Enhanced data-driven decision support for highly invasive vectors

Christopher M. Barker
Department of Pathology, Microbiology, & Immunology
School of Veterinary Medicine, UC Davis

The Team

UC Davis

- Matteo Marcantonio, Marisa Donnelly, Olivia Winokur, Sarah Abusaa, Mathew Leland, Diego Montecino, Andrew Provencio, Jody Simpson, Chris Barker

UC Riverside

- Darrel Jenerette, Lingyi Yang

NASA Ames Research Center

- Forrest Melton, John Shupe

Univ of Washington

- Robert Reiner

Fondazione Edmund Mach

- Annapaola Rizzoli, Markus Neteler, Gioia Capelli

Mosquito & Vector Control Assoc of California

- Trinidad Reyes, Alex Scalzo, Susanne Kluh, Wakoli Wekesa, Kenn Fujioka, Leonard Irby, Sarah Wheeler, Marcia Reed, many other agencies

California Department of Public Health

- Marco Metzger, Vicki Kramer, Kerry Padgett

Centers for Disease Control and Prevention

- Roxanne Connelly (Arboviral Diseases Branch)
- Michael Johansson (Dengue Branch)

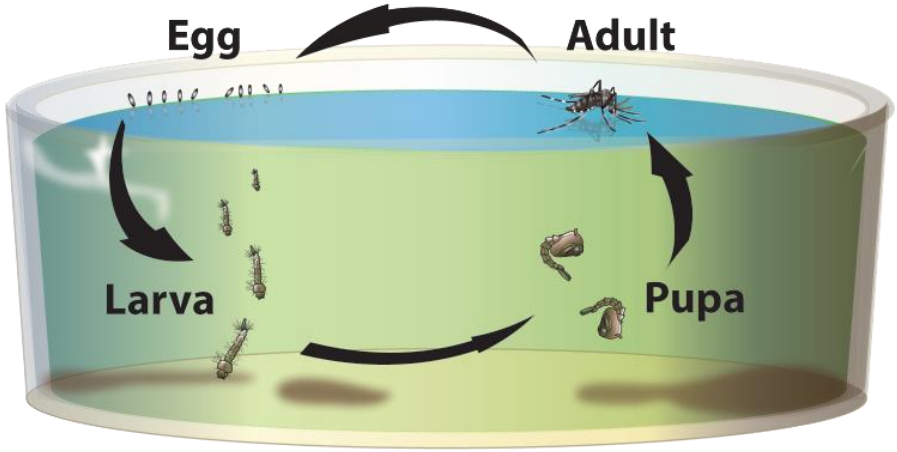
Invasive "Container-Breeding" *Aedes* Mosquitoes

Ae. albopictus
2011

Ae. aegypti
2013

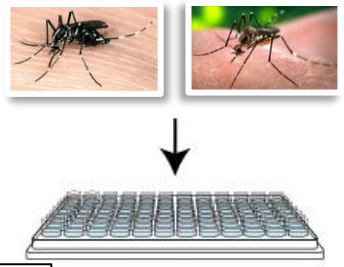
Ae. notoscriptus
2014

“Container-breeding” mosquitoes



Sources: www.glacvcd.org; ECDC, Guidelines for the surveillance of native mosquitoes in Europe, 2014

Surveillance for Zika virus and invasive mosquitoes



Homogenization
MagMAX™ Lysis/Binding Solution

RT-PCR to detect Zika virus in mosquitoes

MagMAX™ Sample Preparation System
MagMAX™ Express-96 Magnetic Particle Processor
MagMAX™-96 Viral RNA Isolation Kit

Real-Time RT-PCR
TaqMan® One-Step RT-PCR Kit
Applied Biosystems® 7900 HT
Fast Real-Time PCR System

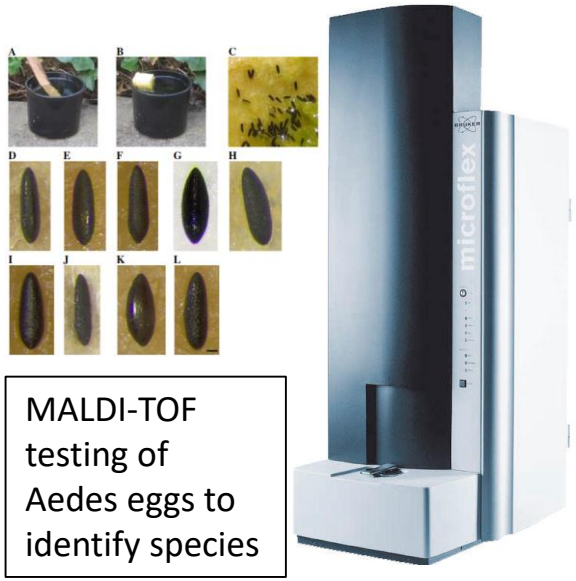
MVCAC

UCDAVIS
UNIVERSITY OF CALIFORNIA

DART
DAVIS ARBOVIRUS RESEARCH & TRAINING

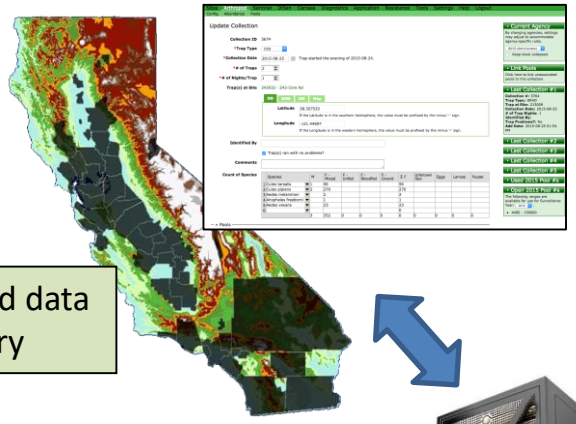
CDPH
California Department Of PublicHealth

Viruses
- DENV
- CHIKV
- ZIKV
- WNV
- SLEV
- WEEV

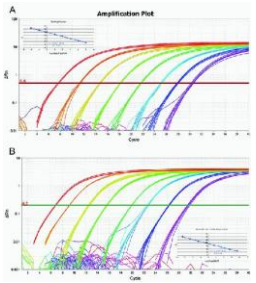


MALDI-TOF testing of Aedes eggs to identify species

CalSurv California Vectorborne Disease Surveillance Gateway



Field data entry

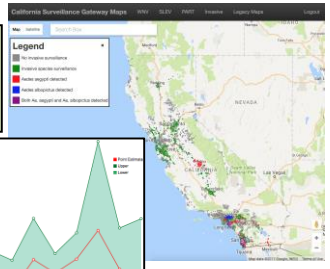


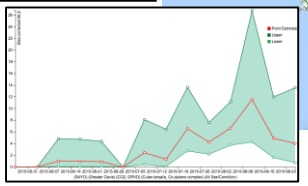
Laboratory data entry

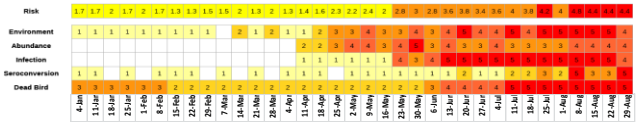
National Databases

CDC ArboNET MosquitoNET

Interactive Maps and Tools

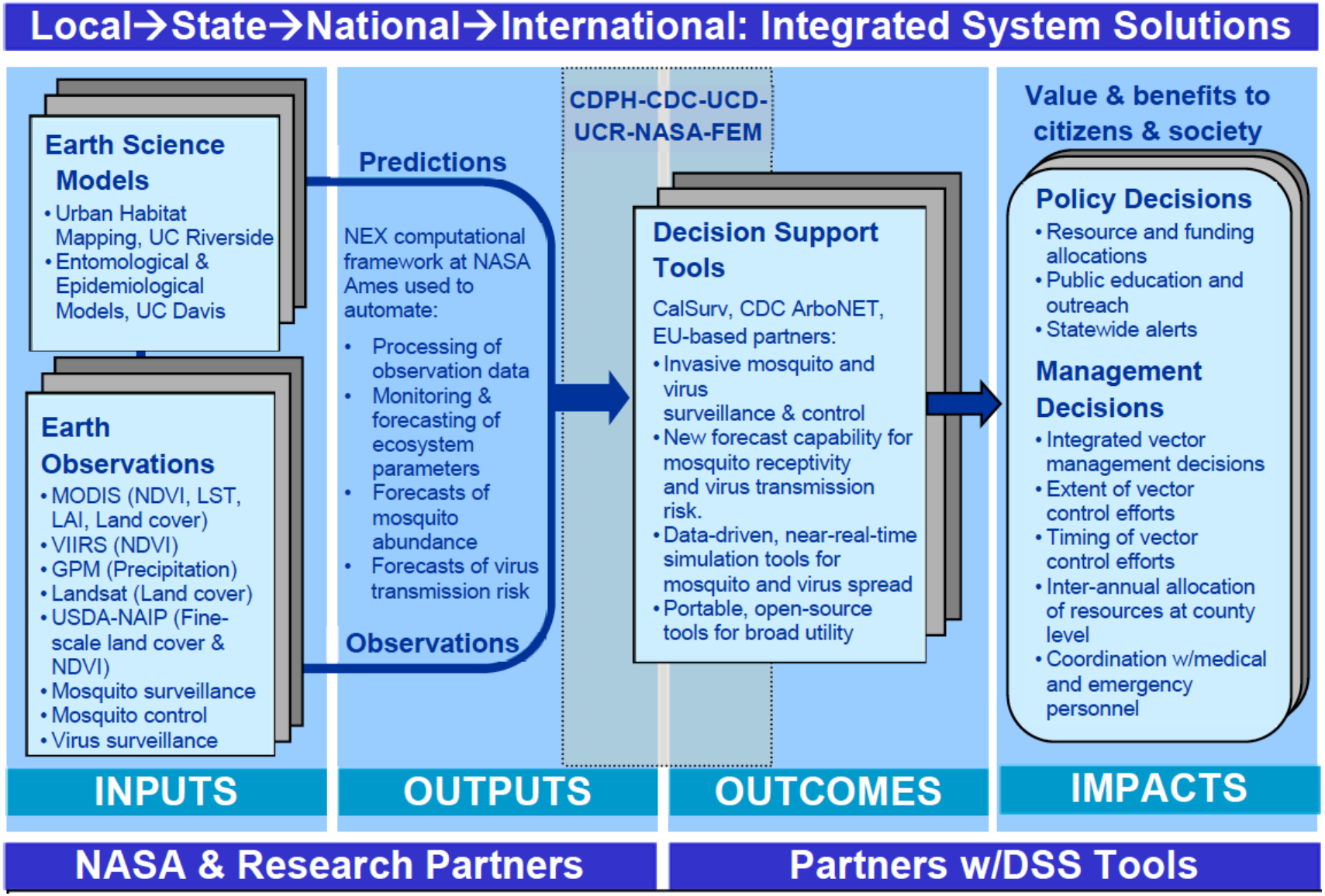




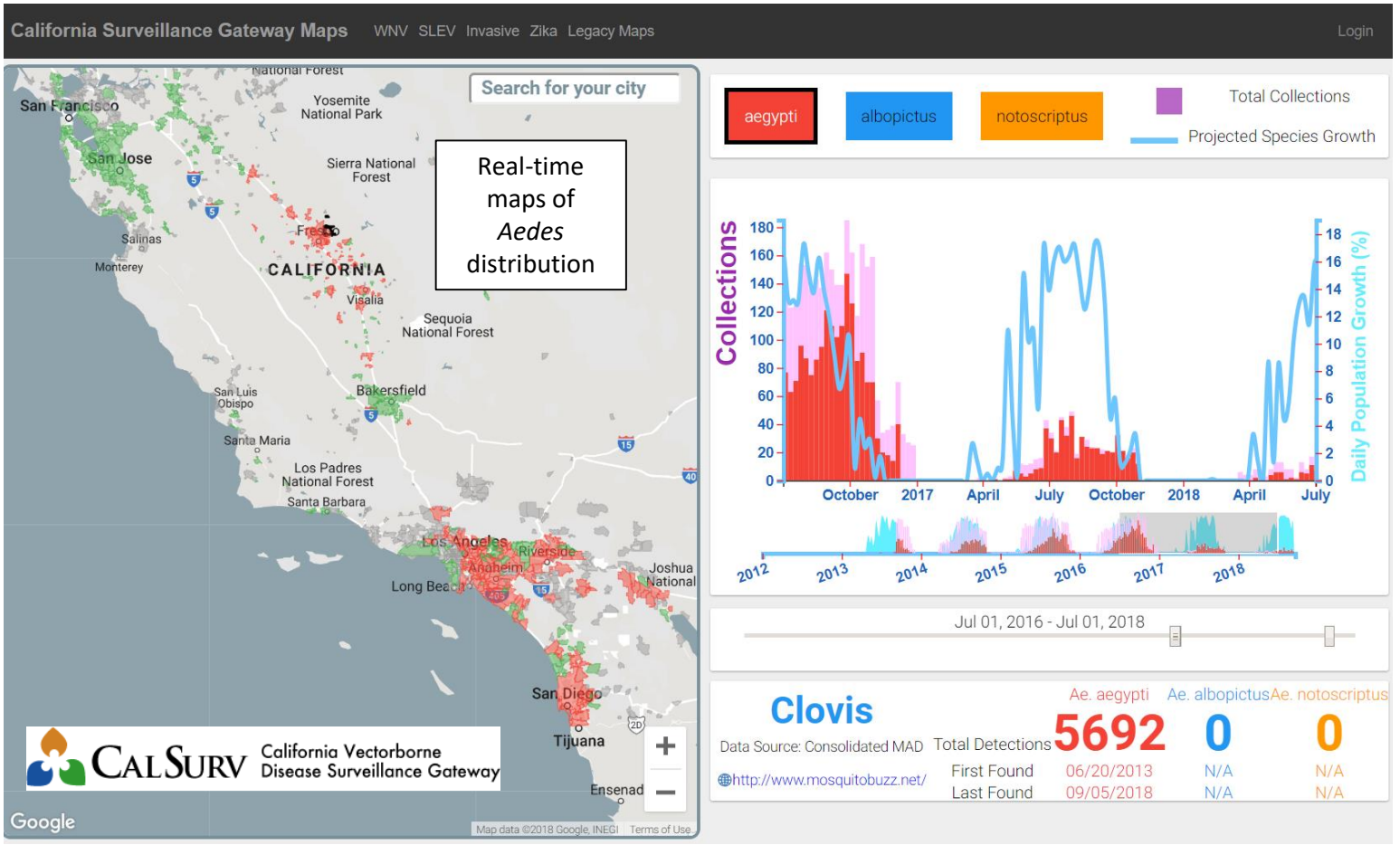


Arbovirus bulletins, Automated emails

Project Milestones



Aim 1: Mapping Zika virus vectors



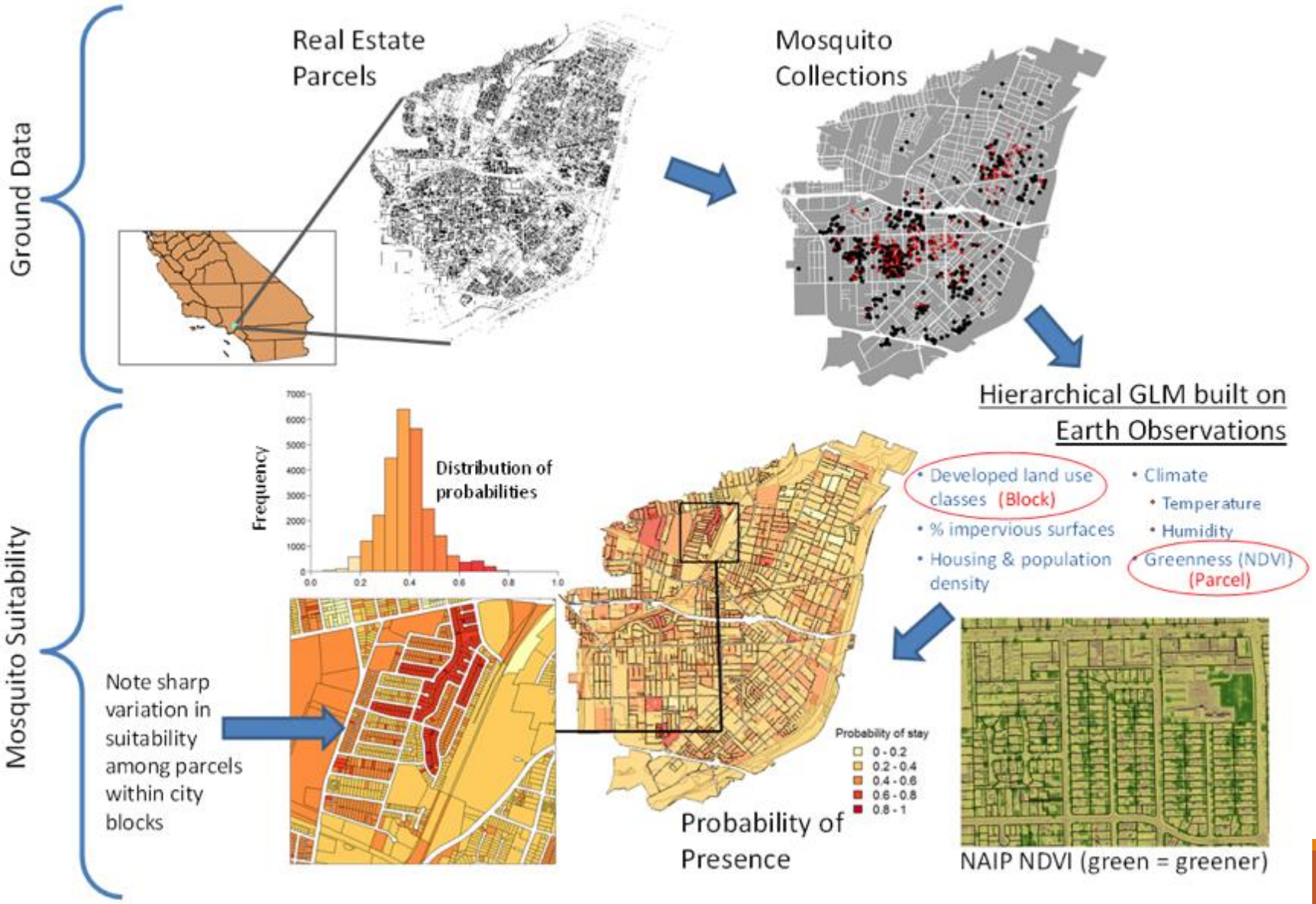
NASA products: TOPS,
NEX Global Daily Downscaled Climate Projections

Barker CM, Donnelly MAP, Marcantonio M, Melton F, Barker CM. CalSurv Gateway: a decision support system for integrated vector management. *(in prep)*

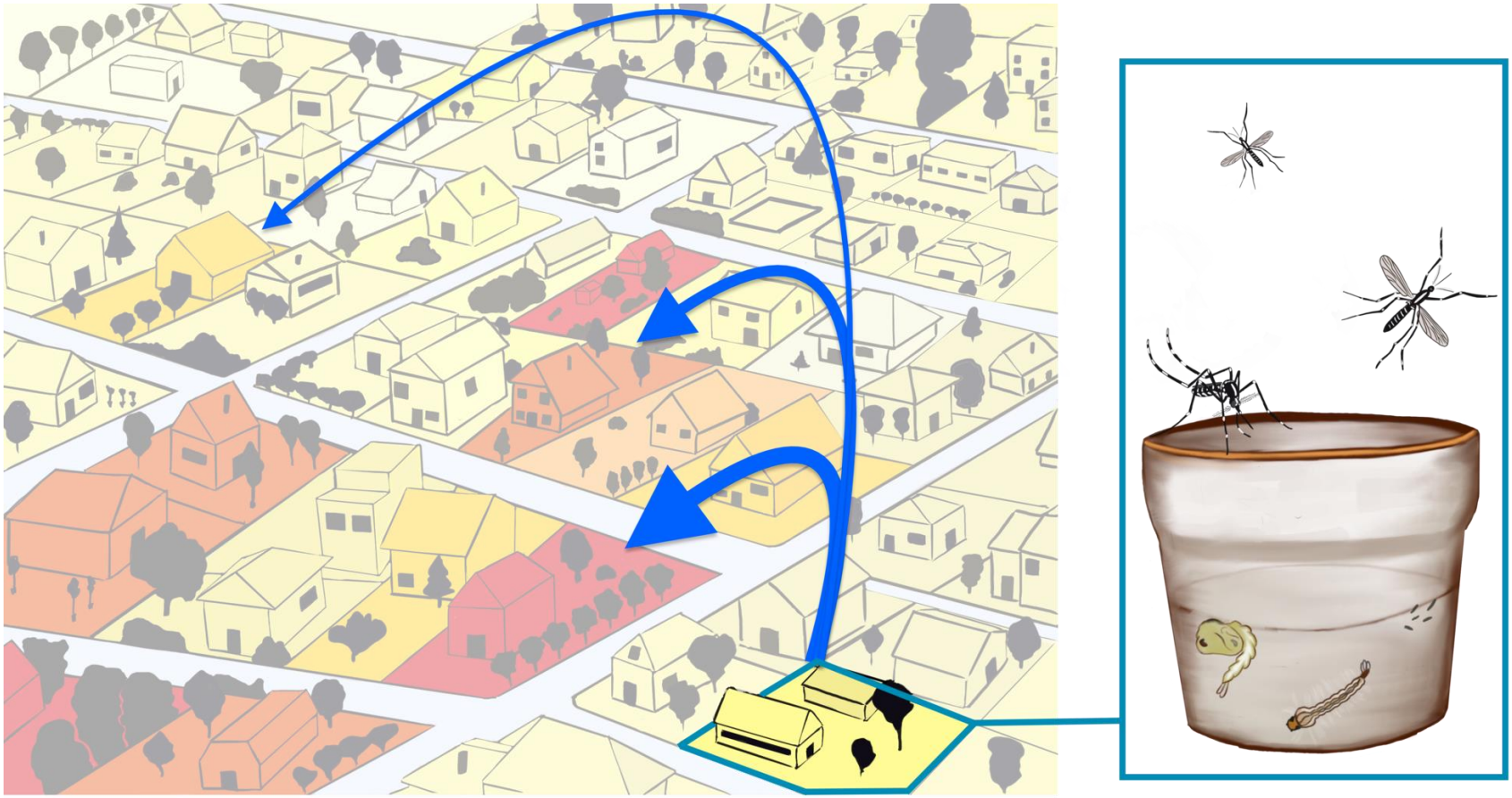
https://maps.calsurv.org → Invasive

Climate-based suitability maps for Zika virus vectors
(M Donnelly, PhD Dissertation)

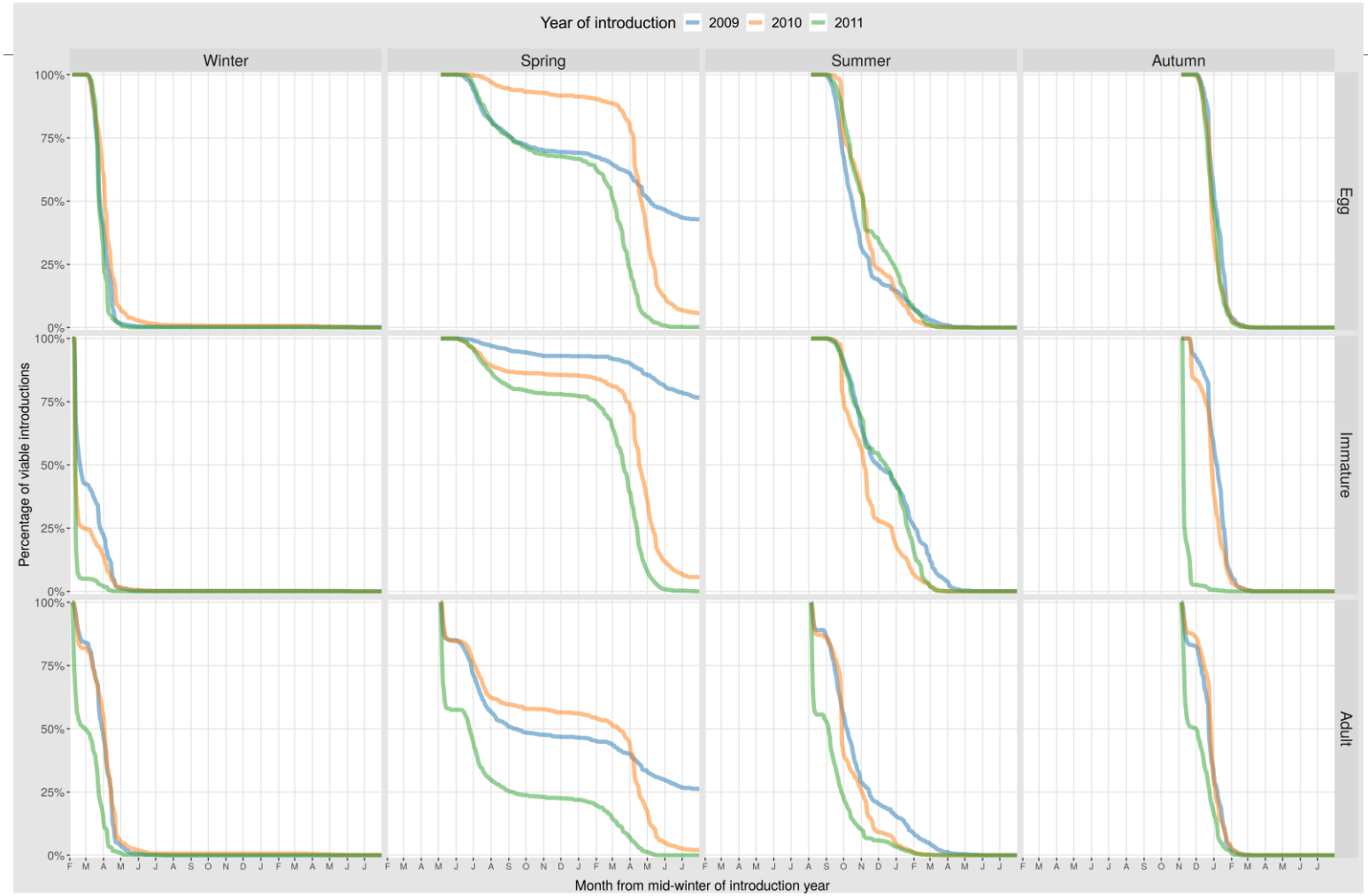
Aim 2: Data-Based Estimates for Suitability of Households



Aim 2: Simulations of Aedes spread

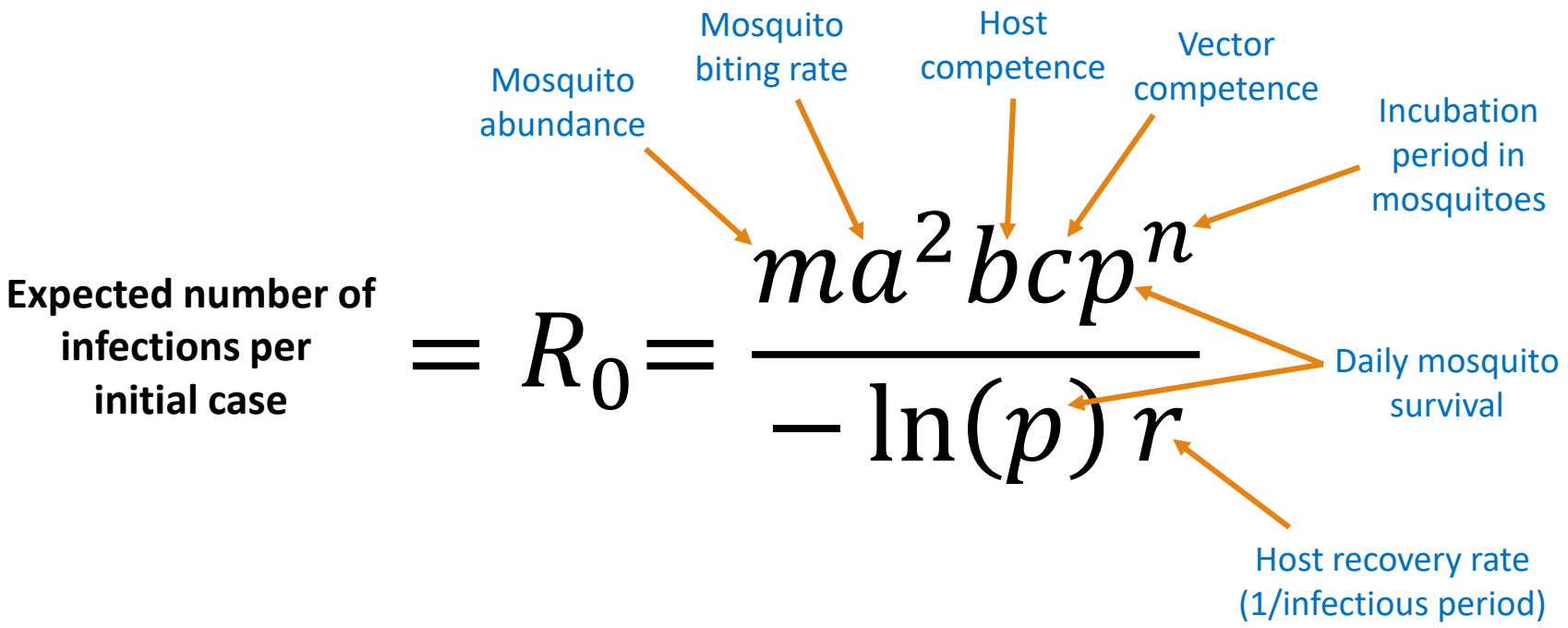


Aim 2: Simulations of Aedes spread

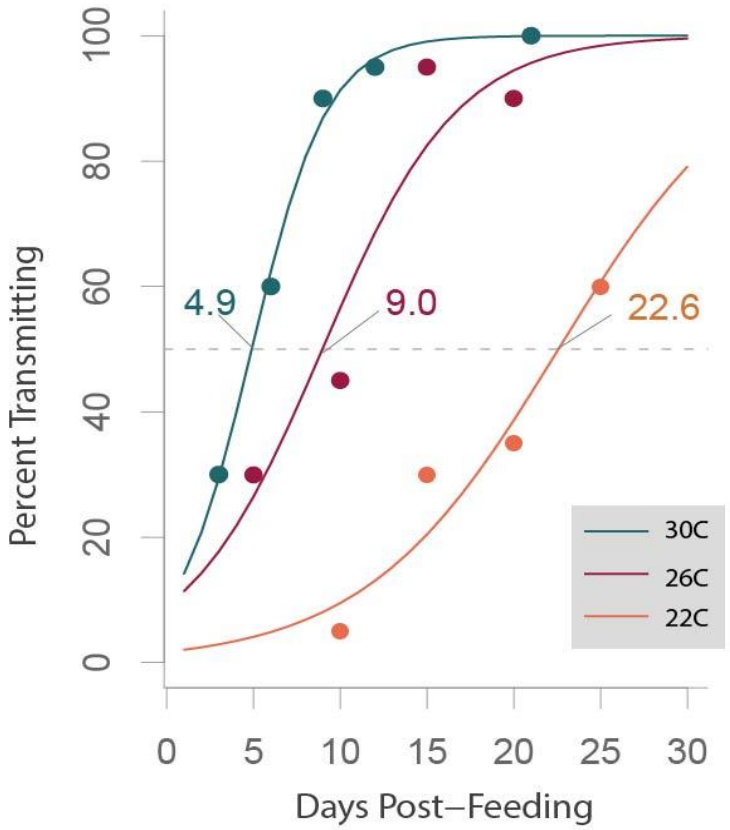


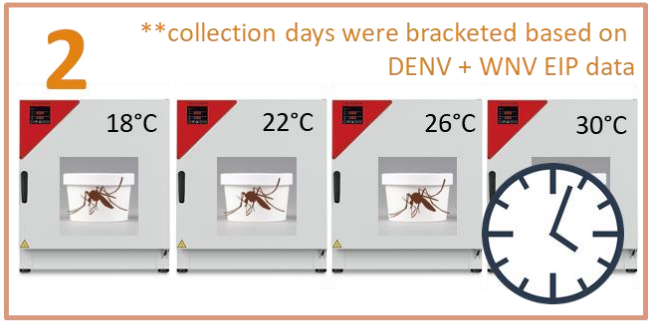
Marcantonio M, Montecino D, Perkins TA, Barker CM. HAedes: an integrative model for *Aedes* population dynamics and movement among households in urban landscapes. *(in review)*

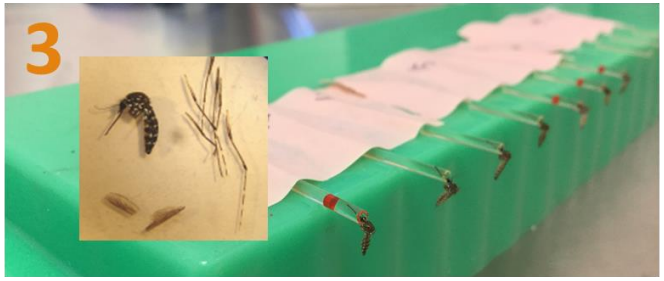
Estimating Zika virus transmission risk

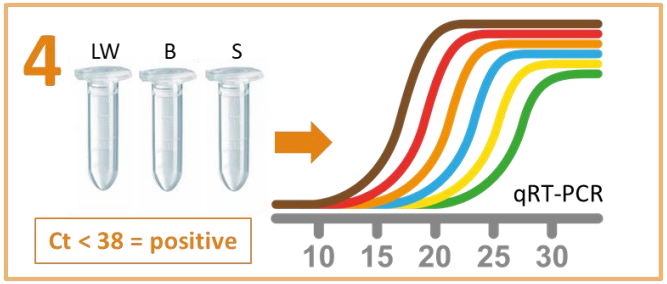


Incubation period of Zika virus in *Aedes aegypti*



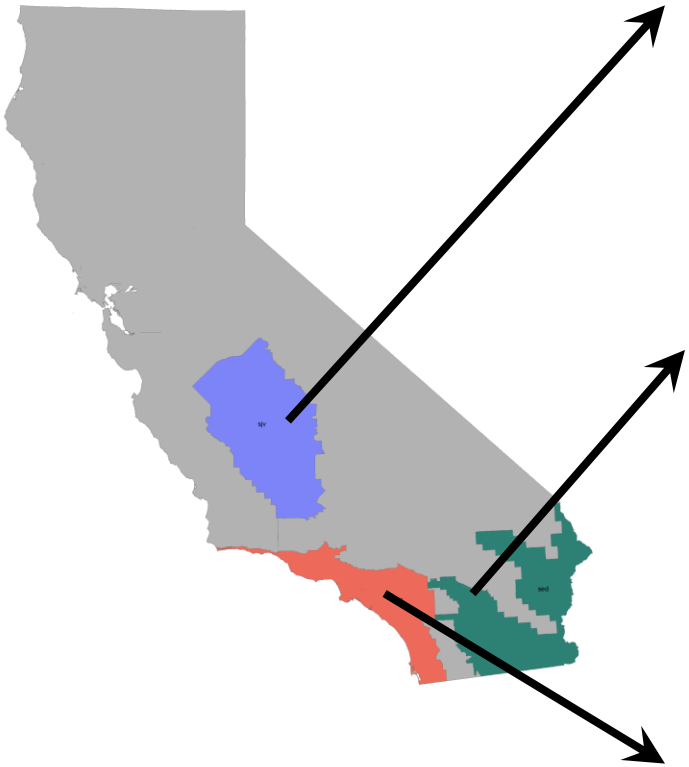


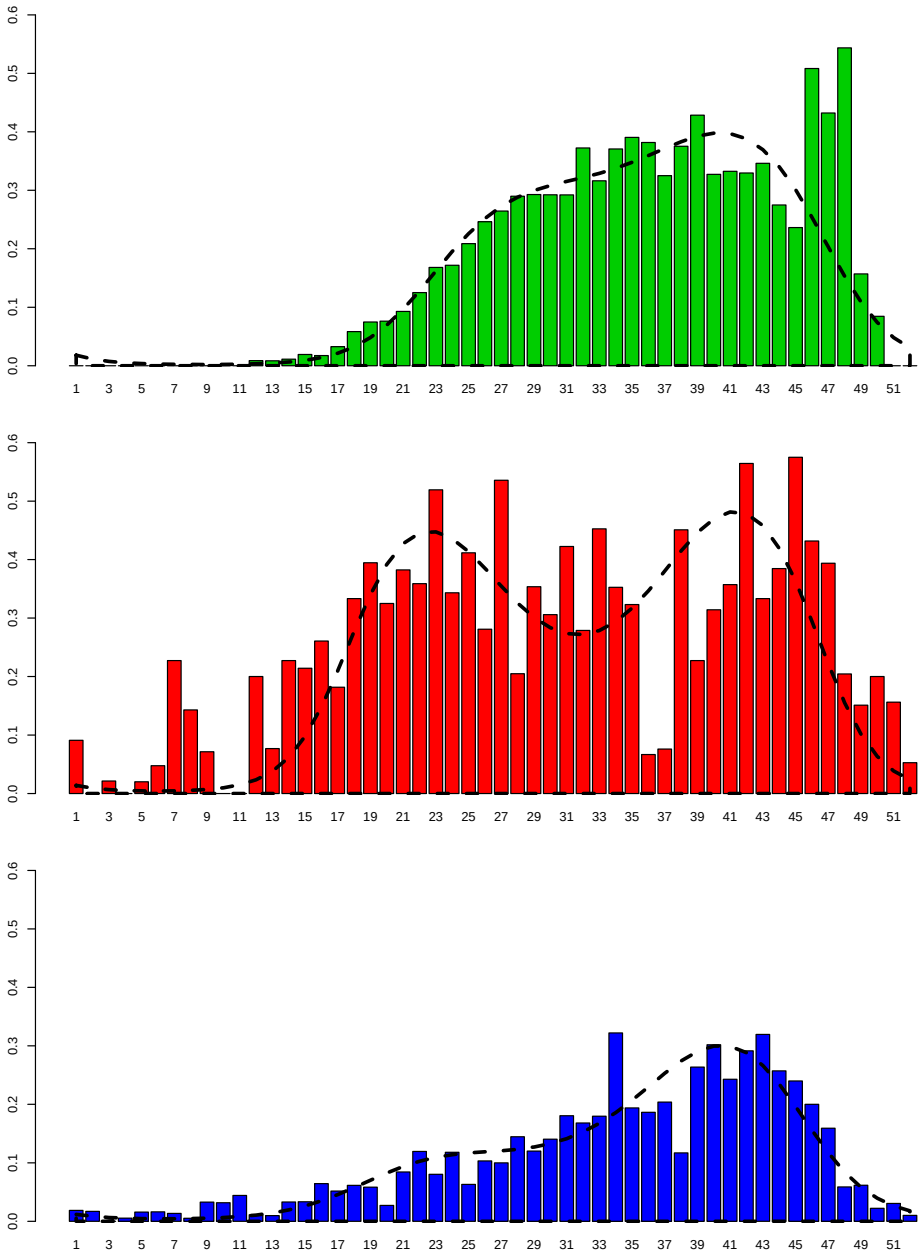




Winokur, Main, Nicholson, Barker. Effect of temperature on the extrinsic incubation period of Zika virus in *Aedes aegypti*. *(in prep)*

Seasonality of *Aedes aegypti*

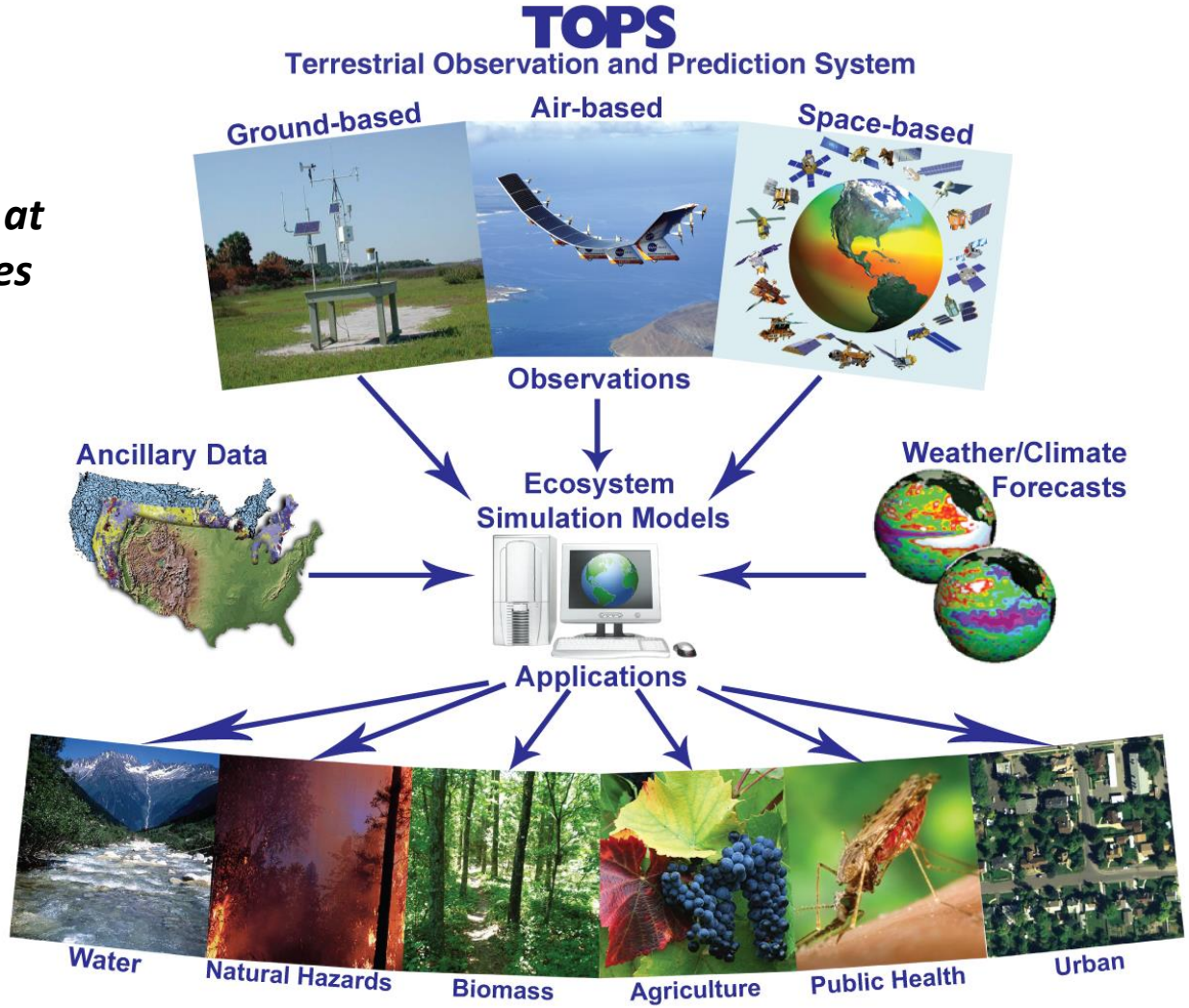




Prob (detection)

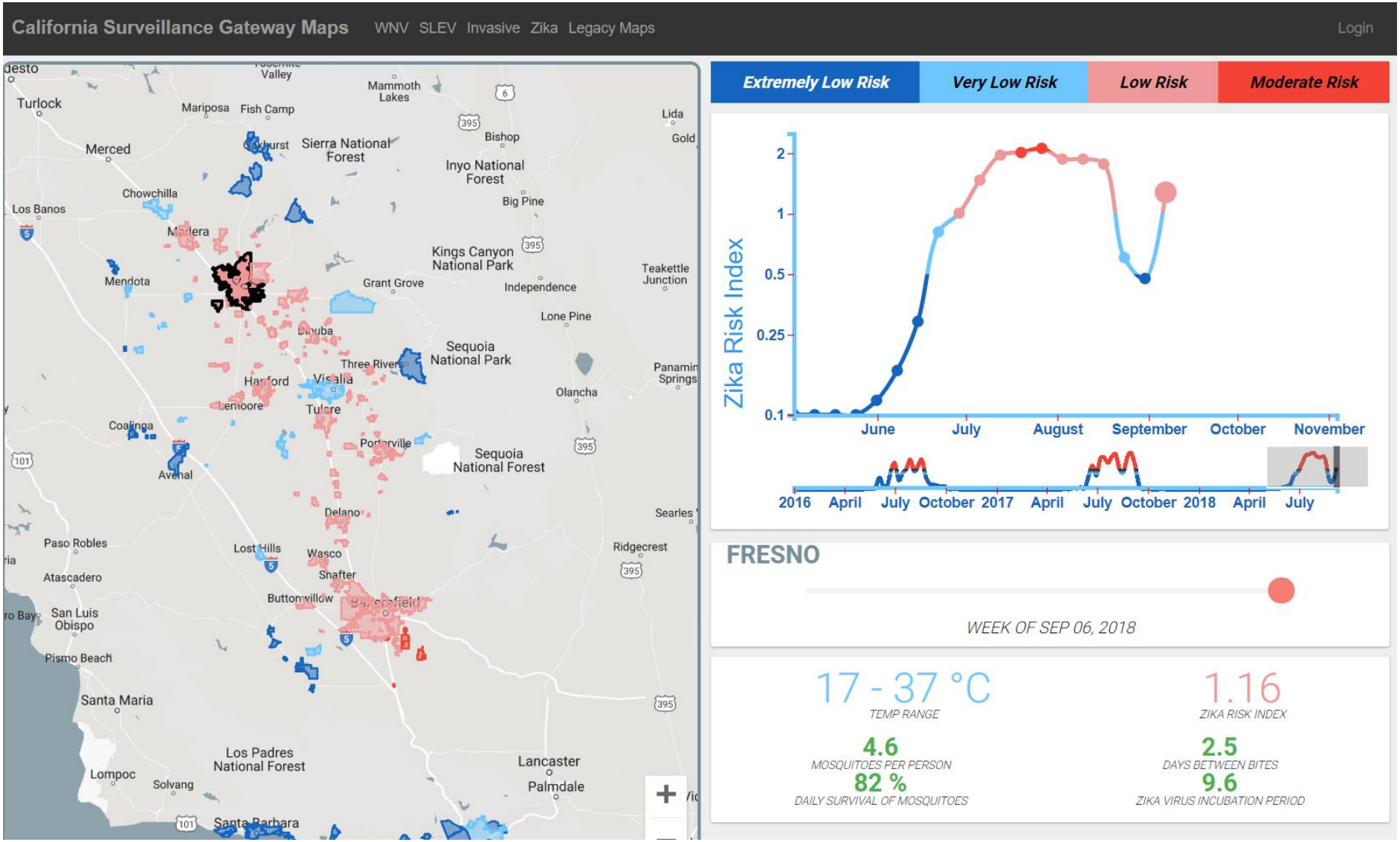
TOPS: Common Modeling Framework

Monitoring, modeling, & forecasting at multiple scales



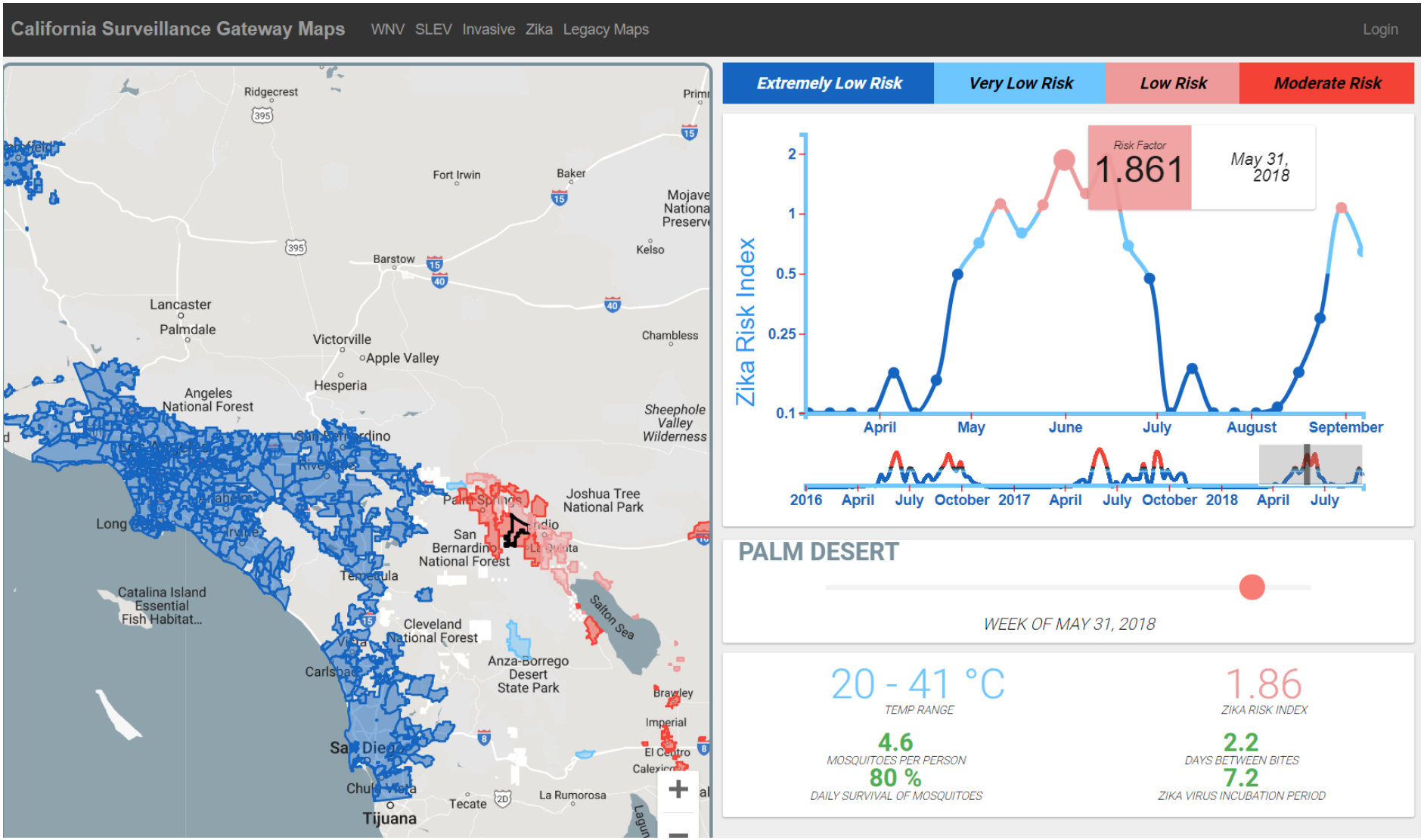
Nemani et al., 2003 and 2007

Aim 3: Risk for ZIKV outbreak in the U.S.?



http://maps.calsurv.org → Zika

Aim 3: Risk for ZIKV outbreak in the U.S.?



http://maps.calsurv.org → Zika

Milestones & ARL Targets

Current ARL = 7/8 (Sep 2018)

Application Completed and Qualified (Functionality Proven)

Task	Qtr →	Year 1				Year 2				Year 3				Year 4			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Initial survey on CalSurv DSS needs		←	→														
Aim 1: Map Aedes distribution and suitability		←	—	—	—	—	→										
Aim 2: Map potential for Aedes invasion and spread				←	—	—	—	—	—	—	—	—	—	—	—	—	→
Aim 3: Develop models for DENV/ZIKV outbreak risk						←	—	—	—	—	—	—	—	—	—	→	
Aim 4: Implement tools in CalSurv DSS		Numbers below represent ARL targets for specific project elements															
A. Aedes distribution maps				3	4	5	6	7	8	8	**9**						
B. Aedes spread simulator						3	3	4	4	5	5	5	6	7	7	7	**8**
C. Zika/dengue outbreak risk maps							3	3	4	4	5	6	7	7	7	**8**	
Aim 5: Generalize models for U.S. and S. Europe													4	5	6	7	**8**

CalSurv Gateway DSS, next steps

Mechanistic Models for Aedes spread

HAedes suitability and spatial simulations → R package?

Aedes challenge with CDC DVBD, coming Fall 2018

Simulator for surveillance and control strategies

Microhabitat temperatures (vs. MODIS), with Univ of Liverpool

Modeling the observational process

Mapping for multiple data streams (NASA products: MODIS, GPM; Sarah Abusaa, UCD; Robert Reiner, UW)

DSS Partner Engagement & "Handoff"

New funding from California legislature

CDC support for expansion to other states

- New users in other states and territories: UT, NJ, Guam

Pacific Southwest Center of Excellence in Vector-Borne Diseases

CalSurv