

# Assessing seasonality of vectorborne and zoonotic infectious diseases

Siobhan Mor & Elena Naumova



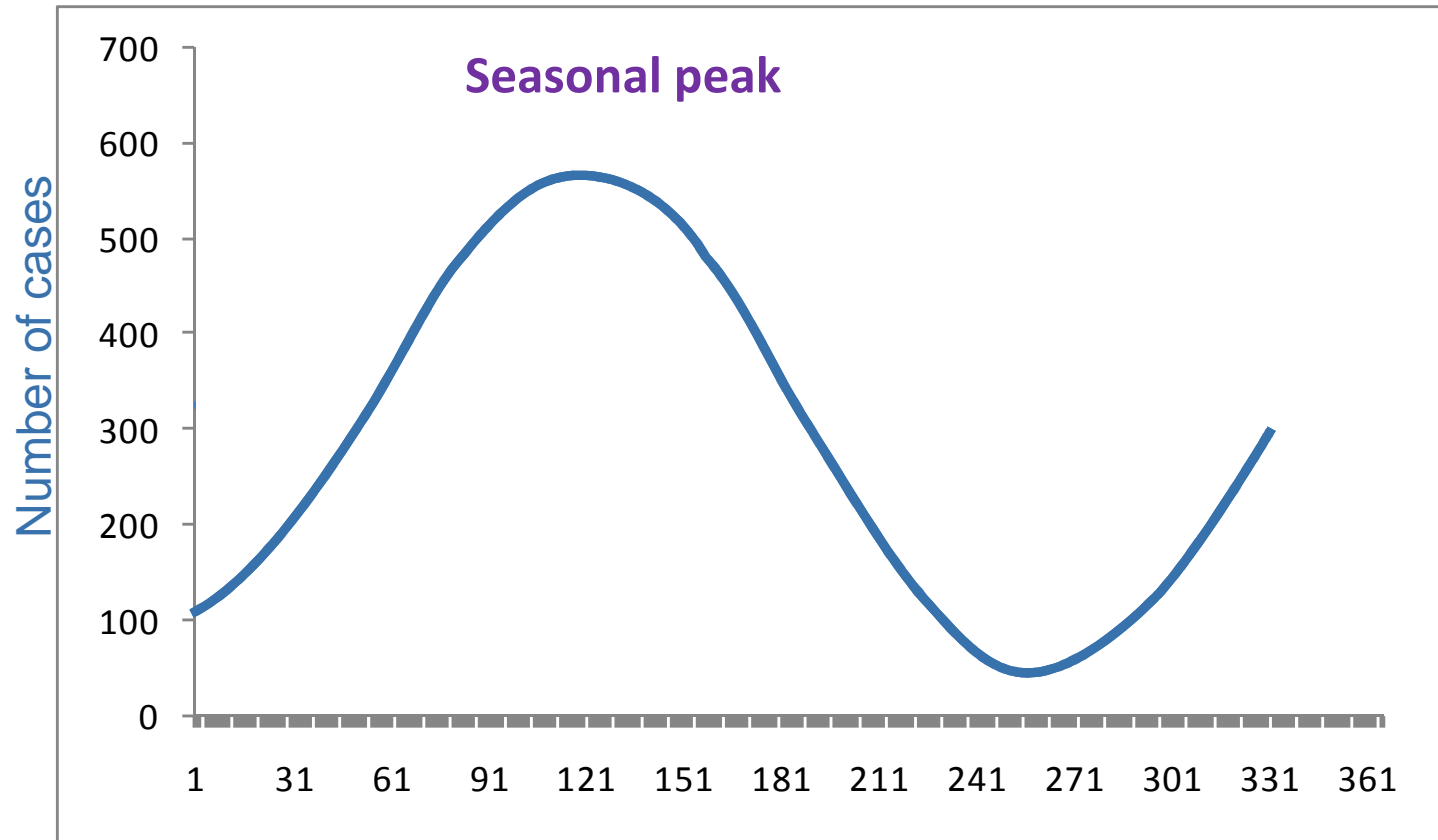
# Seasonality

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- Well known phenomena
- Often attributable to environmental factors
  - Enhance design of integrated warning systems
- Limited use of analytical tools for seasonality assessment by public health professionals



$$\log [Y(t)] = \beta_0 + \beta_1 \sin(2\pi\omega t) + \beta_2 \cos(2\pi\omega t) + e(t)$$



Hypothetical disease

Time in days



# $\delta$ -method

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$$\text{Amplitude } (\Upsilon) = (\beta_1 + \beta_2)^{1/2}$$

$$\text{Phase angle } (\Psi) = -\arctan(\beta_1/\beta_2)$$

Epidemiologic Characteristic	Estimation
<b>Average peak timing of disease incidence</b> (in days), a position of the maximum point on the seasonal curve	$365 (1-\Psi/\Upsilon)/2$
<b>Average intensity in incidence</b> , the difference between the maximum and minimum value on the seasonal curve	$\exp\{\beta_0 + \Upsilon\} - \exp\{\beta_0 - \Upsilon\}$

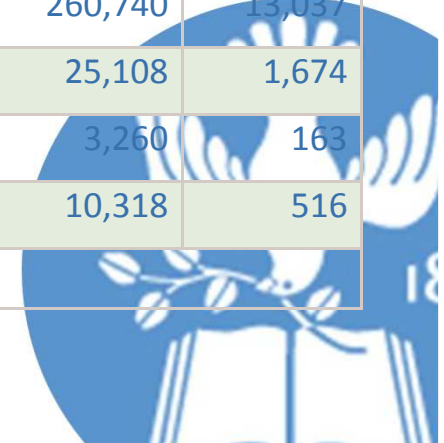
Naumova EN, MacNeill IB. Seasonality assessment for biosurveillance systems. In Balakrishnan N, et al., eds. *Advances in Statistical Methods for the Health Sciences : applications to cancer and AIDS studies, genome sequence analysis, and survival analysis*. Boston : Birkhauser, 2006.

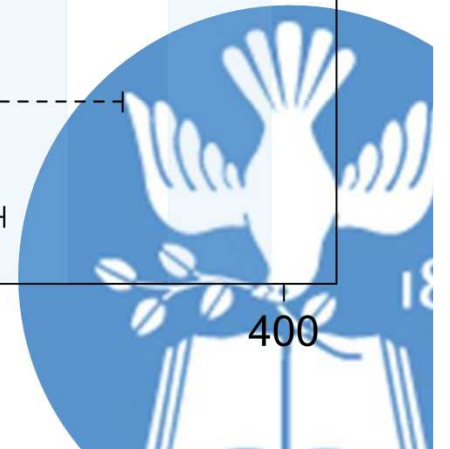
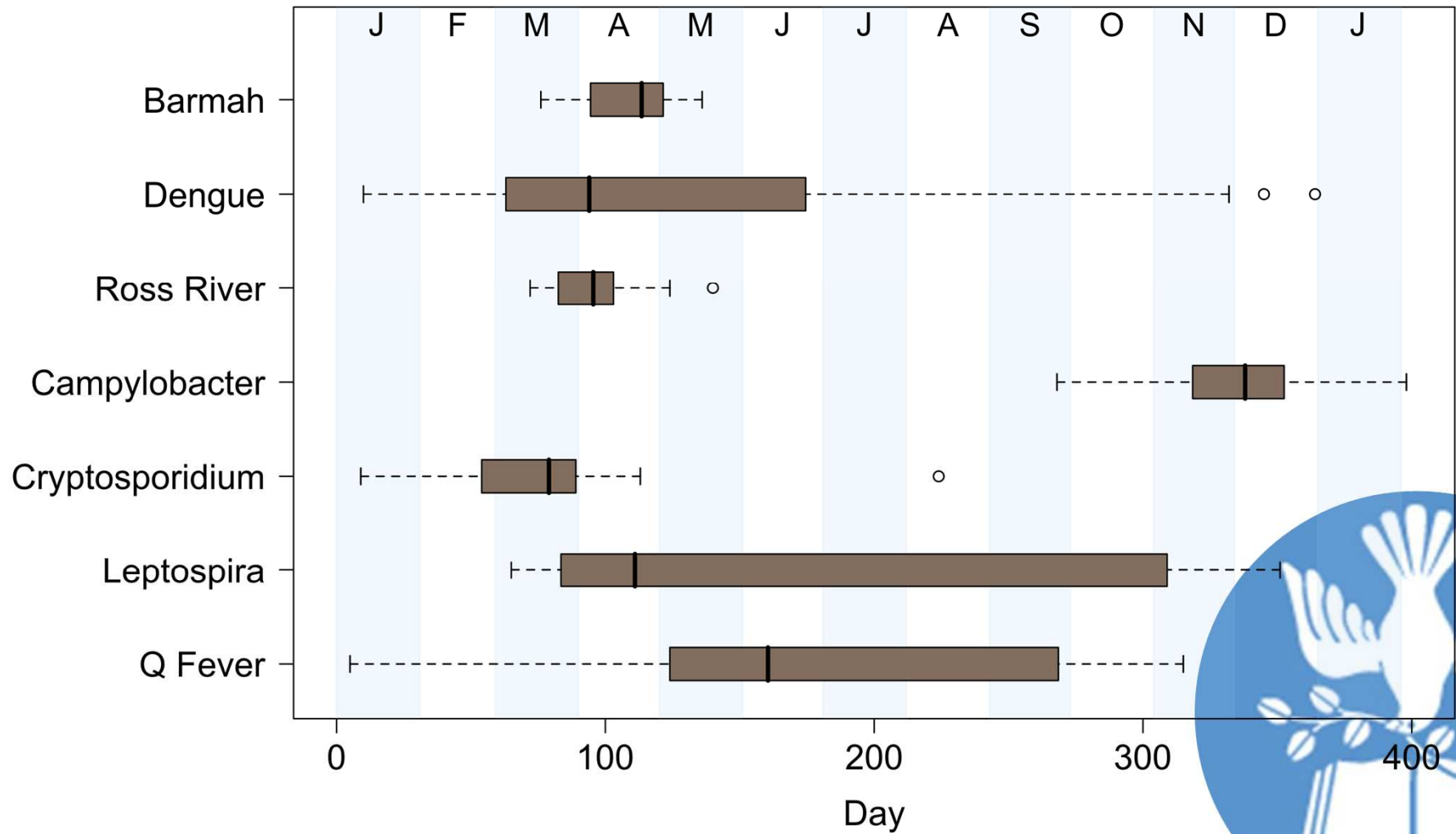


# Data – NNDSS Australia

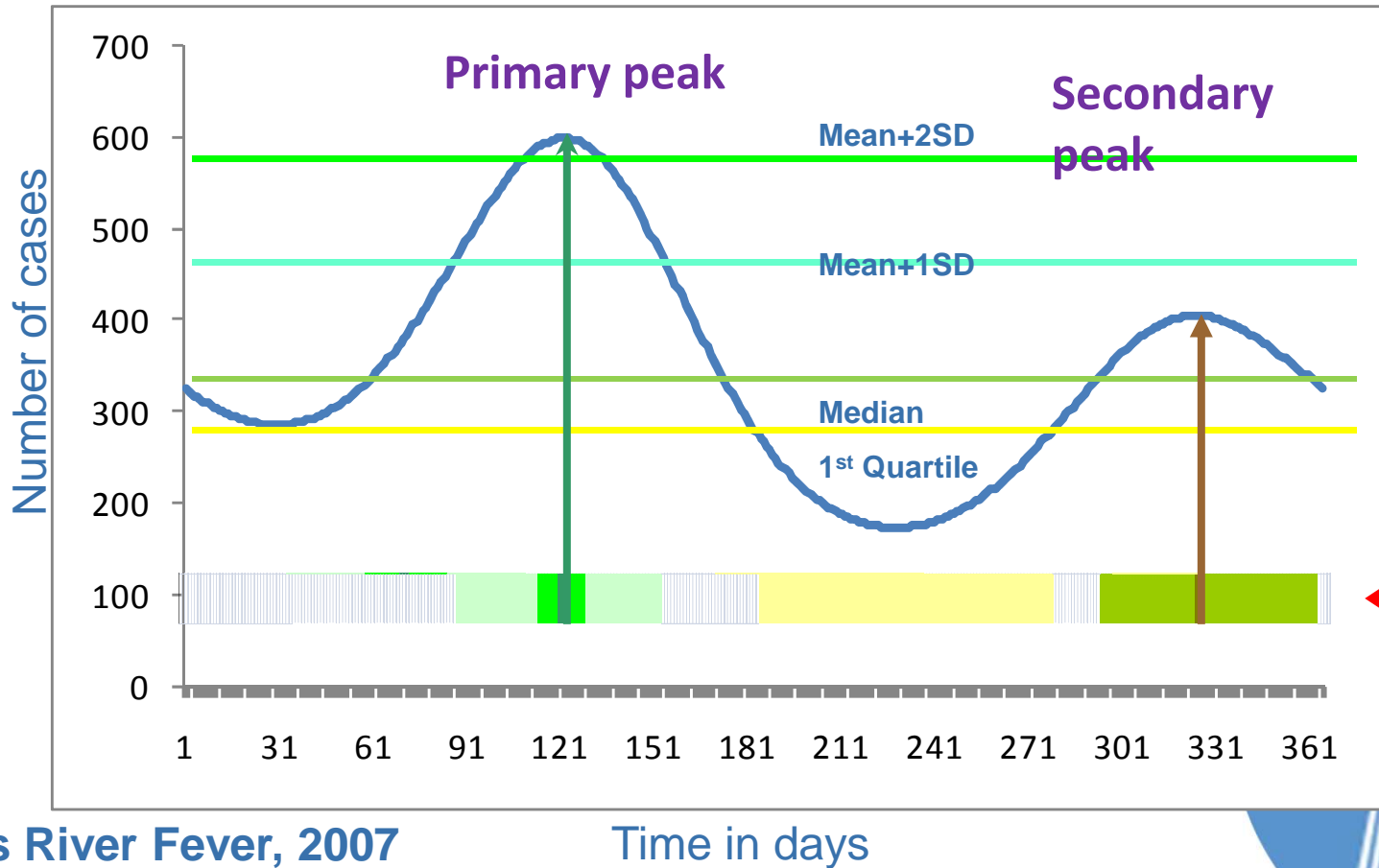
Disease	Main transmission route	Reservoir	Start time series*	Total cases	Mean cases/year
Barmah Forest Fever	Vectorborne	Marsupials	1995	18,323	1,145
Dengue Fever	Vectorborne	Humans	1991	7,177	359
Ross River Fever	Vectorborne	Marsupials	1991	86,014	4,301
Campylobacteriosis	Fecal-oral	Poultry/ruminants	1991	260,740	13,037
Cryptosporidiosis	Fecal-oral	Humans/ruminants	1997	25,108	1,674
Leptosporidiosis	Direct contact	Rodents/ruminants	1991	3,260	163
Q fever	Direct contact	Ruminants	1991	10,318	516

\* End time series: 2010 for all diseases





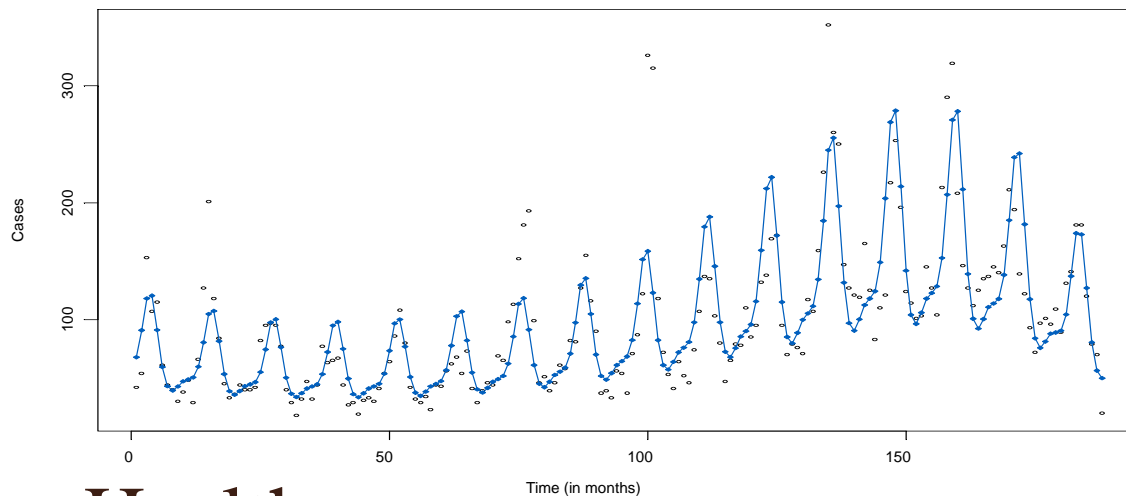
$$\log [Y(t)] = \beta_0 + \beta_1 \sin(2\pi\omega t) + \beta_2 \cos(2\pi\omega t) + \beta_3 \sin(4\pi\omega t) + \beta_4 \cos(4\pi\omega t) + e(t)$$



# Results – Barmah ex.

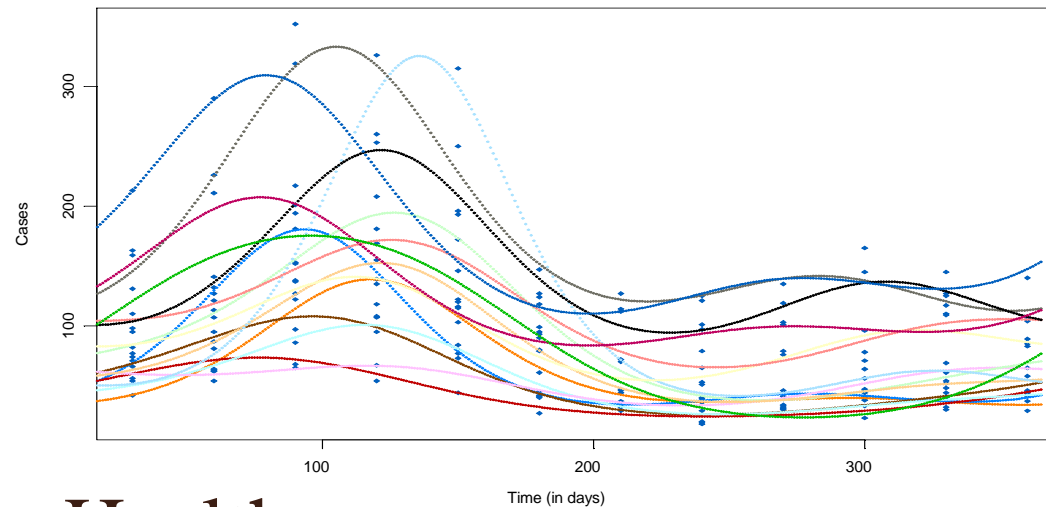
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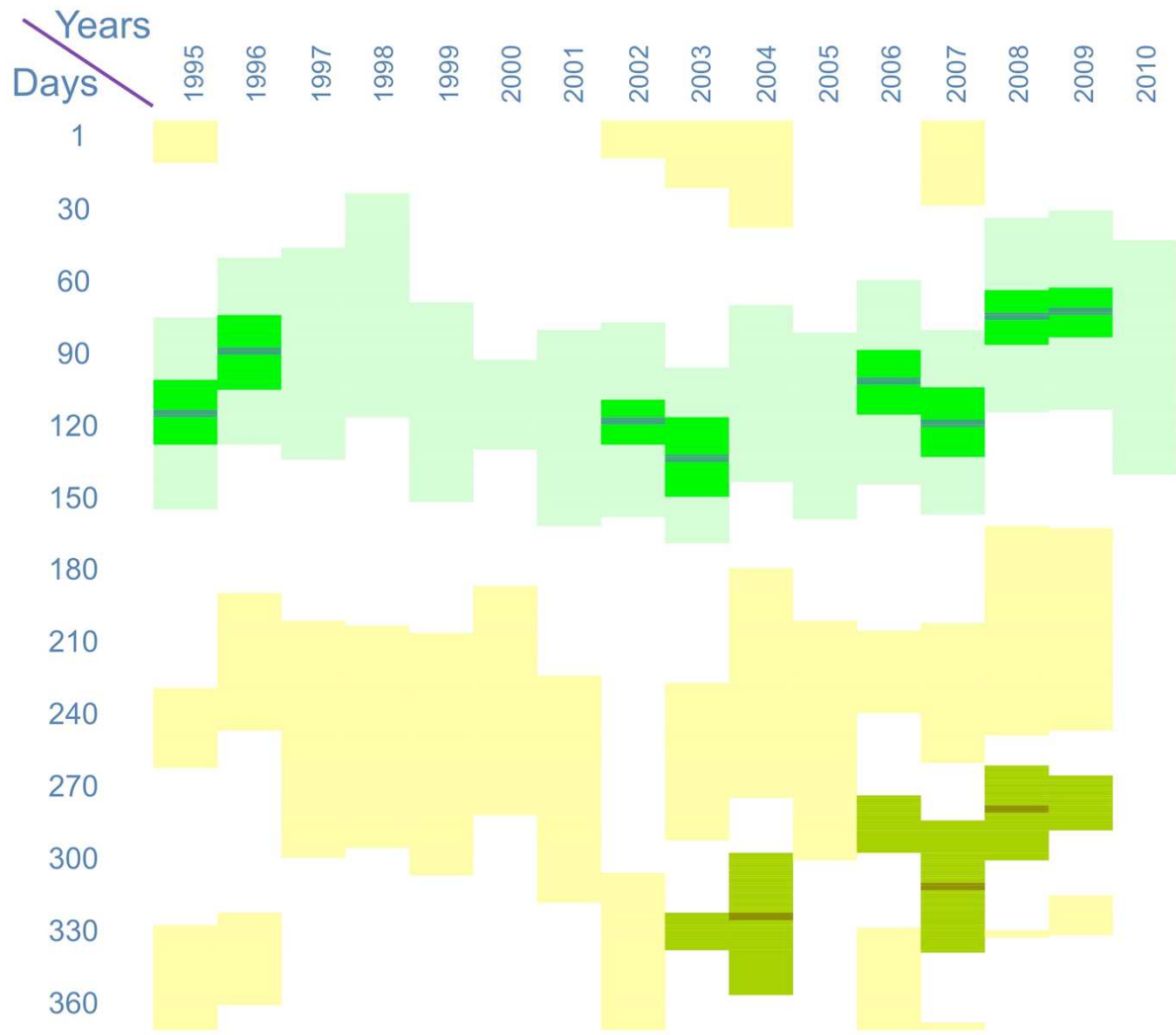
- Full model
  - polynomial components and 2 harmonics



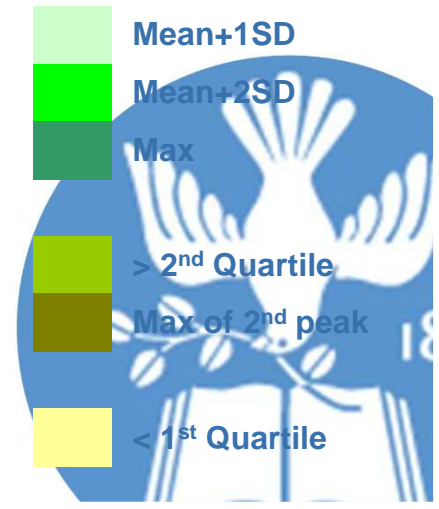
# Results – Barmah ex.

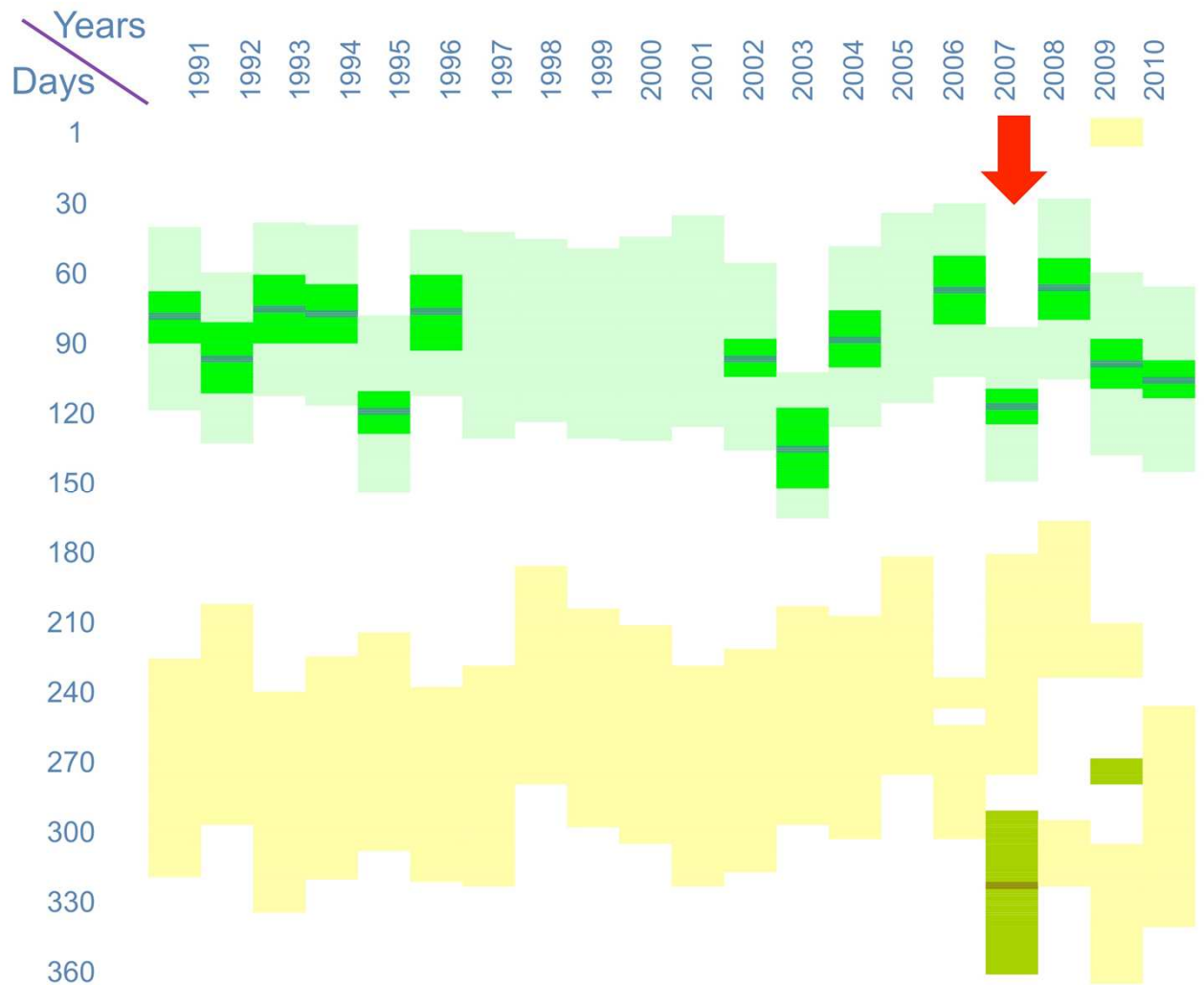
- Annual model
  - 2 harmonics



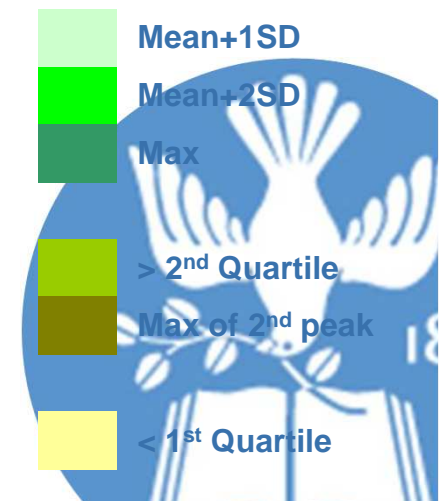


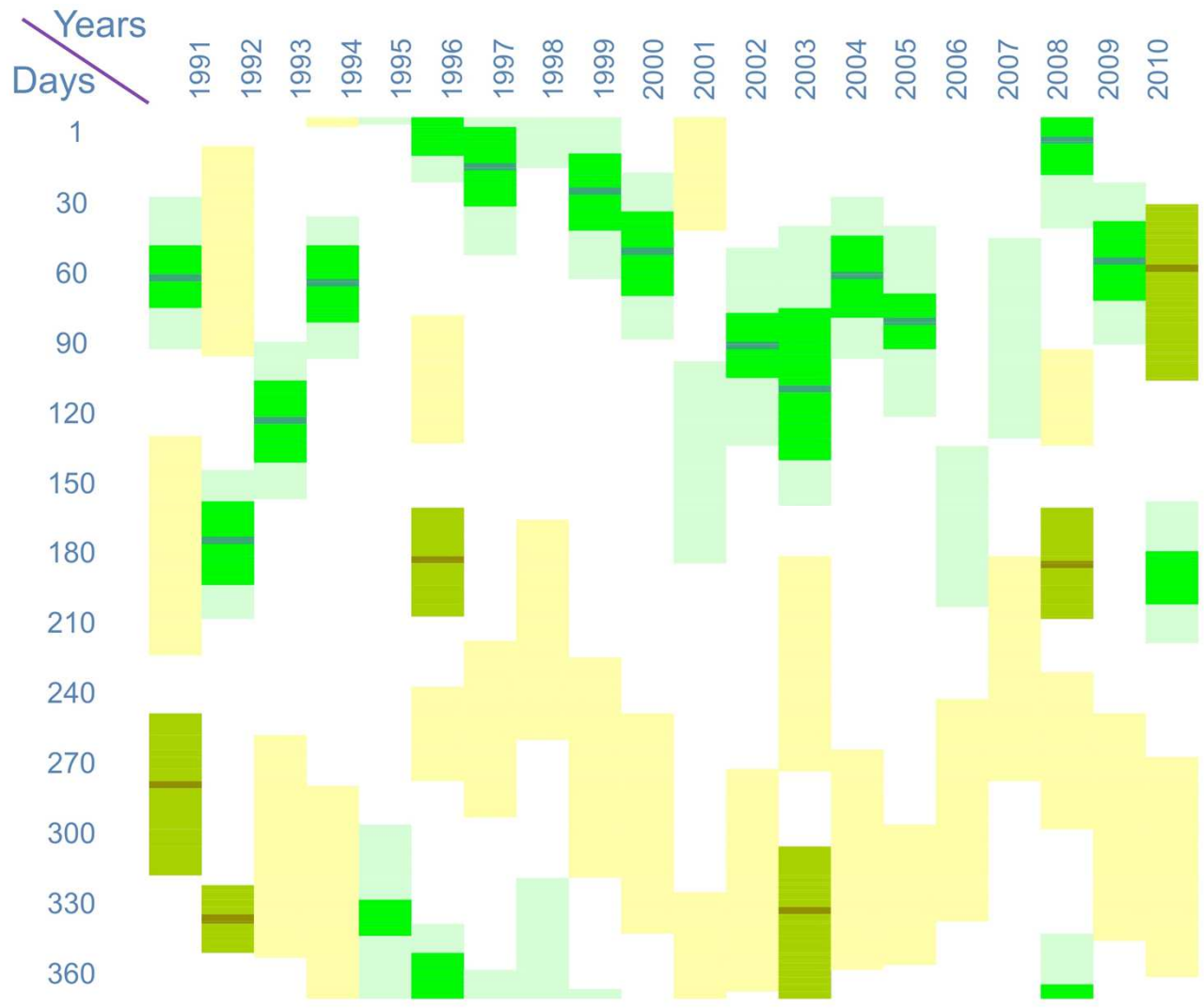
Distribution of Annual Peak Timing:  
Barmah ex.



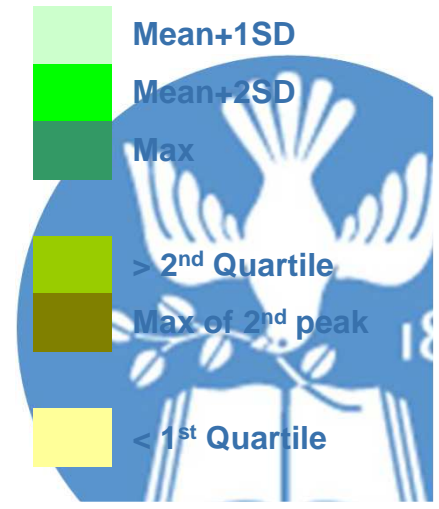


Distribution of Annual Peak Timing:  
Ross River ex.





Distribution of Annual Peak Timing:  
Dengue ex.



# Future directions

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- Refine temporal and geographic scales
- Assess correlation
  - Environmental parameters (ex. rainfall, humidity, temperature)
  - Remote sensing data (ex. NDVI)



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**Thank you**

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