

Τεχνολογικό  
Πανεπιστήμιο  
Κύπρου

# DEVELOPMENT OF AN INVASIVE MOSQUITO SURVEILLANCE AND MANAGEMENT STRATEGY IN CYPRUS

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# Cyprus: the island of love and beauty



- Member of the EU from 2004
- Total area 9,251 km<sup>2</sup>
- Population of the island 1.2 million (UN estimates)
- PoE privately administered

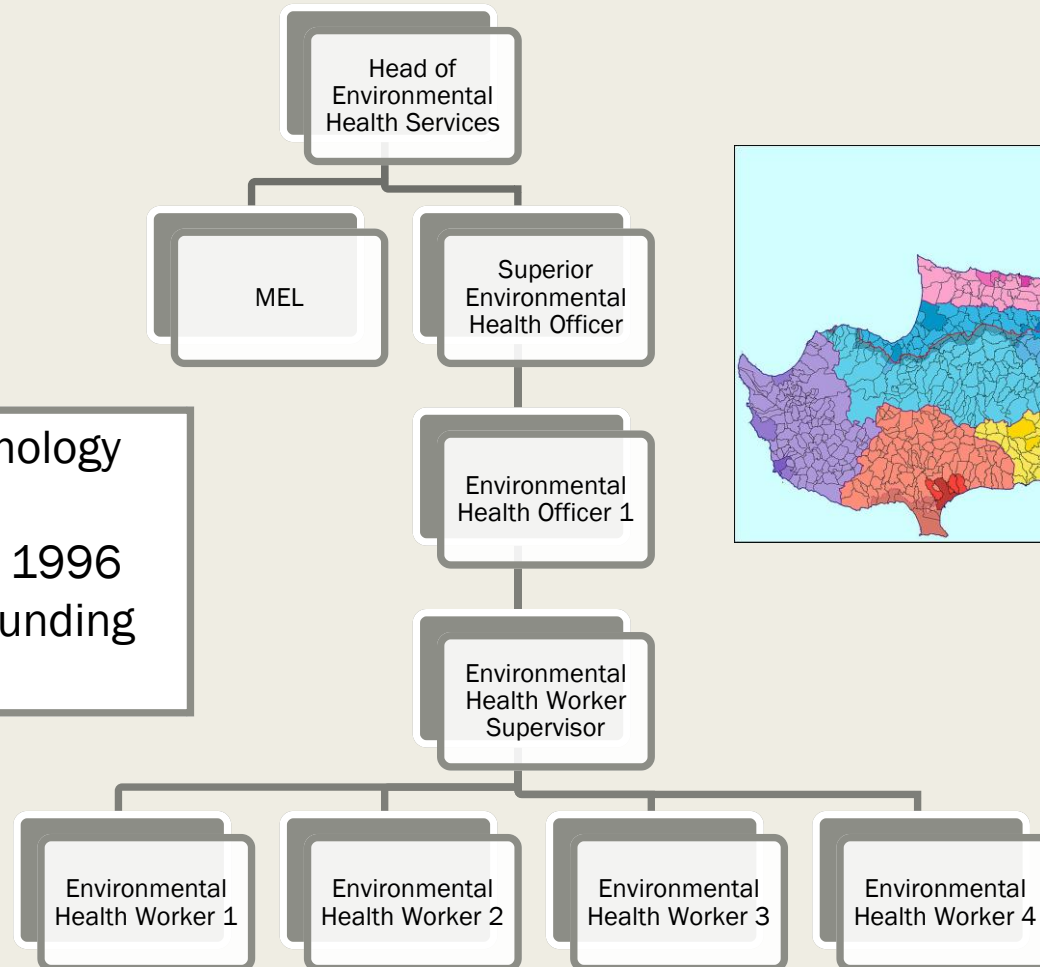
■ A Green Line demilitarized by the UN in 1974 after the military intervention by the Turkish army on the island

- 59% of the island is under effective control of the Republic of Cyprus
- 36% of the island is administered by Turkish-Cypriot so called TRNC a country recognized only by Turkey
- 3% is UK Sovereign Base Area
- 2% UN administered buffer zone

# NATIVE MOSQUITO SPECIES SURVEILLANCE AND CONTROL



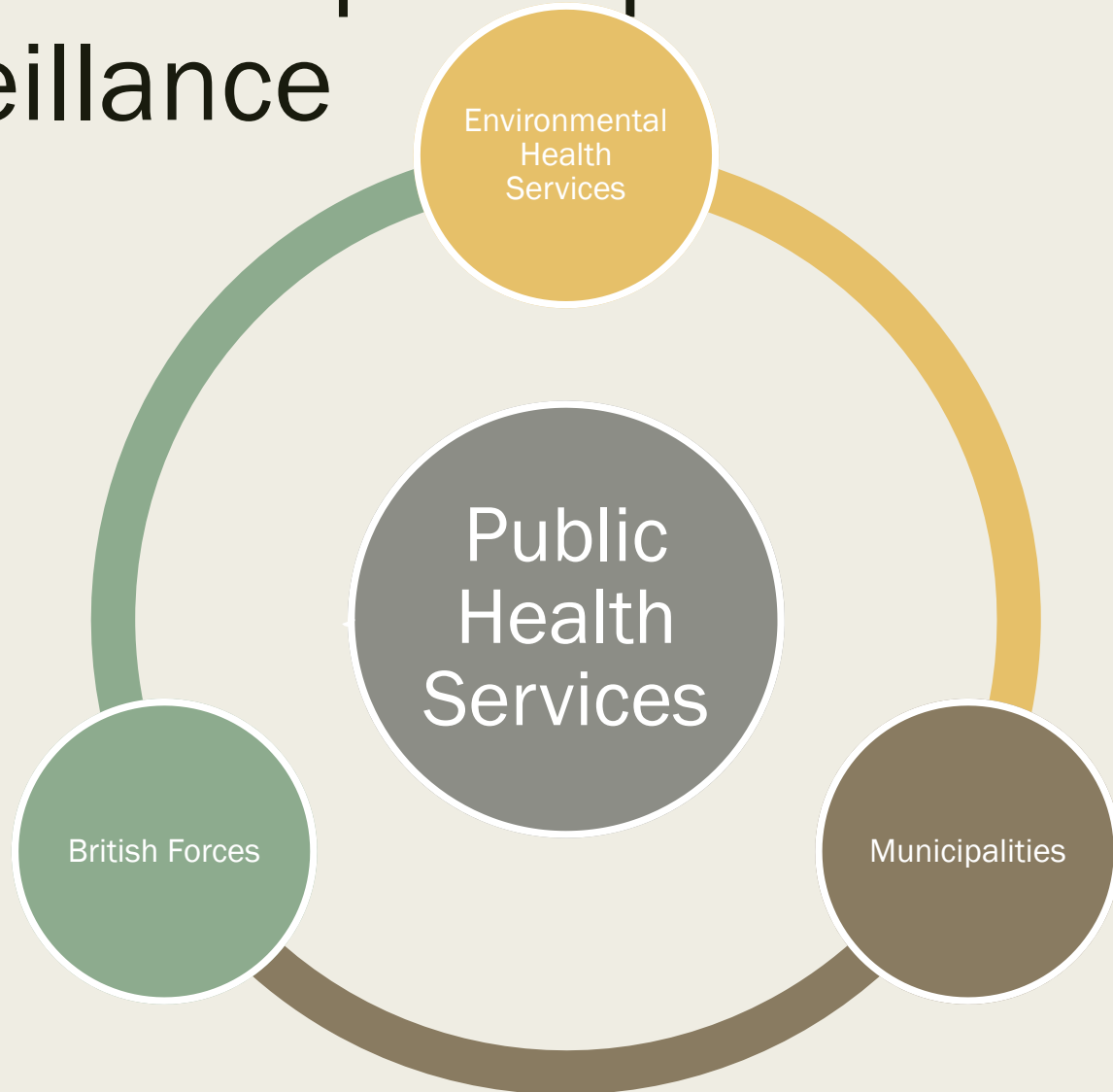
# Organogram of mosquito surveillance and control



Medical Entomology  
Laboratory  
established in 1996  
with WHO co-funding  
130 EHW



# Native mosquito species surveillance



# Native mosquito species surveillance

- Visual inspection (qualitatively)
- Recording and investigating complaints
- 2005-2008: Alternative methods for mosquito control in Cyprus (KOUNOUPIA), CyRPF

# Native mosquito species surveillance

- Visual inspection (qualitatively)
- Recording and investigating complaints
- 2005-2008: Alternative methods for mosquito control in Cyprus (KOUNOUPIA), CyRPF
  - *Identification of permanent and ephemeral breeding sites in rural areas*
  - *Mapping of permanent breeding sites in rural areas*
  - *Insecticide resistance monitoring*
  - *Semi-field larvicides experiments (insect growth regulator and toxin formulation)*
  - *Ecological monitoring of breeding sites*
  - *Education of Environmental Health Inspectors and general public*

# Native mosquito species surveillance

- Visual inspection (qualitatively)
- Recording and investigating complaints
- 2005-2008: Alternative methods for mosquito control in Cyprus (KOUNOUPIA), CyRPF

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## SCIENTIFIC NOTE

### THE MOSQUITO FAUNA OF THE REPUBLIC OF CYPRUS: A REVISED LIST

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ANDREAS HADJIVASSILIS<sup>1</sup>

23 mosquito species

Susceptibility of *Culex*

VECTOR/ PATROCEN/ HOST INTERACTION, TRANSMISSION

Susceptibility of *Culex pipiens* (Diptera: Culicidae) Field Populations  
in Cyprus to Conventional Organic Insecticides, *Bacillus thuringiensis*  
subsp. *israelensis*, and Methoprene

MARLEN I. VASQUEZ,<sup>1,2</sup> MARIOS VIOLARIS,<sup>1</sup> ANDREAS HADJIVASSILIS,<sup>1</sup>  
AND MARGARET C. WIRTH<sup>3</sup>

# Breeding sites identification



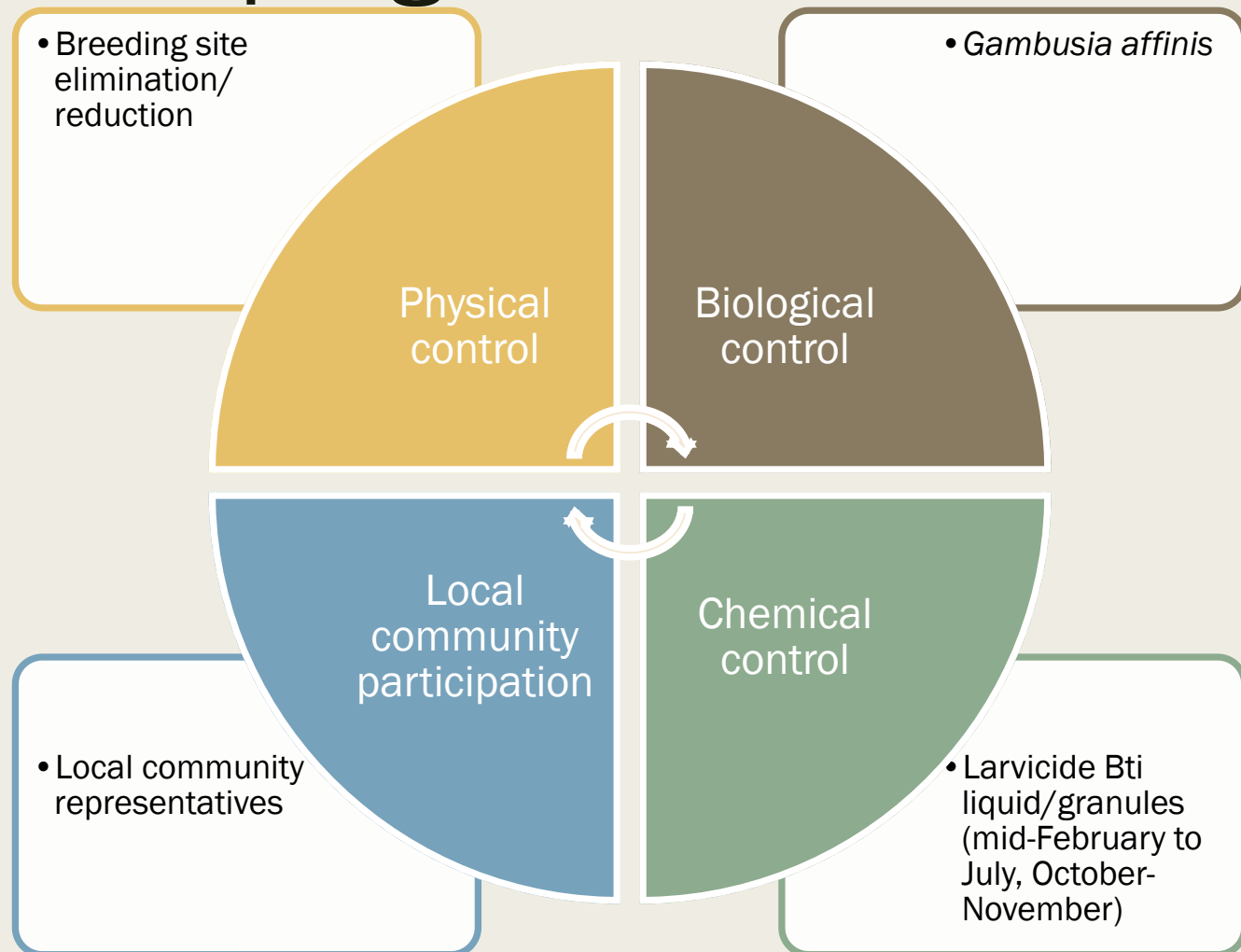
# Breeding sites identification



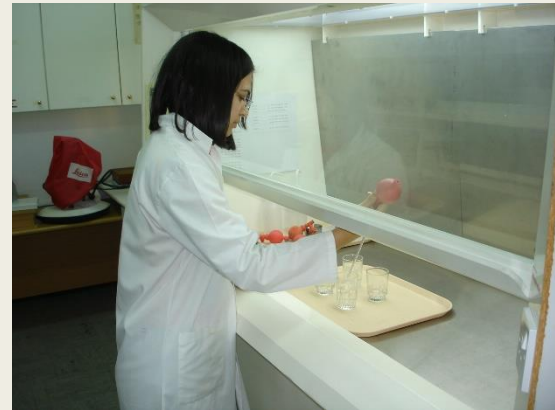
# Breeding sites identification



# Control of native species – routine program



# Rearing and bioassaying



# Bioassaying



# Semi-field experiments



A photograph of a classroom or meeting room. A woman is standing at the front, presenting to a group of people seated at round tables covered with red cloths. A large screen displays a presentation slide titled 'Marketing Mix'. The slide lists the 4Ps: Product, Price, Promotion, and Place, each with a brief description. The room has a brick wall at the front and a large window on the left with green curtains. The ceiling has several rectangular light fixtures. The audience is seen from behind, seated at round tables with red tablecloths. There are water bottles and glasses on the tables. The presentation slide on the screen reads:   
**Marketing Mix**  
The marketing mix is a set of actions, or tactics, that a company uses to promote its brand or product in the market.  
The marketing mix consists of four elements, often referred to as the 4Ps:  
1. **Product**: The goods or services that a company offers to its customers.  
2. **Price**: The amount of money that a customer pays for a product or service.  
3. **Promotion**: The communication and advertising efforts that a company uses to inform its target audience about its products and services.  
4. **Place**: The distribution channels that a company uses to get its products and services to its customers.

**Map of Cyprus:** A map of Cyprus showing the locations of mosquito population monitoring sites. The map is color-coded by region: North (red), South (green), and Central (blue). The map also shows the locations of the three main mosquito species: Culex pipiens (red), Culex tritaeniorhynchus (green), and Culex pipiens (blue).

**Table 1: Mosquito species and their distribution in Cyprus**

Species	North	South	Central
Culex pipiens	Yes	Yes	Yes
Culex tritaeniorhynchus	Yes	Yes	Yes
Culex pipiens	Yes	Yes	Yes

**Table 2: Bioassay results**

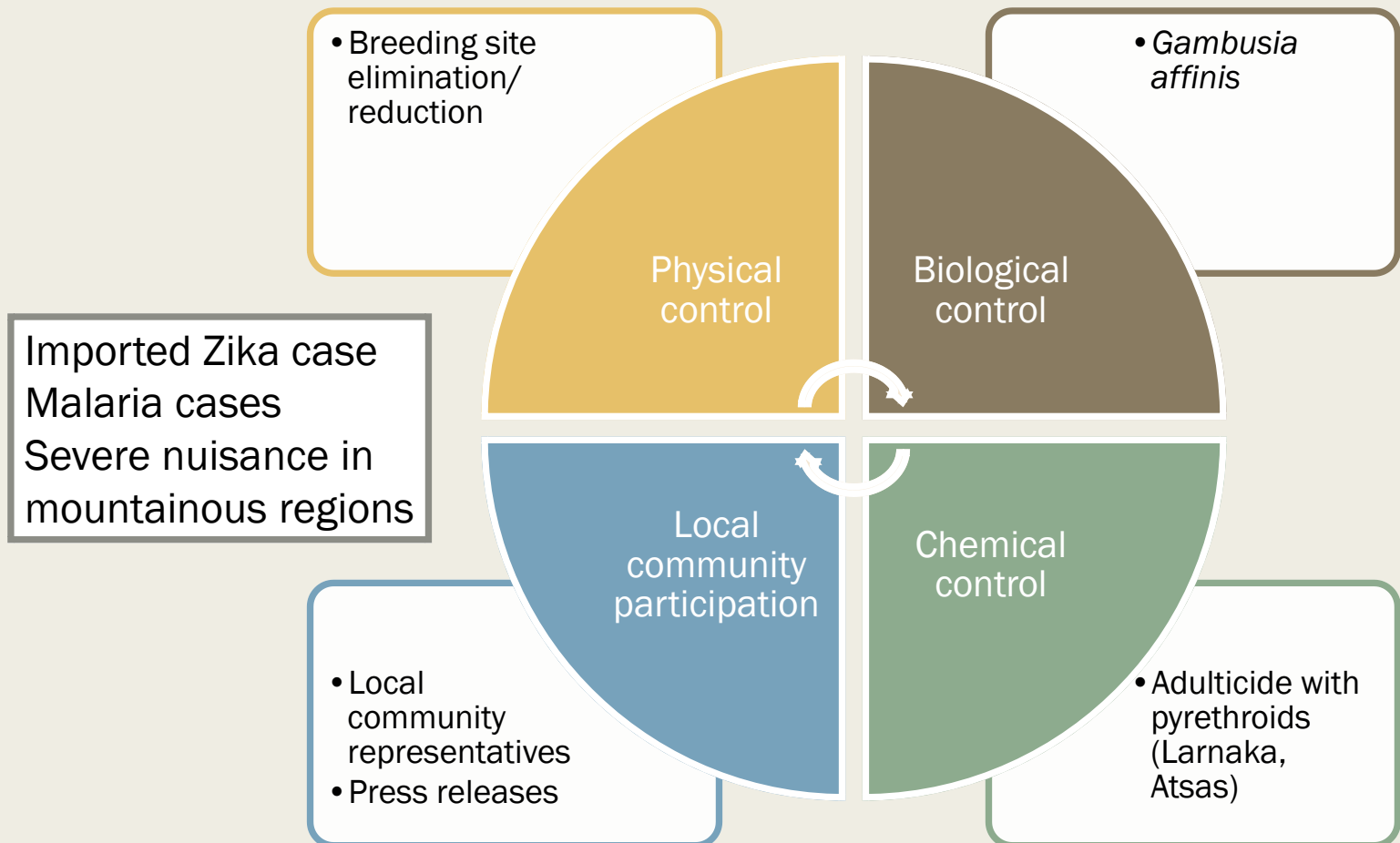
Species	North	South	Central
Culex pipiens	100%	100%	100%
Culex tritaeniorhynchus	100%	100%	100%
Culex pipiens	100%	100%	100%

**Table 3: Mosquito population monitoring data**

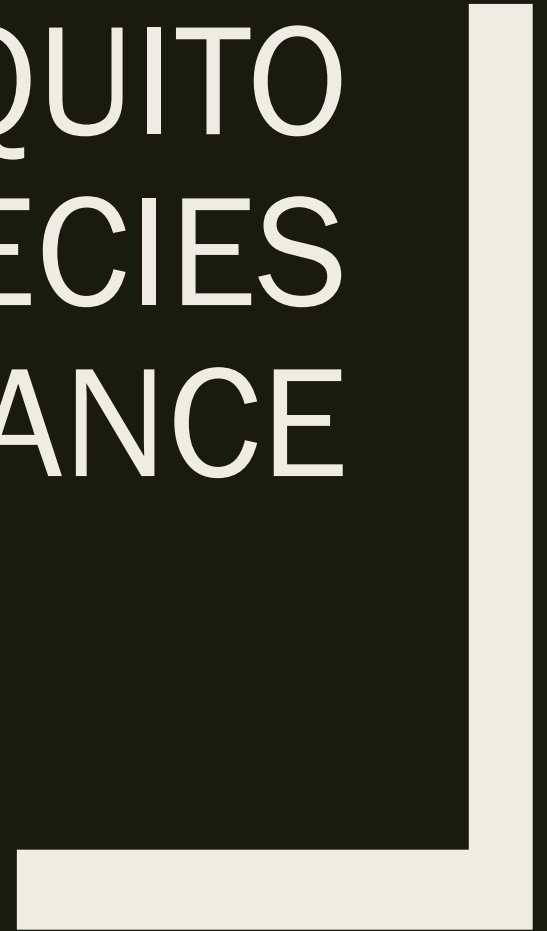
Species	North	South	Central
Culex pipiens	100%	100%	100%
Culex tritaeniorhynchus	100%	100%	100%
Culex pipiens	100%	100%	100%

[illegible]

# Control of native species – *ad hoc* interventions



# INVASIVE MOSQUITO SPECIES SURVEILLANCE



# Surveillance of invasive mosquito species

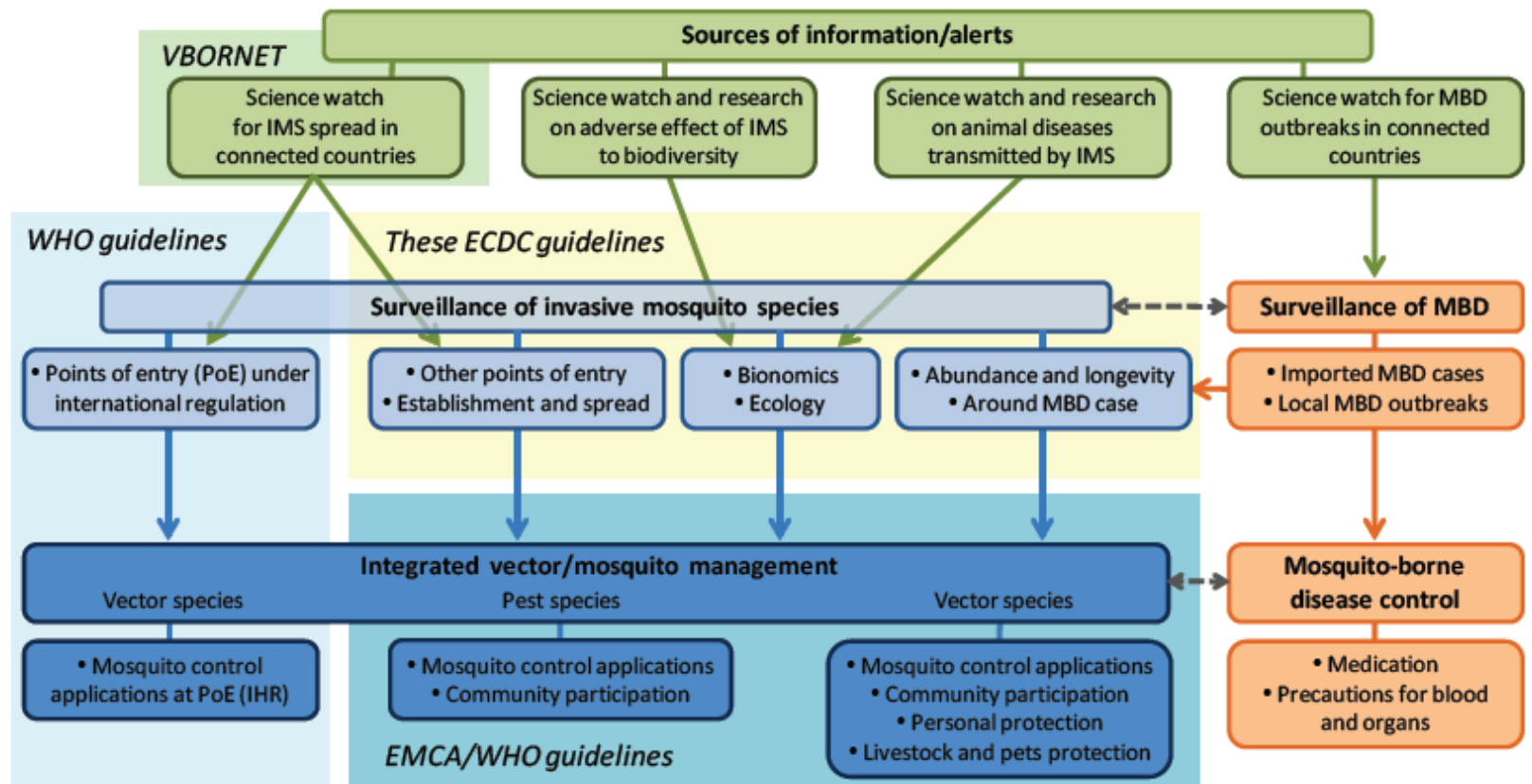
- 2012-2014: Climate impacts on vector-borne disease in the Eastern Mediterranean and the Middle East (CIVMME), FP7
  - *Network for passive monitoring*
    - BG-sentinel and ovitraps: Limassol port (10+10) and buffer zone Nicosia (10+10)
    - From March to July 2 times/week, 24 h and 1 week, respectively
    - Density 20-30 m distance
- **No invasive species: limited captures, no eggs in some cases culicinae larvae only**

# Invasive mosquito species screening (September 2016-March 2017)

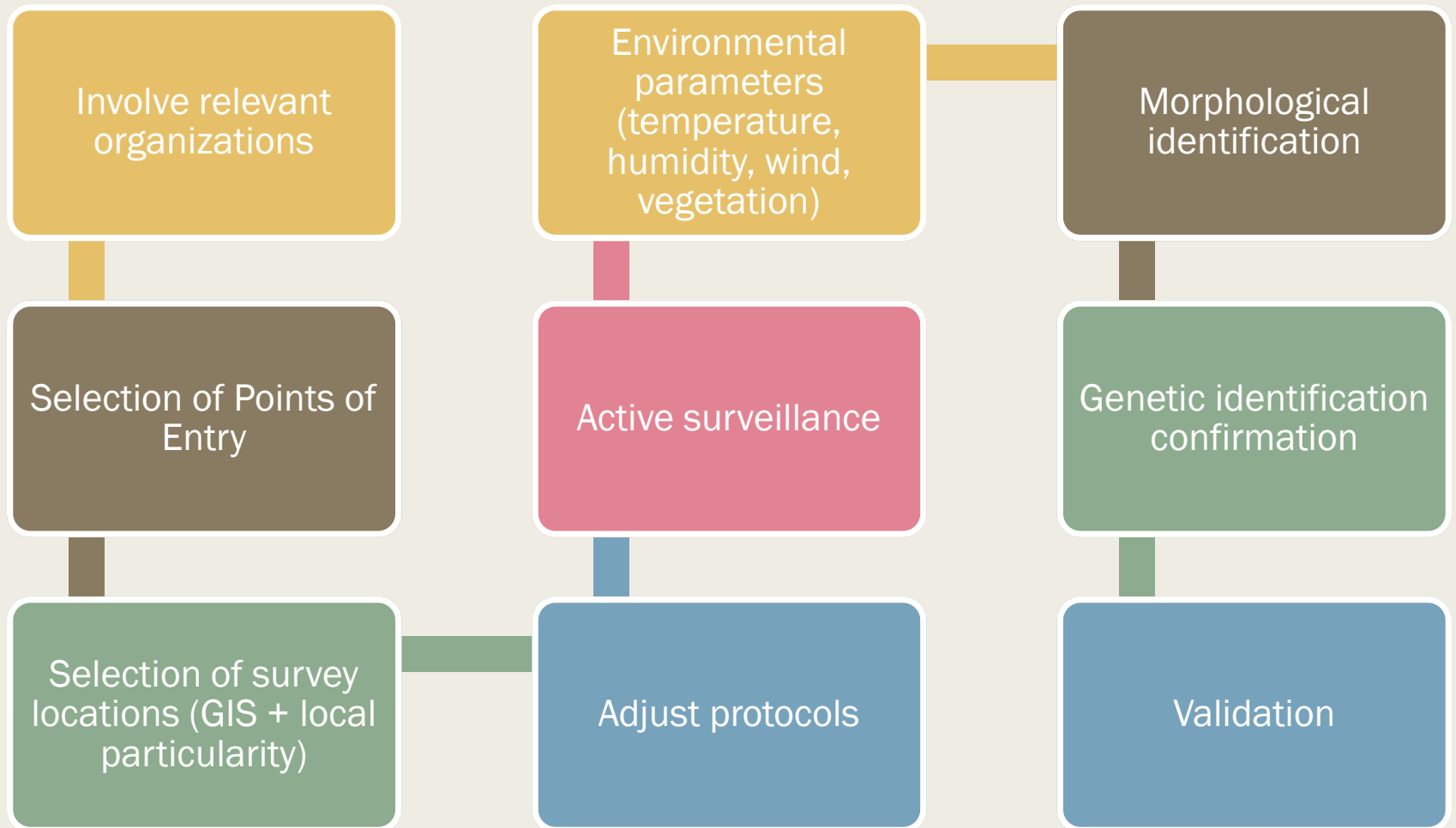


- BG-Sentinel and ovitraps
- Screening exercise
- Development of protocols
- Voluntary citizen participation
- Reduced numbers *Culex* sp.

# Surveillance strategy for invasive species



# Methodology



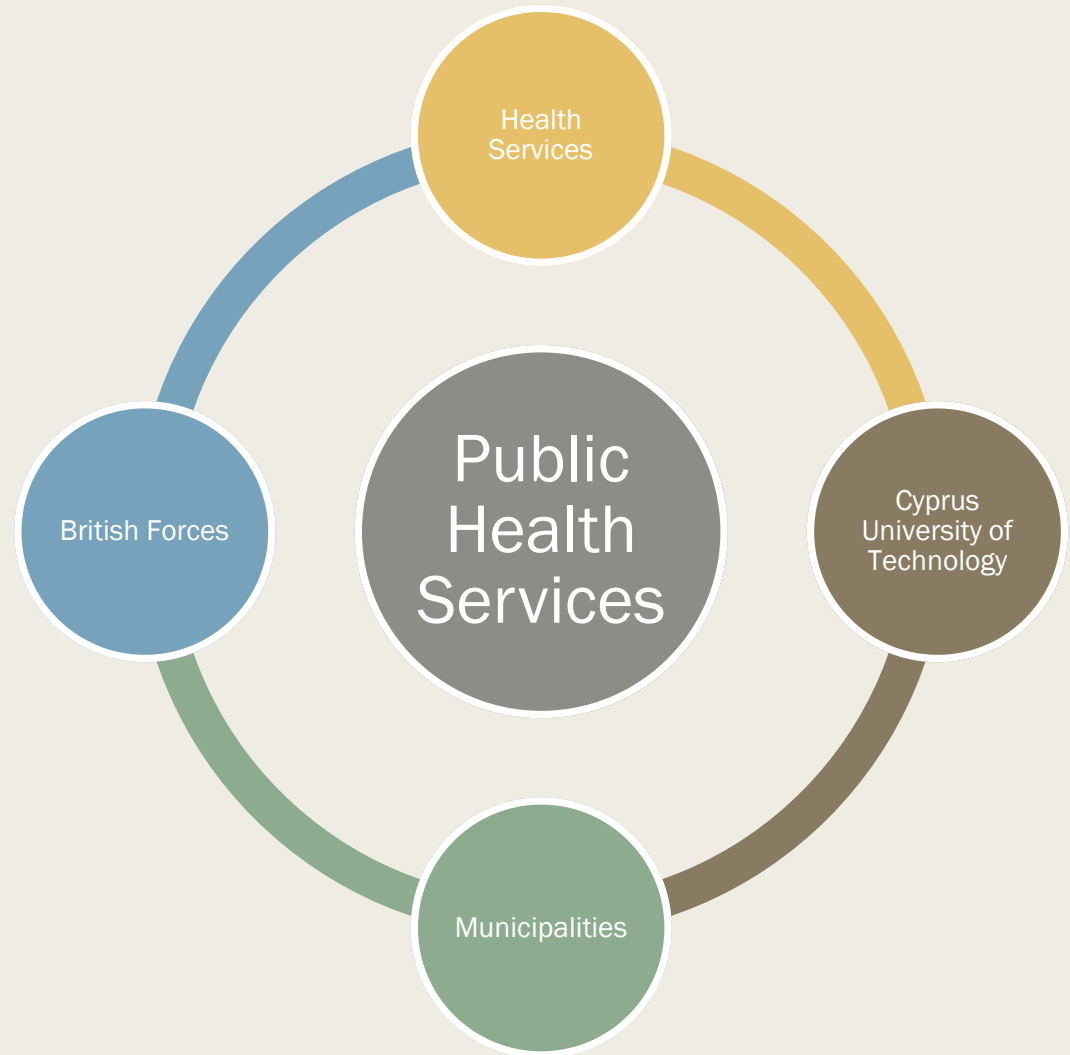
# Active invasive mosquito species surveillance

Duration: May 2016 - June 2017

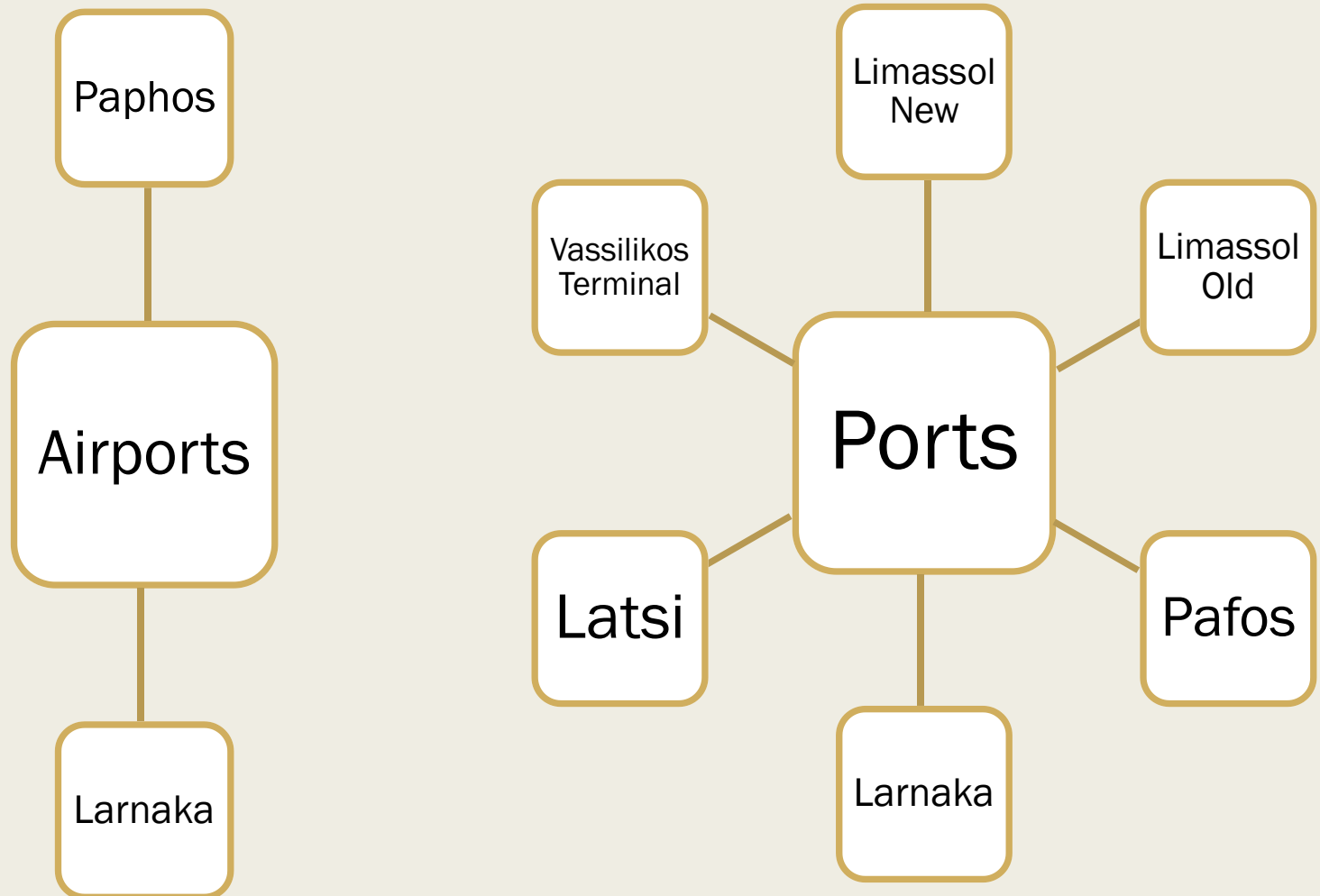
Active participation of local communities

Frequency Biweekly

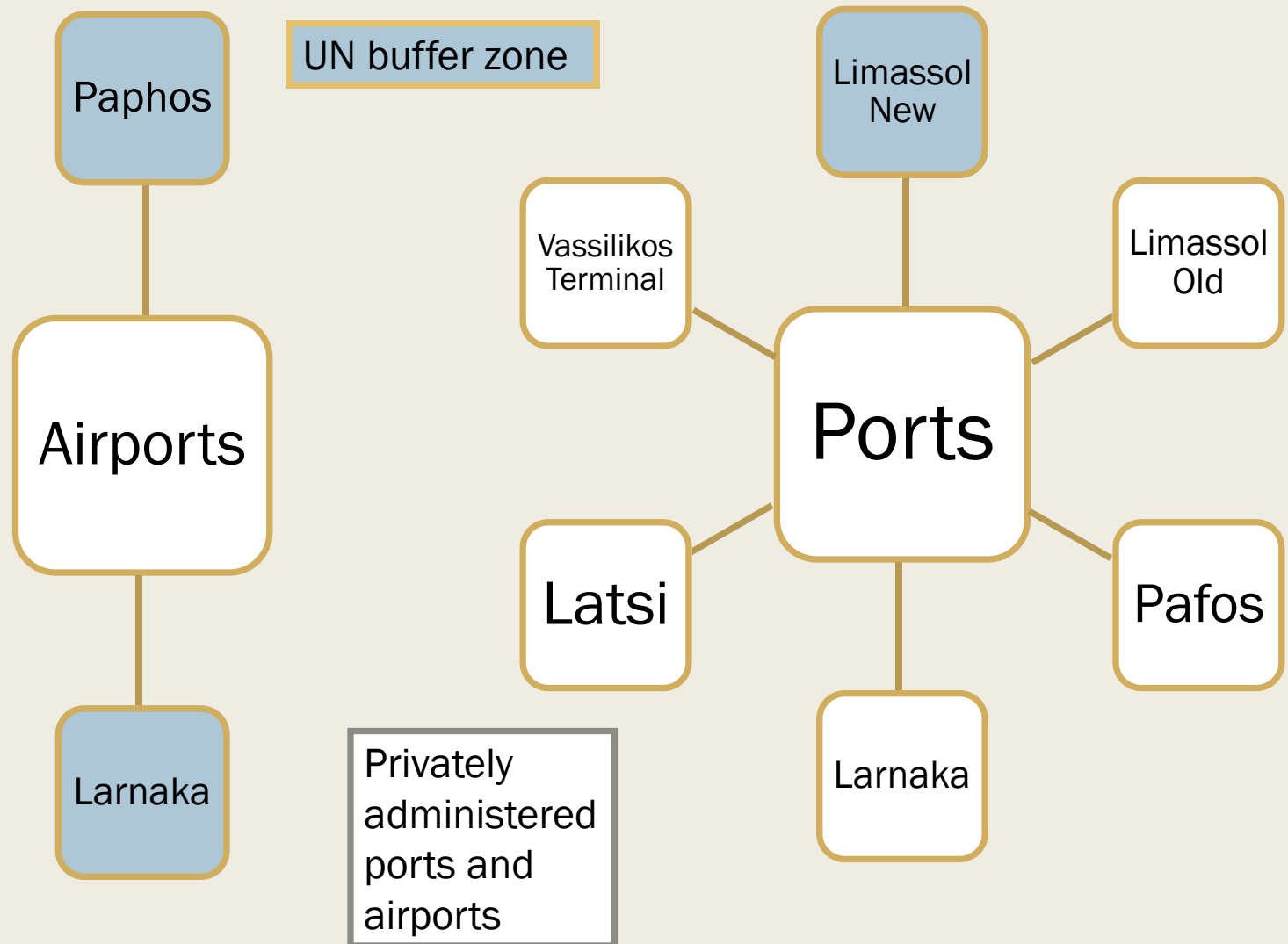
BG Sentinel+BG-Lure+CO<sub>2</sub>  
(dry ice)



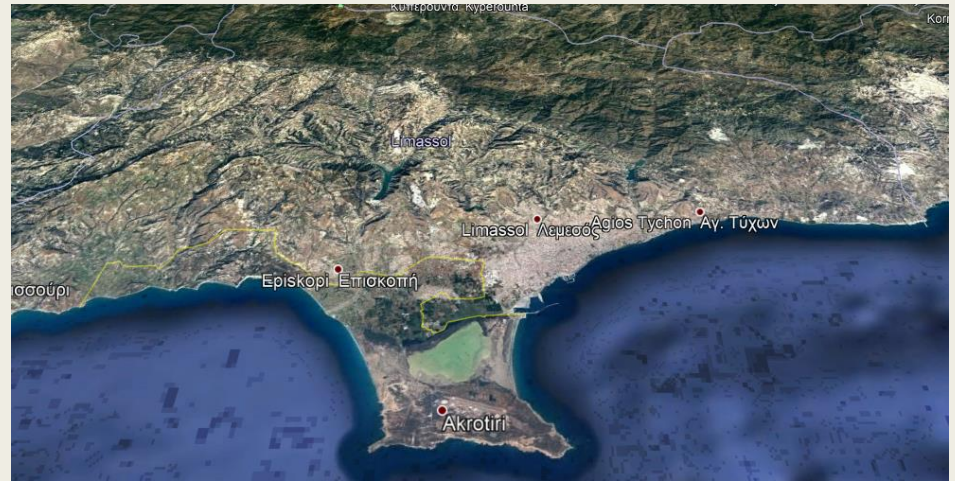
# Selection of Points of Entry



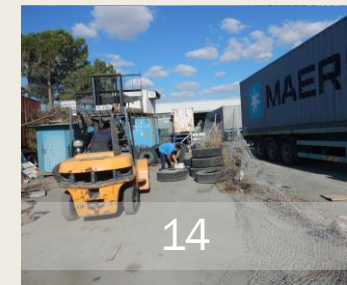
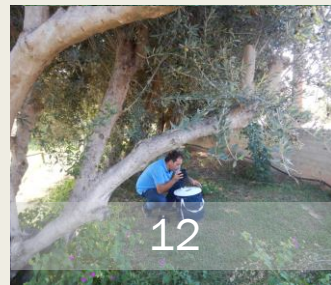
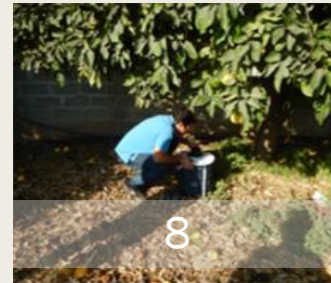
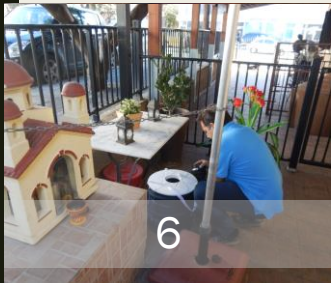
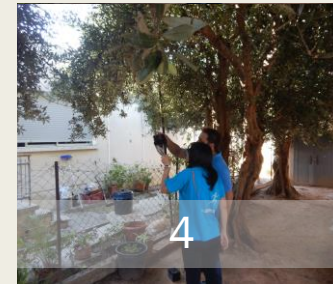
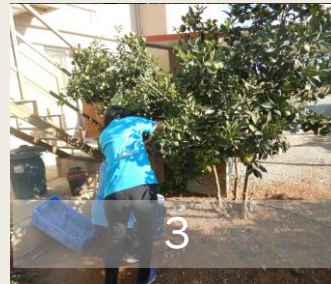
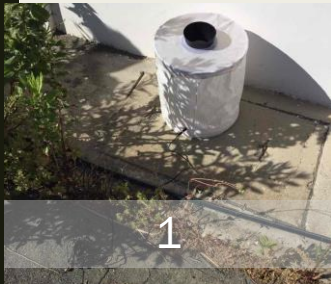
# Selection of Points of Entry



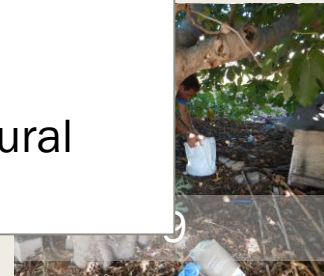
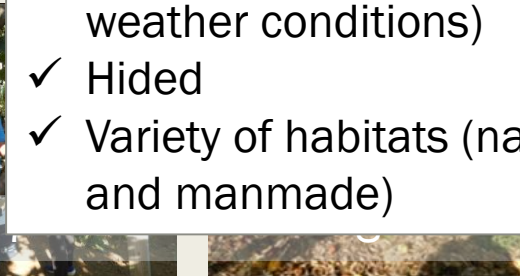
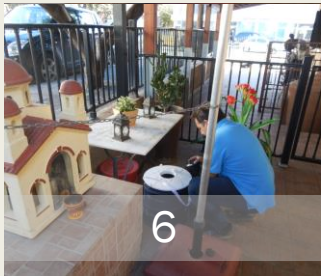
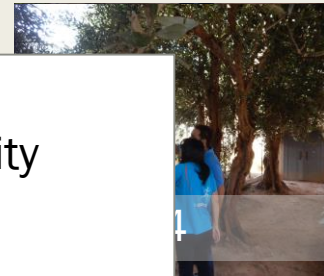
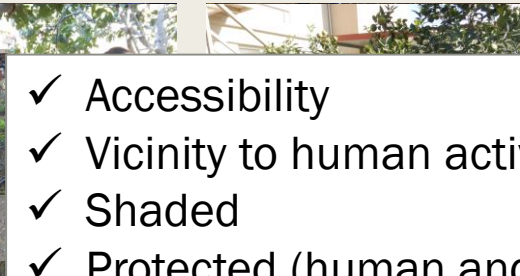
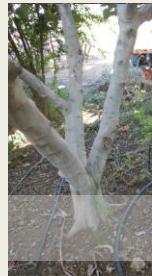
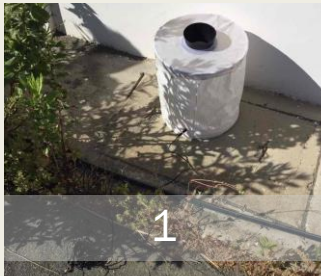
# Selection of survey locations



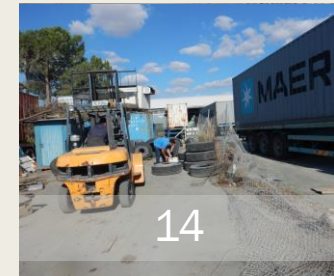
# Selection of sites



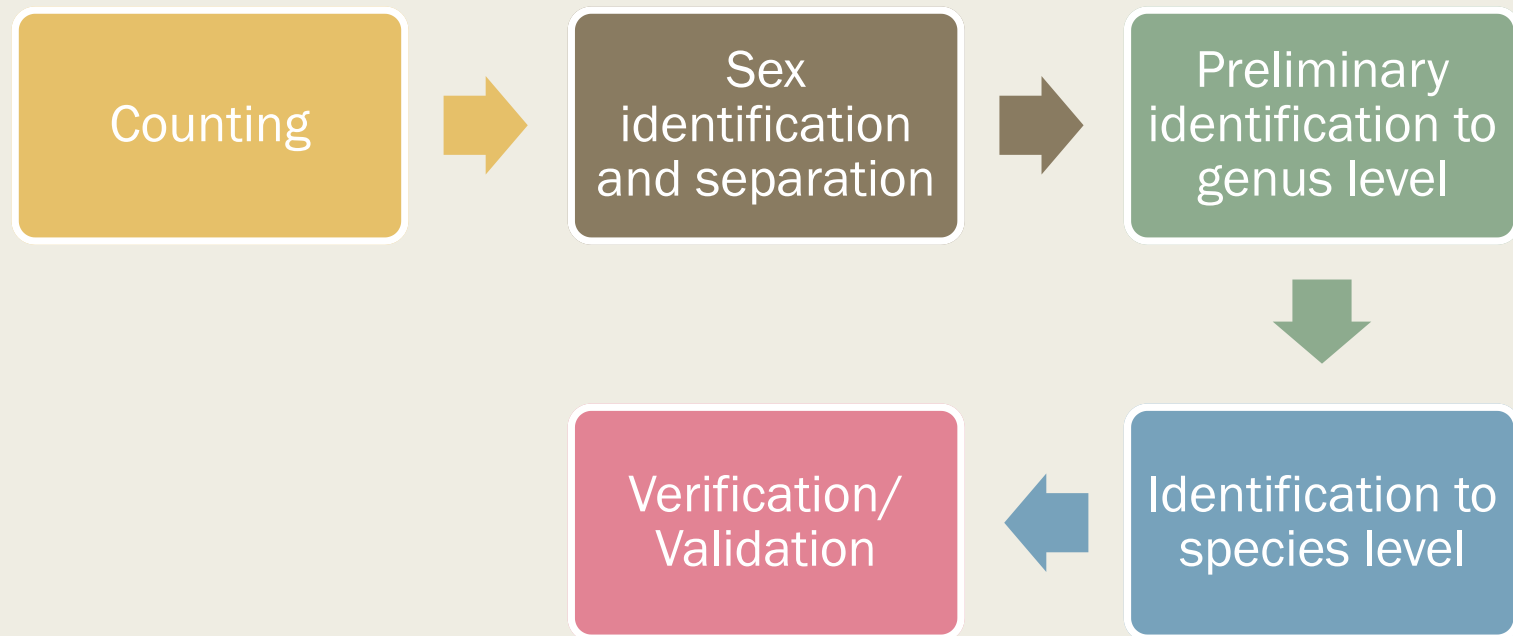
# Active surveillance



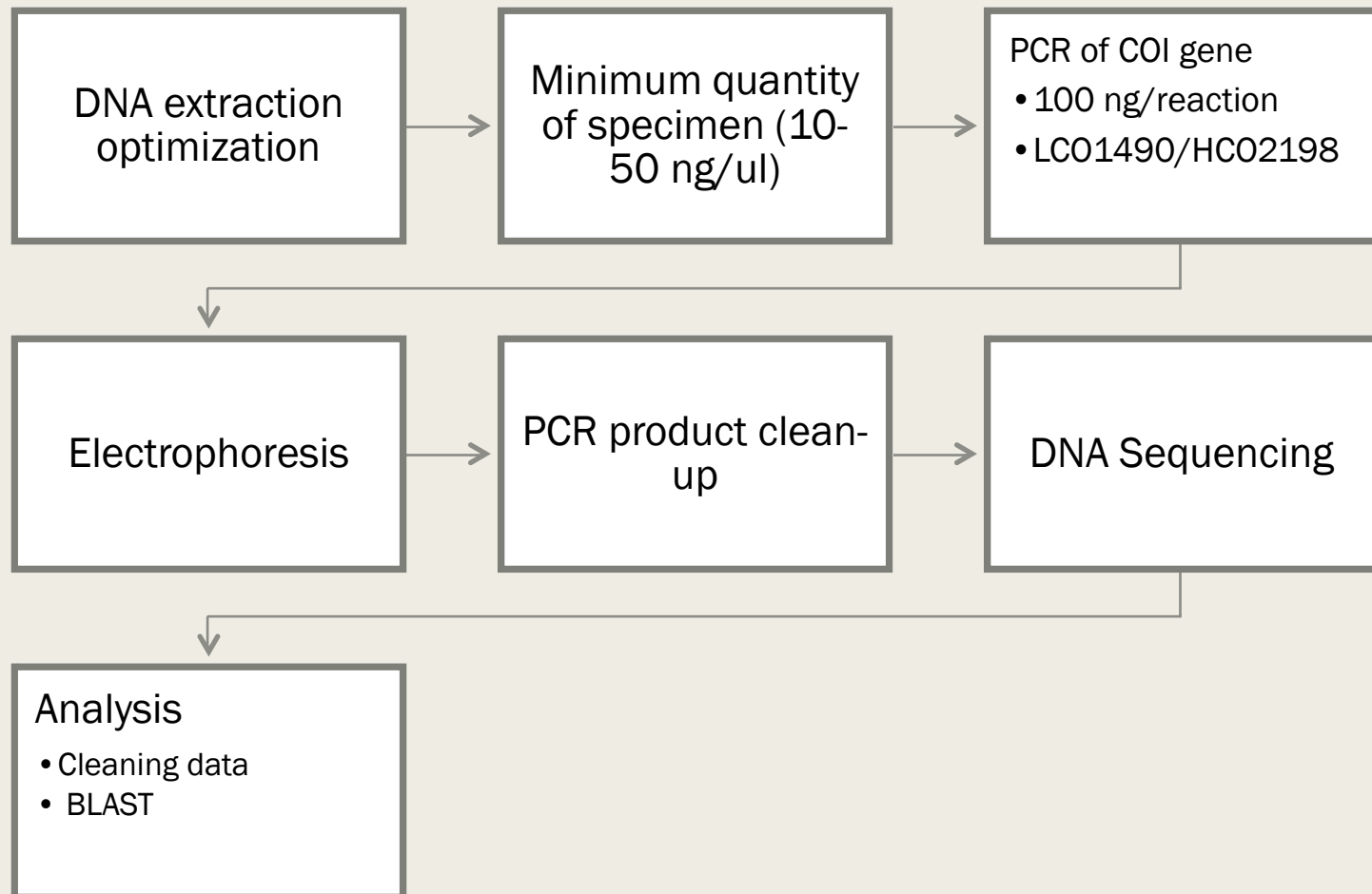
- ✓ Accessibility
- ✓ Vicinity to human activity
- ✓ Shaded
- ✓ Protected (human and weather conditions)
- ✓ Hided
- ✓ Variety of habitats (natural and manmade)



# Morphological identification



# Genetic identification



# Species genetically identified

- *Ae. detritus*
- *Ae. cretinus*
- *Ae. caspius*
- *An. claviger*
- *An. superpictus*
- *Cx. perexiguus*
- *Cx. hortensis*

- *Ae. albopictus*

- Destructive method
- Restrictions in number of runs you can perform

# Species genetically identified

■ *Ae. detritus*

■ *Ae. cretinus*

■ *Ae. caspius*

■ *An. claviger*

■ *An. superpictus*

■ *Cx. perexiguus*

■ *Cx. hortensis*

■ *Ae. albopictus*

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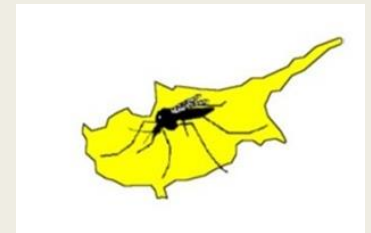
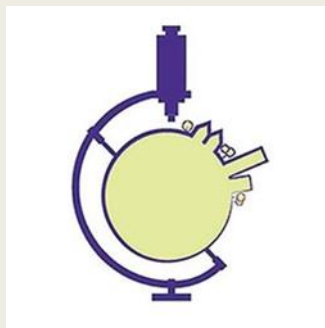
# Open questions

- Is 1 kg of CO<sub>2</sub> enough for the BG sentinel traps?
- How far should ovitraps-BG Sentinel be placed? Should a different region be selected only for ovitraps?
- How to deal with unidentifiable specimens?
- How do you store specimens?
- How many specimens should a pool analysis have for molecular identification?
- Should separate dates be merged for molecular identification?
- Is there a strong preference of qPCR for molecular identification?
- Are you working on COI gene?
- How to store data?
- Is any of your institutions open for collaboration for validating our results?
- Has any of you tried or thinking to implement metabarcoding approaches?
- What else do you recommend?

# Future directions

- Complement monitoring with ovitraps
- Improve genetic identification (16S, metabarcoding)
- Evaluate vector capacity (WNV)
- Evaluate the SIT potential application to suppress *Ae. caspius*, *Ae. detritus*
- Implement drone technology to monitor or control mosquitoes in the region

# Acknowledgements



- Mr Koulis Kavkalias
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- Ms Anthi Zachariou
- Ms Florentia Themistokleous