Aedes Control to Protect from Zika Virus Disease – The Toolbox Today and Tomorrow

Karl Malamud-Roam

3/11/16

The IR-4 Project

Pest Management Solutions for Specialty Crops and Minor Uses

Zika Virus Disease – Will Rutgers & IR-4 Save the World?

Karl Malamud-Roam

3/11/16

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Why am I here?

- Me
  - Medical Geographer / Disease Ecologist
  - Mosquito Killer (CA)
  - PHP Program Manager
  - Self-taught lawyer, lobbying, marketer
- You
  - Entomologists
- Us
  - Team

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Pest Management
Solutions for Specialty
Crops and Minor Uses

- A federal / state collaboration (est. 1963)
- Publicly funded (USDA, land-grant universities, etc.)
- HQ in Rutgers U.
- 125 FTE's; $20+ million/yr.
- Goal: Support pest management product registration in small markets

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IR-4 Mission Statement

To facilitate regulatory approval of sustainable pest management technology for specialty crops and specialty uses to promote public wellbeing.

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Arboviruses before 2014

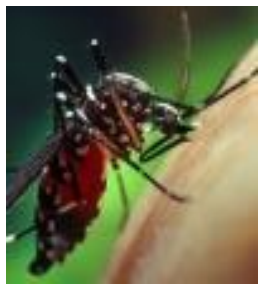
Zika Virus – the Game-Changer

Pest Management

Baby with Microcephaly

Defining the Problem(s)

Pest Management



Disease

Germ

ZIKA

Vector

Vector Control

Zika Virus Today

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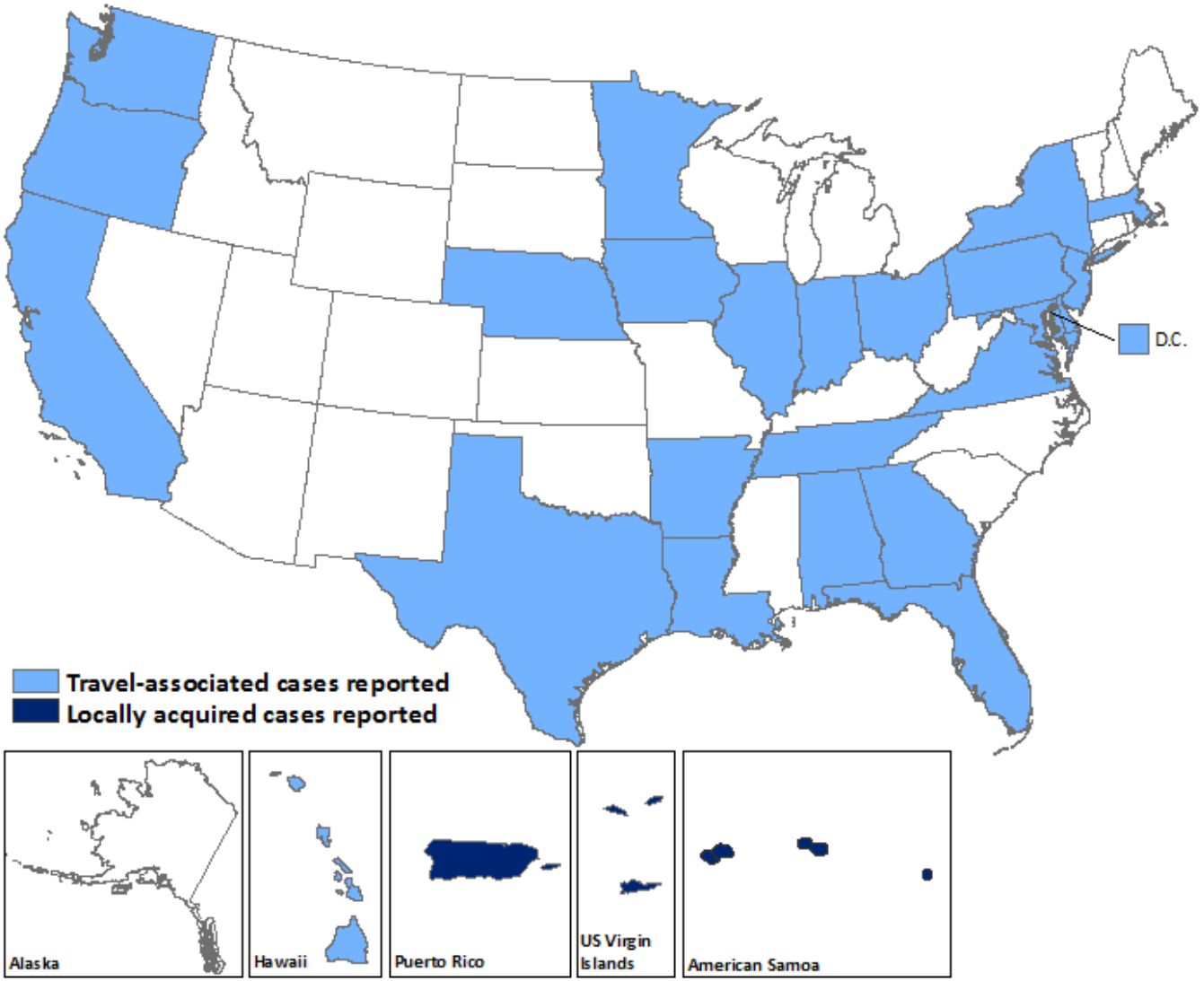
Zika Virus Today



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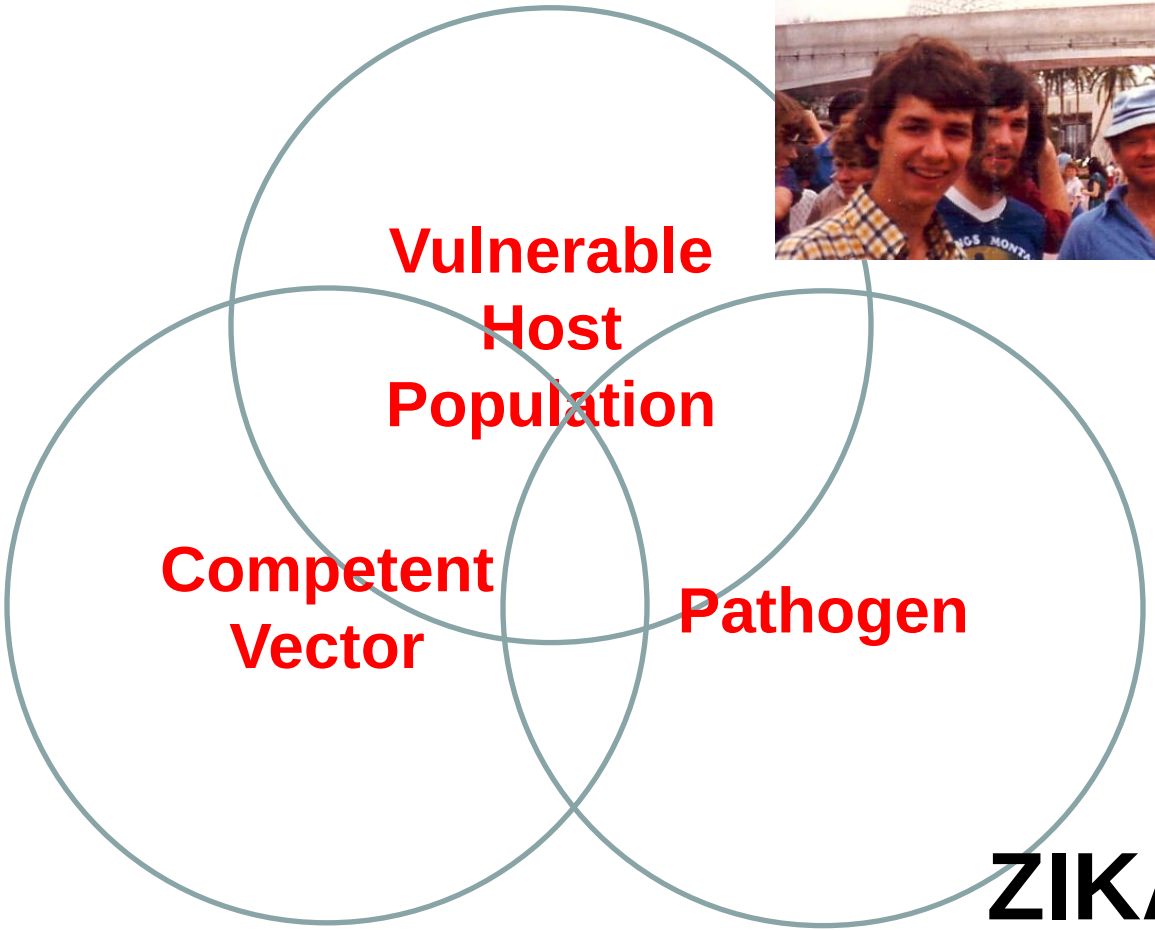
Arbovirus Pathogenesis



ZIKA

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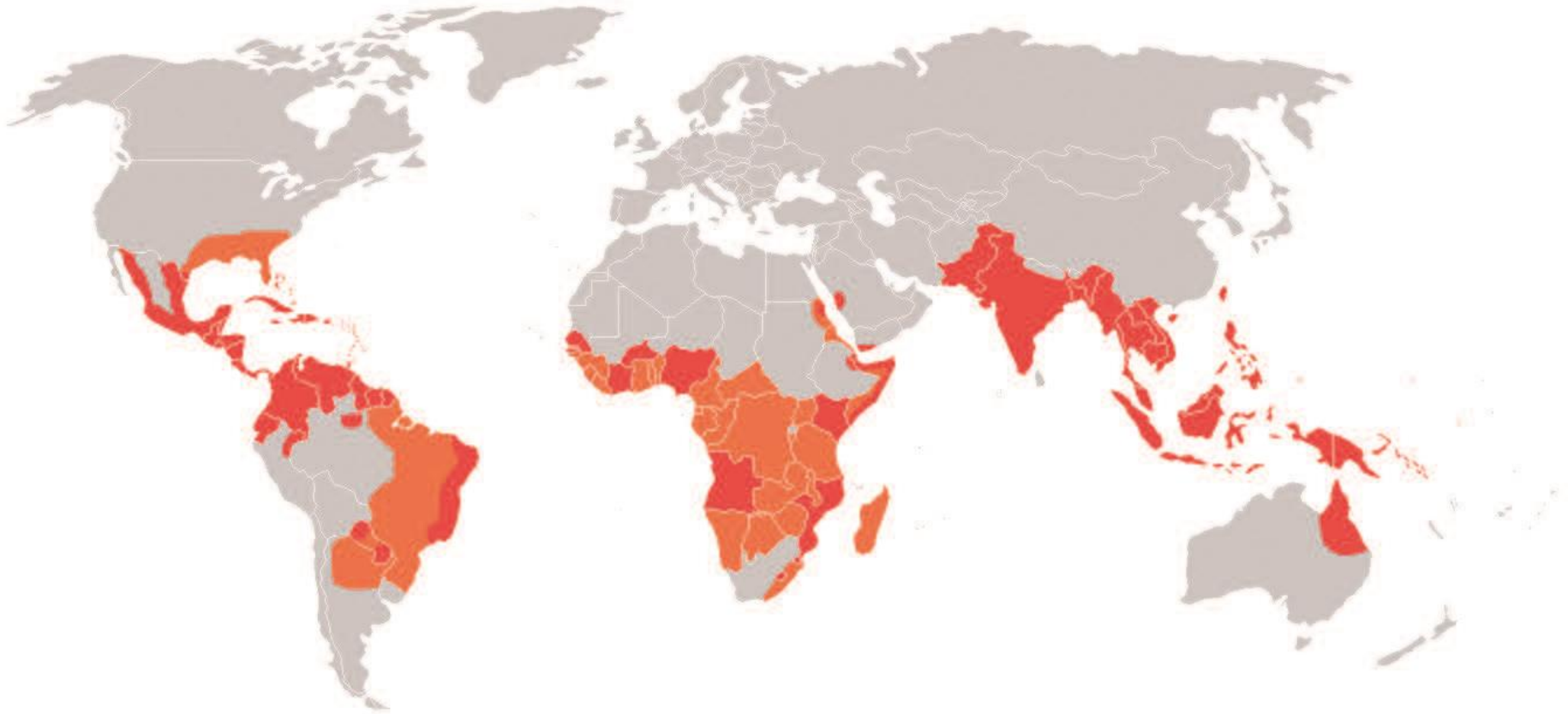
Zika Virus Tomorrow?



Aedes aegypti distribution

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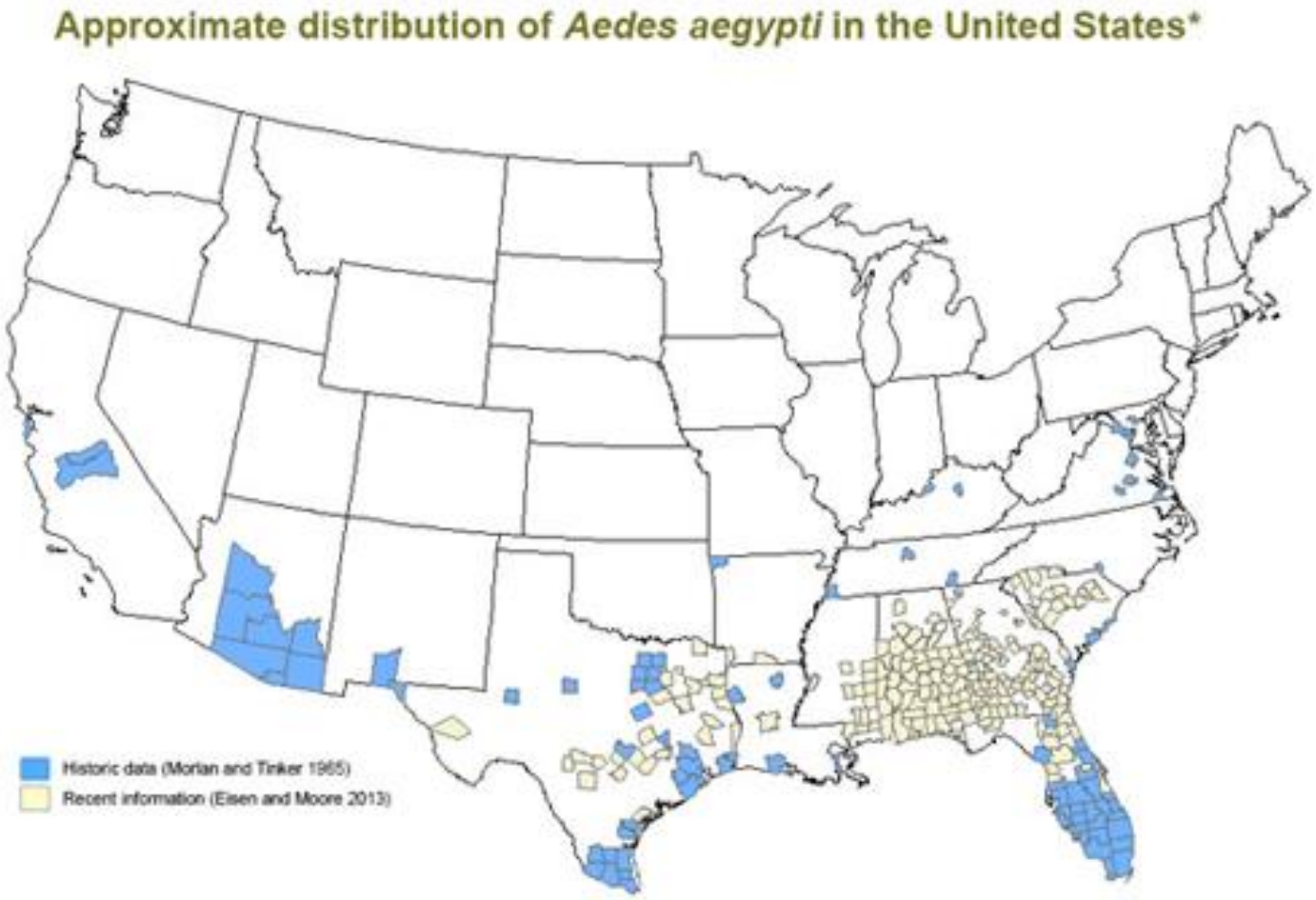
Aedes aegypti Today



*This map was developed using currently available information. *Aedes aegypti* mosquito populations (a known vector of chikungunya) may be detected in areas not shaded on this map, and may not be consistently found in all shaded areas. The shaded areas are NOT locations of chikungunya transmission.

Aedes albopictus Today

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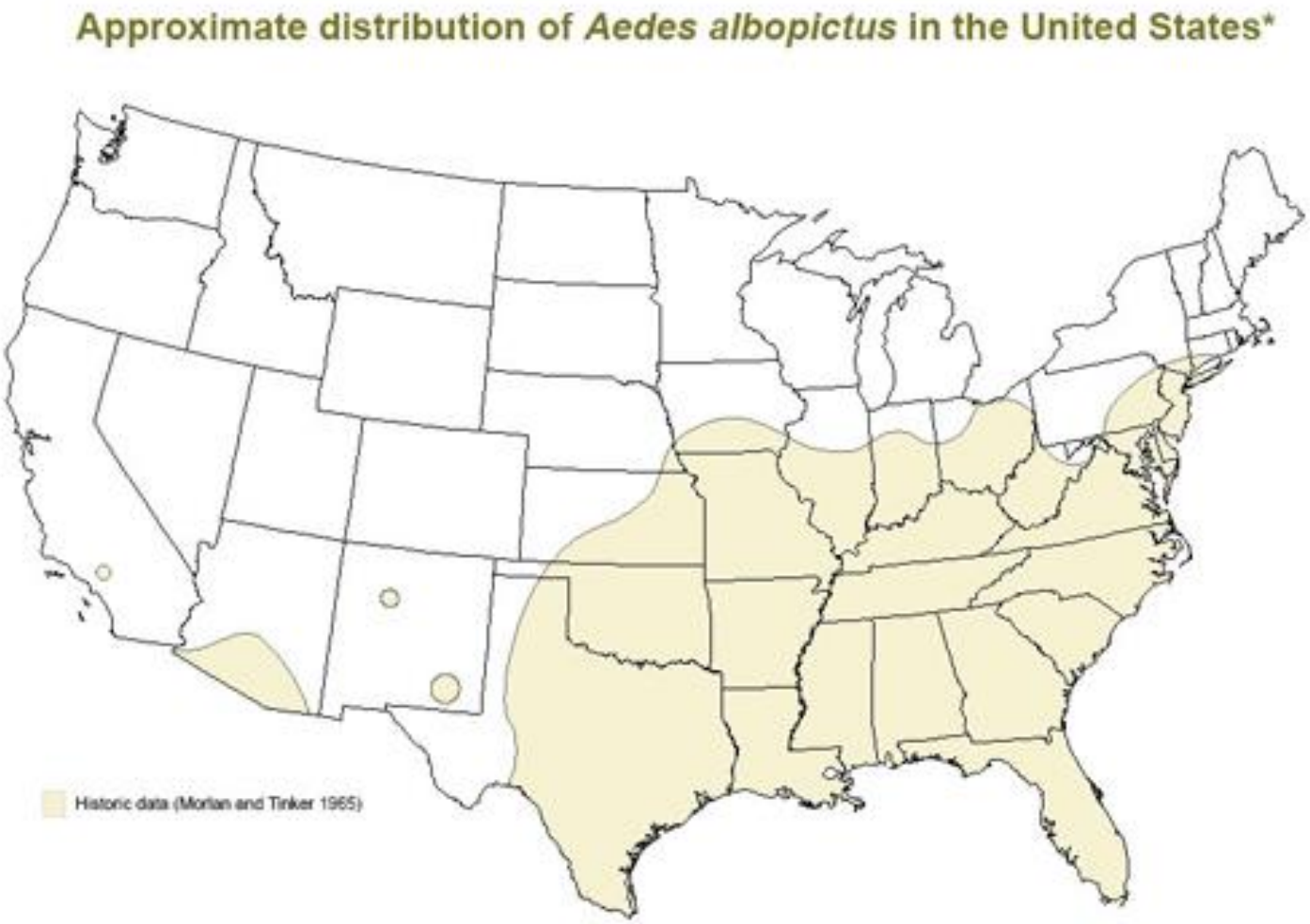

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Aedes aegypti Yesterday

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Plate 9 B. Distribution of *Aedes aegypti*—USA: AL, AR, DC, FL, GA, IL, IN, KS, KY, LA, MS, MO, NC, OK, SC, TN, TX, VA (146), MD (716), NY (48), NJ (232), AZ (490), OH (Berry & Parsons, pers. comm. 1978); Map modified after Morland & Tinker (500); Tax. 42, 431.

Aedes aegypti distribution before Ae. albopictus

Protecting from Zika Virus Disease

Today				2+ Years	5+ Years?
Prevent Disease				**Vaccinate**	**Cure**
Action	**How?**	**Who?**	**Federal Role**	Likely available in 2018	Probably well in the future
Prevent Mosquitoes	• Drain Standing Water	• Individuals • Families • Communities	• Educate • Support Local Govt.		
Avoid & Repel Mosquitoes	• Travel with Care • Screens / AC • Repellents • Protective Clothing	• Individuals • Families	• Educate		
Find & Kill Mosquitoes	**• Surveillance** **• Vector Control**	**• Local Govt.** **• State Govt.** • CDC • Private Sector • Families	**• Support Local & State Govt.** ○ Technical Assistance ○ Funding **• Support Proven Tools** **• Support New Tools**		

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Proven PHP Tools

- In Cancellation: Temephos, Resmethrin, Allethrin, Agnique
- Human Health High Risk: Chlorpyrifos, OP's generally
- Ecorisks – Endangered Species + Pollinators
  - Defining data & risk assessment needs w/ EPA & users
- Critical Needs: Malathion, Naled

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Established Adult Control Tools

- **Pyrethroids**
  - **Allethrins**
  - **Bifenthrin**
  - **Deltamethrin**
  - **d-Phenothrin = Sumithrin**
  - **Etofenprox**
  - **Resmethrin**
  - **Pyrethrins**
  - **Permethrin**
  - **Prallethrin**
- **OP's**
  - **Malathion**
  - **Naled = Dibrom**
  - **Chlorpyrifos**

Innovation = New Tools

The Aedes Control Toolbox – Tactics & Techniques

	Established	2016 Add	2017-18 Add	2019+ Add
Personal Protection	• **Avoid Mosquitoes** • **Repellents (on Skin)** • **Treated Clothing**		• **Next-Gen Clothing**	• **Next-Gen Repellents**
Family & Household	• **Drain Water & Clear Trash** • **Physical Barriers** ○ Screens / AC • **Treated Nets** • **Attract & Kill, HS** ○ CO2-baited Traps • **Larvicides** (Bti tablets) • **Adulticides** ○ Spatial (Coils, etc.) ○ Misting Systems	• **ATSB (Garlic)** • **LOT** ○ DDVP ○ Fungus + IGR ○ Sticky Trap • **Larvicides** ○ Potable Water • **Spatial Repellents** ○ 25b	• **Treated Curtains** • **ATSB (25b)** • **LOT** • **Autodissemination of IGR** • **Indoor Spatial Bite Protection** ○ Pyrethroid	• **ATSB (Conv.)** • **LOT** ○ Toxin on Water • **Indoor Spatial Bite Protection** ○ Non-pyrethroid • **Laser?**

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Innovation = New Tools

The Aedes Control Toolbox – Tactics & Techniques

	Established	2016 Add	2017-18 Add	2019+ Add
Local Govt. & Community	• **Drain Water & Clear Trash** • **Biological Control of Larvae (Fish, etc.)** • **Ground Spray** ○ Larvicides ○ Adult Space Spray ○ Outdoor Residual • **Education, Mobilization**	• **Ground Spray** ○ ATSB (Garlic) ○ IRS ○ Indoor Surface Sprays • **LOT** • **SIT** ○ Wolbachia vs. Aedes albopictus	• **Ground Spray** ○ Larvicides ○ ATSB (25b) • **LOT** • **SIT** ○ Wolbachia vs. Aedes aegypti ○ RIDL	• **New Pesticides** • **Ground Spray** ○ ATSB (Conv.) • **SIT** ○ Chemical ○ Irradiated • **RNAi** • **Wolbachia vs. pathogen**
Large-Scale	• **Aerial Spray** ○ Adulticides ○ Larvicides		• **Aerial Spray** (Next-gen equipment & formulations)	• **Area-wide SIT** • **Next-gen GM mosquitoes**

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New Application Methods

- Deltamethrin aerial application
- Larvicide in drinking water
- Indoor residual spray
- Treated curtains

New Tools – Attract & Kill

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- Lethal Ovitraps (LOT)
  - 2016: DDVP; Sticky trap
  - 2017: Fungus + IGR
- Autodissemination
- Attractive Toxic Sugar Baits (ATSB)
  - 2016: Garlic
  - 2017: Additional 25(b)
  - 2018: Conventionals (Boric Acid, etc.)
- Host-seeking traps (efficacy?)
- Surveillance traps
- Improved attractants

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New Tools – Mating Disruption

- *Wolbachia*
  - Cytoplasmic incompatibility – *Ae. albopictus*
  - Cytoplasmic incompatibility – *Ae. aegyptus*
  - Pathogen transmission disruption
- GM Insects
  - RIDL (Oxitec)
  - Pathogen transmission disruption
- Pheromones?

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New Tools – Etc.

- New AI classes & AI's
  - Biopesticides
  - IVCC
  - New topical repellents
- New application Technology
- Treated fabrics
  - Clothing
  - Bed nets
- "Spatial repellents"
- Cattle fever tick control

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Life Stage & Interventions

- Achee et al 2015
- Egg
- Larval
- Emergence
- Sugar-feeding
- Mating
- Blood-feeding
- Oviposition

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Optimization of Interventions

- Shot Gun (Try Everything)
- Horse Race (Which is “Best”?)
- Crew Race (Synergy)
- Relay Race (Sequence)

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Sequential Reduction Model

- 1. Reduce Habitat
- 2. Reduce Adult Population
  - Spray (outdoor & indoor?)
  - Start
  - Attract & Kill (mixed intervention)
- 3. Targeted Attack on Adult Females
  - Release sterile males (GM-RIDL, Wolbachia, etc.)

Mosquito Control to Prevent Zika Virus Disease: Key Roles and Responsibilities

Preventing Disease Through Bite Prevention						
Action	**How?**	**Individuals & Families**	**Local Govt.**	**State Govt.**	**Federal Govt.**	**AMCA Request**
Prevent Mosquitoes	• Drain Standing Water	• **Act**	• **Act** • **Educate**	• Educate • Support Local Govt.	• Educate • Support Local Govt.	n/a
Avoid & Repel Mosquitoes	• Travel with Care • Screens / AC • Repellents • Protective Clothing	• **Act**	• Educate • Support families	• Educate • Support Local Govt.	• Educate	n/a
Find Mosquitoes	• Mosquito Surveillance	• Report	• **Act**	• **Act** • **Coordinate**	• **Coordinate** • **Support Local & State Govt.**	• **ELC ($50M)**
Kill Mosquitoes	• Vector Control	• Act • Contract w/ Private Sector	• **Act**	• Act • Contract w/ Private Sector	• **Support Local & State Govt.** • **Support Proven Tools** • **Support New Tools**	• **MASH ($100M)** • **FQPA ($12M)** • **Multiple ($15M)**

Zika & IR-4

- **Support Existing, Proven Tools**
  - Temephos
  - Others in Cancellation (Resmethrin, Allethrin, Agnique)
  - At-Risk (OP's)
- **Support New Tools**
  - Efficacy, Comparative Efficacy
  - Regulatory Support
- **Data Support**
  - Drinking Water, Indoor Residual Spray, Organics

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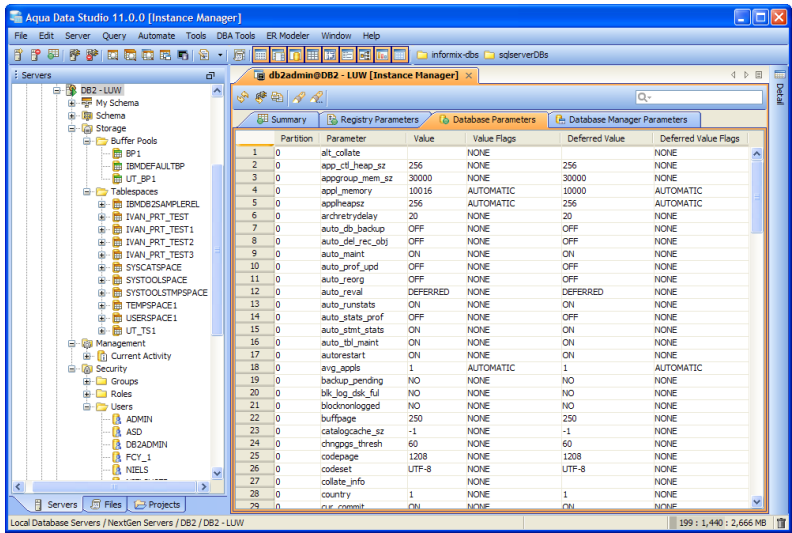
PHP Data Management

- Solving Problems
  - Larval Control in Drinking Water
  - Indoor Residual Sprays / Surface Sprays
  - Organics
  - Replacing Lost Products
- Moving Product Module Online
  - Cornell funding?



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Comparative Efficacy Testing

- Challenges
  - Confounding
  - Size
  - Timing
  - etc.

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Ae. aegypti vs. *albopictus*

- Vector Competence vs. Capacity
- **Hypothesis**:
  - Is *Aedes albopictus* protecting NJ from Zika Virus!?

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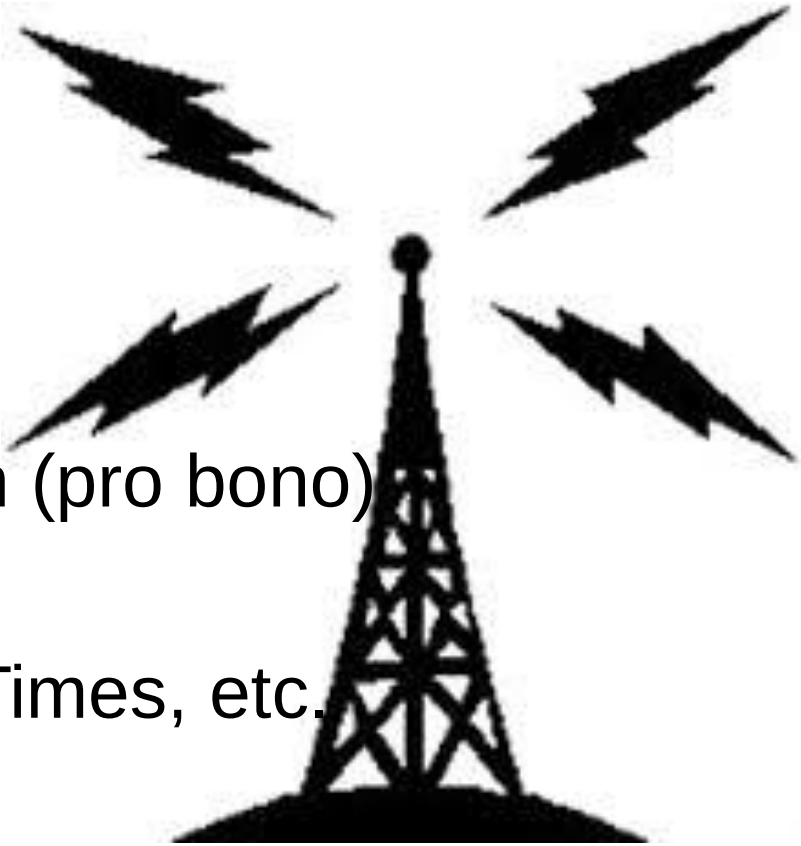
PHP Communications

- IR-4 Communications team
  - Publications
  - Website
  - Social Media
- USDA (NIFA, ARS, etc.)
- MAGA Design / Dan Roam (pro bono)
- Rutgers
- National Geographic, NY Times, etc.



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Conclusions

- We must evaluate vectorial capacity in *Aedes* spp.
- We must learn, fast, how to integrate established and novel vector control interventions to control *Aedes.*
- Vector control is critical, effective, and at risk.
  - Government must help.
  - We must help.