Citizen Science Data Modeling

Frederic Bartumeus
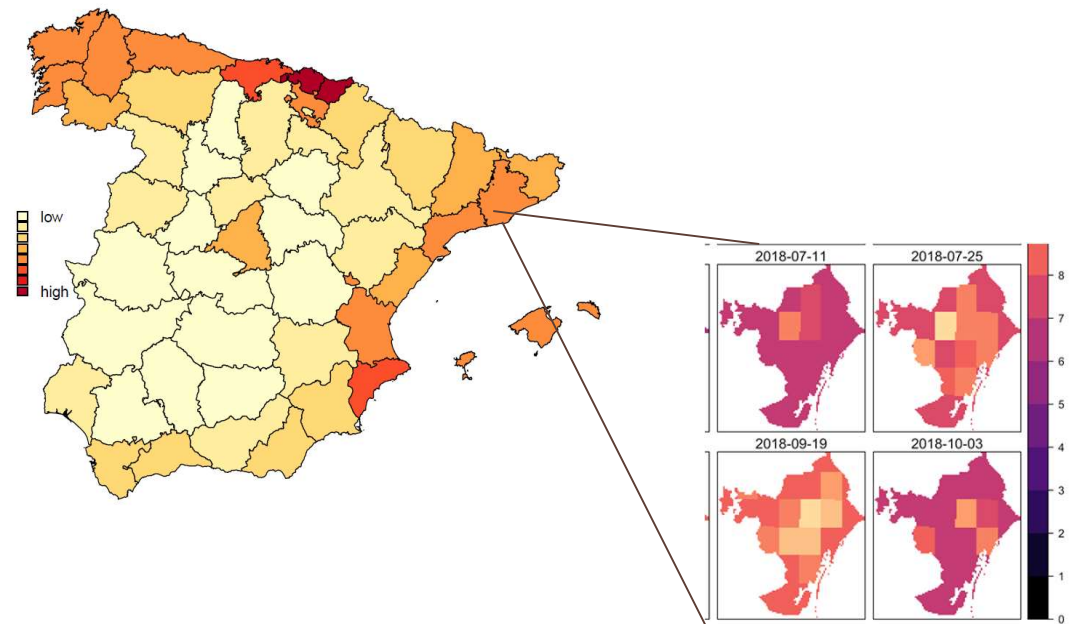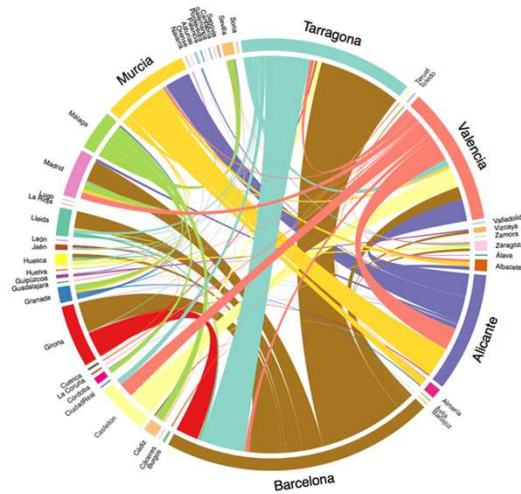Theoretical and Computational Ecology Group
CEAB-CSIC & CREAF

John RB Palmer
Socio-Demography Research Group
Pompeu Fabra University

Vector Modelling
(mosquito abundance, fluxes encounter rates, biting patterns?)
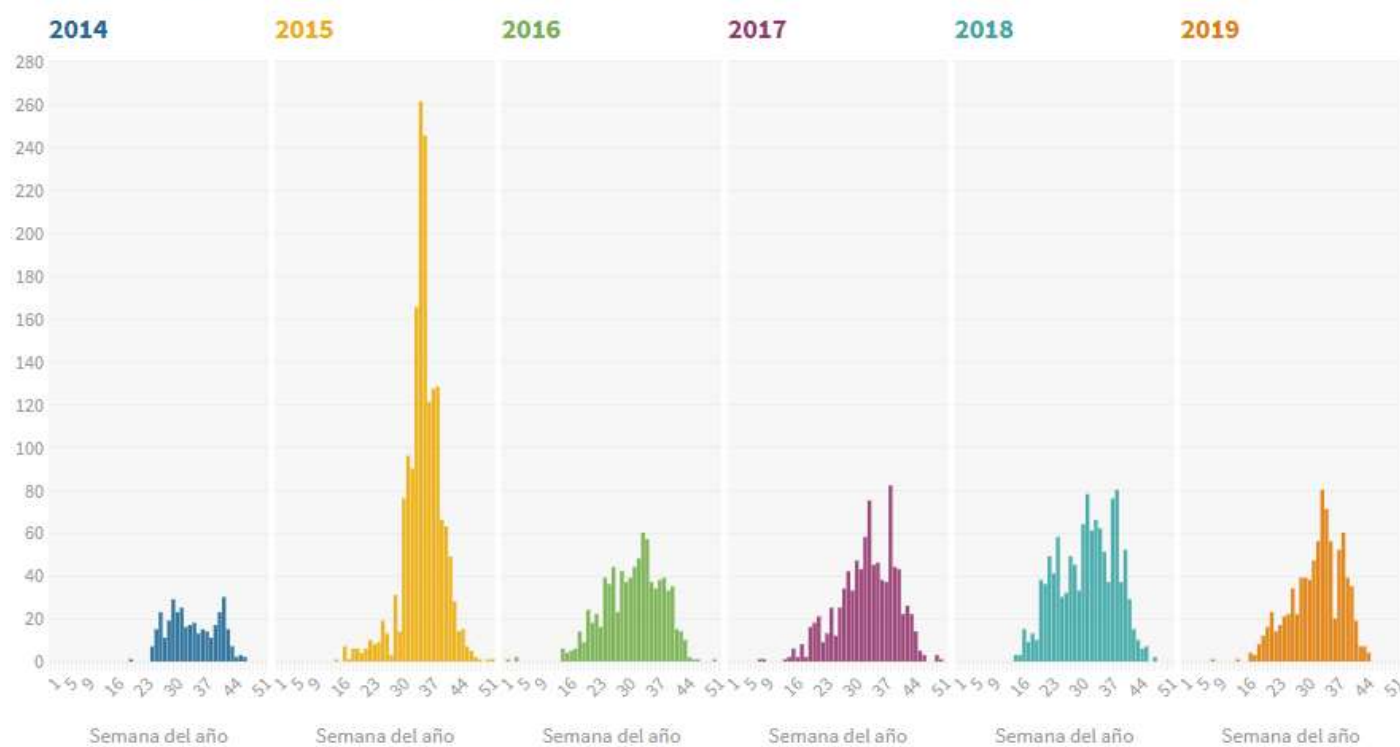
Sampling Bias Problem

Does absence of reports indicate absence of mosquitoes or of citizen scientists?

Does abundance of reports indicate abundance of mosquitoes or of citizen scientists?
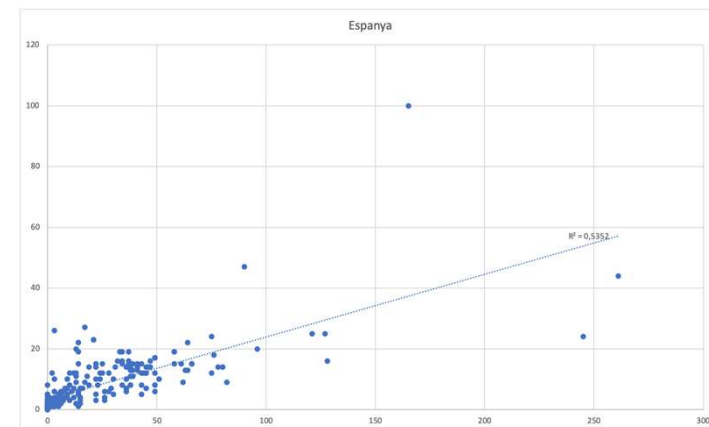
Mosquito tigre observados por semana

2014 2015 2016 2017 2018 2019

Semana del año   Semana del año   Semana del año   Semana del año   Semana del año   Semana del año
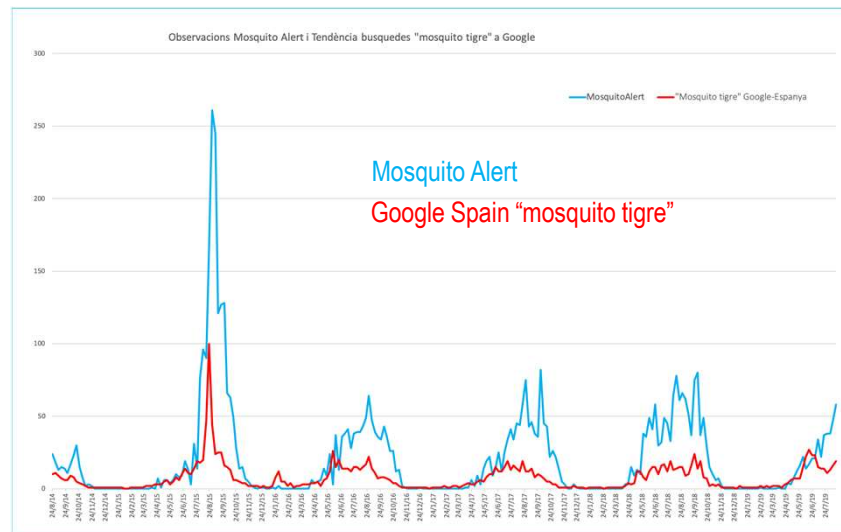
Source: Mosquito Alert

MOSQUITO ALERT

5 años más tarde nos encontramos con un modelo parecido, aunque más complejo
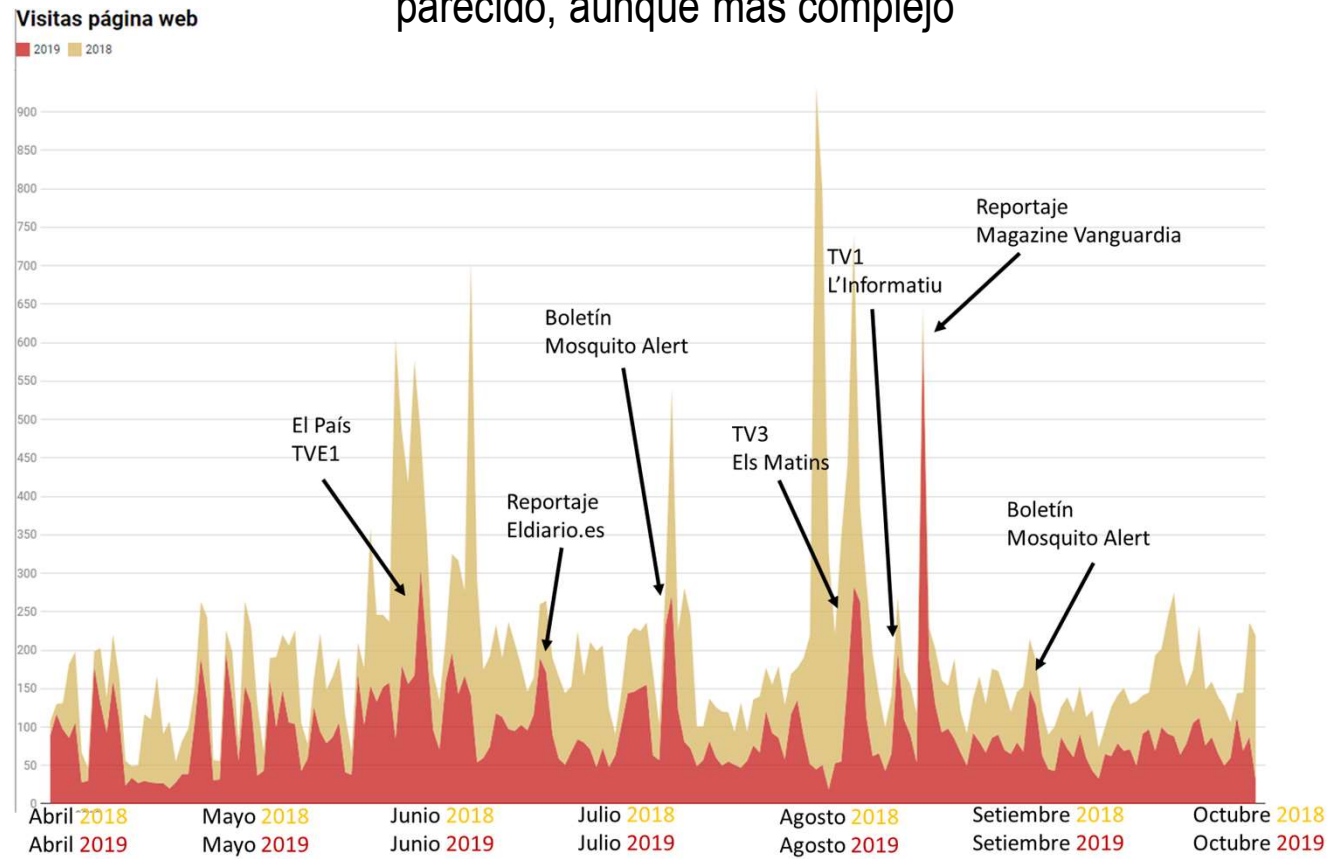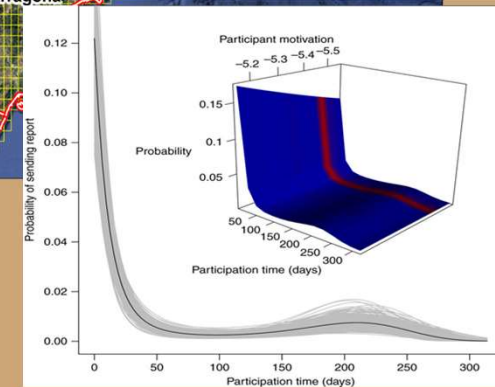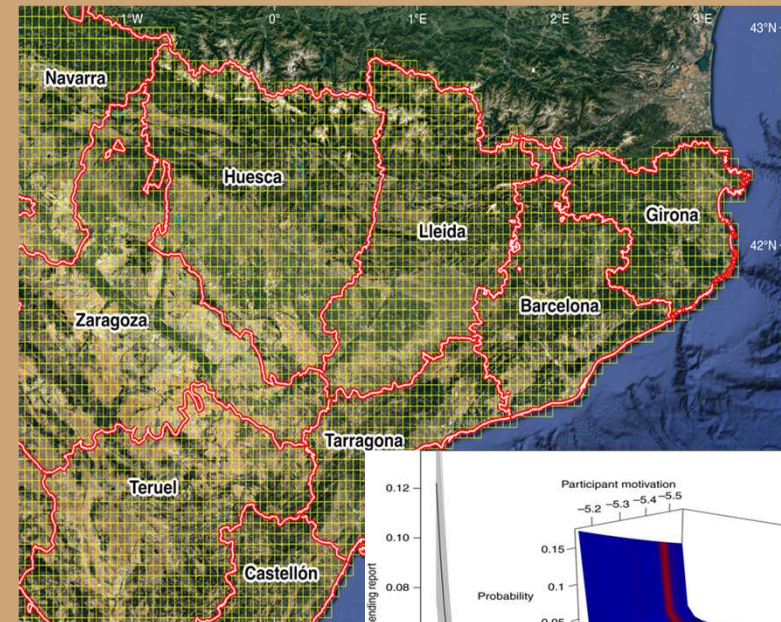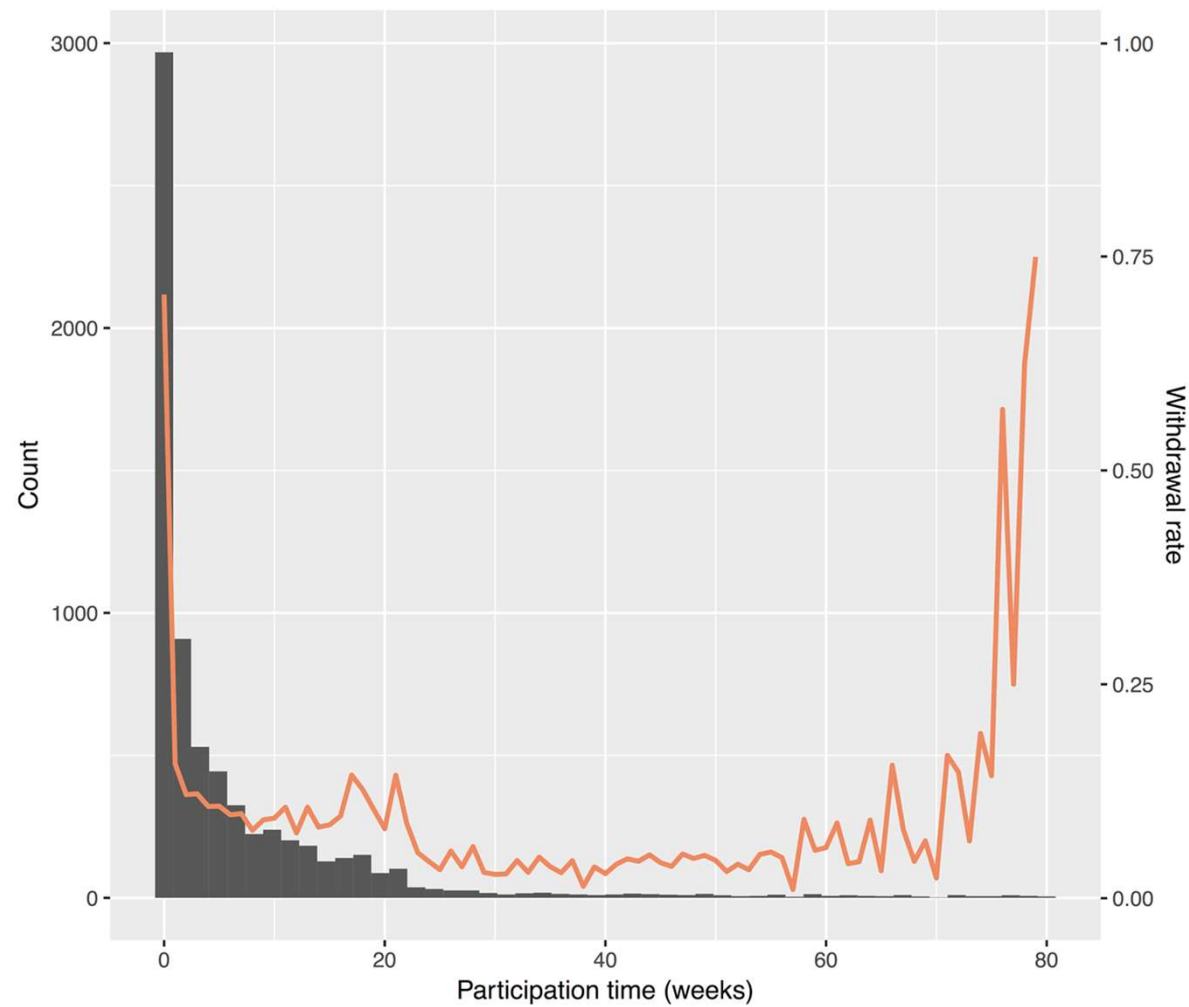
Google and Mosquito Alert

Modelling Sampling Biases

- Participation patterns
- Background tracking

Studying Participation Patterns

Sampling Effort and Reporting Dynamics
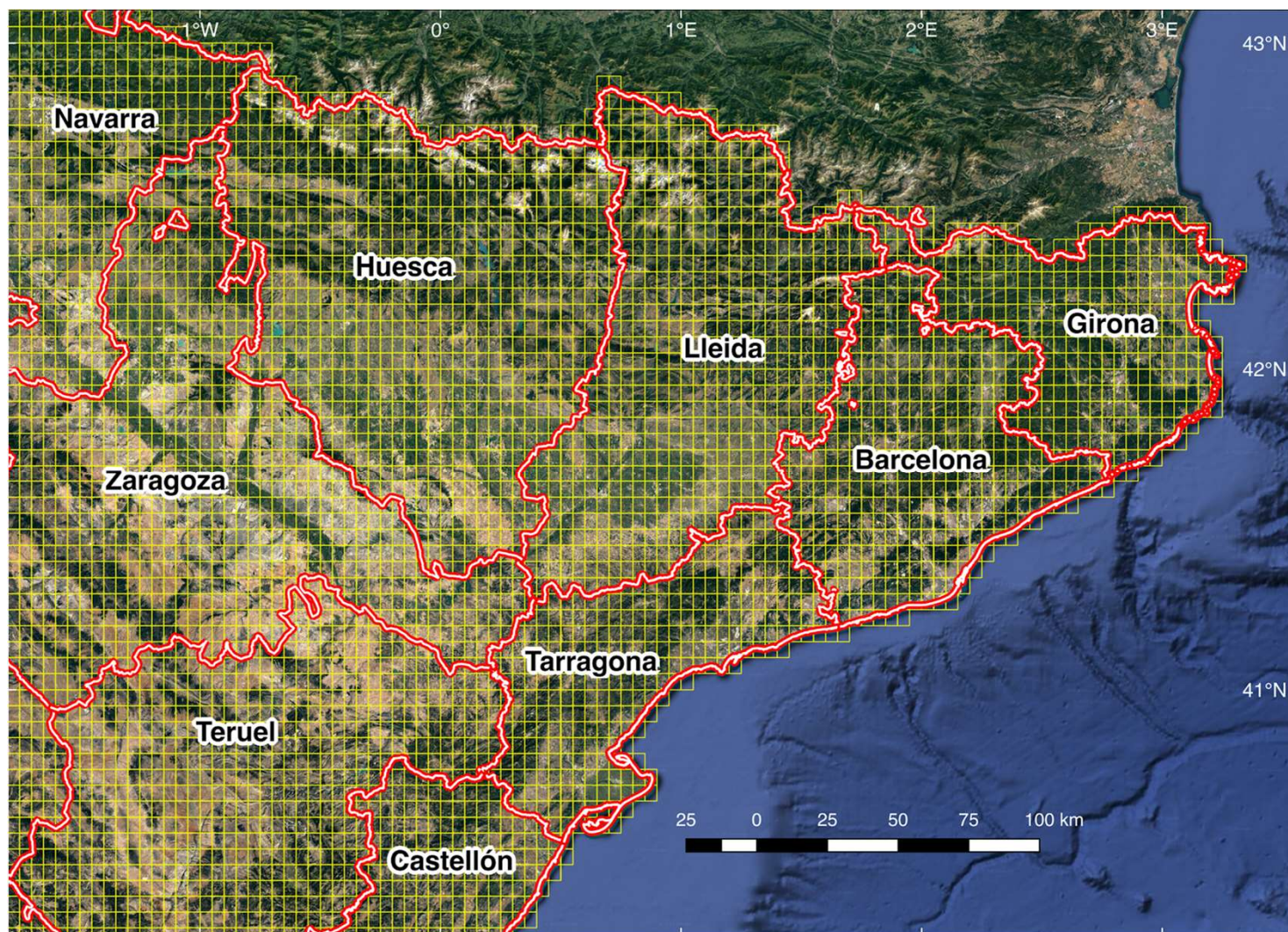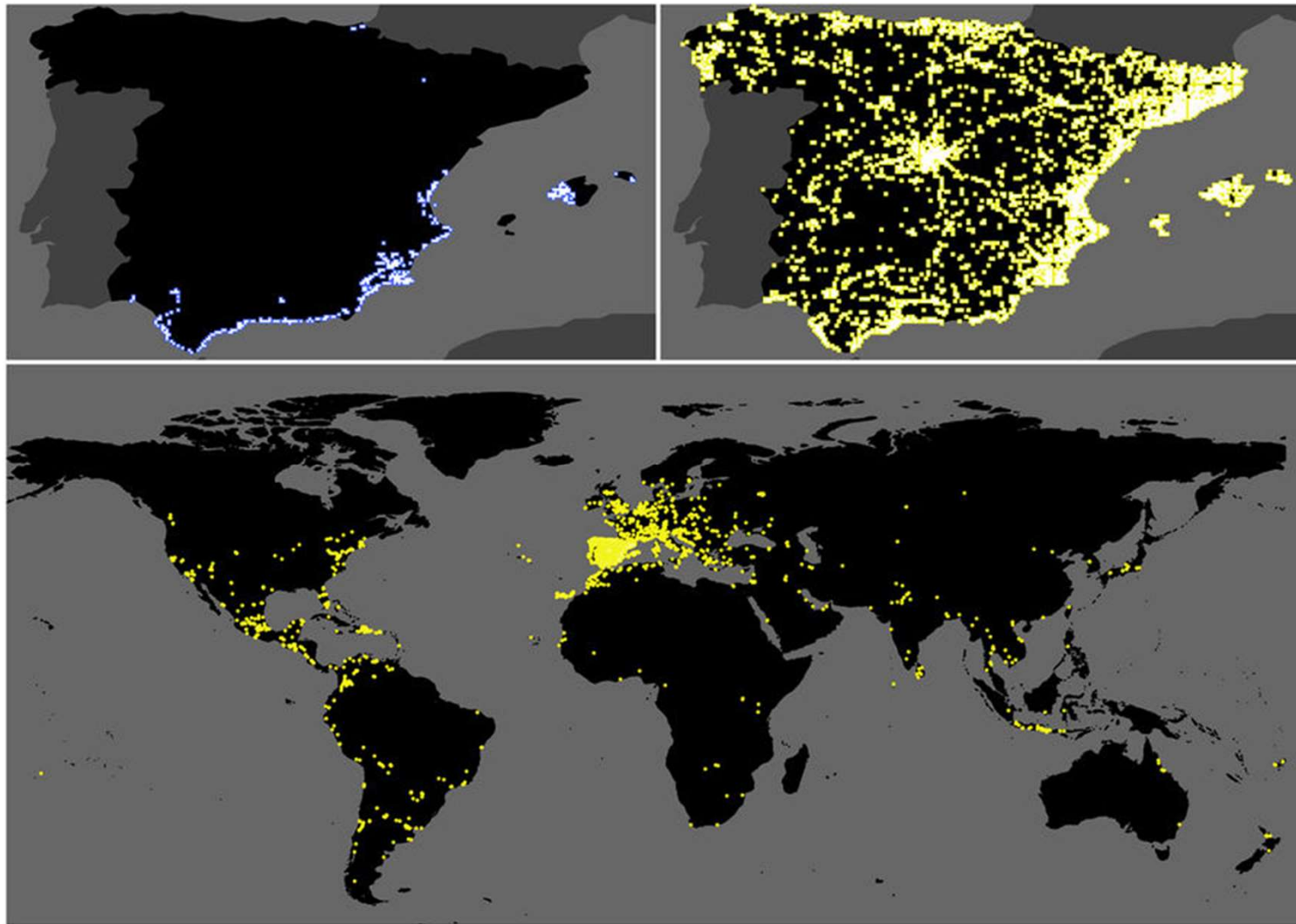
Most participants withdraw soon after registering.

Long tail of participation times.

U-shaped participation-time-specific withdrawal rate.

Background tracks are masked by sampling cells. Until mid-2017 these were 0.05 degrees longitude and latitude (~25 km sq).

Ovitraps (left) vs. Mosquito Alert participants (right) in Spain during 2014-15.

Over 59,000 participants worldwide to date.
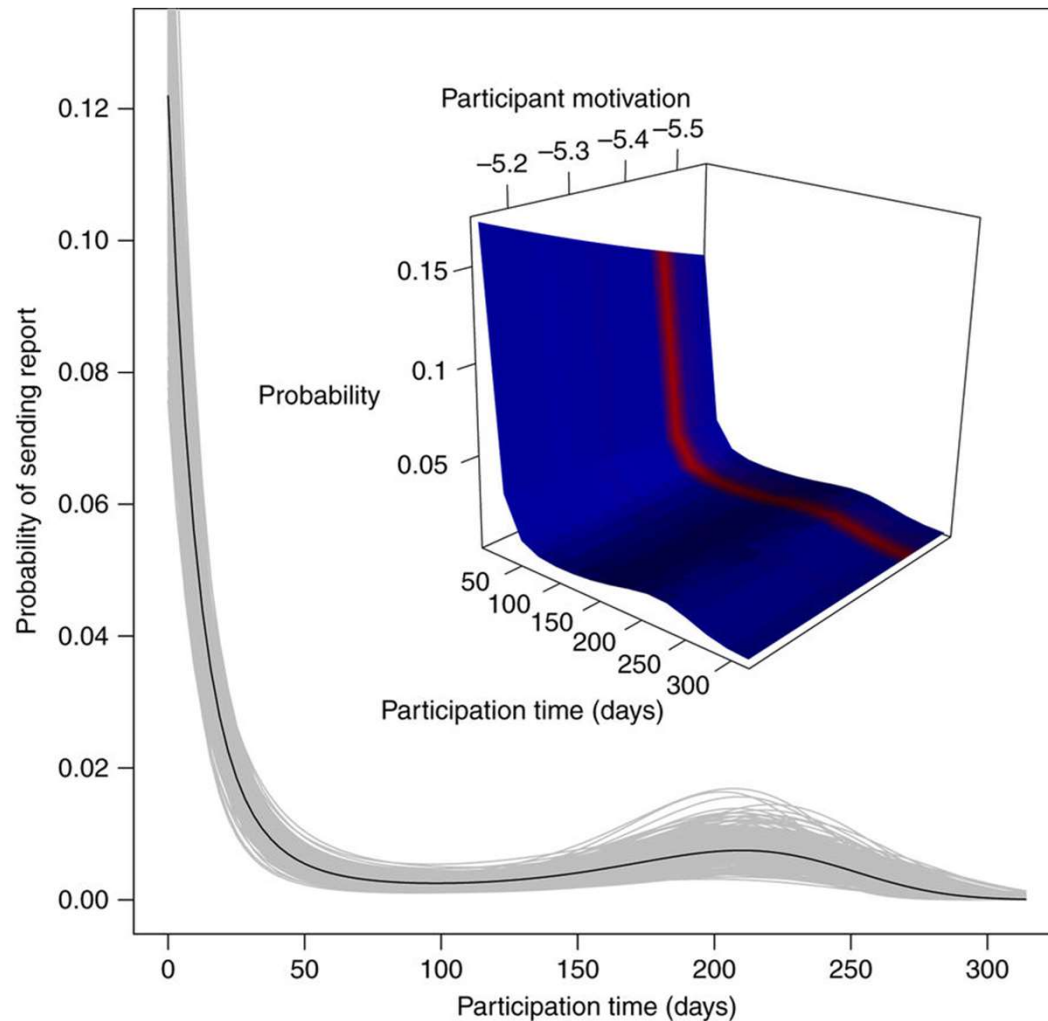
Reporting Dynamics

Reporting propensity is related to participation time.

People most likely to report soon after registering, and propensity drops over time.

Individuals vary in motivation.

We combine this model with the background tracks to estimate sampling effort for each cell-biweek.

**Sampling Effort:** calculated for biweek-cell from number of participants and reporting propensity of each participant (modelled from participation time).

Mosquito Alert Probability: modelled for biweek-cell with reliable reports as function of reporting propensity and time of year.

Bayesian multilevel logistic regression with random intercepts and seasonality slopes (third degree polynomial of Julian date) at the cell level.
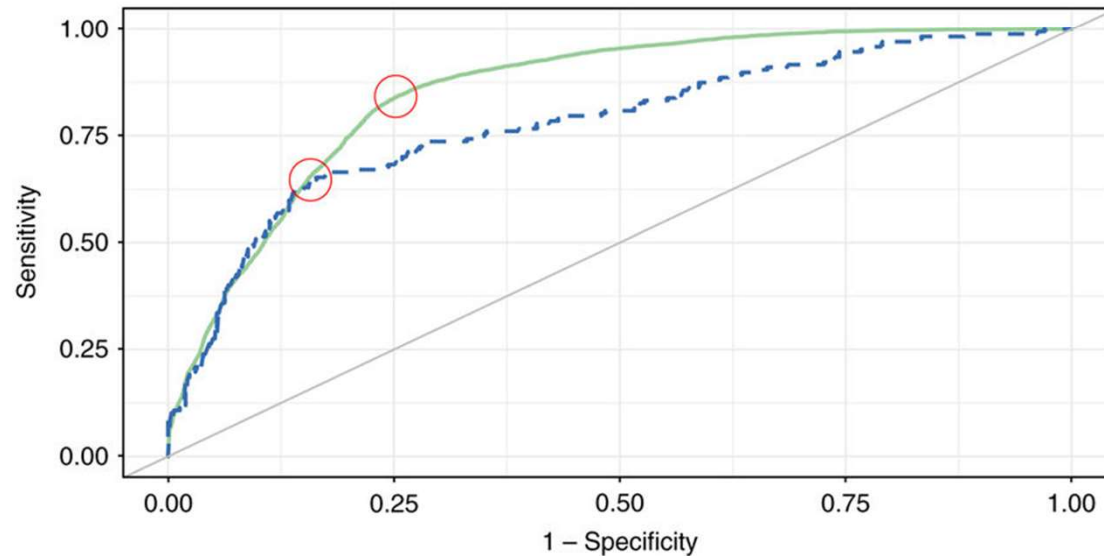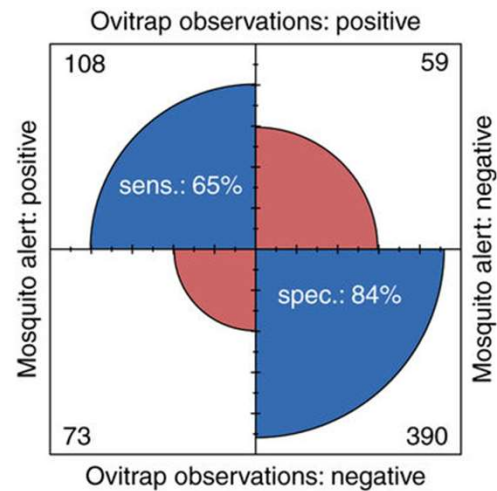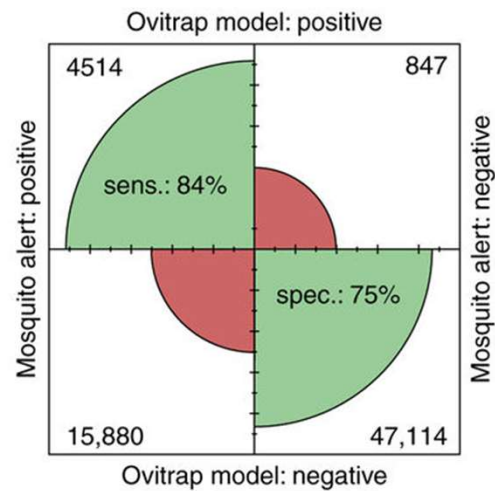
Citizen science validated against ovitraps

This model does a good job of predicting ovitrap egg presence in overlapping cell-biweeks. AUC=.85 when compared to ovitrap model and .78 compared to raw ovitrap data.

Mean September municipal alert probabilities

0.00 – 0.10
0.11 – 0.20
0.21 – 0.30
0.31 – 0.40
0.41 – 0.50
0.51 – 0.60
0.61 – 0.70
0.71 – 0.80

Spanish provinces
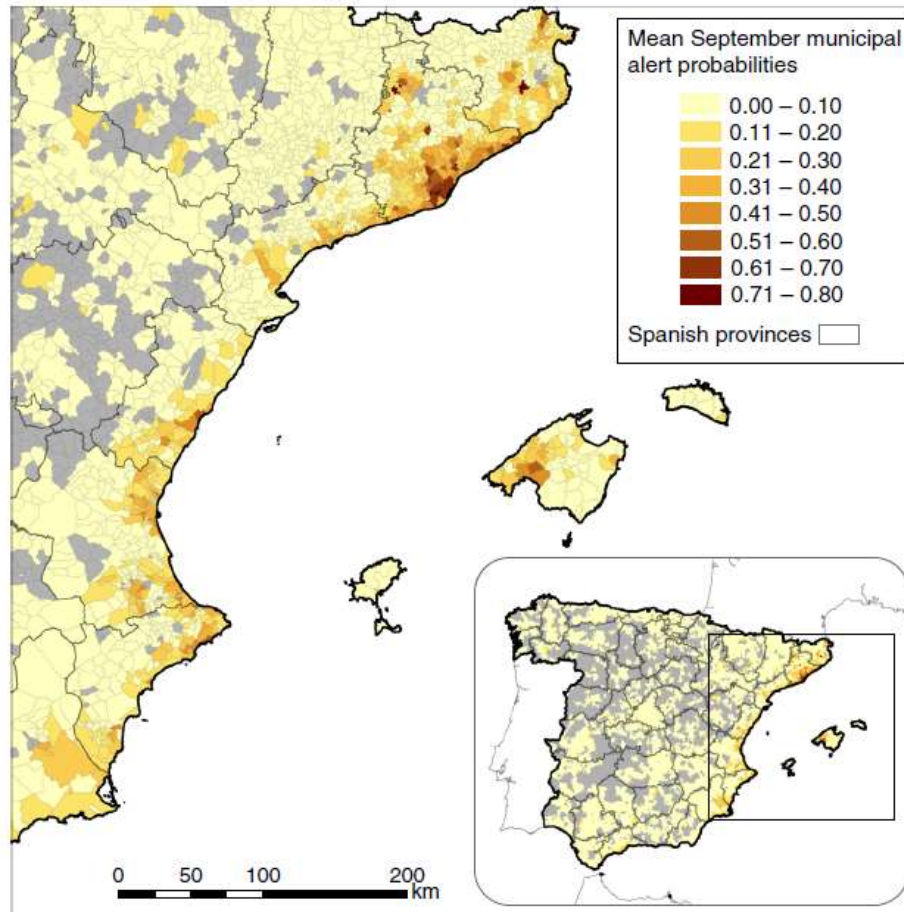
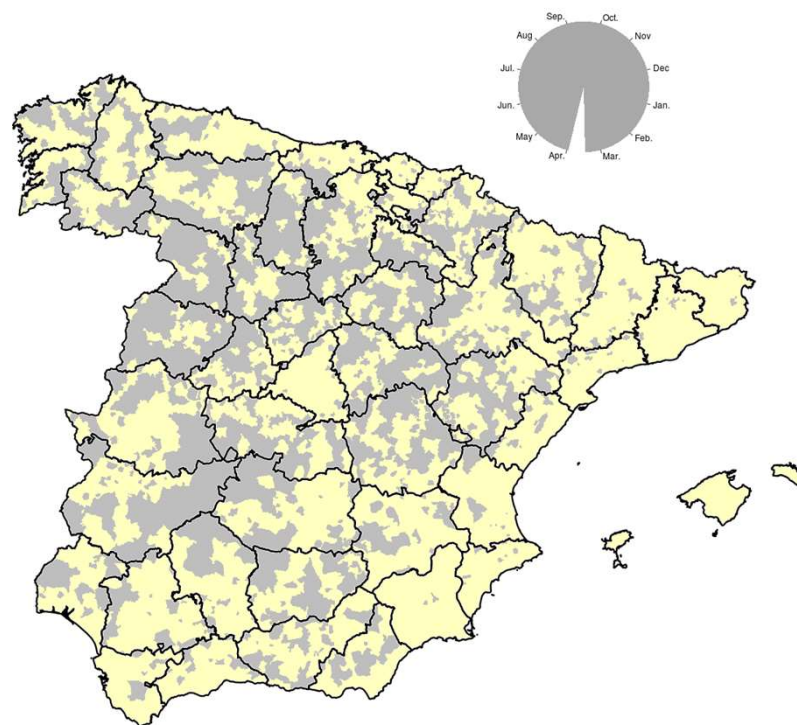Mosquito Alert also provides estimates and predictions of human-tiger-mosquito encounter probabilities at the biweek-sampling-cell scale.

Citizen science provides a reliable and scalable tool to track disease-carrying mosquitoes.
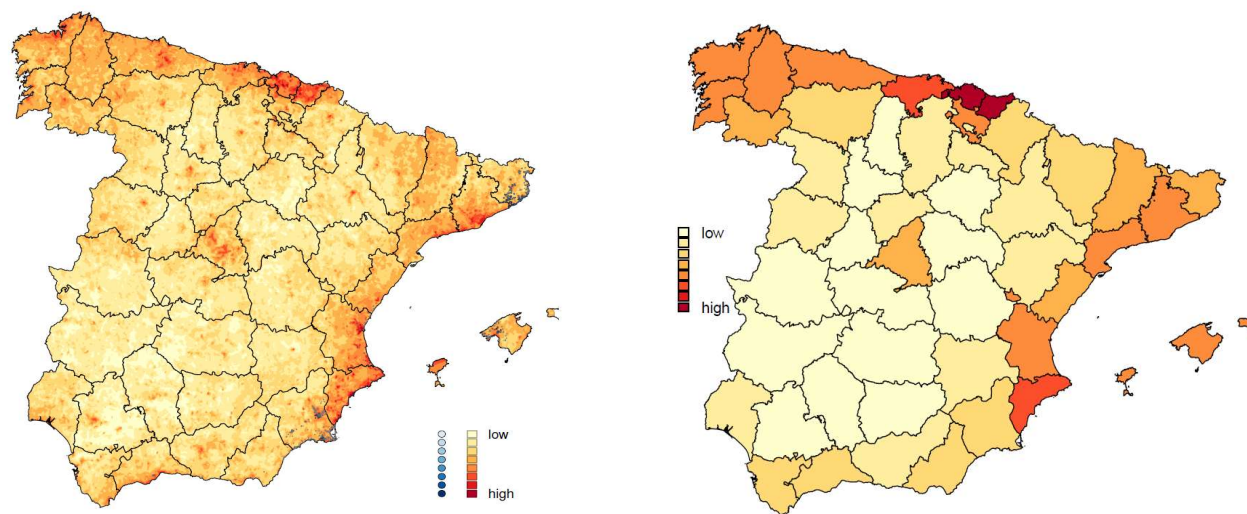**Palmer et al (2017)** *Nat Comms* **8(1):916**

Tiger Mosquito Alert Probability. Seasonal Cicle 2015.

Future directions: Vector Potential Distribution

Tiger Mosquito Potential Distribution
(Data Soucre: April-November 2014)
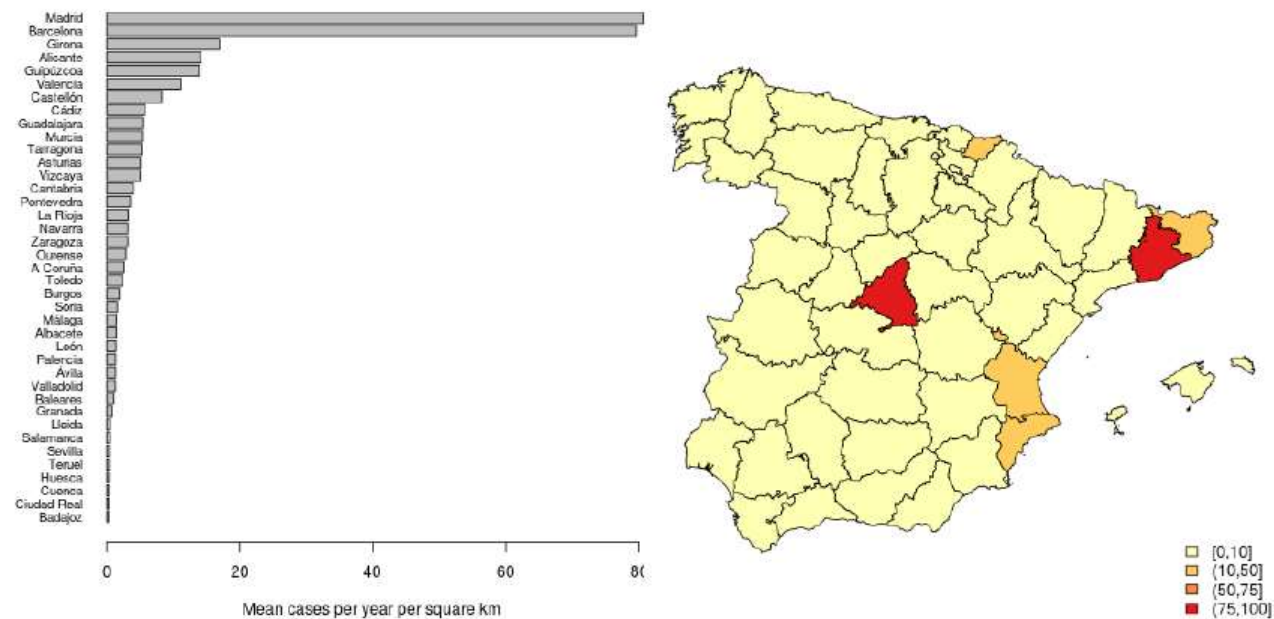
Health Risk Models (CHIK)

Figure 4: Chikungunya case density in Spanish provinces. Number of cases per 10,000 sq. km.

Tiger Mosquito Alert Probability. Seasonal Cicle. 2015.
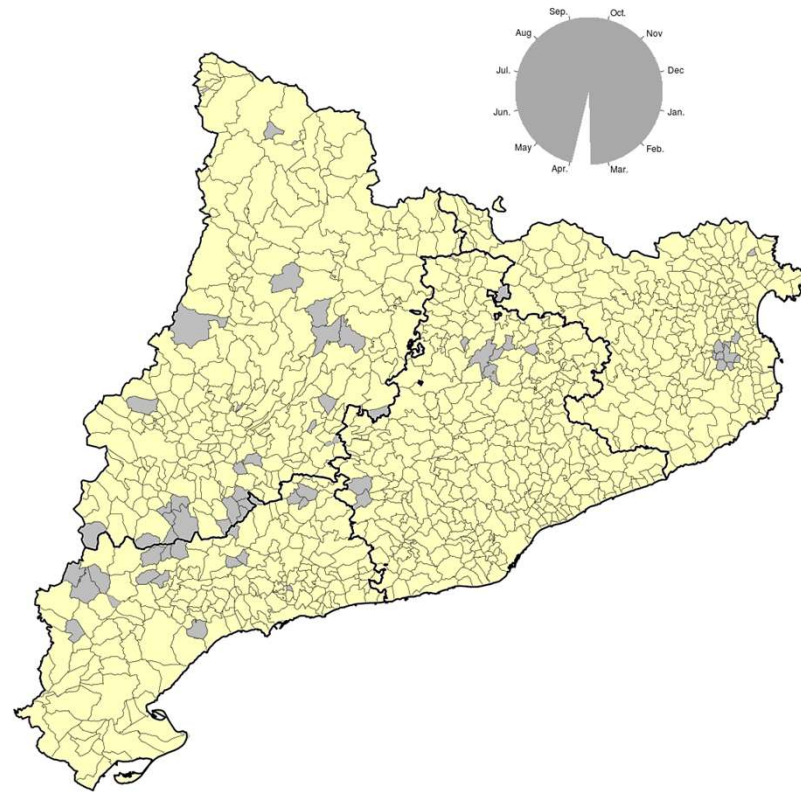
Disease Risk Models CHIKV
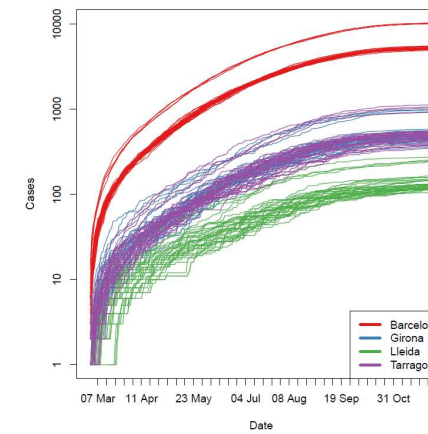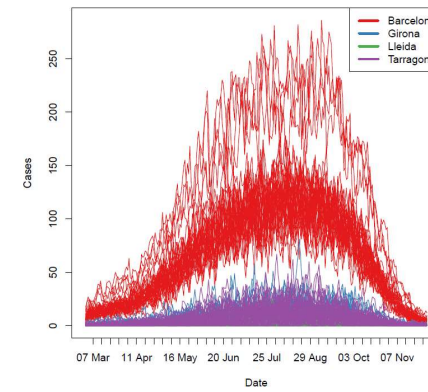
"Citizen science provides a reliable and scalable tool to track disease-carrying mosquitoes." *Nature Communications* 8, no. 1 (2017): 916

John Palmer, Aitana Oltra, Francisco Collantes, Juan Antonio Delgado, Javier Lucientes, Sarah Delacour, Mikel Bengoa, Roger Eritja, and Frederic Bartumeus.

Mosquito Alert participants helped show that tiger mosquitos hitchhike in cars.

770 cars sampled
4 positives

Bayesian estimate with credible intervals

Stopping cars as Bernoulli trials

$$\binom{n}{k} p^k (1-p)^{n-k}$$

Binomial distribution
n=770 cars, k=4 positives

5 [2-10] out of 1000 cars carry a tiger mosquito

July – October. Metropolitan Area of Barcelona.

*"Considering 6.528.979 car trips per workday in the area in summer implies **between 11.572 and 70.513 Ae. albopictus daily** displacements by car in the area"*
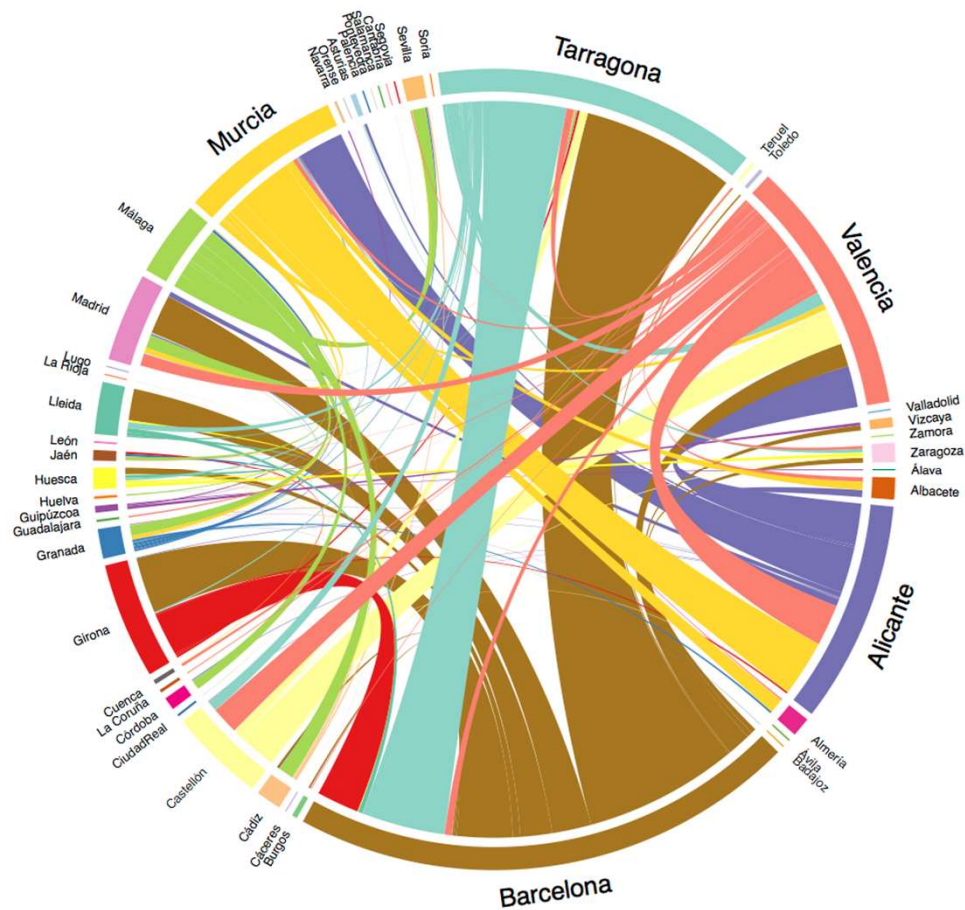
Combining hitchhiking probabilities with commuting patterns (from Spain's Active Population Survey) lets us make the first (rough) estimates of inter-province tiger mosquito transfers by car.

Eritja et al. Sci Rep 2017

Inter-Province Annual Mosquito Fluxes
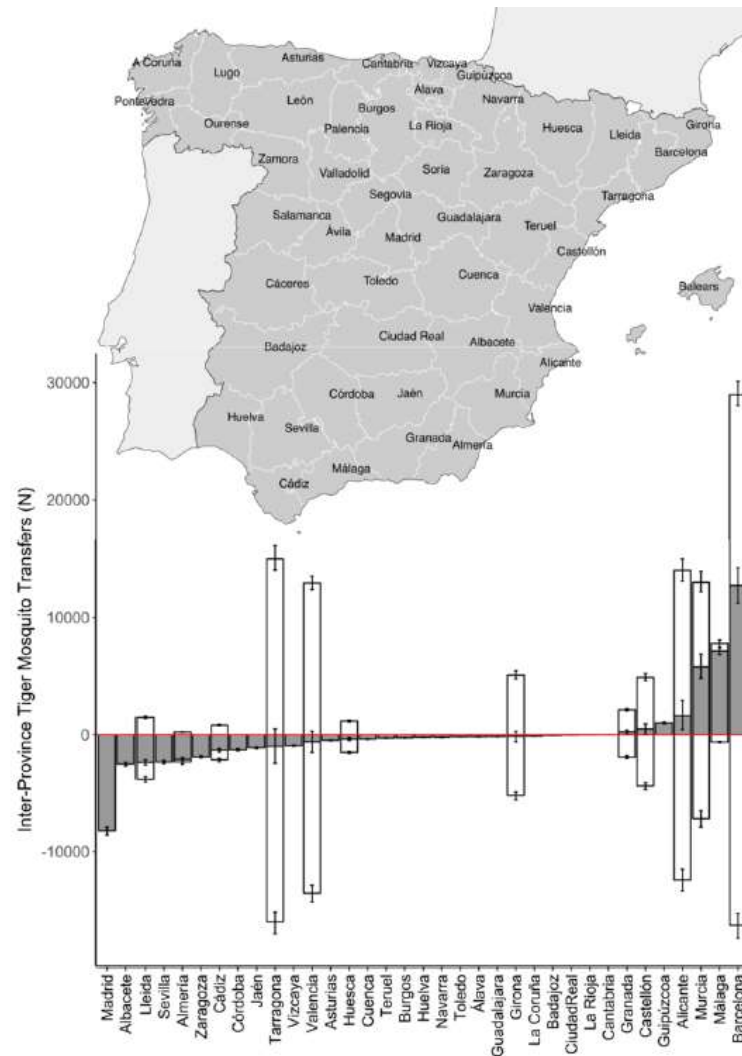
SCIENTIFIC REP&RTS

OPEN | ## Direct Evidence of Adult Aedes albopictus Dispersal by Car

Roger Eritja[1,2], John R. B. Palmer[1,3,4], David Roiz[5], Isis Sanpera-Calbet[2] & Frederic Bartumeus[1,3,6]

Phase II: Finer Scale (5 km^2 cells)

What about comparisons with adult traps?

What about smaller scales?

Agència de Salut Pública

20 Adult mosquito traps in Barcelona checked weekly in 2018 to provide "ground truth" estimates.
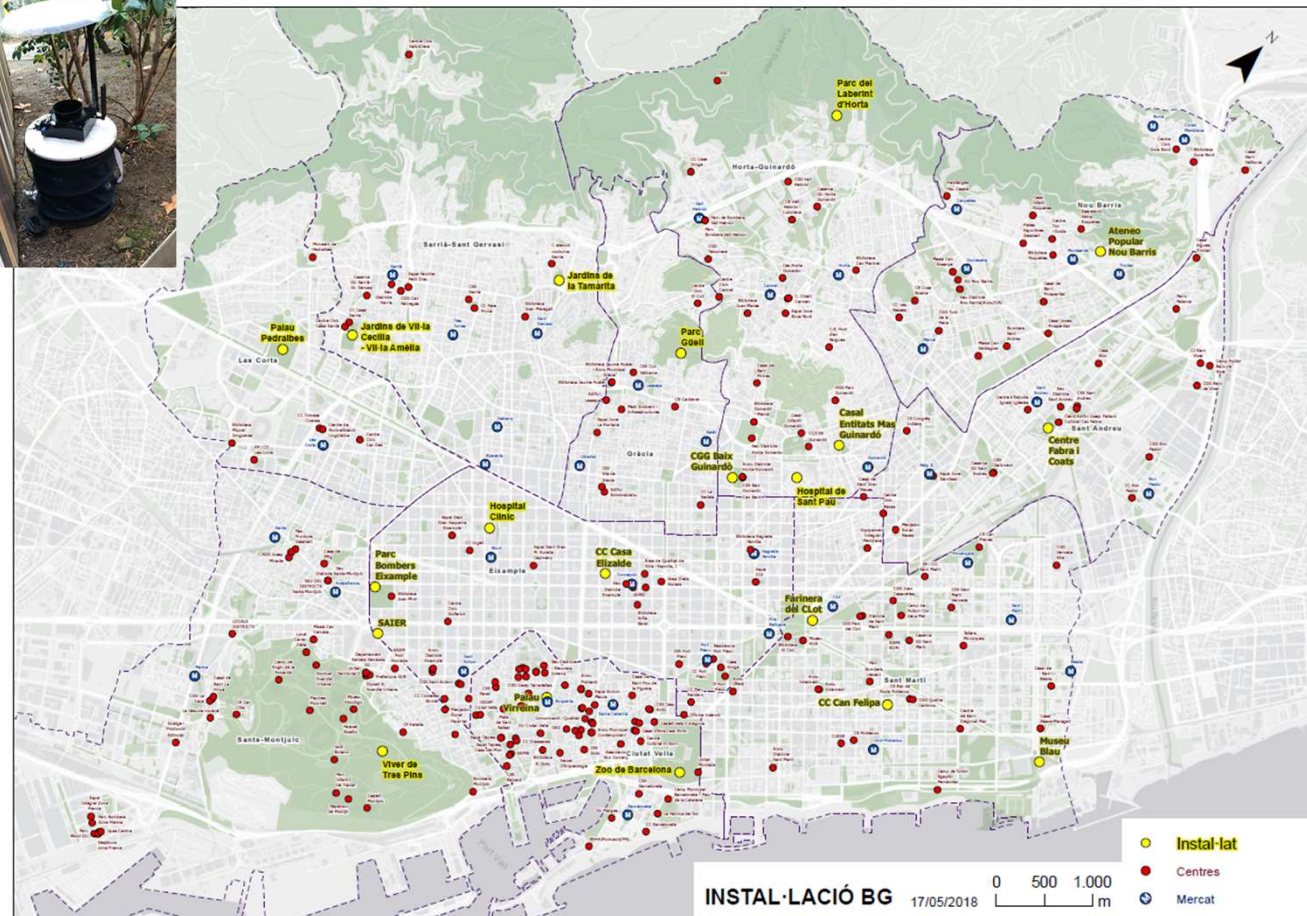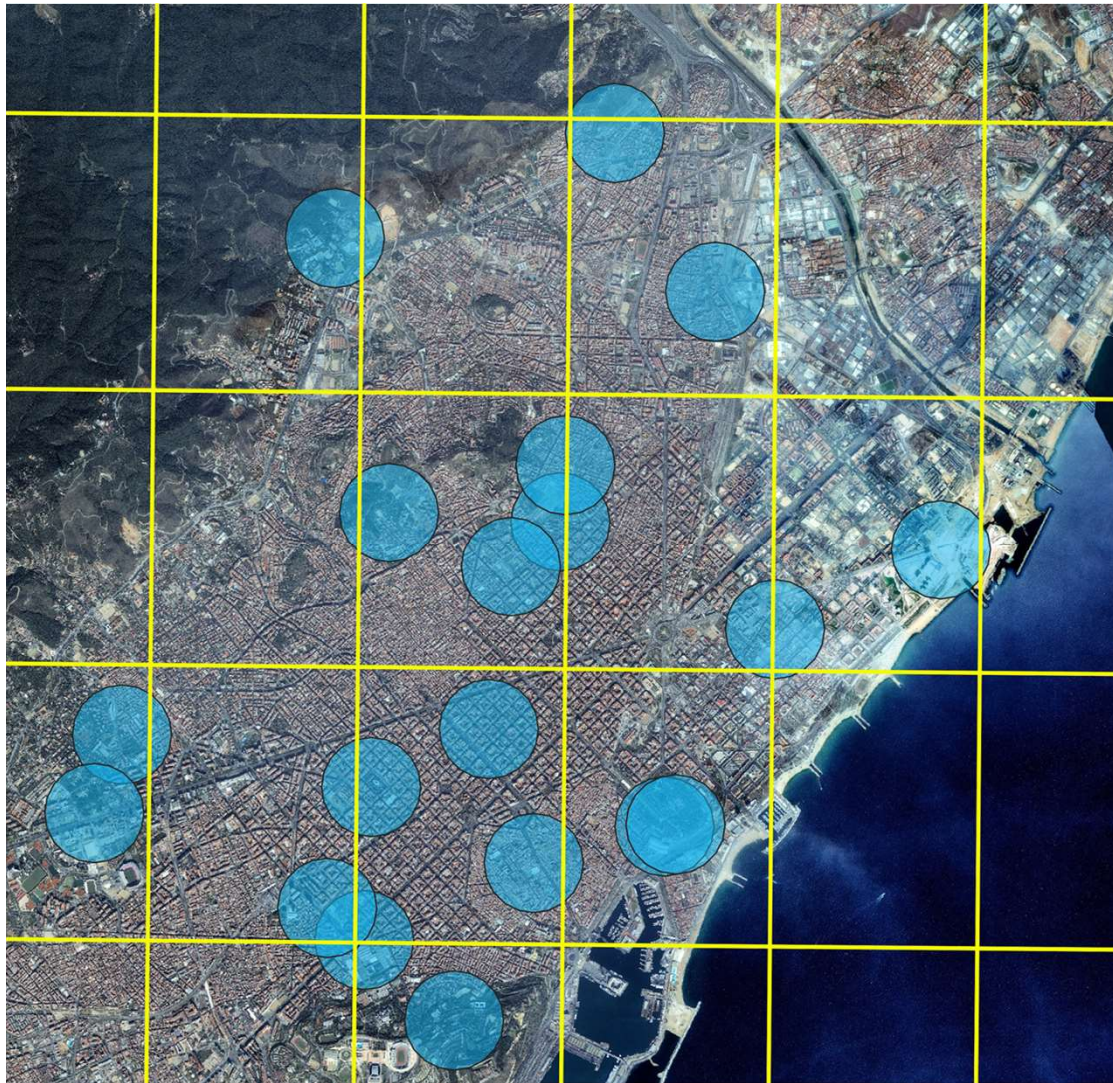
Smaller Sampling Cells (~4 Km²)

Sampling cells reduced to 0.025 degrees in mid-2017.

Citizen reports compared with 19 BG-sentinel adult mosquito traps placed in Barcelona and checked weekly during 2018 by Barcelona Public Health Agency

Aedes Invasive Mosquitoes:
Linking Citizen Science to Epidemiological Models

COST ACTION CA17108
WORKSHOP. Blanes 25-27. March 2019.

	GLOBE Observer	mosquitoWEB	muggenradar.nl	ZanzaMapp.it	MOSQUITO ALERT	Mückenatlas Jede Mücke zählt!
Images	Yes	No (sample)	No	No	Yes	No (sample)
Taxonomic identification	Yes	Yes	No	No	Yes	Yes
Biting	No	Yes	No	Yes	No	No
Nuisance info	No	No	Yes	Yes	No	No
Image encounters	No	No	No	No	No	No
Breeding site Larvae	Yes	Yes	No	No	Yes	No
Protection / Measures	No	No	Yes	Yes	No	No
Human Mobility	No	No	No	No	Yes	No

FUTURE STEPS...

- Add japonicus/koreicus
- Adding a bitting module

- Pilots in EU:
- Language translation
- Standardized CitSci system

Anonymous CC by Mosquito Alert