



share and move to face nasty bugs

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EPIDEMOIOLOGICAL MODELS DURING EMERGING PANDEMICS

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Dynamic Processes in Complex Societies
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DEFENSE AGAINST PANDEMICS

PROACTIVE PREPAREDNESS

Predicting viral candidates for future pandemic threats from molecular markers

ENHANCED SURVEILLANCE

Identifying zoonotic spillover at “fault lines” where humans and animals meet

RAPID RESPONSE

Timely detecting new outbreaks and organizing international response

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EPIDEMIOLOGICAL
MODELS

WAYS IN WHICH MODELS CAN HELP



Basic knowledge of disease/outbreak

- Generation times and serial intervals
- Transmission distances
- Relevant routes of transmission
- Superspreading
- Probable time of index case



Quantification of risks

- Transmission potential
- Probability of importation
- Probability and size of local epidemics



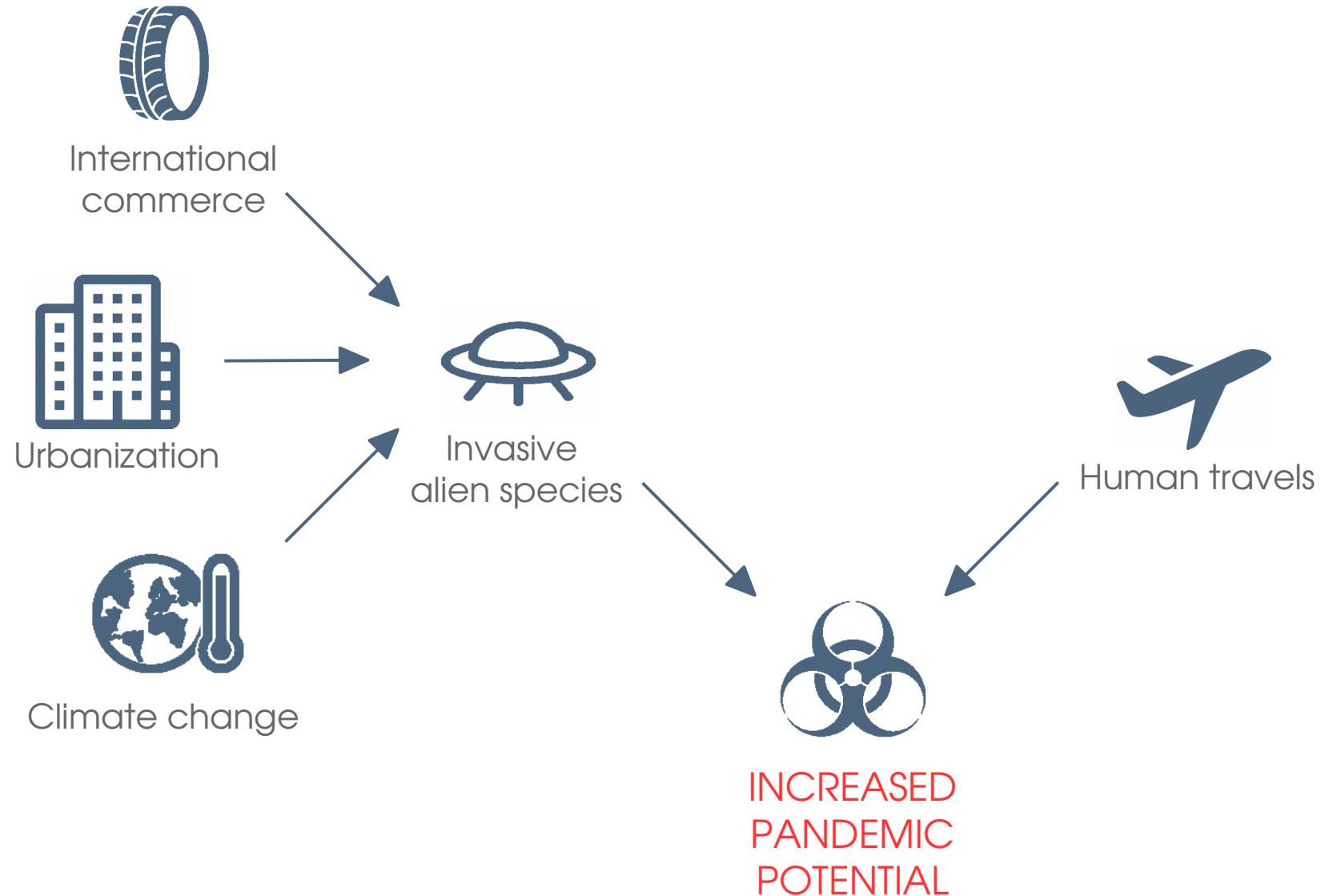
Planning of interventions

- Travel restrictions
- Social distancing (e.g. school closure)
- Reduction of vector populations
- Vaccinations and other pharmaceutical interventions

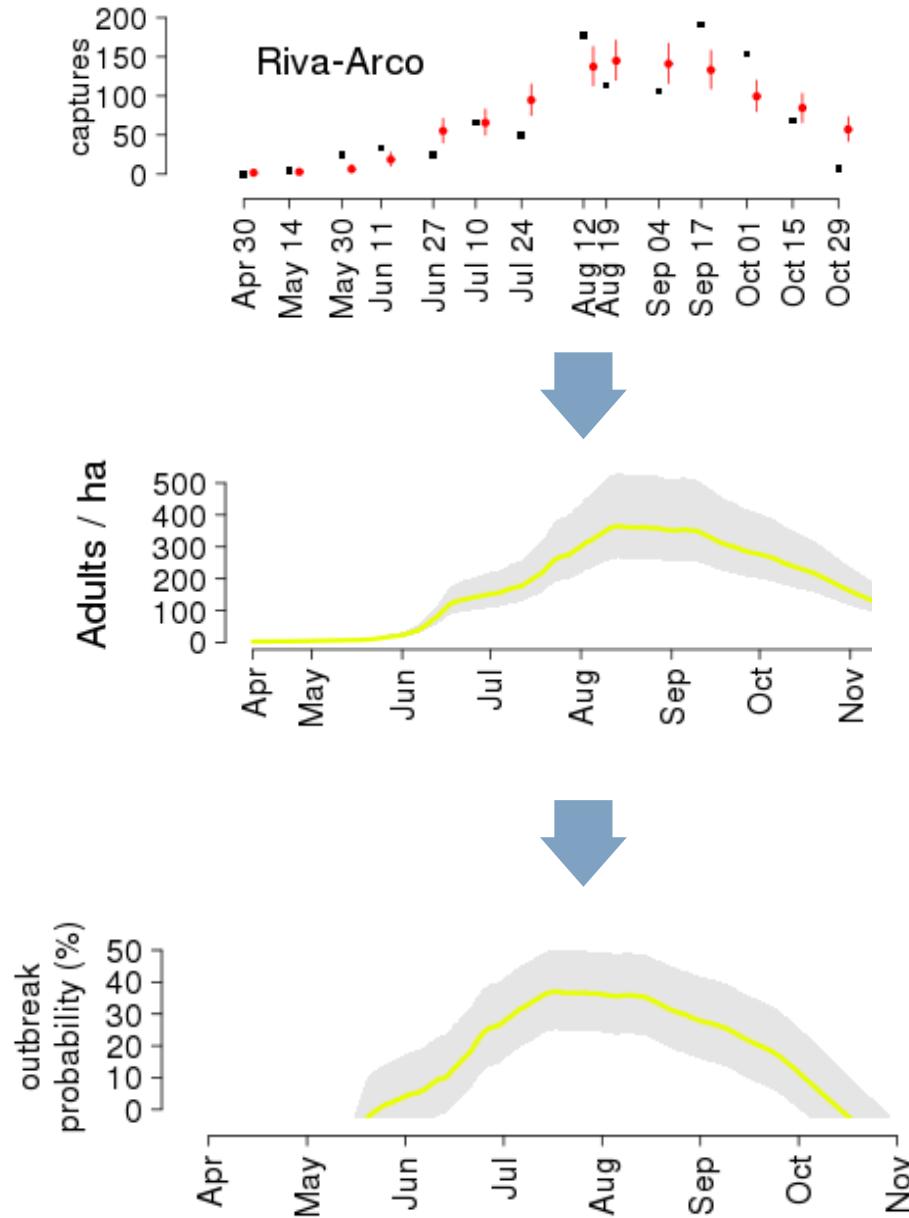
Mosquito-borne diseases



MOSQUITO-BORNE DISEASES



MODELING MOSQUITOES

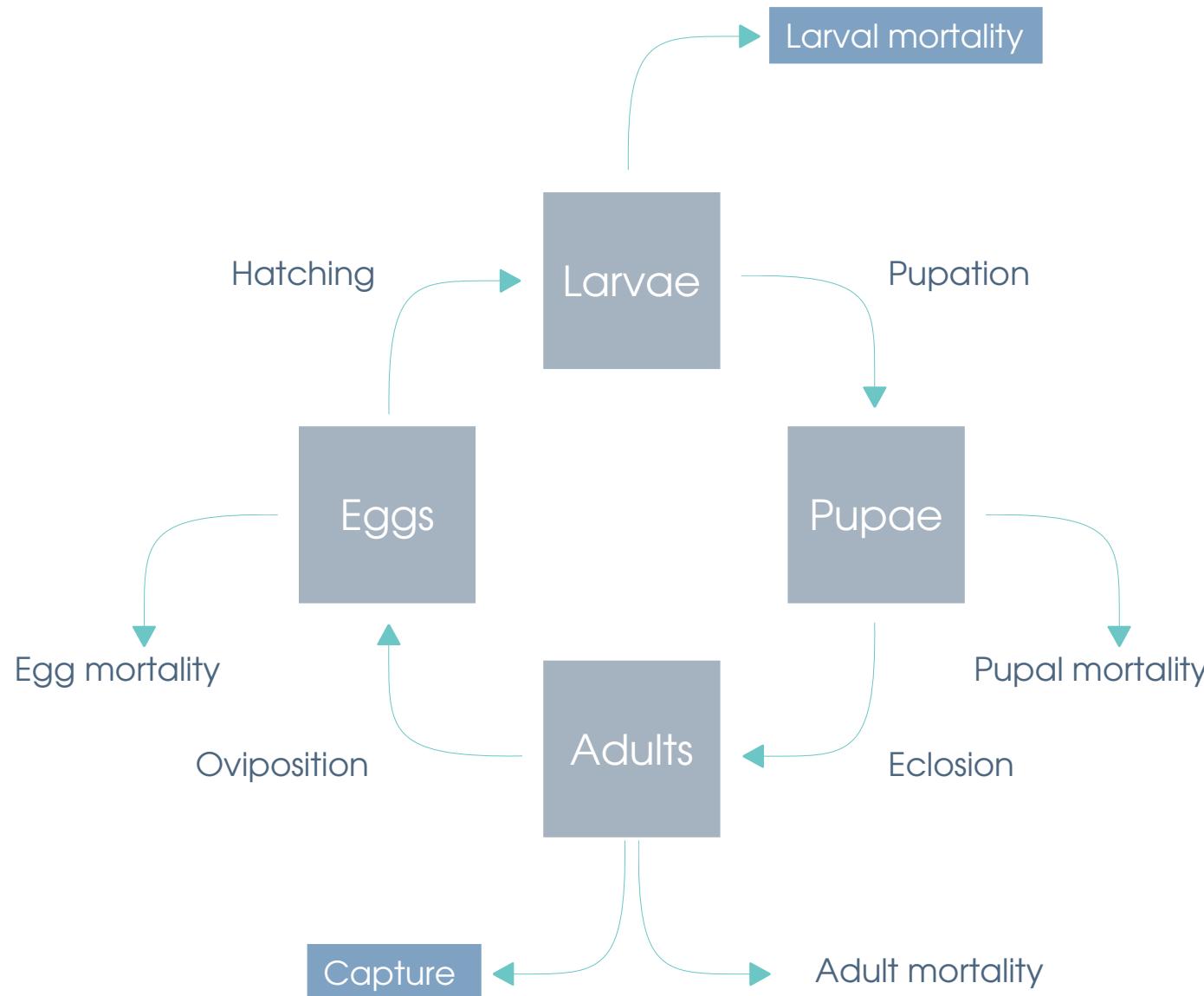


From capture data...

...to mosquito density...

...to epi risks

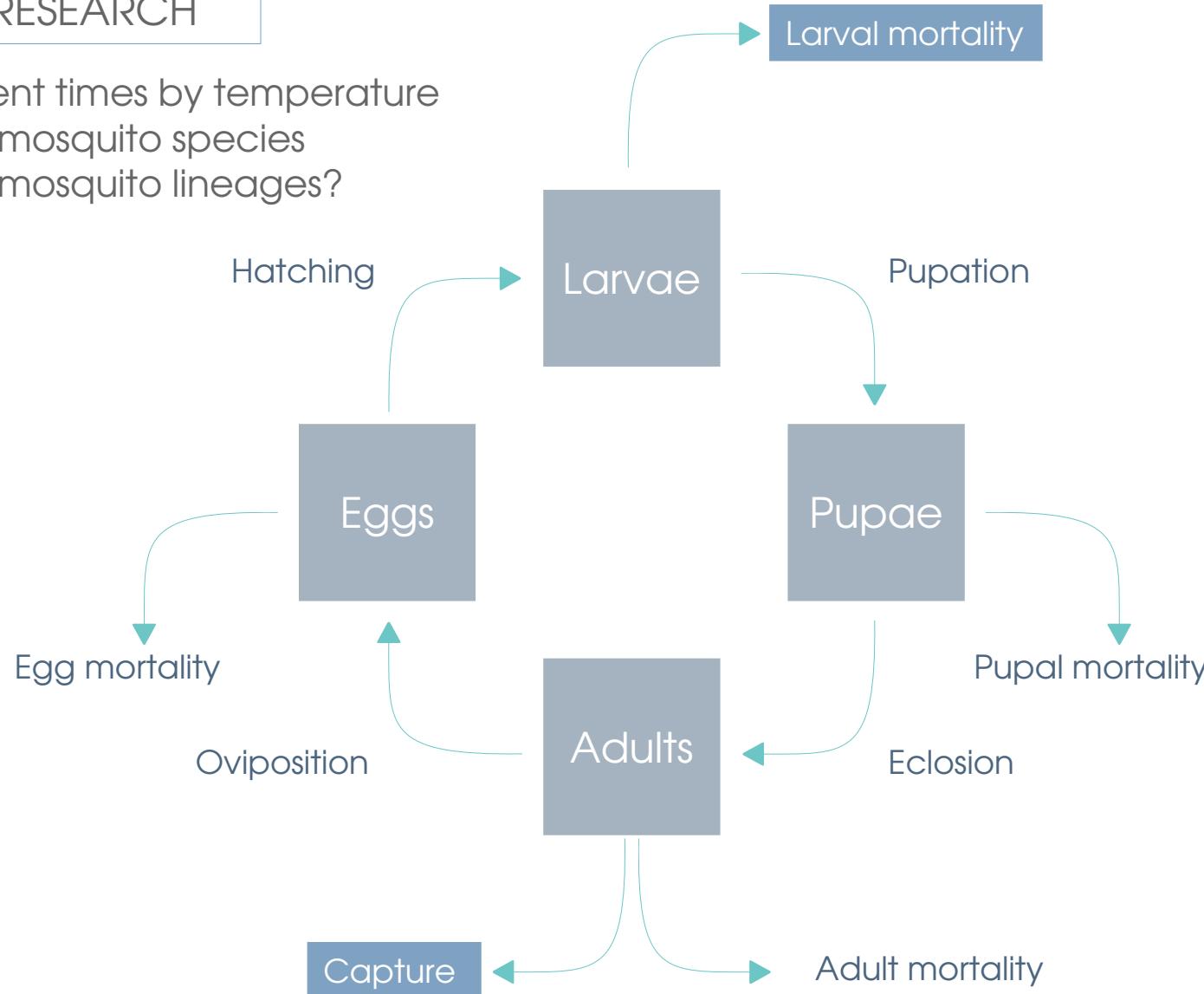
THE CIRCLE OF LIFE



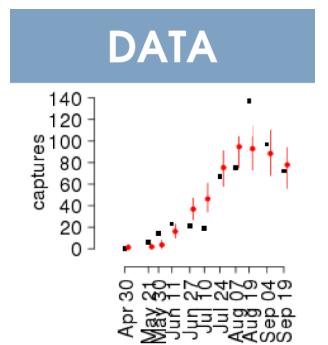
THE CIRCLE OF LIFE

BASIC RESEARCH

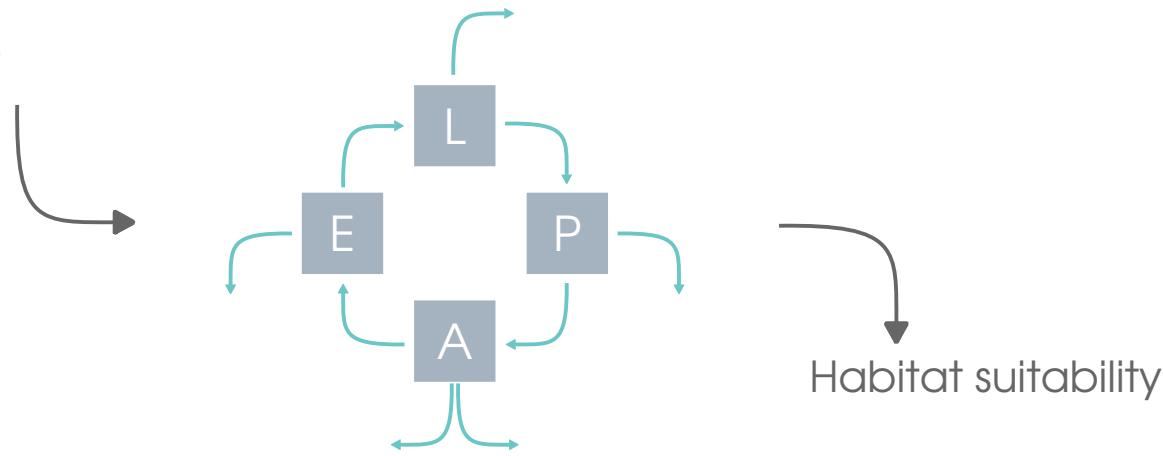
Development times by temperature
Specific of mosquito species
Specific of mosquito lineages?



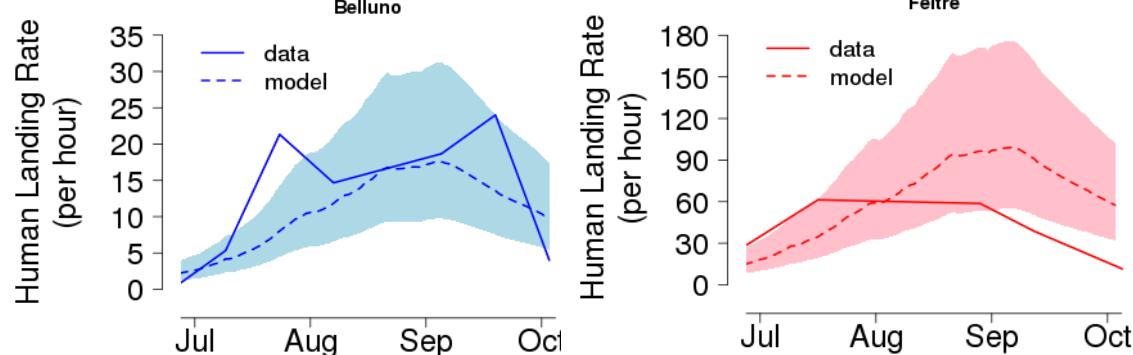
CALIBRATION



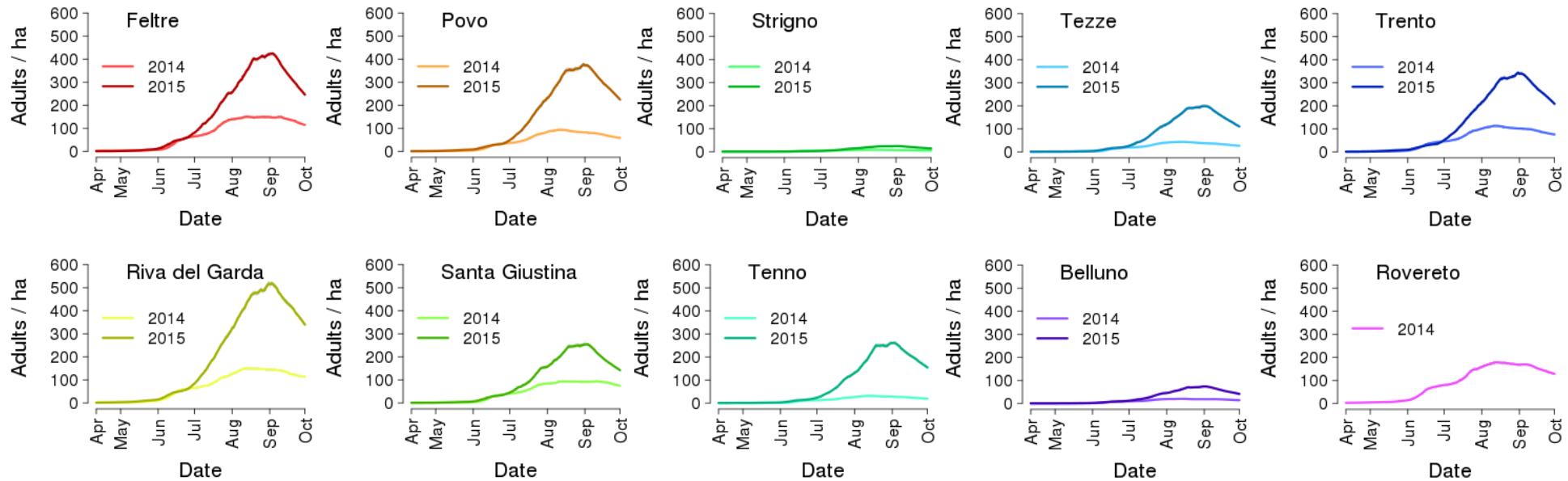
POPULATION MODEL



DETERMINATION OF MOSQUITO BITING RATE

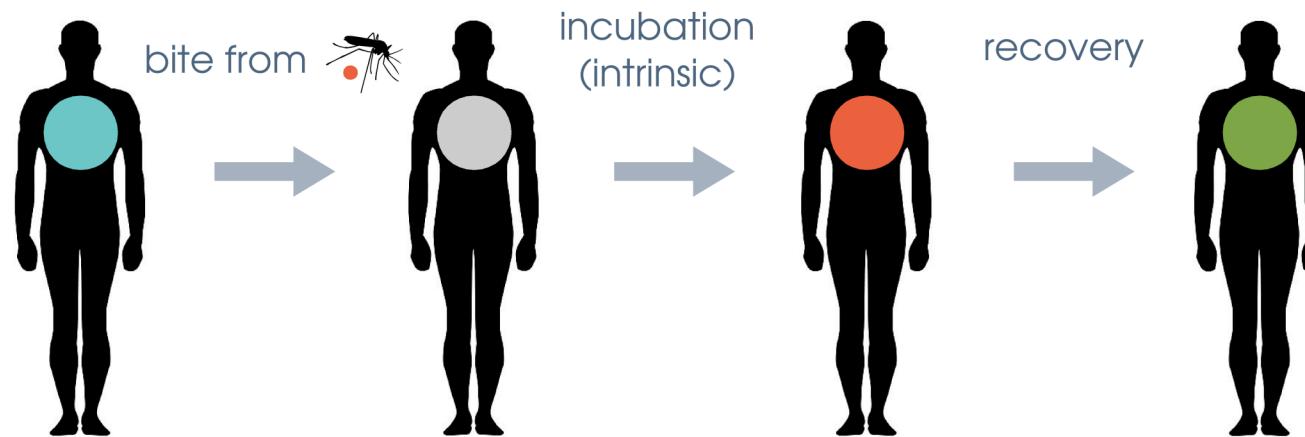
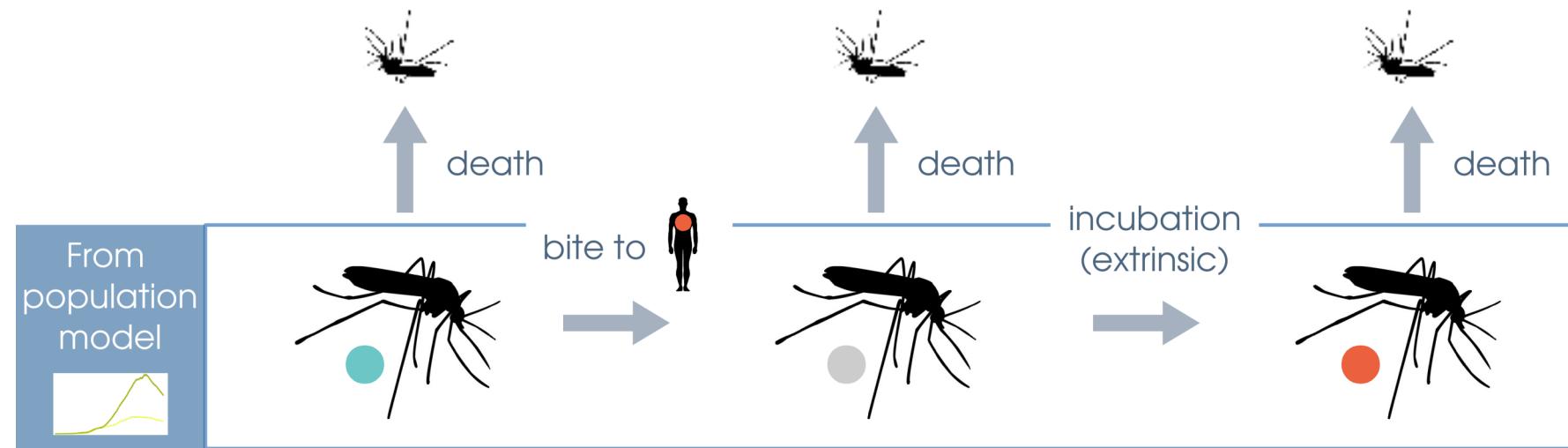


ESTIMATED ♀ MOSQUITO DENSITY

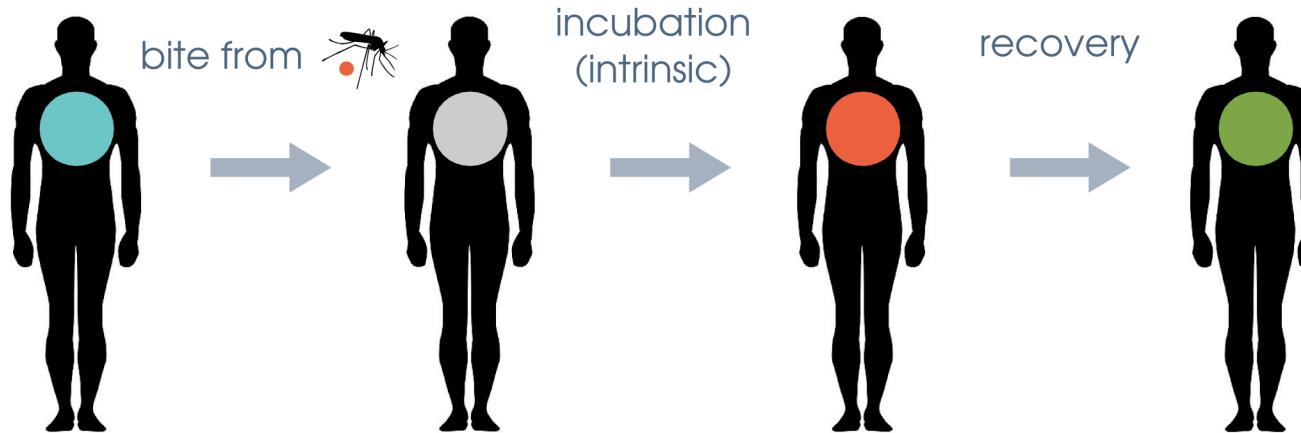
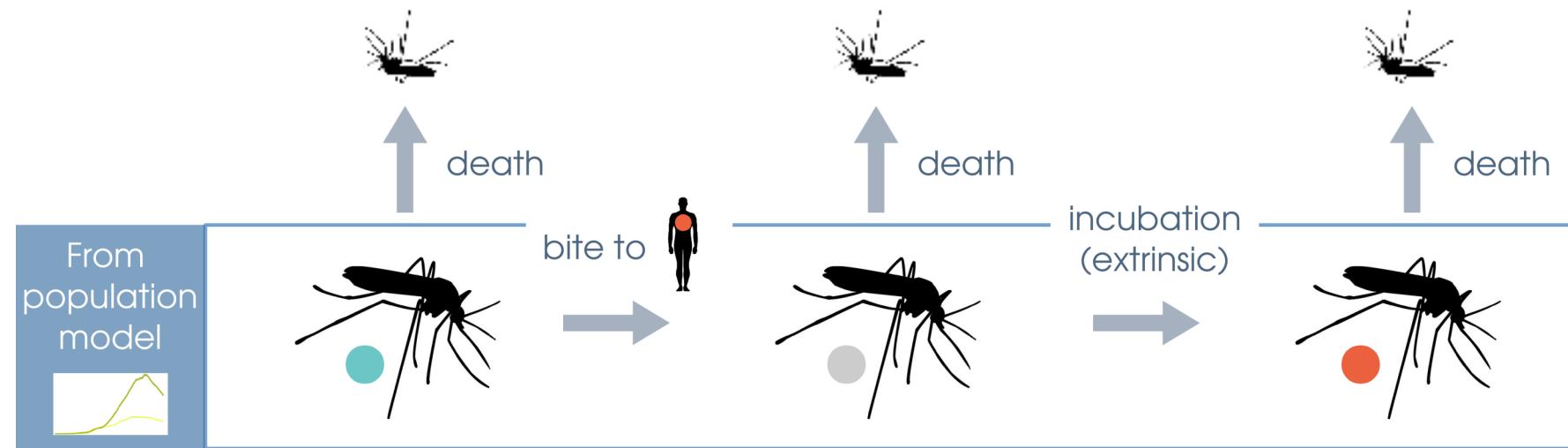


Remarkable heterogeneity in
mosquito abundances
over sites and season

MODELING DISEASE TRANSMISSION



MODELING DISEASE TRANSMISSION



BASIC RESEARCH

Natural history of infection in humans

Vector competence: susceptibility and transmissibility of infection
Specific of mosquito lineages
Prone to evolutionary adaptation

EPIDEMIOLOGICAL RISKS

IMPORTED CASES
BY MONTH

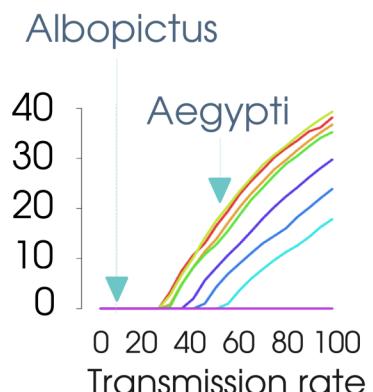
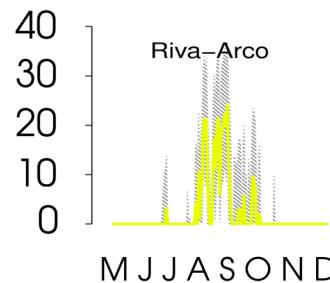
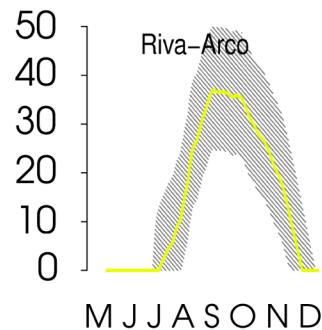
CHIKUNGUNYA

DENGUE

ZIKA



OUTBREAK
PROBABILITY (%)



PEAK R_0

0.25 - 4.0

0.15 - 2.3

0.02 - 0.25

SITES AT RISK

8/10

6/10

0/10

MEAN OUTBREAK
PROBABILITY

4.9-36%

4.2-10.8%

-

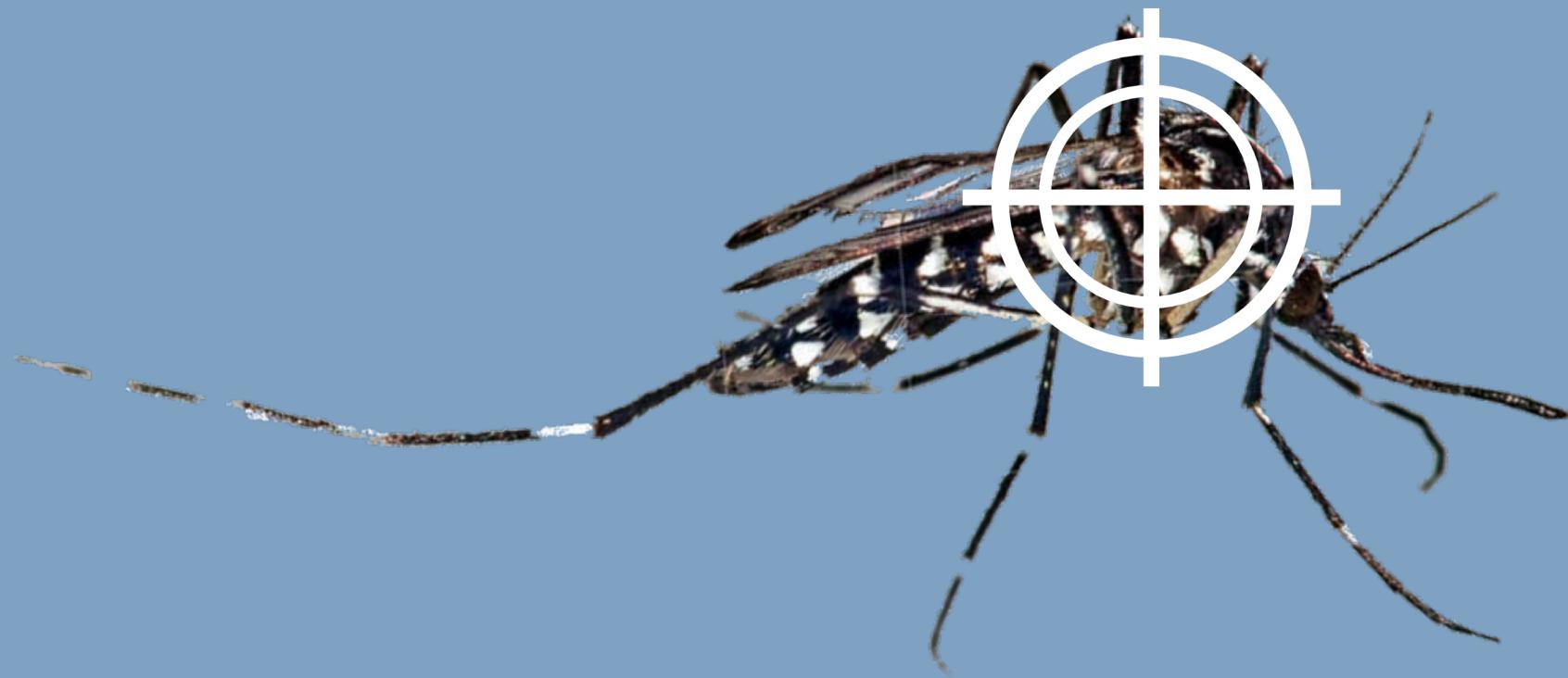
LENGTH OF
EPIDEMIC SEASON

2-4.5 months

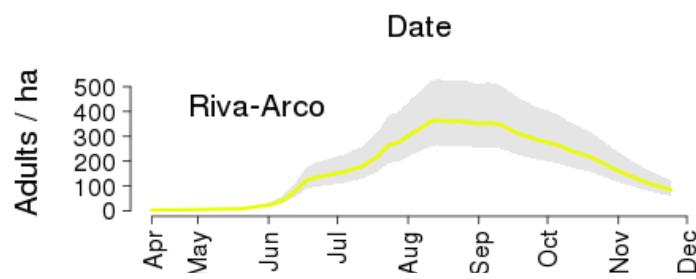
1-2 months

-

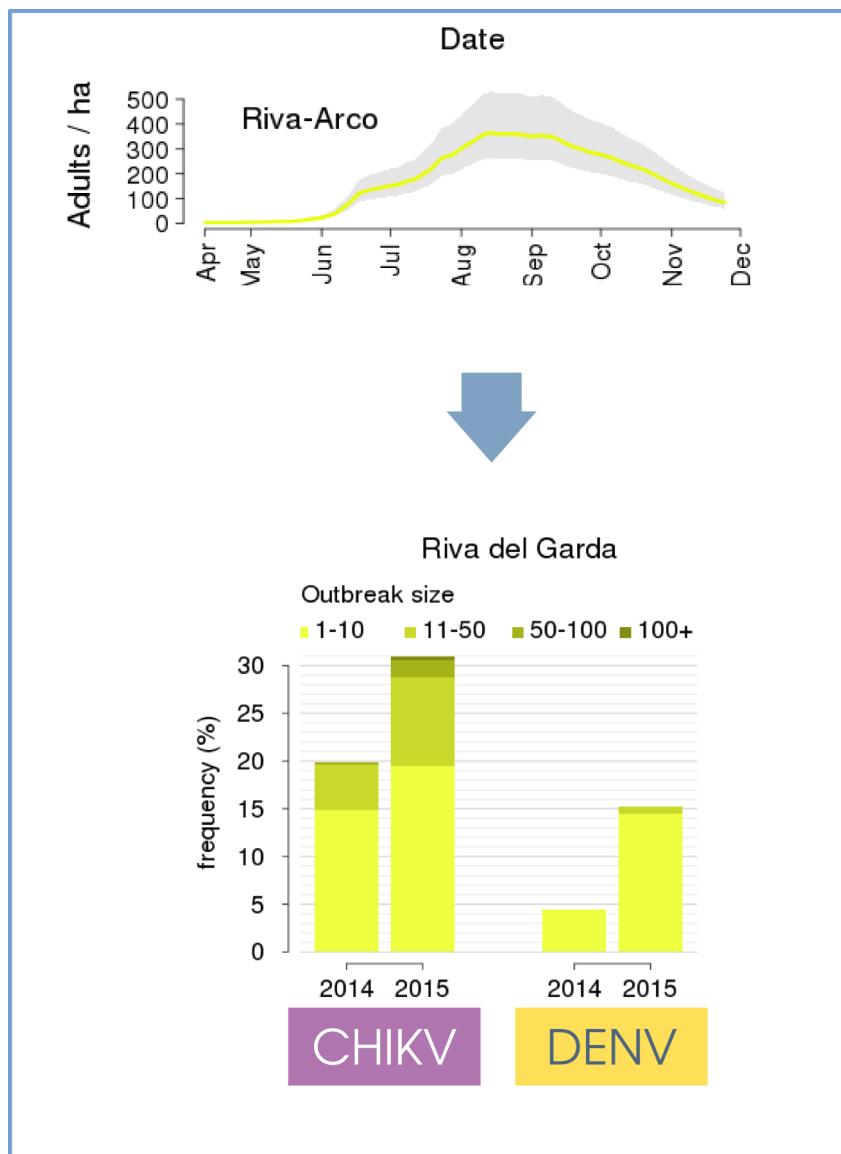
Vector control



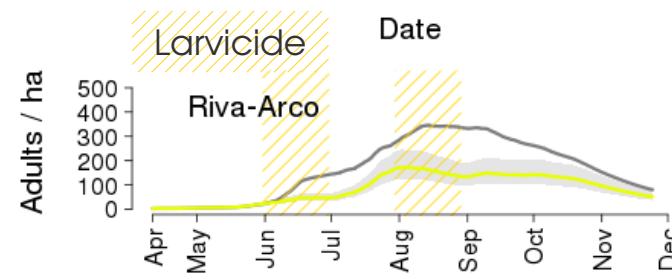
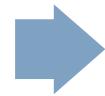
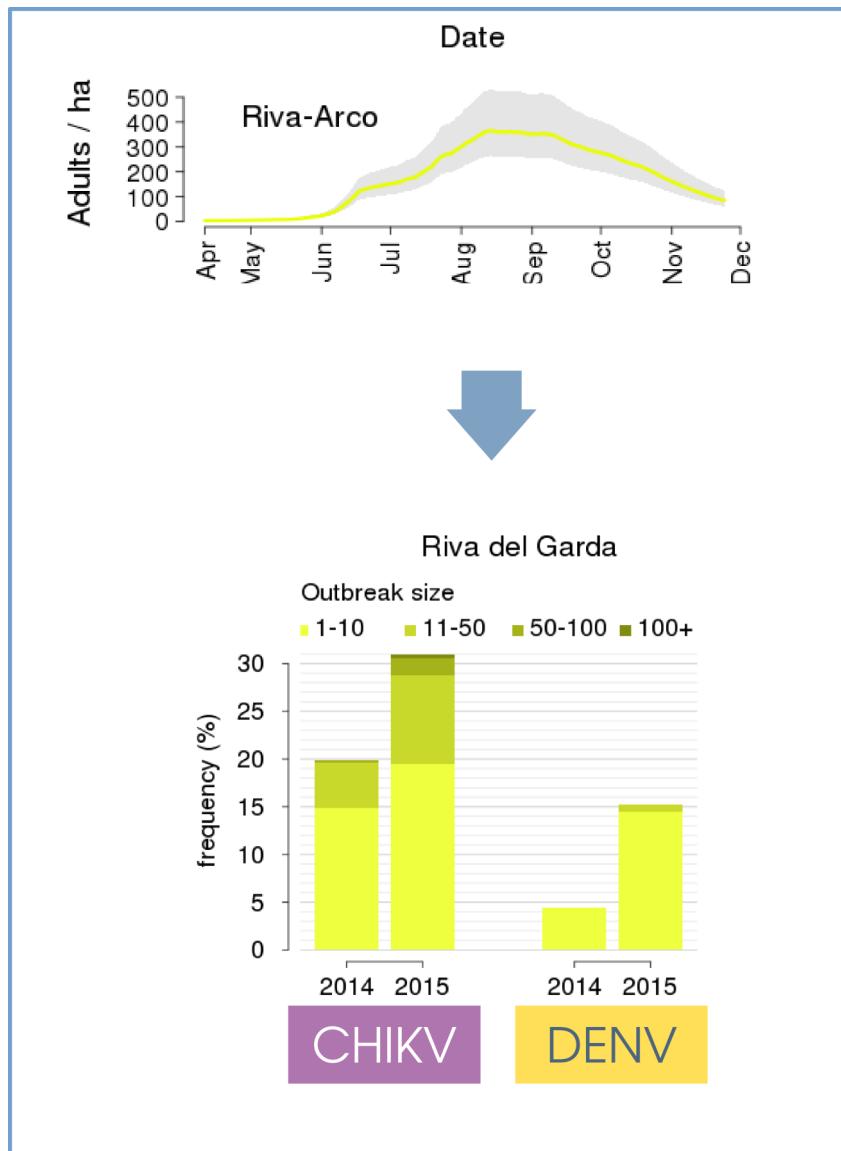
VECTOR CONTROL



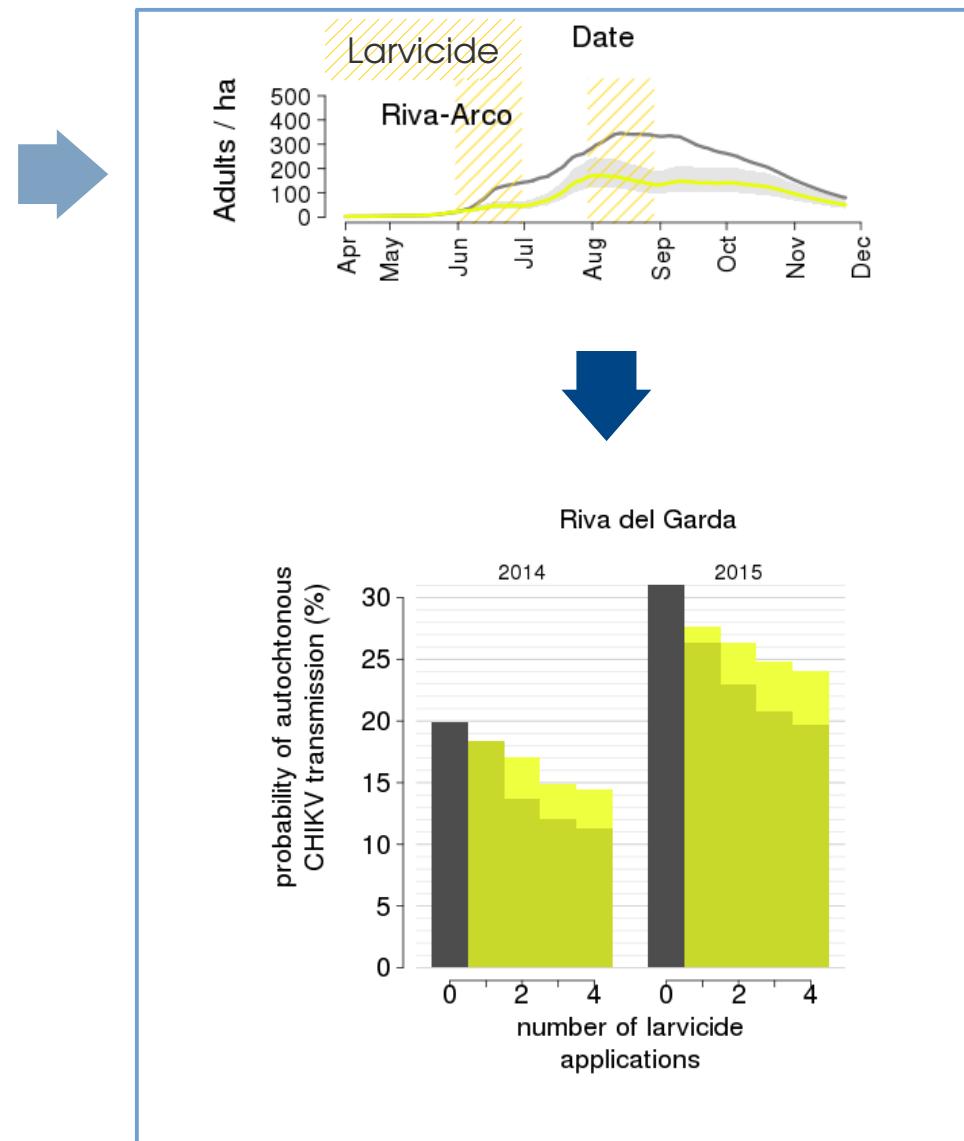
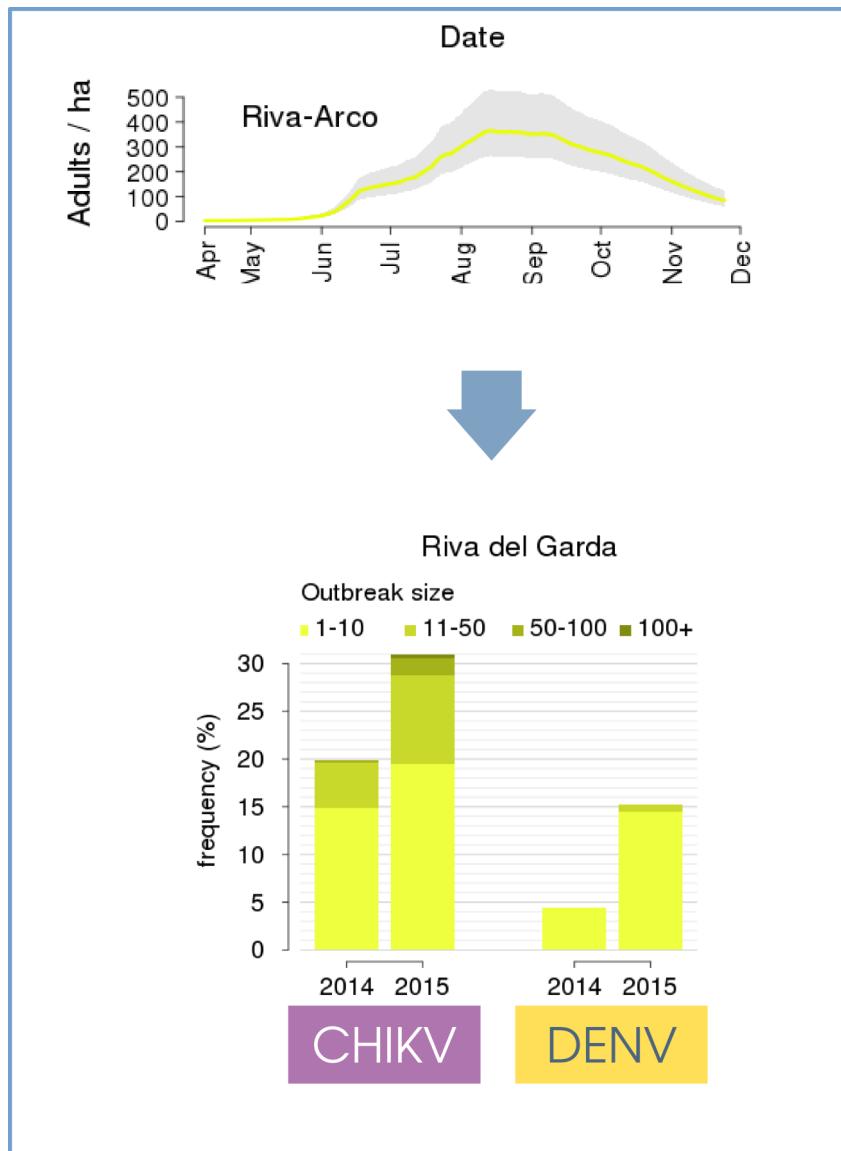
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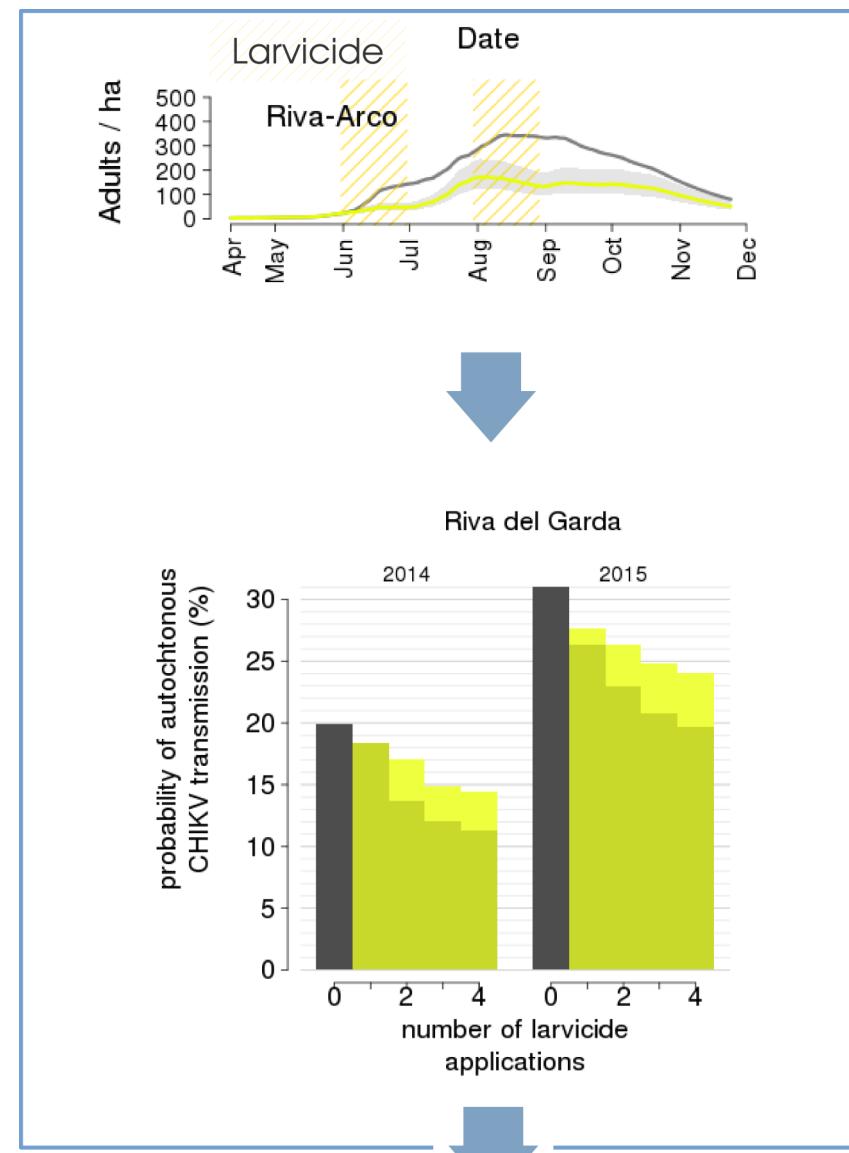
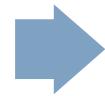
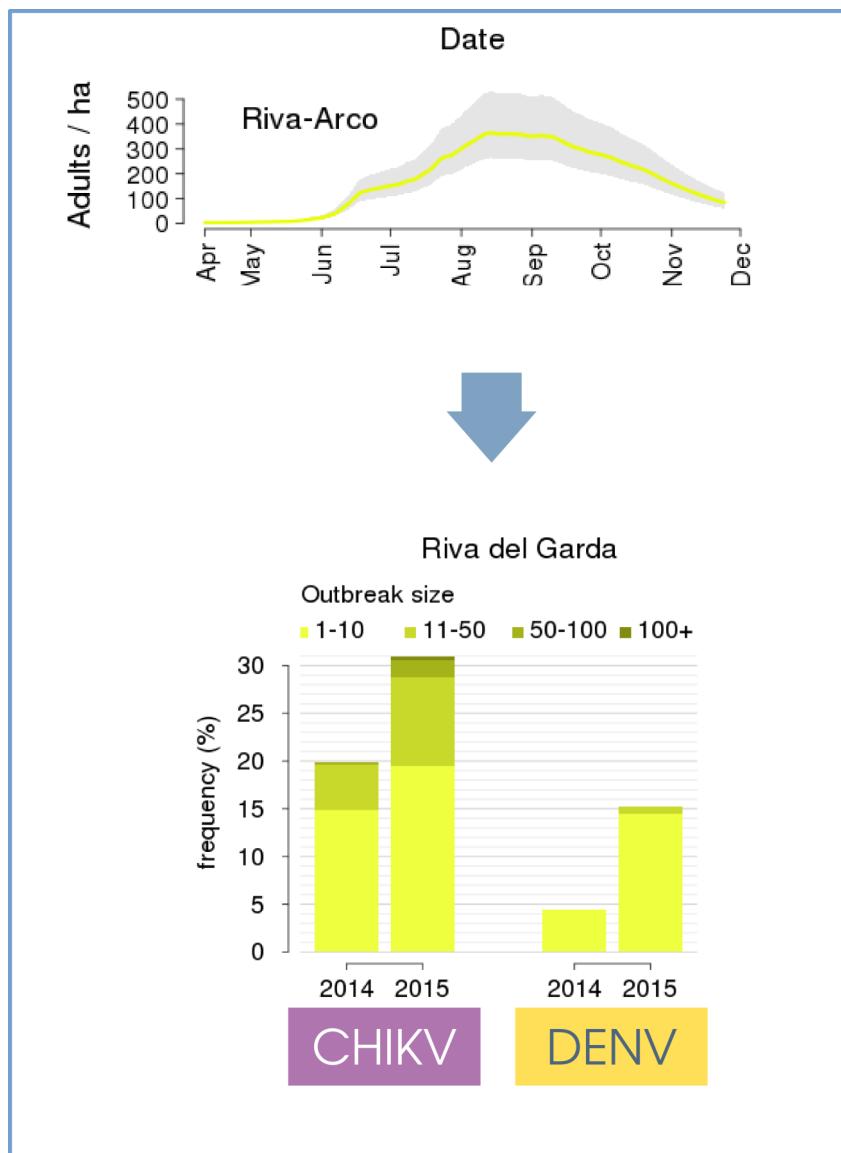
VECTOR CONTROL



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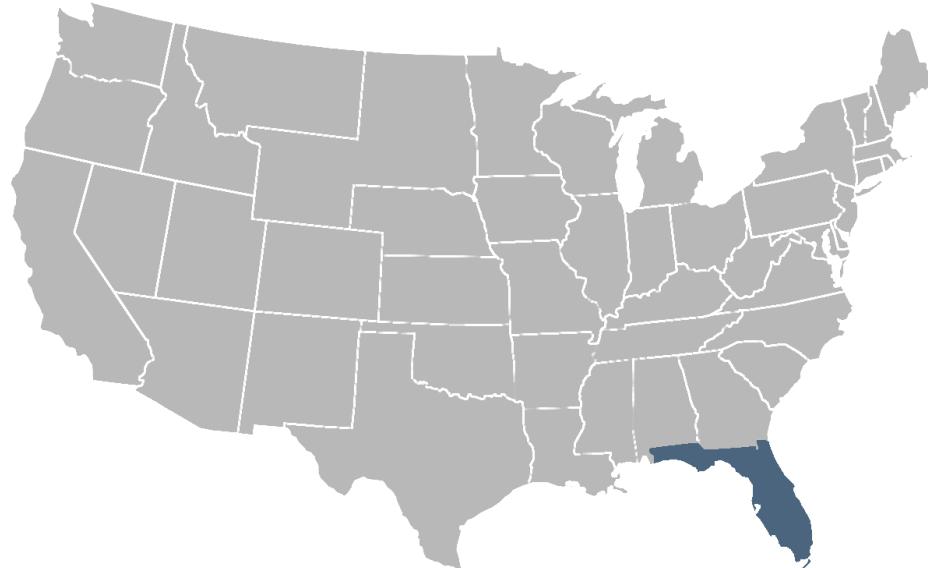


Cost-effectiveness analysis

From potential
to actual outbreaks



ZIKA OUTBREAK IN MIAMI

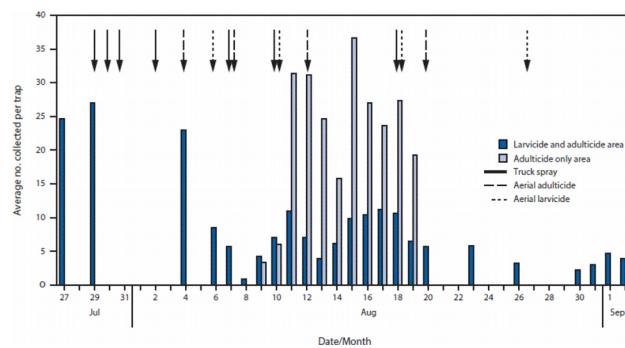


2016

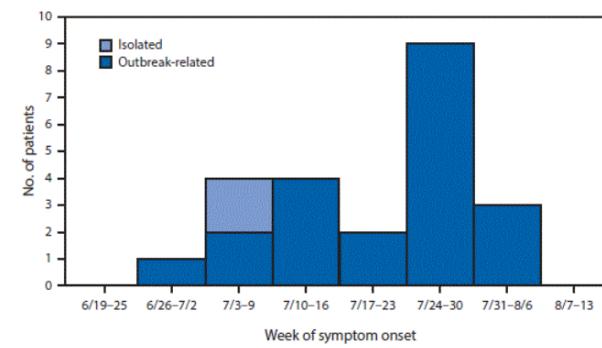
250 detected cases overall
4 distinct foci of infection

First focus: Wynwood neighborhood
21 notified cases
First detection: July 26
Published report: September 30

Data on mosquitoes



Epidemic curve



MODEL

MODEL INSIGHT ON WYNWOOD OUTBREAK



First case imported **3-5 months** before outbreak detection

R_0

Peak of **2.7** in mid-June



14% of local population infected (mostly asymptomatic)



6-29 pregnant women infected



Probability of infected blood collection: **12%**



Additional outbreaks likely due to **commuters**



Implemented interventions avoided **56%** of potential cases

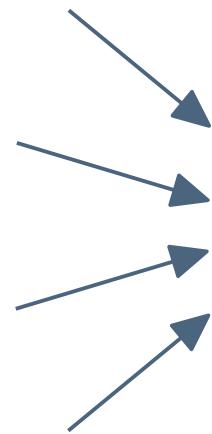
SPREAD OF ZIKA IN THE AMERICAS

Long distance travels

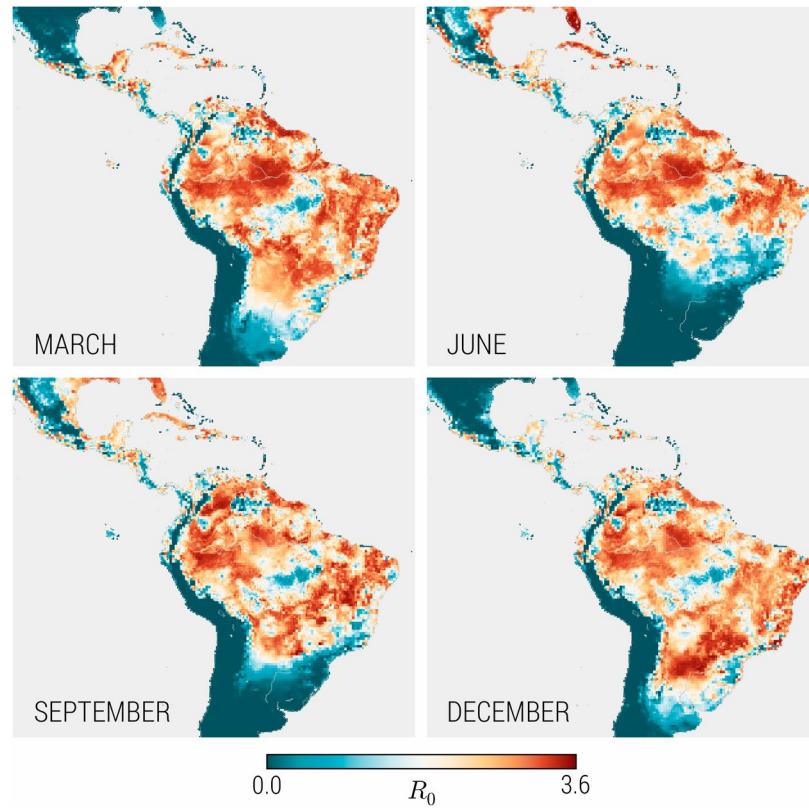
Epidemic data

Temperature data

Habitat suitability



Risk maps for Zika in Latin America



SPREAD OF ZIKA IN THE AMERICAS

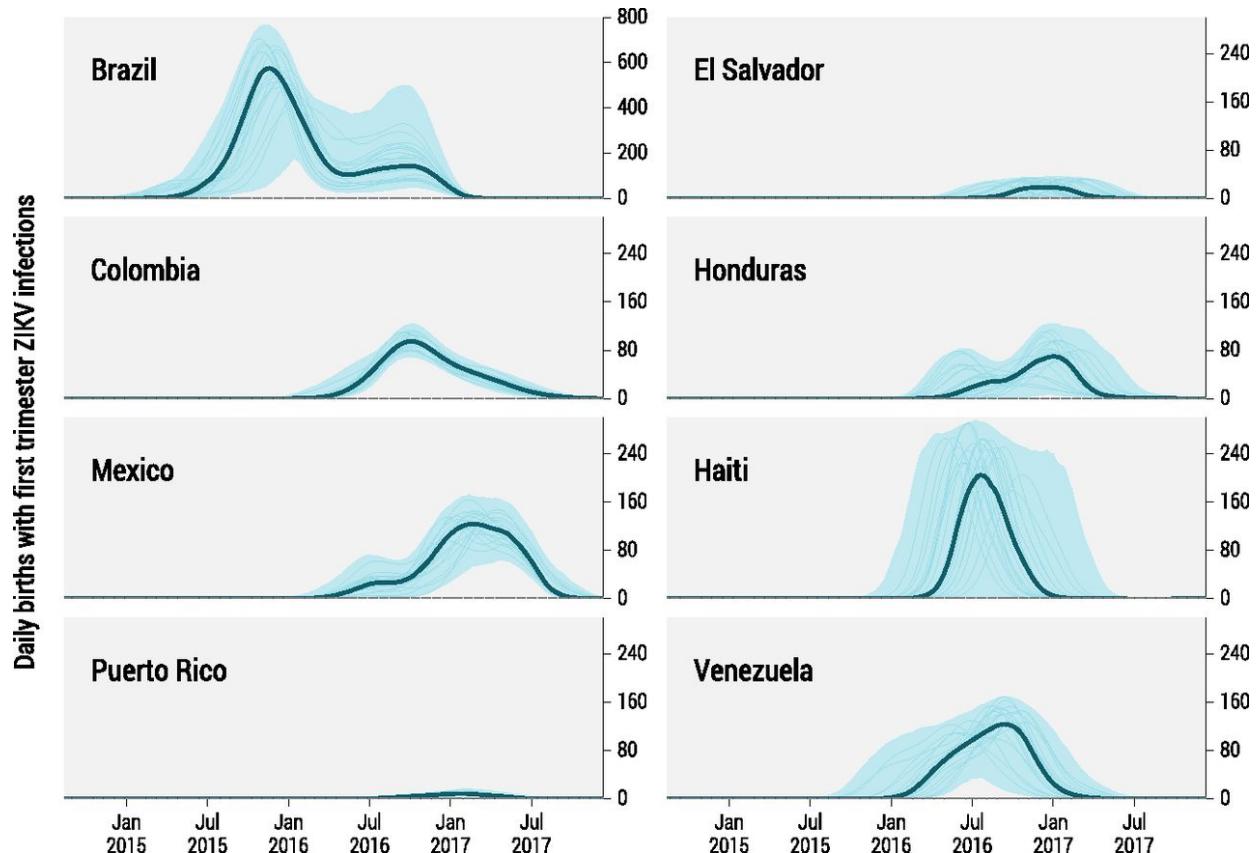
Long distance travels

Epidemic data

Temperature data

Habitat suitability

Risk of Zika-induced microcephaly in Latin America



CONCLUSIONS

1. Models amplify power of data

CONCLUSIONS

2. Sharing data gives them value

CONCLUSIONS

3. Basic knowledge is needed

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