

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

Science Talk

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**The Barkedji pilot project:
entomological findings on
malaria vectors**

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Introduction

- Malaria situation
 - Substantial reductions (ITNs, IRS, artemisin-based combination therapies)
 - Still a burden (WHO, 2012)
- Role of environmental and climatic factors as driving force for malaria transmission
- Models based on weather parameters can assess changes on malaria disease
- Vulnerability of the in sahelian area to climate change
 - Localisation at the southern limit of Sahara desert
 - High inter-annual variability of meteorological parameters
 - High dependence of human populations to rainfall-based activities (agriculture, farming, domestic animals breeding)

Introduction

- Susceptibility to epidemics due to the instability and endemicity of malaria disease in the whole population
- Importance of modelling (warning system)
- Global approach
 - Use of a dynamical and statistical models available
 - Validation and improvement
 - Generate field data

LMM parameters

Malaria Model

Run

Parameters

Generic Model Parameters

<i>Name</i>	<i>Value</i>
Human Blood Index	0,5
Inoculation Rate	0,5
Human Recovery Rate	0,0284
Gonotrophic Cycle Survival	0,5
Mosquito Mature Age	16
Human Infectious Age	15

Dg High Humidity	37,1
Tg High Humidity	7,7
Dg Low Humidity	65,4
Tg Low Humidity	4,5
Ds	111
Ts	18
Offset T	0
Offset R	0

Summary Statistics

Start/End Month (1 to 12)	1
Start Year	3

LMM Model Parameters

<i>Name</i>	<i>Value</i>
GonoLength	37
SporoLength	111
Rainfall Laying Multiplier	1
Rainfall Threshold - Humidity	10
Mosquito Trickle	1,01
Human Trickle	0

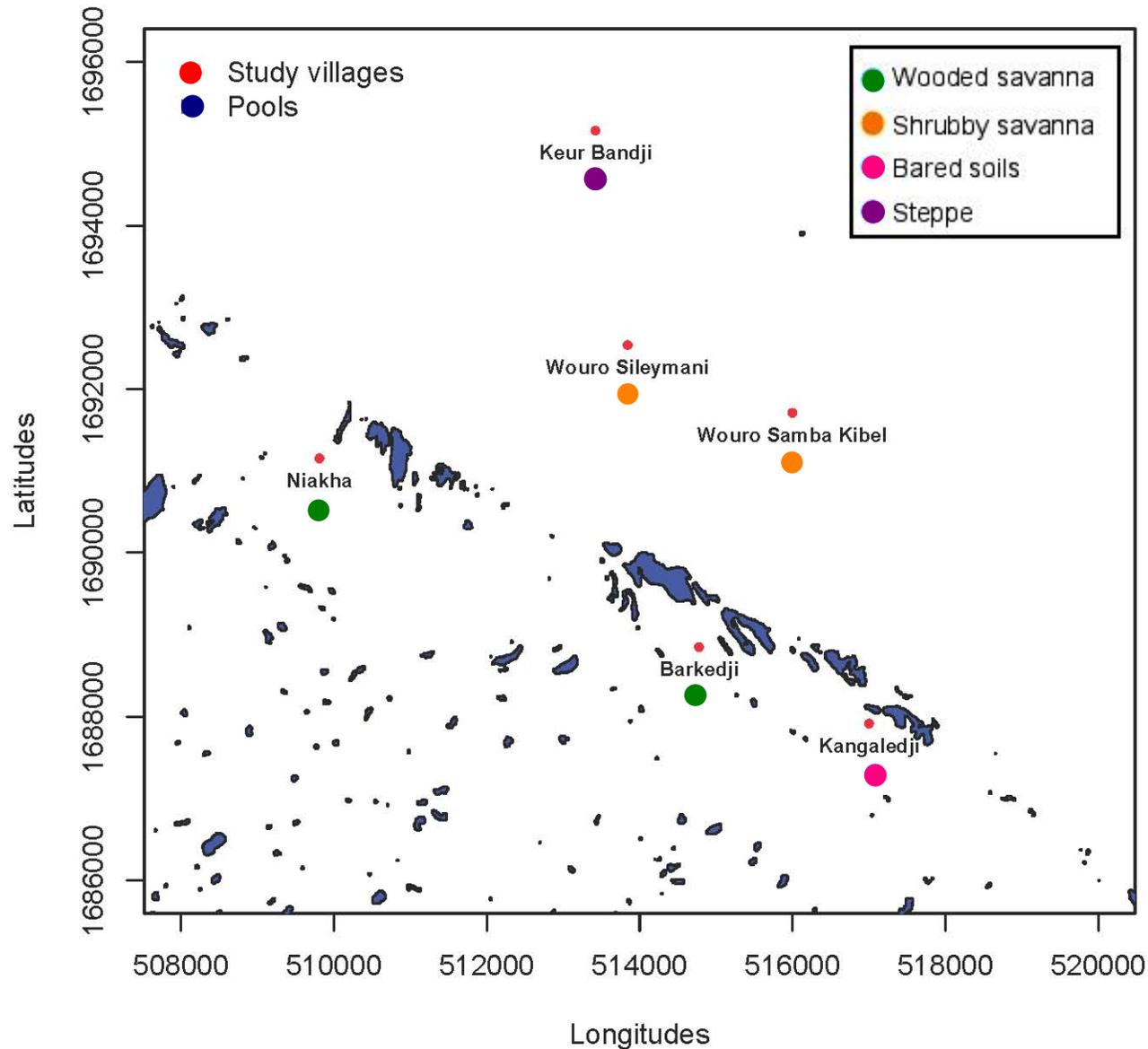
LMM parameters

1. **Human Blood Index (HBI):** proportion of bites taken from humans
2. **Inoculation Rate (IR):** probability of human infection given an infectious bite
3. **Human Recovery Rate (HRR):** Proportion of human population which return from infectious to susceptible, per day
4. **Gonotrophic Cycle Survival:** proportion of mosquitoes surviving each gonotrophic cycle
($p = \text{parous} / (\text{parous} + \text{nulliparous})^{1/x}$)
5. **Mosquito Mature Age:** Larval Development time (days) – Lab or transplantation to be determined)
6. **Human Infectious Age:** Length of human latent period (days)

Study area/sites

- Barkedji area: six villages belonging to four different land cover/land use (classification from CSE studies)
 - Barkedji and Niakha: **Wooded Savanna**
 - Wouro Samba Kibel and Wouro Sileymani: **Shrubby Savanna**
 - Keur Bandji: **Steppe**
 - Kangaledji: **Bared soils**

Study area/sites



Why this/these area/sites:

- Previous results on 28 villages
- Presence of temporary ground pools
- Different ecological classes
- Inter-annual variability of climatic parameters
- Seasonality of malaria transmission

Methodology

- Landing Collections (LC)
 - Location: Indoor and Outdoor sleeping rooms
 - Basis: every two weeks from July to December (11 collections sessions from 2010-2012)
 - Two consecutive nights in Barkedji and one in night in the other villages
- Pyrethrum Spray Catches (PSC)
 - Location: Indoor sleeping rooms
 - Basis: the same as for HLC
 - One collection session

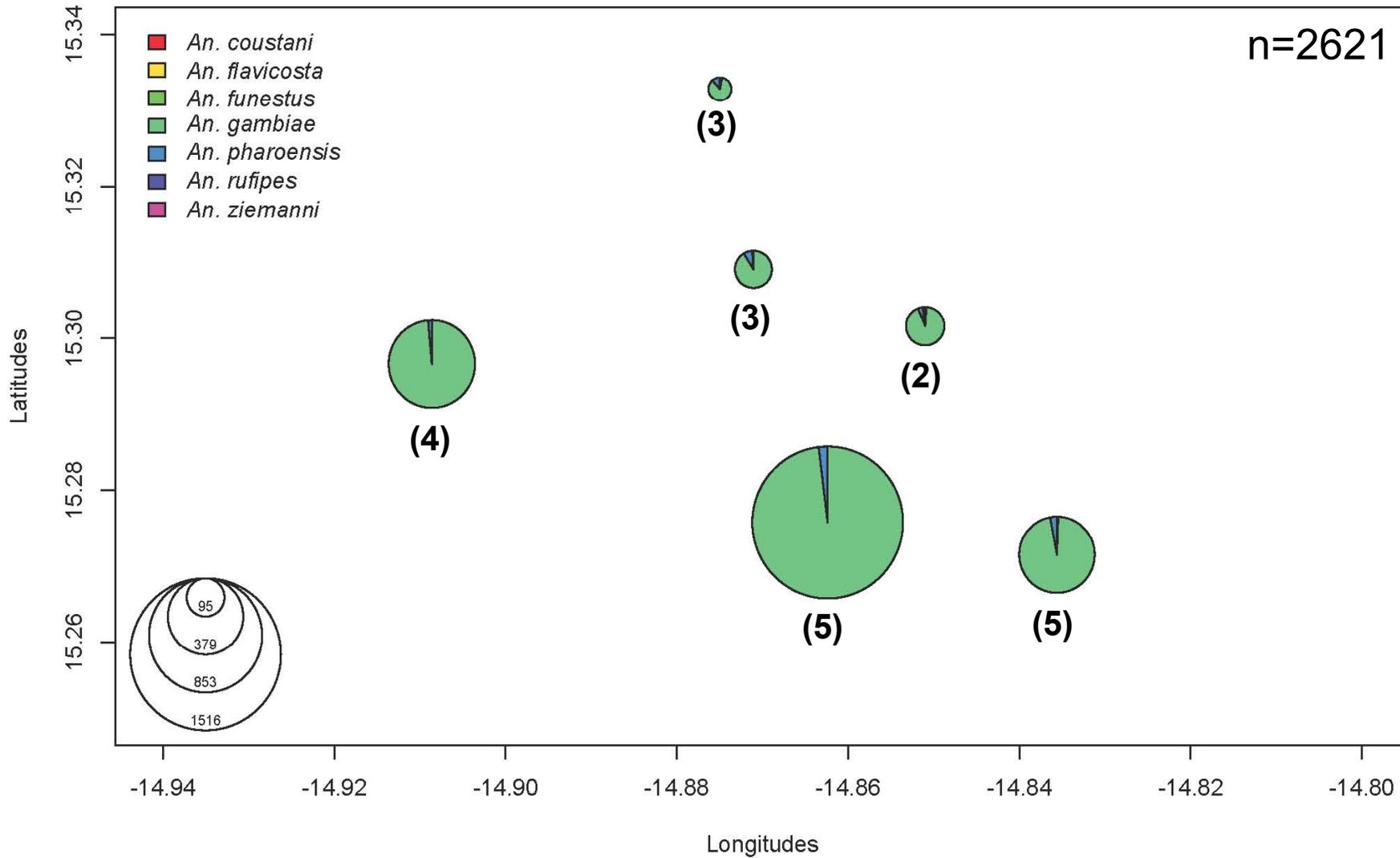
Methodology

- Field processing
 - Morphological identification (keys)
 - Dissection of ovaries of a sub-sample (physiologic age determination)
 - Blood meals of bloodfed females blotted on filter paper
 - Storage in tubes with silicagel
- Laboratory processing
 - Identification of blood meals source from engorged mosquitoes
 - Detection and identification of *Plasmodium falciparum* from infected mosquitoes

Data analysis

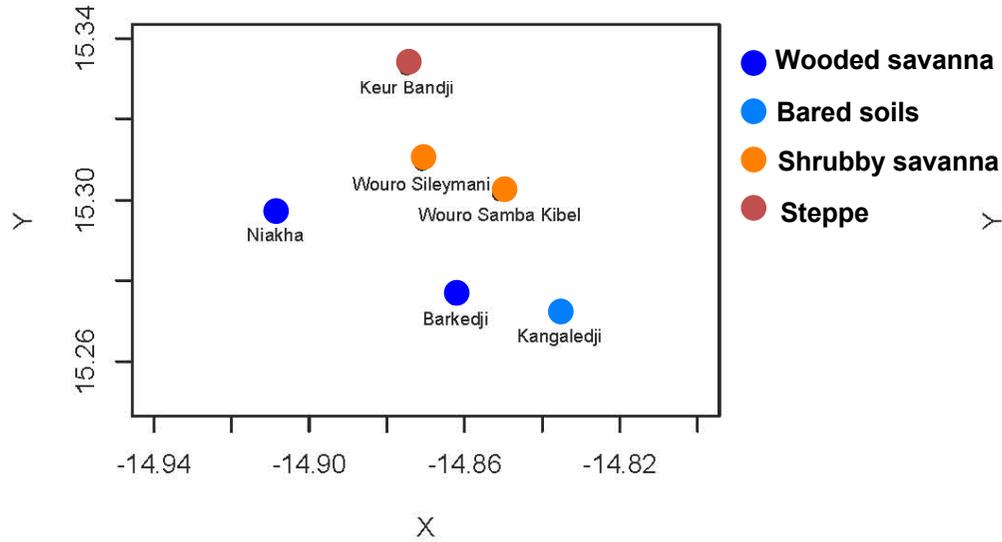
- Entomological parameters
 - Human Biting rates
 - Parity rates
 - Trophic preferences and anthropophilic rates
 - Infection rates
 - Entomological inoculation rates
- R Gui software (graphics, statistical comparisons)

Abundance and distribution

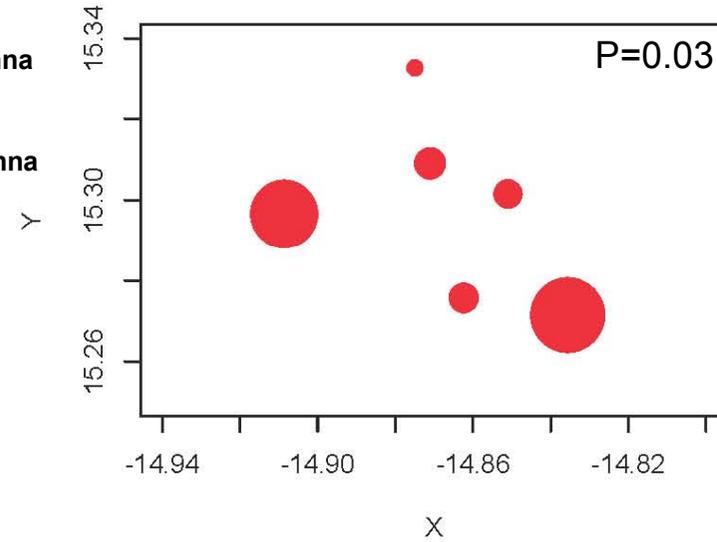


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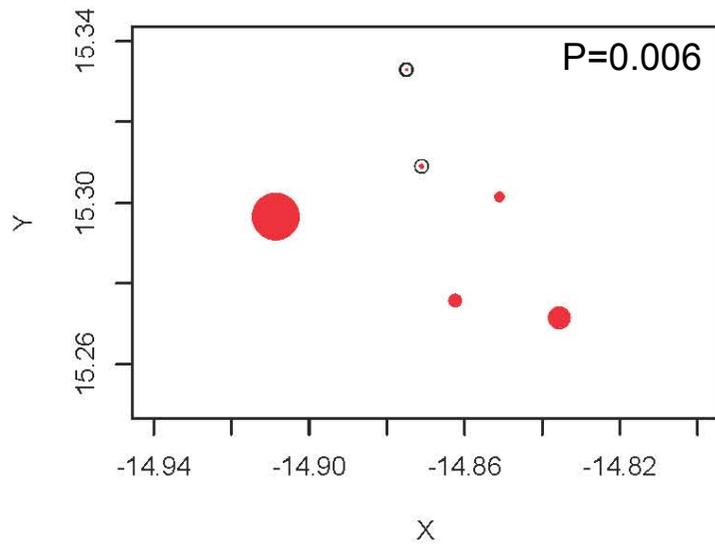
Study sites



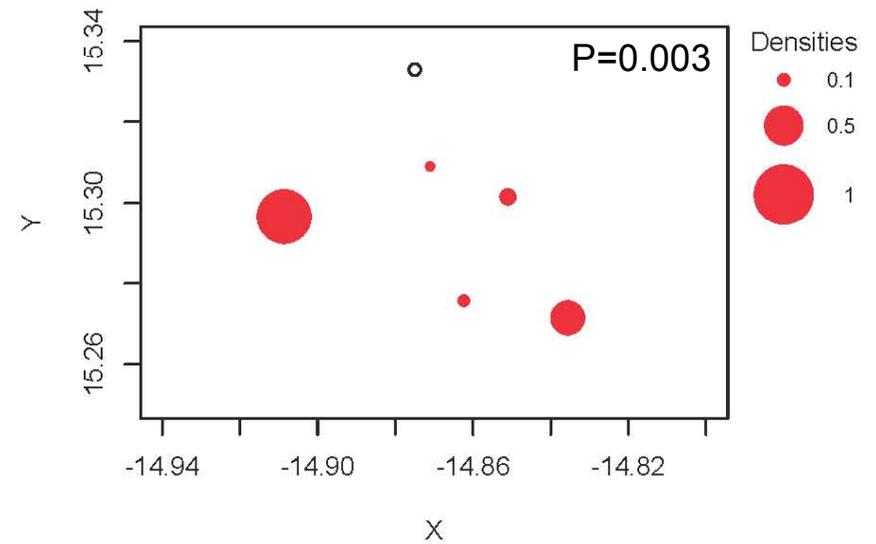
2010



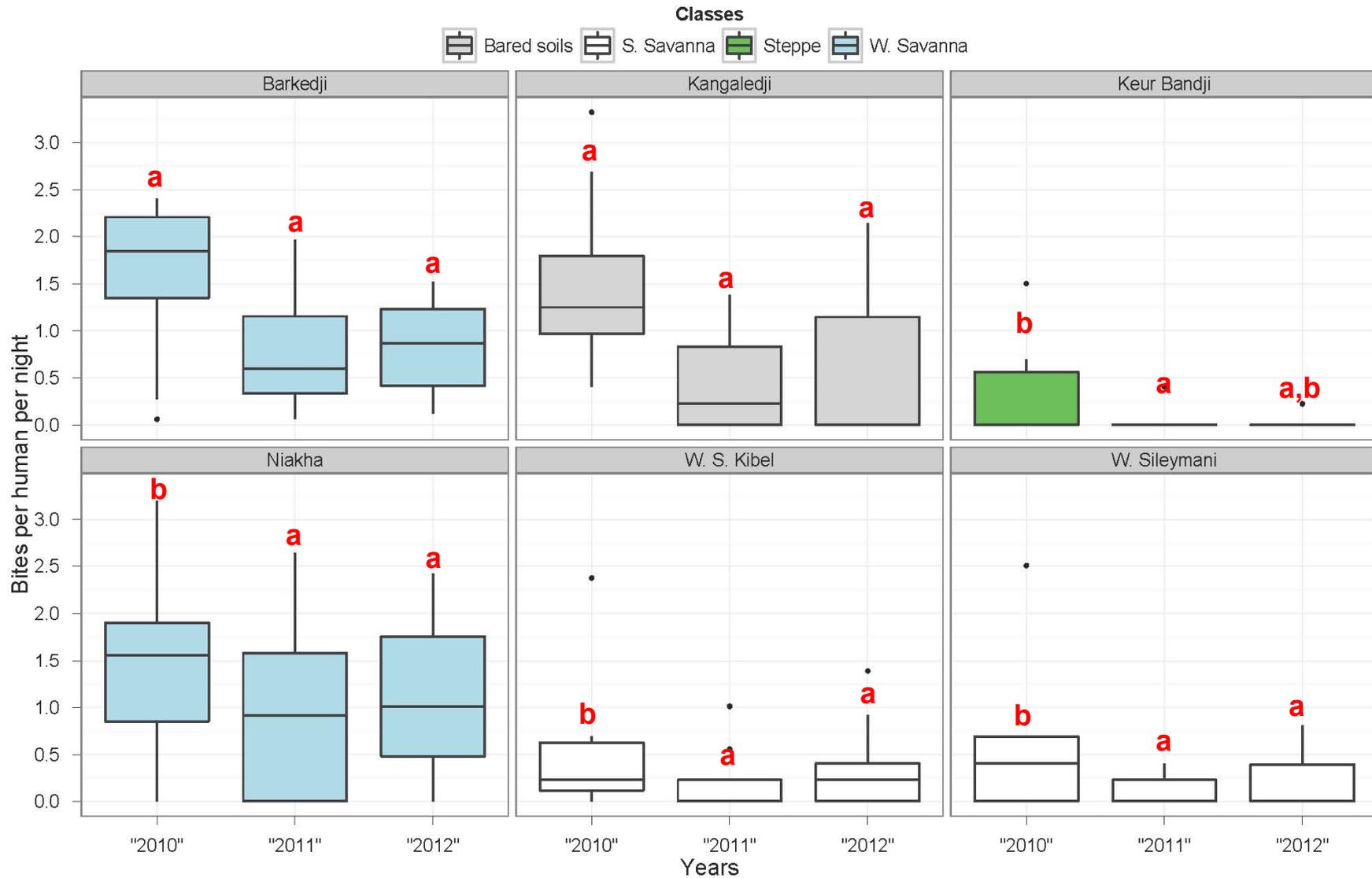
2011



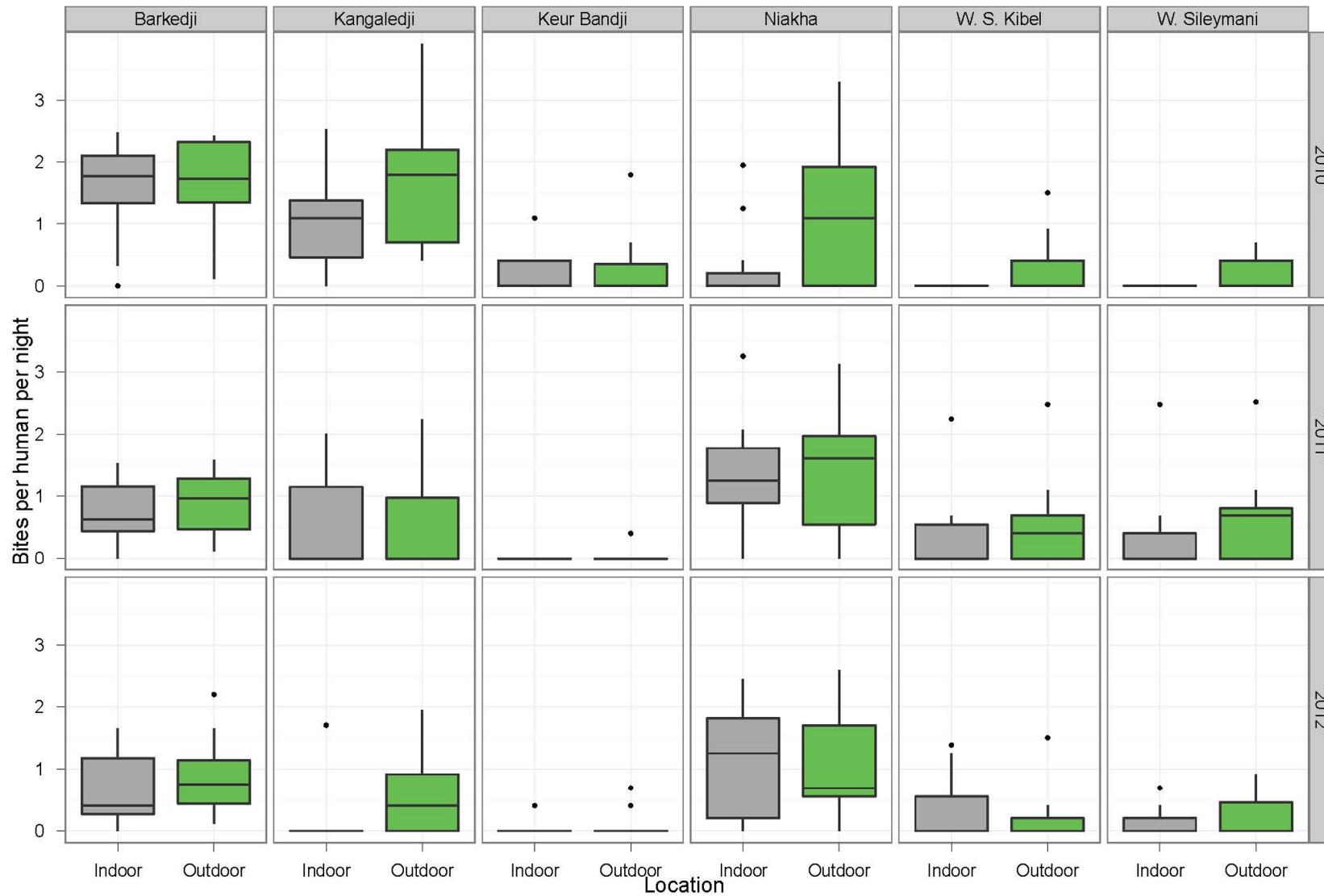
2012



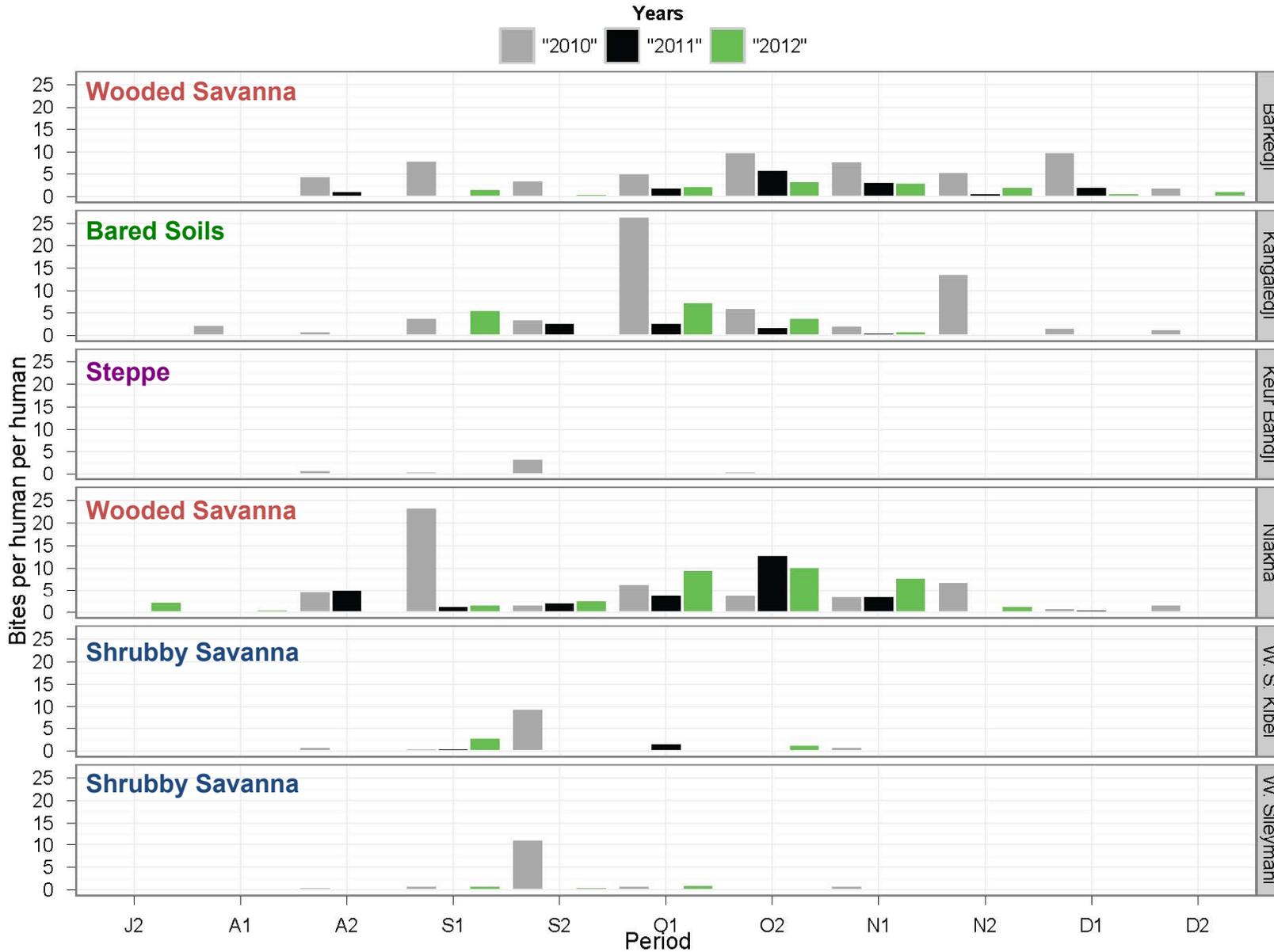
Densities



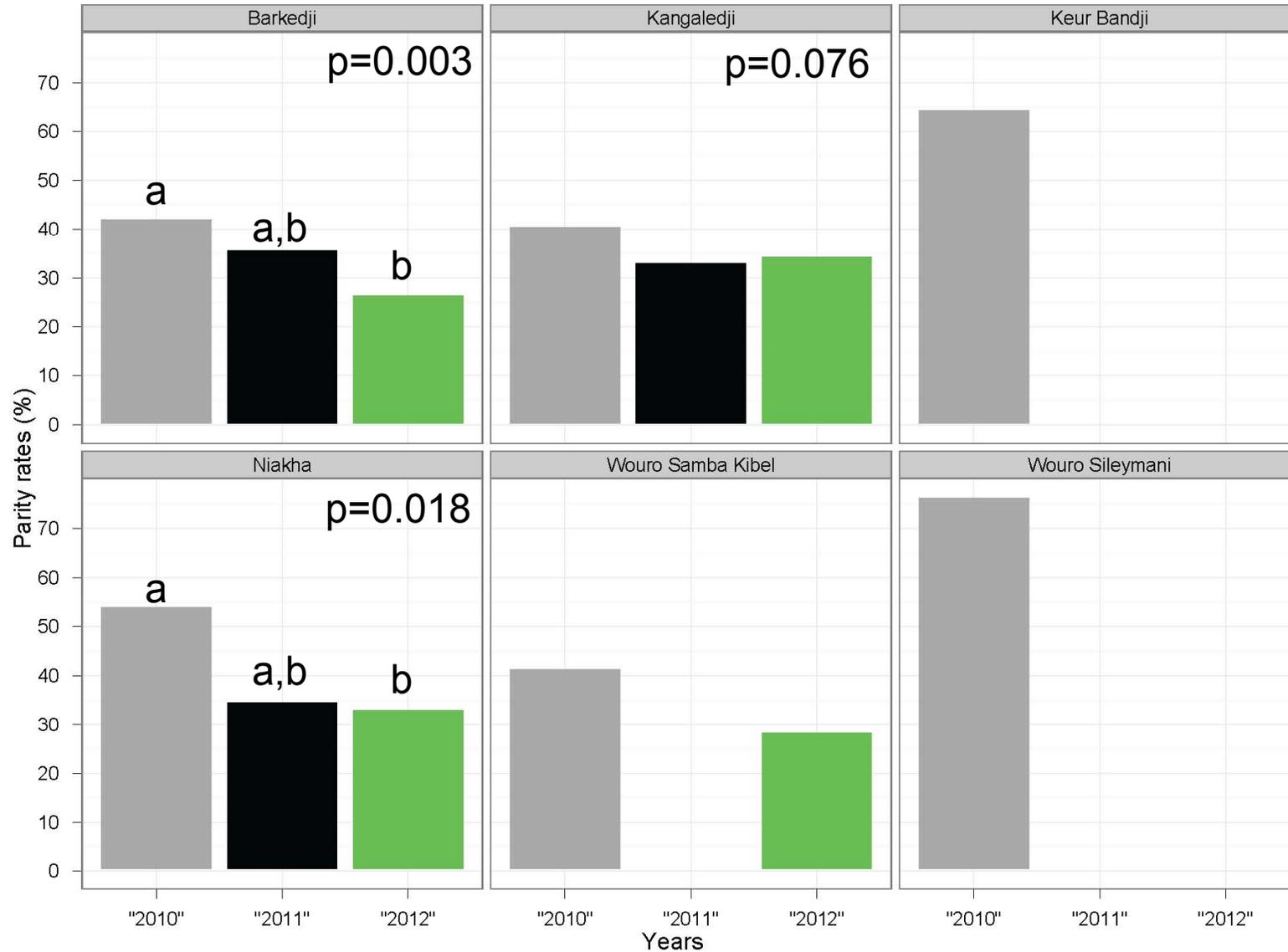
Densities



Densities

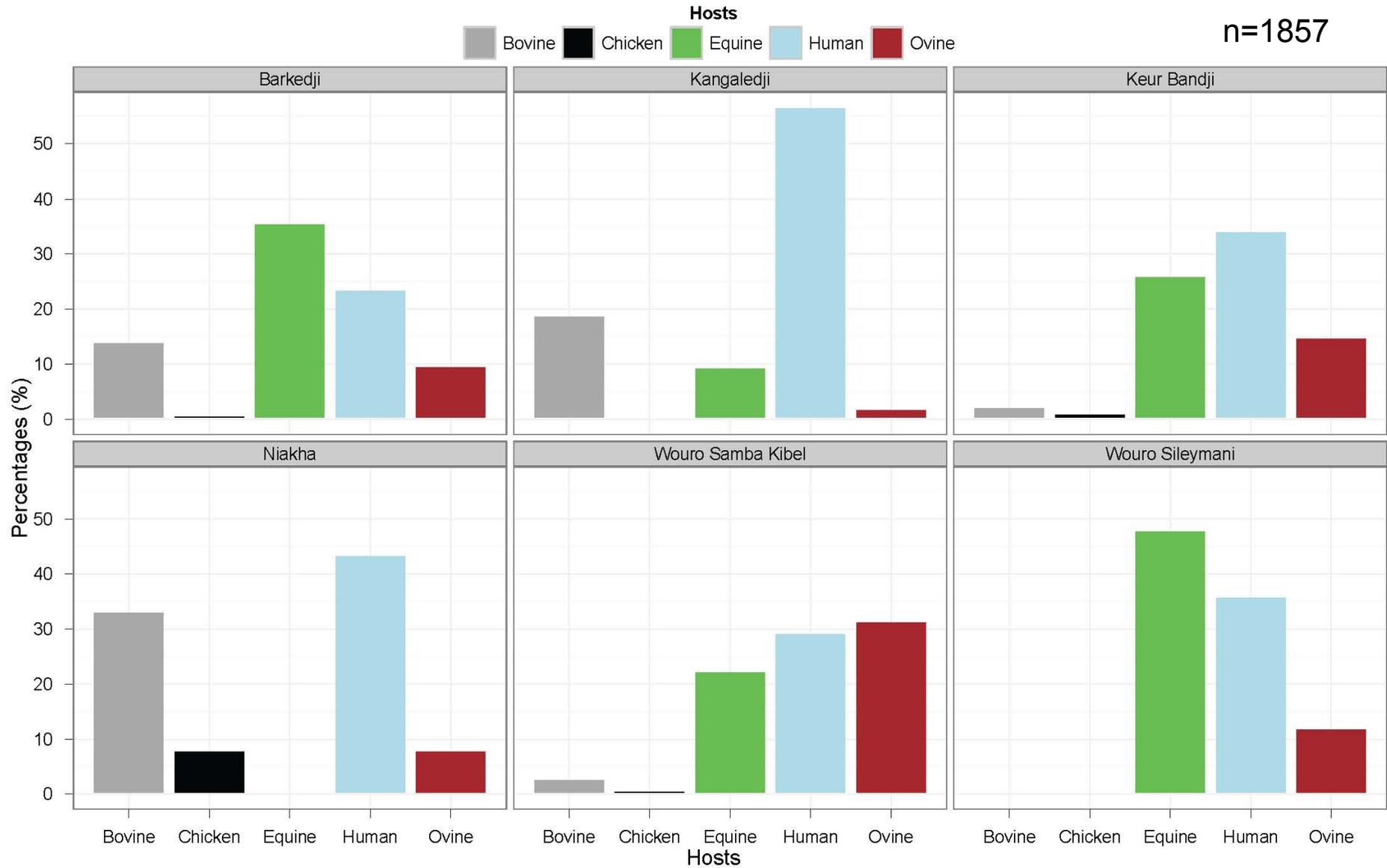


Parity rates

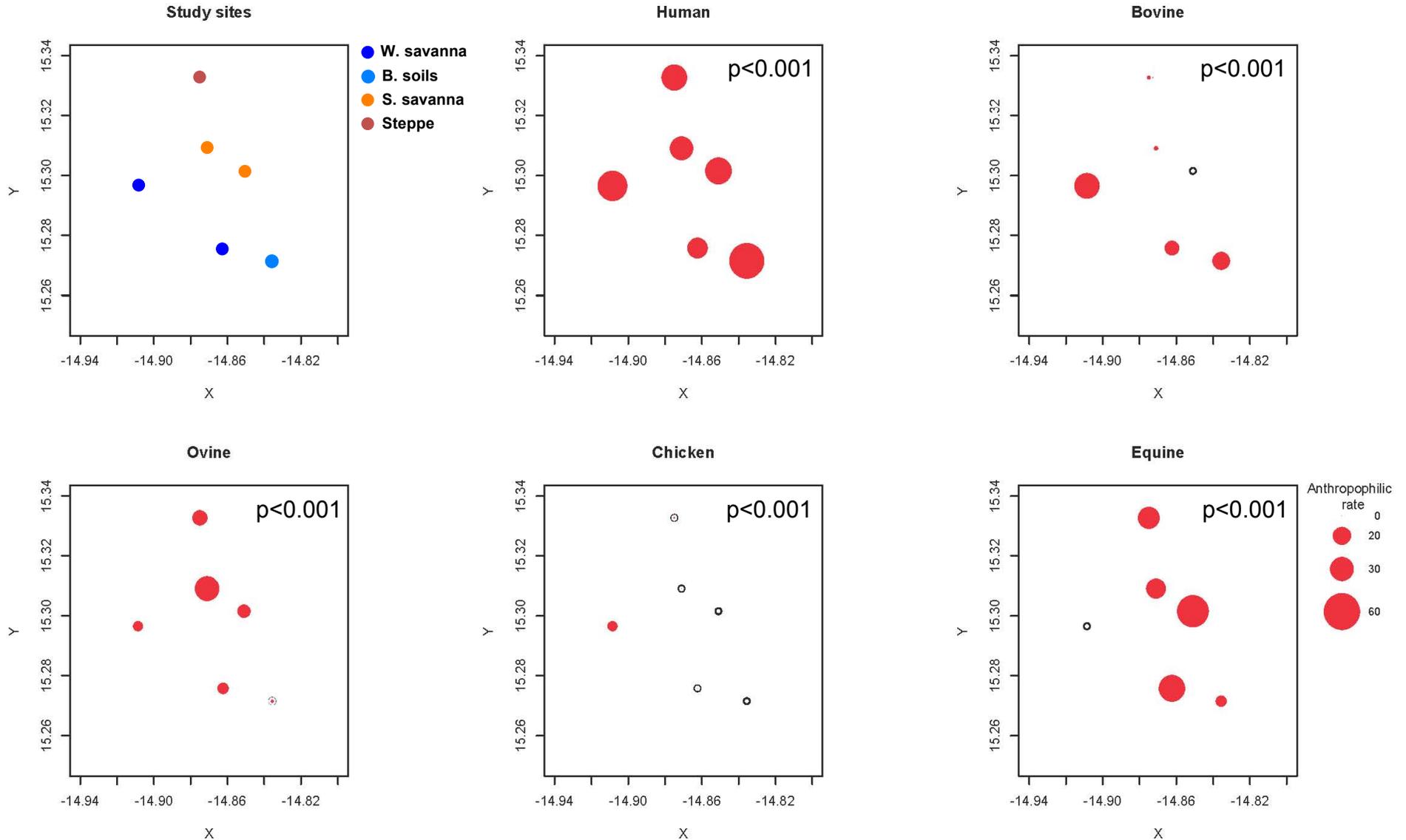


Trophic preferences

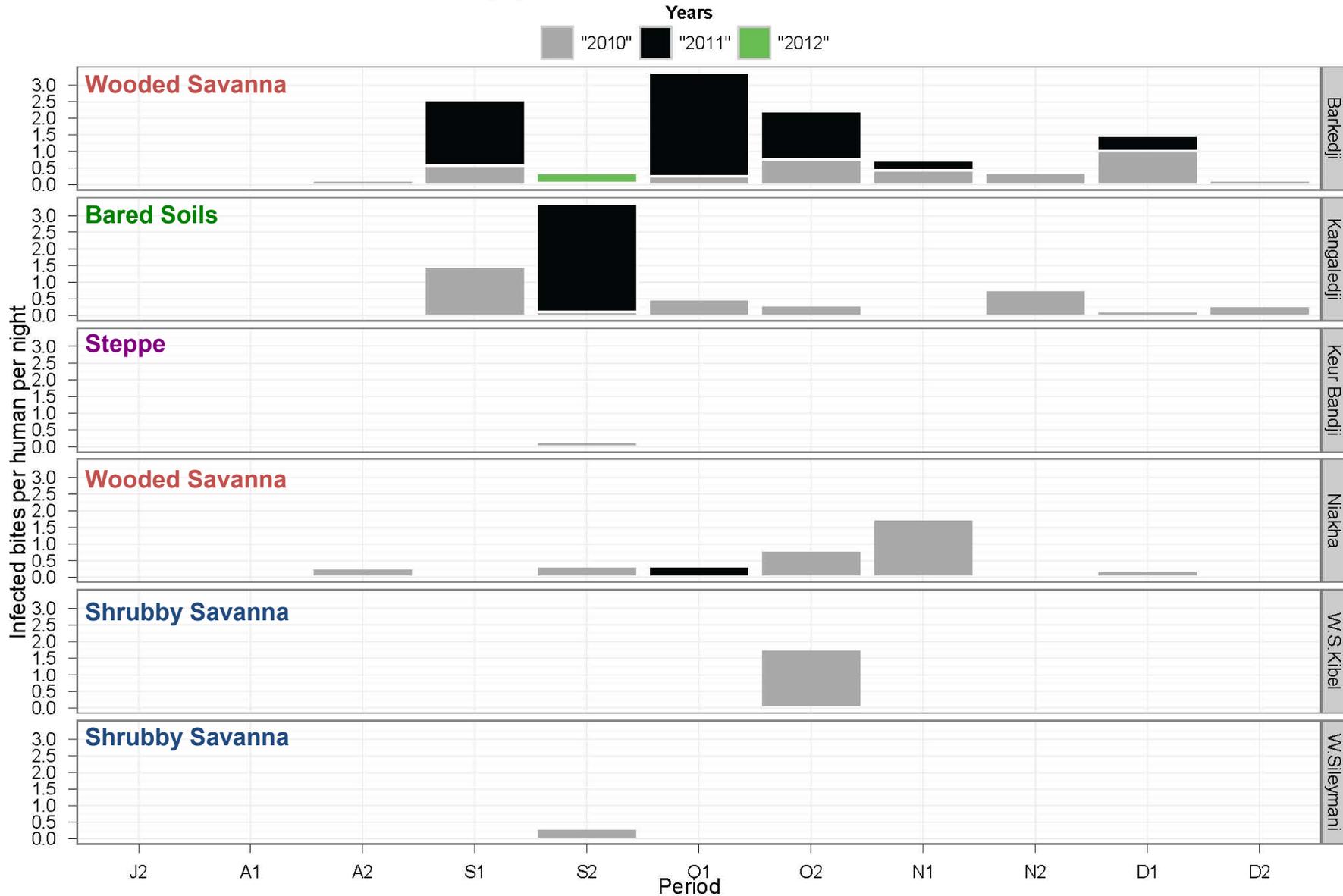
n=1857



Trophic preferences

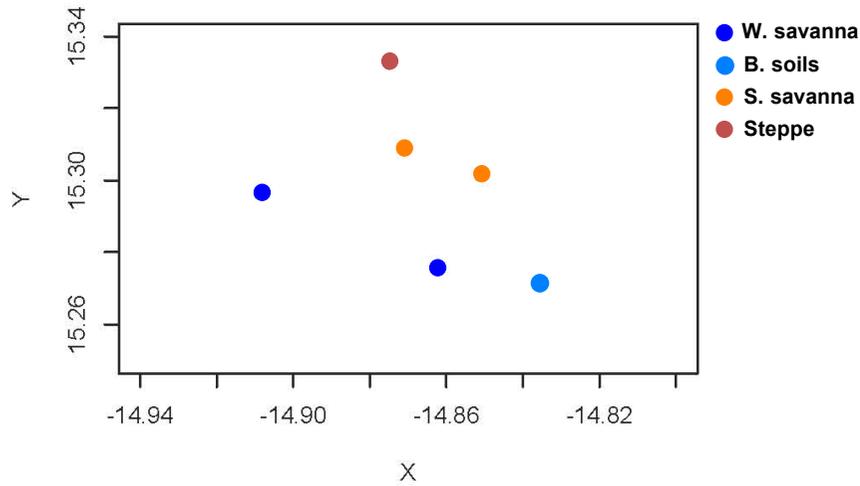


Entomological Inoculation Rate

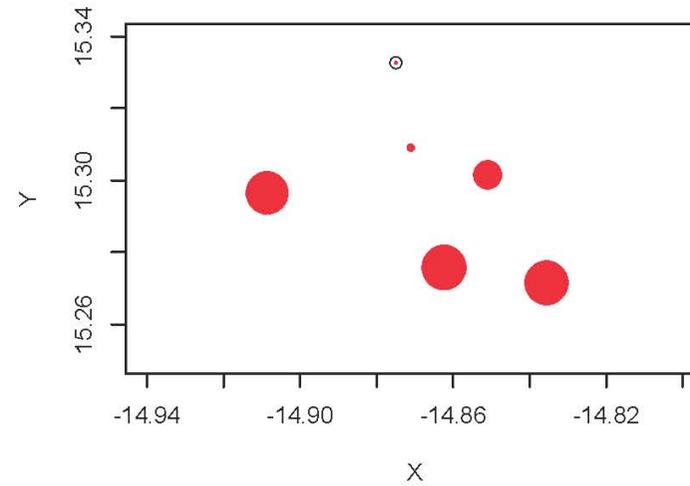


Entomological Inoculation Rate

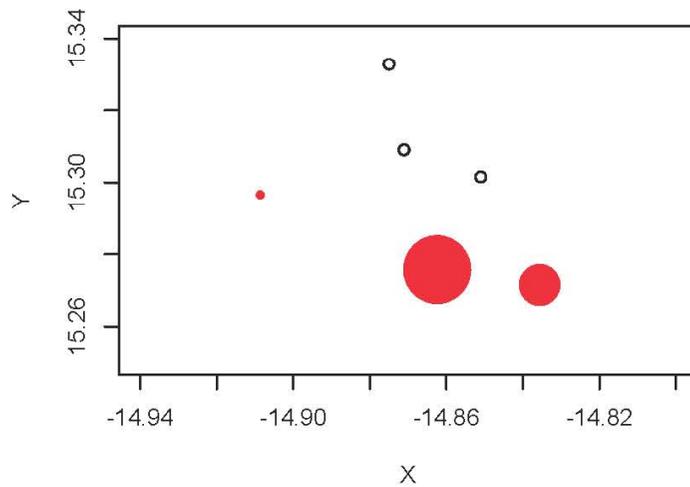
Study sites



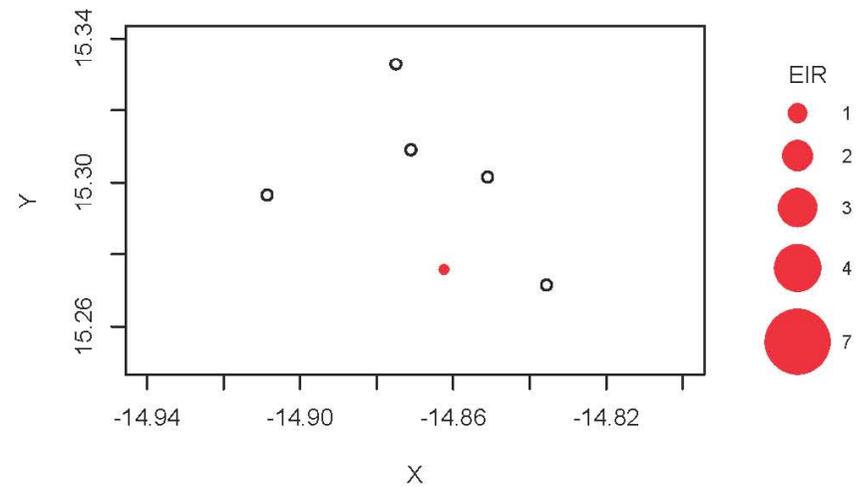
EIR 2010



EIR 2011



EIR 2012



Entomological Parameters

Parameters	Barkedji	Kangaledji	Keur Bandji	Niakha	W.S.Kibel	W. Sileymani
Land cover/land use	Wooded savanna	Bared soil	Steppe	Wooded savanna	Shrubby savanna	Shrubby savanna
Human biting rate (ma)	2.816	2.780	0.227	3.712	0.689	0.629
Parity rate (A)	0.393	0.393	0.579	0.459	0.320	0.650
Duration of the gonotrophic cycle (x)	2	2	2	2	2	2
Human blood index (HBI)	0.283	0.652	0.435	0.467	0.333	0.375
Human daily biting frequency (a)	0.141	0.326	0.217	0.233	0.166	0.187
Duration of sporogonic cycle (n in days)	9.5	10.4	9.6	9.6	9.5	9.5
Daily survival rate (p)	0.627	0.627	0.761	0.677	0.566	0.806
Survival rate after n days (p^n)	0.012	0.008	0.073	0.024	0.004	0.129
Mosquito life expectancy ($1/\log_e p$)	2.142	2.142	3.661	2.563	1.757	4.637
Mosquito infective life expectancy ($p^n/\log_e p$)	0.025	0.017	0.267	0.061	0.007	0.598
Stability index ($a/\log_e p$)	0.066	0.152	0.059	0.091	0.094	0.040
Vectorial capacity ($ma^2 \cdot p^n/\log_e p$)	0.010	0.015	0.013	0.053	0.001	0.070

Summary

- Significant variations of entomological parameters within a limited area
 - Anopheline species abundance and distribution different between villages and collection years
 - Spatial and temporal variations of biting rates both between villages and collection years
 - Host-seeking behaviour: exophagic behaviour for malaria vectors and a feeding pattern dependent on the availability of alternative hosts
 - The entomological inoculation showed heterogeneous transmission with minima in shrubby savanna and steppe villages
- The use of these estimated parameters will be useful for validation or improvement of existing model in the prediction of epidemics based on climatic and environmental parameters.