PacMOSSI

Pacific Mosquito Surveillance Strengthening for Impact

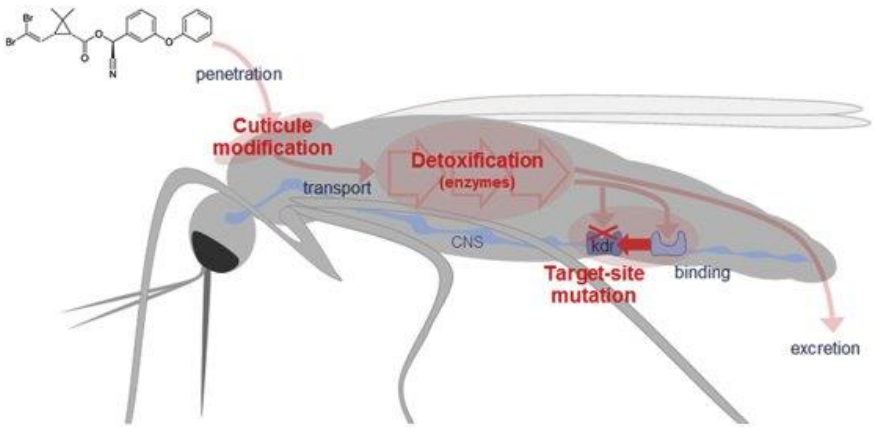
Insecticide Resistance Management (IRM)

PacMOSSI Strategic Planning Online Workshop for Vector Control and Surveillance in the Pacific

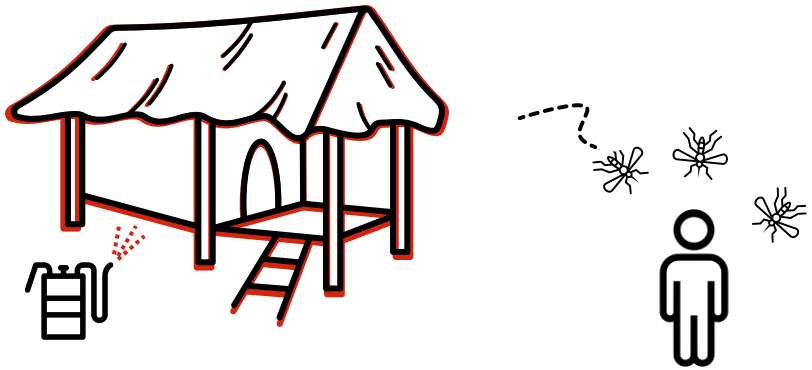
26-28th April 2022

Tanya Russell, James Cook University

Insecticide resistance is the capacity of mosquitoes to survive insecticide treatments.



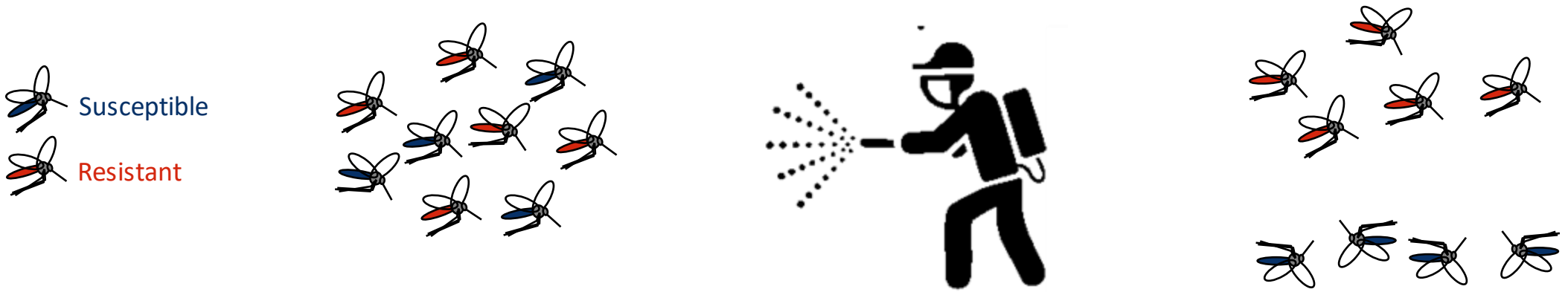
Physiological resistance



Behavioural resistance

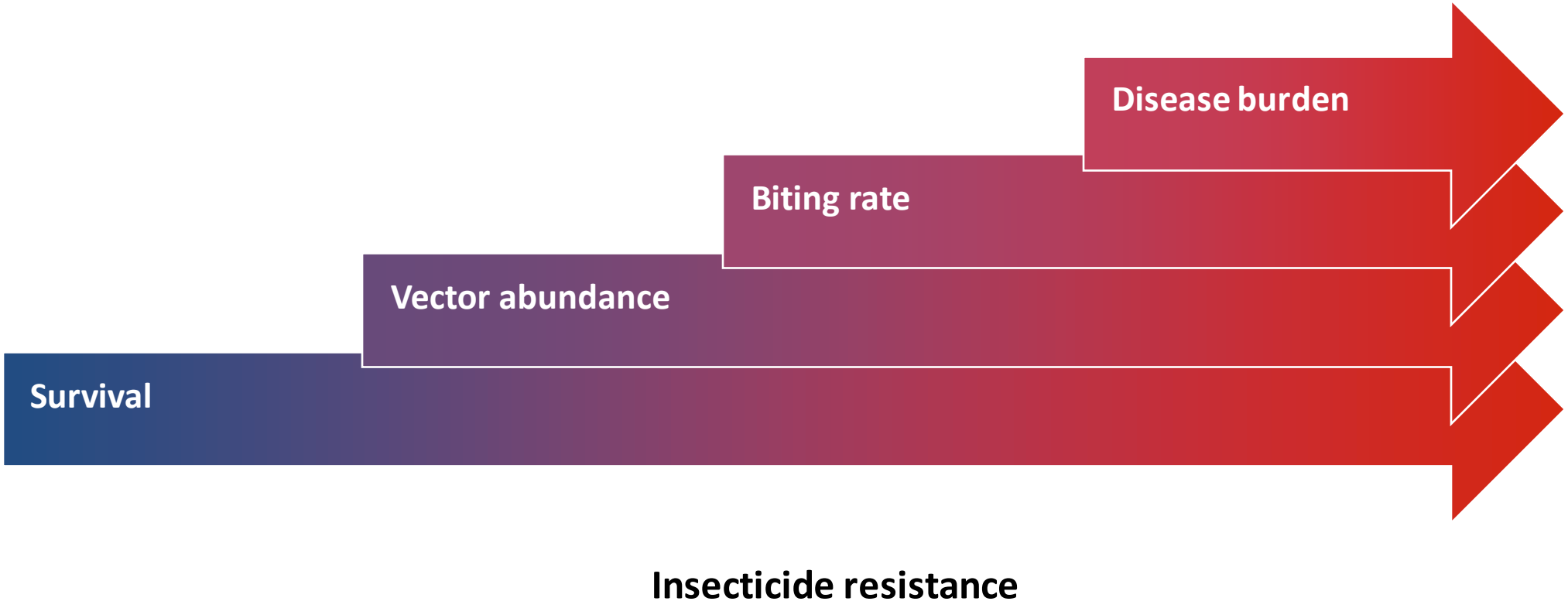
Physiological insecticide resistance

Develops in response to sustained insecticide use.

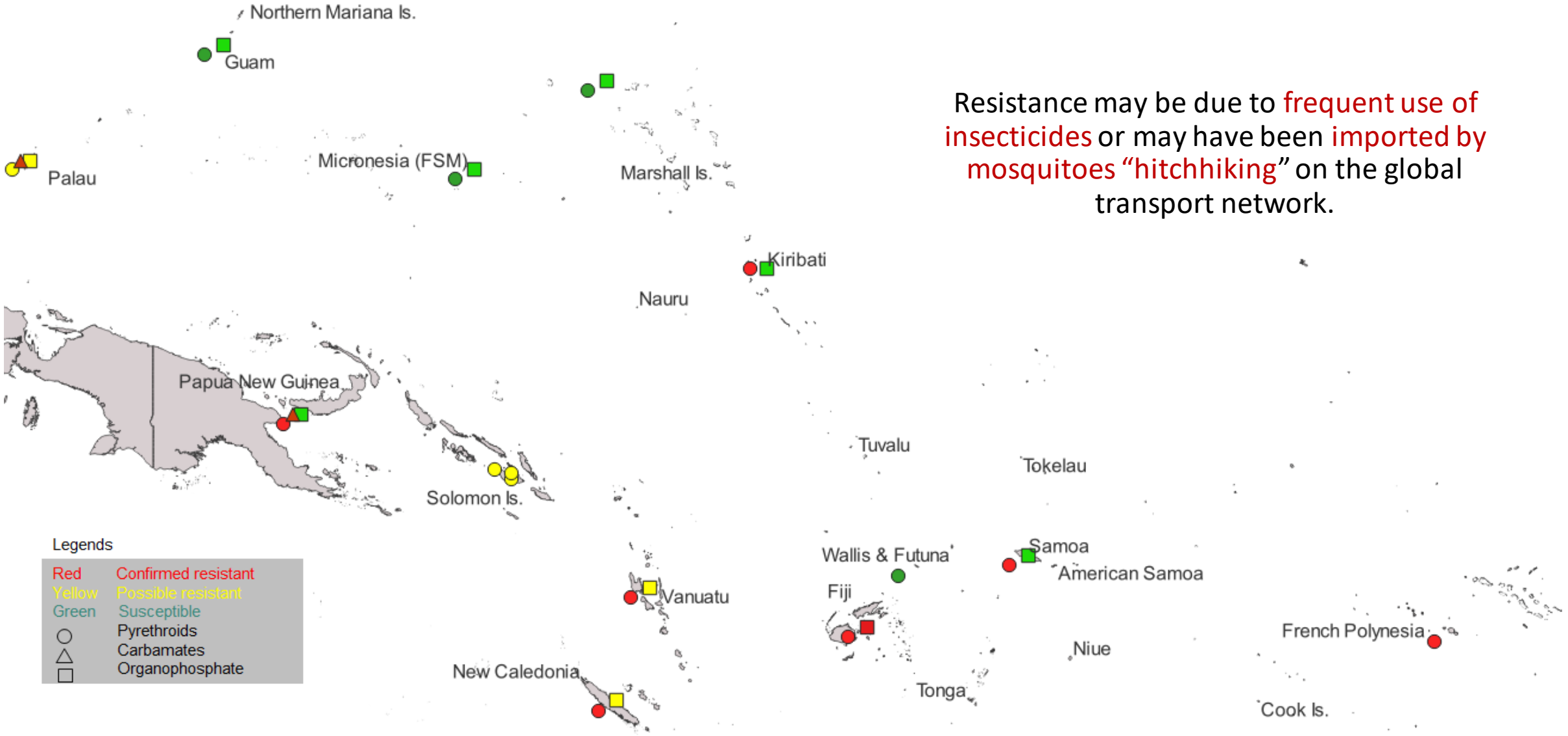


Adaptations for resistance → …are selected by insecticides → …and become common

Insecticide resistance can reduce the impact of vector control tools and increase disease burden.



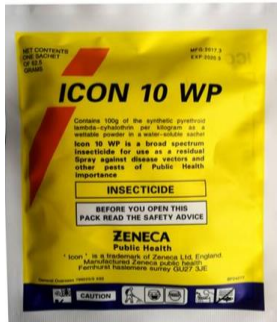
Insecticide resistance is common in Pacific populations of *Aedes aegypti*



Resistance may be due to frequent use of insecticides or may have been imported by mosquitoes "hitchhiking" on the global transport network.

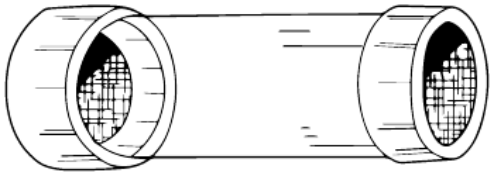
Insecticide resistance threatens the efficacy and effectiveness of vector control products.

These are some examples of LLINs and space sprays, and the insecticides they rely on for their impact.

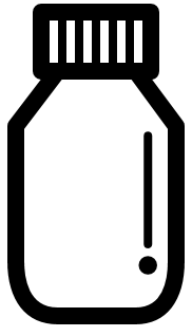
Vector control products (examples)						
Insecticide:	**Permethrin**	**Deltamethrin**	**Lambda-cyhalothrin**	**Bendiocarb**	**Clothianidin**	**Malathion**
Insecticide class:	**Pyrethroids**			**Carbamate**	**Neonicotinoid**	**Organophosphate**

Insecticide resistance bioassays

Physiological Insecticide Resistance in adult mosquitoes is monitored using WHO tube tests, or CDC bottle assays. The percentage death observed in exposed groups of mosquitoes determines whether they are resistant or susceptible.



WHO tube tests



CDC bottle assays

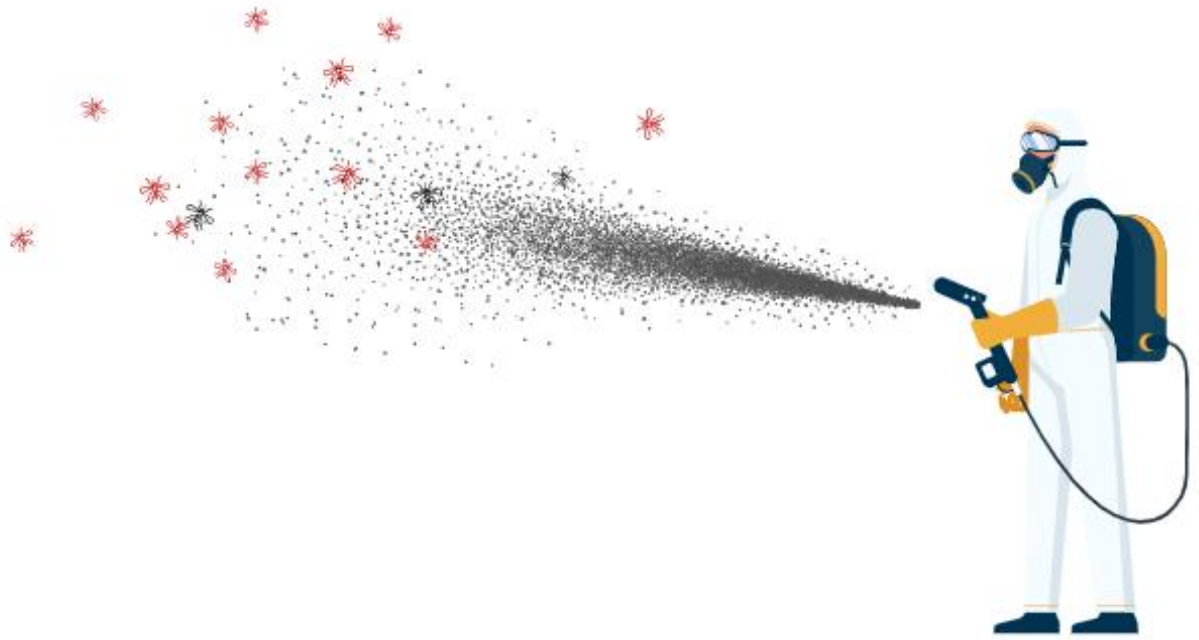
<90% = Resistant

90-97% = Possible resistance: re-test

≥98% = Susceptible

Why what is IRM and why IRM is important?

- IRM are decisions and strategies used at a programmatic level
- To prevent the emergence of resistance in susceptible populations
- To slow the evolution of resistance
- It is best to pre-emptively prevent resistance



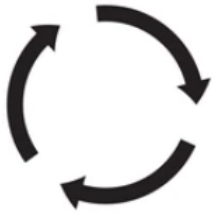
Insecticide Resistance Management

Key technical principles for addressing insecticide resistance are as follows:

- Insecticides should be deployed with care and deliberation.
- Vector control programmes should avoid using a single class of insecticide everywhere and over consecutive years.
- IRM principles and methods should be incorporated into all vector control programmes, not as an option, but as a **core component** of programme design.
- Collaborate with the agricultural sector for an intersectoral approach.
- Routine **monitoring** of insecticide resistance is essential to **inform** the selection and deployment of insecticides.
- The short-term additional costs of IRM should be balanced against the long-term potential public health impact and potential costs of insecticide resistance.

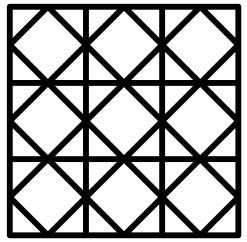
Insecticide resistance management strategies

Most strategies use multiple insecticide classes with different modes of action.

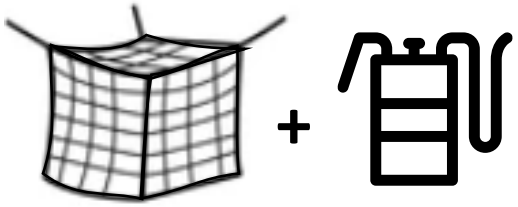


Rotation

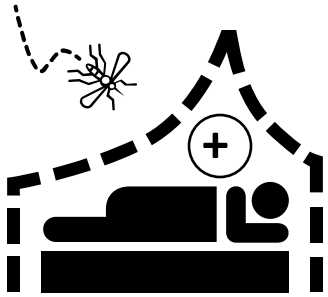
Mixtures



Mosaics



Combinations



Synergists

Rotation

- Rotations involve switching between insecticides with different modes of action
  - May be planned at pre-set time intervals
  - Or triggered (i.e. the development of resistance)

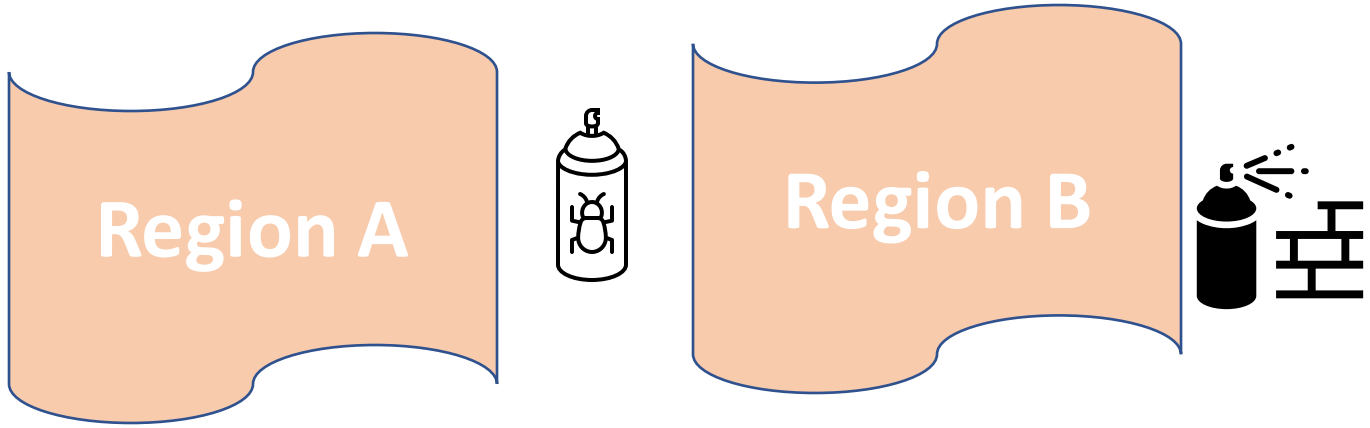
- Assumption: Resistance of an insecticide will be reduced over time when a 2nd insecticide is introduced

Better to implement <u>before</u>
resistance has been reported

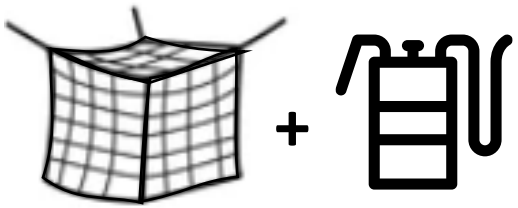
Mixtures

- Mixtures are co-formulations that combine two or more insecticides with different modes of action.
- Mixtures requires mosquitoes to be susceptible to all insecticides.
- Ideally, all insecticides in a mixture should have a similar residual life and remain bioavailable over time.

Mosaics



Different insecticide class in neighboring areas

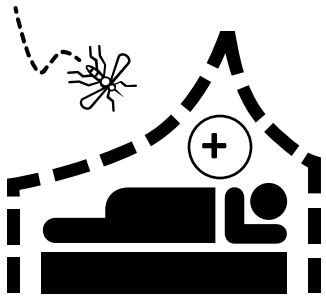


Combinations

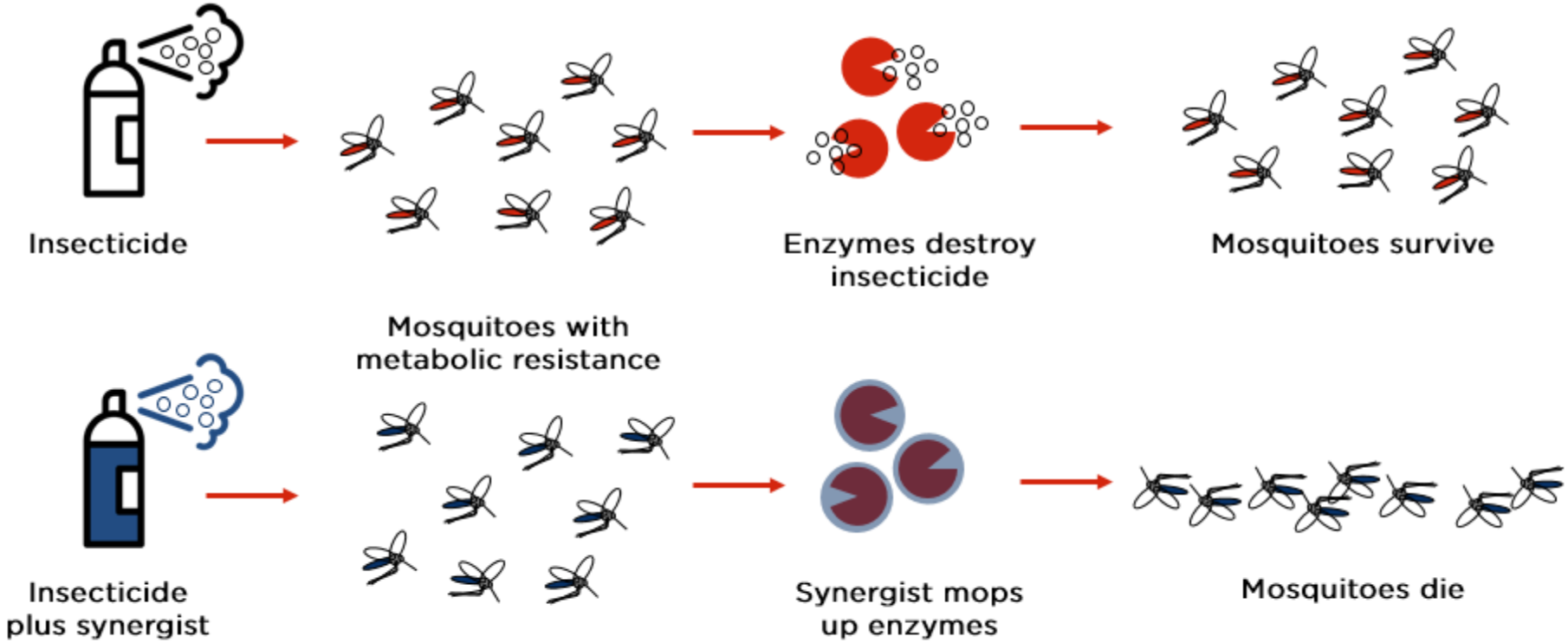
- Use different classes of insecticides with different modes of actions at each stage

Examples:

- Pyrethroid-only LLINs + non-pyrethroid IRS
- Pyrethroid IRS + Juvenile Growth Hormone larviciding



Synergists


Insecticide
Mosquitoes with metabolic resistance
Enzymes destroy insecticide
Mosquitoes survive
Insecticide plus synergist
Synergist mops up enzymes
Mosquitoes die

Elements of IRM strategic plan

- Occurrence of *Aedes* vectors
- Description of vector control interventions
- Overview of insecticide resistance status of *Aedes*
- Description of objective and rationale for IRM
- Outline of the key strategy to be used
- Outline of decision making process

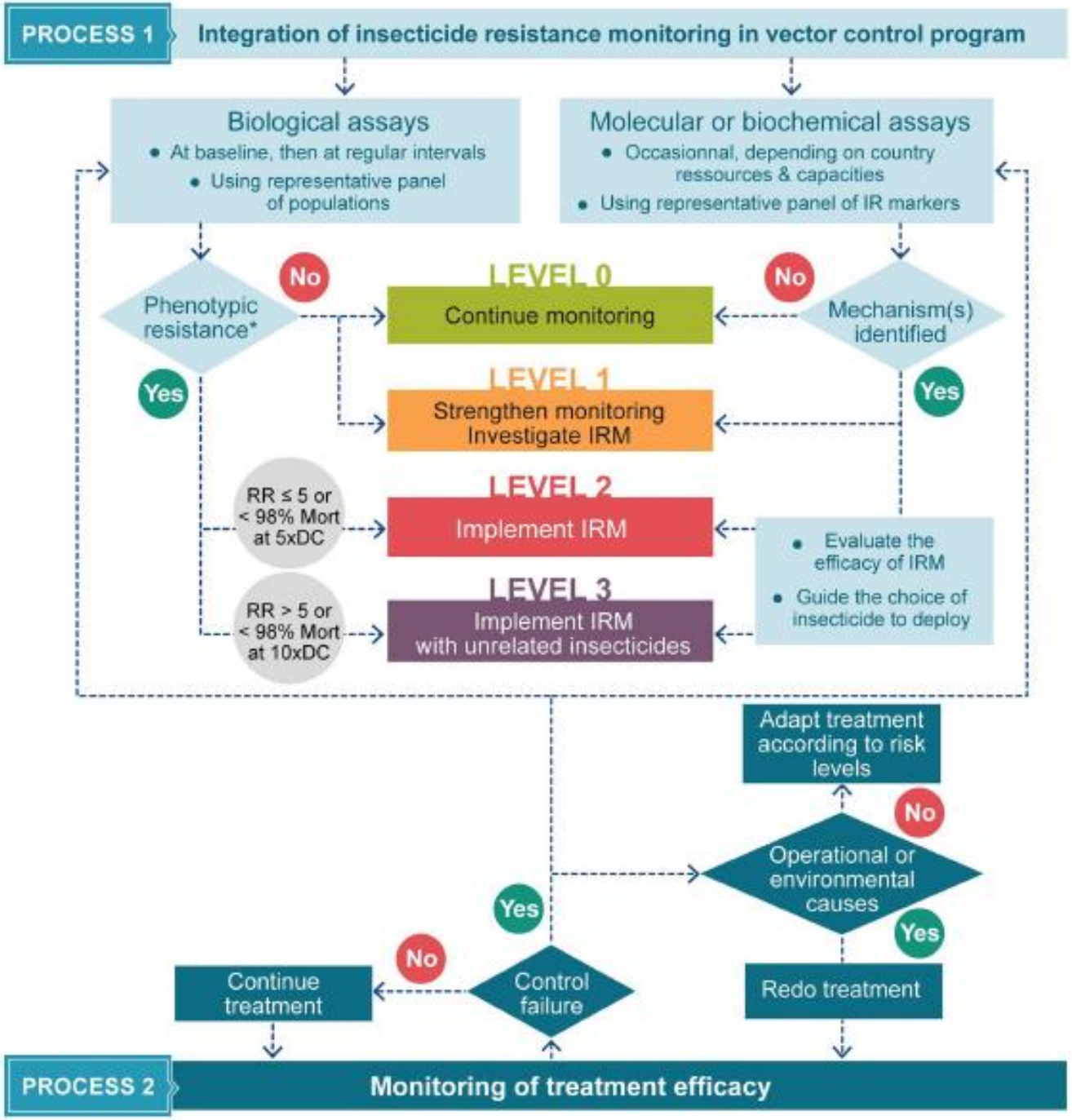
Fundamental factors for IRM

- Decision-making body
- Regulatory requirements and procedures
- Quality assurance for vector control products
- Monitoring of interventions
- Operational research

What to do if insecticide resistance is found?

- Use a different class of insecticide.
- Use insecticides judiciously
- If resistance is detected, confirm the data with subsequent tests and rule out misapplication or other
- Investigate all possible causes of treatment failure.
- Assess the extent of the problem area.
- Notify WHO and regional authorities.

Flow chart to support decision-making of IRM strategy during implementation of a vector control program



https://journals.plos.org/plosntds/article/figure?id=10.1371/journal.pntd.0007615.g002