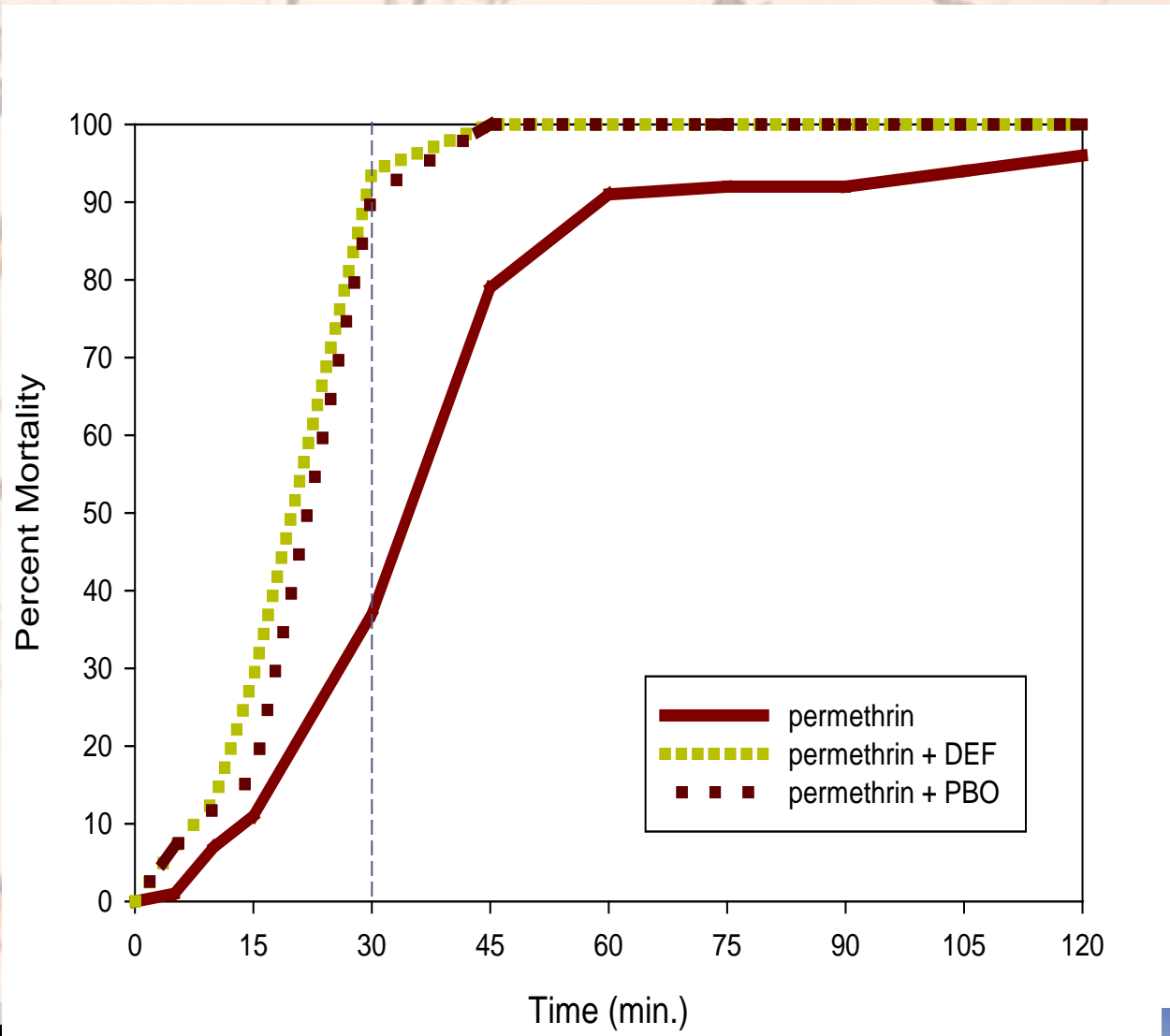
- ▶ Change dose of chemical.
- ▶ Change chemicals within same class.
- ▶ Change chemical to a different class.
- ▶ Use a rotation or mosaic of chemical treatments.
- ▶ Reduce number of treatments by accepting higher action thresholds.
- ▶ Target a different life stage better.

**Decisions should be based  
on surveillance data**

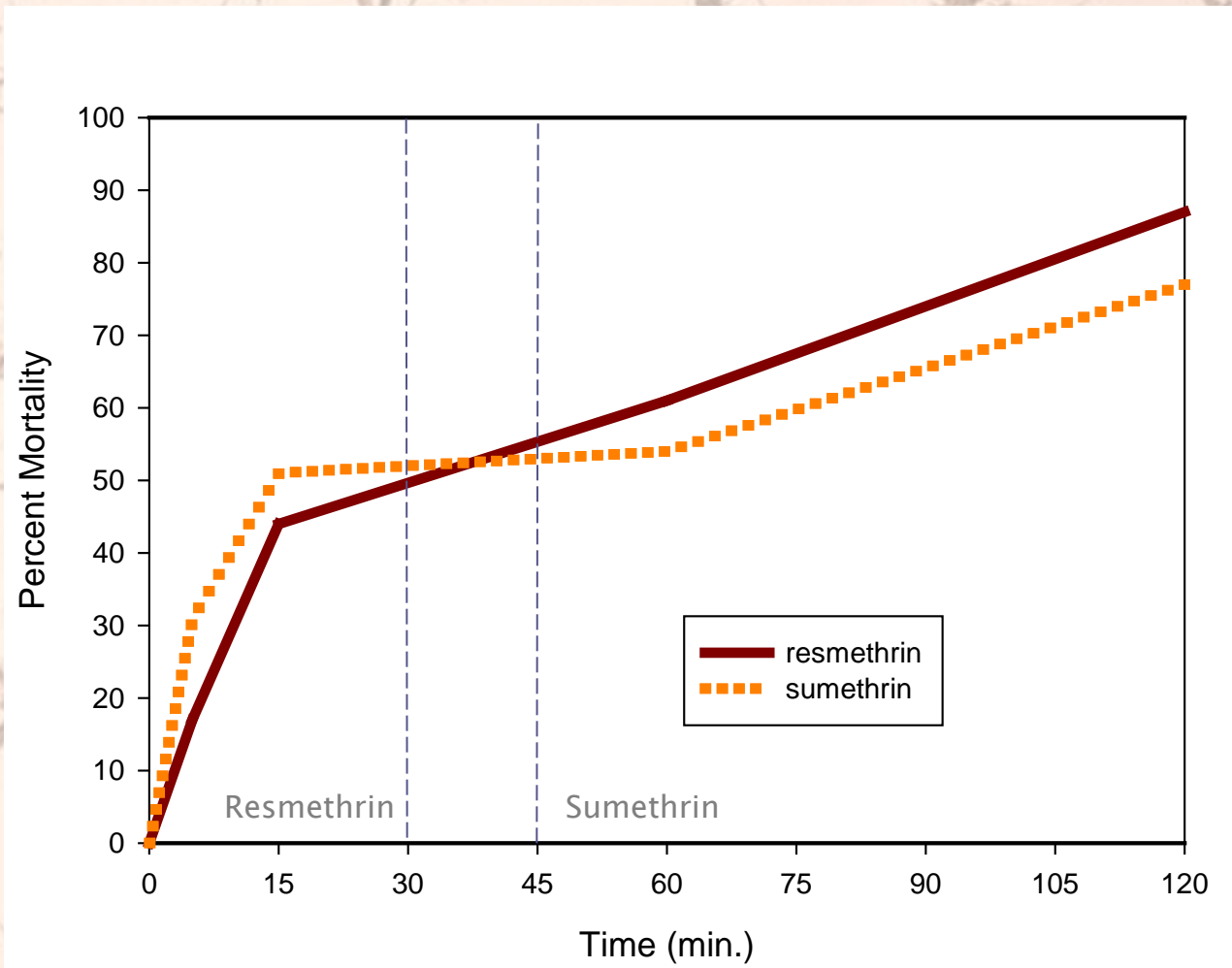


# Changing Chemicals?

# Phenotypic expression of resistance mechanisms for *Cx. quinquefasciatus* from Maricopa Co AZ 2010 using bottle bioassays



Bottle bioassay results for  
*Cx. quinquefasciatus*  
from Maricopa Co. AZ  
in 2010



# Mosquitocides Available for MADs in the US

## ▶ Adulticides:

- Organophosphates
  - Naled
  - Malathion
  - Chlorpyrifos
- Pyrethroids
  - Permethrin
  - Pyrethrum
  - d-phenothrin (Sumethrin)
  - Resmethrin
  - Etofenprox

## ▶ Larvacides:

- Biologicals
  - *Bacillus thuringiensis israelensis* (B.t.i.)
  - *Bacillus sphaericus*
- Insect Growth Regulators
  - Methoprene
- Oils
- Monomolecular films
- Organophosphate
  - Temephos
- Nicotinic acetylcholine receptor
  - Spinosad

# Special uses not commonly employed by MADs

## ▶ Barrier Treatments

- Pyrethroids
  - Permethrin
  - Deltamethrin
  - Beta-cyfluthrin
  - Bifenthrin
  - Lambda-cyhalothrin
  - Tau-fluvalinate

## ▶ Misting Systems

- Pyrethrins
- Pyrethroids
  - Permethrin
- Oils
- Rosemary/  
Cinnamon/  
lemongrass

# New Products

## ▶ Targeting Larvae

- Natralur™ – Spinosad = mix of spinosyn A & D
  - Nicotinic acetylcholine receptor (nAChR) allosteric modulators

## ▶ Targeting Adults

- Zenivex™ – Etofenprox = pyrethroid ether
  - Sodium channel modulator with no ester linkage

# On the Horizon?

- ▶ Lethal Ovitrap with pyriproxyfen = pyridine
  - Juvenile hormone analog
- ▶ Lethal Ovitrap with Bifenthrin = pyrethroid
  - Sodium channel modulator

# Questions

