AMVAC ENVIRONMENTAL PRODUCTS

“It’ll NEVER work !

The use of aerial applications in the control of peridomestic vectors

Peter H. Connelly and Charles A. Silcox, Ph.D.
AMVAC Environmental Products Mar 2017

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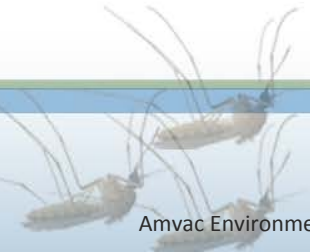
It'll NEVER work !

- "You're going to do WHAT with our cloaking technology ?"
- Prior to 1961 – "You'll never control mosquitoes by air"
- Early 70's cold aerosol fogging... "It will never work"
- "You will never get water to behave like oil in ULV applications"
- "You will never hit that spray block with a 7000 foot offset"
- "Naled will never be used in California for mosquito control"
- **"You cannot control *Aedes aegypti* with aerial applications"**

Our thoughts are constrained by what we KNOW-
or what we think we know !



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It'll NEVER work !

- "We will never make a 32 bit operating system."

— Bill Gates

- There is **no reason anyone would want** a computer in their home."
- — Ken Olson, president, chairman and founder of Digital Equipment Corp. (DEC), maker of big business mainframe computers, arguing against the PC in 1977

- ""There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will."

— Albert Einstein, 1932

- "The horse is here to stay but the automobile is only a novelty – a fad."

— The president of the Michigan Savings Bank advising Henry Ford's lawyer, Horace Rackham, not to invest in the Ford Motor Co., 1903

- "This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."

— A memo at Western Union, 1878 (or 1876).

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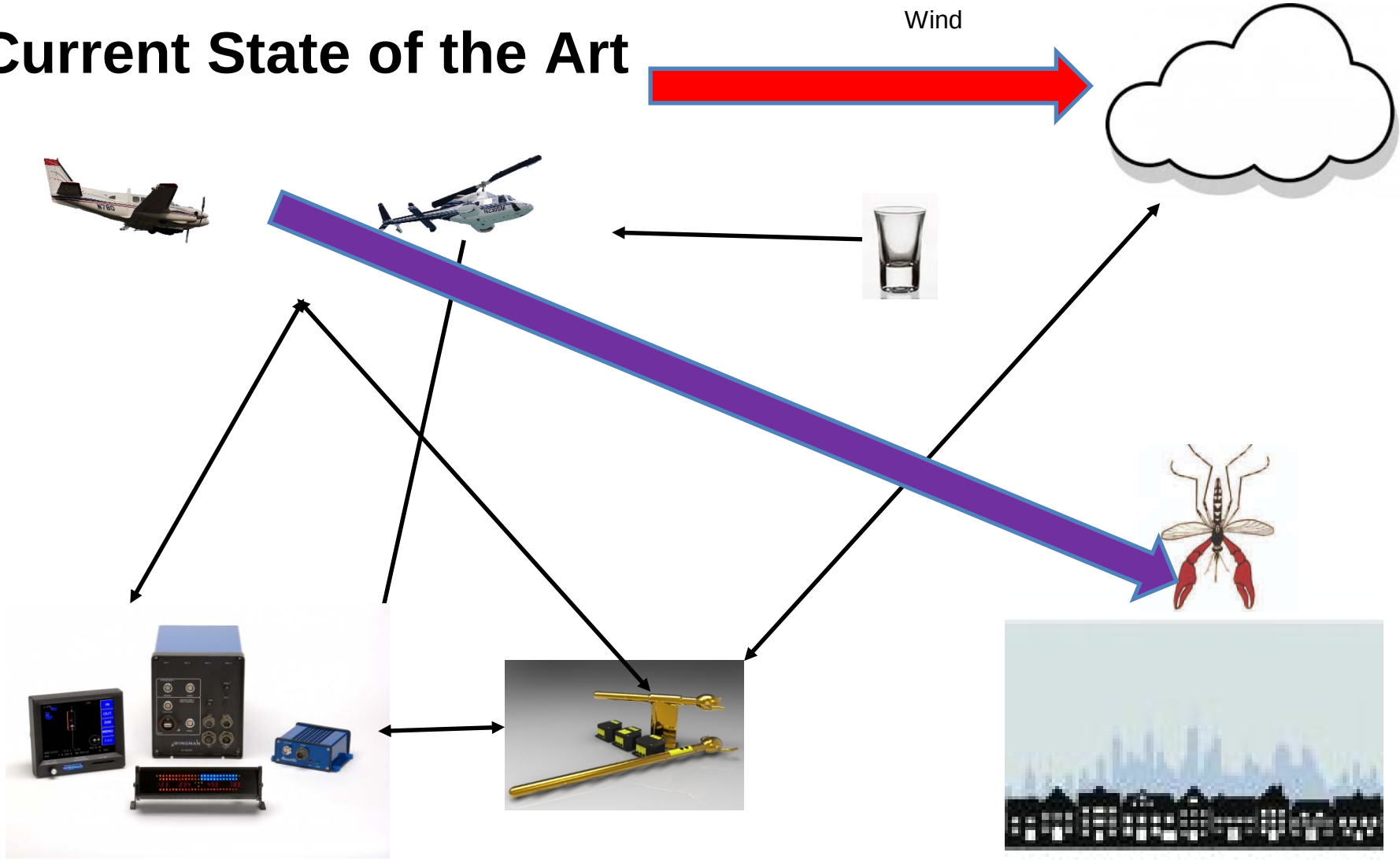
State of the ART

Current State of the Art



Why is this important ?

- In 1961 dengue was found in 7 countries only. Now over 100
- WHO indicates 40 to 50 % of the global population lives in dengue endemic areas
- The malaria toll equivalent is a number you will not believe
- Thousands of people die and suffer each day while we have thresholds for control that seem trivial in comparison
- Dr. Nielson, Meek, Chapman, Bidlingmeyer, Meisch, Mulrennan, Perich, Tidwell, Provost, Livingston, Pant, Self, Etc did it before we got here, and we owe it to all those that will follow us.
- We now have locally acquired CHIKV, Dengue and ZIKA in the U.S.

- It's the right thing to do !!

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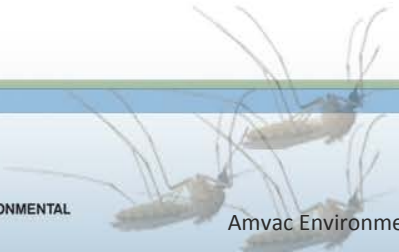
Global *Aedes aegypti* Project (GAaP)



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Summary of all scores

Component	Rank	Max Score	San Juan Puerto Rico 1987	Buga Columbia	New Orleans 1987	Santa Domingo 1988	Menado 1975	The Bahamas 1977	Menado (Sulawesi) Ind
Study ID			1	2	3	4	5	7	8
Species (relativity)	1	1,500	1500	1,500	1,500	1,500	1,500	1500	1500
Product used	2	1,000	1000	1,000	666	666	666	666	333
Aircraft (ability to push)	3	750	750	250	500	750	250	750	750
VMD at nozzle	4	750	250	250	500	250	250	250	250
Offset technology used	5	750	750	250	500	500	250	250	250
Multiplicity	6	750	500	750	500	750	750	750	250
Periodicity data available/used	7	500	500	500	500	500	333	500	333
Susceptibility	8	500	500	333	500	500	333	333	333
Weather AGL (Release height)	9	500	500	333	333	166	333	166	333
Weather GND	10	500	333	500	500	333	500	500	500
Proofing cage specimens or/or slides	11	500	500	500	500	500	500	500	500
Droplet density	12	500	166	500	500	333	500	166	500
Inside deposition	13	500	500	500	166	500	500	166	500
Canopy	14	400	266	266	400	133	266	133	266
Altitude	15	400	400	400	266	400	400	400	400
Efficacy	16	200	200	200	200	123	200	200	200
Raw score		10,000	8,615	8,032	8,031	7,904	7,531	7,230	5,698

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IMPROVING THE ODDS

- **Surveillance** – Trapping and landing rates to determine best timing for adult control
- Use a **smaller VMD** – at or below 30 um - **Micronair, High Pressure or better**
- Use an aircraft capable of **flying low enough and with significant vortices**.
- **Use the latest technology** including nozzle delivery systems, offset determination, flux modeling, real time weather /flight guidance
- **Timing**- Determine the periodicity where deployed and intervene EARLY !!

- Product selection-
  - **Pre-determine susceptibility** to all products through your staff or independent sources.
  - Products with heavier specific gravity than all other Ai's used (higher degree of predictability with smaller droplets.)
  - Rapid degradation in the environment
- Make **multiple applications** if necessary timed carefully and ONLY in a fully integrated IPM program including source reduction, larval control and community awareness and action in REDUCING containers.

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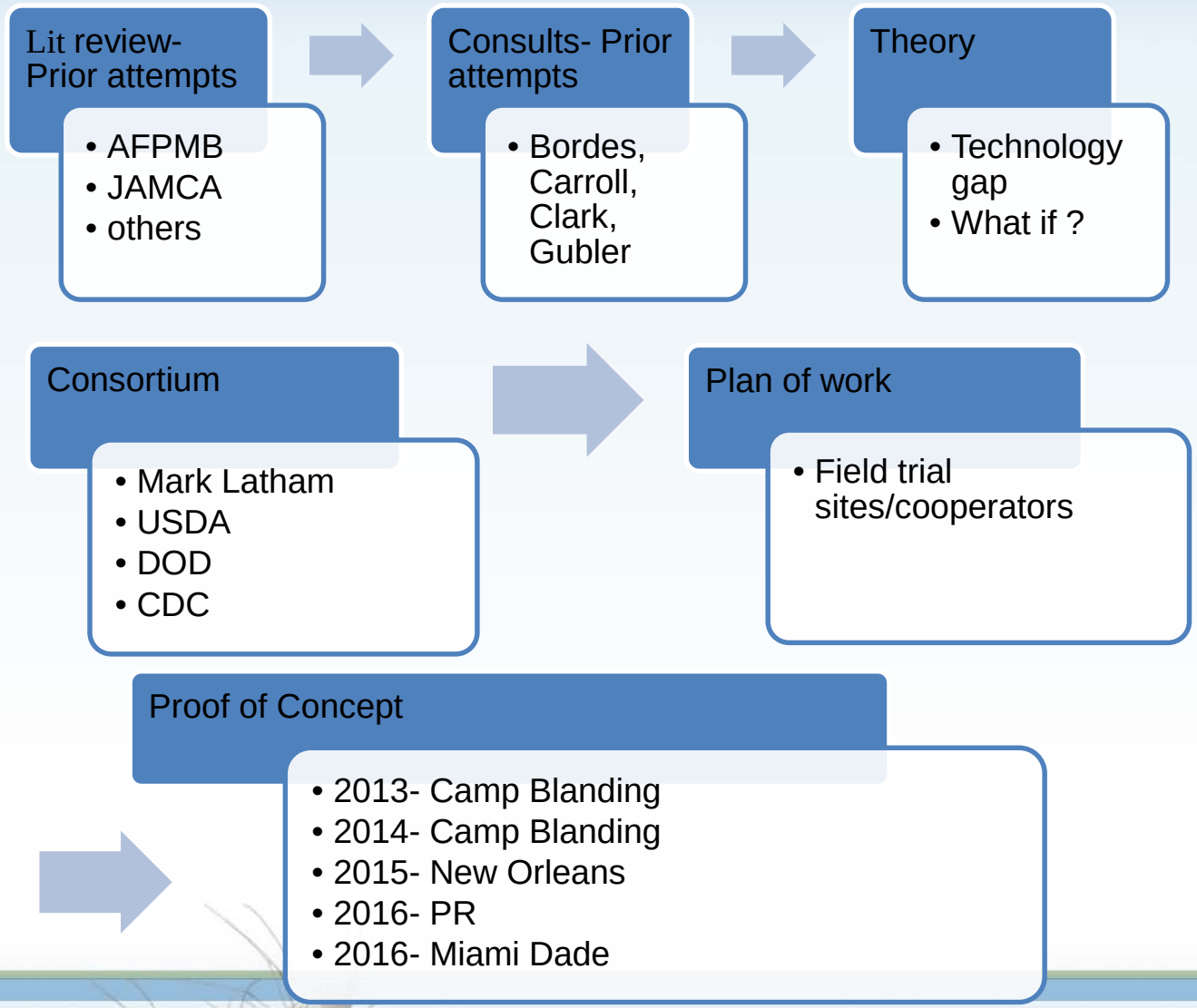
GAaP



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Starting supposition

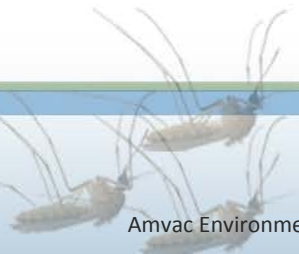
- If there is no known resistance developed in the target insect to a product
- Getting the product to the target insect is all that matters

- If in aerial ULV applications you can correct for >>>
  - larger droplets that often do not reach the intended target
    - Settling prior to reaching the target
    - Waste of significant amounts of product

–Use a product with the efficacy- no known resistance- and the specific gravity that will allow the product to reach the target

–Incorporate this in an IPM program including community wide source reduction

- Solution…change the paradigm ! Change the results !



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Global *Aedes aegypti* Project (GAaP)

Field Trials Conducted To Date

- October 2013 – Camp Blanding, FL
- August 2014 – Camp Blanding, FL
- July 2015 – New Orleans, LA

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Global Aedes aegypti Project (GAaP)
Camp Blanding Testing
Starke, FL
October 2013

Blanding I

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GAaP Trial – Starke, FL
Camp Blanding Trial – October 2013

MOUT Complex

“Open” Building

“Closed” Building

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GAaP Trial – Starke, FL
Camp Blanding Trial – October 2013

Mosquito Bioassay Methodology

Bioassay Cage

Bioassay Cage
Indoors on Floor
(And Inside Box)

Spinner with 2 Glass Rods

Bioassay Cage
Outdoors on Pole
(And Inside Box)

Outdoor Test Site

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GAAP Trial – Starke, FL
Camp Blanding I Trial – October 2013

USAF C-130

IMG_0483.MOV

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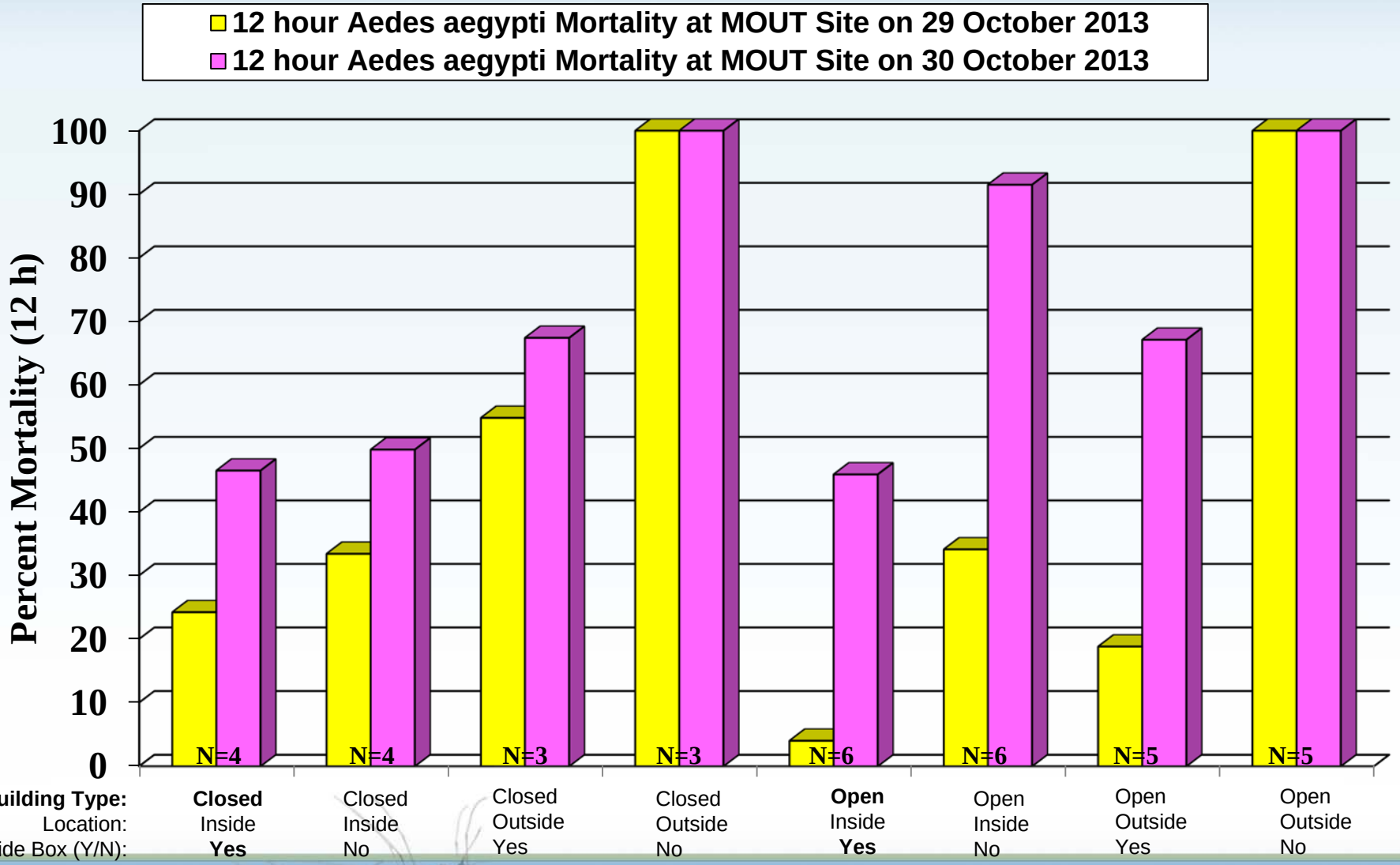
GAAP Trial – Camp Blanding, FL
MOUT Complex – 29 & 30 October 2013



Application Date:	**29 October 2013**	30 **October 2013**
Application Method:	C-130 – MASS	C-130 – MASS
Product/Application Rate:	Dibrom EC / 0.84 fl.oz. per Acre	Dibrom EC / 1 fl.oz. per Acre
Altitude:	150 feet (AGL)	150 feet (AGL)
Speed:	200 knots (230.2 MPH)	200 knots (230.2 MPH)
Nozzle:	**SS8001 (24 nozzles)**	SS8003 (8 nozzles)

AMVAC ENVIRONMENTAL PRODUCTS

13C03I159XFL792

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Global *Aedes aegypti* Project (GAaP)
Camp Blanding Testing
Starke, FL
August 2014

Blanding II

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GAaP Trial – Starke, FL
Camp Blanding Trial – August 2014

Aircraft Information

Hughes 500D

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GAaP Trial – Starke, FL
Camp Blanding Trial – August 2014

Aircraft Information

- Aircraft: Hughes 500D
- Identification: N862MC
- Insecticide Delivery System:
  - High Pressure
- Spray Boom:
  - Custom 316 Stainless
  - Nozzles
    - 26 August: Bette PJ20 (2 Nozzles per boom; 4 Nozzles Total)
    - 27 August: Bette PJ10 (2 Nozzles per boom; 4 Nozzles Total)
  - Pressure: 1,500 psi
  - Flow Rate: 94 fl.oz. per minute (26 August)
    46 fl.oz. per minute (27 August)
- Differential GPS: Wingman®
- Information Management: AIMMS-20

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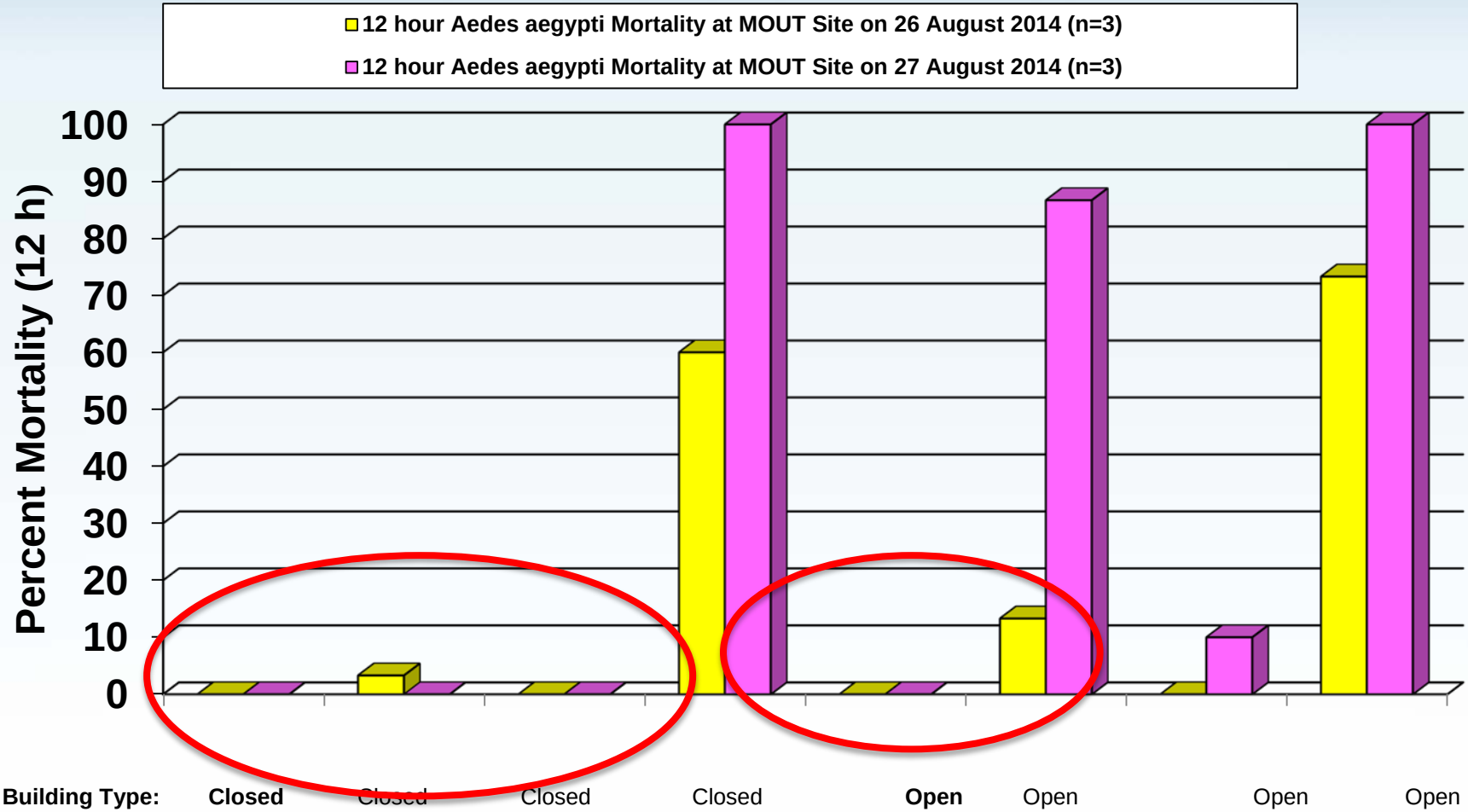
GAaP Trial – Camp Blanding, FL
MOUT Complex – 26 & 27 August 2014



Building Type:	**Closed**	Closed	Closed	Closed	**Open**	Open		Open	Open
Location:	Inside	Inside	Outside	Outside	Inside	Inside		Outside	Outside
Inside Box (Y/N):	**Yes**	No	Yes	No	**Yes**	No		Yes	No

Application Date:	**26 August 2014**	**27 August 2014**
Application Method:	**Rotary – Hughes** 500	Rotary – Hughes 500
Product/Application Rate:	Dibrom EC / 1 fl.oz. per Acre	Dibrom EC / 1 fl.oz. per Acre
Altitude:	150 feet (AGL)	100 feet (AGL)
Speed:	105 MPH	50 MPH
Nozzle:	**HP**	**HP Plus**

AMVAC ENVIRONMENTAL PRODUCTS

14C08I036XFL717

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AMVAC

Global *Aedes aegypti* Project (GAaP) Operational Testing New Orleans, LA July 2015

Nola I

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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Cooperating Organizations/Personnel

- New Orleans Mosquito & Termite Control Board
  - Dr. Claudia Riegel, Director
  - Sarah Michaels, Entomologist
  - Ed Foster, Pilot
- Manatee County Mosquito Control District
  - Mark Latham
- AMVAC Chemical Corporation
  - Peter Connelly

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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Trial Location

- New Orleans, LA – midtown area
  - Inner city location with raised housing and dense tree canopy
- Two test areas within an approximately 5,000 acre block
  - Test Area “A” – Marginy
  - Test Area “B” – Mid-City
- Both areas had monitoring records for many years
  - Citizen complaints and trap counts

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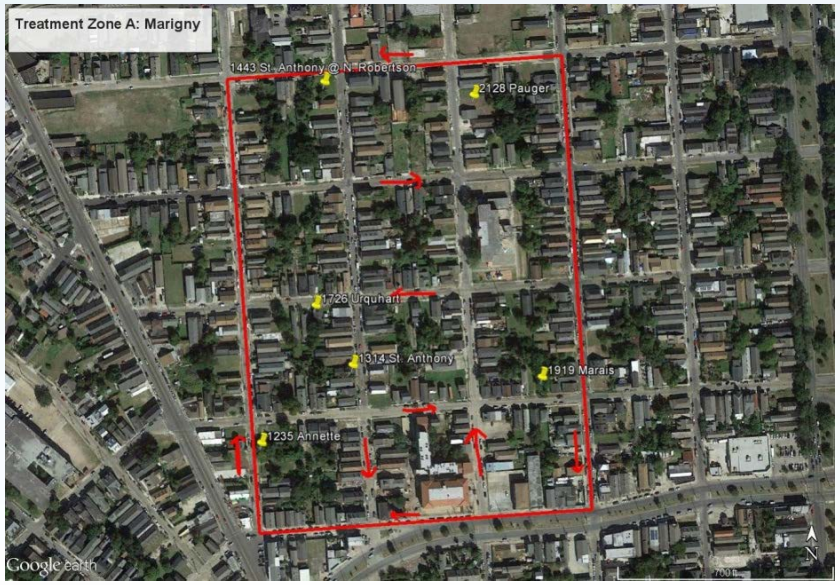
GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Trial Location



Treatment Area A - Marginy

Treatment Area B – Mid-City

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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Aircraft Information

- Aircraft: Briton Norman Islander
- Insecticide Reservior:
  - MicronAir 30 gallon “Pods”
  - One under each wing
- Spray Boom:
  - Two series of four flat fan SS8001 nozzles
  - Pressure: Approximately 60 psi
  - Flow Rate: 86 fl.oz. of Dibrom Concentrate per minute
- Application Delivery Guidance: Wingman®
- Information Management: AIMS

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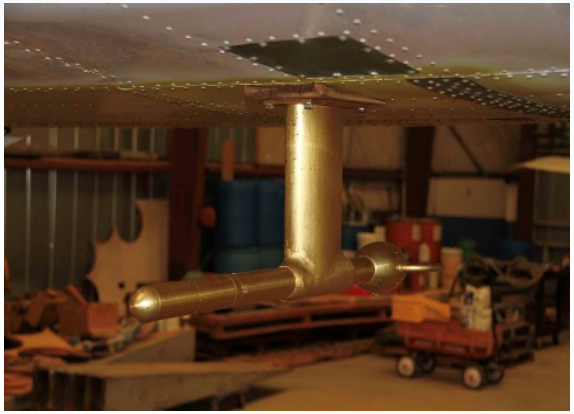
GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015
Aircraft Information



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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Application Information

- Application Date: 27 July 2015
- EPA Reg. No.: 5481-480
- Active Ingredient: naled
- Application Rate: 0.75 fl.oz. per acre (0.077 lb AI/A)
- Nozzles: 2X4 SS8001 (8 total nozzles)
- Aircraft Speed: 95 knots (109.3 MPH)
- Application Altitude: 200 - 450 feet (AGL)
- Swath Width: 500 feet
- Wind Direction: SSE
- Wind Speed: 7 to 15 MPH at release altitude
- Ambient Temperature: 84 to 86^{o} F
- Relative Humidity: 55-65%
- First Pass Initiated: 8:02 PM (2002h)
- Final Pass Initiated: 8:43 PM (2043h)

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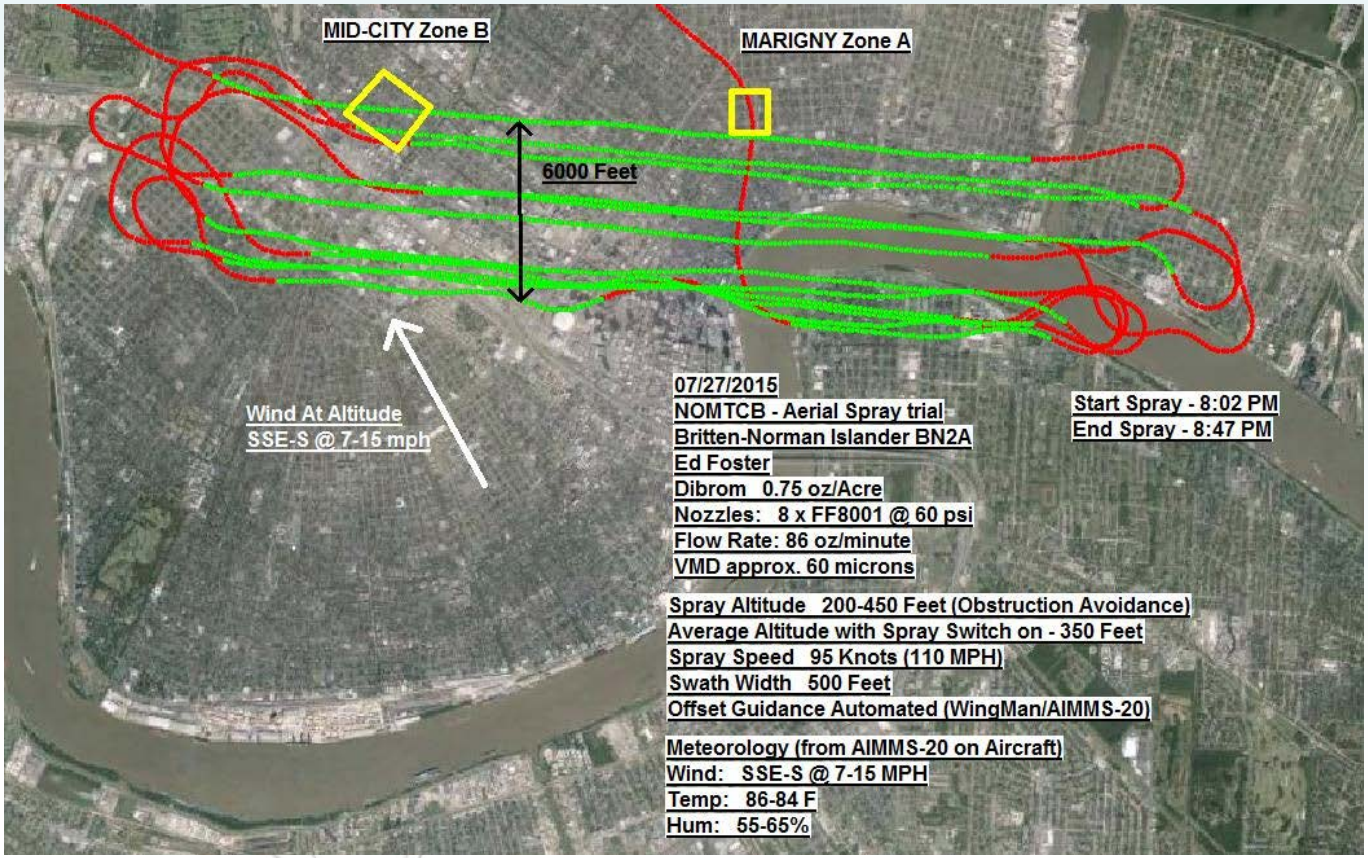
GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Application Information – Flight Details



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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Mosquito Bioassay Methodology

- *Aedes aegypti* and *Ae. albopictus* adults (F-1) reared from field collected populations
- 25 to 30 adult females per cage
- Cages consisted of cardboard tubing covered with tulle on both ends
- Number of Cages: 48 total cages – 24 *Ae. aegypti* and 24 *Ae. albopictus*
- Cage placement within each of the two test blocks
  - 6 cages of each species in open areas
  - 6 cages of each species in “sequestered” areas (dense tree canopy or under houses)
- Pre-application mortality assessment: At time of cage placement
- Post-application mortality assessments
  - 1 Hour (at time of pick-up before transfer to clean cage)
  - 24 Hours
- Untreated control mosquitoes
  - Both species, upwind of application, handling identical to treated mosquitoes

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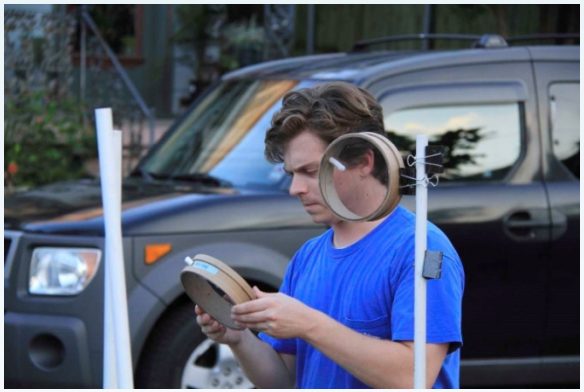
GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Mosquito Bioassay Methodology



Mosquito Cages

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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Mosquito Bioassay Methodology

Cages placed in open and sequestered locations

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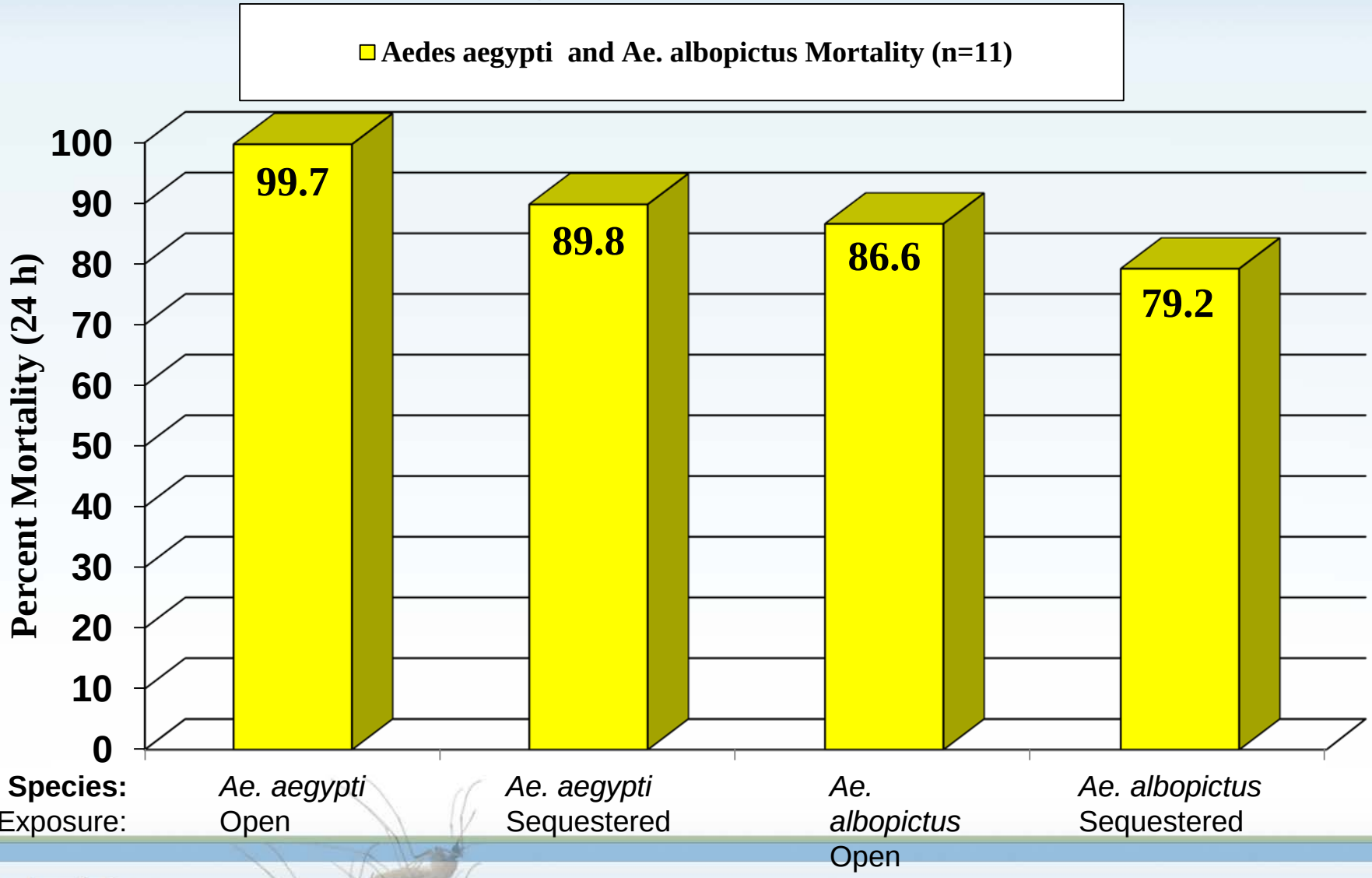
GAAP Trial – New Orleans, LA
Operational Trial – 27 July 2015



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GAaP Trial – New Orleans, LA
Operational Trial – 27 July 2015

Trial Conclusions

- Naled is extremely effective against *Aedes aegypti* adults
  - 99.7 percent effective against *Ae. aegypti* exposed outdoors (n=11)
  - High levels of control in sequestered sites (89.8 percent: n=11)
- In this trial *Aedes albopictus* is slightly less sensitive to naled
  - Still achieved relatively high levels of control
  - 86.6 percent control in open sites (n=11)
  - 79.2 percent control in sequestered sites (n=11)
- Additional replications are required for confirmation of results

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GAAP Trial – Miami- Wynwood
Operational Control Effort – September 2016

Miami Dade 2016

- Multiple applications of aerial naled
- Multiple applications of aerial larvicide
- 300,000 B.t.i Briquets in the storm sewer catch basins in Miami
- Applications of spinosad as larvicide
- Massive source reduction effort
- Comprehensive IPM

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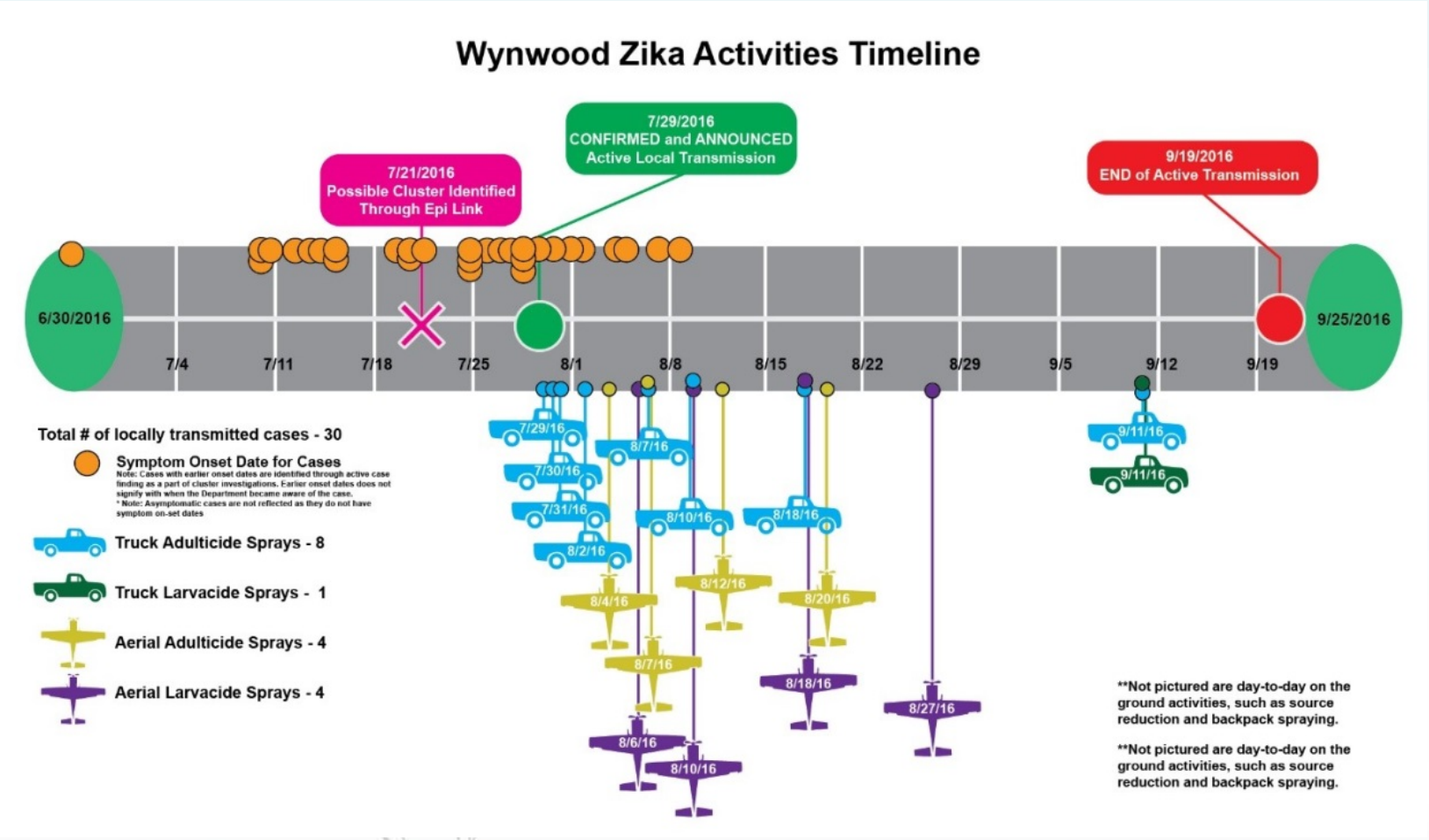
GAAP Trial – Miami- Wynwood
Operational Control Effort – September 2016



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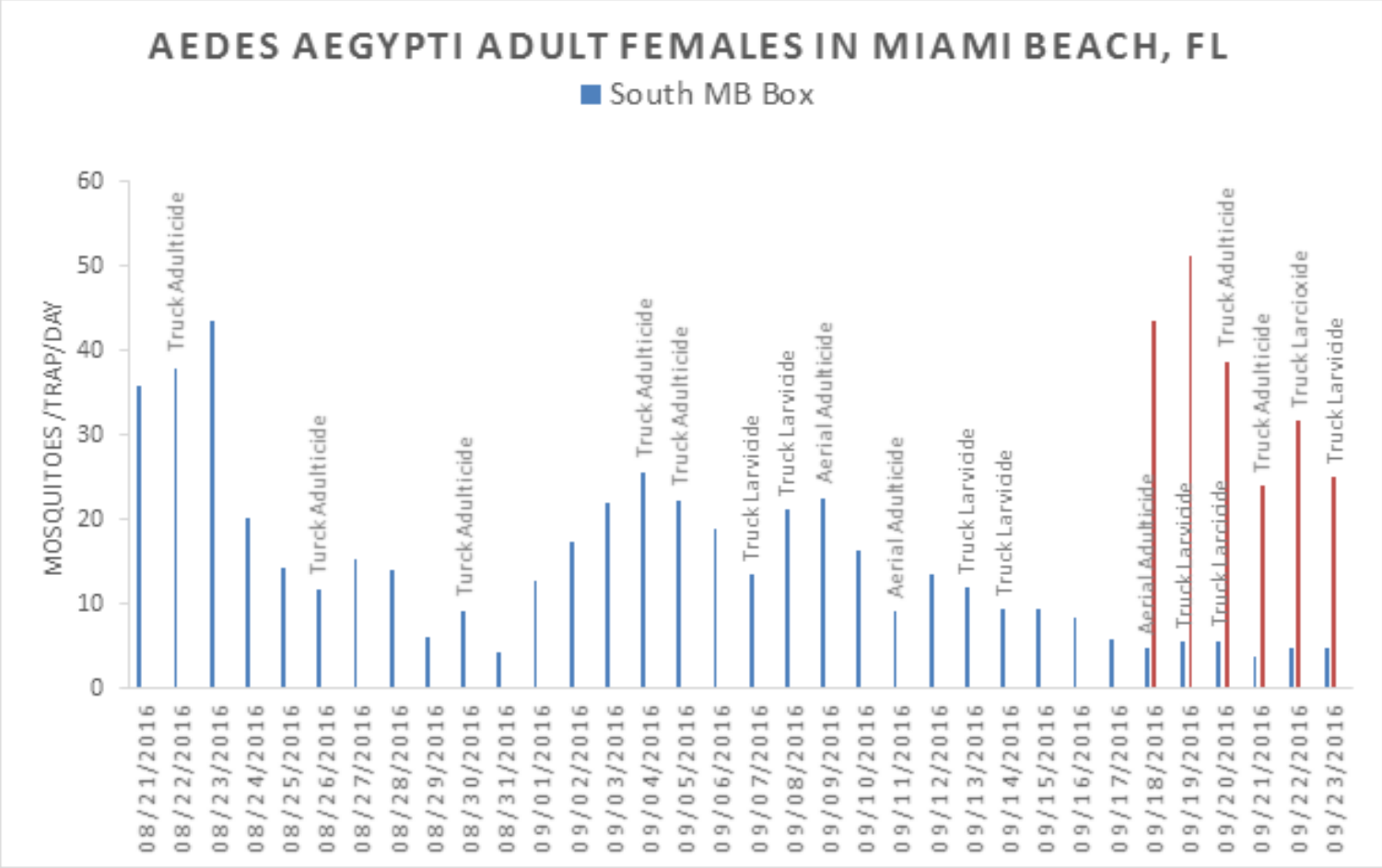
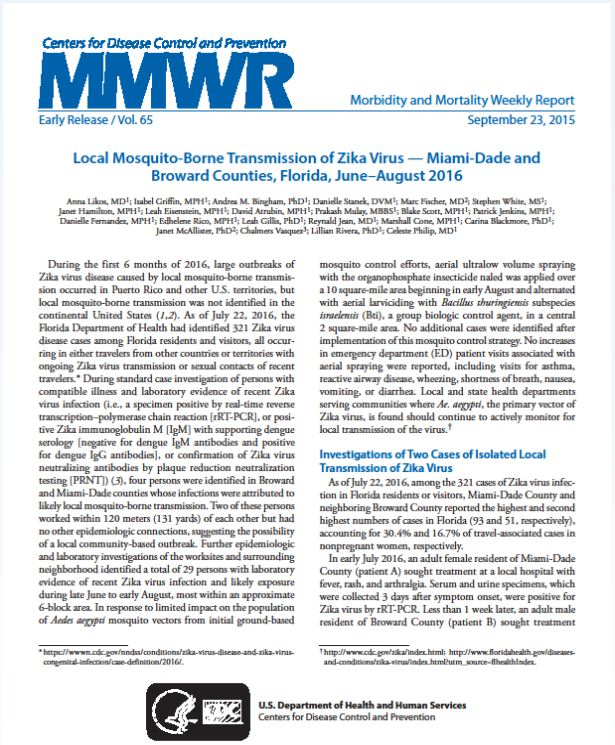
Miami Dade 2017



CDC

"Aggressive mosquito control efforts, including aerial adulticiding and larviciding, most likely contributed to a decrease in Zika virus transmission; no new cases in this area were identified with symptom onset more than 2 weeks after the first aerial adulticide and larvicide applications. The affected community also played a role in preventing new infections when residents and businesses began observing Drain and Cover prevention measures."



Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

Early Release / Vol. 65 September 23, 2015

Local Mosquito-Borne Transmission of Zika Virus — Miami-Dade and Broward Counties, Florida, June–August 2016

Anna Likos, MD[1]; Isabel Griffin, MPH[1]; Andrea M. Bingham, PhD[1]; Danielle Stanek, DVM[1]; Marc Fischer, MD[2]; Stephen White, MS[1]; Janet Hamilton, MPH[1]; Leah Eisenstein, MPH[1]; David Axtubin, MPH[1]; Prakash Mulay, MBBS[1]; Blake Scott, MPH[1]; Patrick Jenkins, MPH[1]; Danielle Fernandez, MPH[1]; Edholene Rico, MPH[1]; Leah Gillis, PhD[1]; Reynald Jean, MD[1]; Marshall Cone, MPH[1]; Carina Blackmore, PhD[2]; Janet McAllister, PhD[2]; Chalmers Vasquez[3]; Lillian Rivera, PhD[3]; Celeste Philip, MD[1]

During the first 6 months of 2016, large outbreaks of Zika virus disease caused by local mosquito-borne transmission occurred in Puerto Rico and other U.S. territories, but local mosquito-borne transmission was not identified in the continental United States (*1*,*2*). As of July 22, 2016, the Florida Department of Health had identified 321 Zika virus disease cases among Florida residents and visitors, all occurring in either travelers from other countries or territories with ongoing Zika virus transmission or sexual contacts of recent travelers.* During standard case investigation of persons with compatible illness and laboratory evidence of recent Zika virus infection (i.e., a specimen positive by real-time reverse transcription–polymerase chain reaction [rRT-PCR], or positive Zika immunoglobulin M [IgM] with supporting dengue serology [negative for dengue IgM antibodies and positive for dengue IgG antibodies], or confirmation of Zika virus neutralizing antibodies by plaque reduction neutralization testing [PRNT]) (*3*), four persons were identified in Broward and Miami-Dade counties whose infections were attributed to likely local mosquito-borne transmission. Two of these persons worked within 120 meters (131 yards) of each other but had no other epidemiologic connections, suggesting the possibility of a local community-based outbreak. Further epidemiologic and laboratory investigations of the worksites and surrounding neighborhood identified a total of 29 persons with laboratory evidence of recent Zika virus infection and likely exposure during late June to early August, most within an approximate 6-block area. In response to limited impact on the population of *Aedes aegypti* mosquito vectors from initial ground-based mosquito control efforts, aerial ultralow volume spraying with the organophosphate insecticide naled was applied over a 10 square-mile area beginning in early August and alternated with aerial larviciding with *Bacillus thuringiensis* subspecies *israelensis* (Bti), a group biologic control agent, in a central 2 square-mile area. No additional cases were identified after implementation of this mosquito control strategy. No increases in emergency department (ED) patient visits associated with aerial spraying were reported, including visits for asthma, reactive airway disease, wheezing, shortness of breath, nausea, vomiting, or diarrhea. Local and state health departments serving communities where *Ae. aegypti*, the primary vector of Zika virus, is found should continue to actively monitor for local transmission of the virus.†

Investigations of Two Cases of Isolated Local Transmission of Zika Virus

As of July 22, 2016, among the 321 cases of Zika virus infection in Florida residents or visitors, Miami-Dade County and neighboring Broward County reported the highest and second highest numbers of cases in Florida (93 and 51, respectively), accounting for 30.4% and 16.7% of travel-associated cases in nonpregnant women, respectively.

In early July 2016, an adult female resident of Miami-Dade County (patient A) sought treatment at a local hospital with fever, rash, and arthralgia. Serum and urine specimens, which were collected 3 days after symptom onset, were positive for Zika virus by rRT-PCR. Less than 1 week later, an adult male resident of Broward County (patient B) sought treatment

*https://wwwn.cdc.gov/nndss/conditions/zika-virus-disease-and-zika-virus-congenital-infection/case-definition/2016/.

†http://www.cdc.gov/zika/index.html; http://www.floridahealth.gov/diseases-and-conditions/zika-virus/index.html?utm_source=flhealth!ndex.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

Moving Forward

- Data published on Miami operational
- Data published on New Orleans operational
- Return to New Orleans in 2017
- Return to Blanding with C-130 or Rotary 2017

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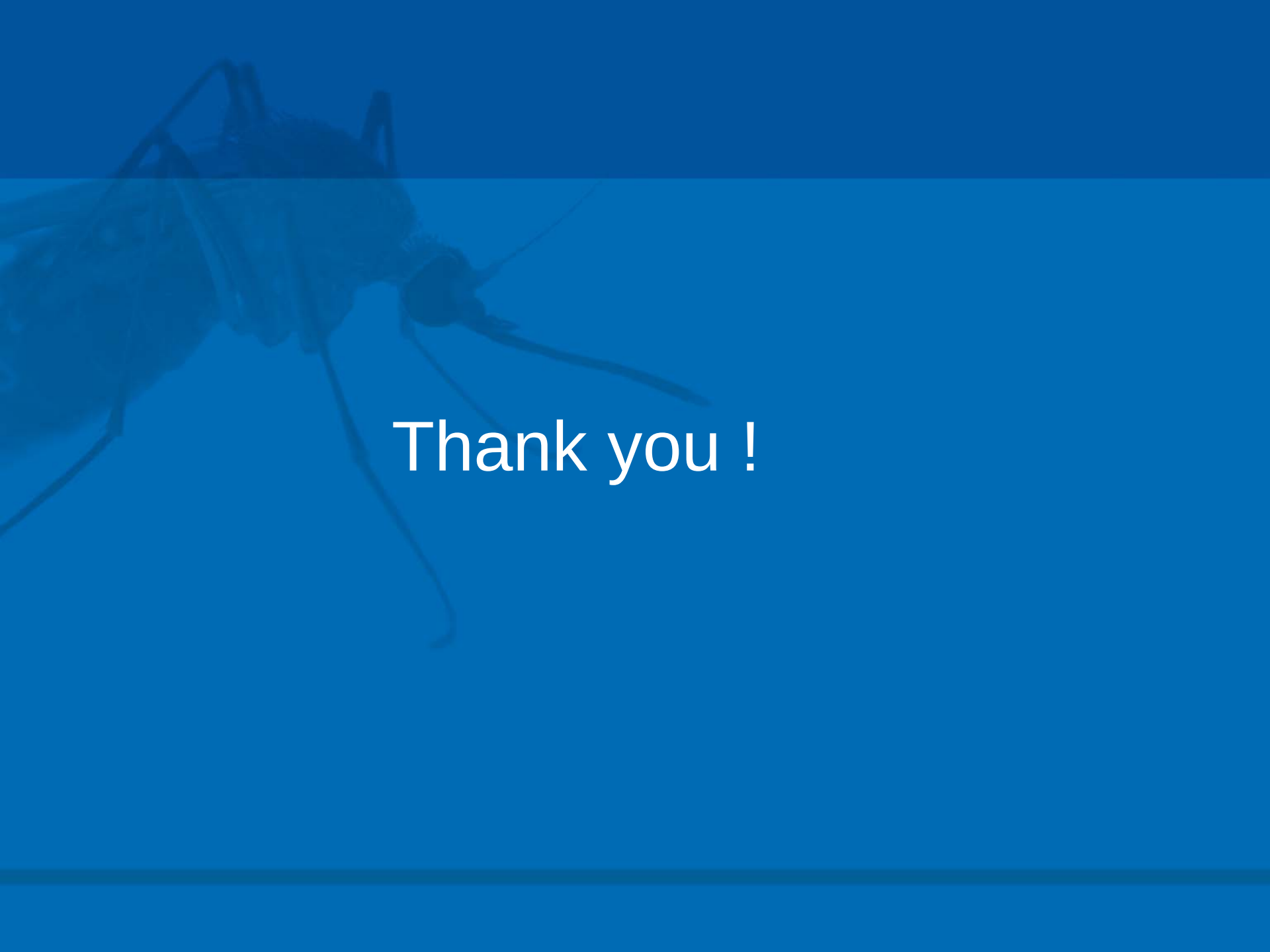

Thank you !

Current AMVAC Product Line
Focus on Public Health

Larvicides

Summit Bti Briquets™

Bacillus thuringiensis
subspecies israelensis

Larvae feed on
very small particles
in the water column
close to the surface

- Catch basins & storm drains
- Ditches & ponds
- Swamps
- Woodland pools
- Drainage areas
- Water retention structures
- Lagoons
- Sediment ponds
- Filtration systems
- Wet wells and other sumps
- All man made an natural containers

Current AMVAC Product Line
Focus on Public Health

Nuvan ®Prostrips
Nuvan ®Prostrips +
Nuvan ®Directed Aerosol
Nuvan ®Fog 2EC
Nuvan ®Fog 5% EC
Nuvan ®Fog 4EC

Dichlorvos (DDVP)

Continuous, long-lasting protection from pests in difficult-to-reach areas such as attics, basements, crawl spaces, closets, pantries, sheds, garages and RVs. Effective against tougher, more common pests, such as ants, bedbugs, cockroaches, bees/wasps, pantry pests, flies and mosquitoes. NUVAN PROSTRIPS' unique vapor action protects areas continuously for just pennies a day—with no odor or mess.

Current AMVAC Product Line
Focus on Public Health

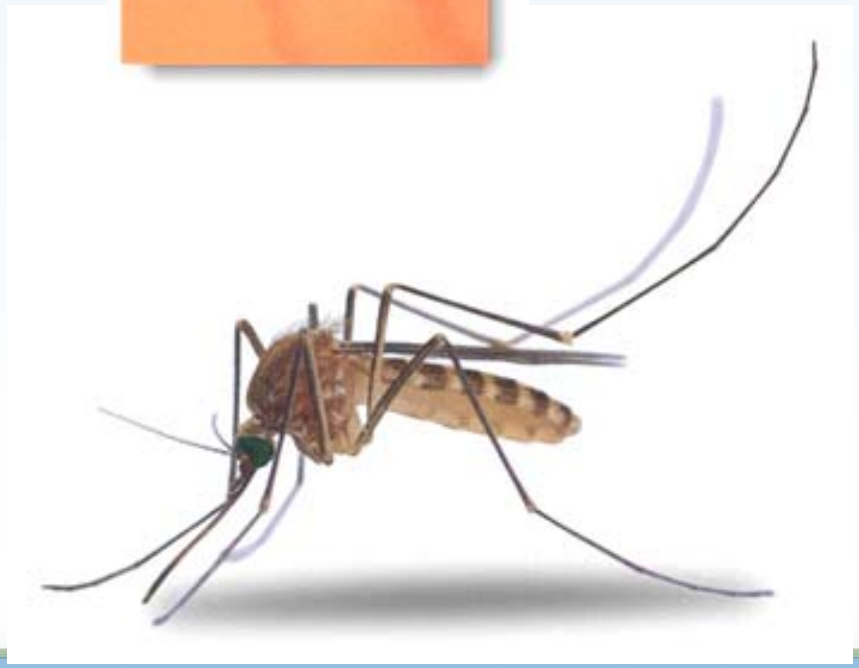
Adulticides

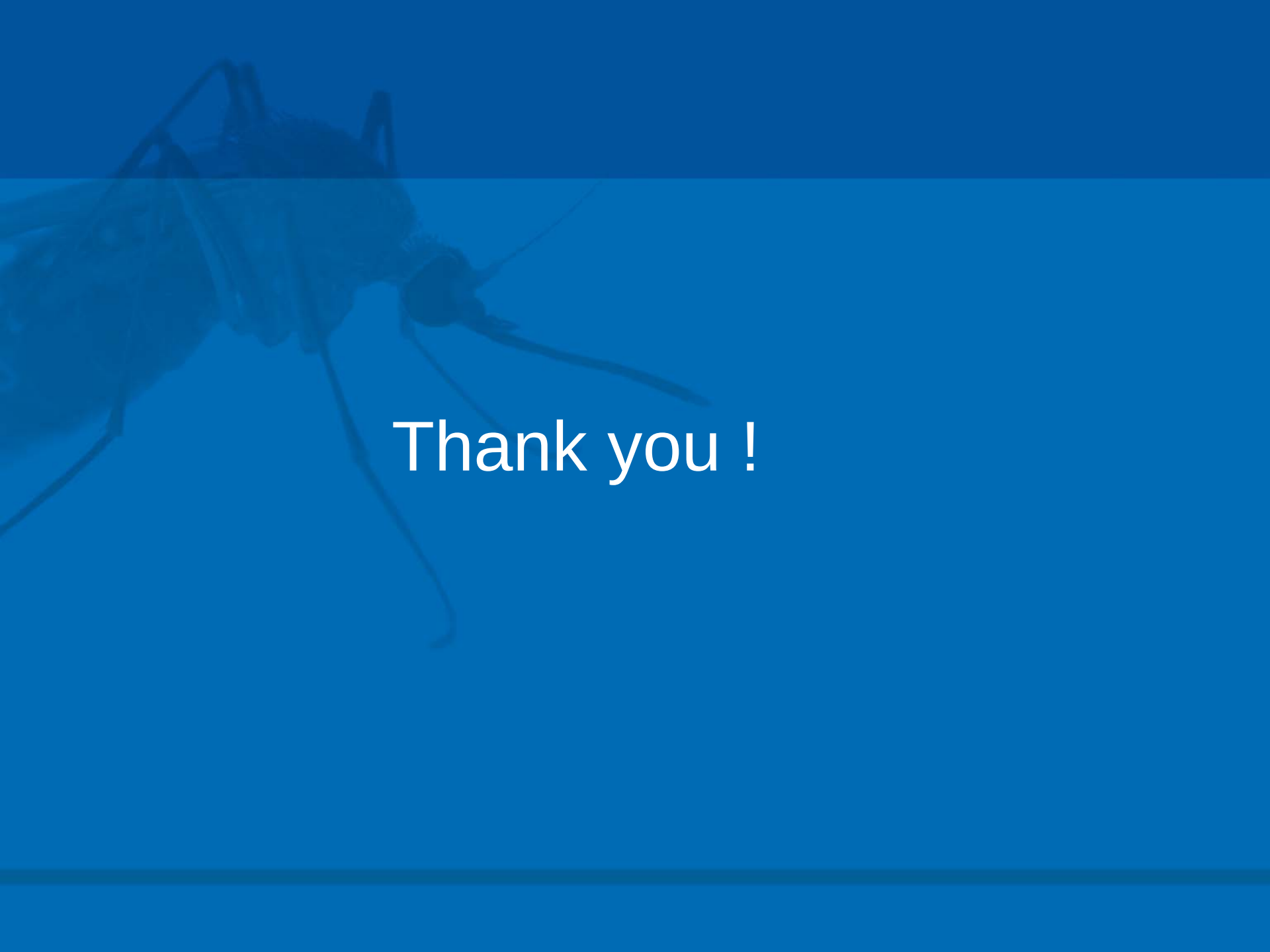
Dibrom® Concentrate
Trumpet ® EC
Naled

Dibrom Concentrate® and/or Trumpet EC® have been involved in assisting in public health emergencies for over five decades

No other adulticide product used before or since, has the history of performance, reliability and safety of Dibrom and Trumpet

Unique characteristics about this chemistry including; no known resistance, specific gravity of the AI, overall effectiveness, rapid breakdown in the environment.




Thank you !