Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)

Science Talk

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Statistical modelling of Rift Valley Fever vectors abundance in a Sahelian area (Barkedji, Senegal,West Africa)

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Introduction

- Rift Valley Fever is a viral disease that represents a threat to human and animal health in Africa (Senegal).

- Prevent Rift Valley Fever disease

- Modelling approaches have been proposed in East Africa

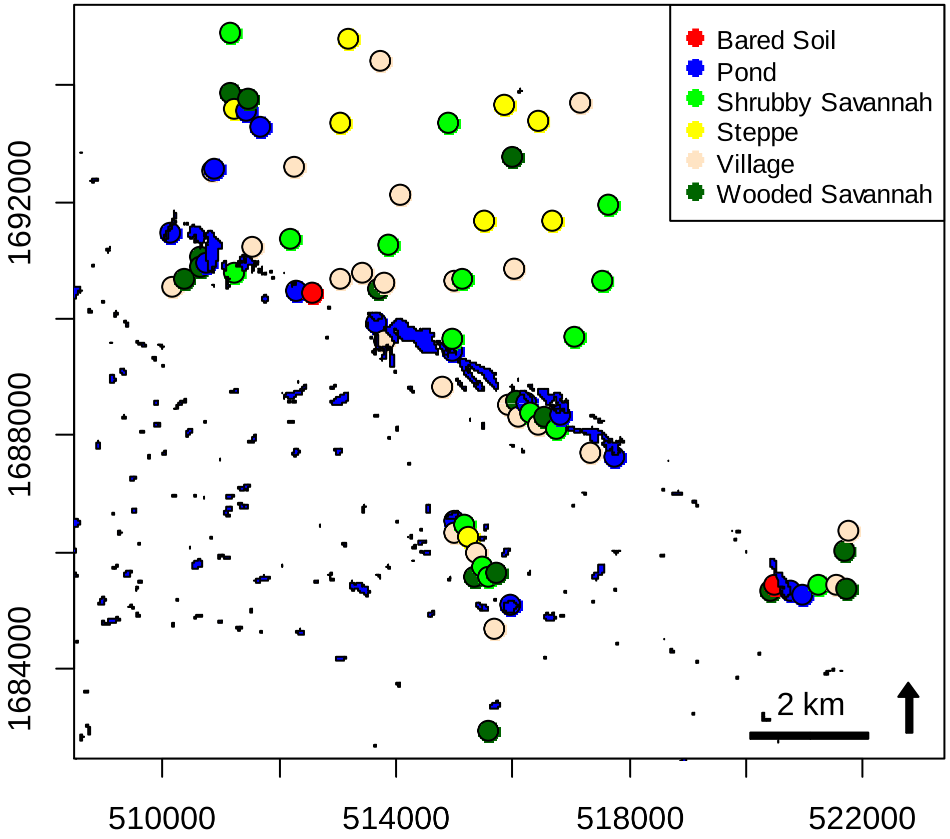
Introduction

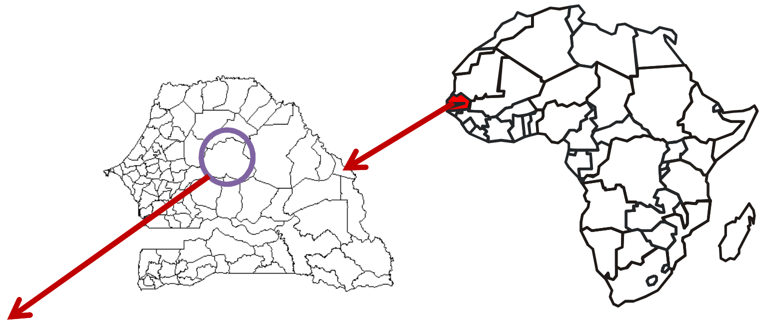
- It is well known that RVF virus emergence, could be predicted up to 5 months in advance using sea surface temperature, climatic and environmental parameters
- Can not be applicable in West Africa situation
- The dynamic of emergence seems to be different
- Models proposed for West Africa, restricted the analysis to the impact of rainfall and do not integrate a spatial dimension

Introduction

- Including several climatic and environmental parameters
- Quantify the abundance of vectors
- Identify climatic and environmental variables affecting abundance of RFV vectors
- Identify periods and areas at risk by generating forecast maps

Study area

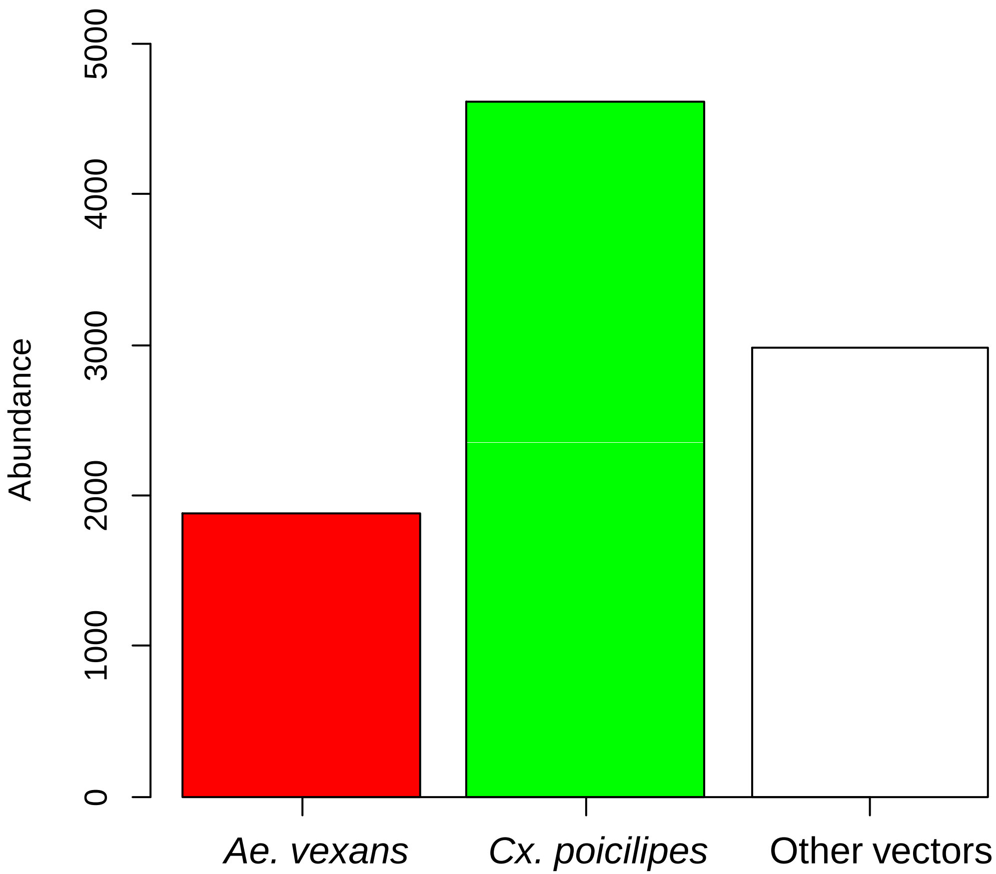




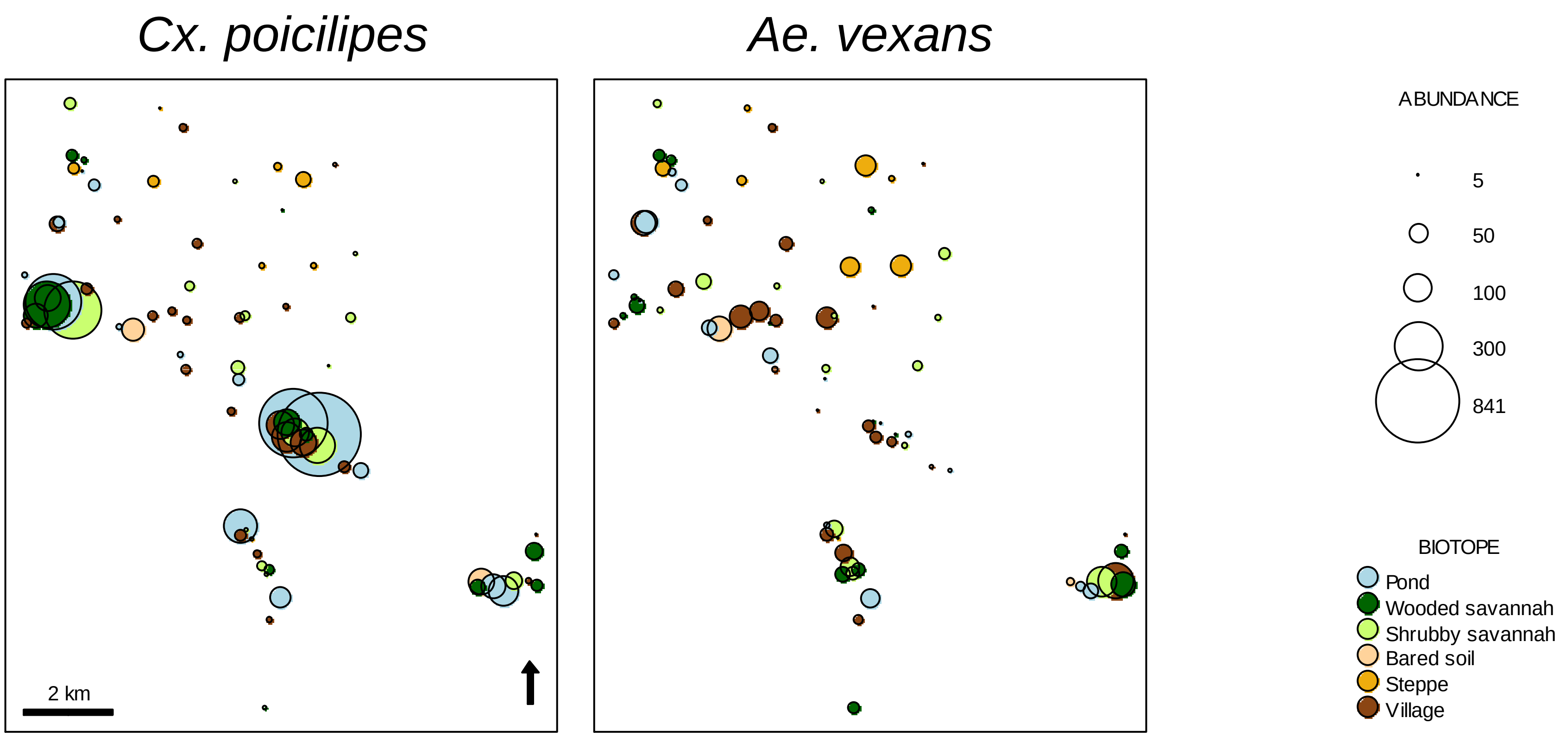
- Radius of 13 km centered on Barkedji
- Fortnightly collection
  (July- Dec during rainy season 2005)
- 79 sites
  Belonging to 6 landscape classes:
  pond, wooded savannah, shrubby savannah, steppe, bared soil, village
- CDC light trap

Vectors abundance

- 14,604 mosquitoes
- Vectors ≈ 65 %
- Two main vectors
(*Aedes vexans* and *Culex poicilipes*)
≈ 69%

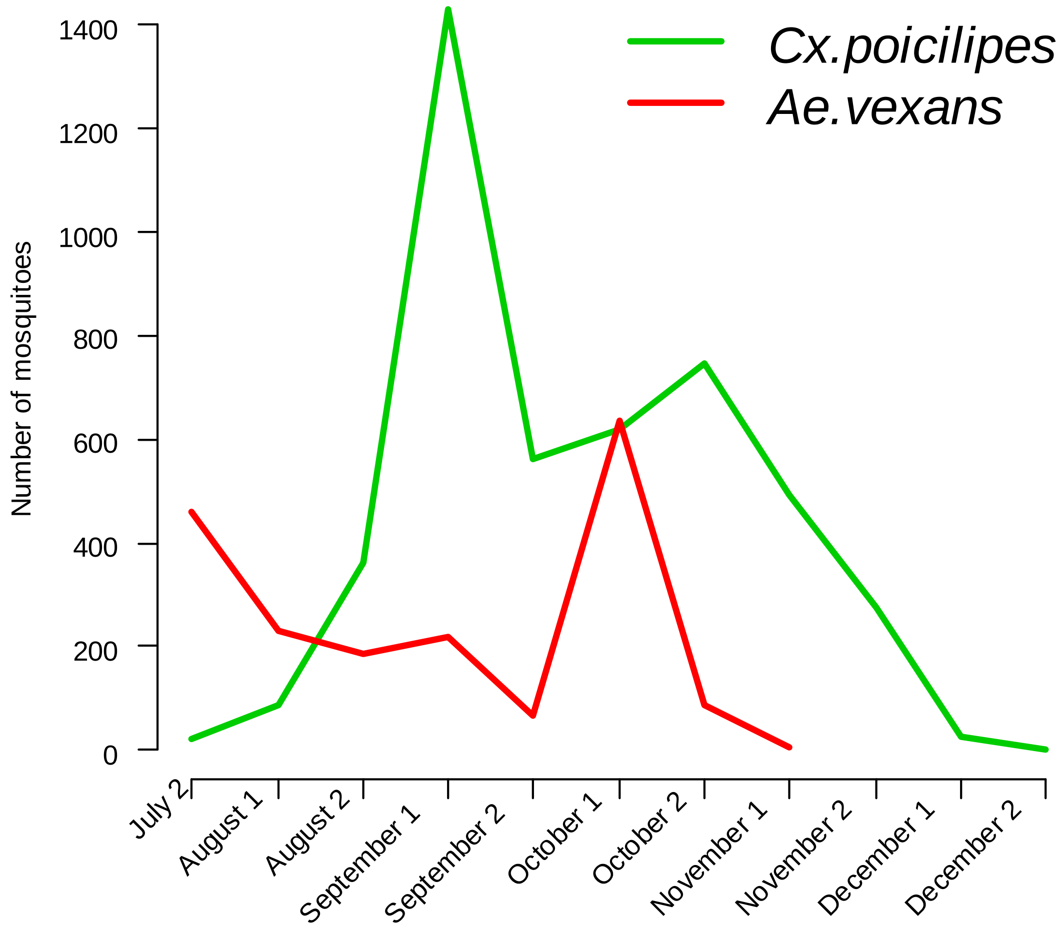


Spatial distribution

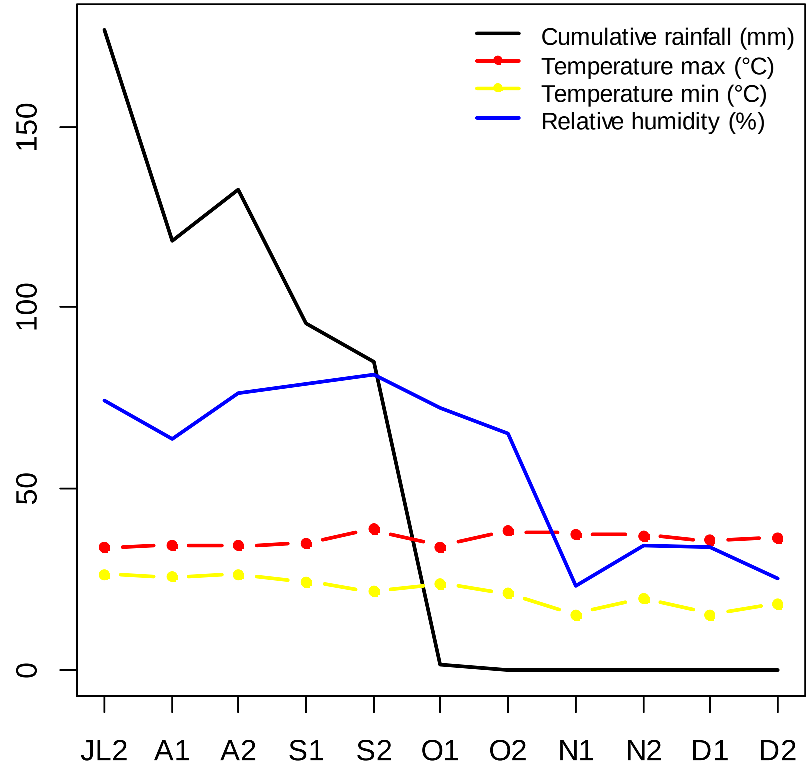


Temporal distribution

- Seasonal activity
- Two abundance peaks



Climatic and environmental variables



Model framework

$$Y_{st} \sim Poisson(\lambda_{st}) \quad s = 1, ..., 79 \quad t = 1, ..., 11$$

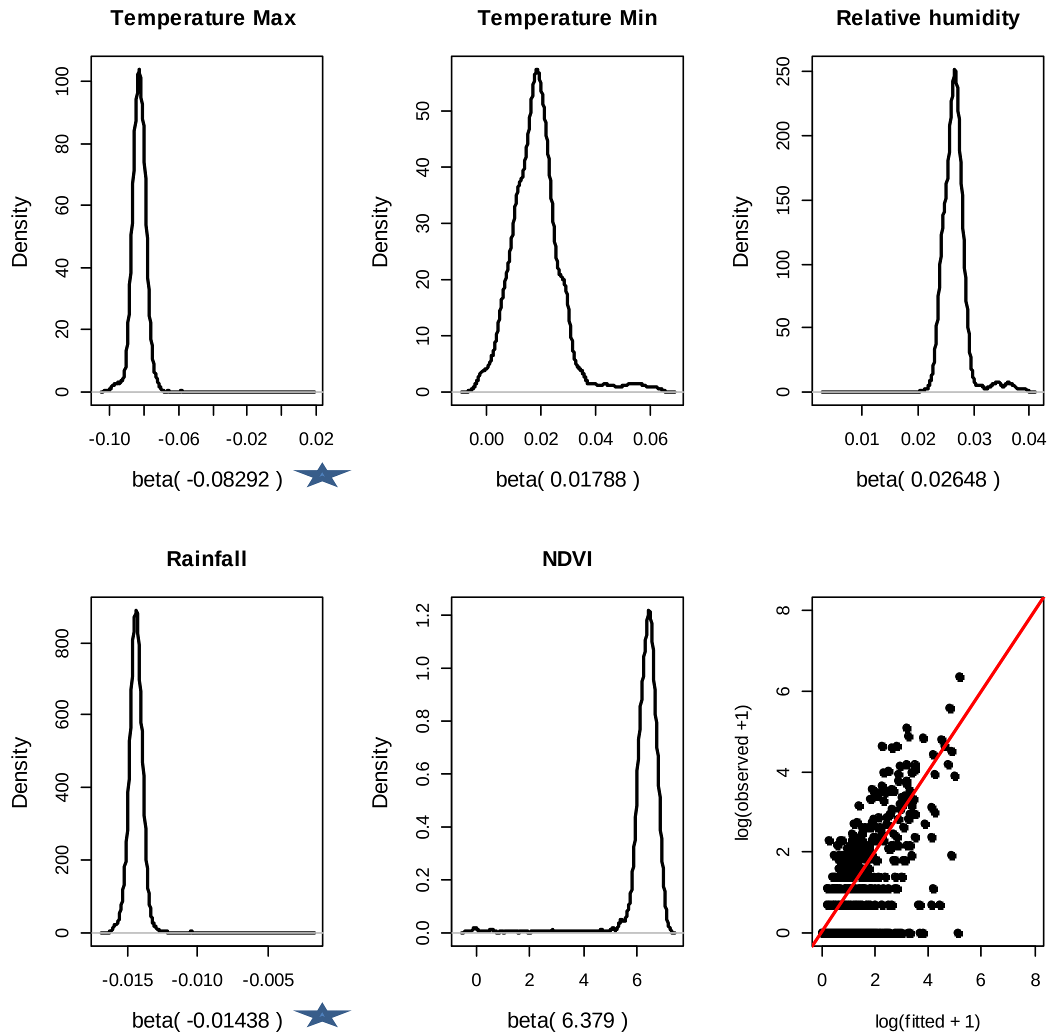
$$\lambda_{st} = \alpha + \sum_q \beta_q X_{stq} + U_s + D_s + B_s + \theta_t + \epsilon_{st}$$

$U_s \sim CAR(\sigma_u^2)$
$D_s \mid s_s \sim N(s_s, \sigma_v^2)$
$B_s \mid s_s \sim N(s_s, \sigma_v^2)$
$\theta_t \mid s_s \sim N(s_s, \sigma_\theta^2)$
$s_s \sim N(0, \sigma_s^2)$
$\epsilon_{st} \sim N(0, \sigma_\epsilon^2)$

$\sigma_u^2, \sigma_\epsilon^2, \sigma_\theta^2, \sigma_v^2 \sim$ vague priors

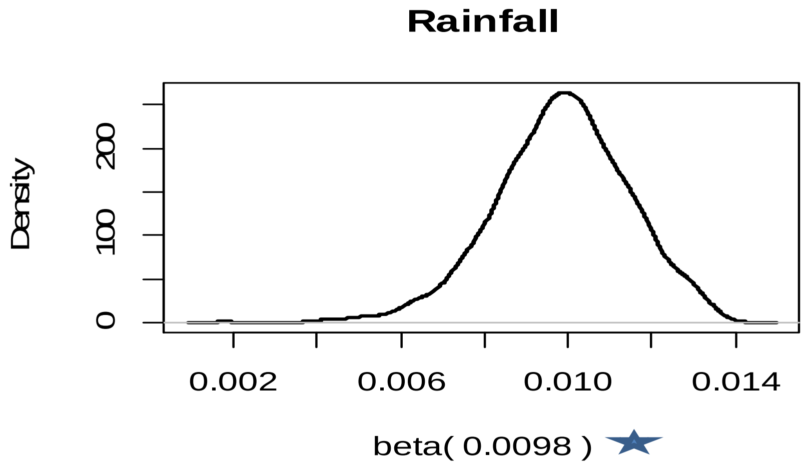
X_{stq} rainfall, temperature (max and min), relative humidity, NDVI
Y_{st} mosquito count
λ_{st} mean mosquito count
D_s distance effects
B_s biotope effects
θ_t time effects

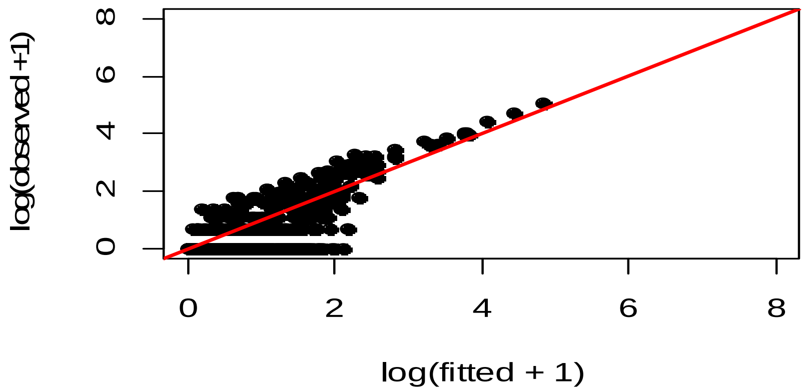
Model diagnostic (*Cx. poicilipes*)



- Deviance information criterion (DIC)
- Lowest DIC ⇨ best model
- Without distance and landscape effects
- Negatively associated by Temperature Max and Rainfall

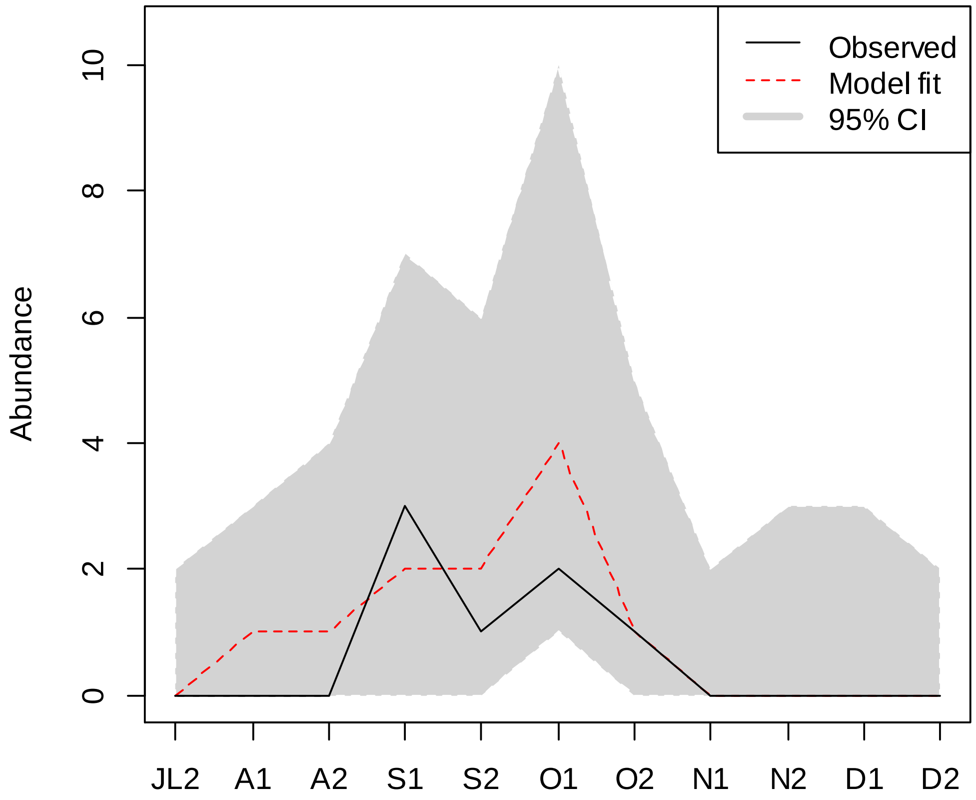
Model diagnostic (*Ae. vexans*)



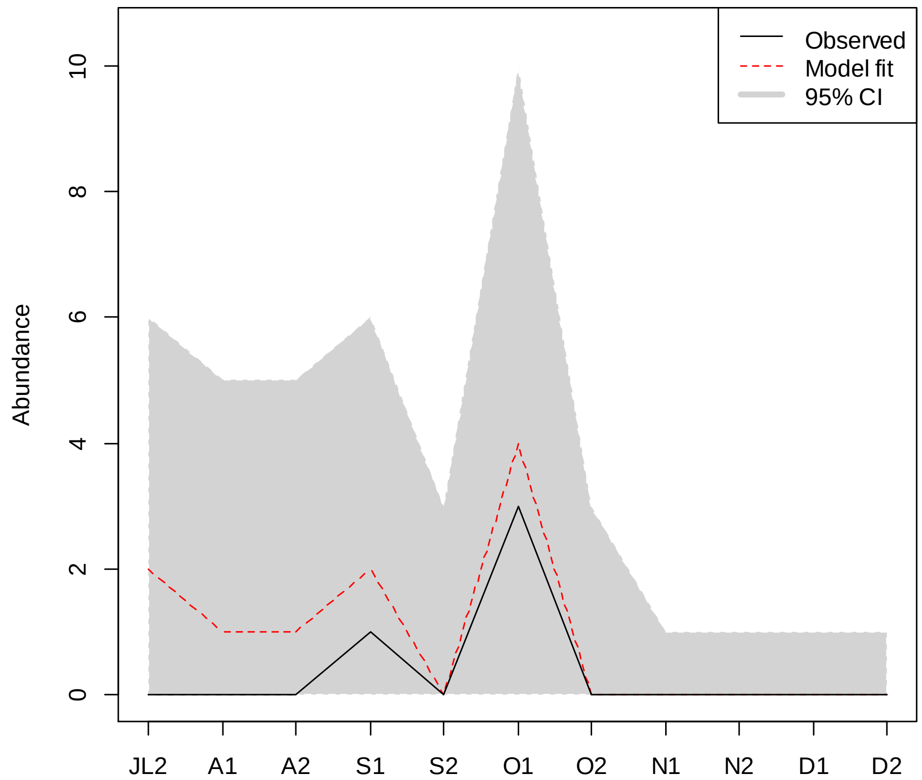


Temporal Prediction

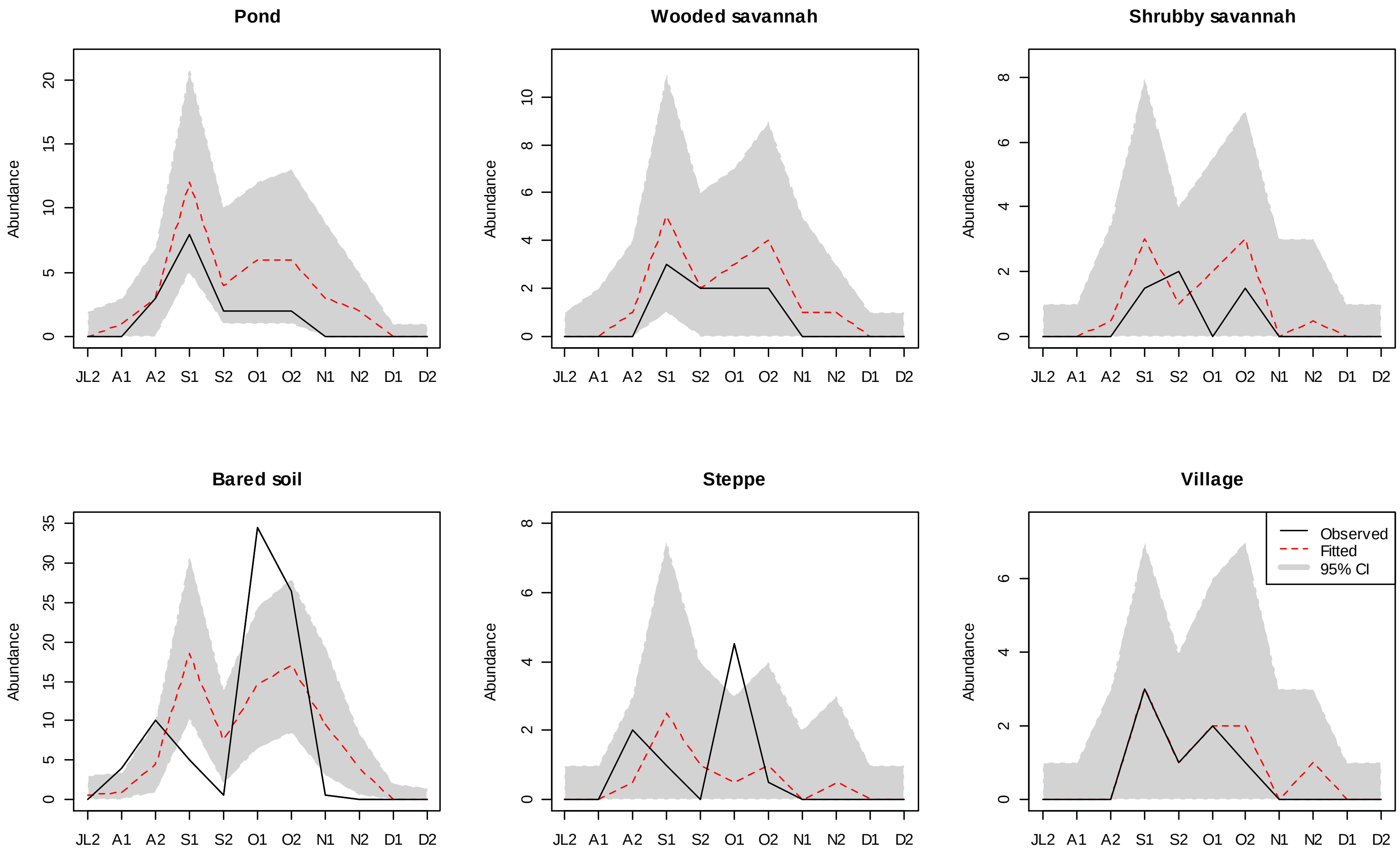
Cx. poicilipes



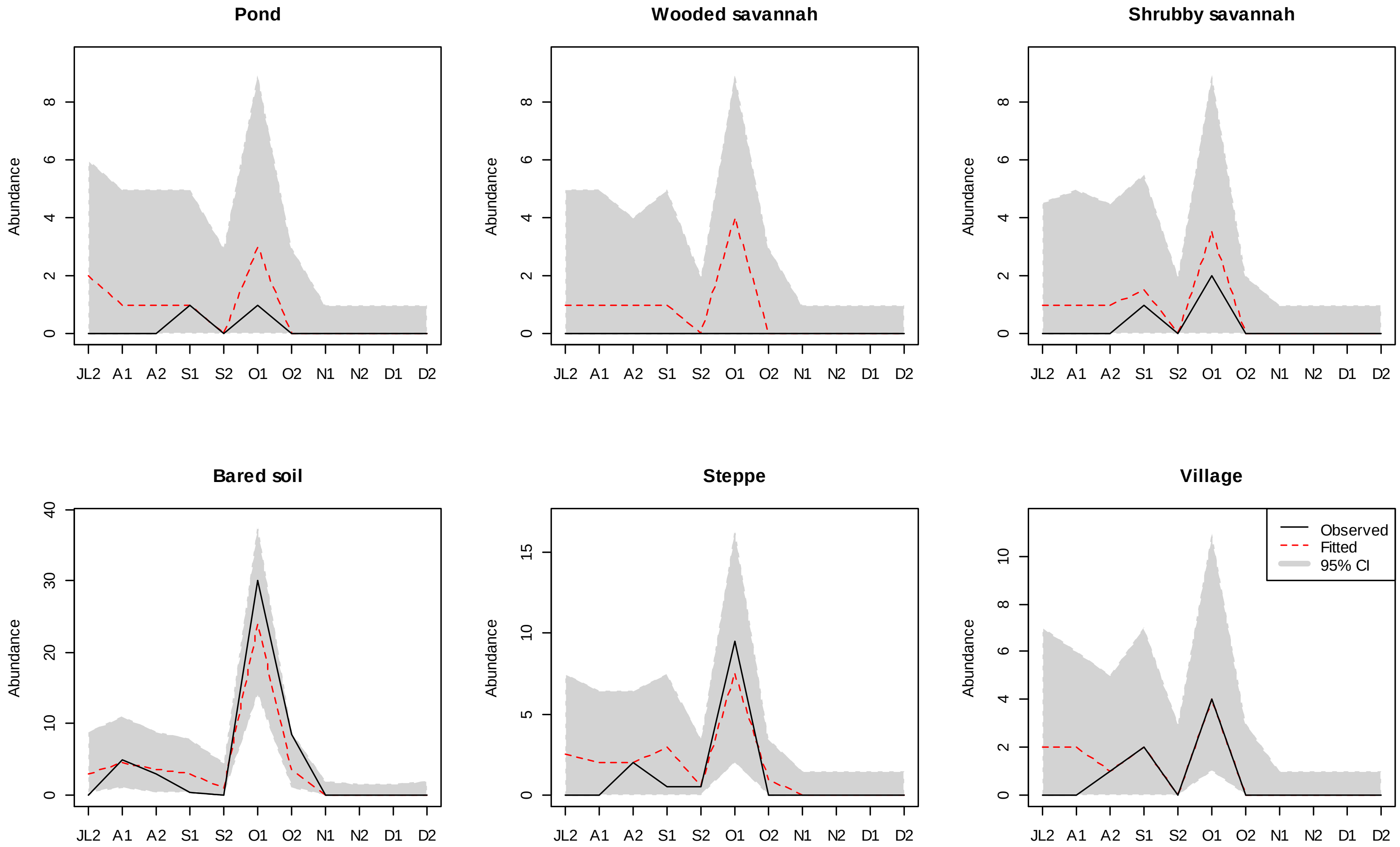
Ae. vexans



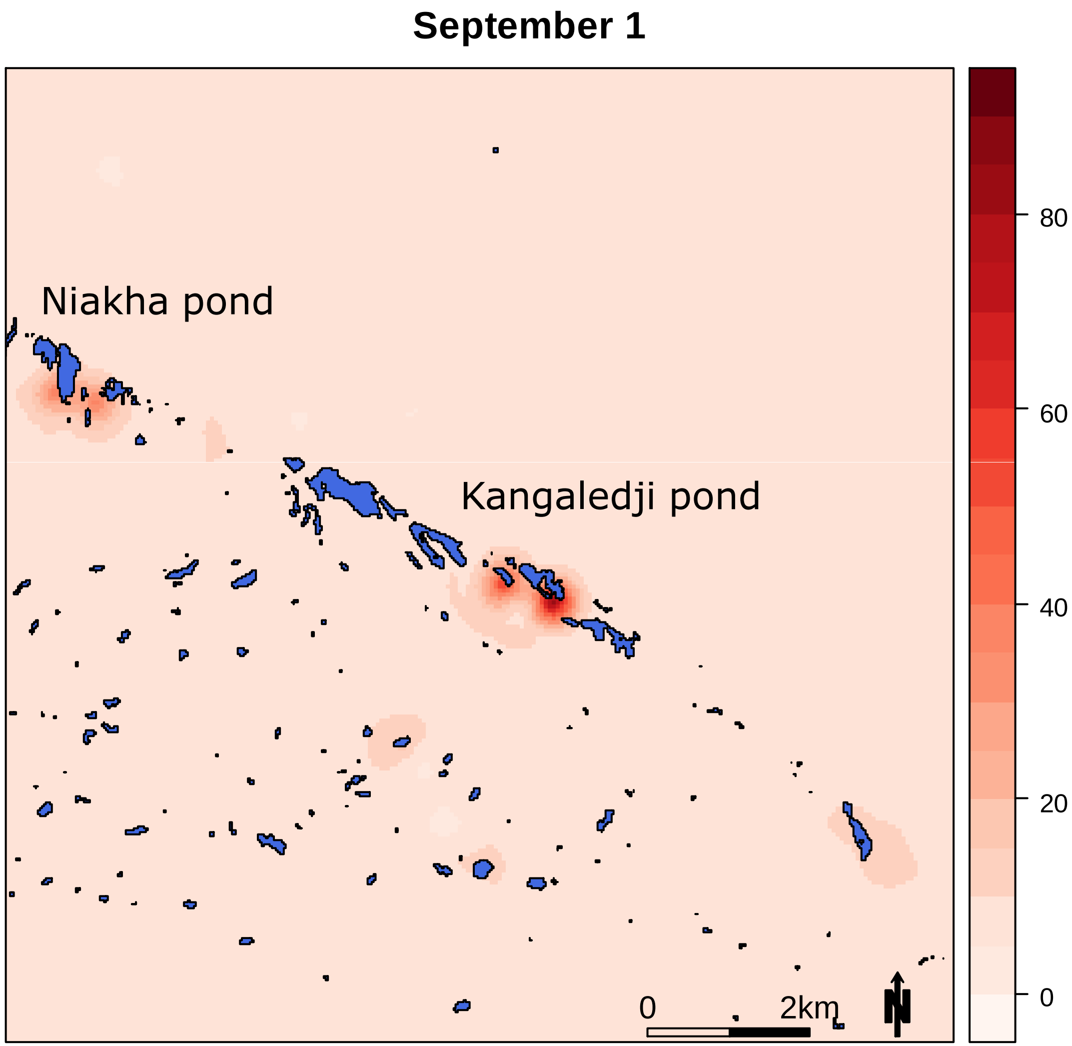
Predictions in biotopes (*Cx. poicilipes*)

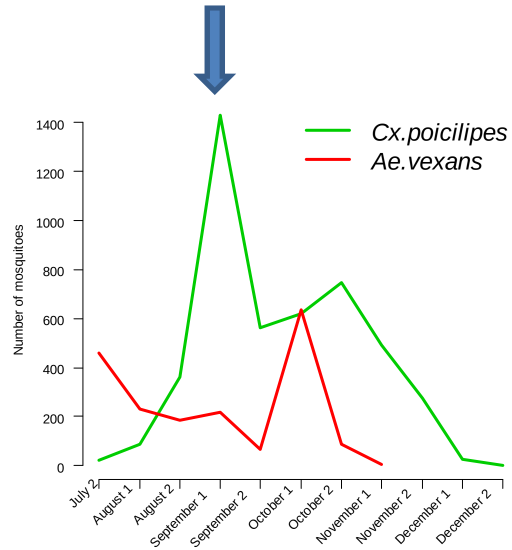


Predictions in biotopes (*Ae. vexans*)



Abundance forecast (*Cx. poicilipes*)





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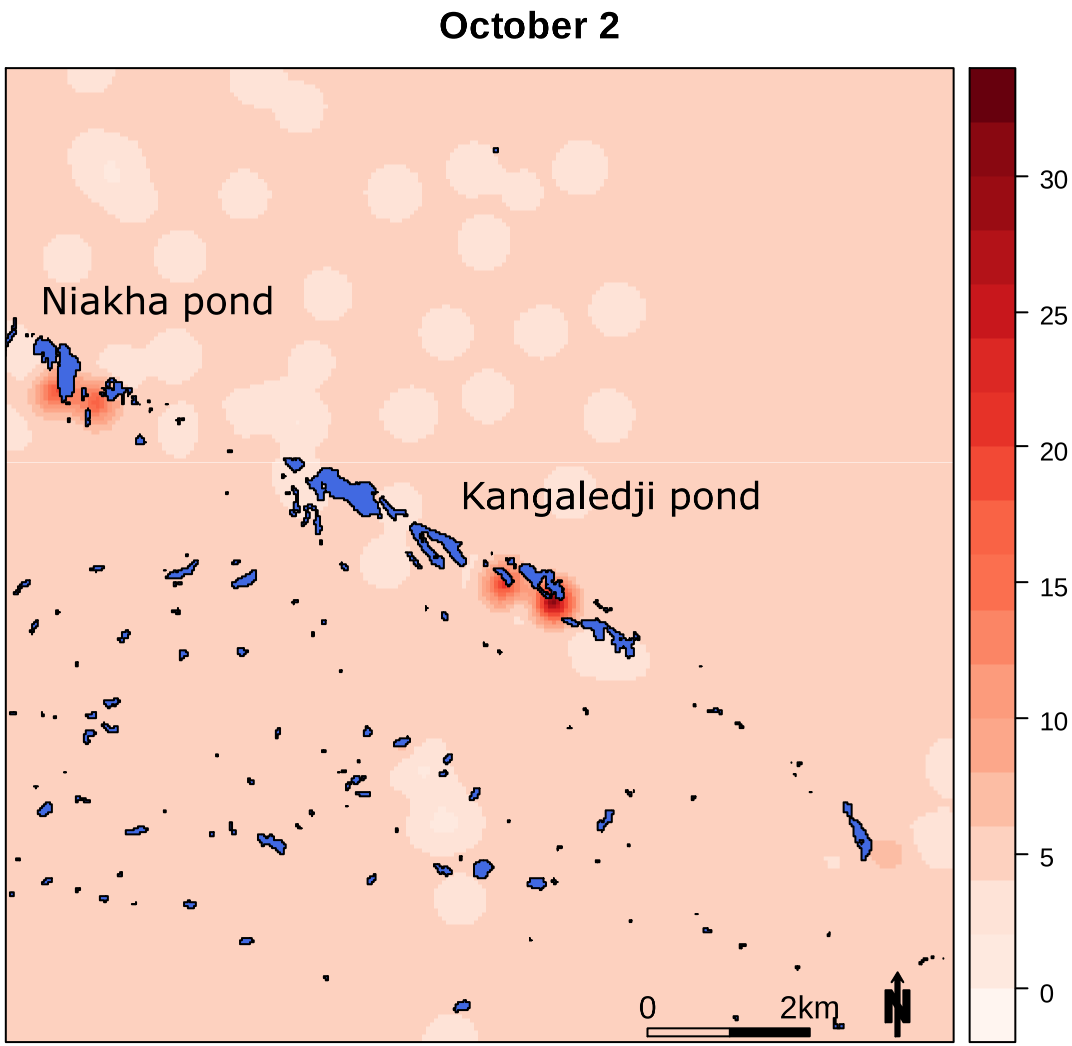

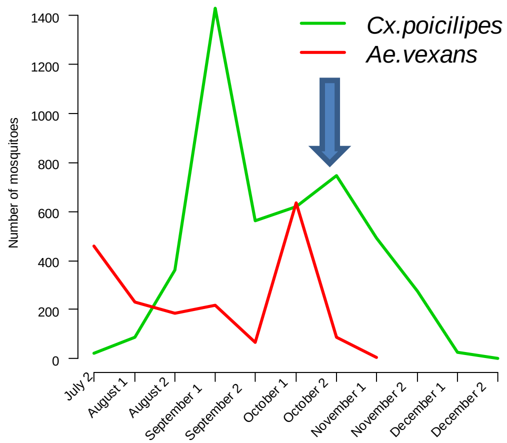

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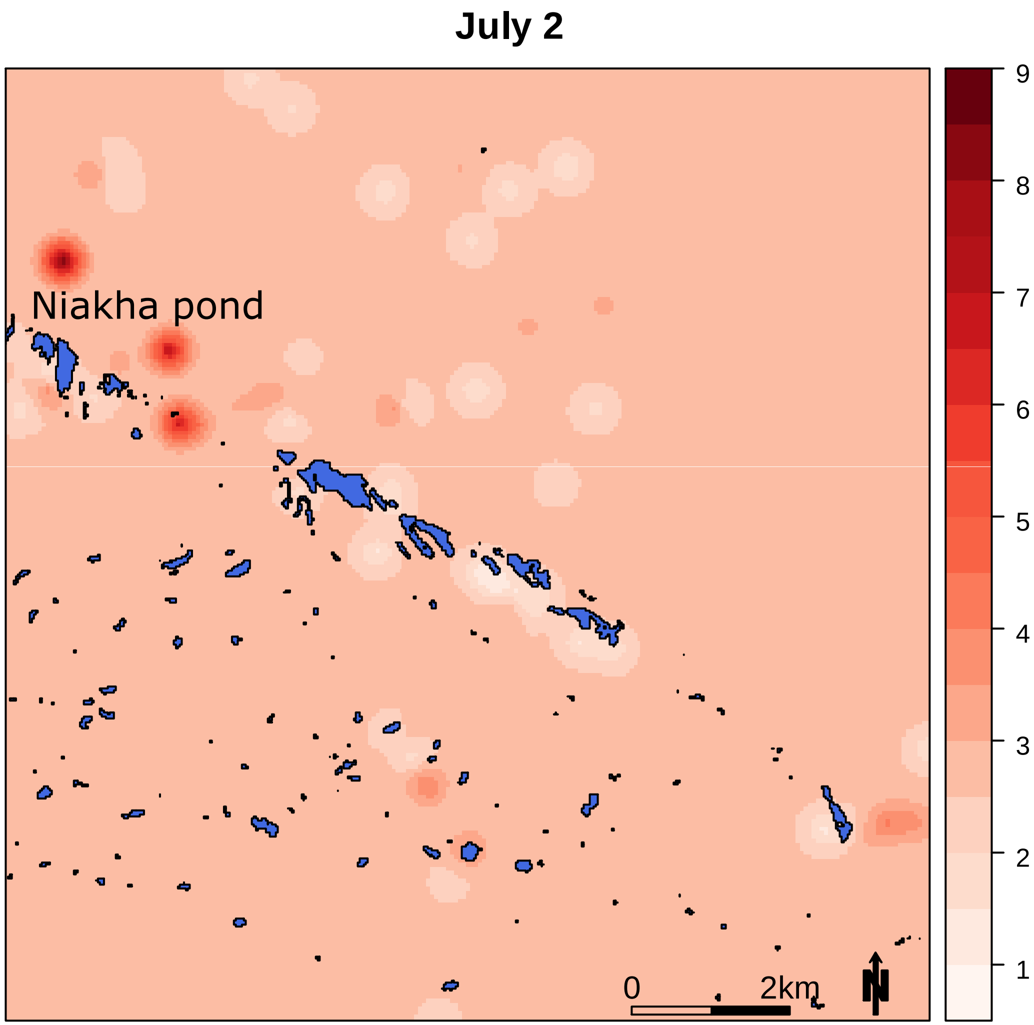
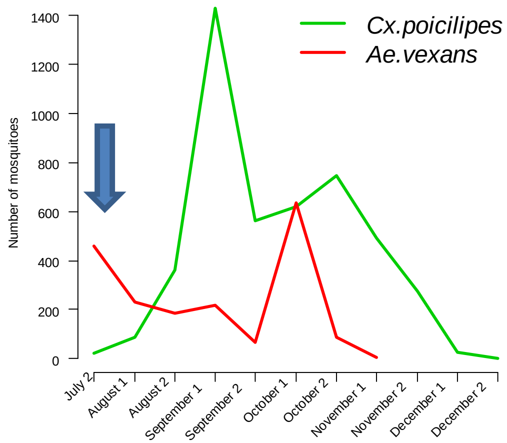
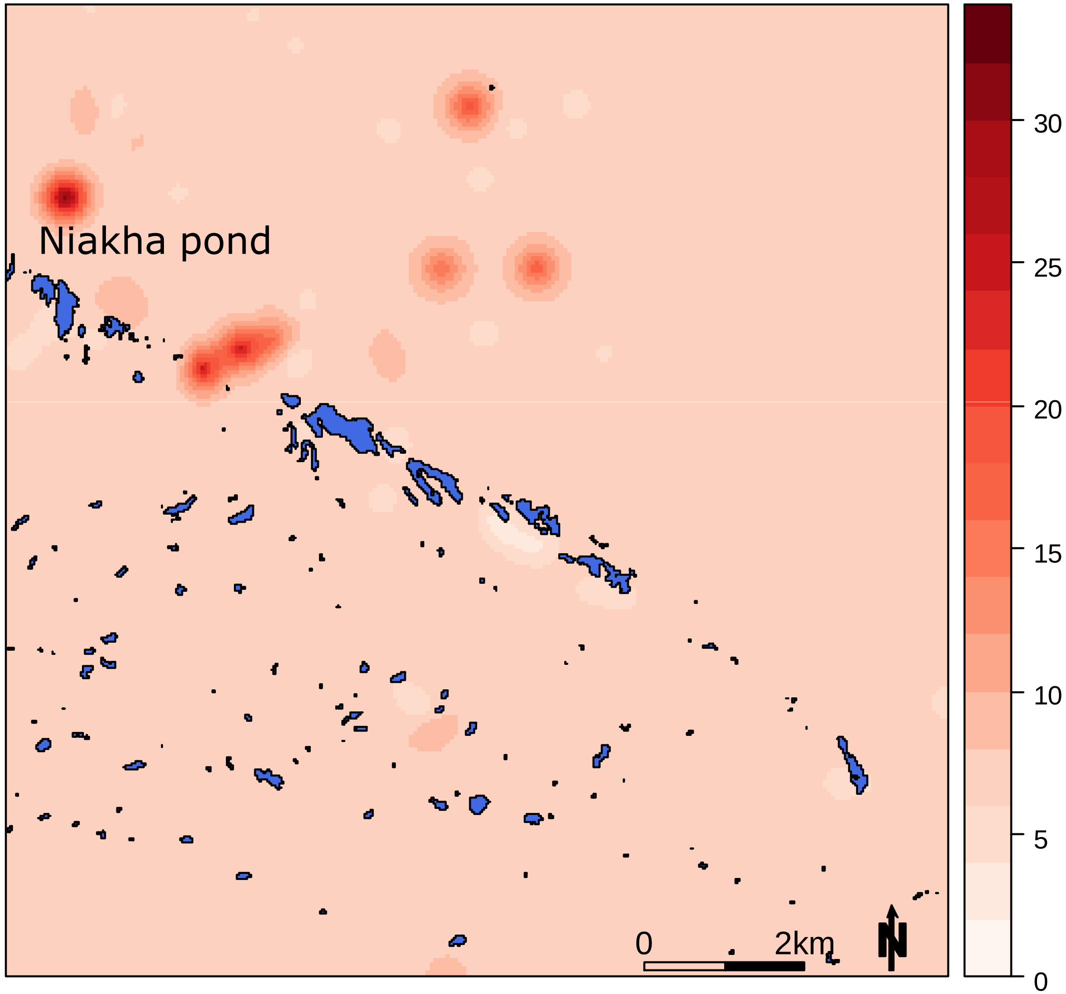
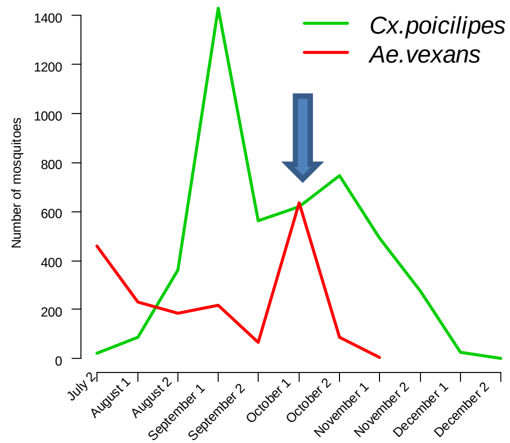




Abundance forecast (*Ae. vexans*)

October 1





summary

- Climate affects the abondance of two main vectors
- Result can be used to improve the surveillance and control of Rift Valley virus vectors
  - With weather forecast to define area at priority for reducing vectors abundance
  - Provide informations to farmers about area at risk
- More informations RVF to improve the model

THANK YOU !