

Too Hot, Too Wet: Bayesian Spatial Modelling of Climate-Driven Salmonella Risk in New South Wales, Australia, 1991–2022

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Key Points:

- High temperatures consistently increased *Salmonella* risk across all LHDs in NSW.
 - A J-shaped relationship was observed for all climate variables.
 - Inland and rural regions experienced more dramatic risk increases.
 - Flooding and humidity were also associated with elevated *Salmonella* risk, especially in coastal and arid regions.
 - Spatial modelling revealed significant geographic variation.

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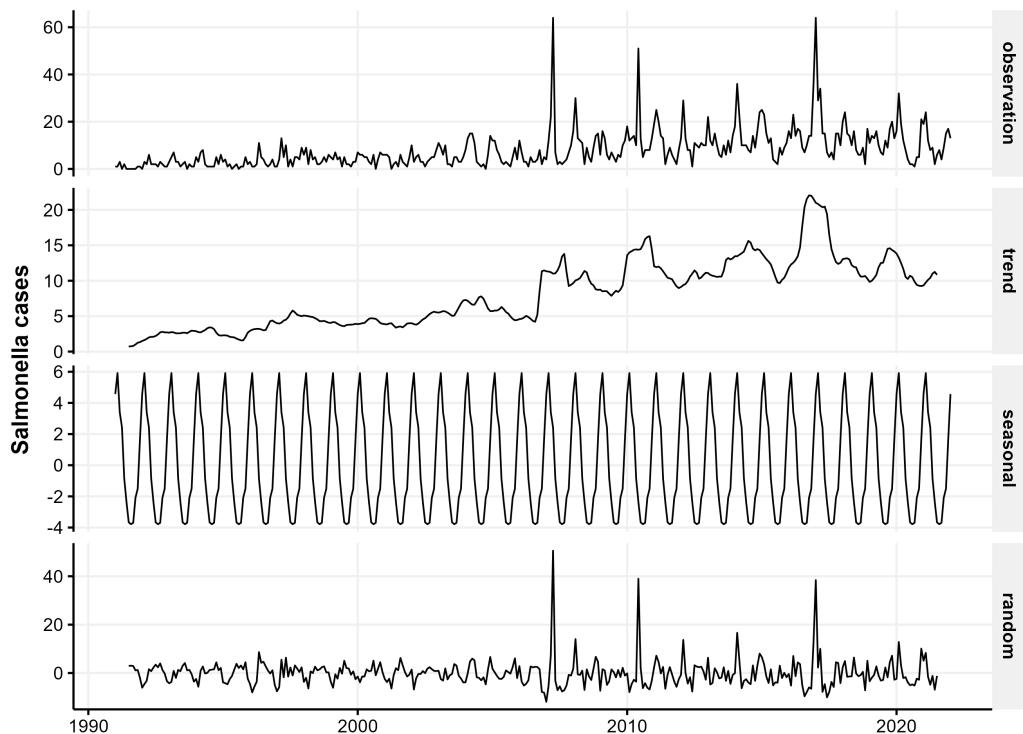
Supplementary Materials

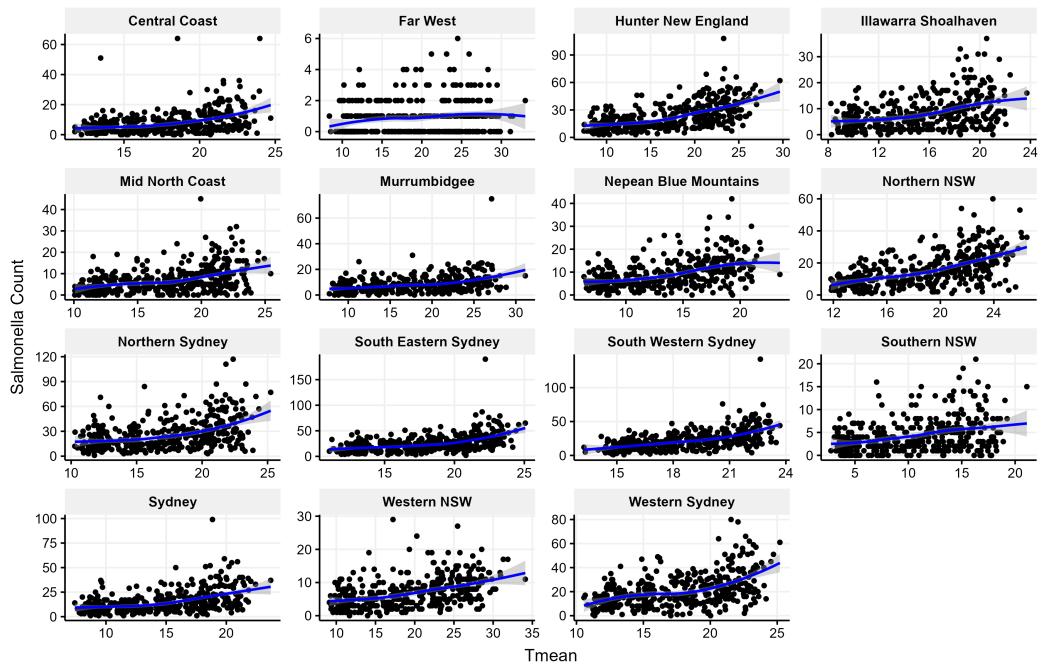
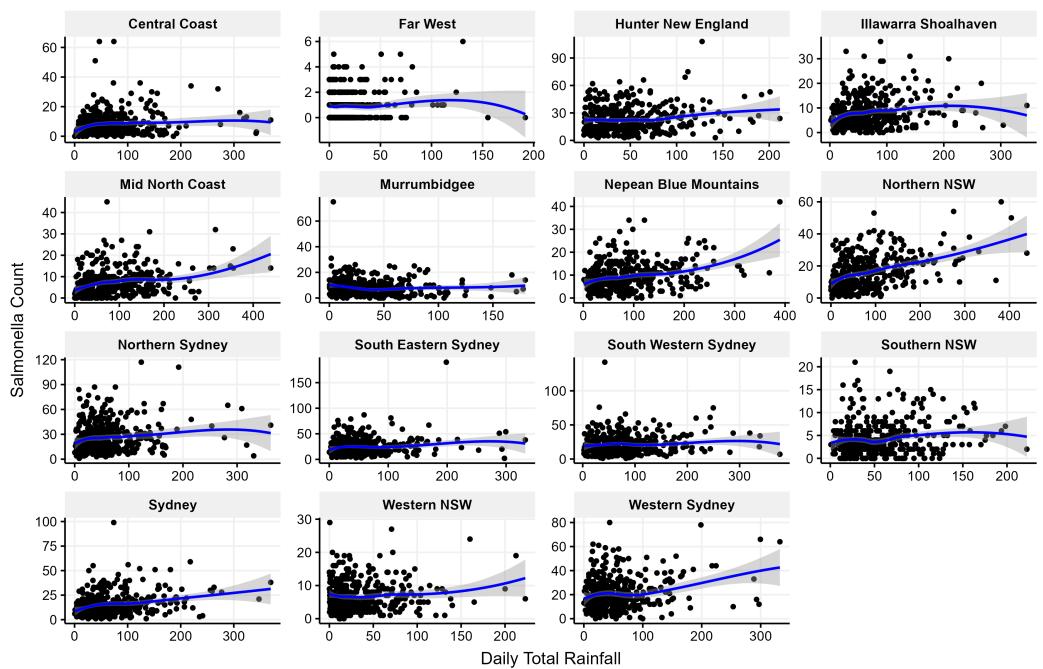
Table S.1: Model fit and predictive performance metrics for case-crossover vs BSM.

Metric	CCM	BSM
RMSE (Root Mean Squared Error)	5.55	5.10
NRMSE (normalized)	0.416	0.382
R^2 (pseudo)	0.827	0.854
MAE (Mean Absolute Error)	3.46	3.01
Symmetric Mean Absolute Percentage Error (SMAPE) (% error)	33.28	29.43
AIC (Akaike Information Criterion)	32395	31335
BIC (Bayesian Information Criterion)	32422	31361
DIC	1.217×10^6	9.980×10^5
QAIC (quasi-likelihood AIC)	1058.7	1212.3
QAIC _{MCMC} (Bayesian)	2.401×10^6	1.963×10^6
Overdispersion ϕ	30.825	26.012

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S.1 Exploratory Data Analysis

Figure S.1: Decomposition of *Salmonella* time series data

Figure S.2: *Salmonella* cases vs monthly mean temperature across the LHDsFigure S.3: *Salmonella* cases vs rainfall across the LHDs

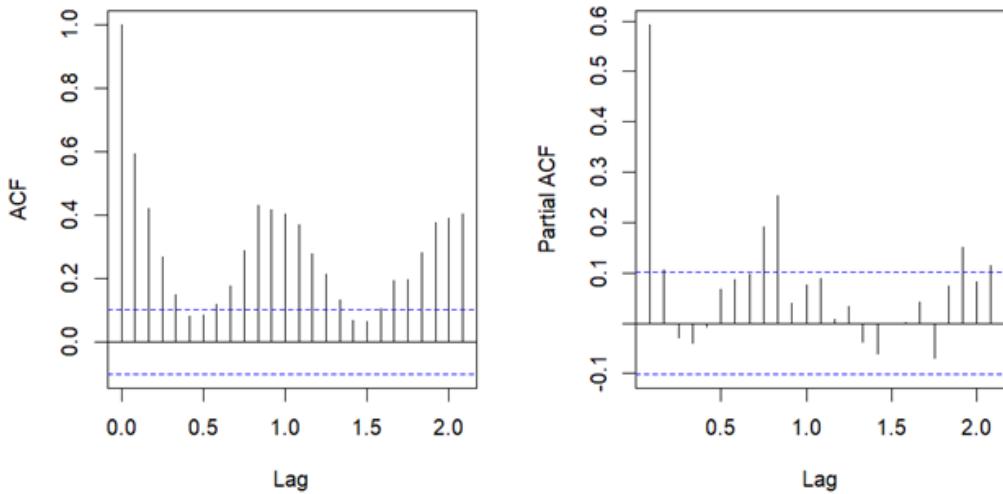


Figure S.4: Autocorrelation function (ACF) and partial ACF of Salmonella incidence rate

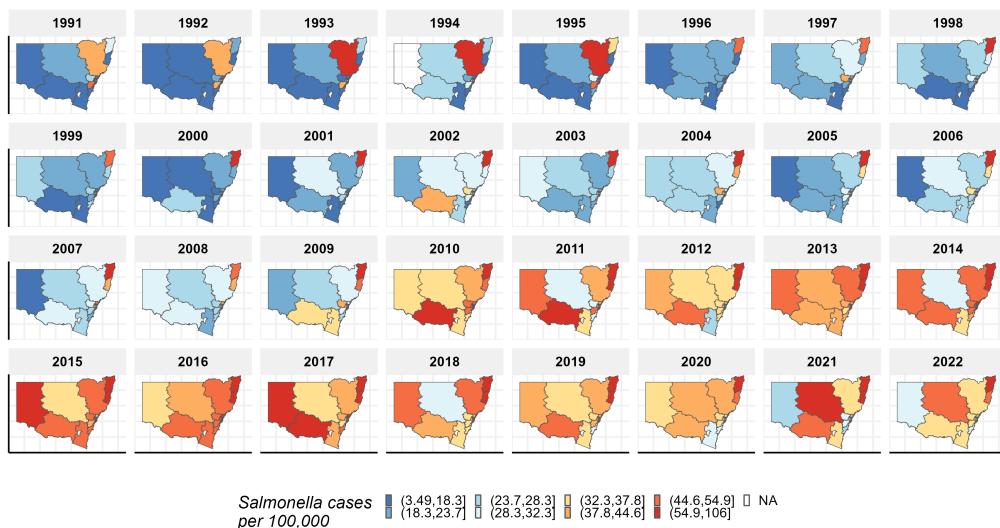


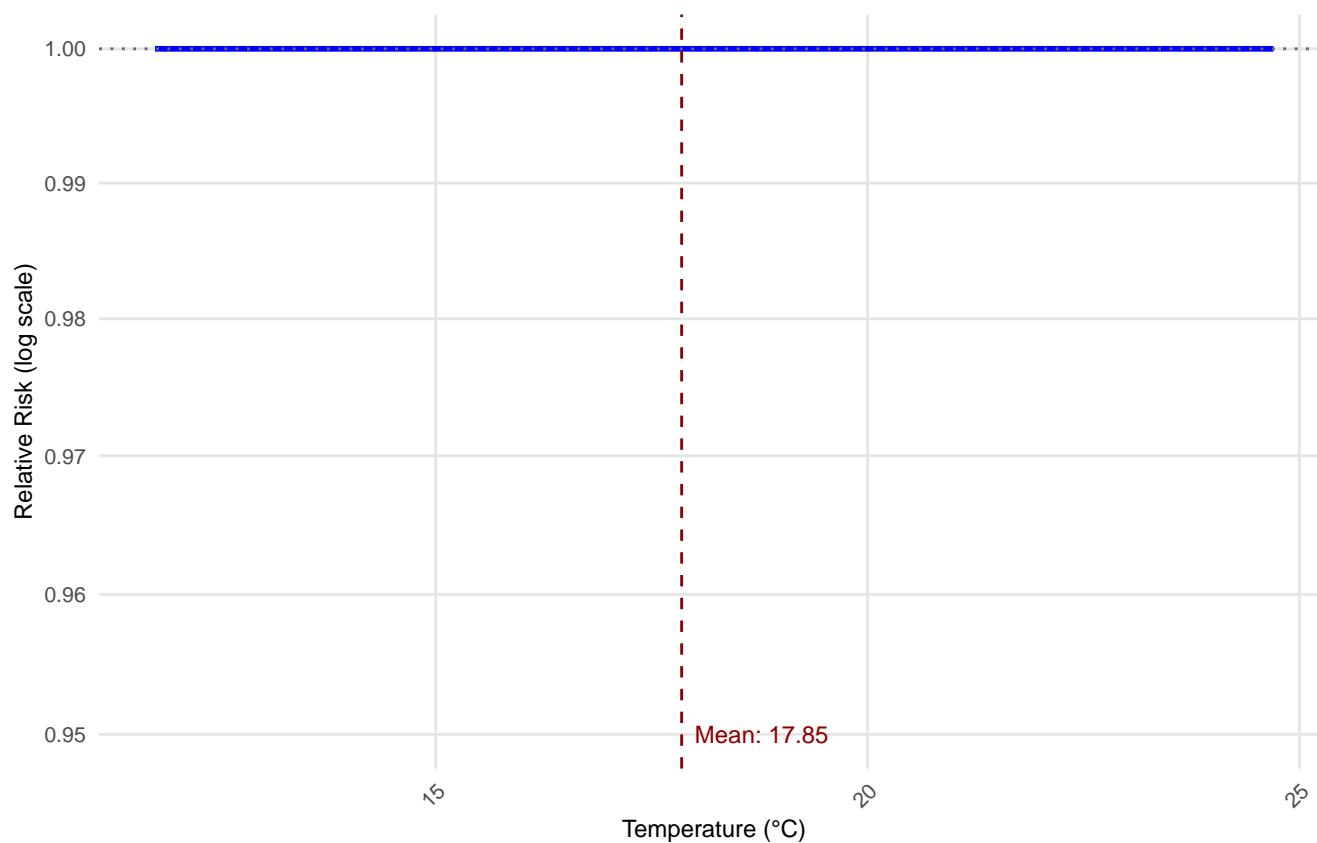
Figure S.5: Spatiotemporal patterns of *Salmonella* cases per 100,000 population across the LHDs in New South Wales, Australia, from 1990 to 2022

590 **S.2 Dose-response curves**

TEMP – Case Crossover– SB-DLNM

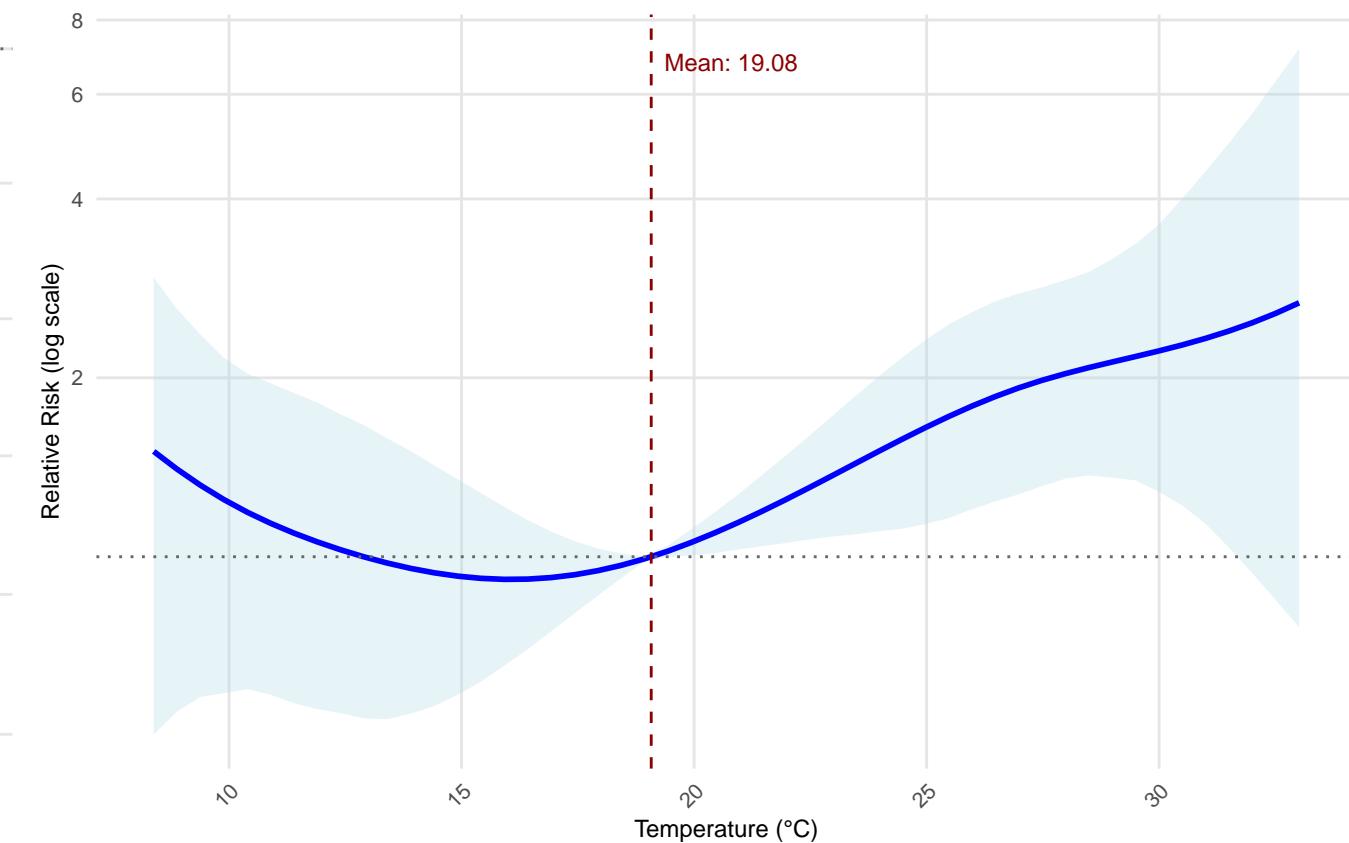
Central Coast – Model Case Crossover

Effect of Temperature (°C)



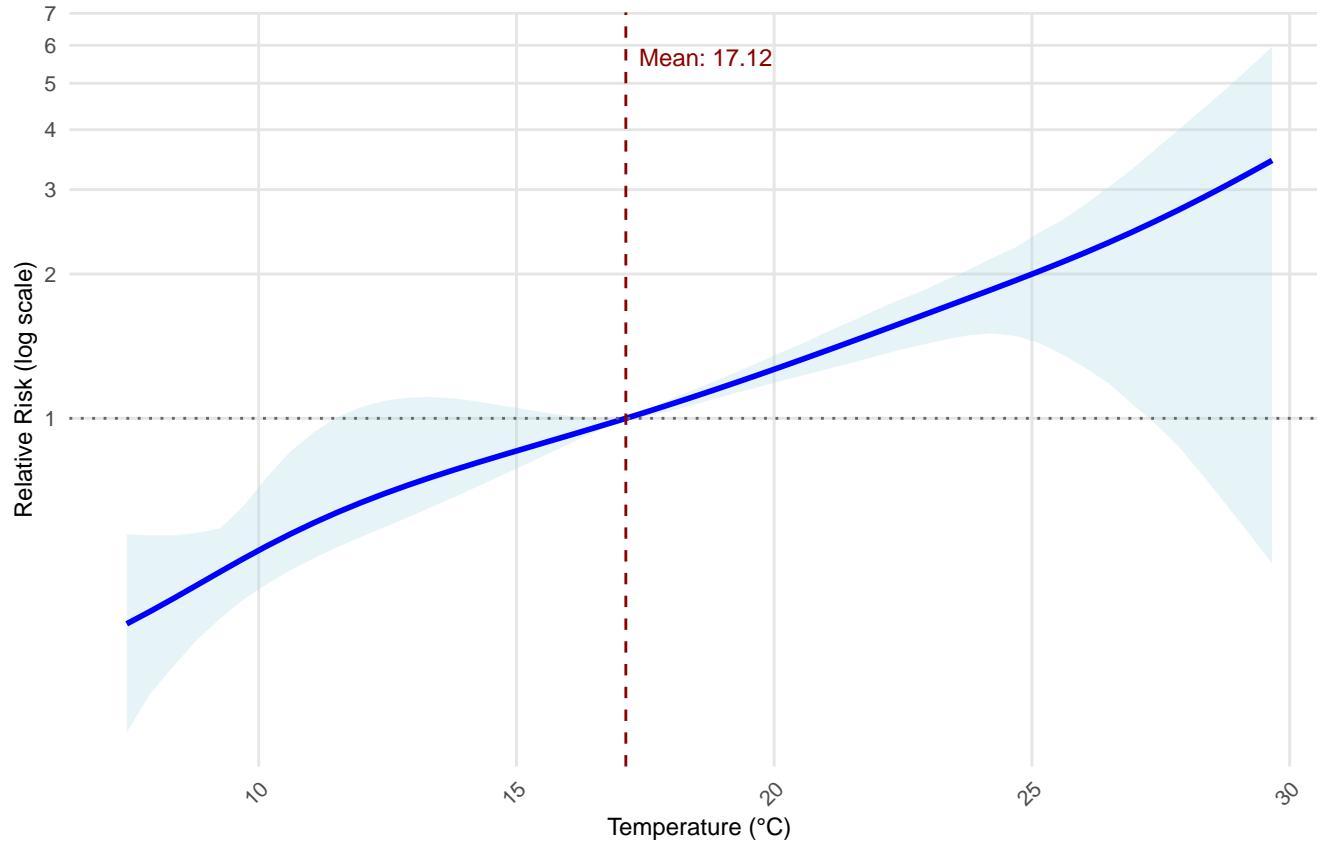
Far West – Model Case Crossover

Effect of Temperature (°C)



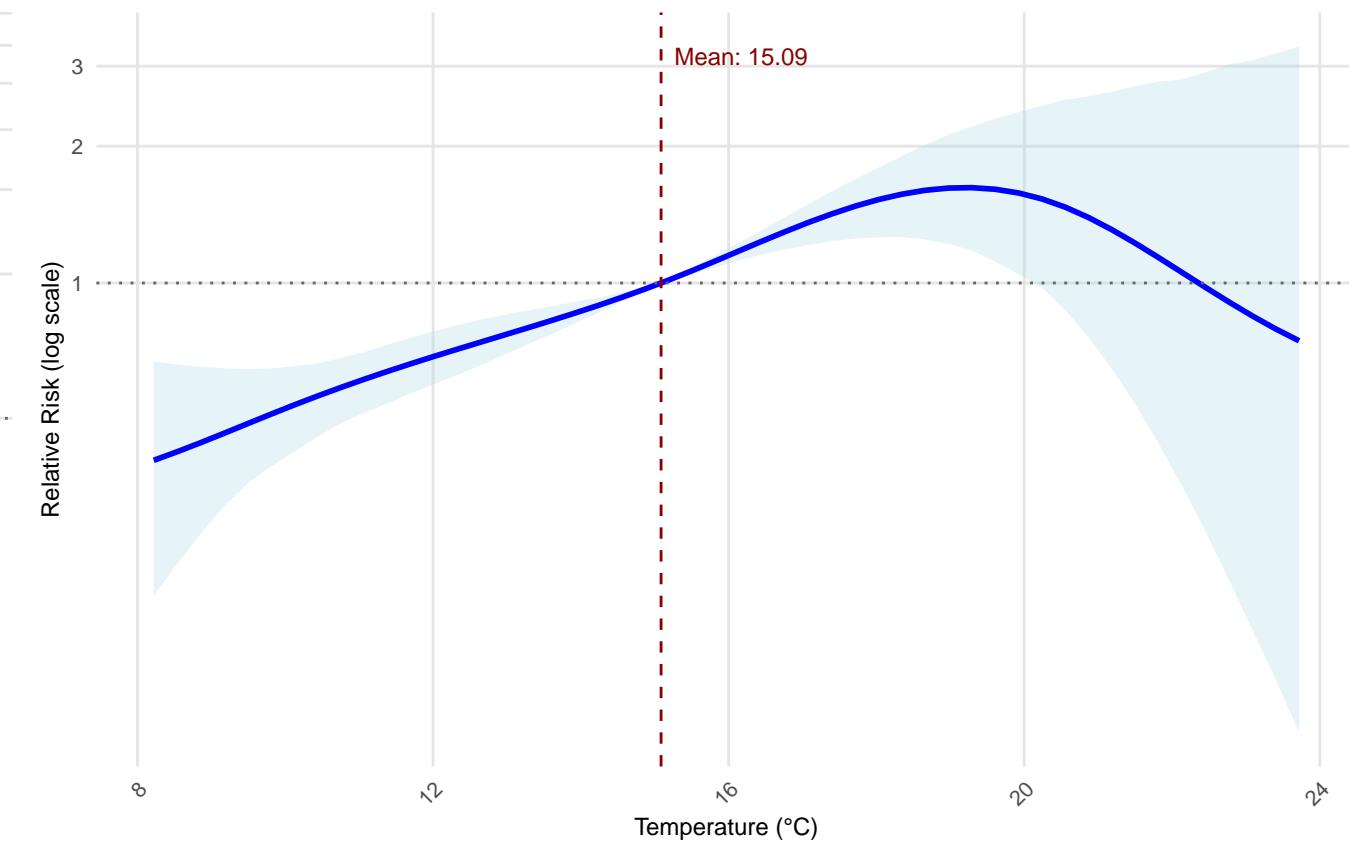
Hunter New England – Model Case Crossover

Effect of Temperature (°C)



Illawarra Shoalhaven – Model Case Crossover

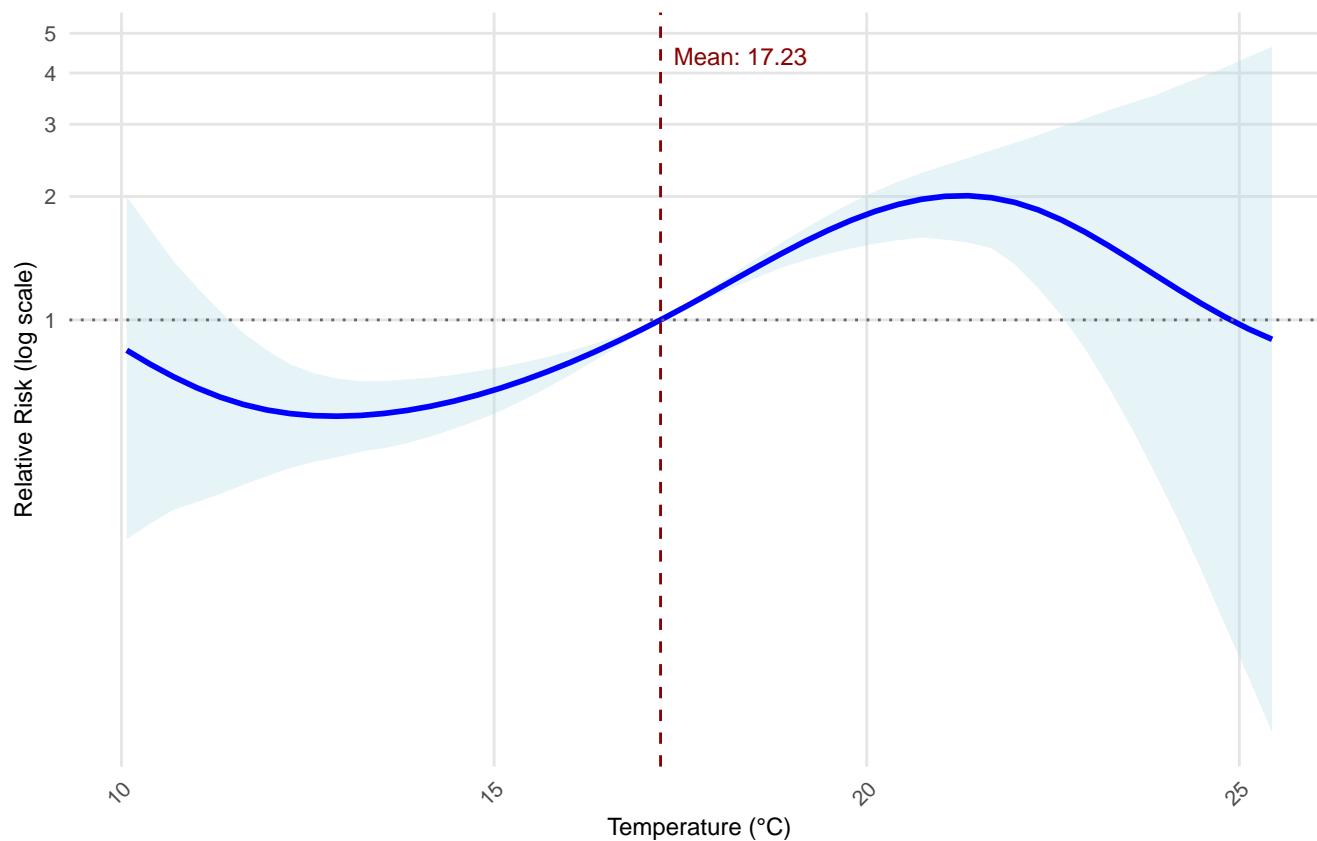
Effect of Temperature (°C)



TEMP – Case Crossover– SB-DLNM

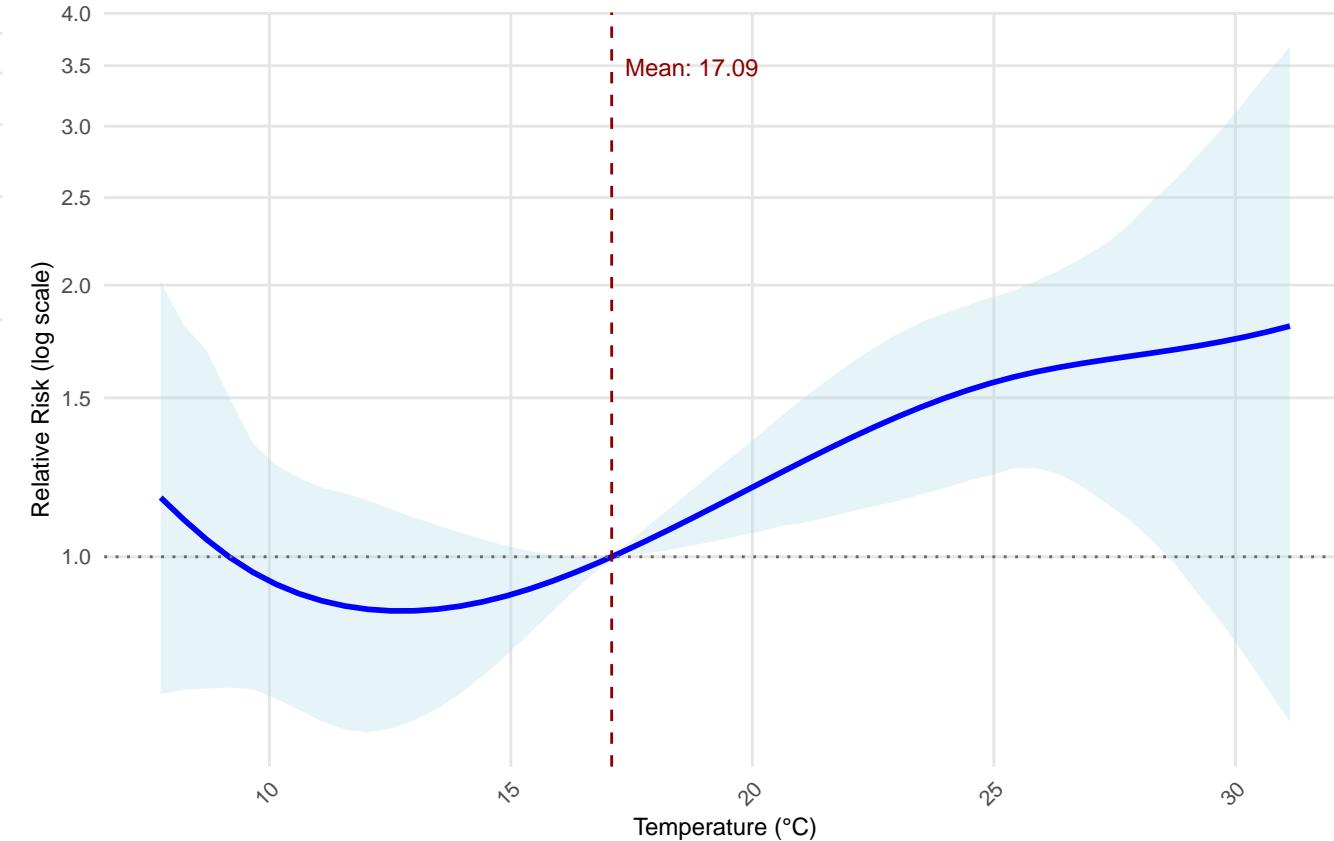
Mid North Coast – Model Case Crossover

Effect of Temperature (°C)



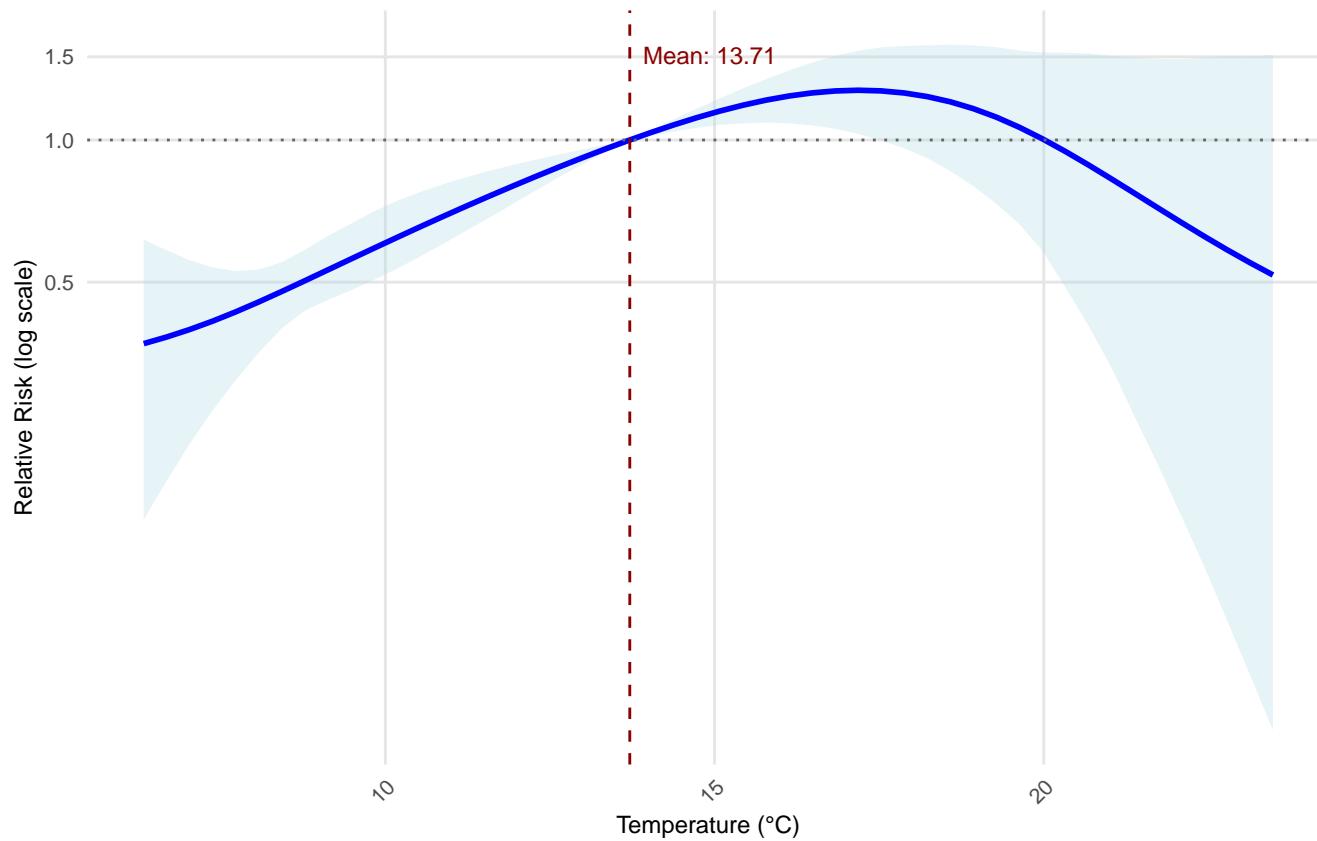
Murrumbidgee – Model Case Crossover

Effect of Temperature (°C)



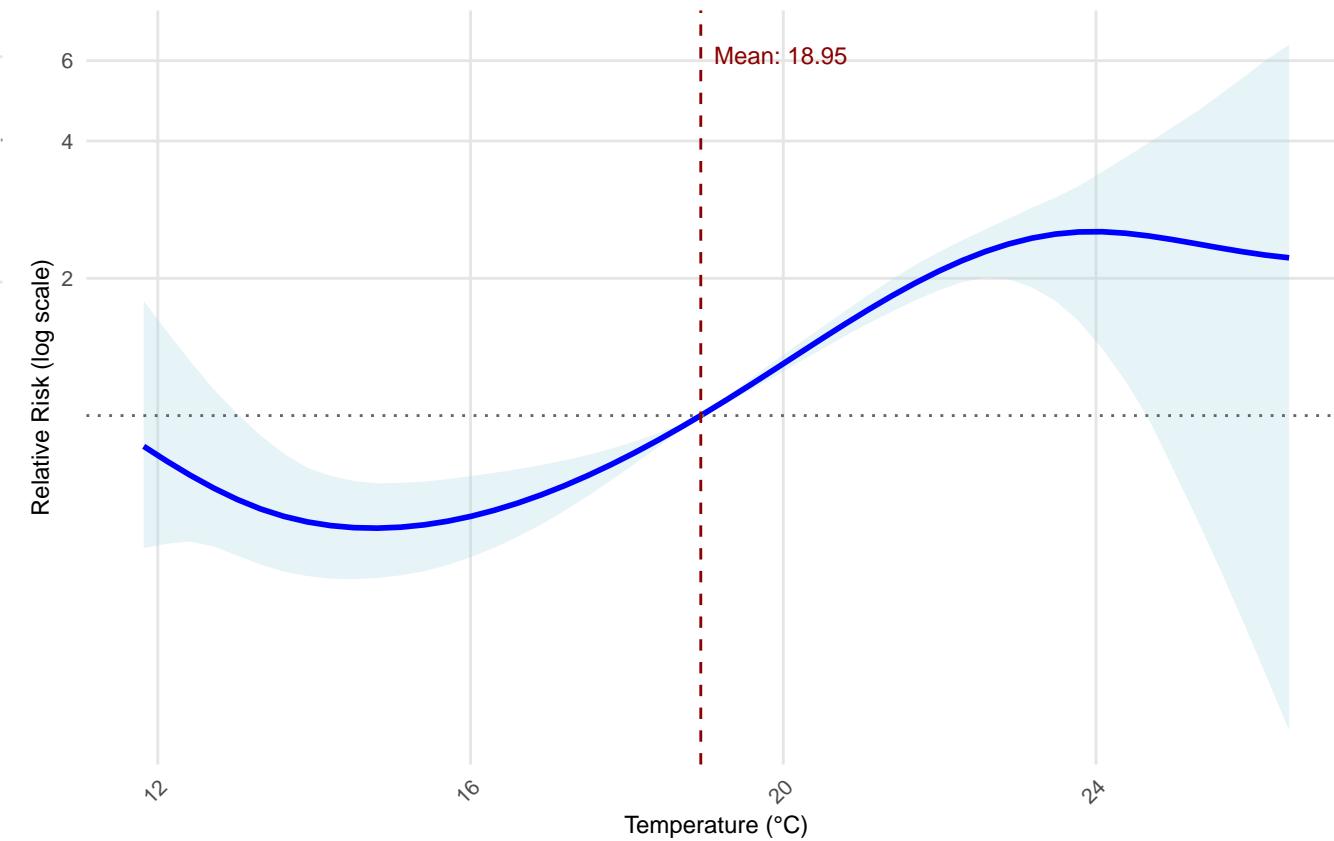
Nepean Blue Mountains – Model Case Crossover

Effect of Temperature (°C)



Northern NSW – Model Case Crossover

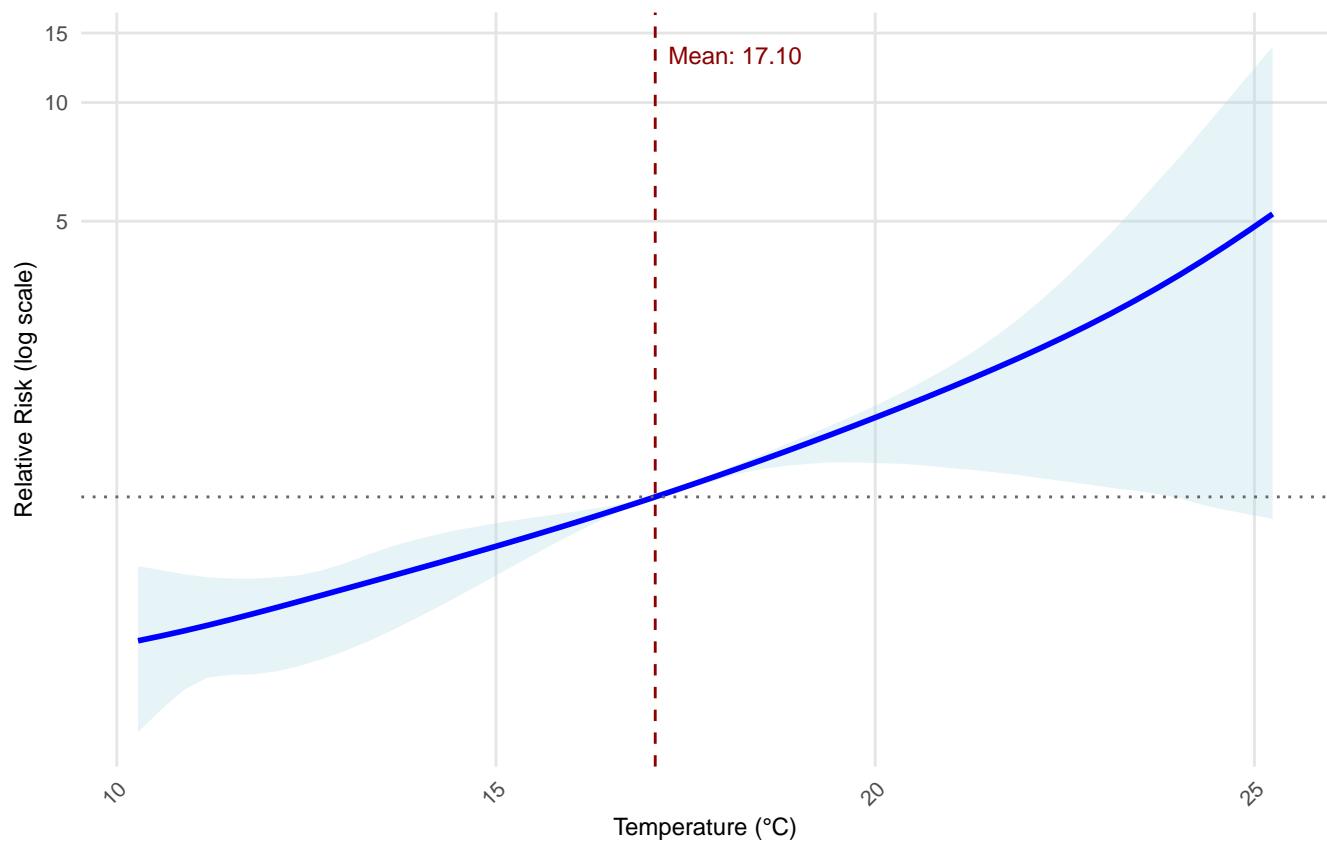
Effect of Temperature (°C)



TEMP – Case Crossover– SB-DLNM

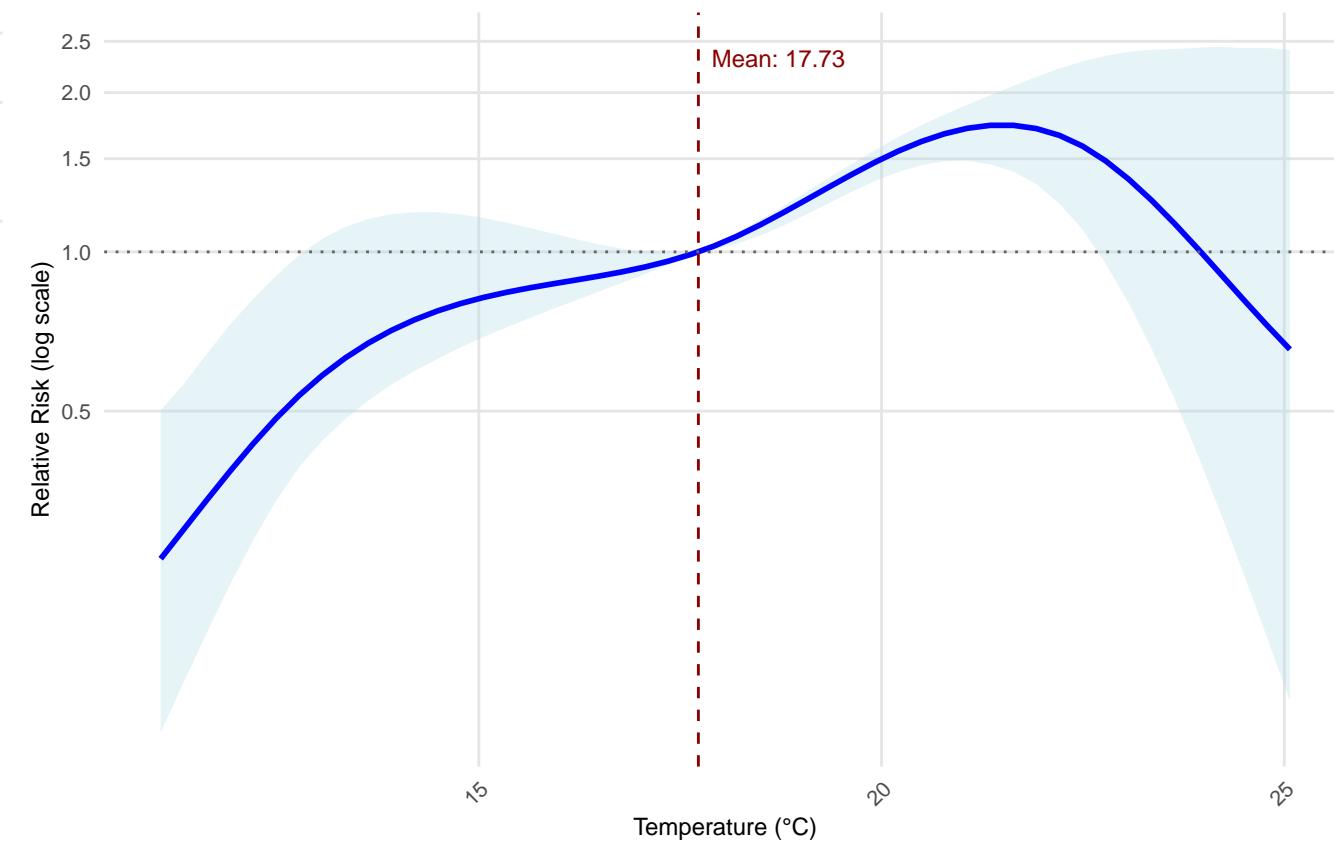
Northern Sydney – Model Case Crossover

Effect of Temperature ($^{\circ}\text{C}$)



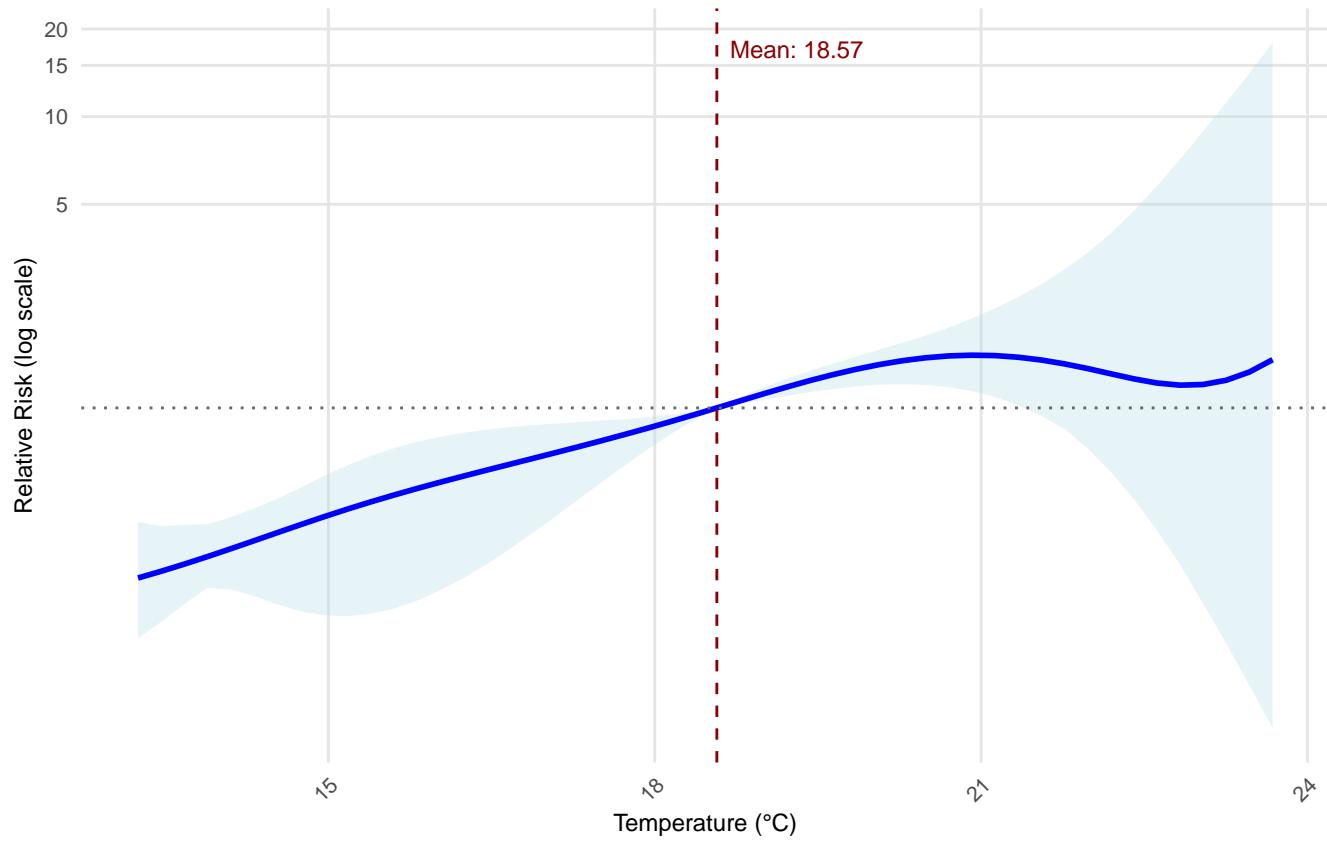
South Eastern Sydney – Model Case Crossover

Effect of Temperature ($^{\circ}\text{C}$)



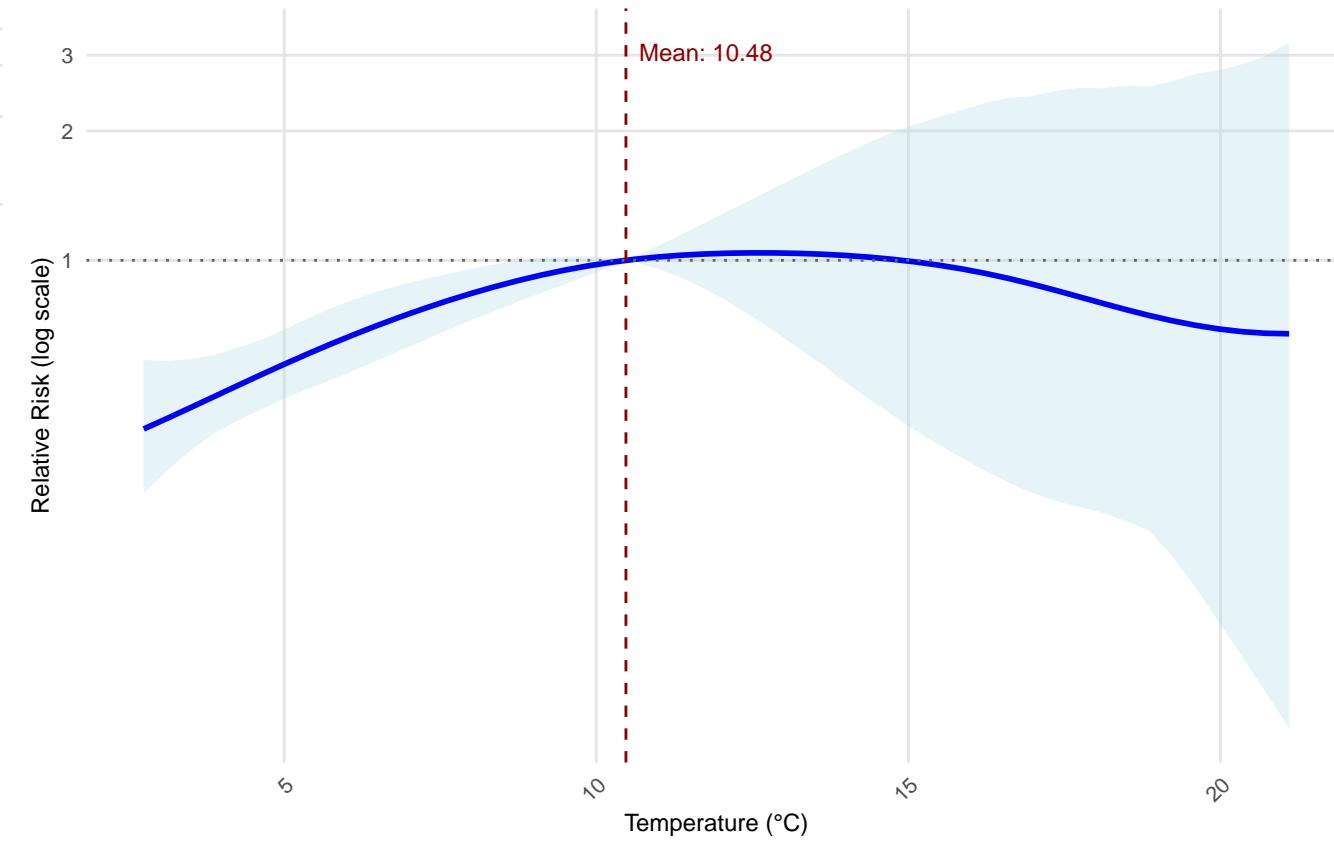
South Western Sydney – Model Case Crossover

Effect of Temperature ($^{\circ}\text{C}$)



Southern NSW – Model Case Crossover

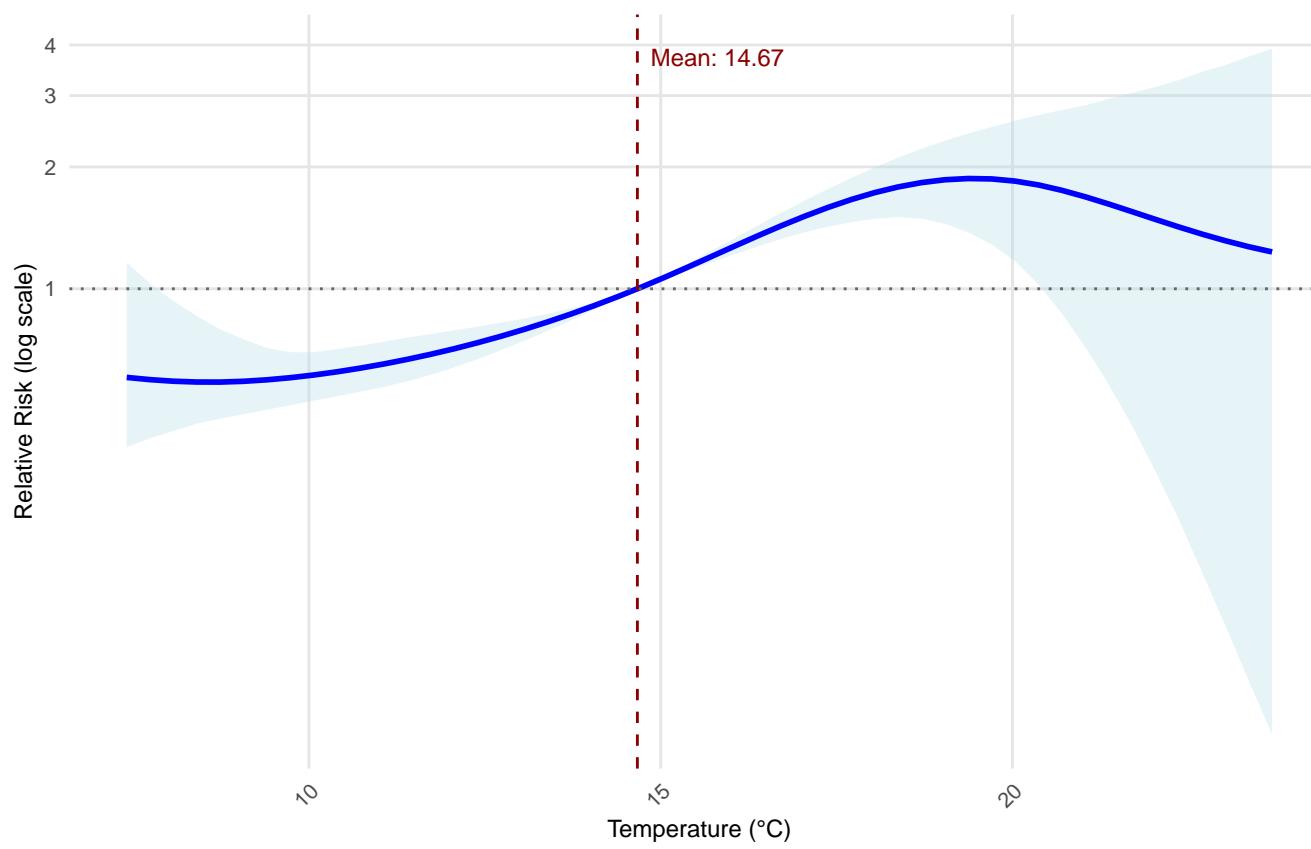
Effect of Temperature ($^{\circ}\text{C}$)



TEMP – Case Crossover– SB-DLNM

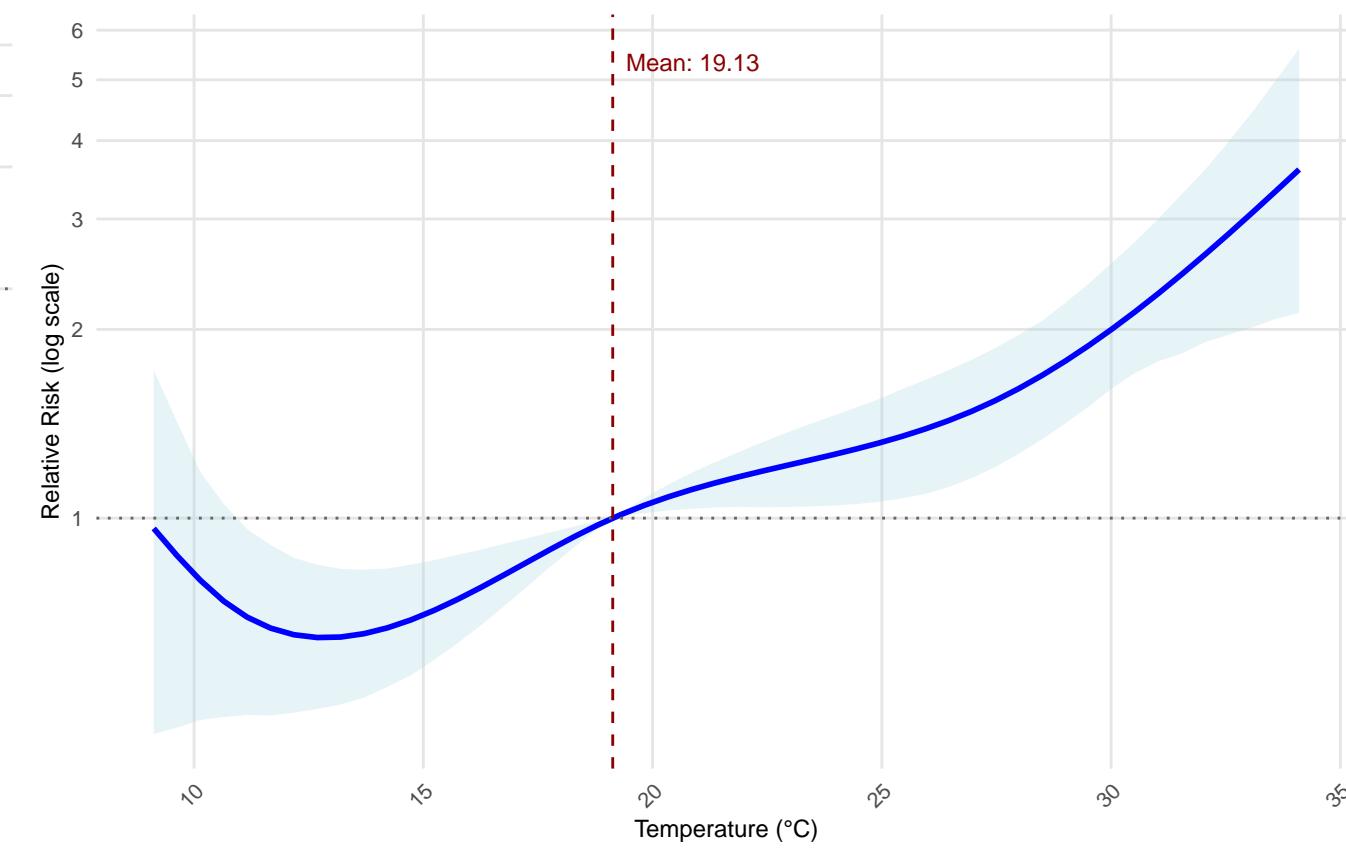
Sydney – Model Case Crossover

Effect of Temperature (°C)



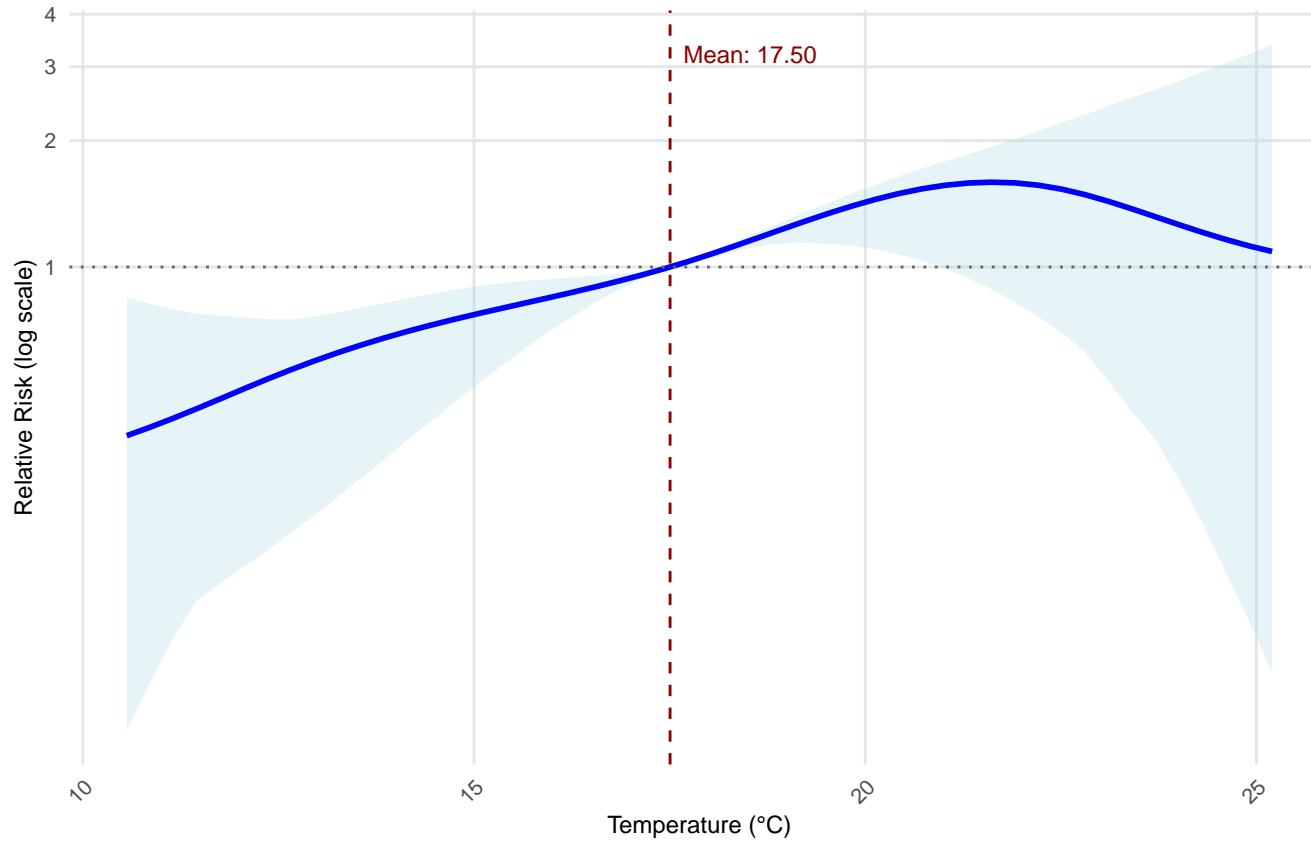
Western NSW – Model Case Crossover

Effect of Temperature (°C)



Western Sydney – Model Case Crossover

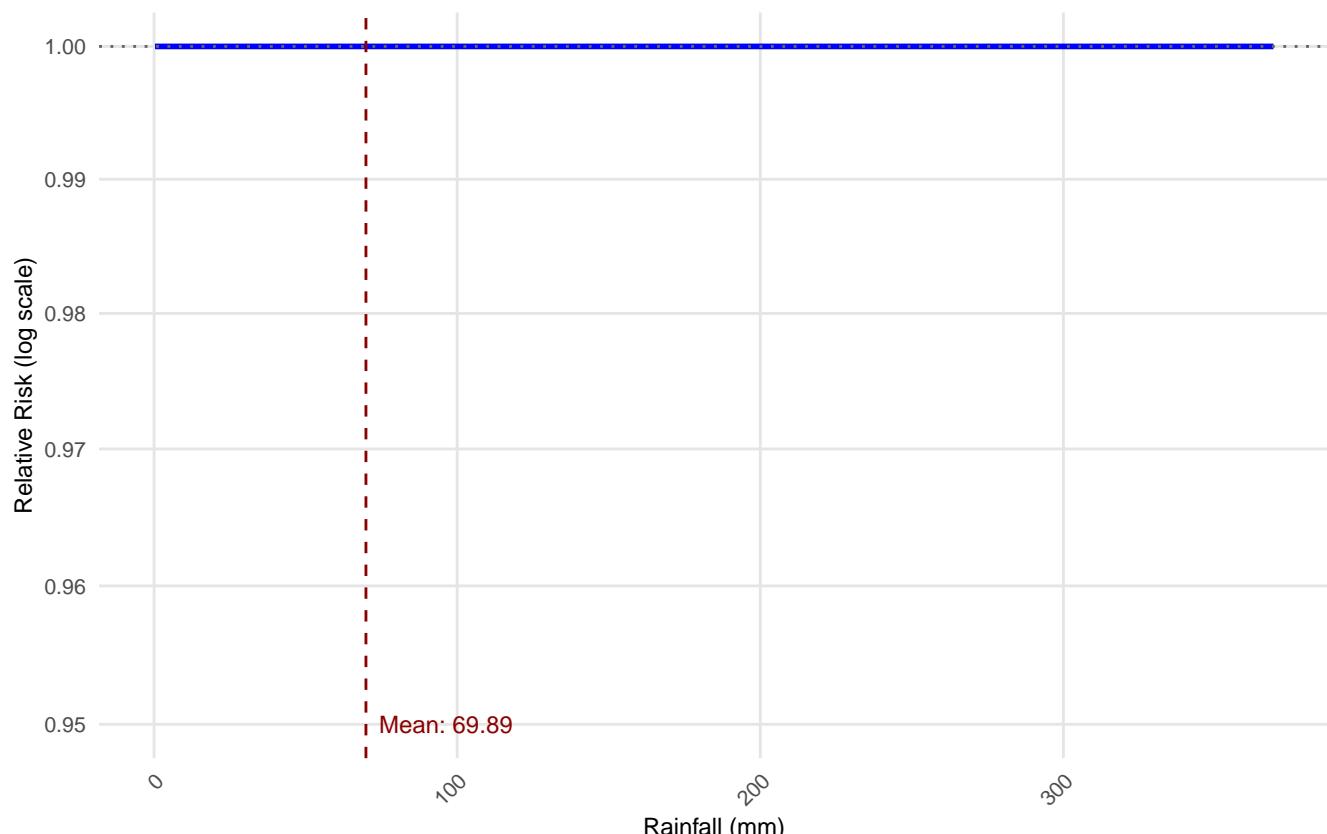
Effect of Temperature (°C)



RAIN – Case Crossover– SB–DLNM

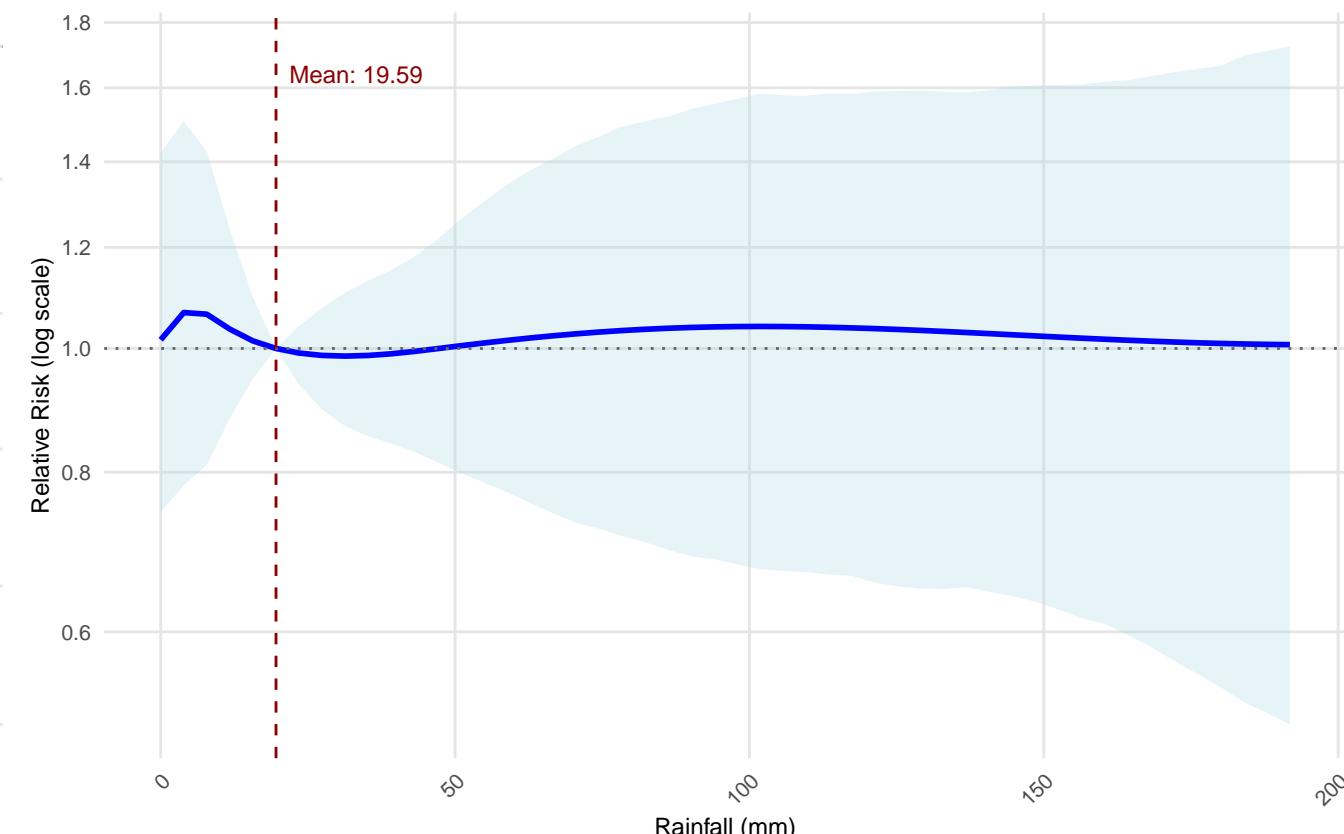
Central Coast – Model Case Crossover

Effect of Rainfall (mm)



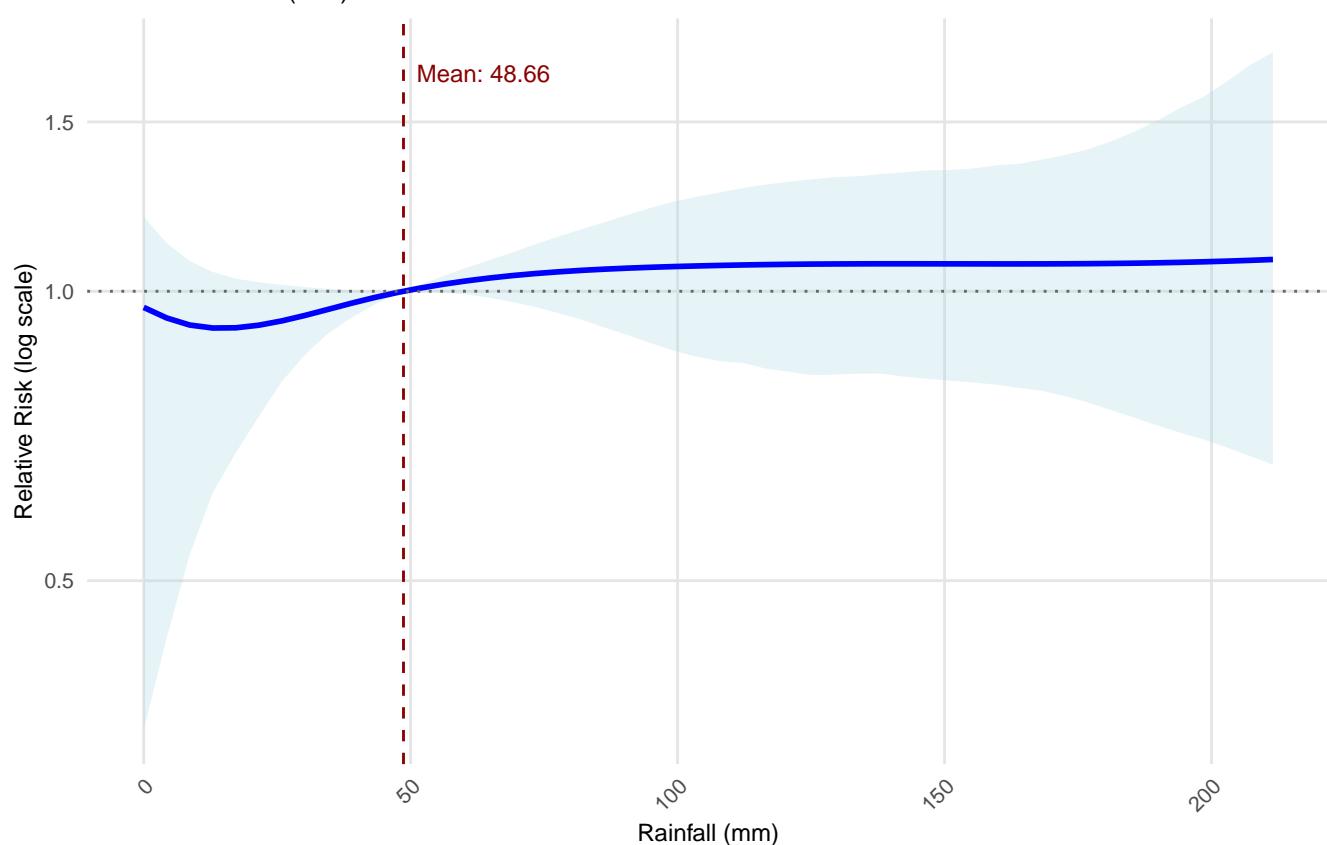
Far West – Model Case Crossover

Effect of Rainfall (mm)



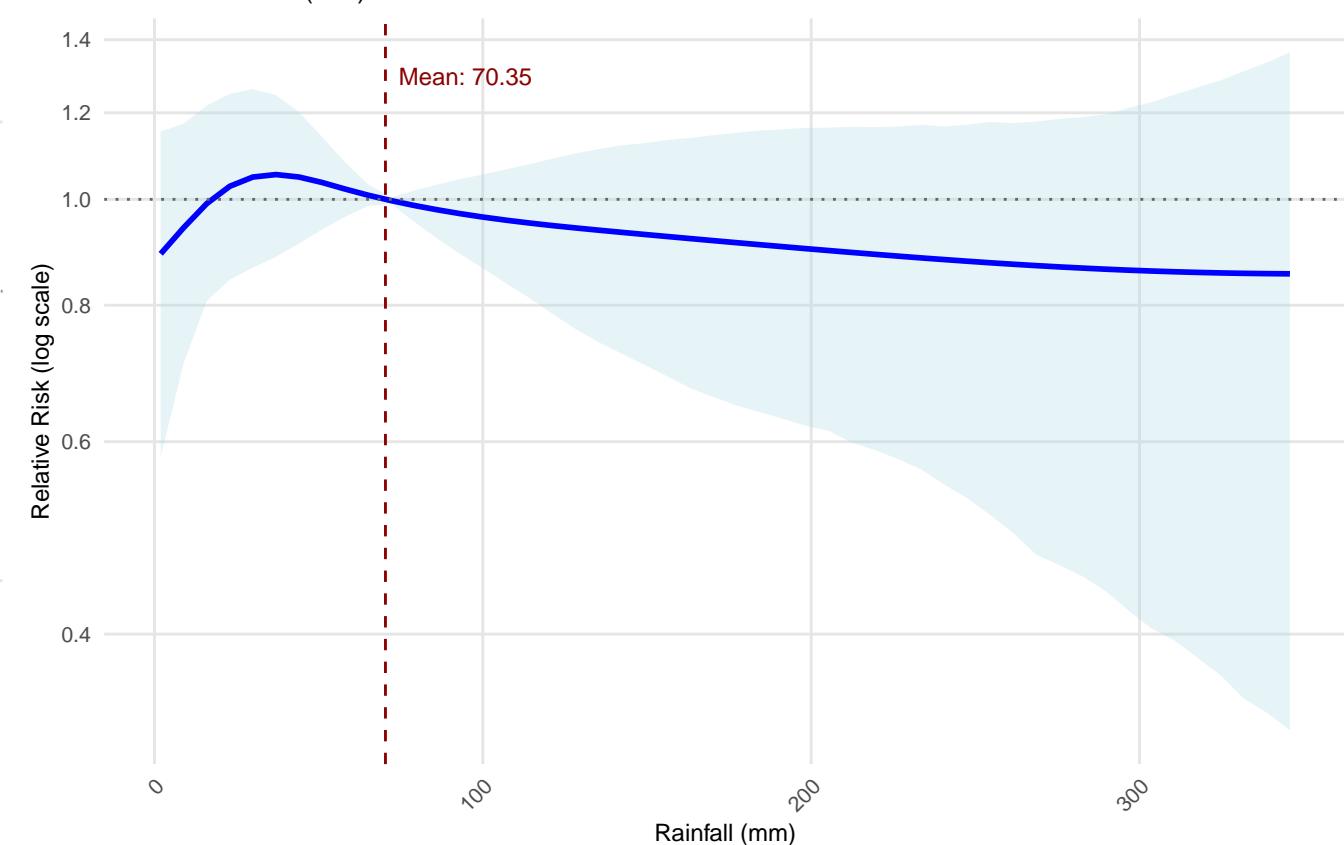
Hunter New England – Model Case Crossover

Effect of Rainfall (mm)



Illawarra Shoalhaven – Model Case Crossover

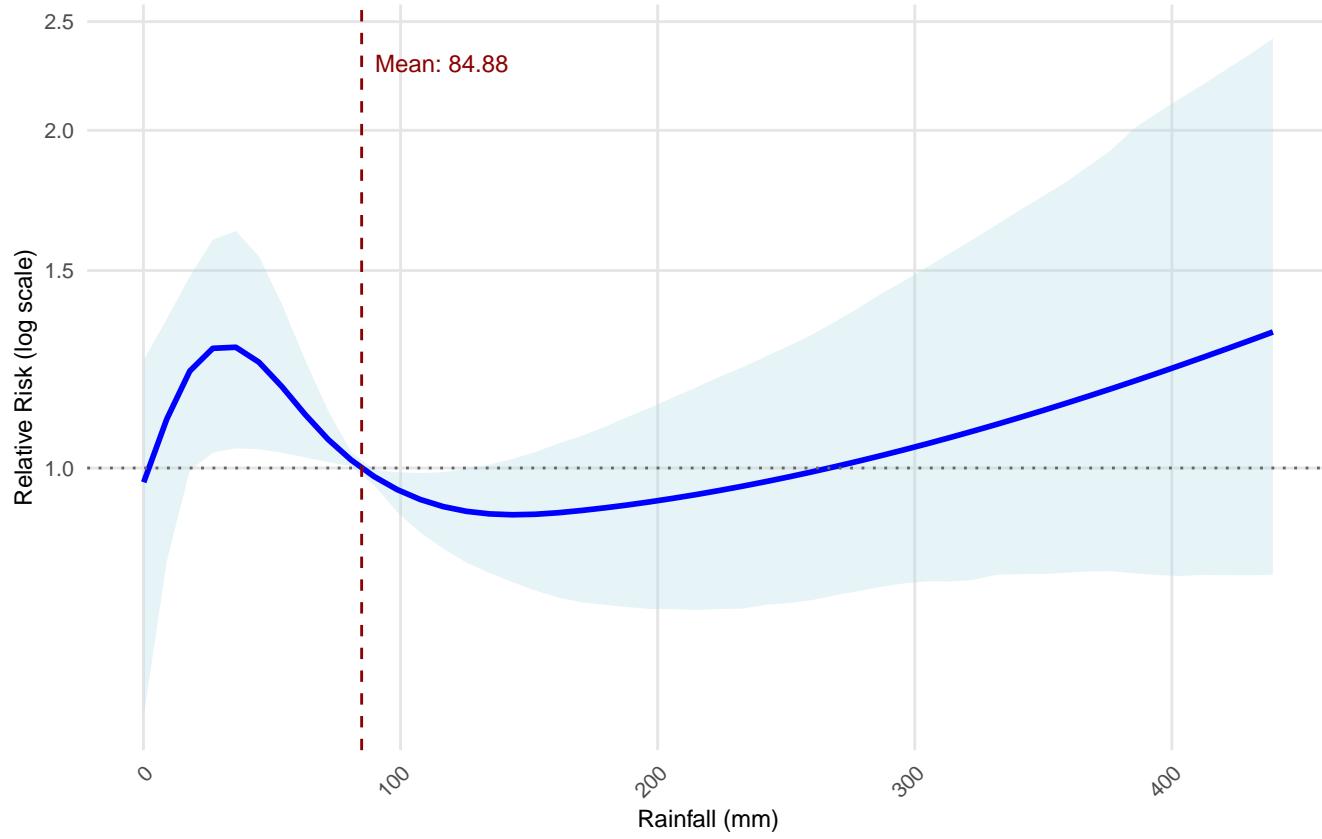
Effect of Rainfall (mm)



RAIN – Case Crossover– SB–DLNM

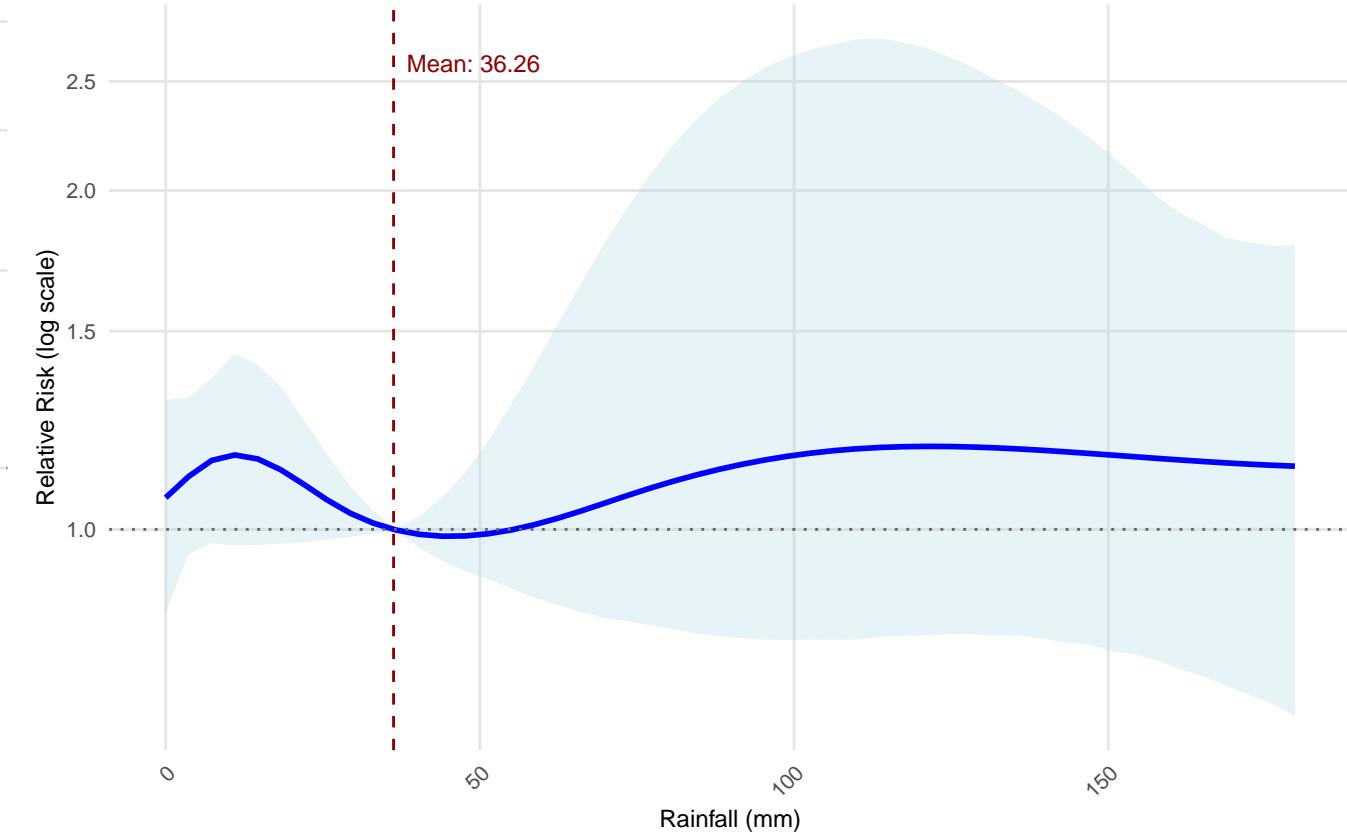
Mid North Coast – Model Case Crossover

Effect of Rainfall (mm)



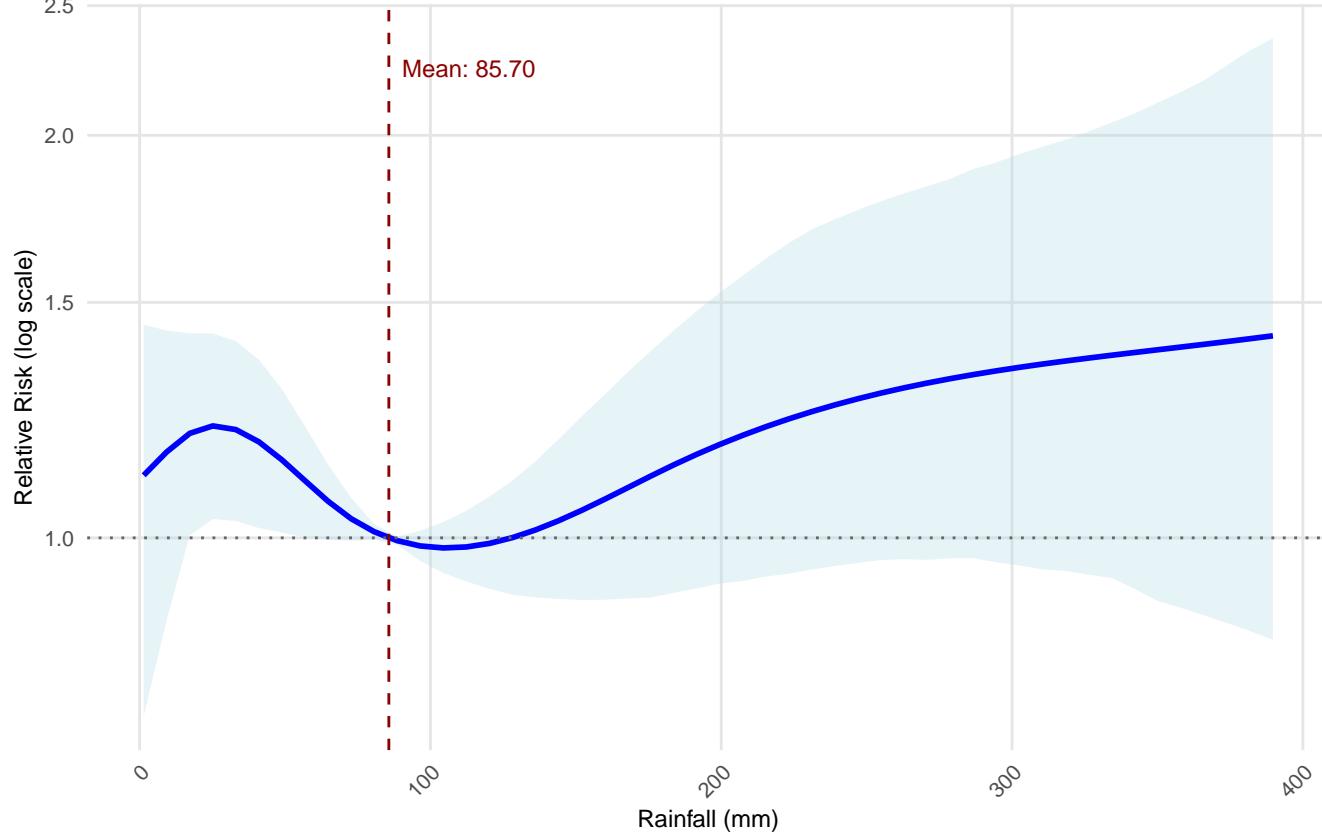
Murrumbidgee – Model Case Crossover

Effect of Rainfall (mm)



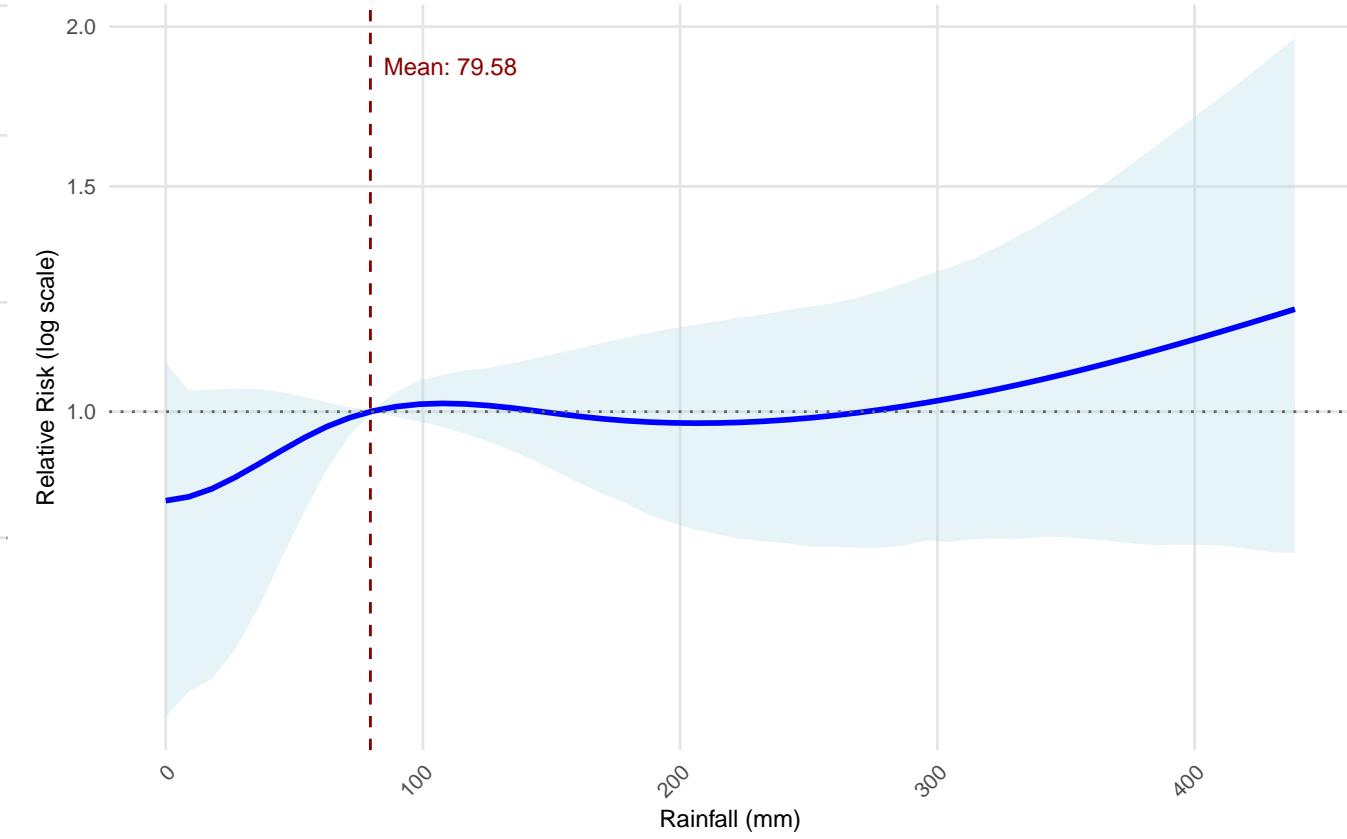
Nepean Blue Mountains – Model Case Crossover

Effect of Rainfall (mm)



Northern NSW – Model Case Crossover

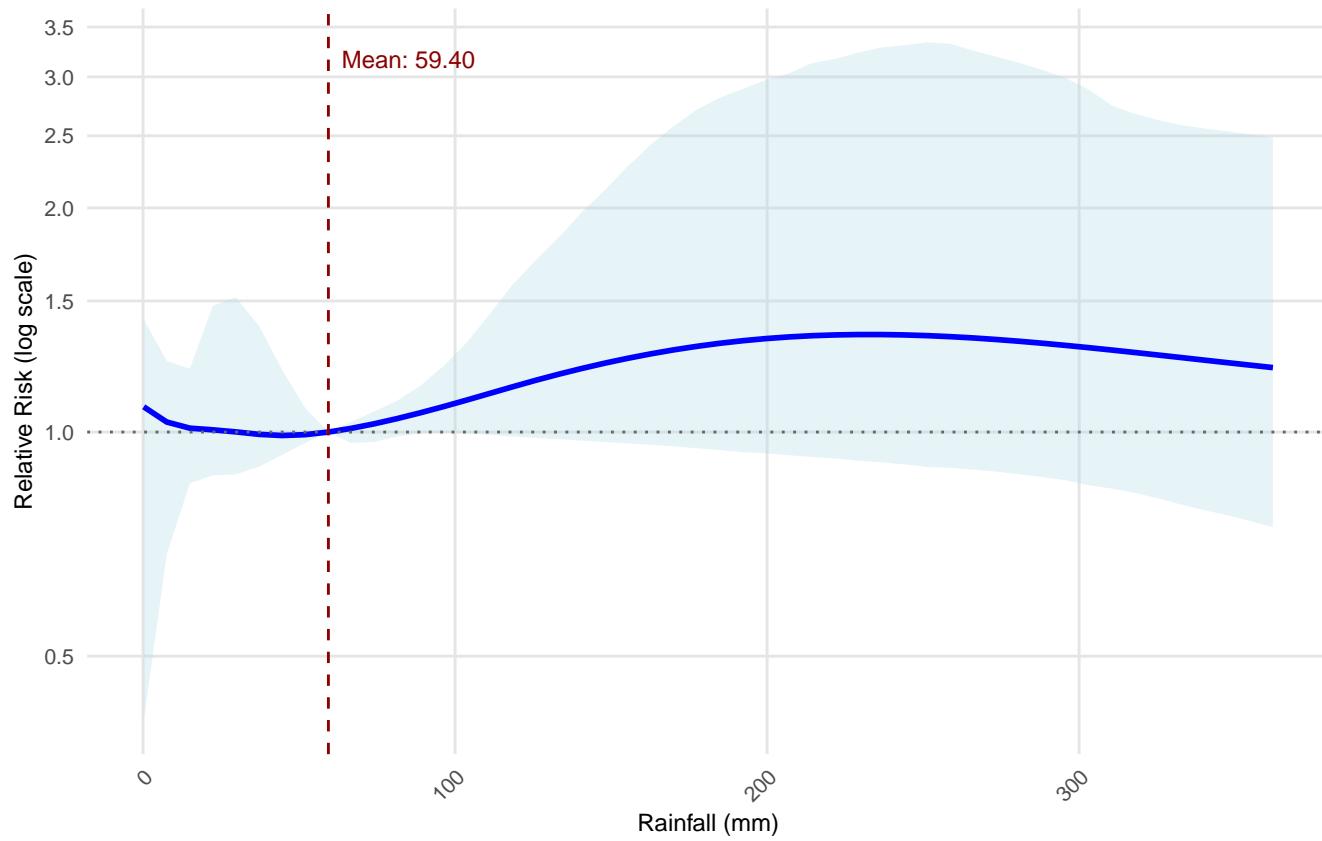
Effect of Rainfall (mm)



RAIN – Case Crossover– SB-DLNM

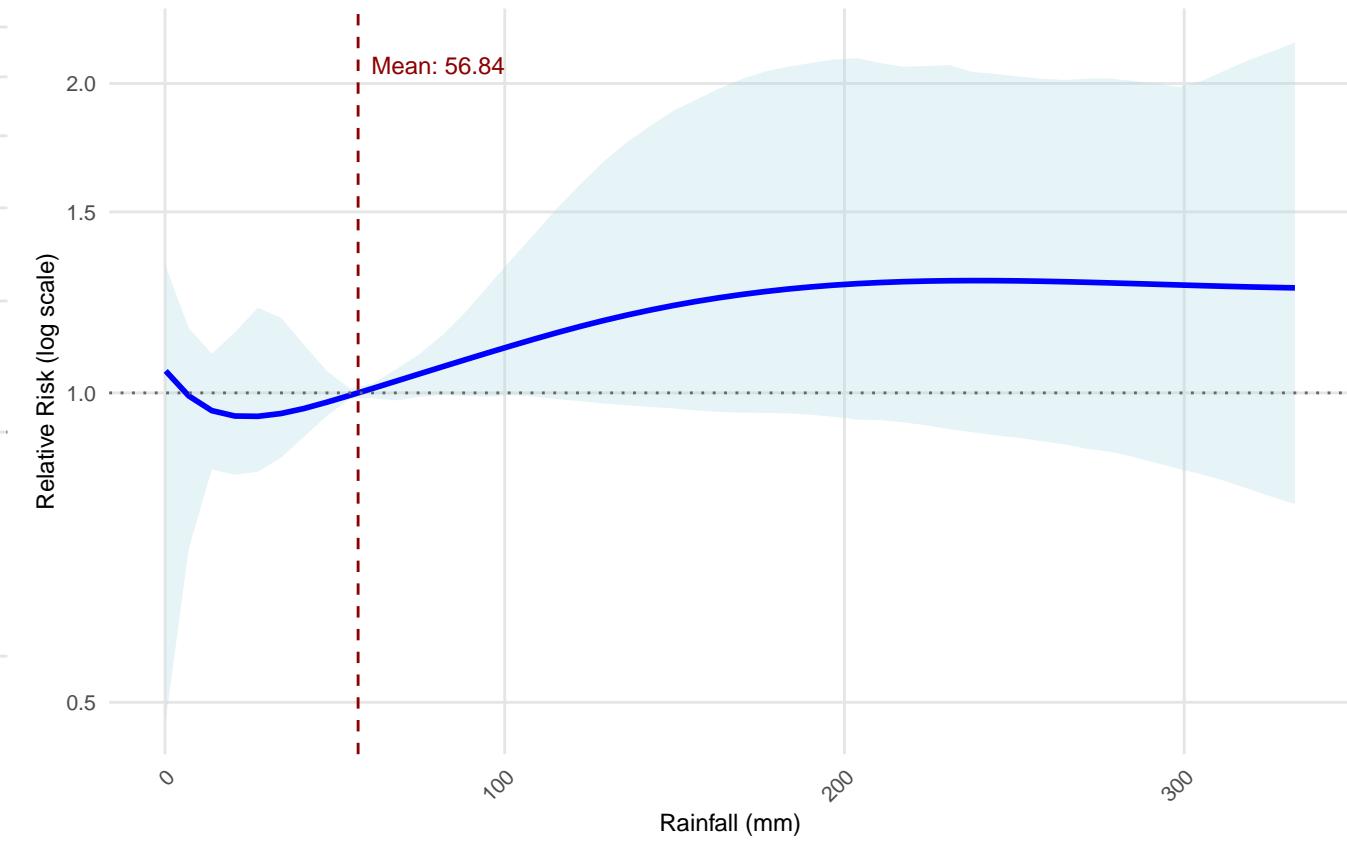
Northern Sydney – Model Case Crossover

Effect of Rainfall (mm)



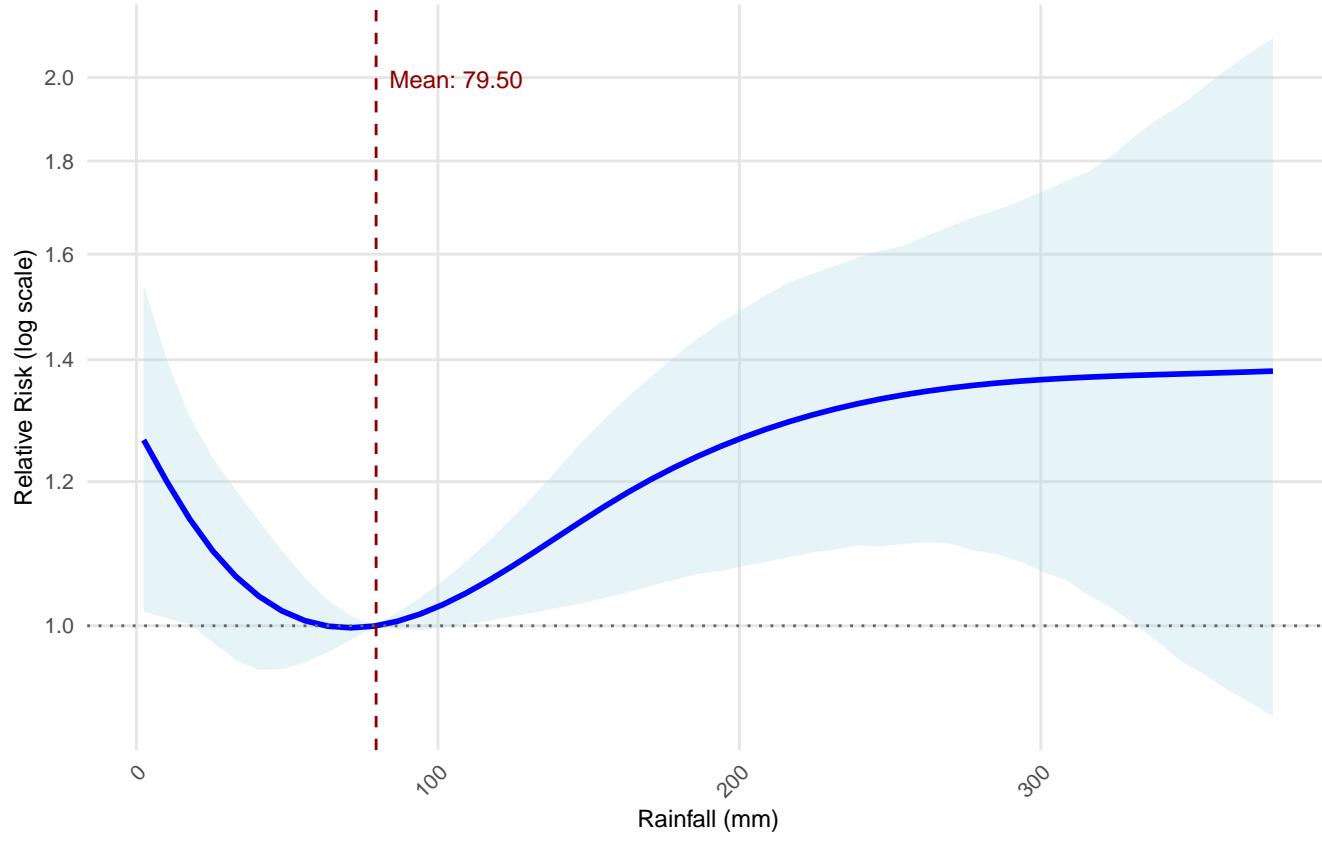
South Eastern Sydney – Model Case Crossover

Effect of Rainfall (mm)



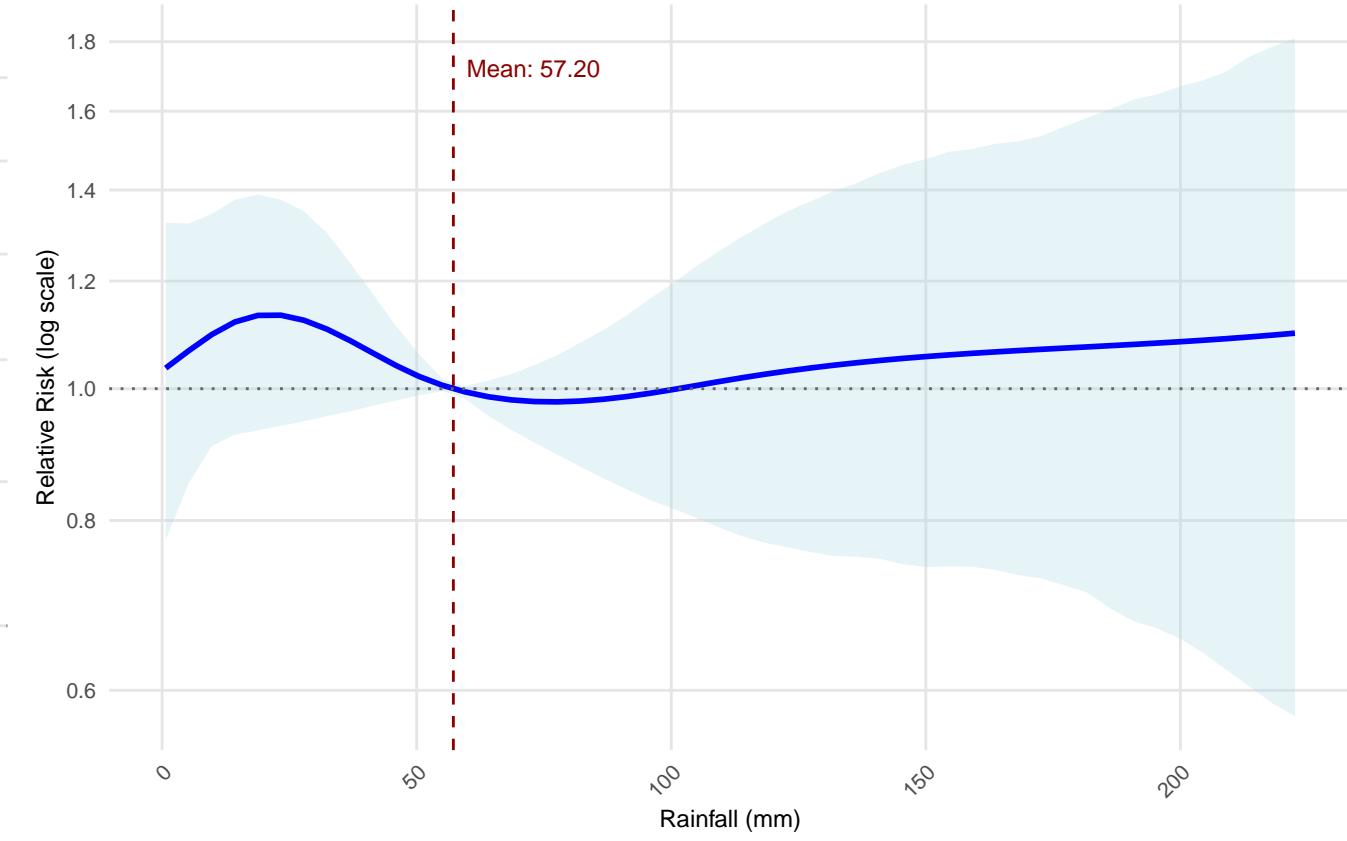
South Western Sydney – Model Case Crossover

Effect of Rainfall (mm)



Southern NSW – Model Case Crossover

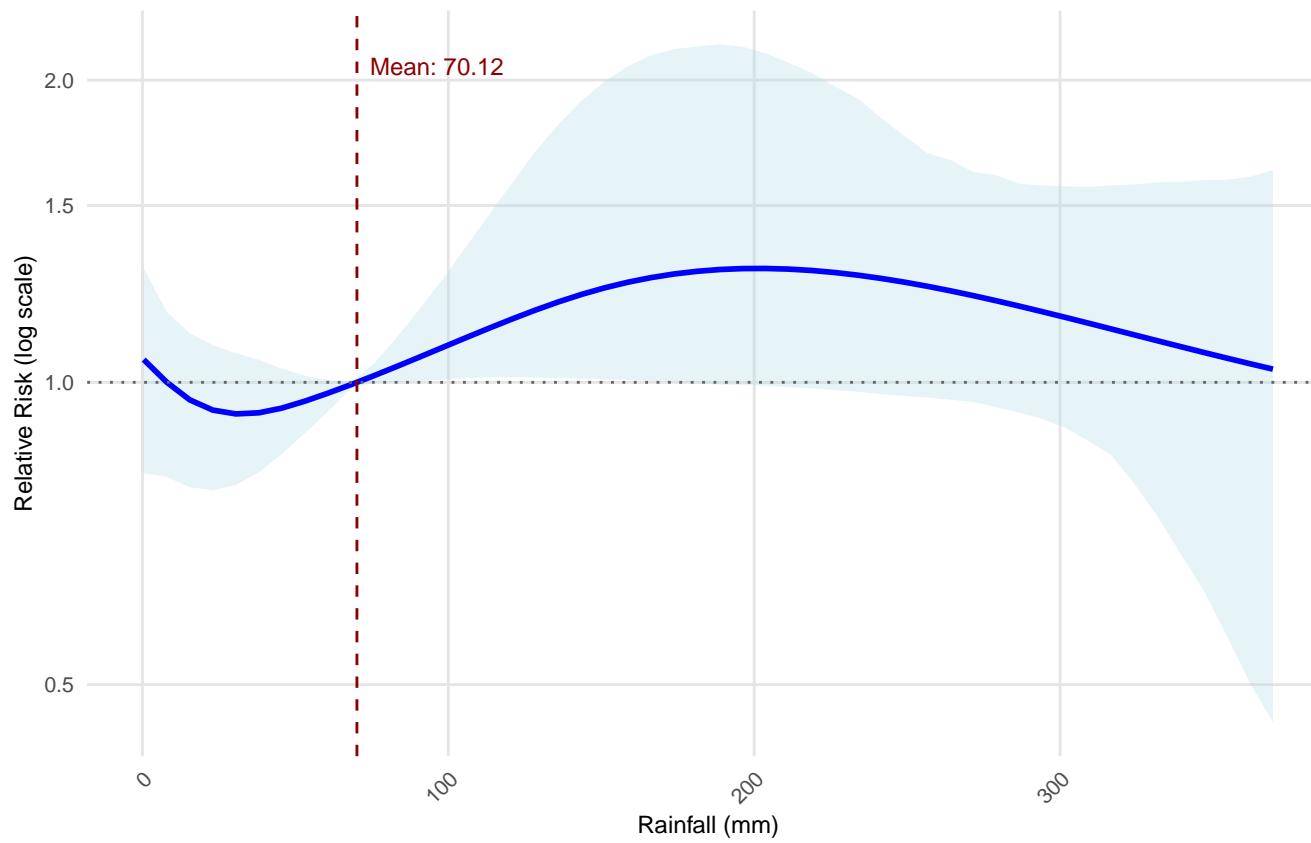
Effect of Rainfall (mm)



RAIN – Case Crossover– SB–DLNM

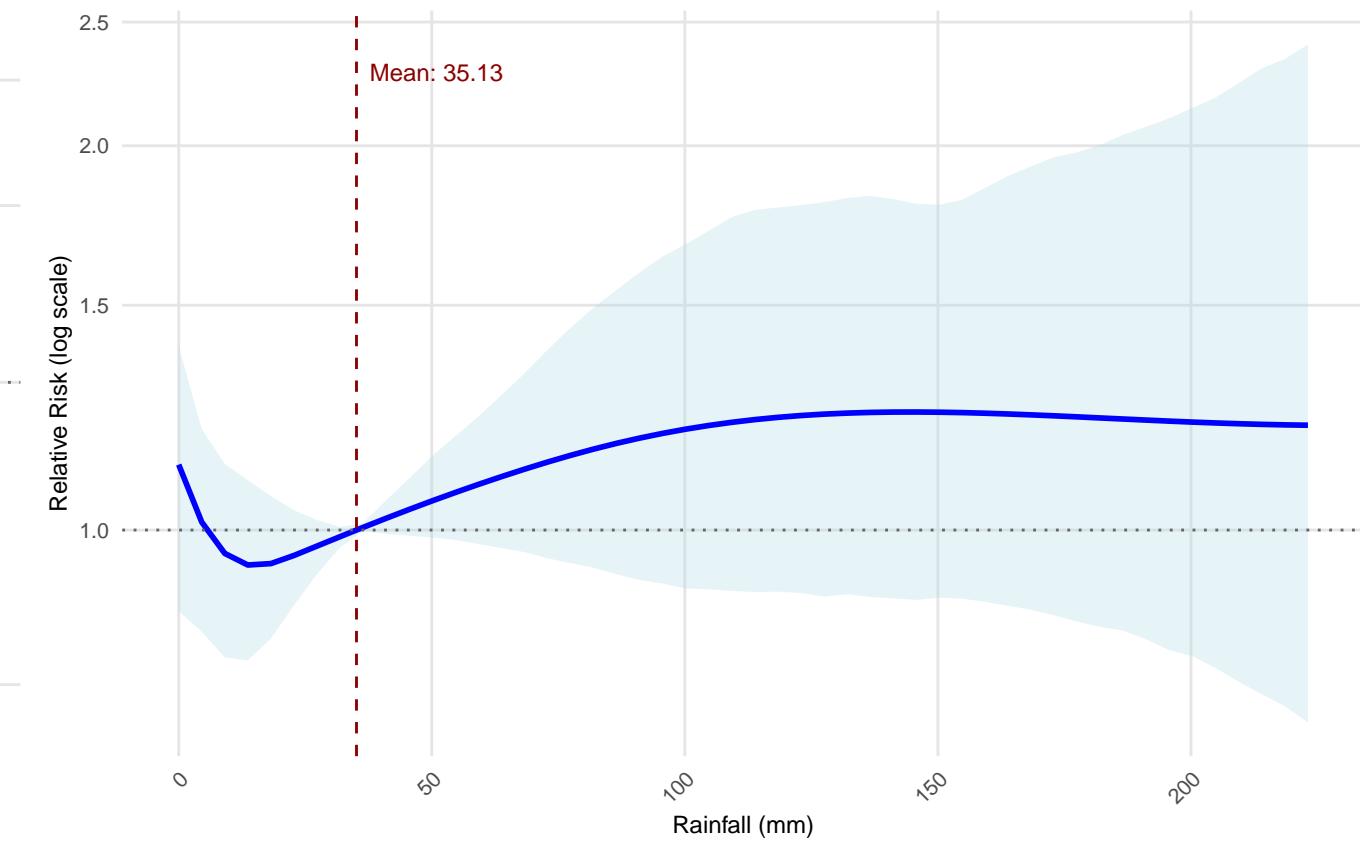
Sydney – Model Case Crossover

Effect of Rainfall (mm)



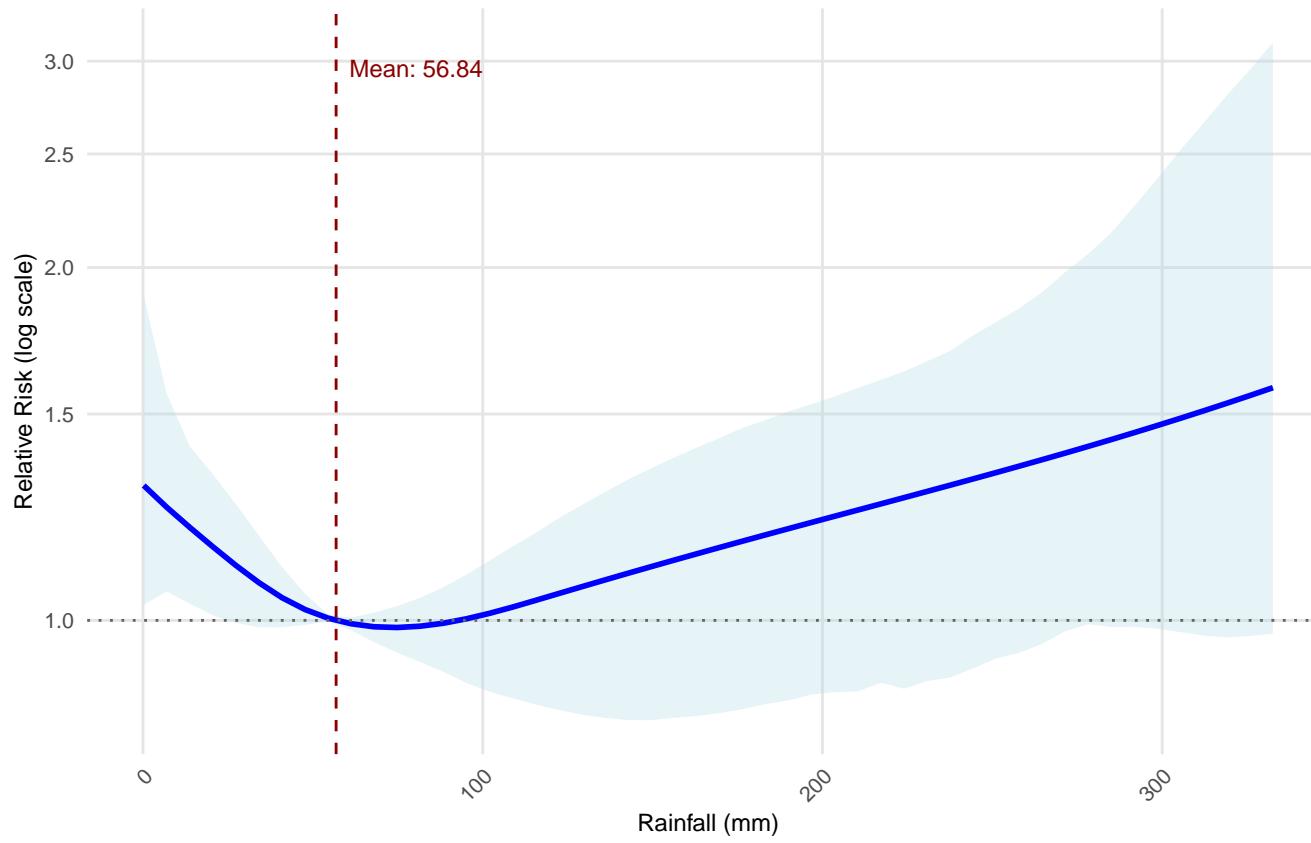
Western NSW – Model Case Crossover

Effect of Rainfall (mm)



Western Sydney – Model Case Crossover

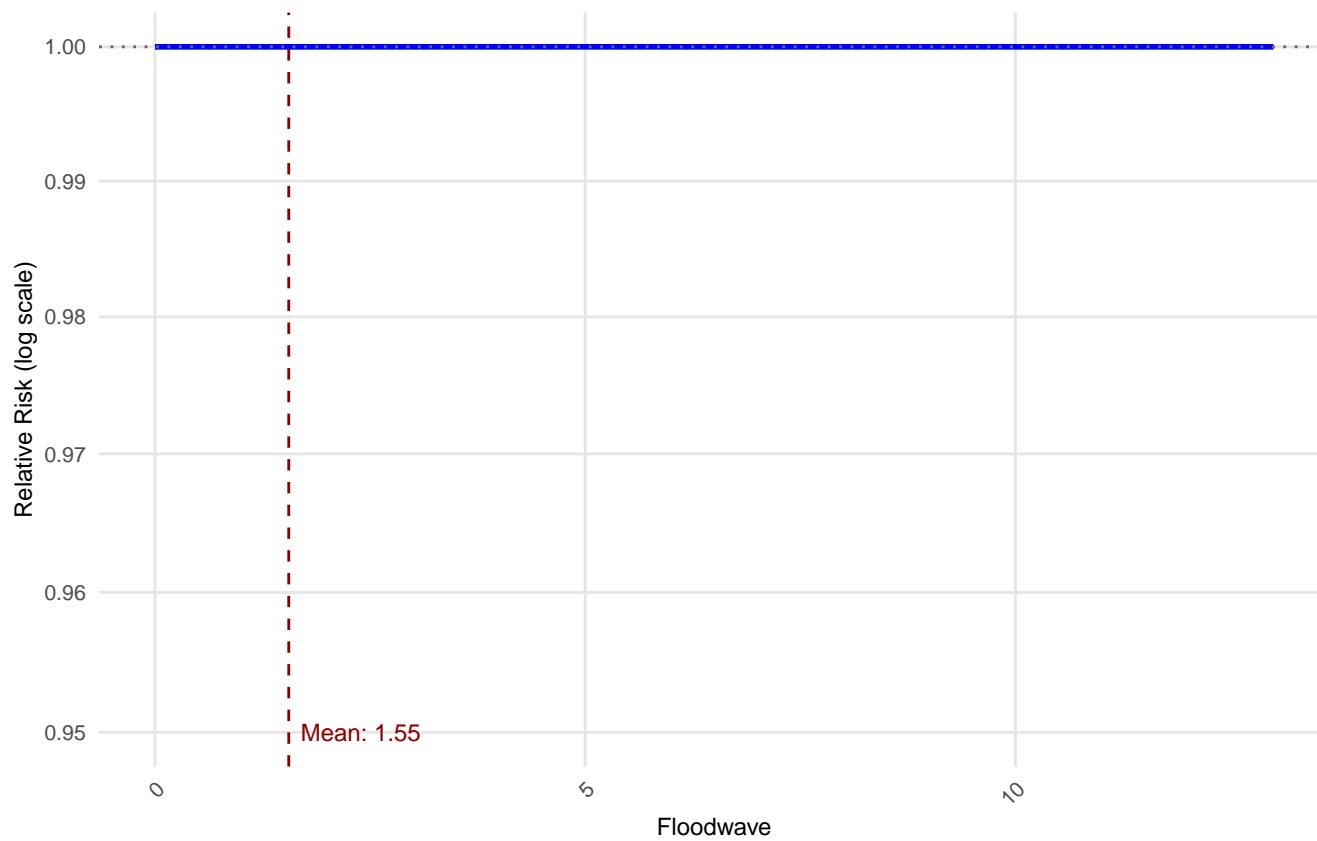
Effect of Rainfall (mm)



FLOOD – Case Crossover– SB-DLNM

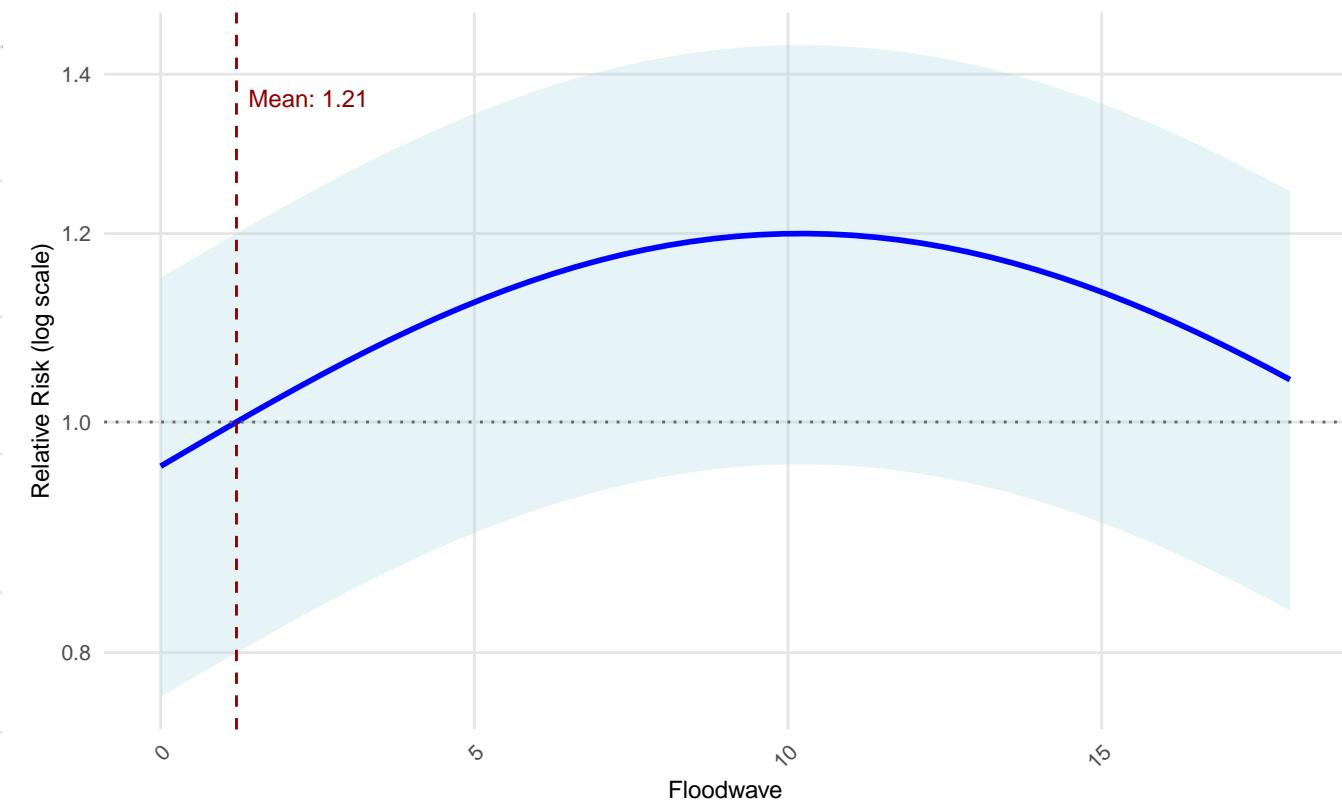
Central Coast – Model Case Crossover

Effect of Floodwave



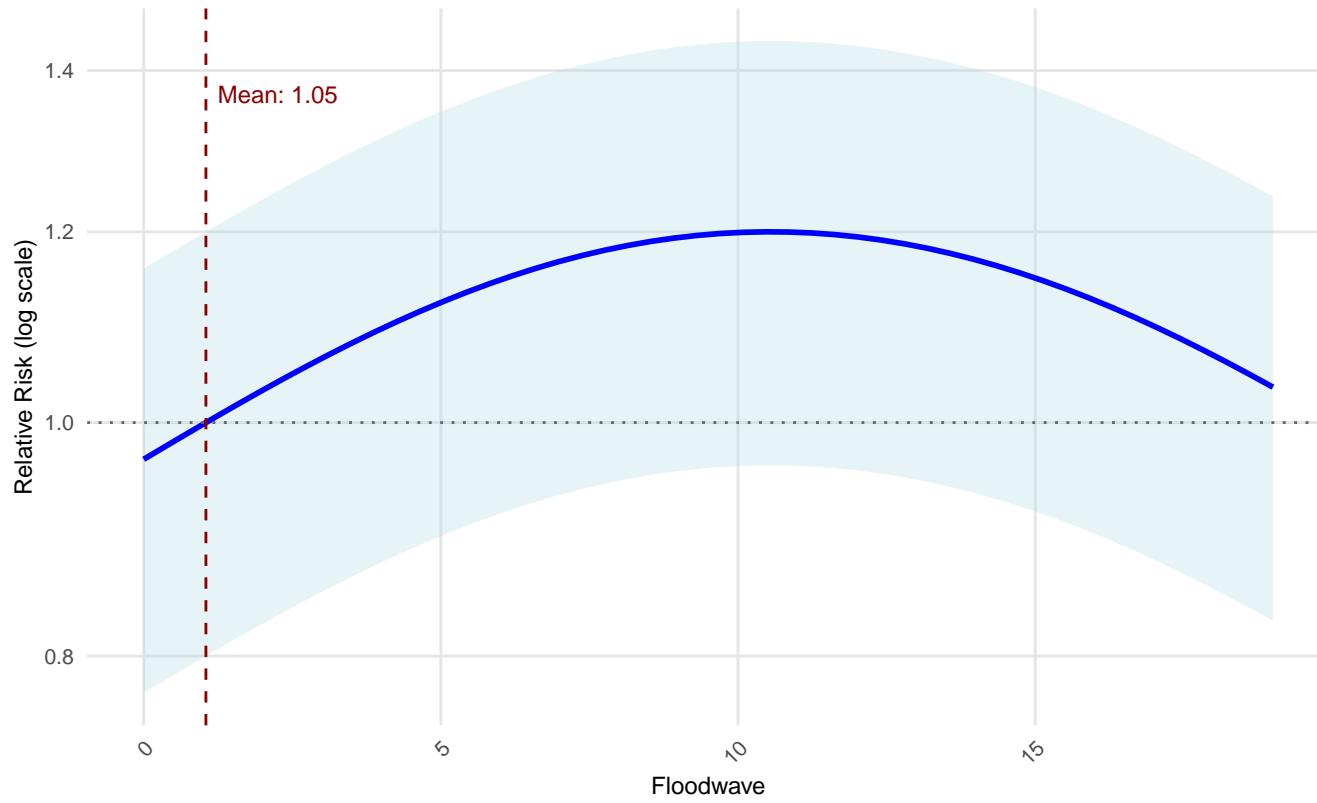
Hunter New England – Model Case Crossover

Effect of Floodwave



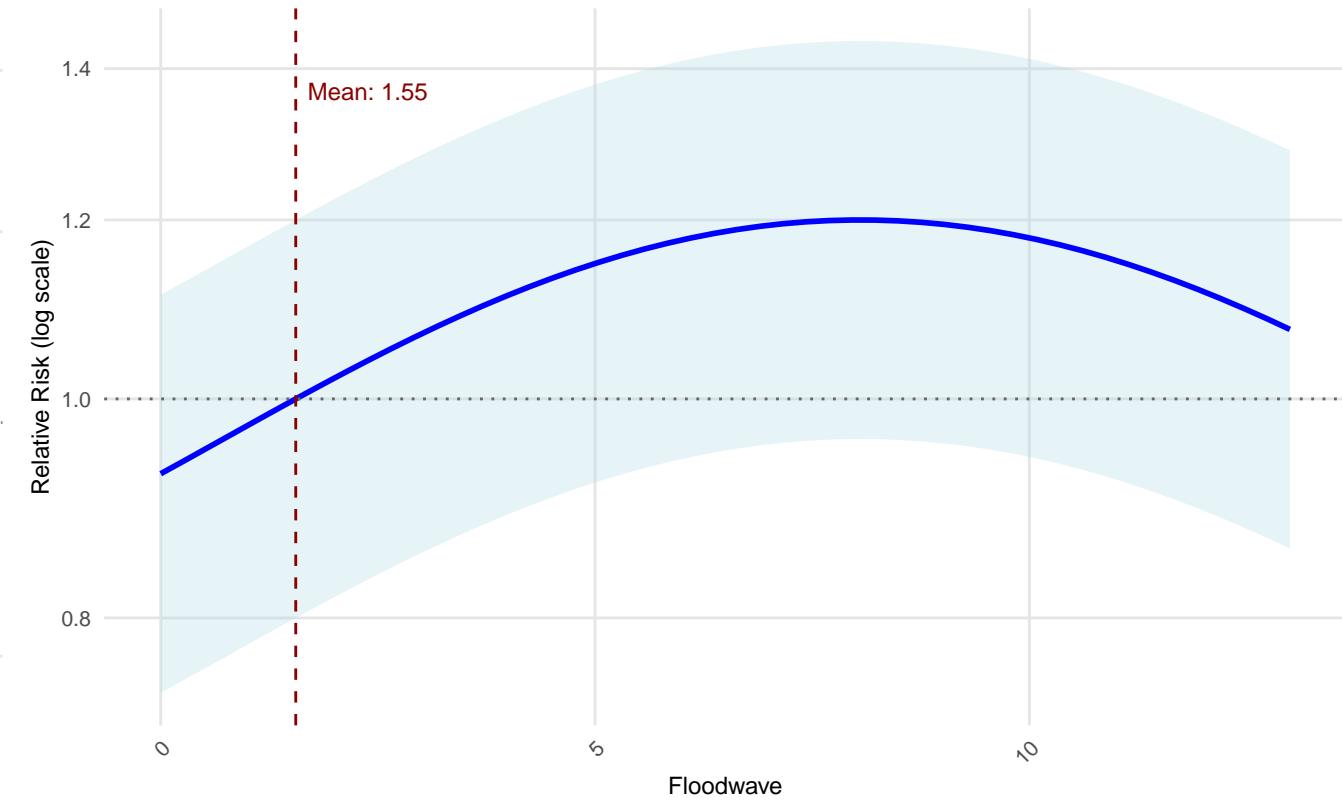
Illawarra Shoalhaven – Model Case Crossover

Effect of Floodwave



Mid North Coast – Model Case Crossover

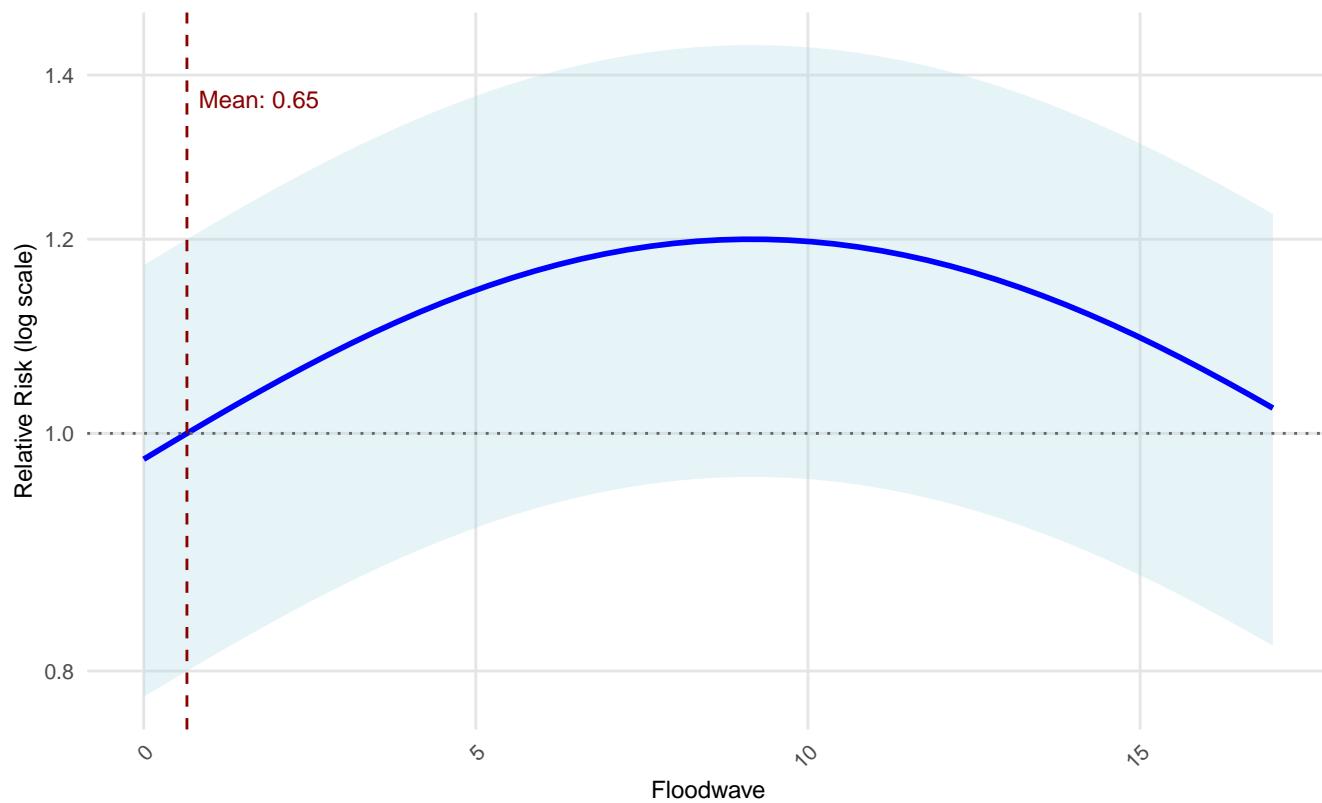
Effect of Floodwave



FLOOD – Case Crossover– SB-DLNM

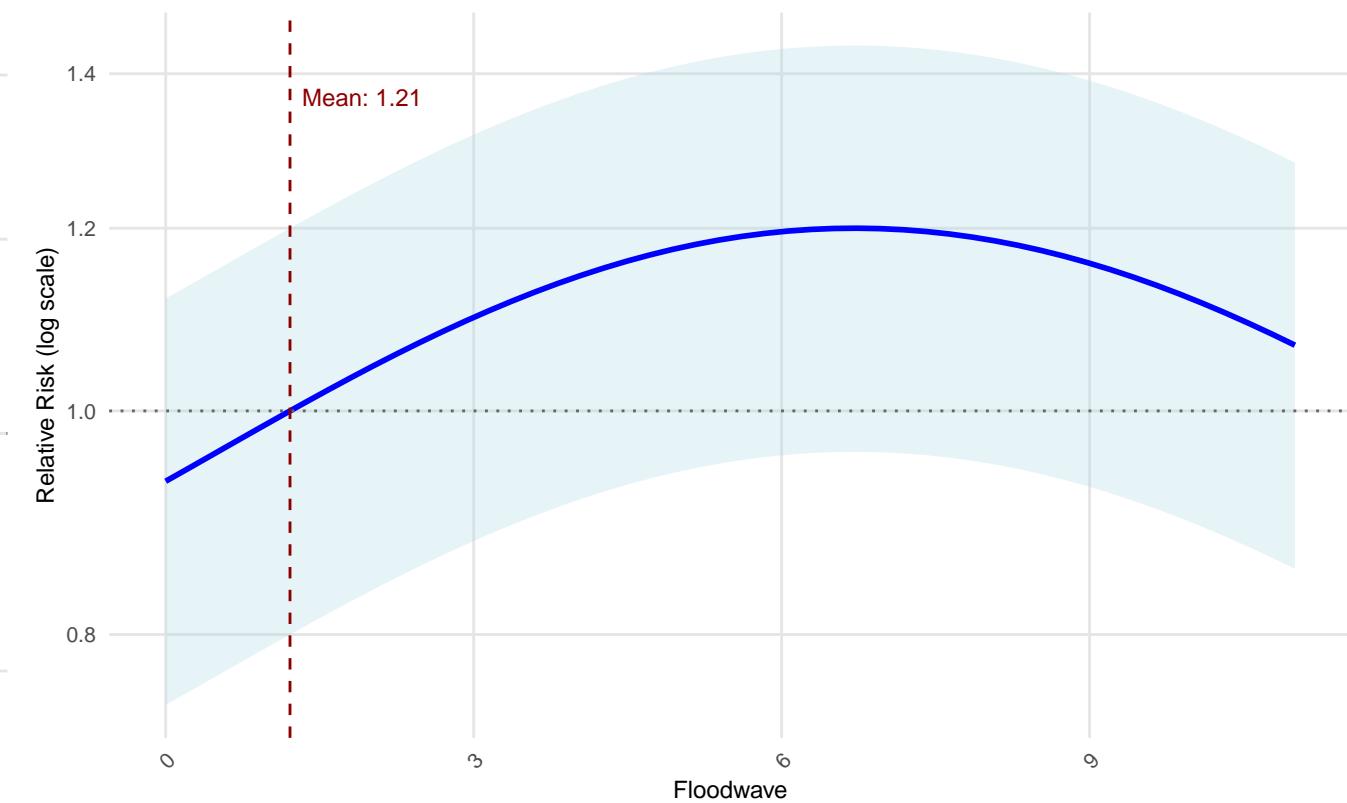
Murrumbidgee – Model Case Crossover

Effect of Floodwave



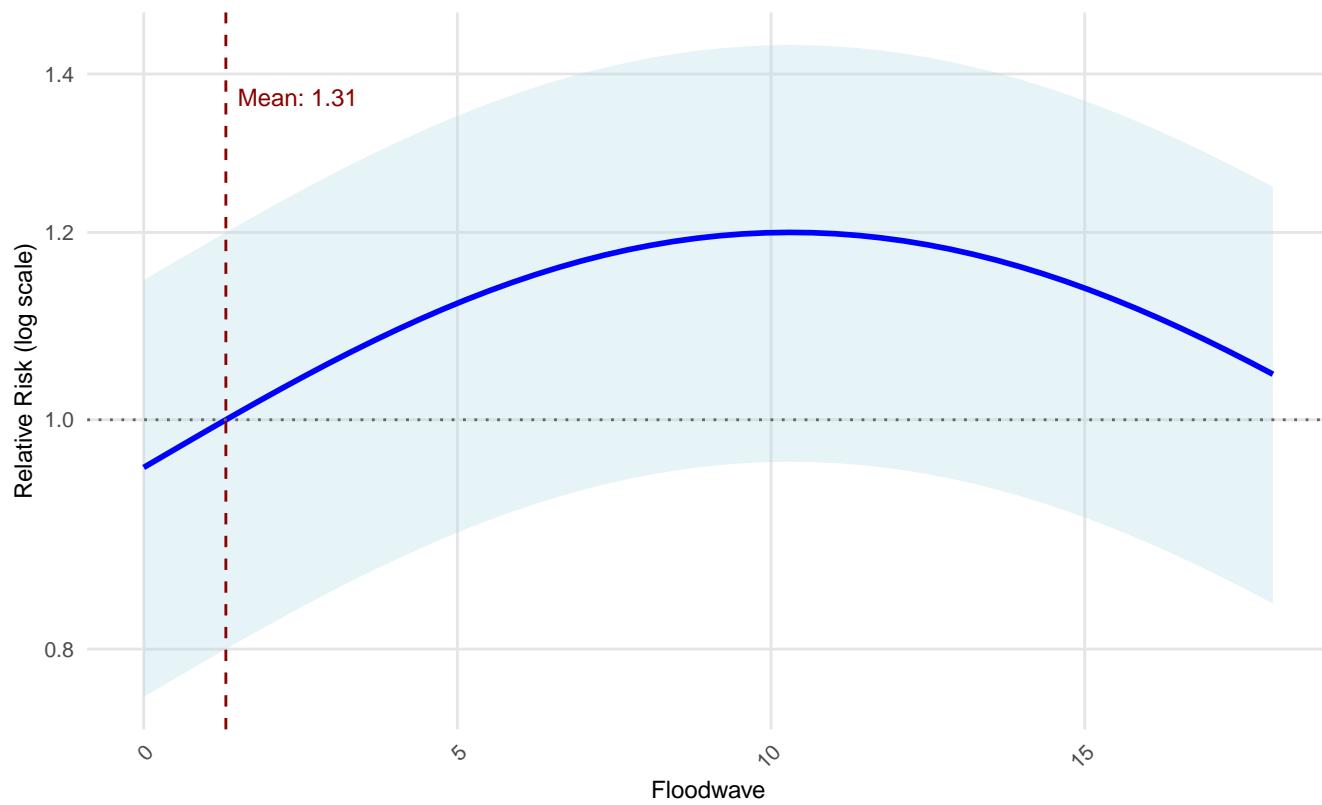
Nepean Blue Mountains – Model Case Crossover

Effect of Floodwave



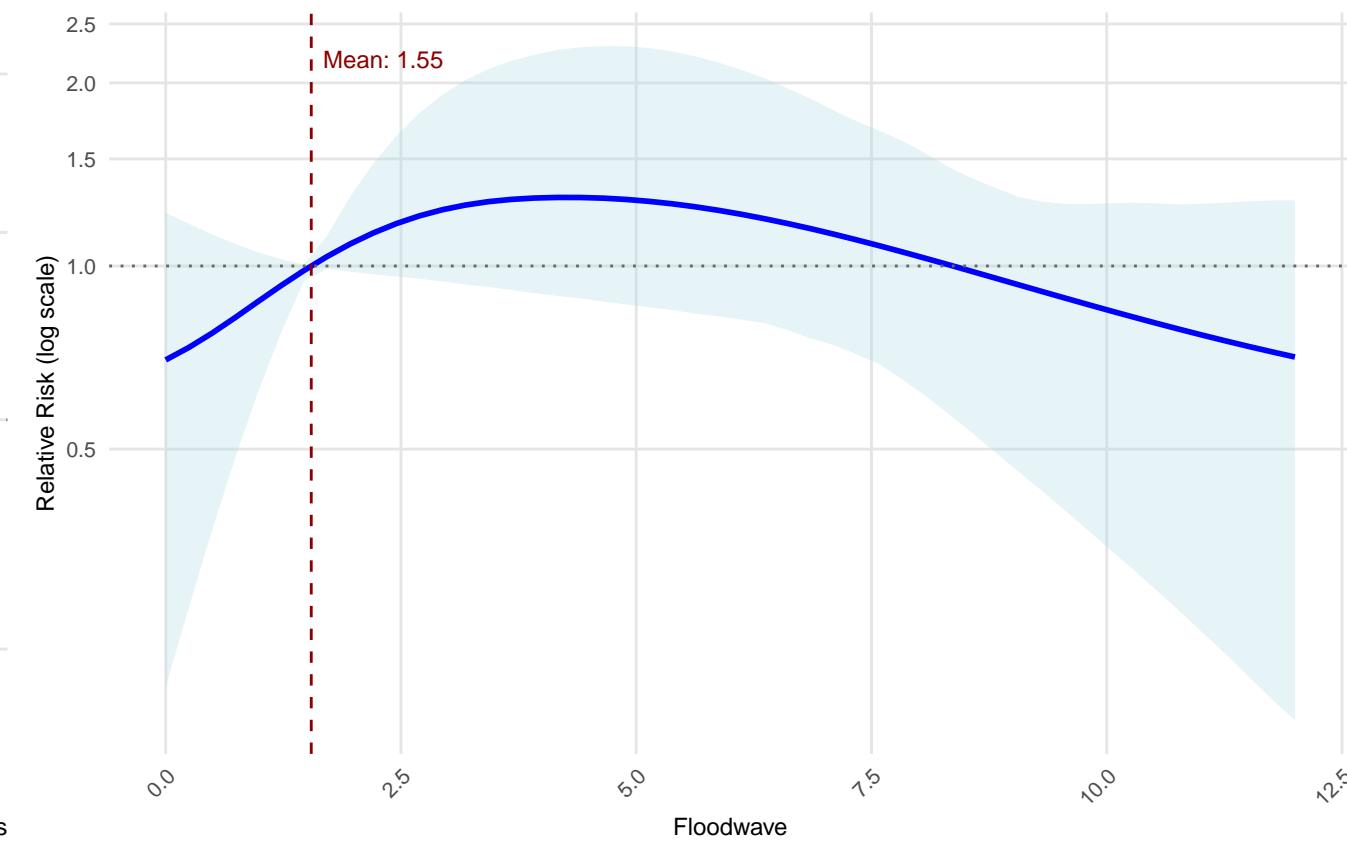
Northern NSW – Model Case Crossover

Effect of Floodwave



Northern Sydney – Model Case Crossover

Effect of Floodwave



Note: Simplified curve due to basis matrix issues

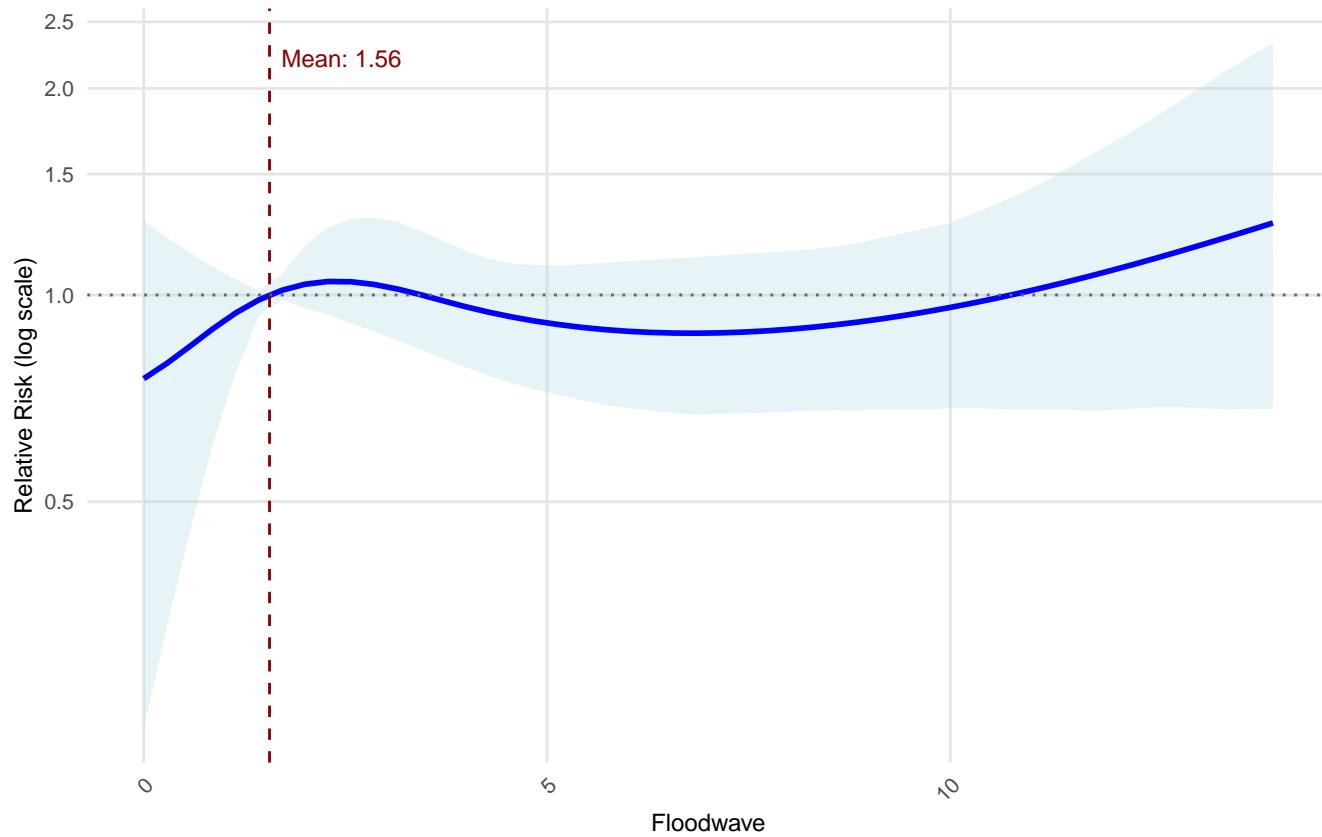
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FLOOD – Case Crossover– SB-DLNM

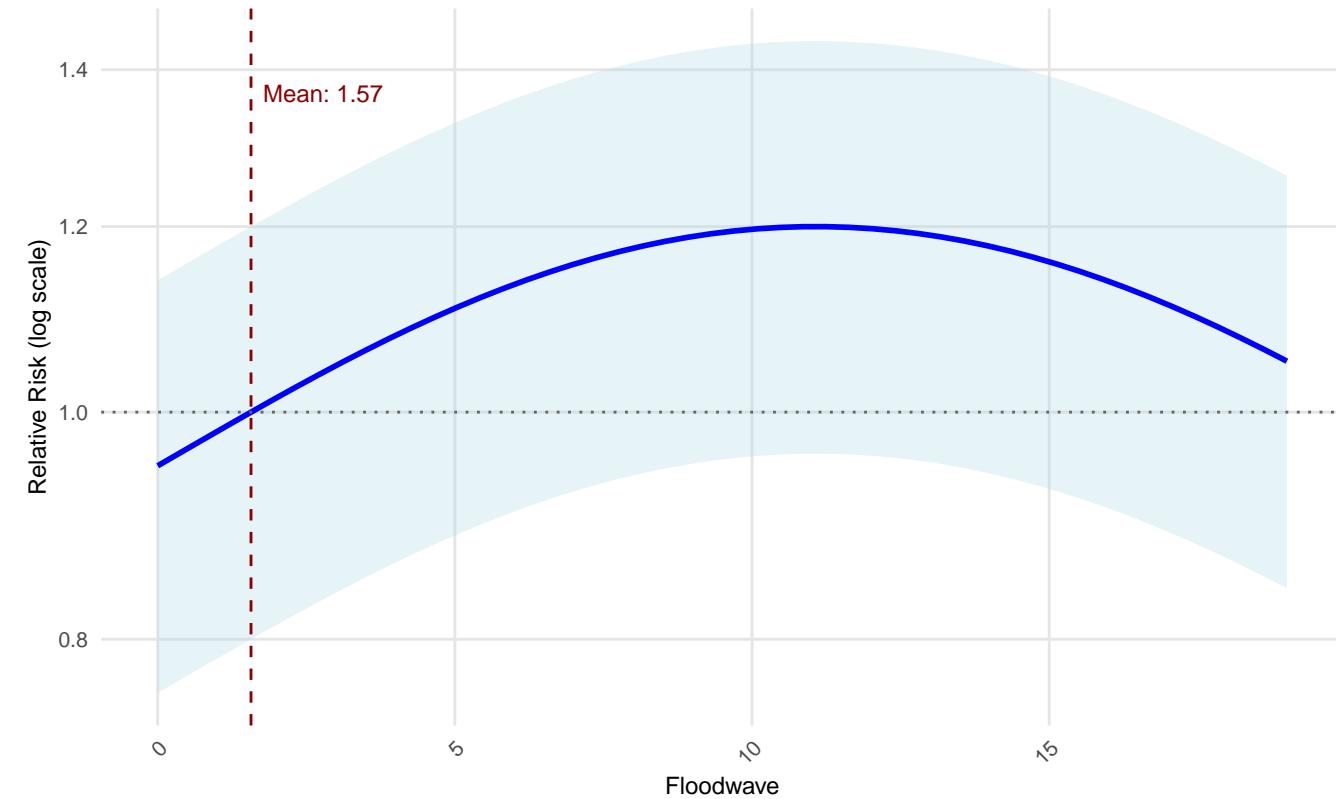
South Eastern Sydney – Model Case Crossover

Effect of Floodwave



South Western Sydney – Model Case Crossover

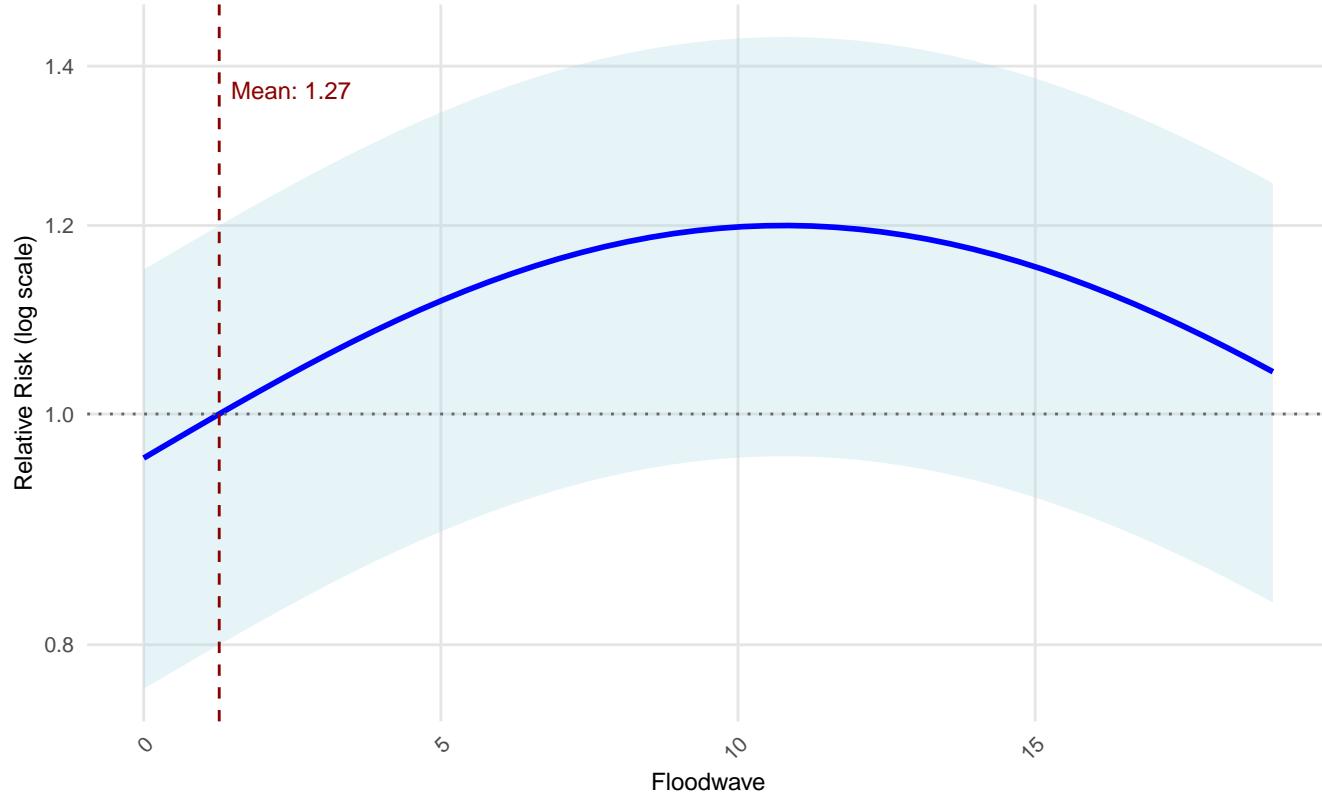
Effect of Floodwave



Note: Simplified curve due to basis matrix issues

Southern NSW – Model Case Crossover

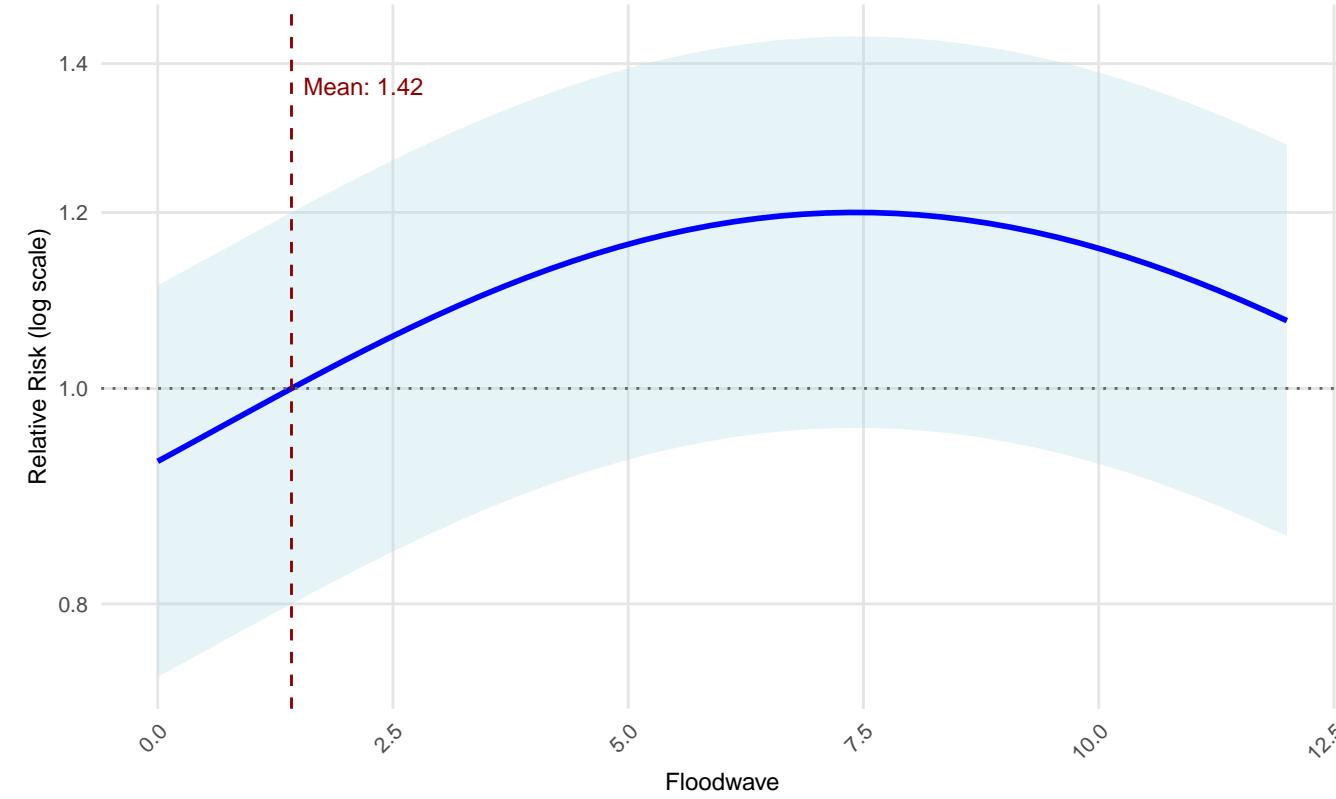
Effect of Floodwave



Note: Simplified curve due to basis matrix issues

Sydney – Model Case Crossover

Effect of Floodwave

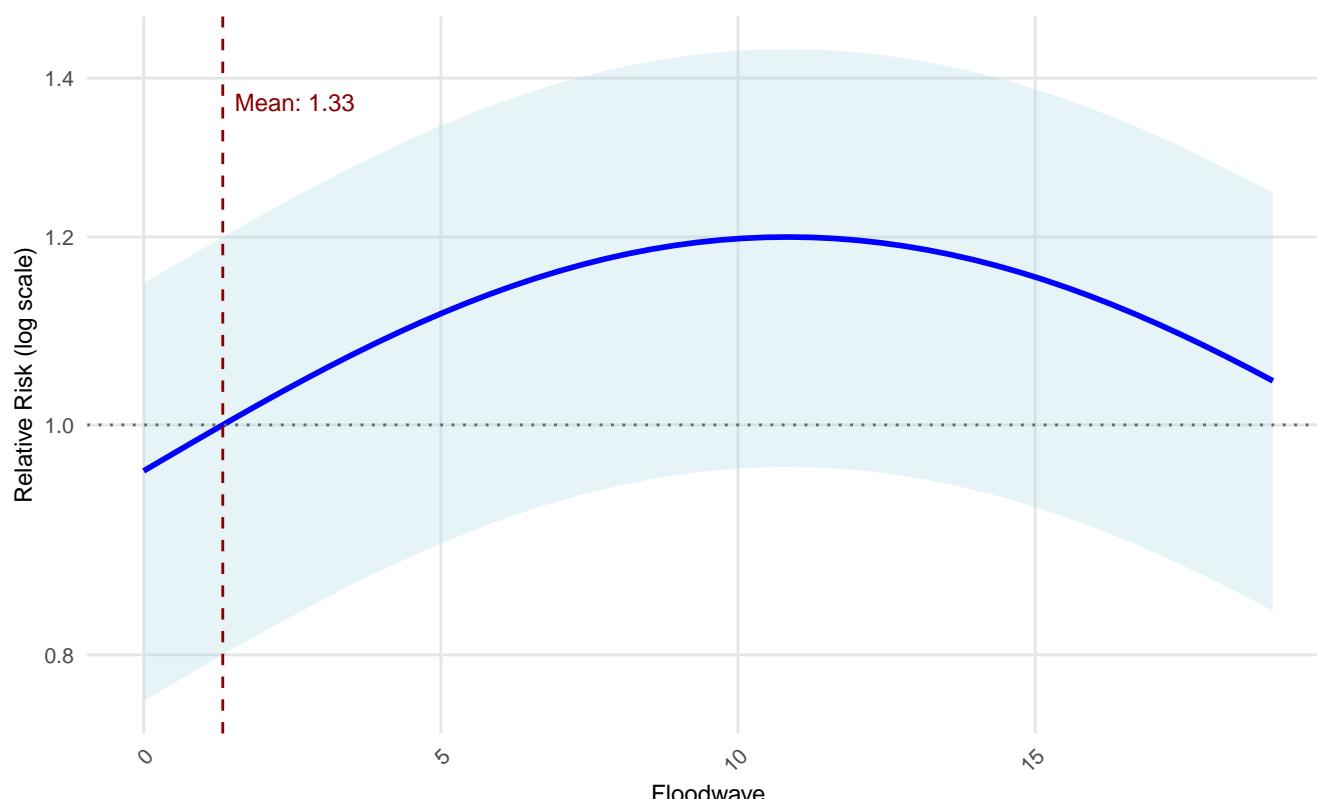


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FLOOD – Case Crossover– SB-DLNM

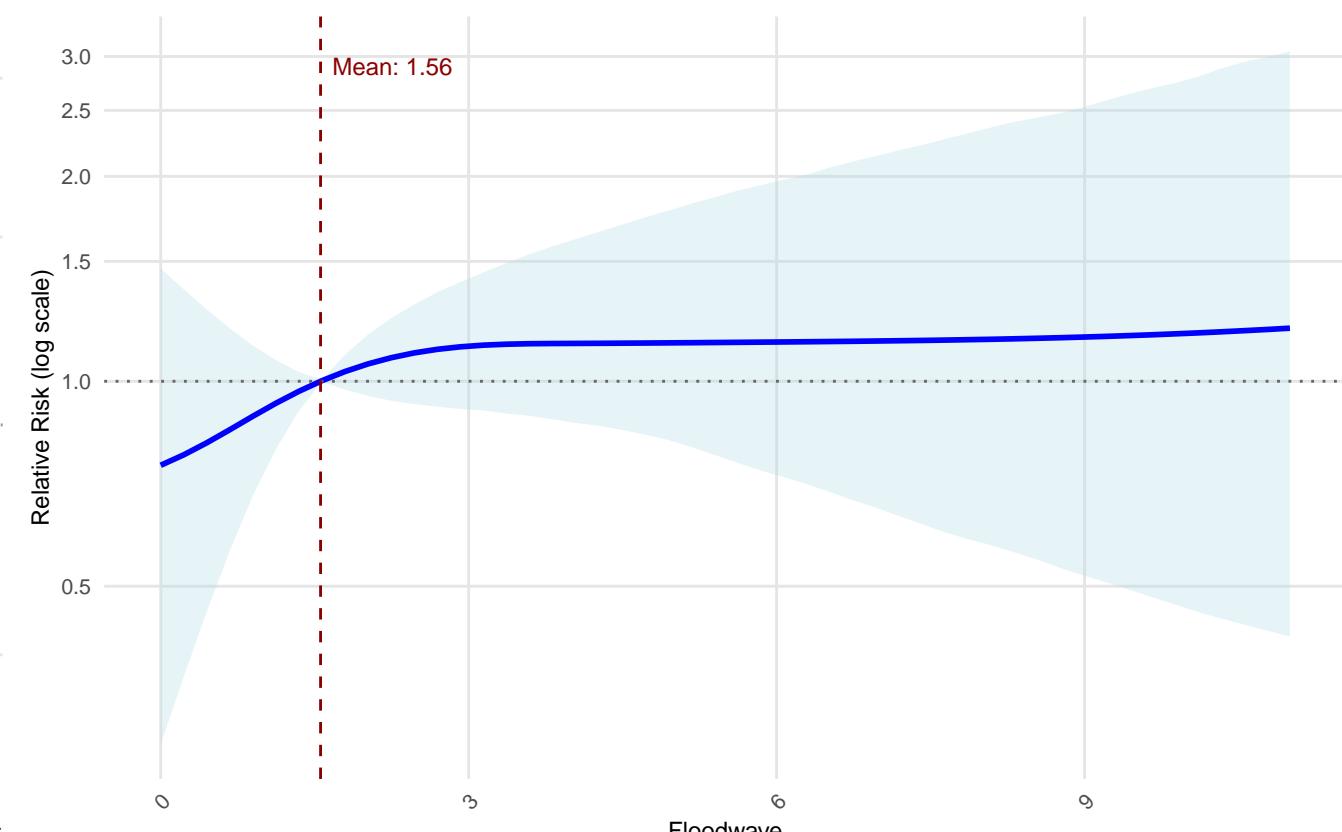
Western NSW – Model Case Crossover

Effect of Floodwave



Western Sydney – Model Case Crossover

Effect of Floodwave

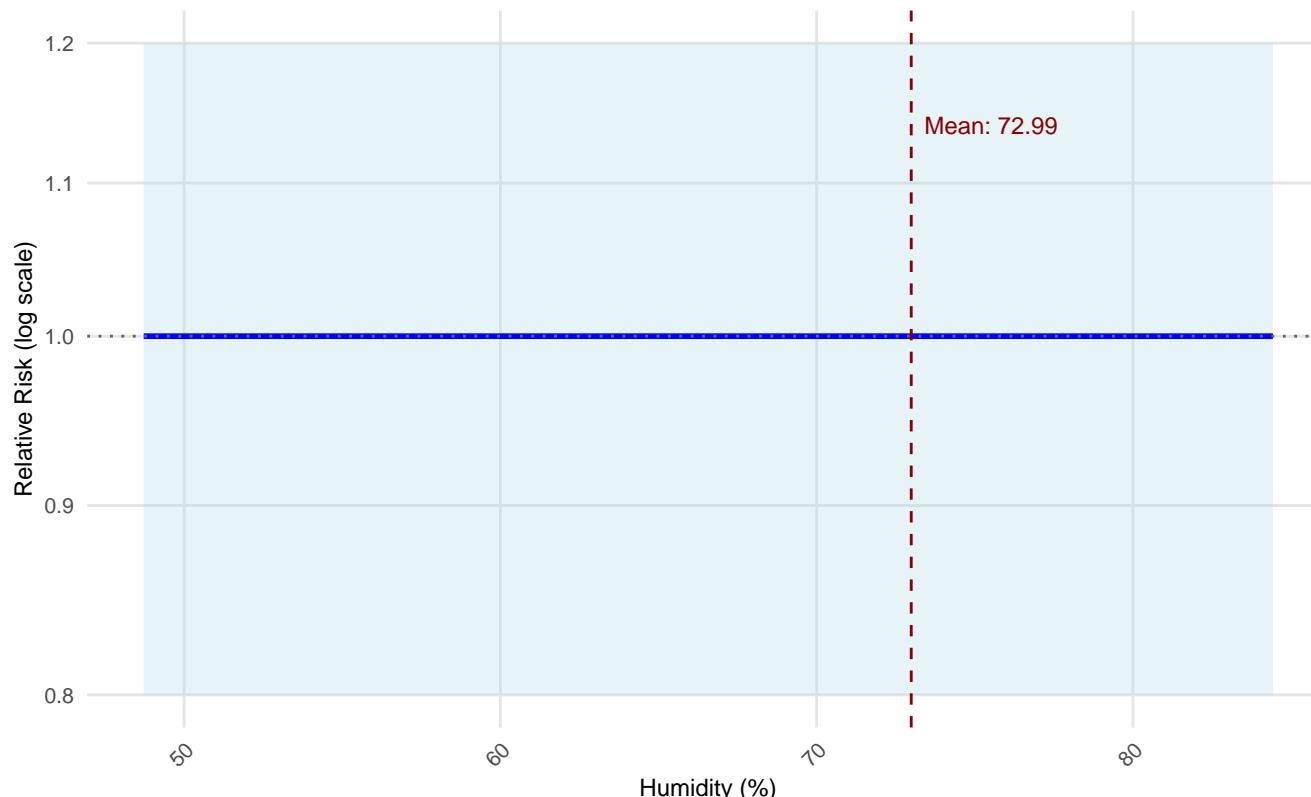


Note: Simplified curve due to basis matrix issues

HUMID – Case Crossover– SB-DLNM

Central Coast – Model Case Crossover

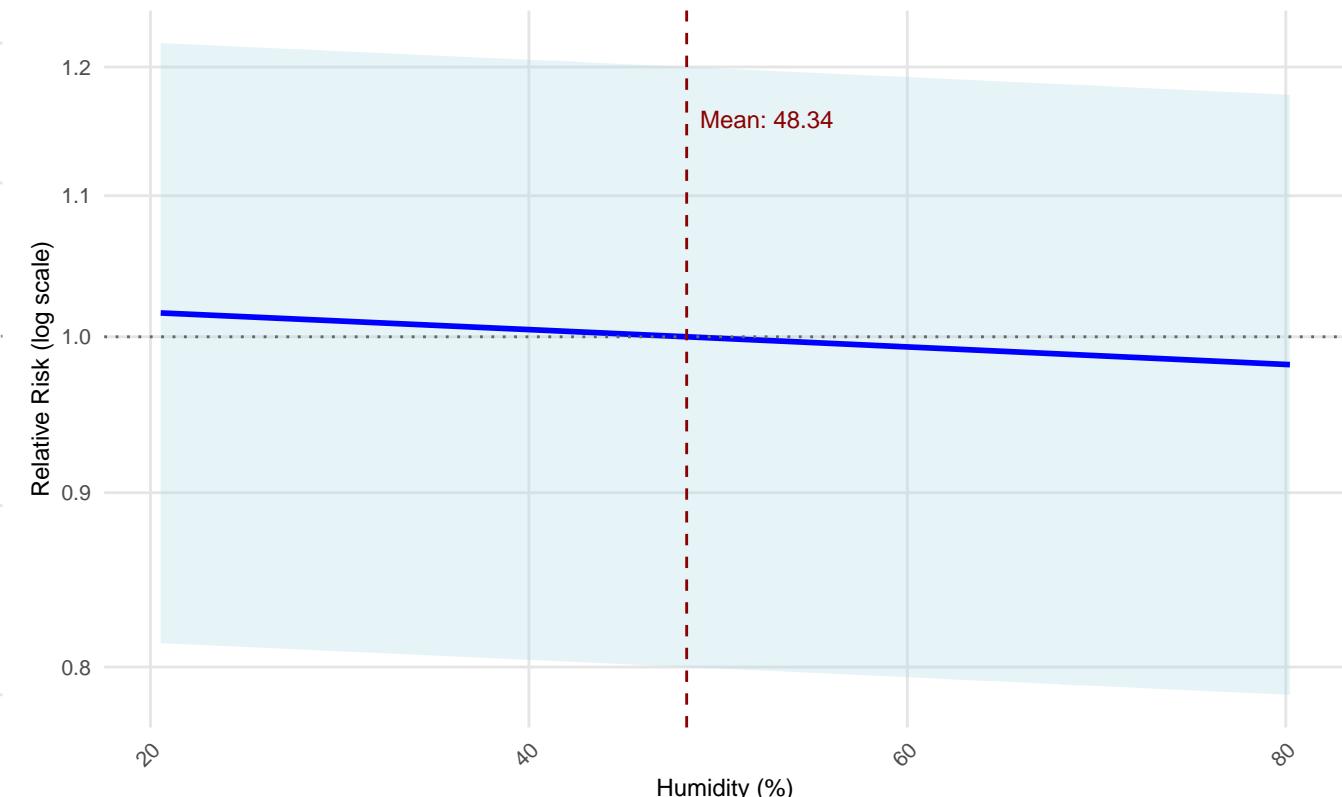
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Far West – Model Case Crossover

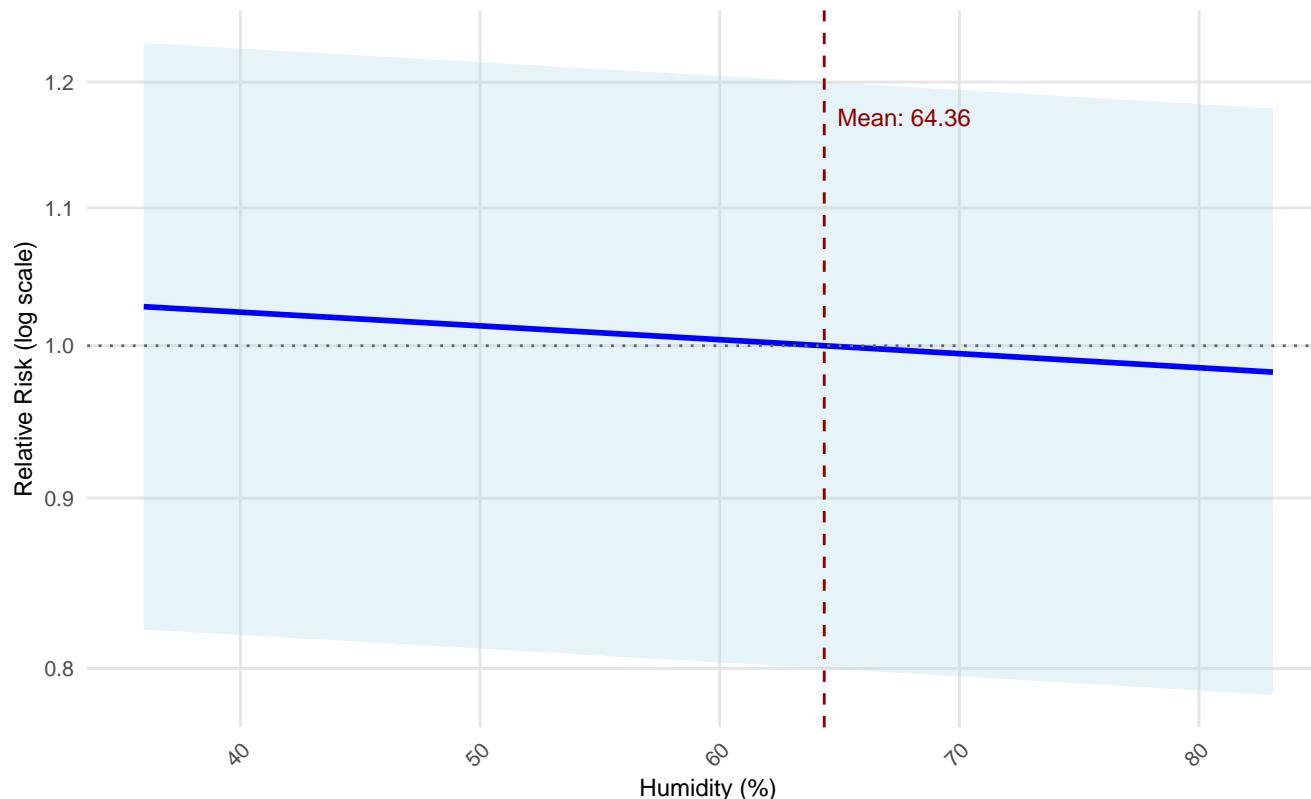
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Hunter New England – Model Case Crossover

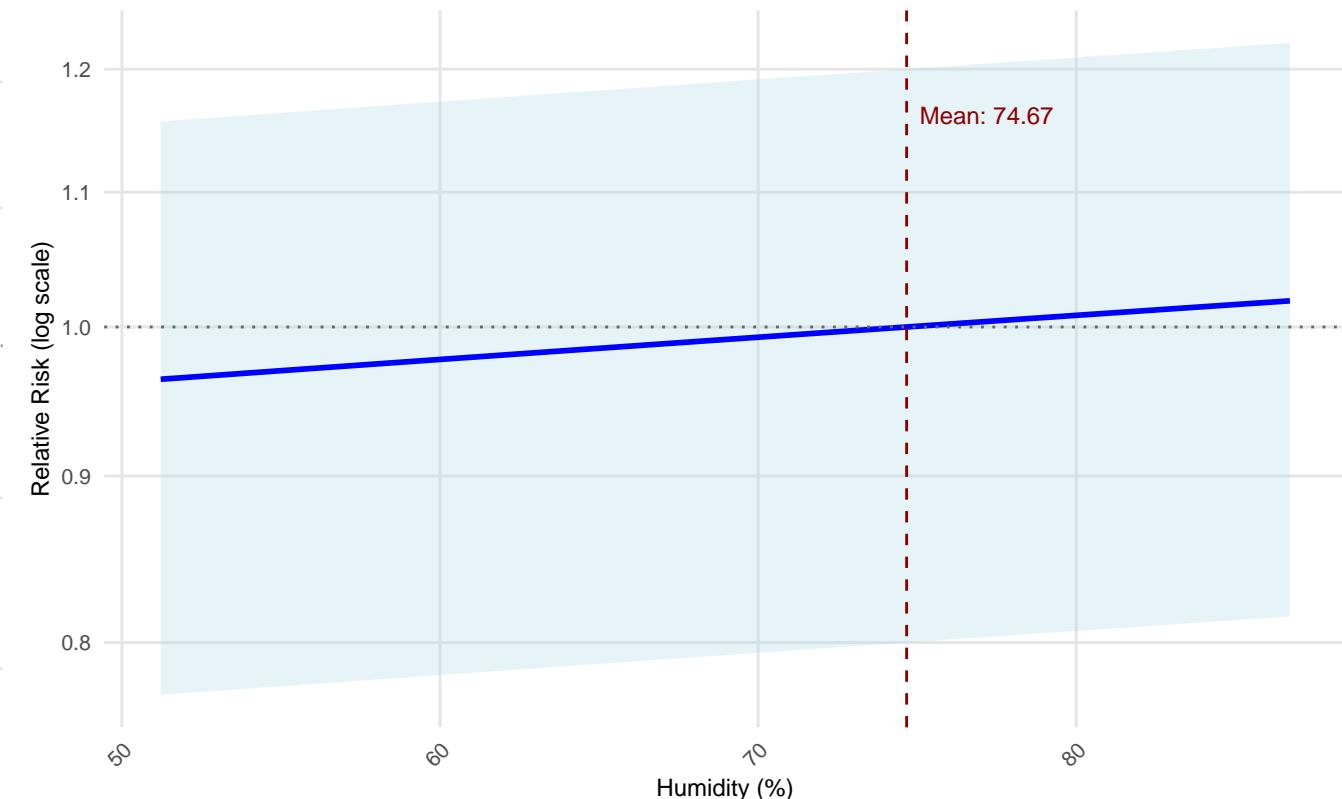
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Illawarra Shoalhaven – Model Case Crossover

Effect of Humidity (%)

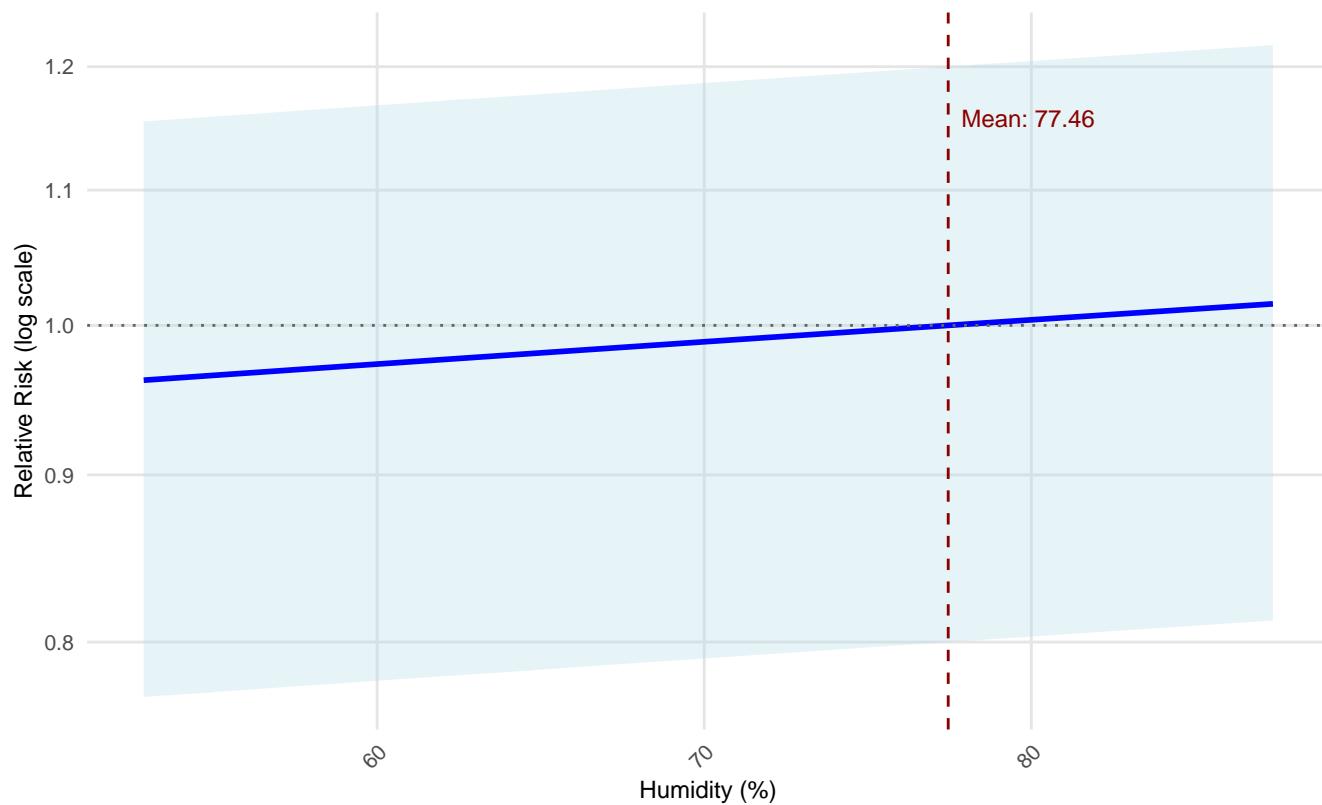


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HUMID – Case Crossover– SB-DLNM

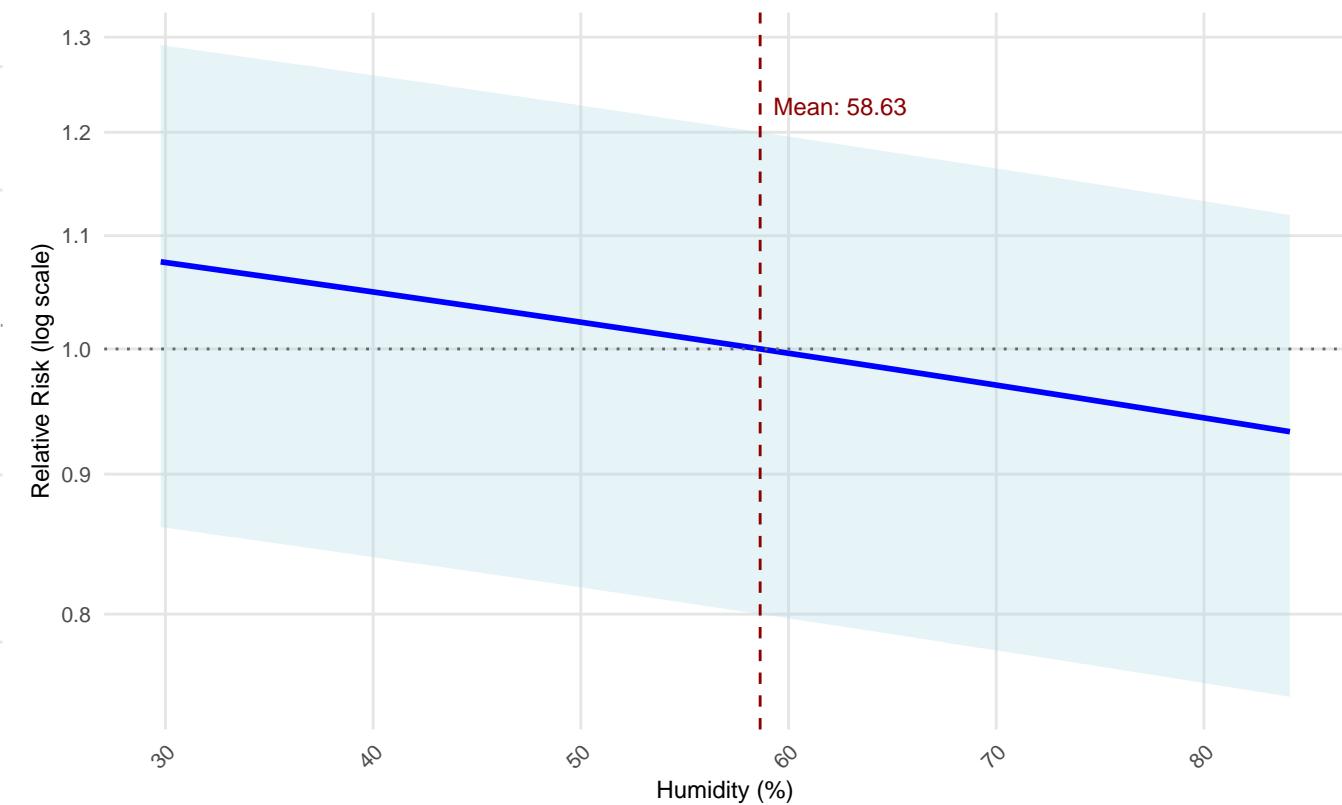
Mid North Coast – Model Case Crossover

Effect of Humidity (%)



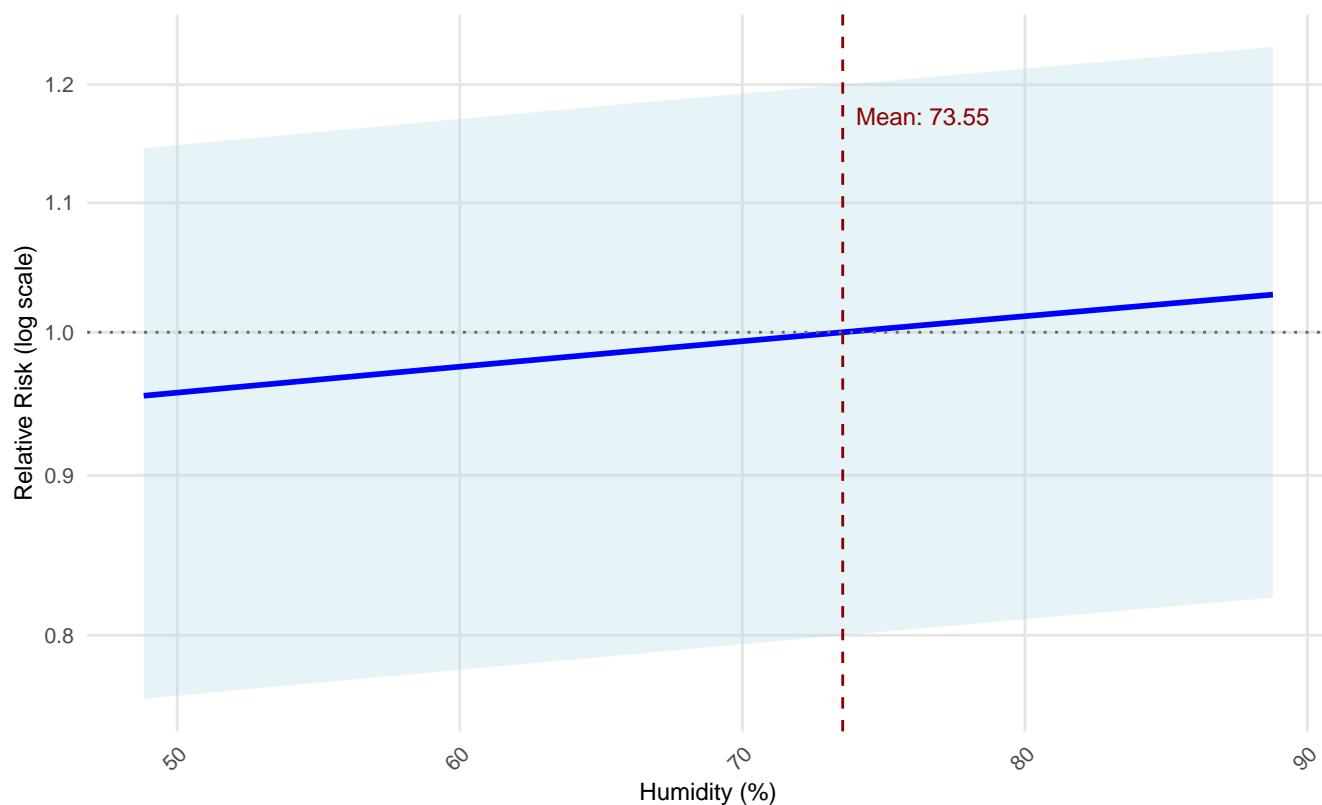
Murrumbidgee – Model Case Crossover

Effect of Humidity (%)



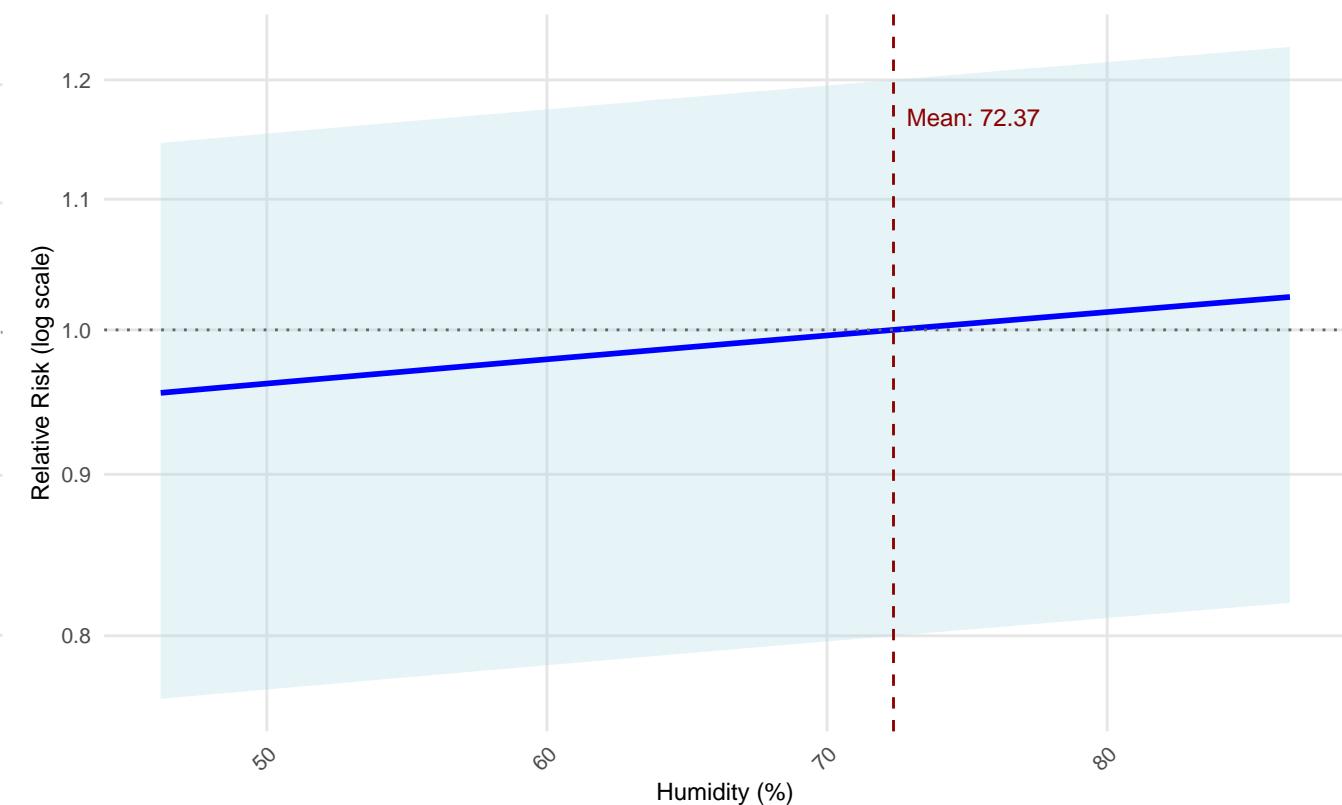
Nepean Blue Mountains – Model Case Crossover

Effect of Humidity (%)



Northern NSW – Model Case Crossover

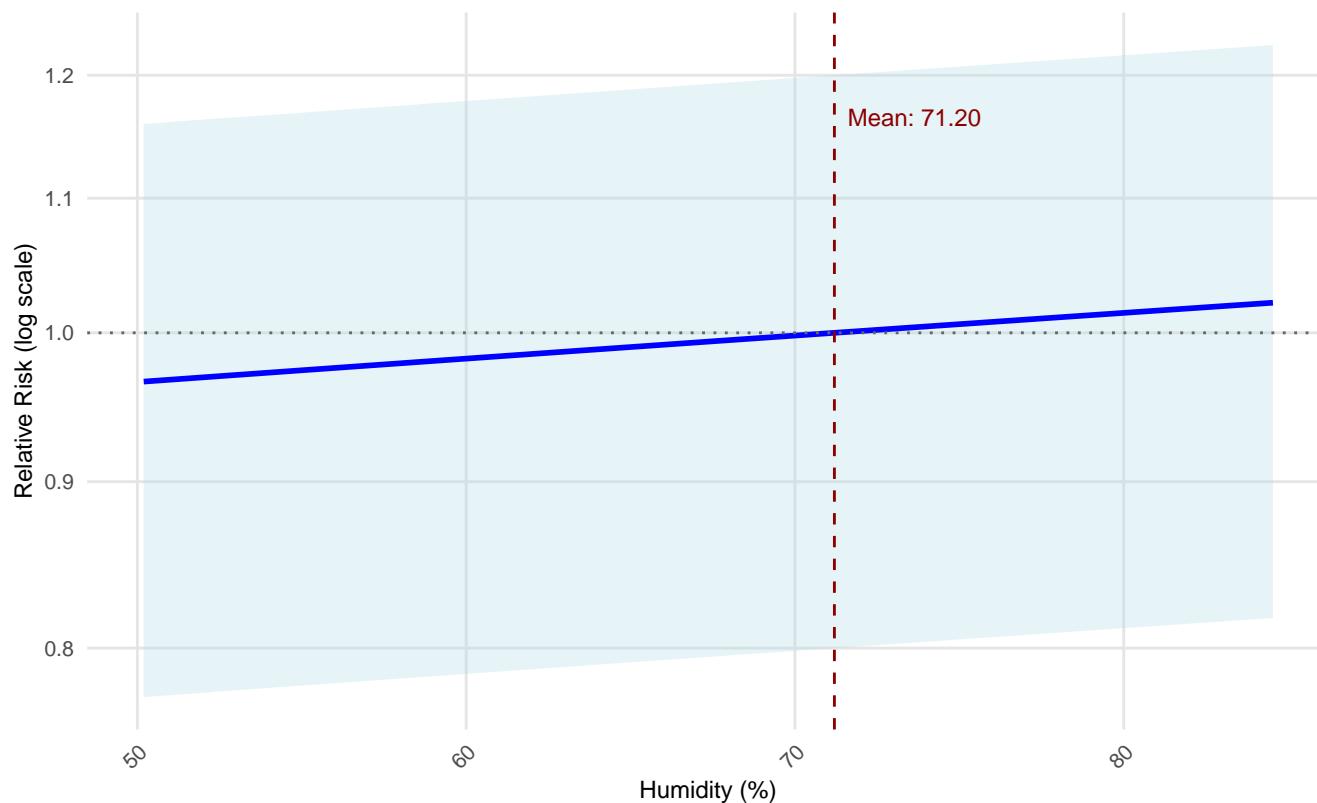
Effect of Humidity (%)



HUMID – Case Crossover– SB-DLNM

Northern Sydney – Model Case Crossover

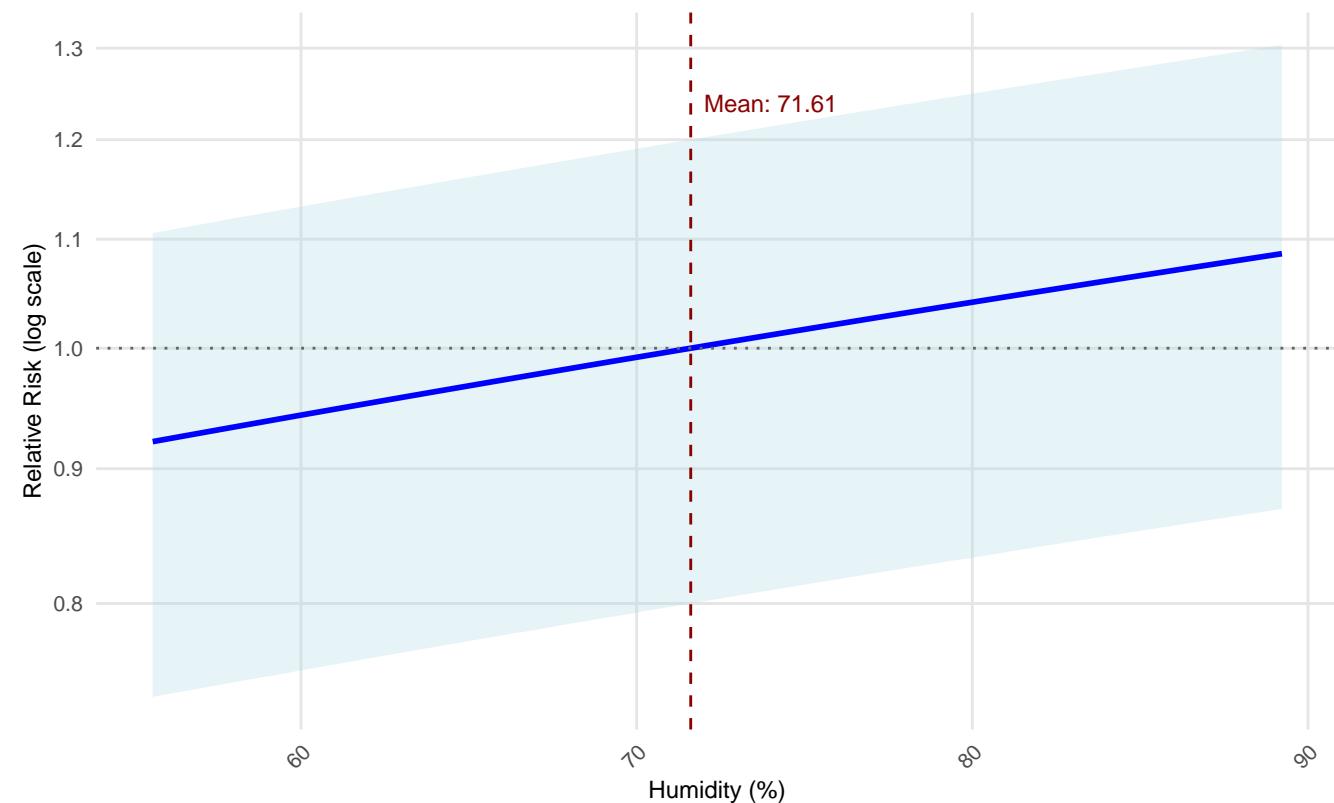
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

South Eastern Sydney – Model Case Crossover

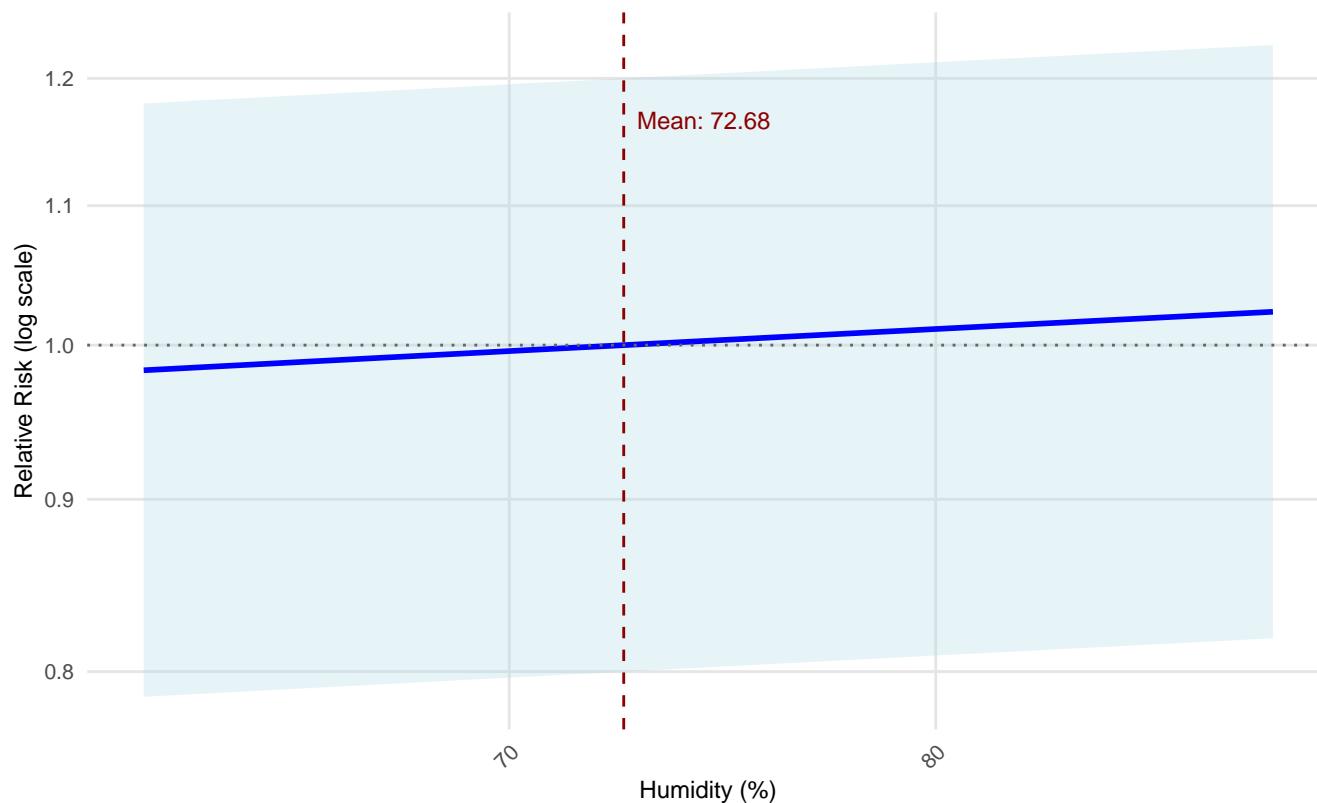
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

South Western Sydney – Model Case Crossover

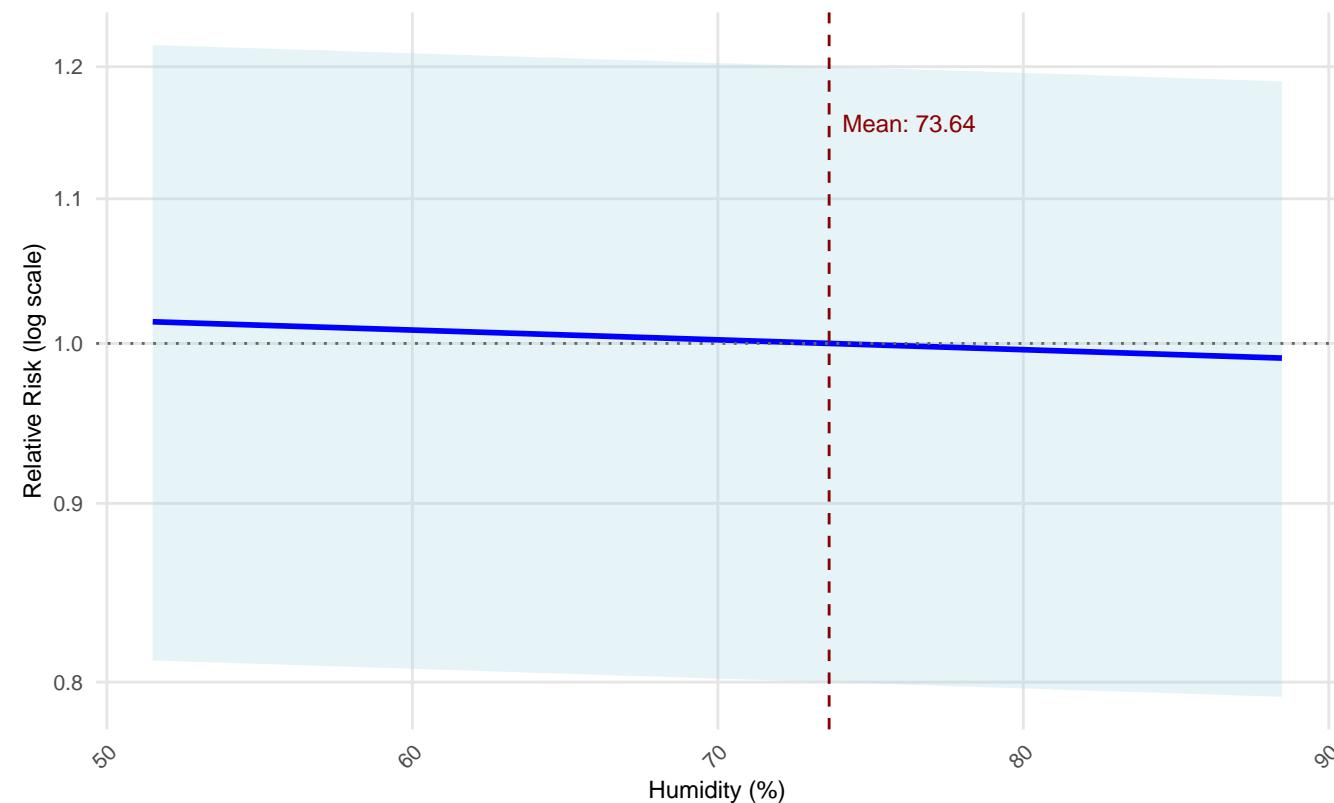
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Southern NSW – Model Case Crossover

Effect of Humidity (%)

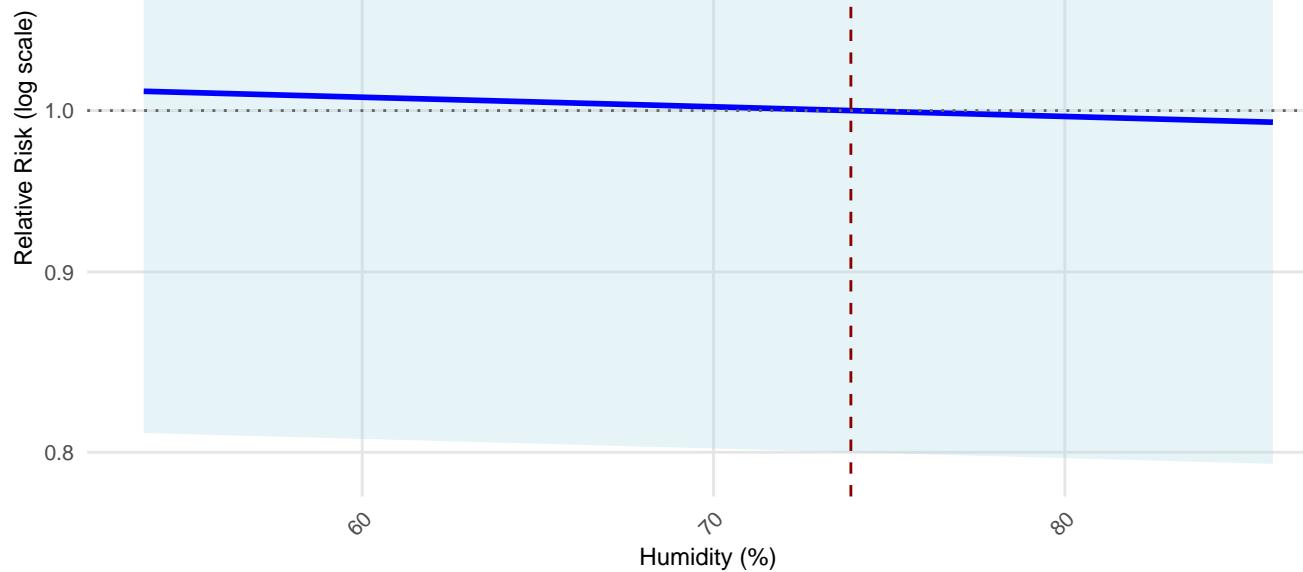


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HUMID – Case Crossover– SB-DLNM

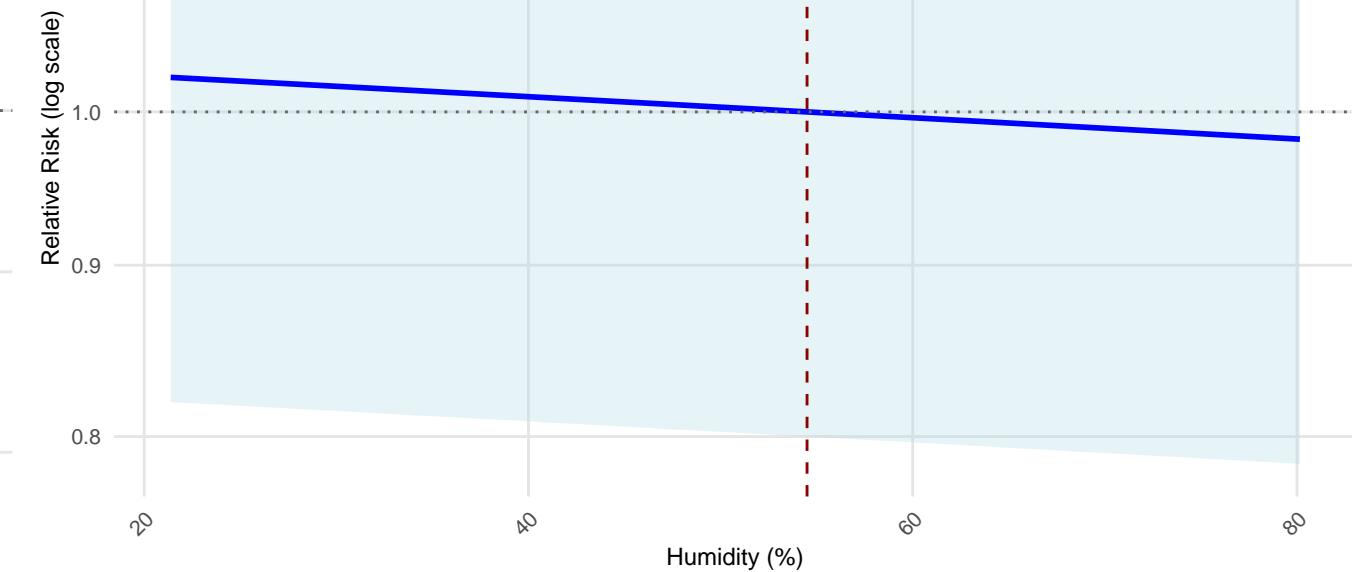
Sydney – Model Case Crossover

Effect of Humidity (%)



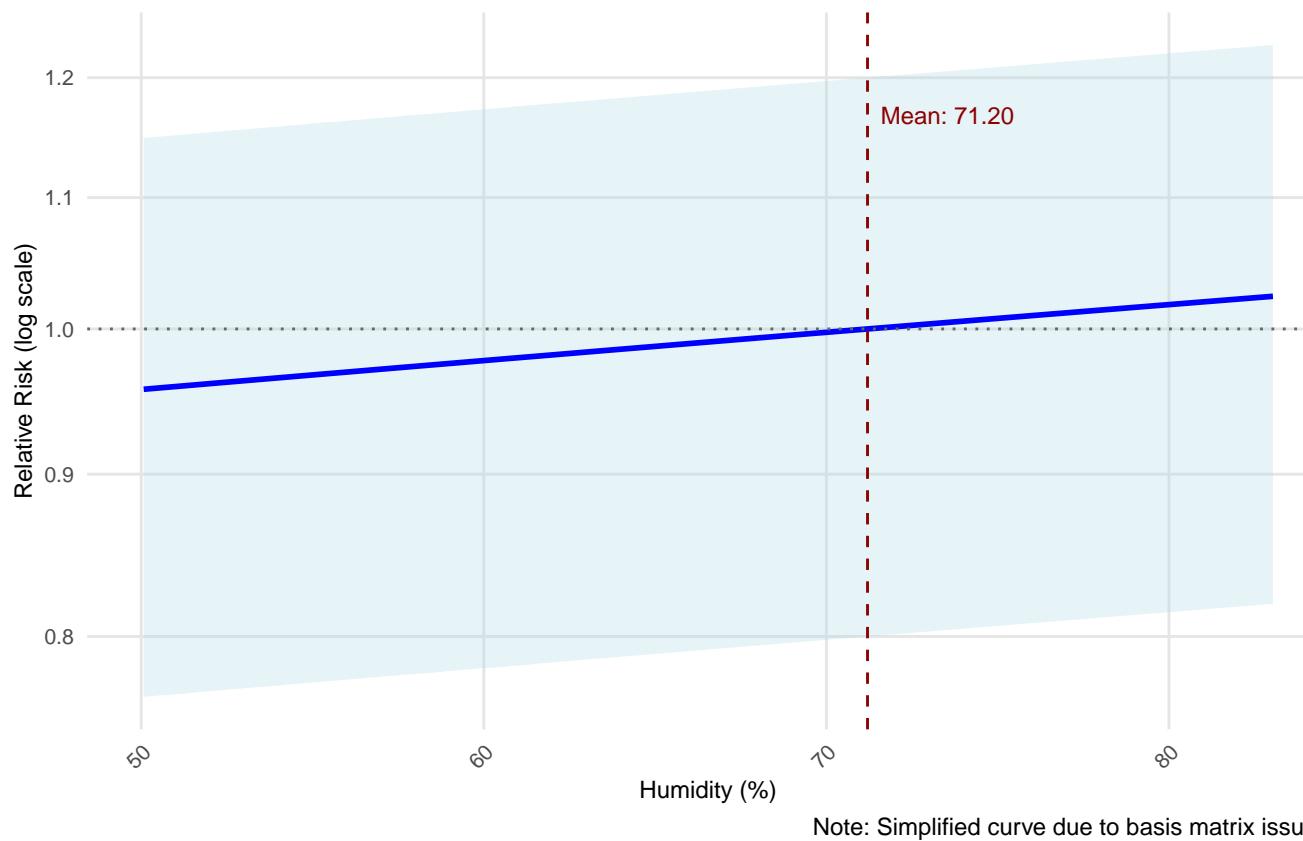
Western NSW – Model Case Crossover

Effect of Humidity (%)



Western Sydney – Model Case Crossover

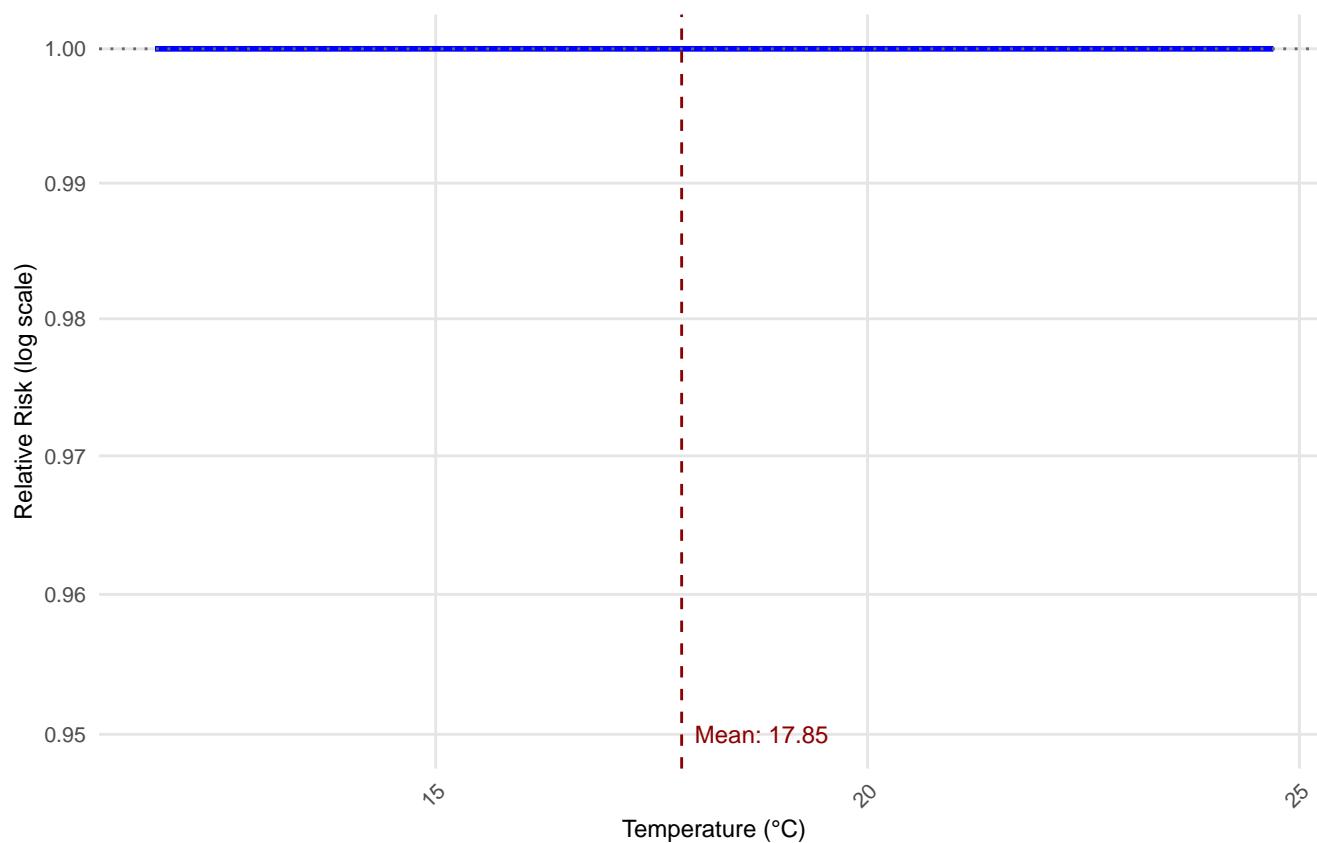
Effect of Humidity (%)



TEMP – Time Series– SB-DLNM

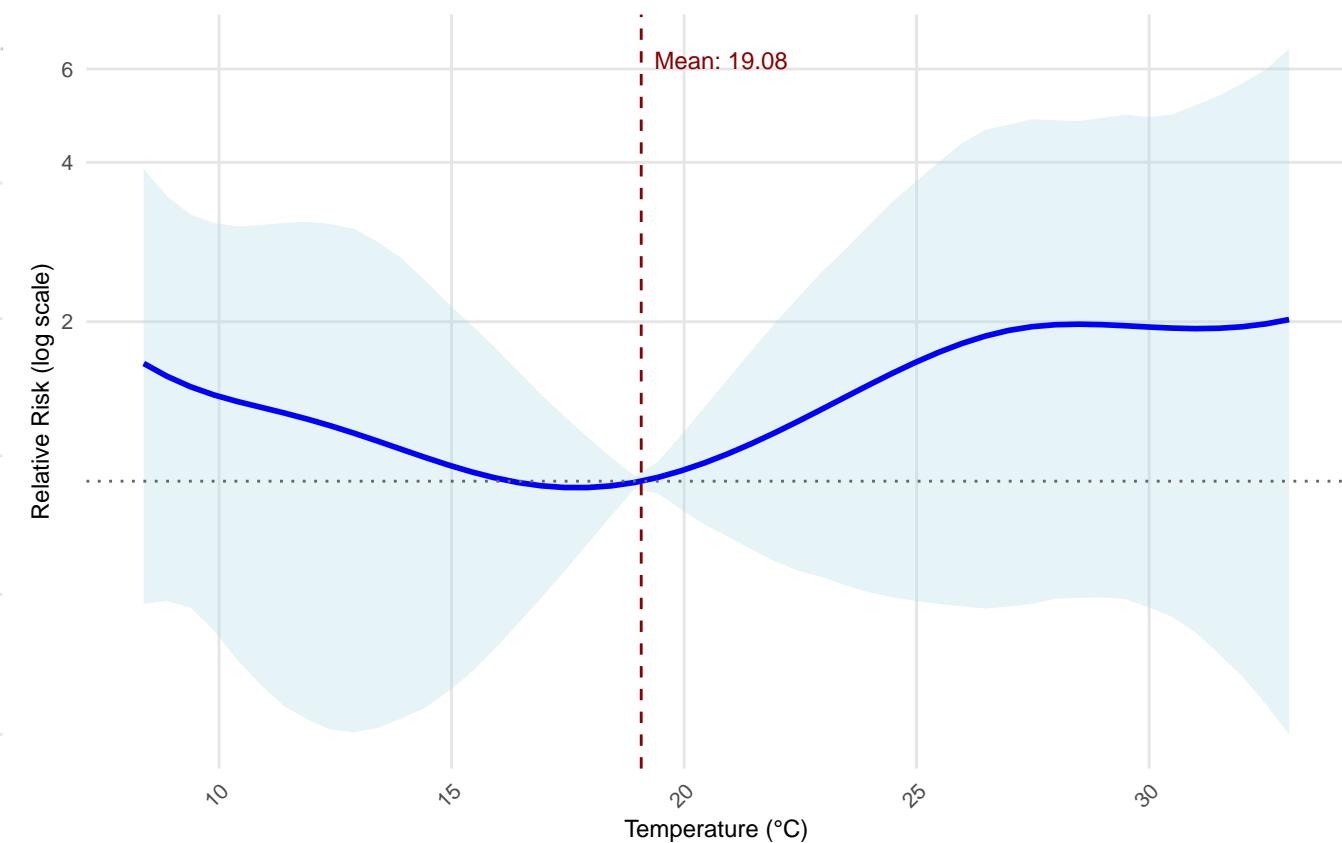
Central Coast – Model Time Series

Effect of Temperature (°C)



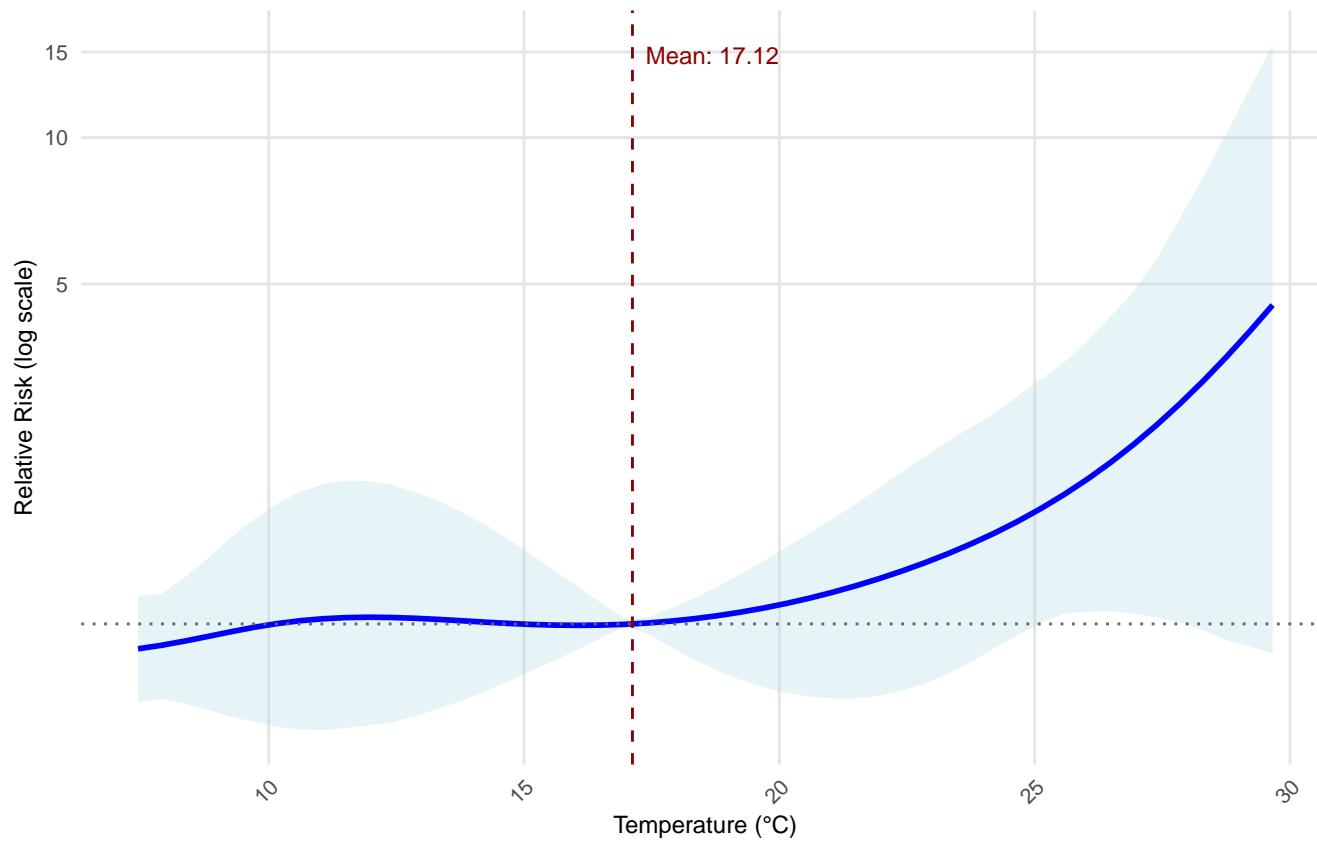
Far West – Model Time Series

Effect of Temperature (°C)



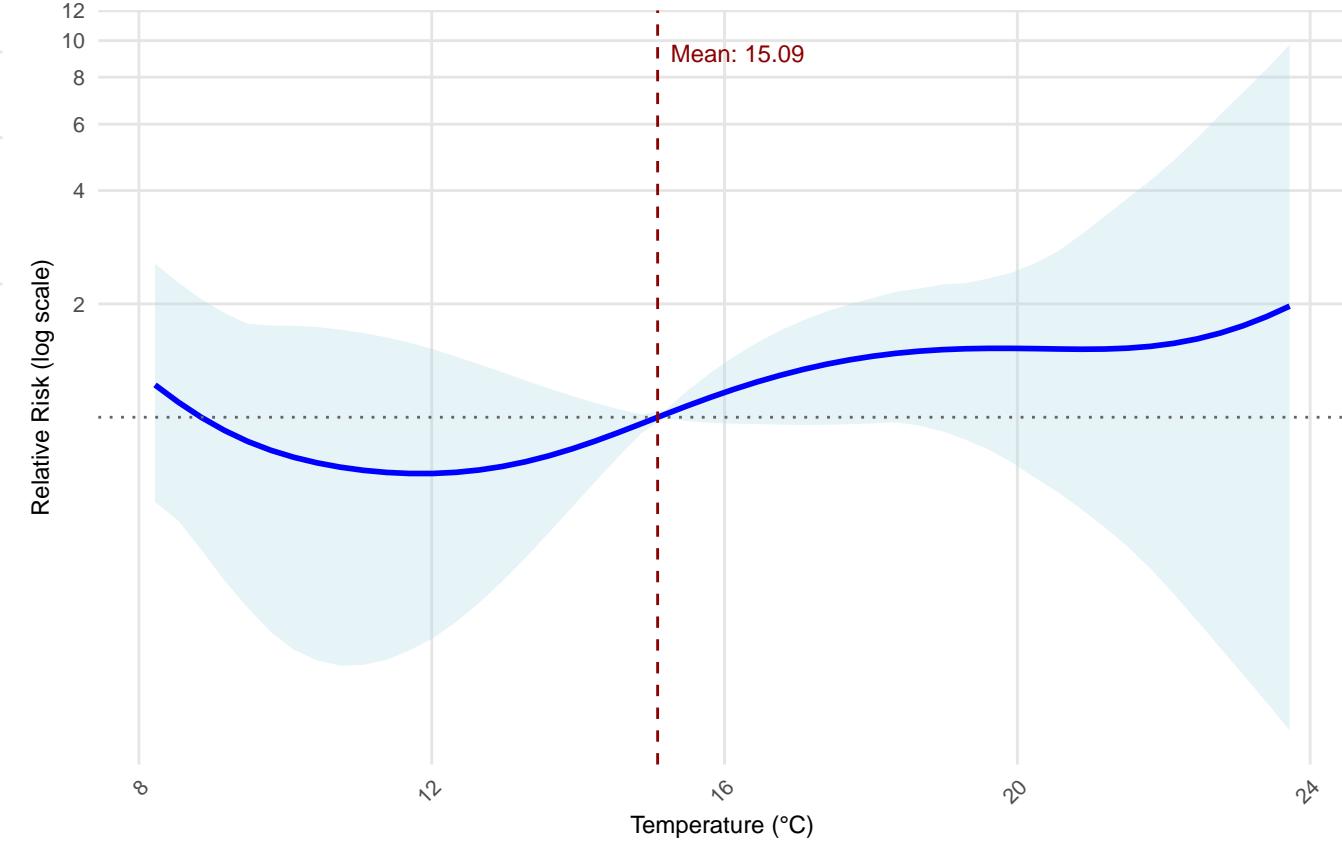
Hunter New England – Model Time Series

Effect of Temperature (°C)



Illawarra Shoalhaven – Model Time Series

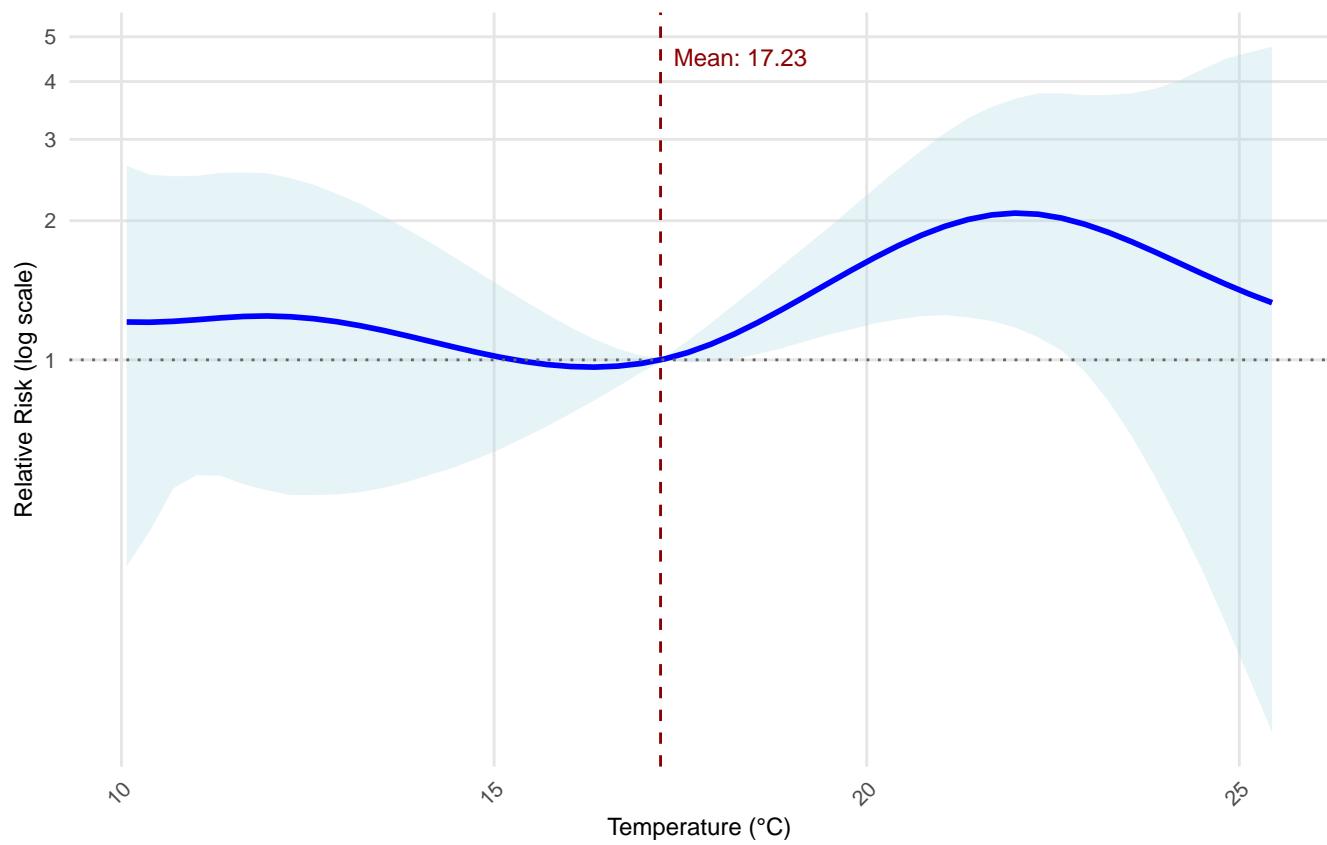
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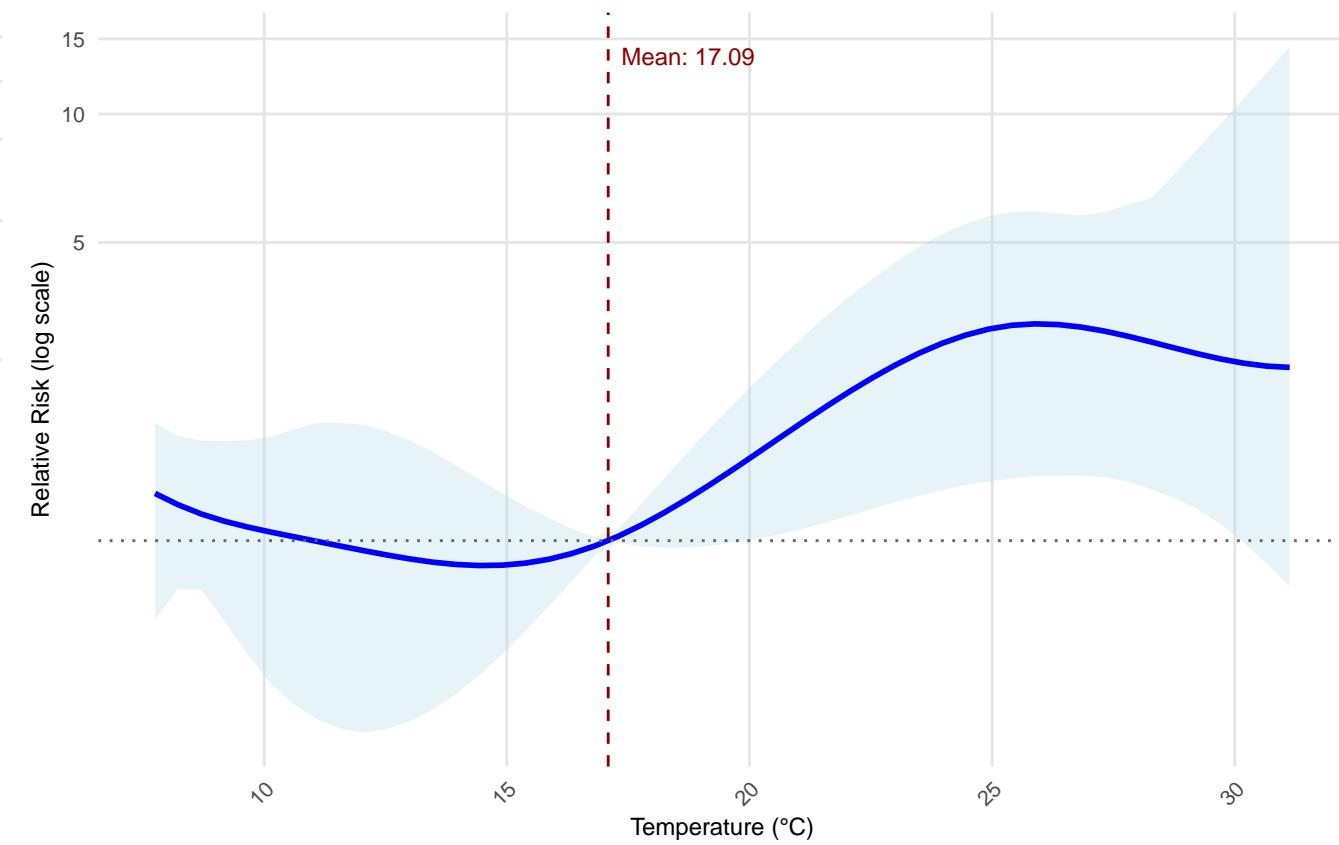
Mid North Coast – Model Time Series

Effect of Temperature (°C)



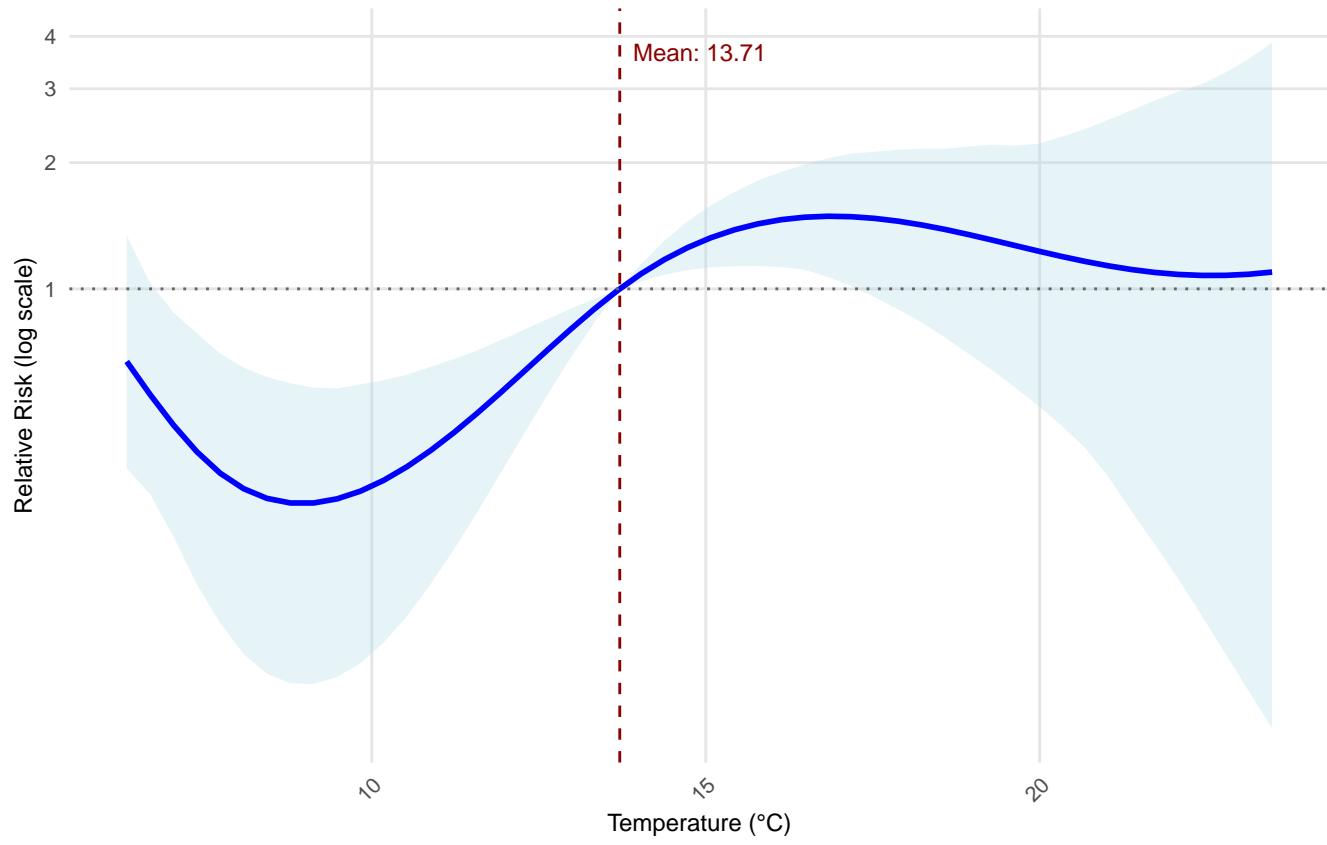
Murrumbidgee – Model Time Series

Effect of Temperature (°C)



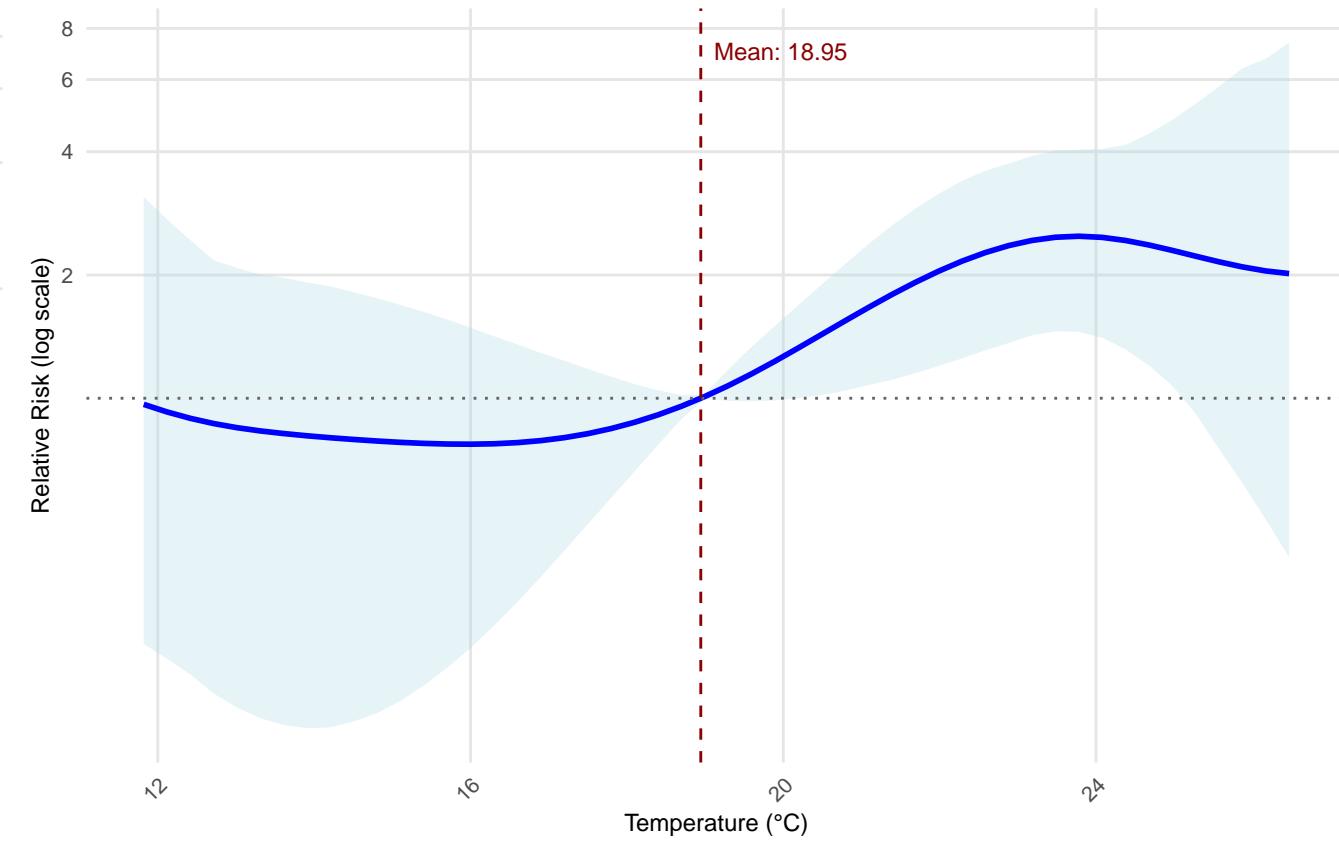
Nepean Blue Mountains – Model Time Series

Effect of Temperature (°C)



Northern NSW – Model Time Series

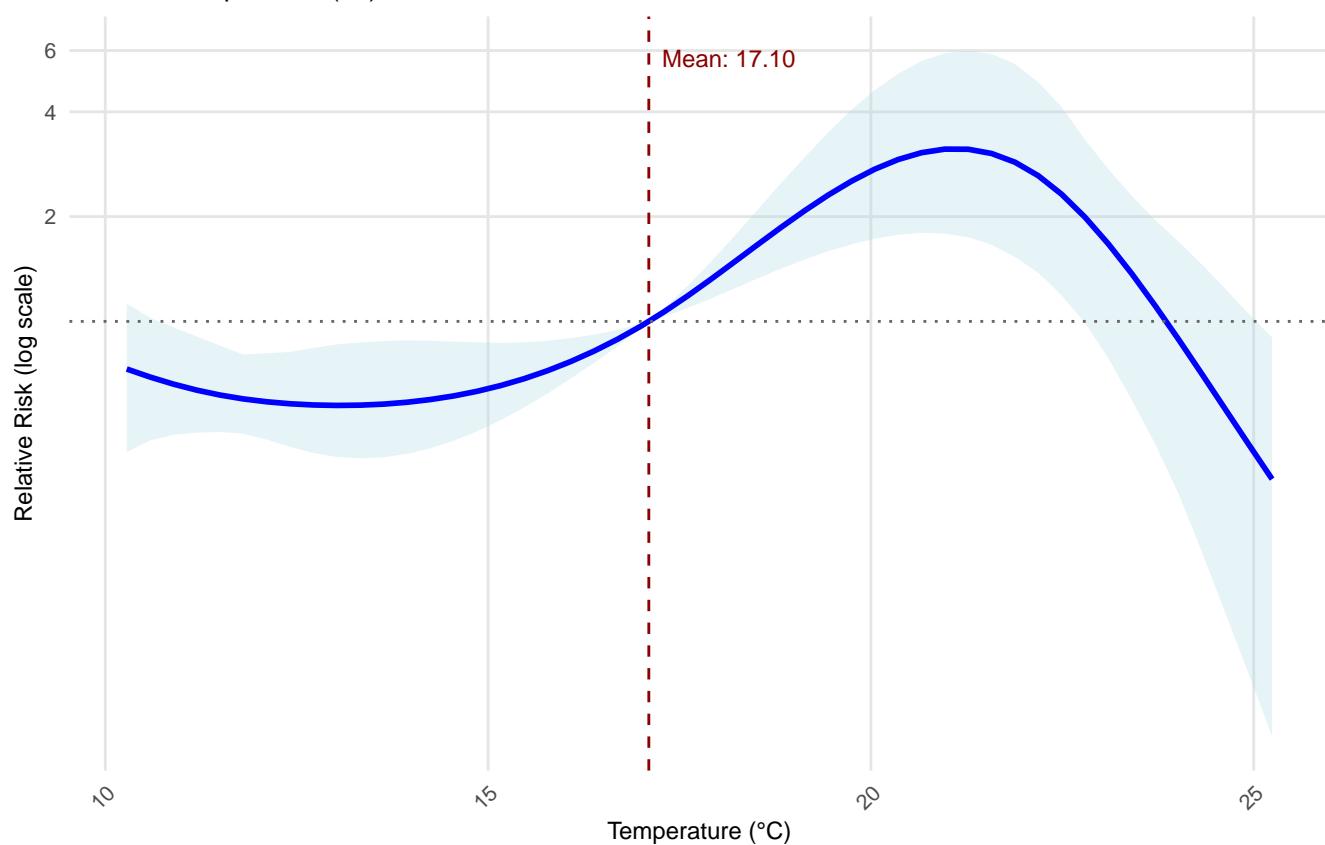
Effect of Temperature (°C)



TEMP – Time Series– SB-DLNM

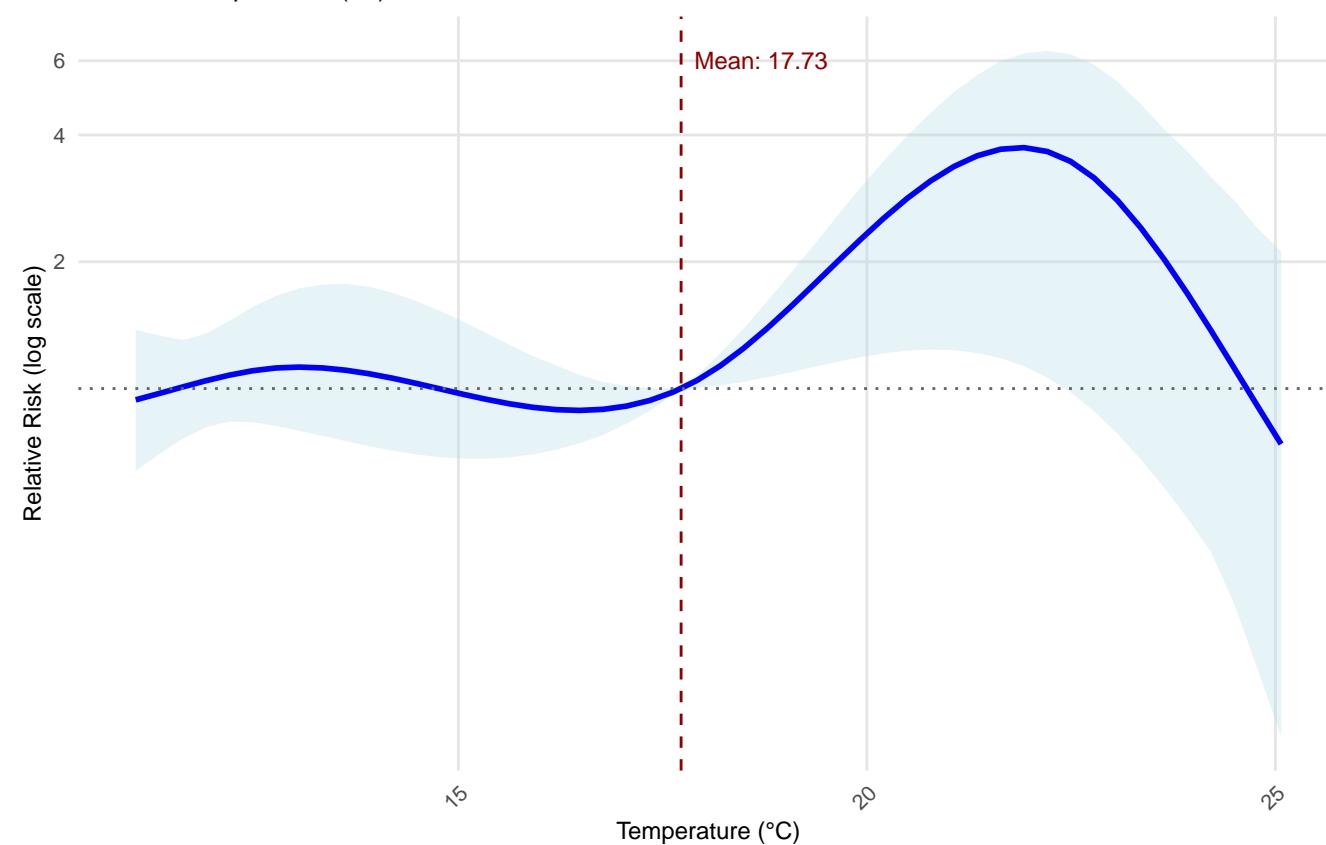
Northern Sydney – Model Time Series

Effect of Temperature (°C)



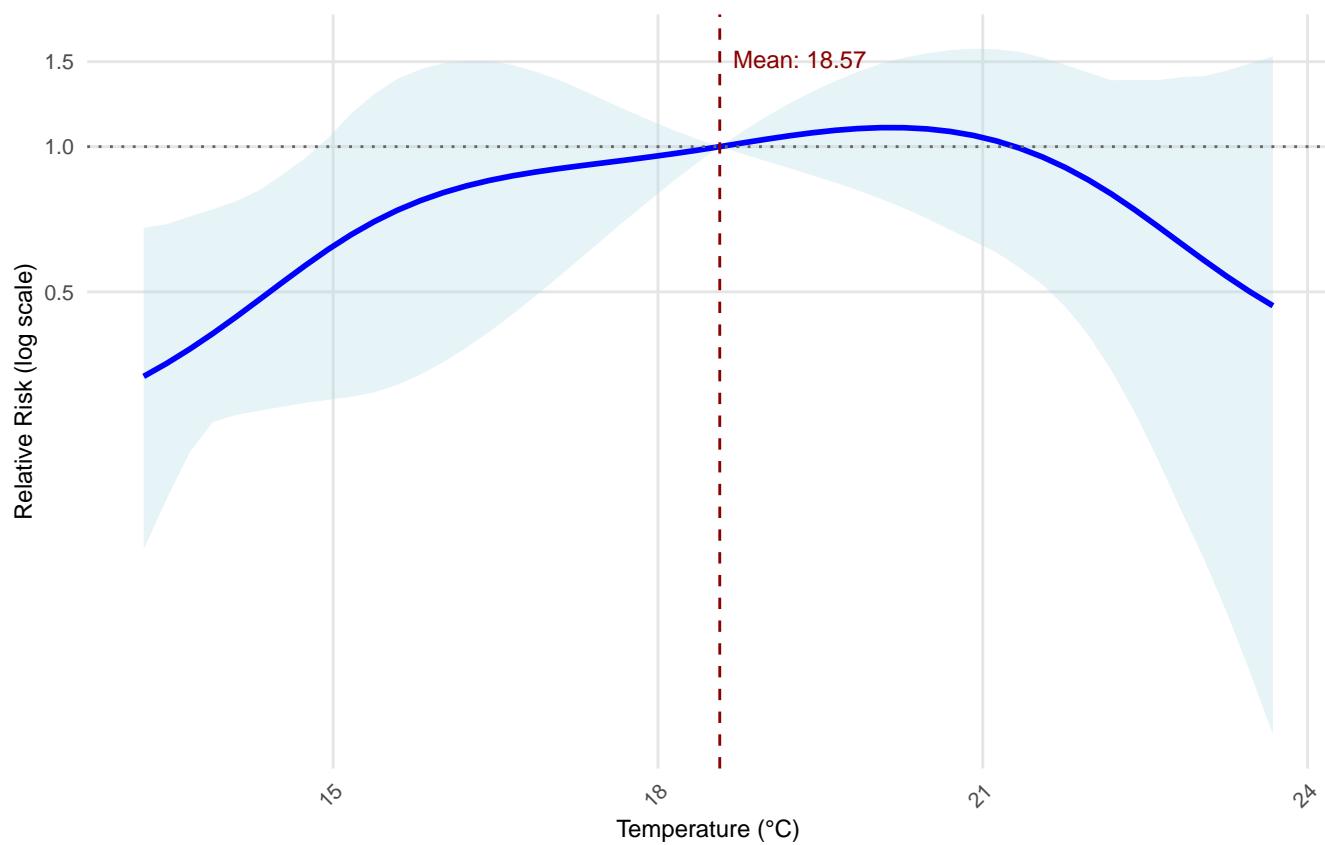
South Eastern Sydney – Model Time Series

Effect of Temperature (°C)



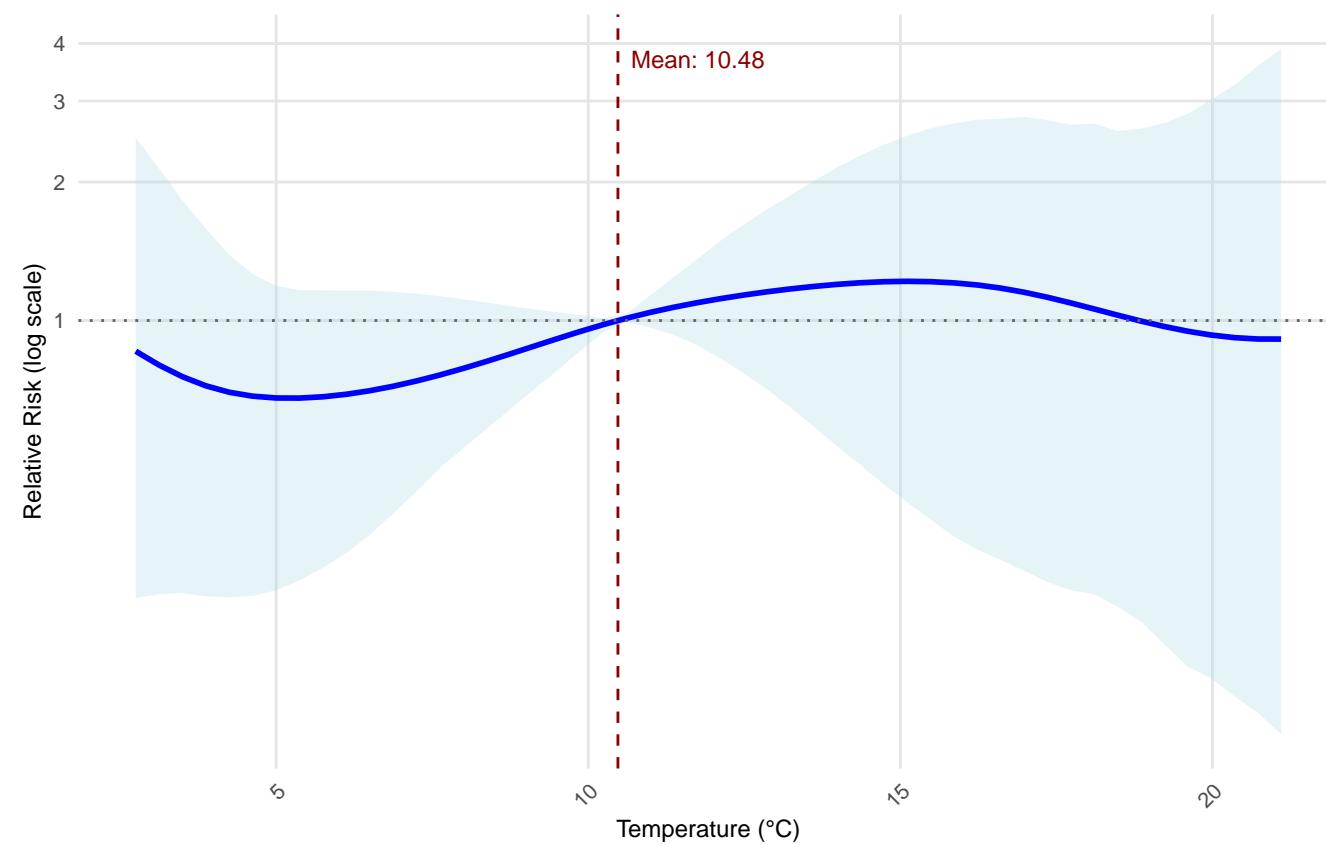
South Western Sydney – Model Time Series

Effect of Temperature (°C)

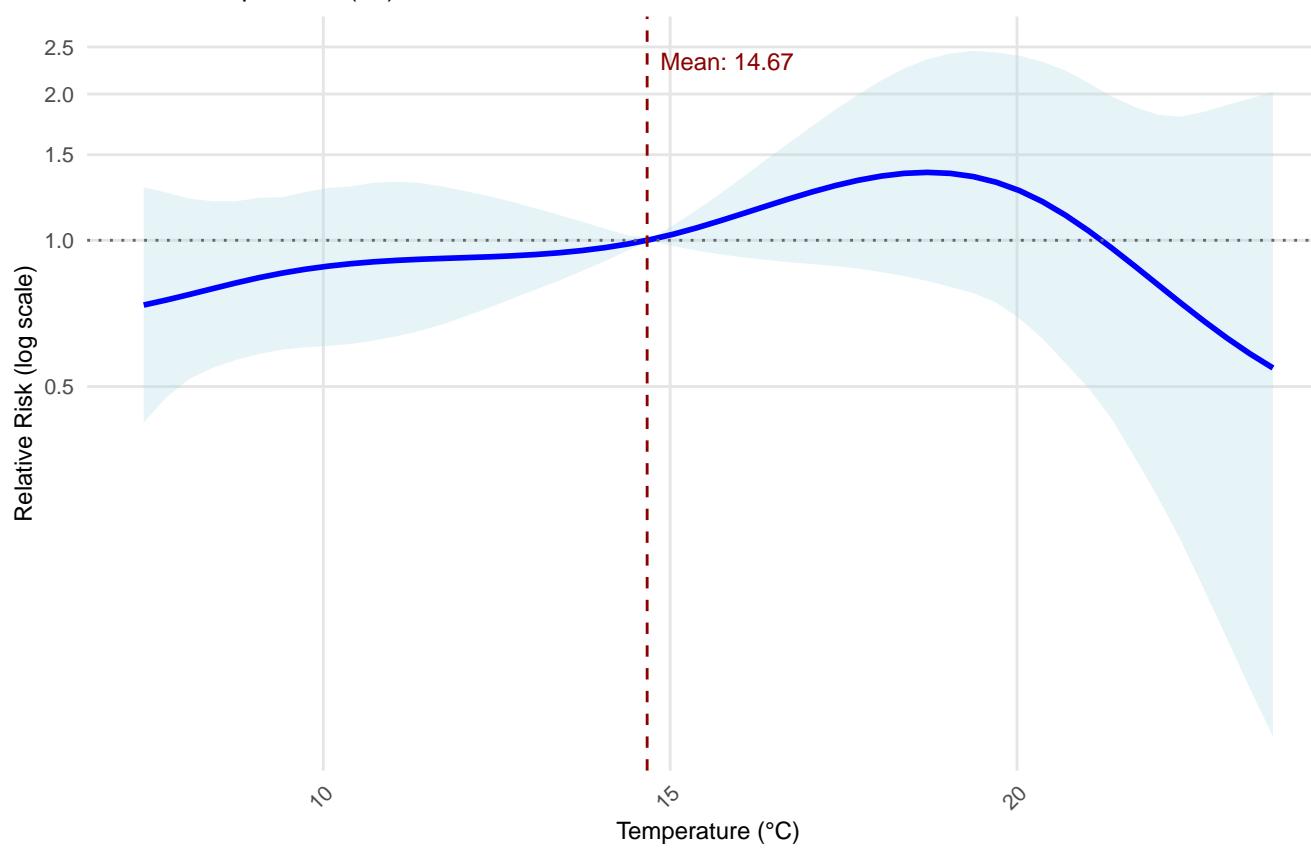
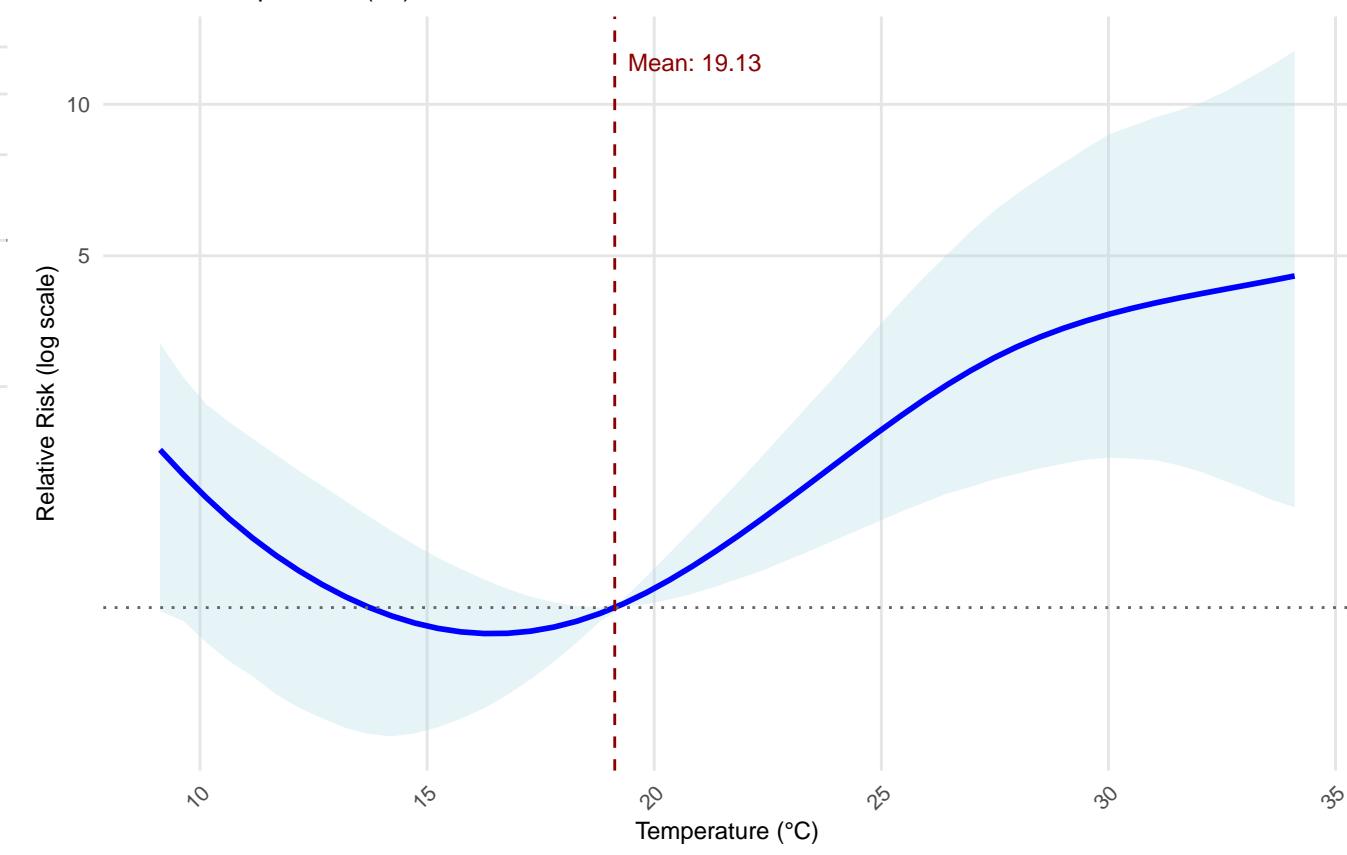
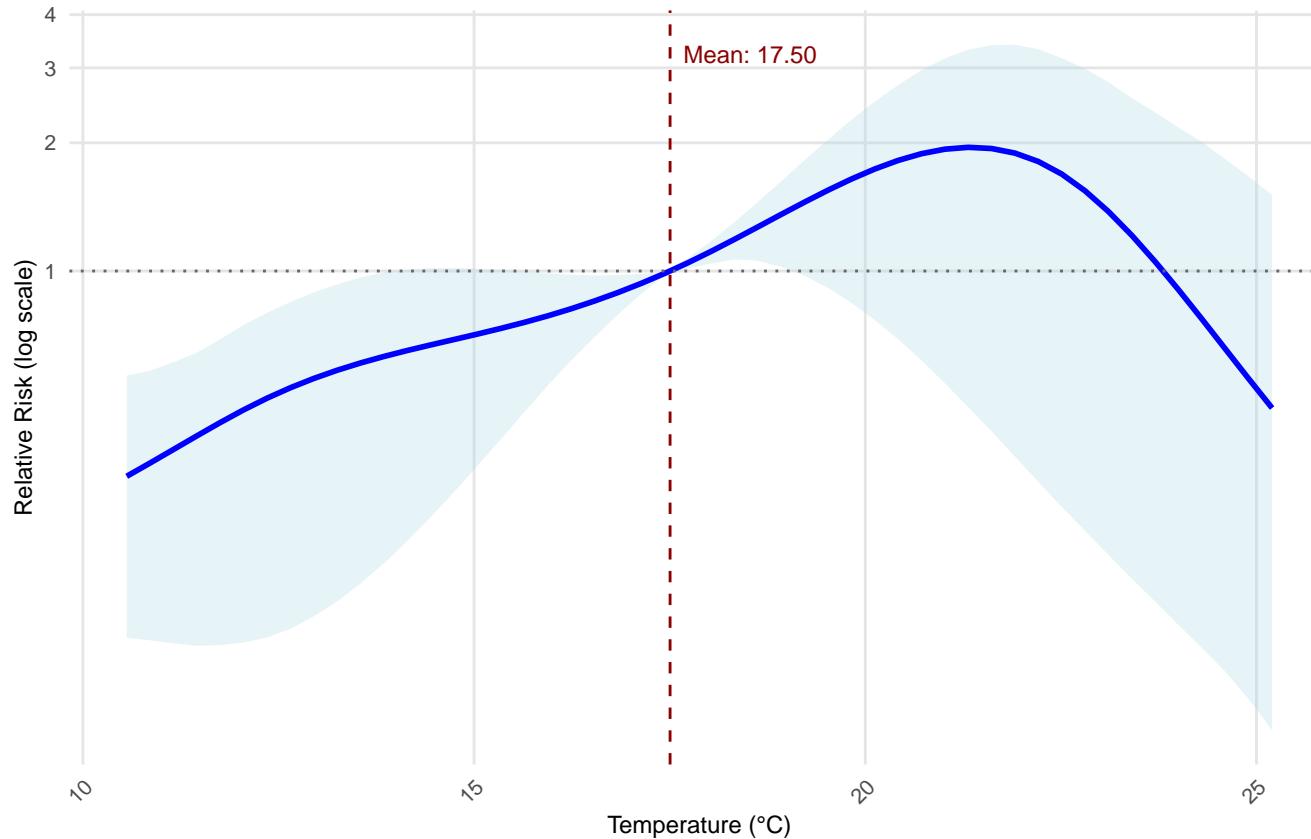


Southern NSW – Model Time Series

Effect of Temperature (°C)



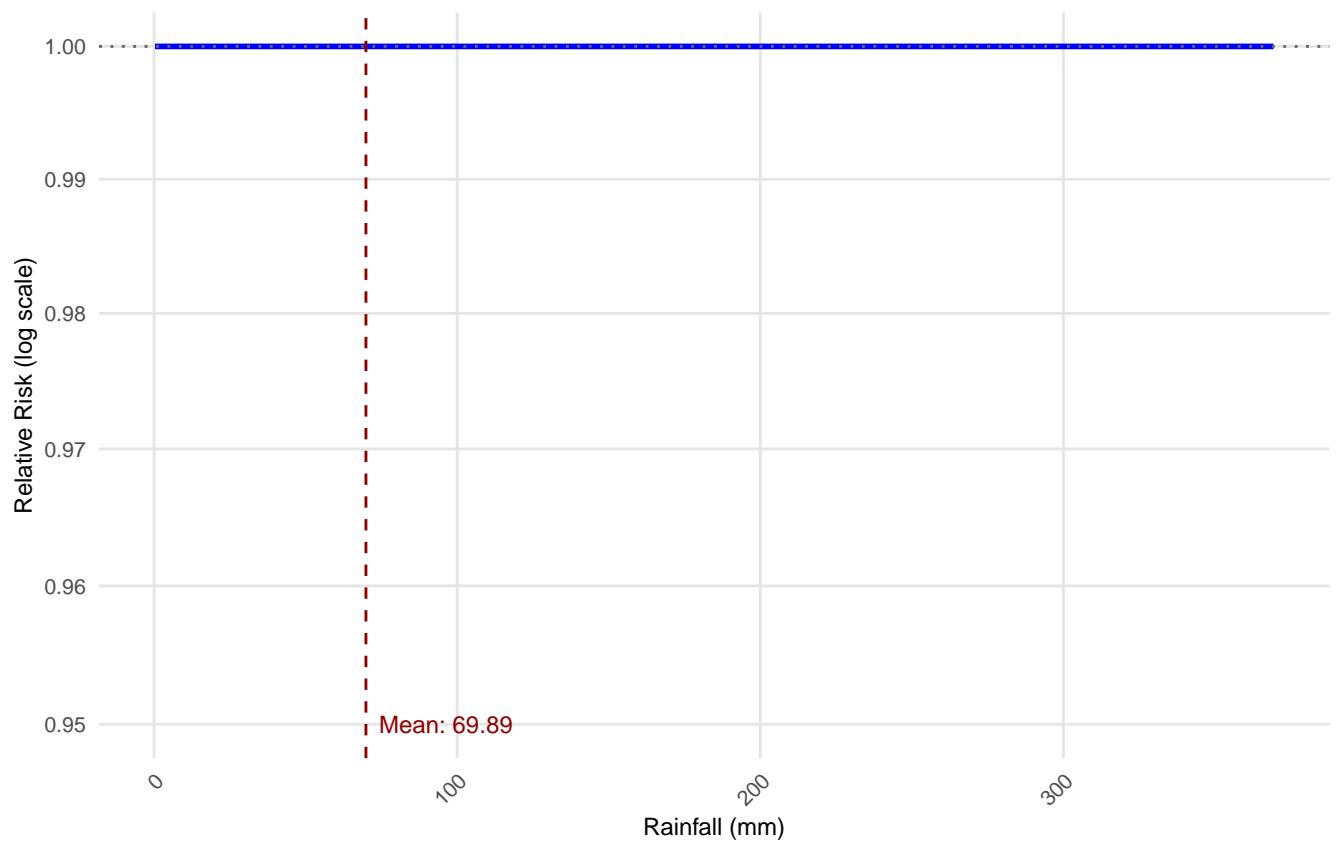
TEMP – Time Series– SB-DLNM

Sydney – Model Time SeriesEffect of Temperature ($^{\circ}\text{C}$)**Western NSW – Model Time Series**Effect of Temperature ($^{\circ}\text{C}$)**Western Sydney – Model Time Series**Effect of Temperature ($^{\circ}\text{C}$)

RAIN – Time Series– SB-DLNM

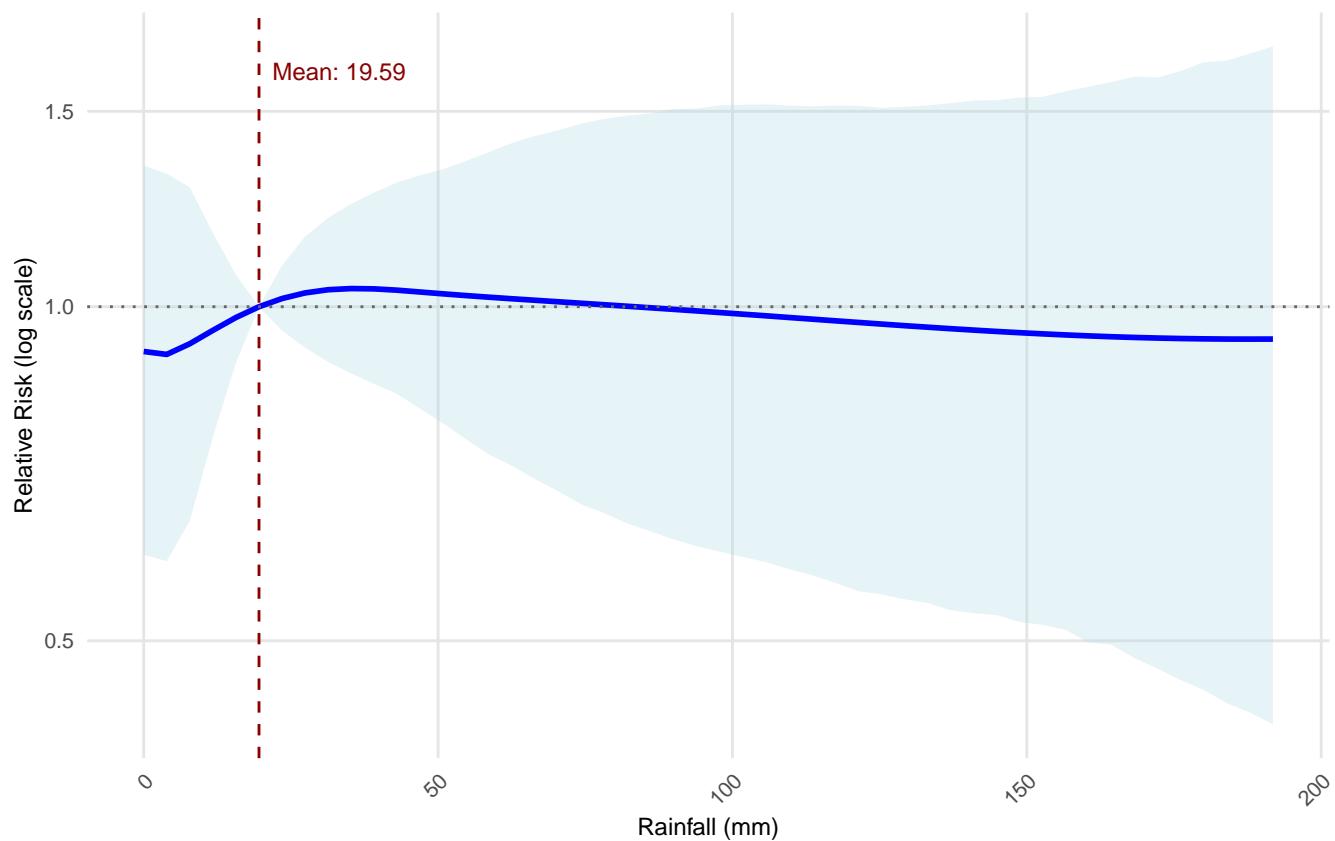
Central Coast – Model Time Series

Effect of Rainfall (mm)



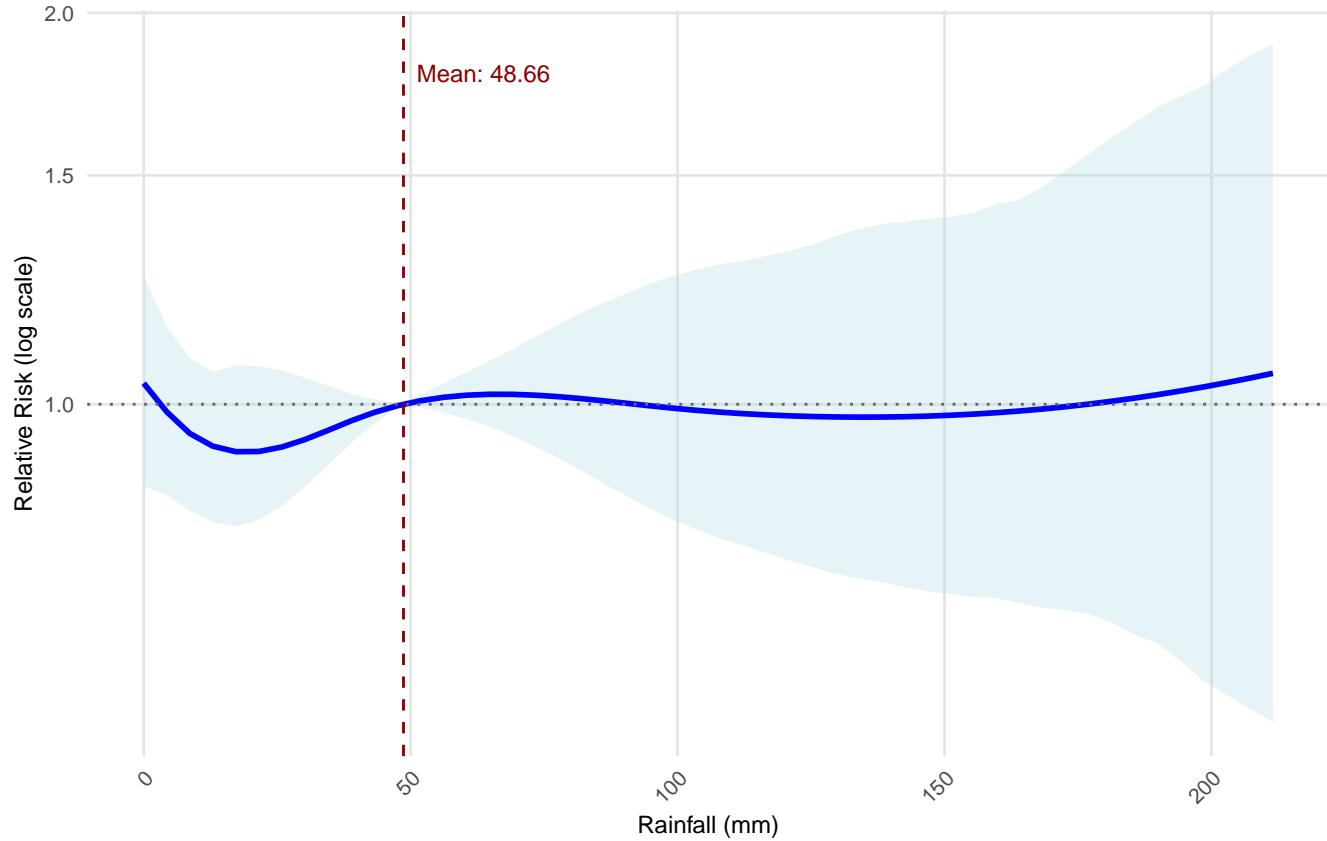
Far West – Model Time Series

Effect of Rainfall (mm)



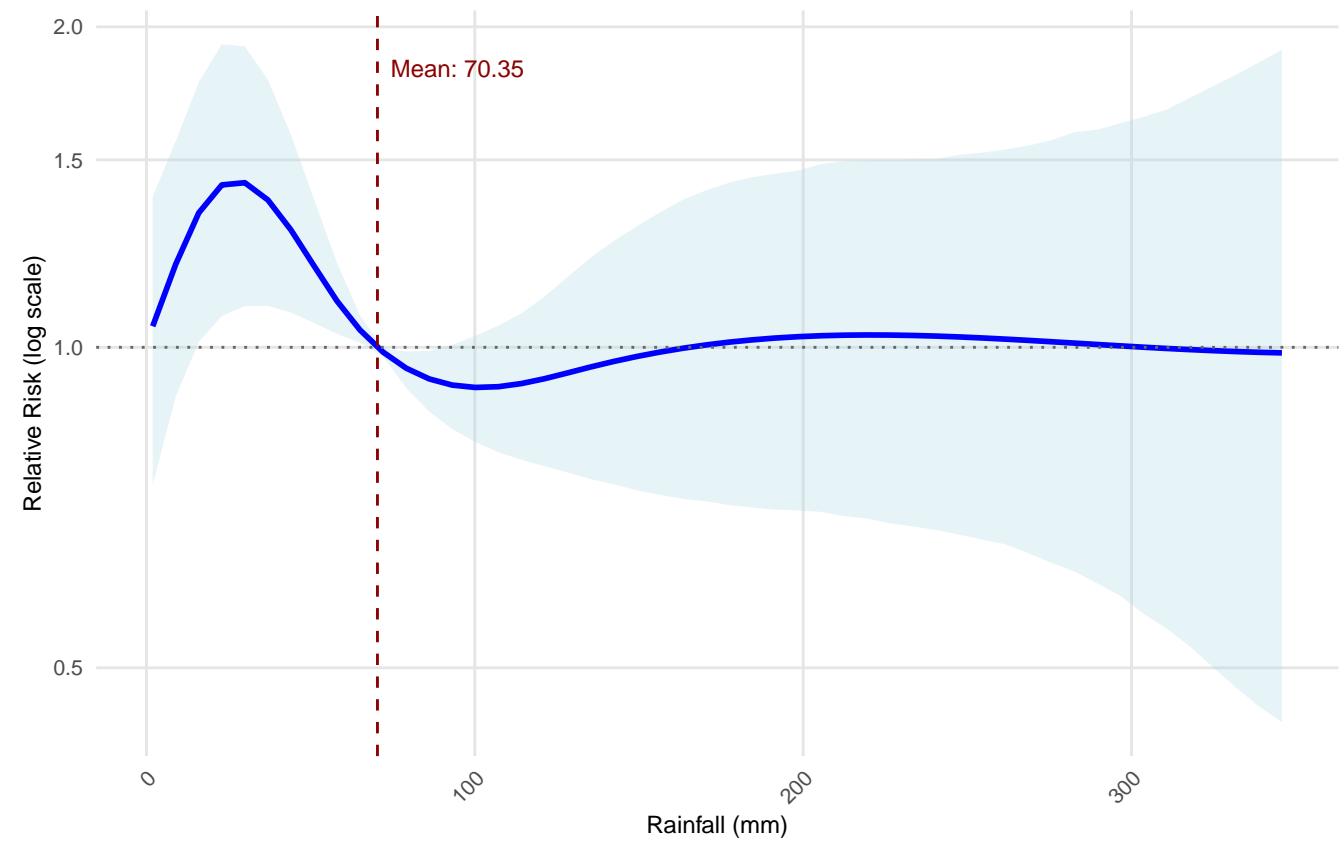
Hunter New England – Model Time Series

Effect of Rainfall (mm)



Illawarra Shoalhaven – Model Time Series

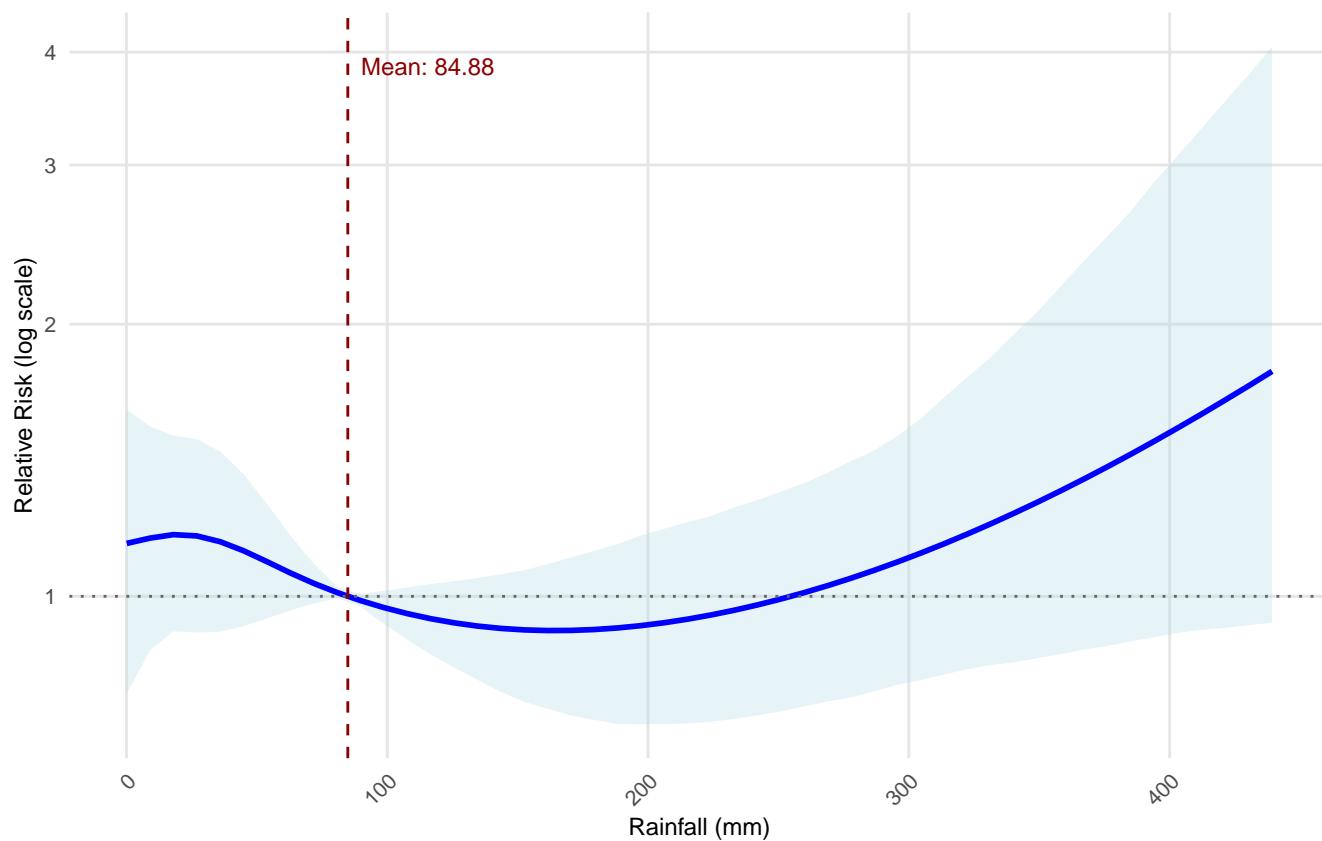
Effect of Rainfall (mm)



RAIN – Time Series– SB-DLNM

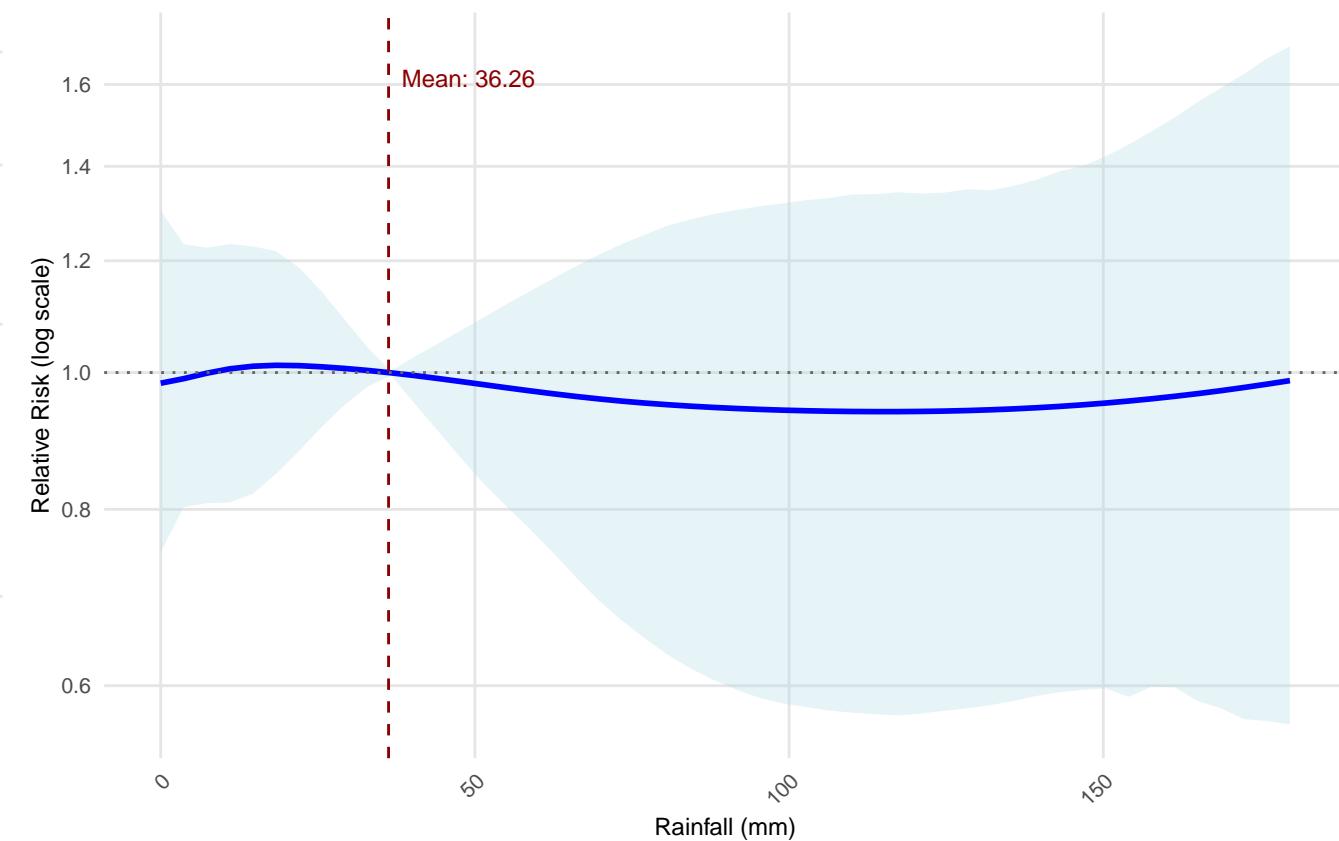
Mid North Coast – Model Time Series

Effect of Rainfall (mm)



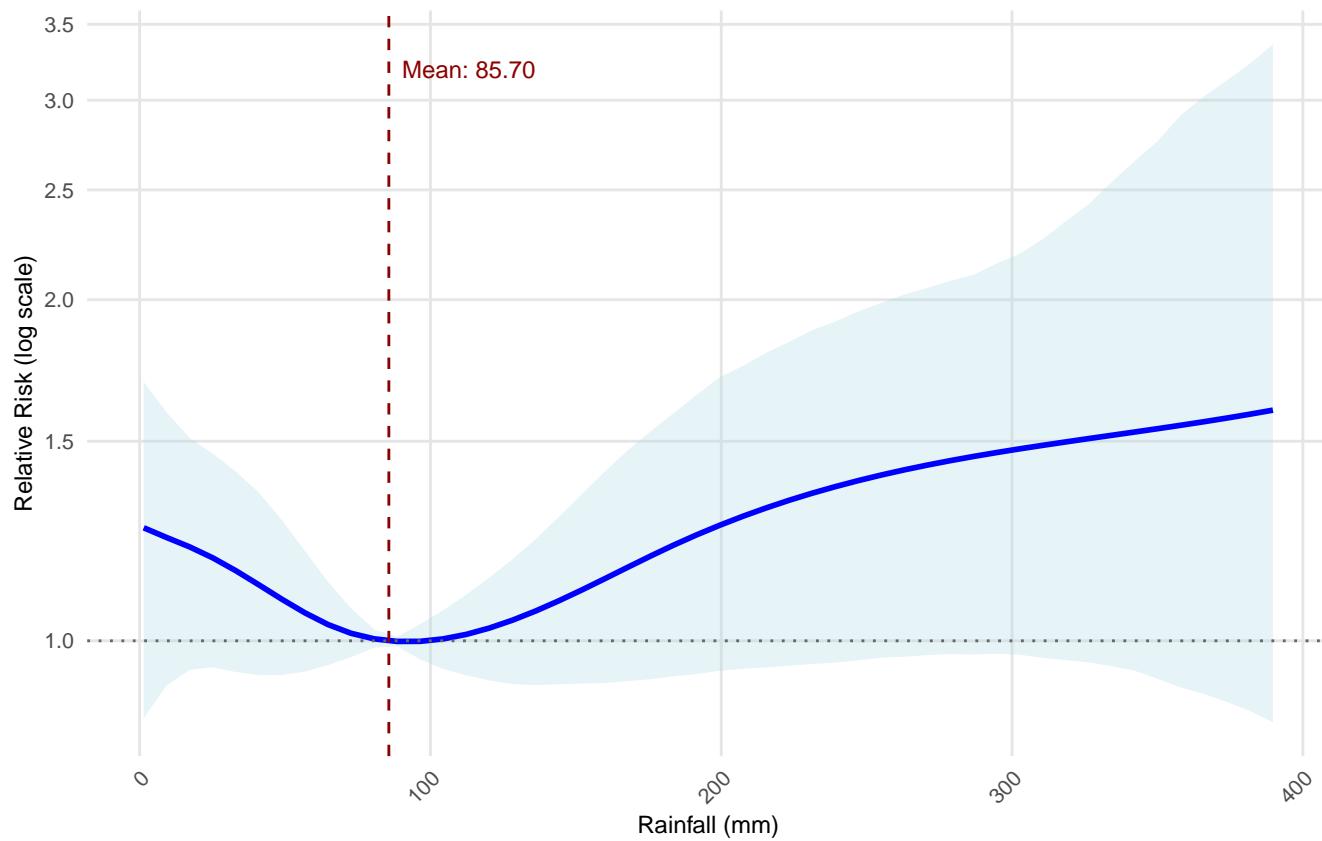
Murrumbidgee – Model Time Series

Effect of Rainfall (mm)



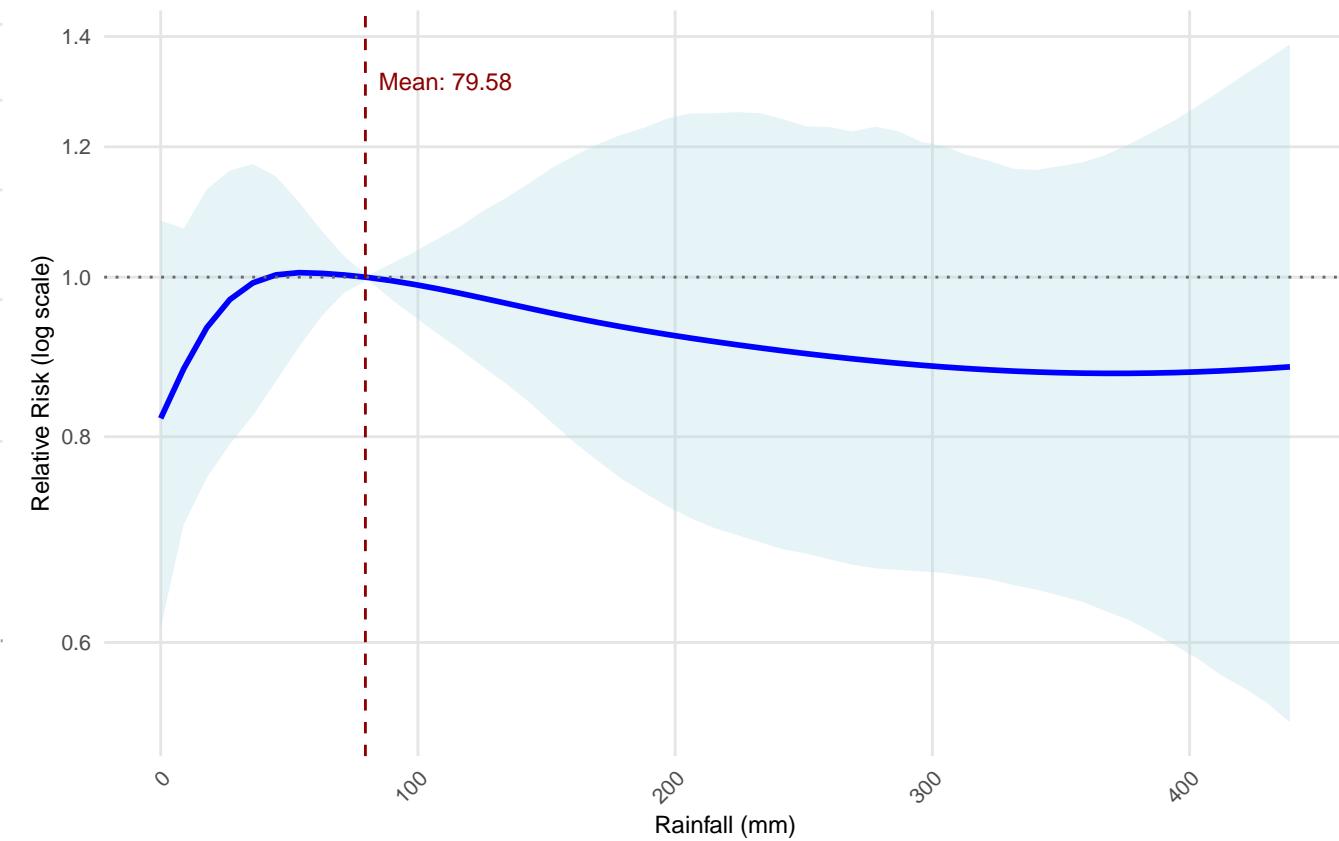
Nepean Blue Mountains – Model Time Series

Effect of Rainfall (mm)



Northern NSW – Model Time Series

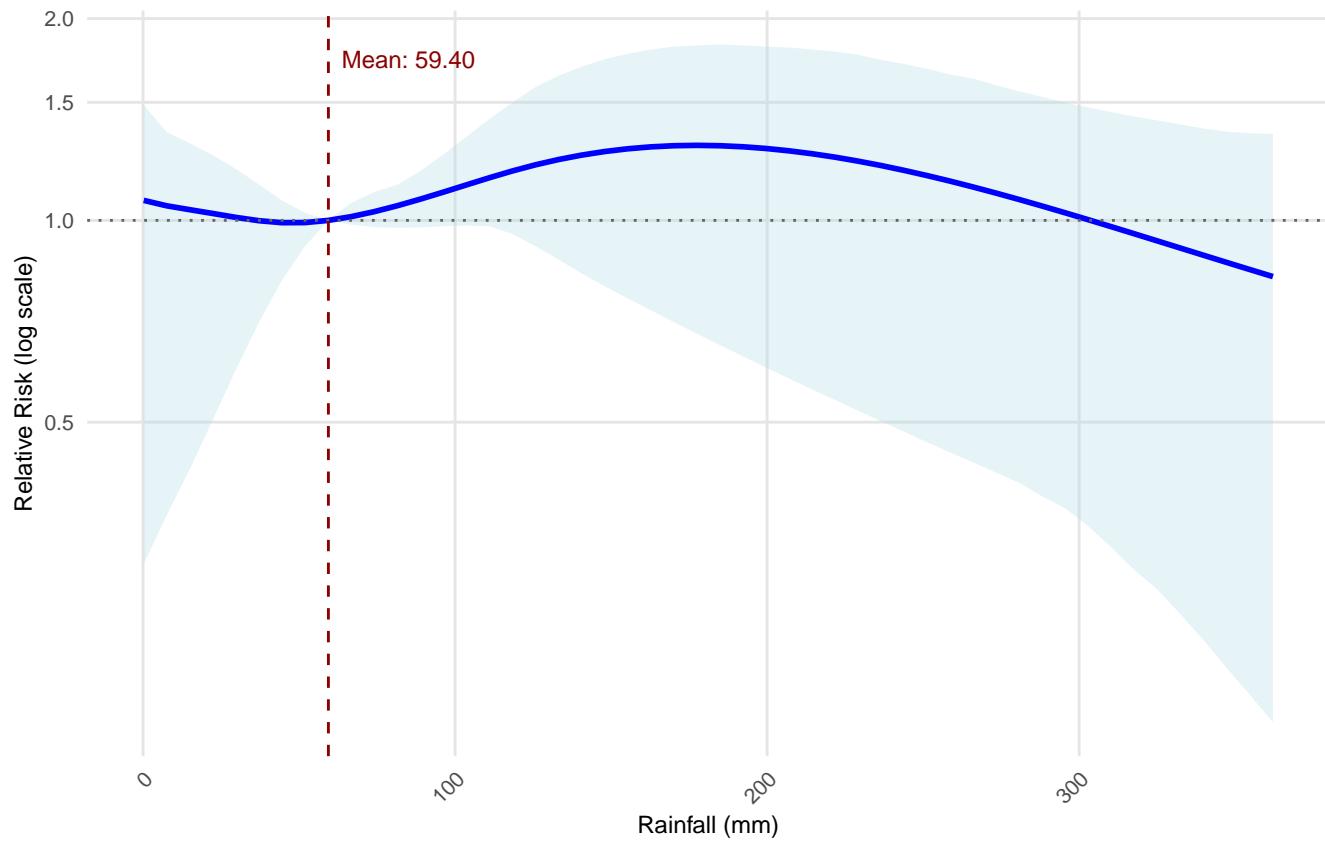
Effect of Rainfall (mm)



RAIN – Time Series– SB-DLNM

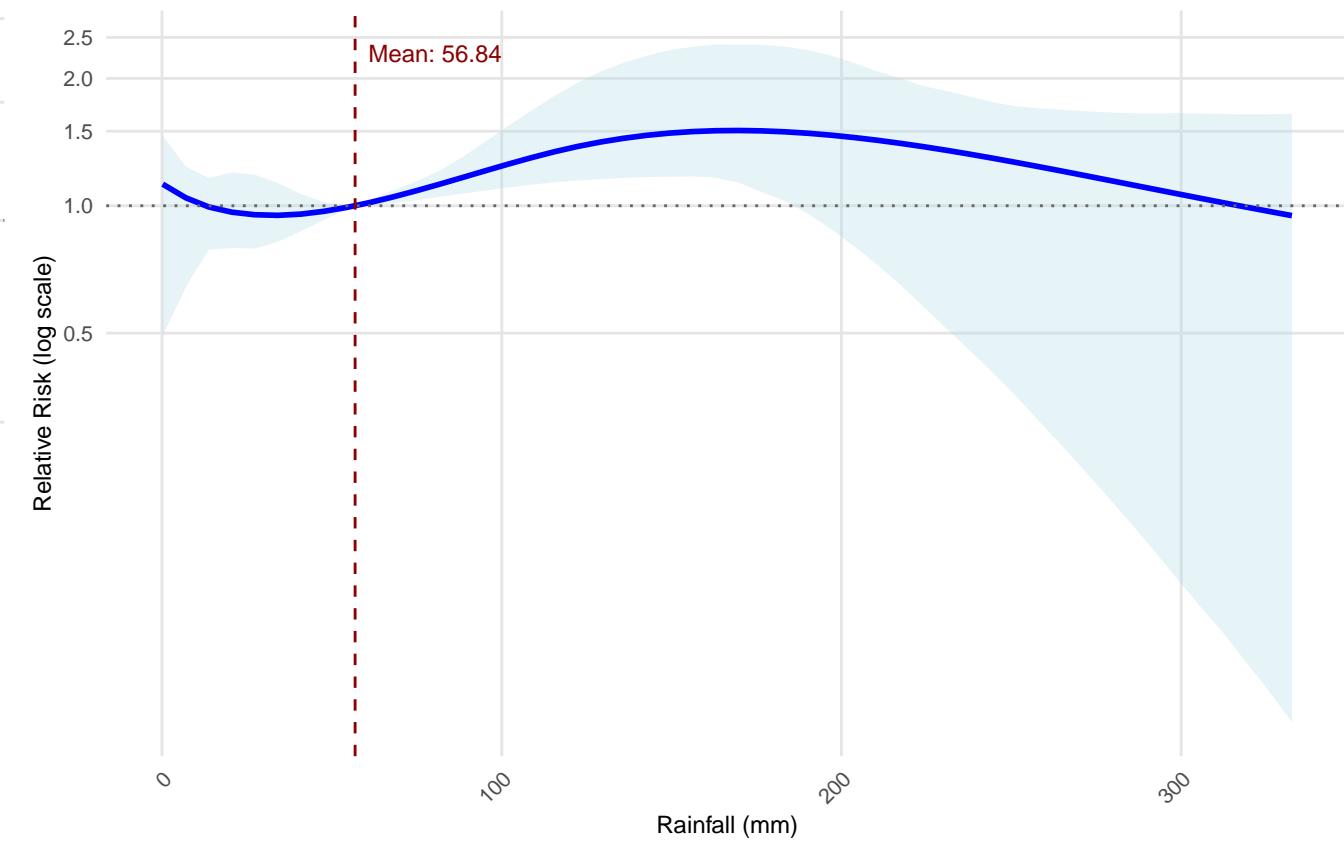
Northern Sydney – Model Time Series

Effect of Rainfall (mm)



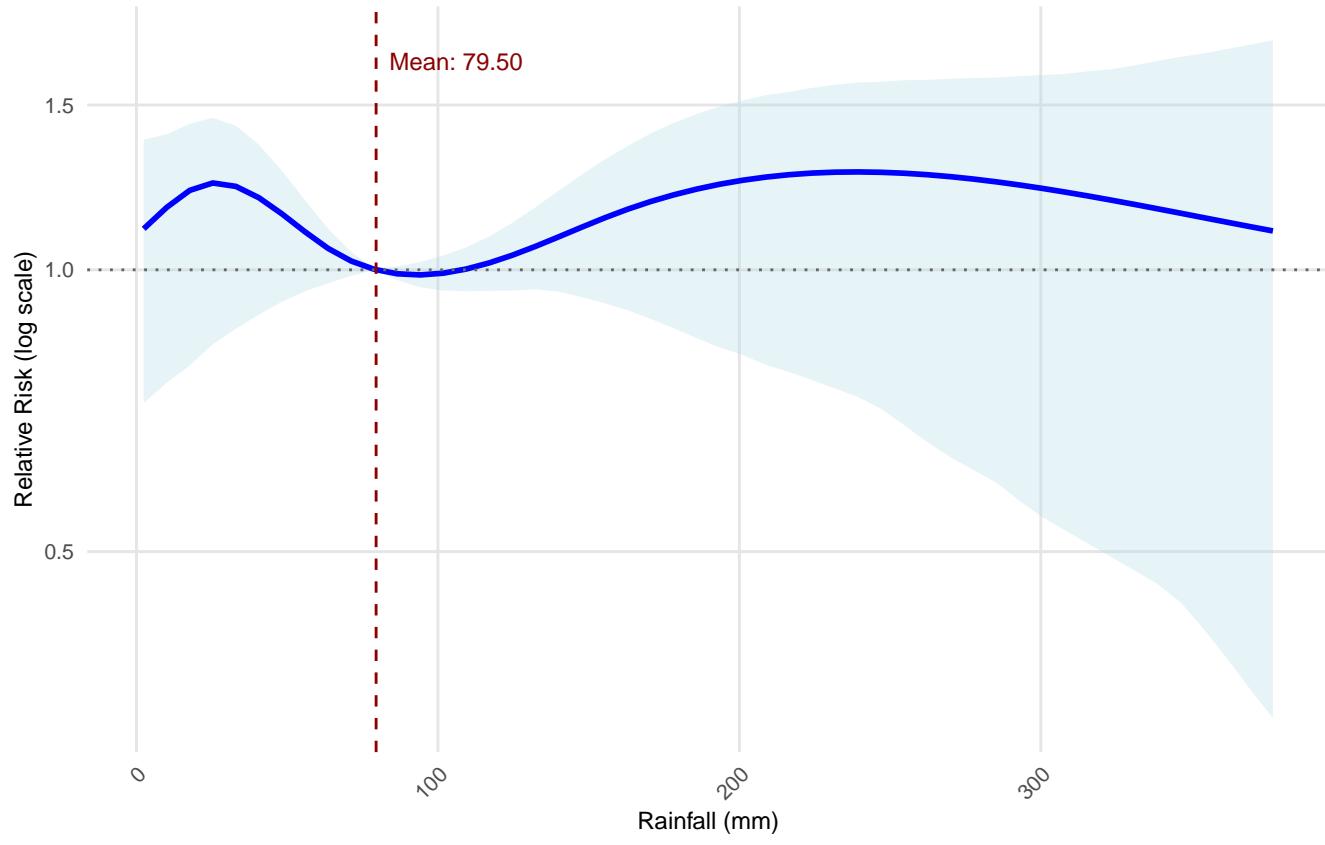
South Eastern Sydney – Model Time Series

Effect of Rainfall (mm)



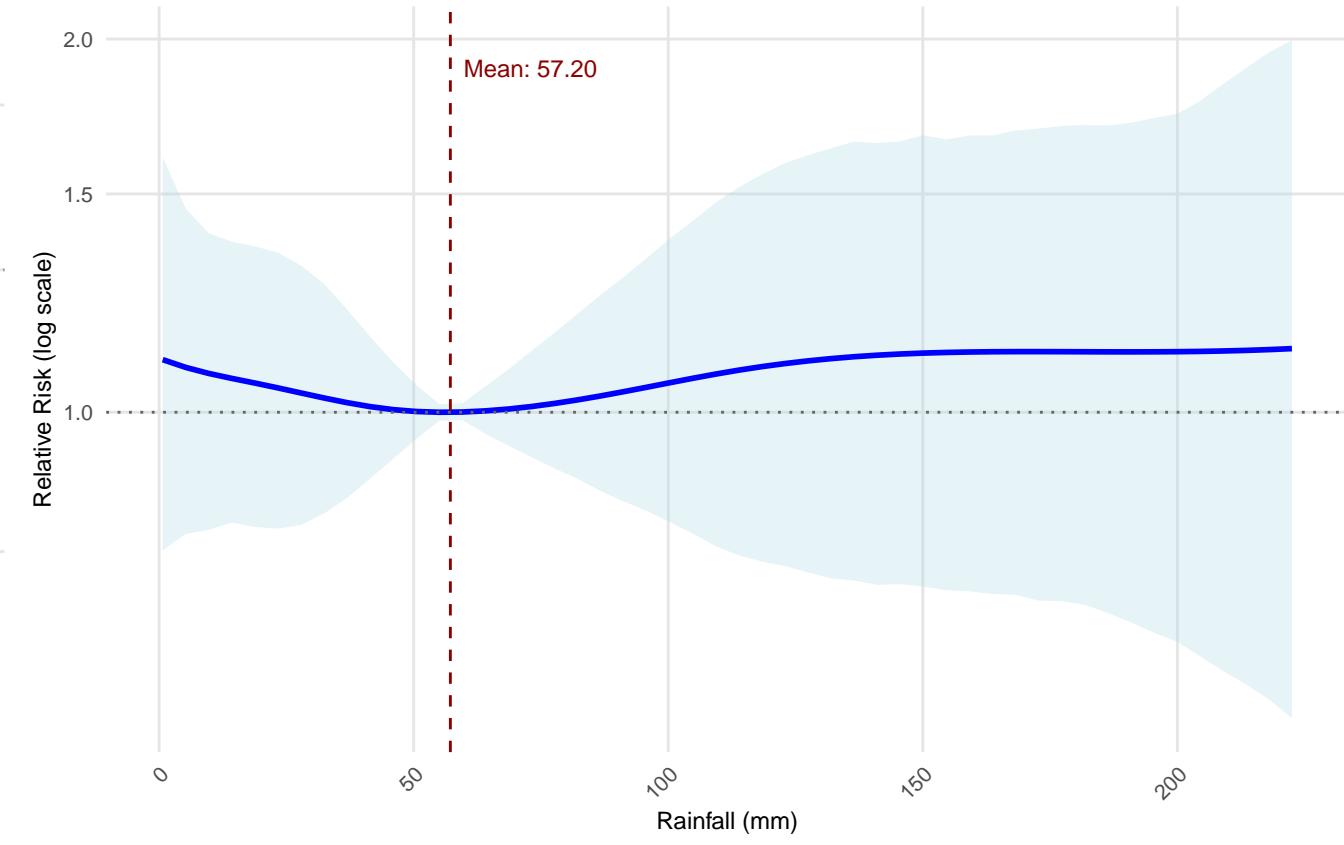
South Western Sydney – Model Time Series

Effect of Rainfall (mm)



Southern NSW – Model Time Series

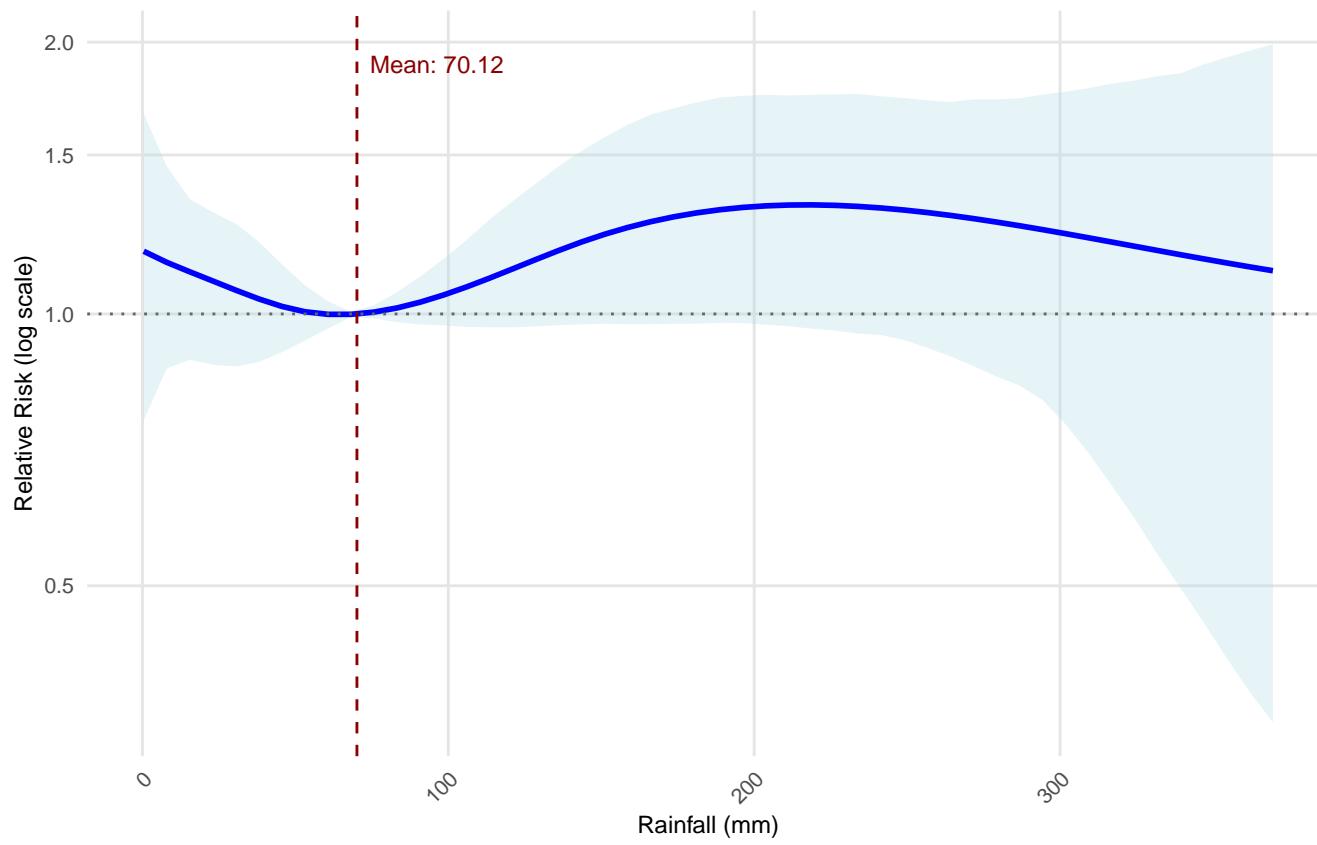
Effect of Rainfall (mm)



RAIN – Time Series– SB-DLNM

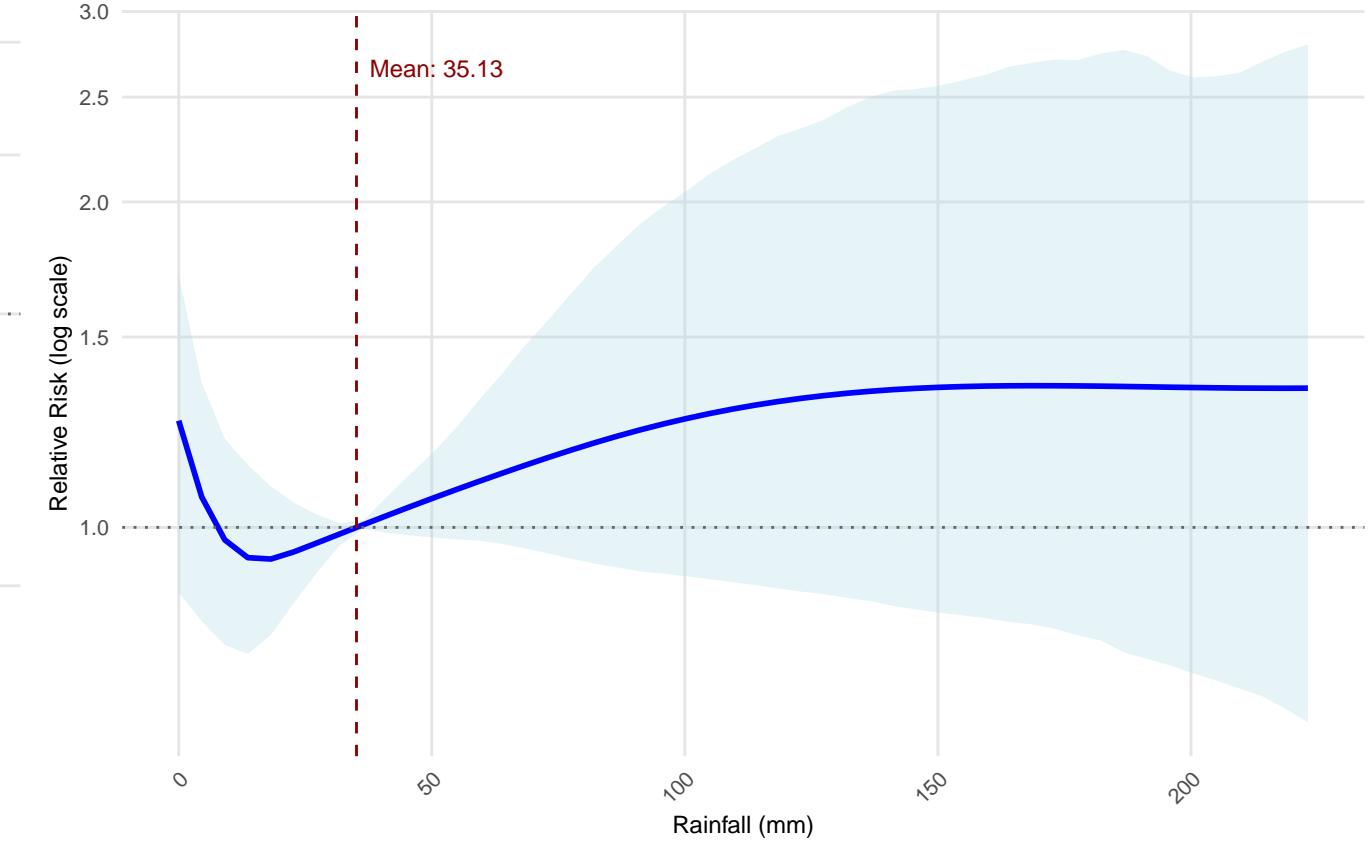
Sydney – Model Time Series

Effect of Rainfall (mm)



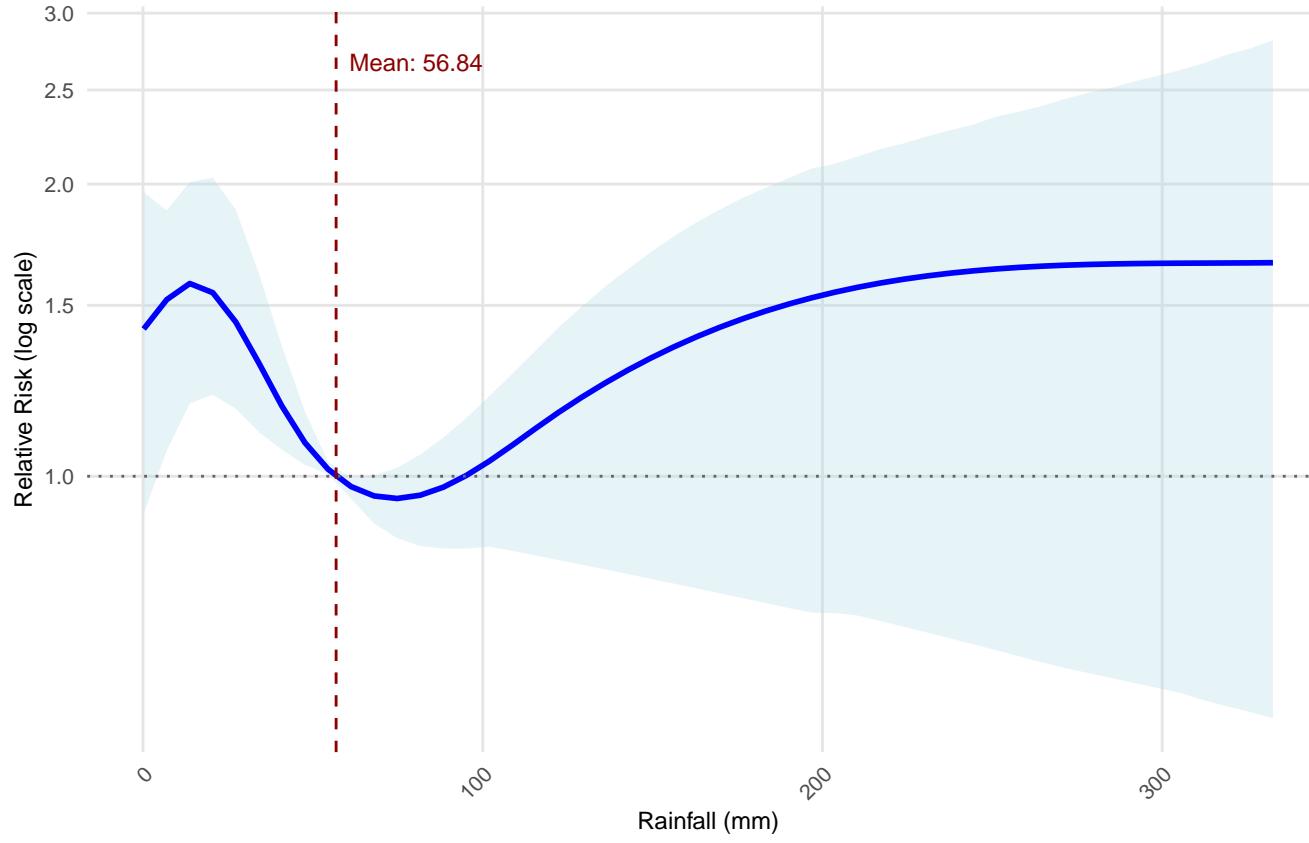
Western NSW – Model Time Series

Effect of Rainfall (mm)



Western Sydney – Model Time Series

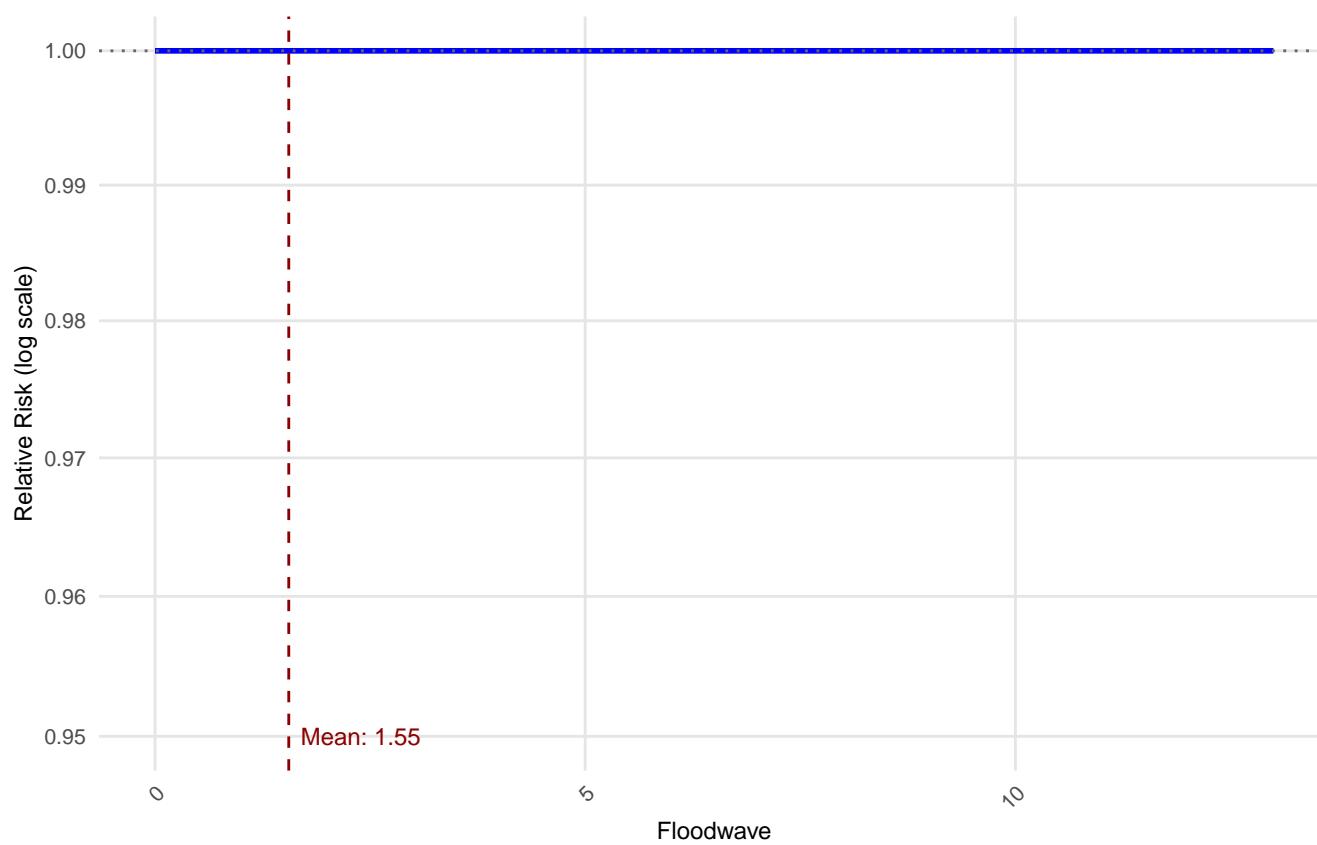
Effect of Rainfall (mm)



FLOOD – Time Series– SB-DLNM

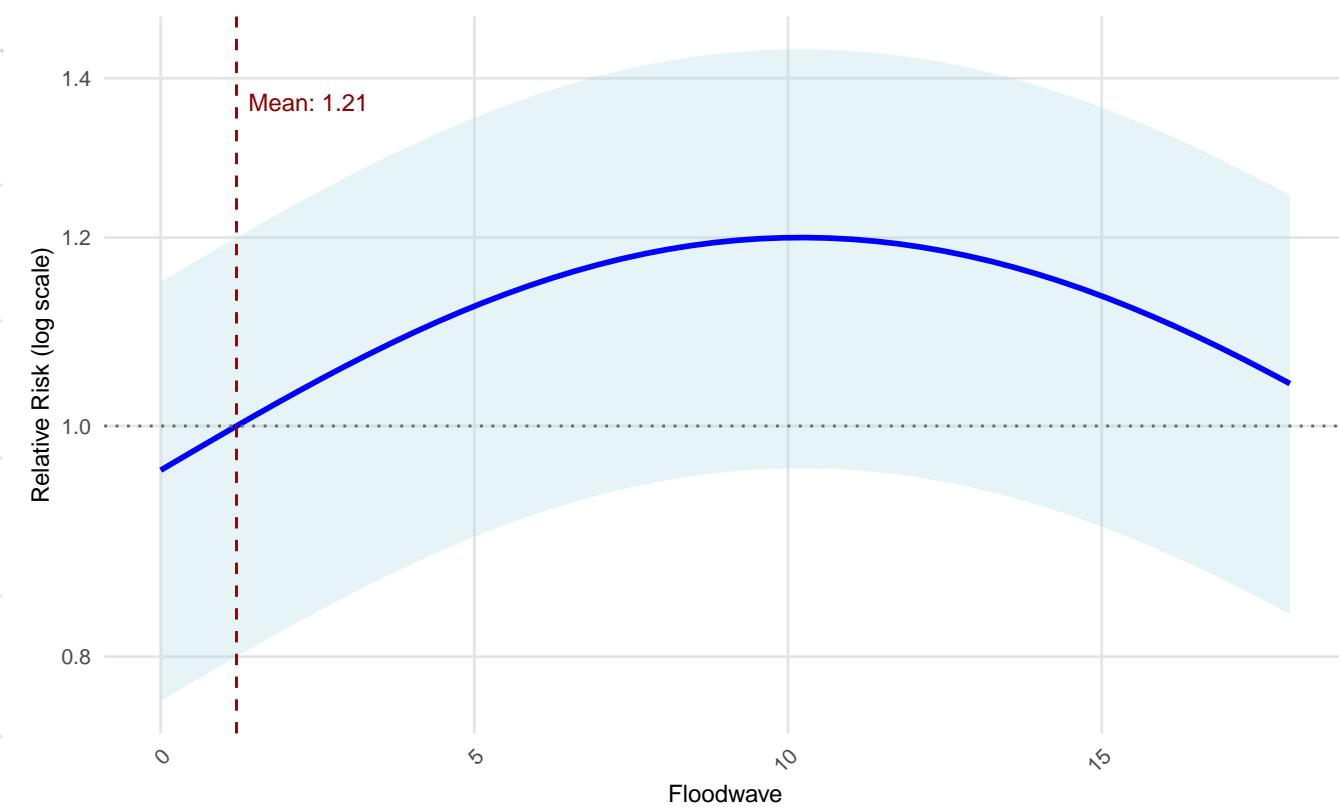
Central Coast – Model Time Series

Effect of Floodwave



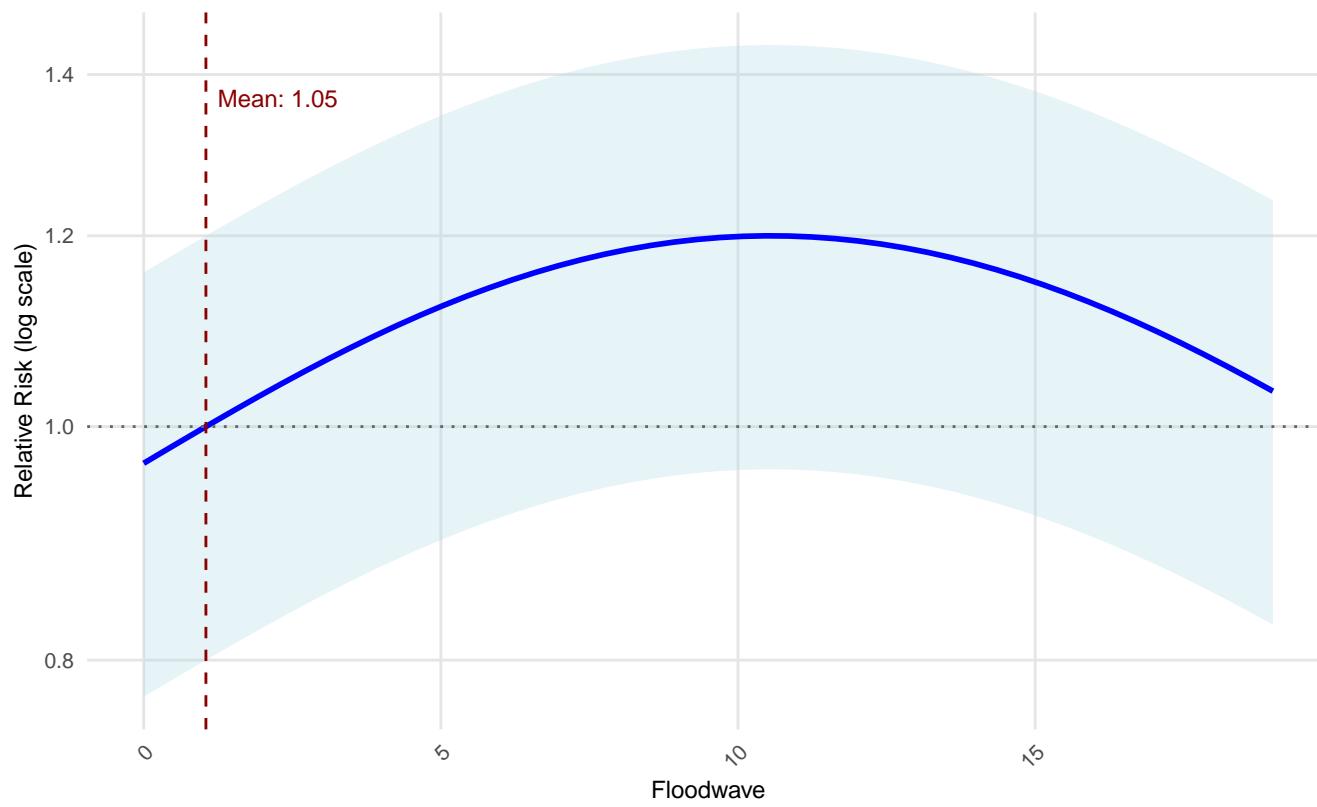
Hunter New England – Model Time Series

Effect of Floodwave



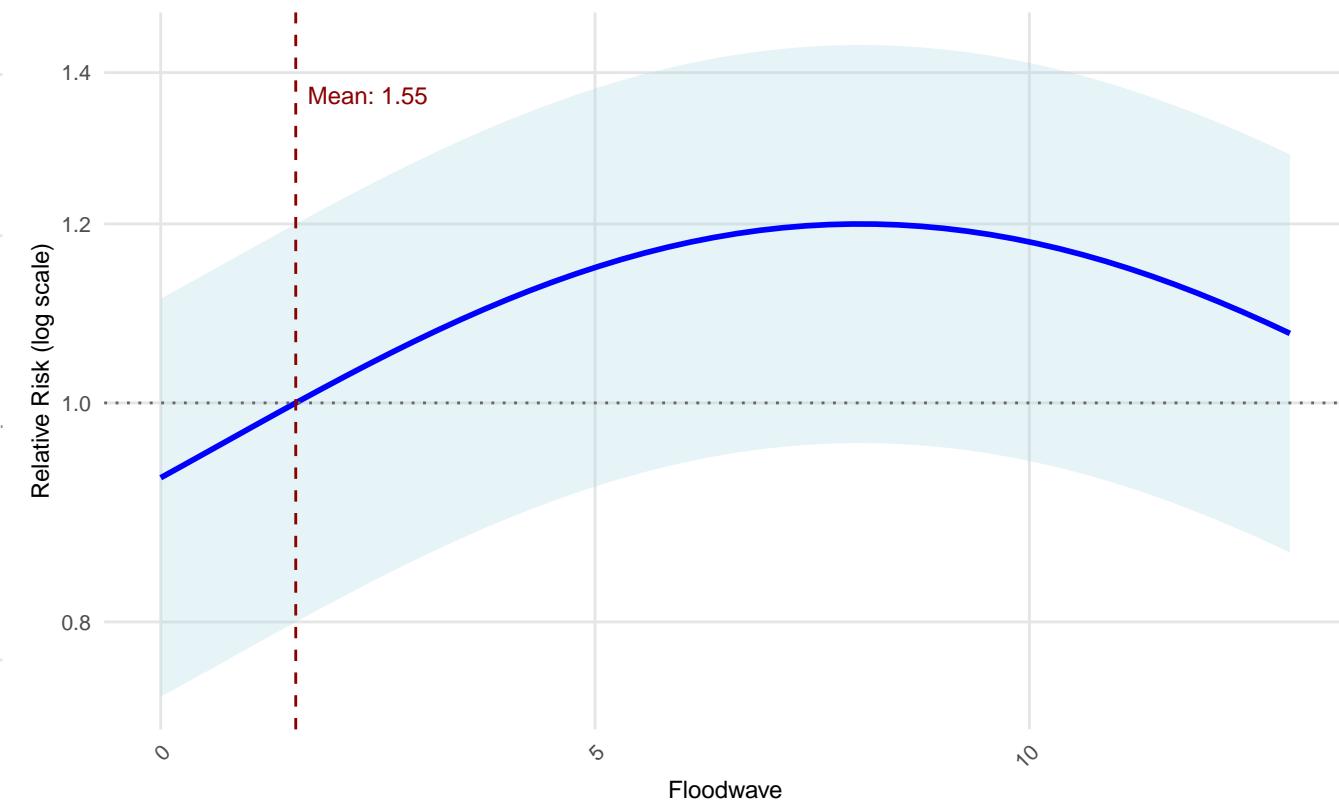
Illawarra Shoalhaven – Model Time Series

Effect of Floodwave



Mid North Coast – Model Time Series

Effect of Floodwave



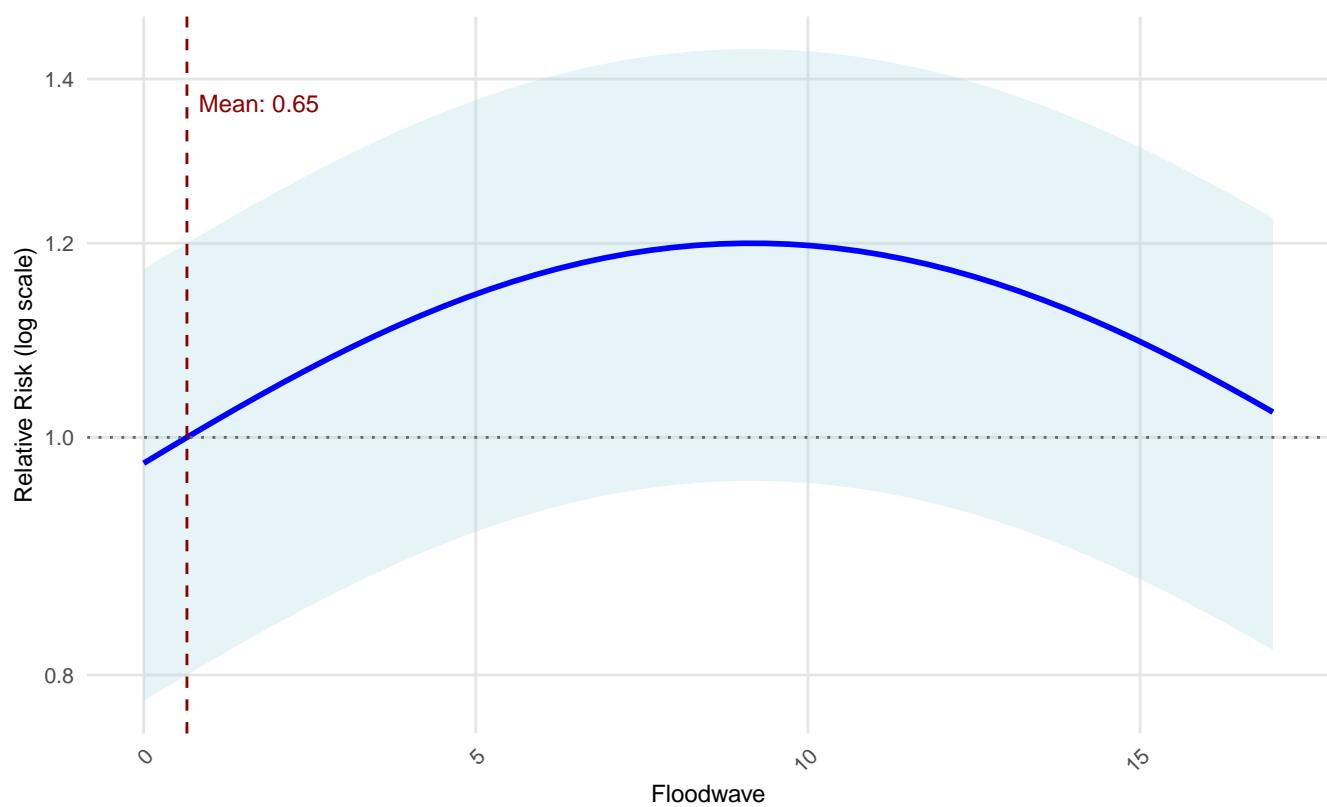
Note: Simplified curve due to basis matrix issues

Note: Simplified curve due to basis matrix issues

FLOOD – Time Series– SB-DLNM

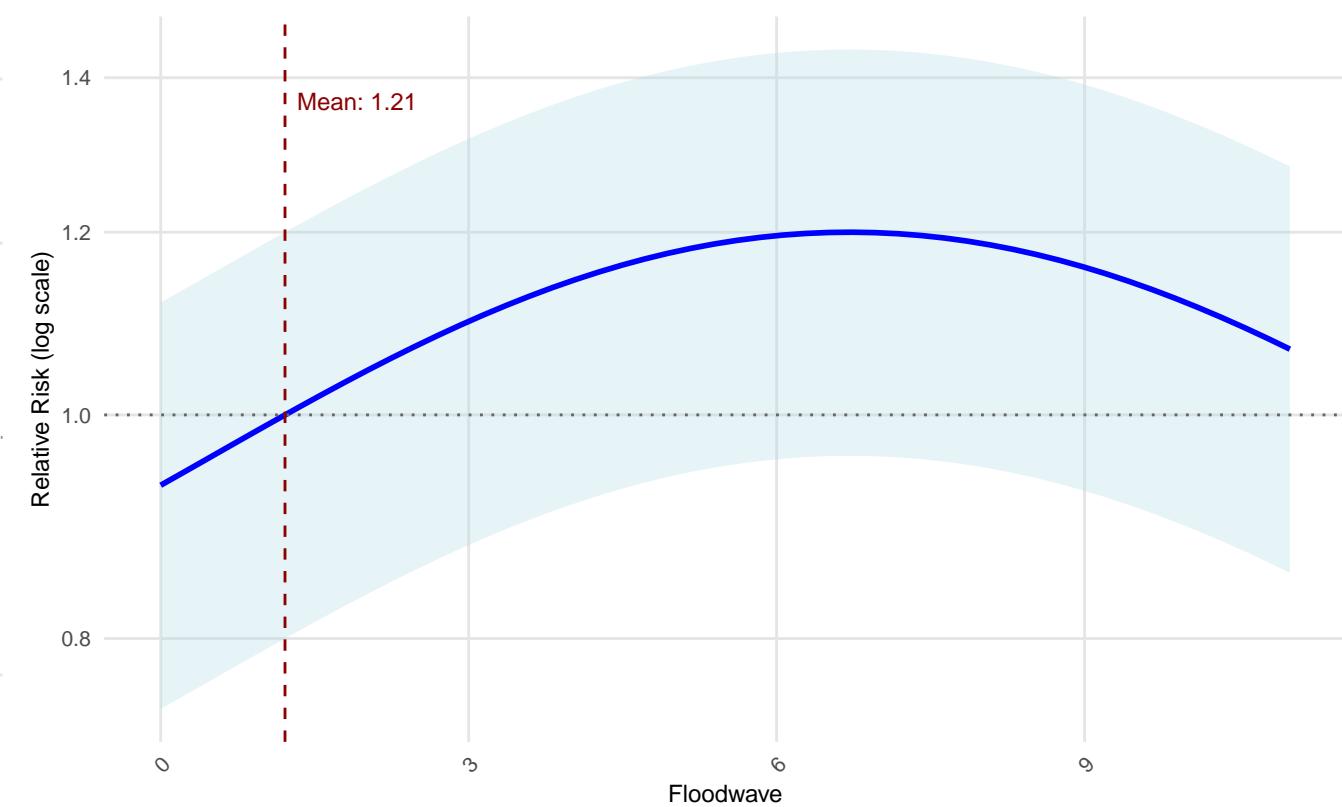
Murrumbidgee – Model Time Series

Effect of Floodwave



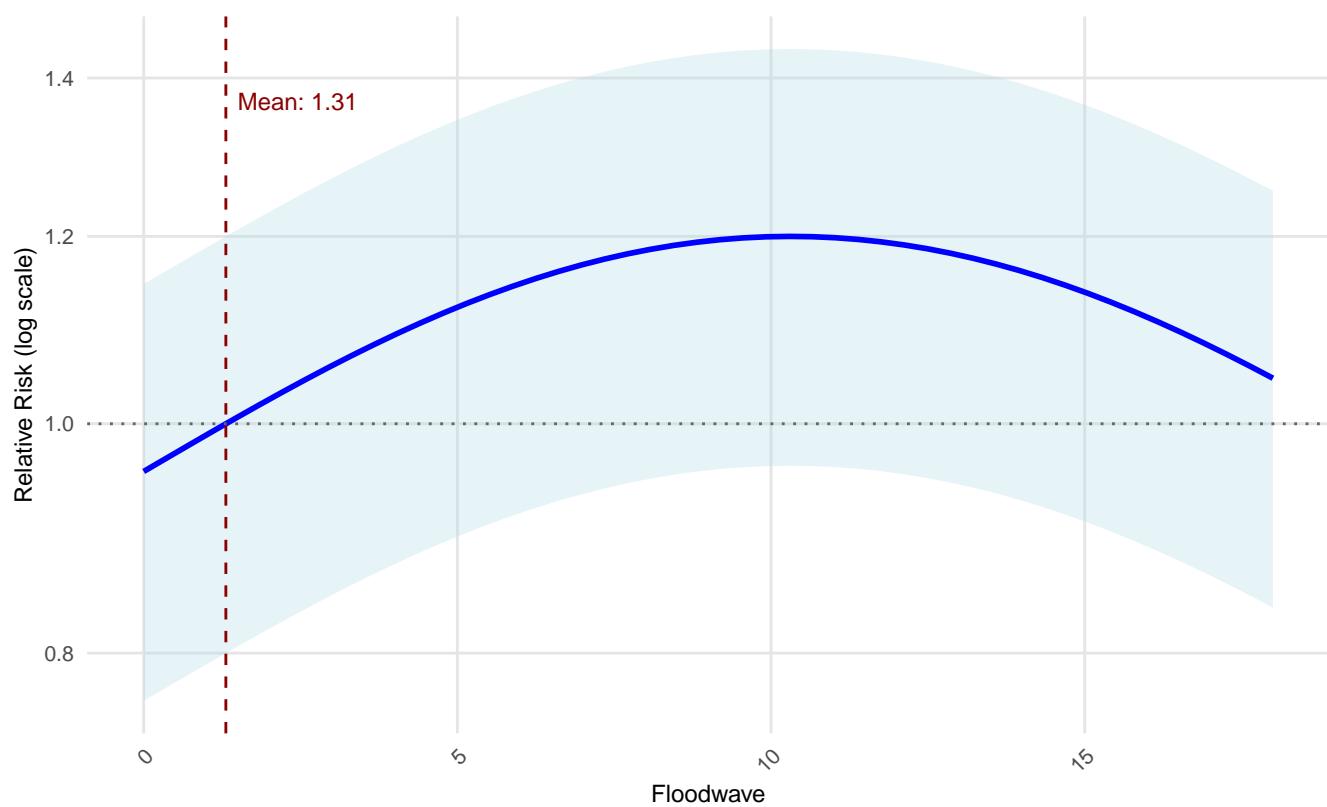
Nepean Blue Mountains – Model Time Series

Effect of Floodwave



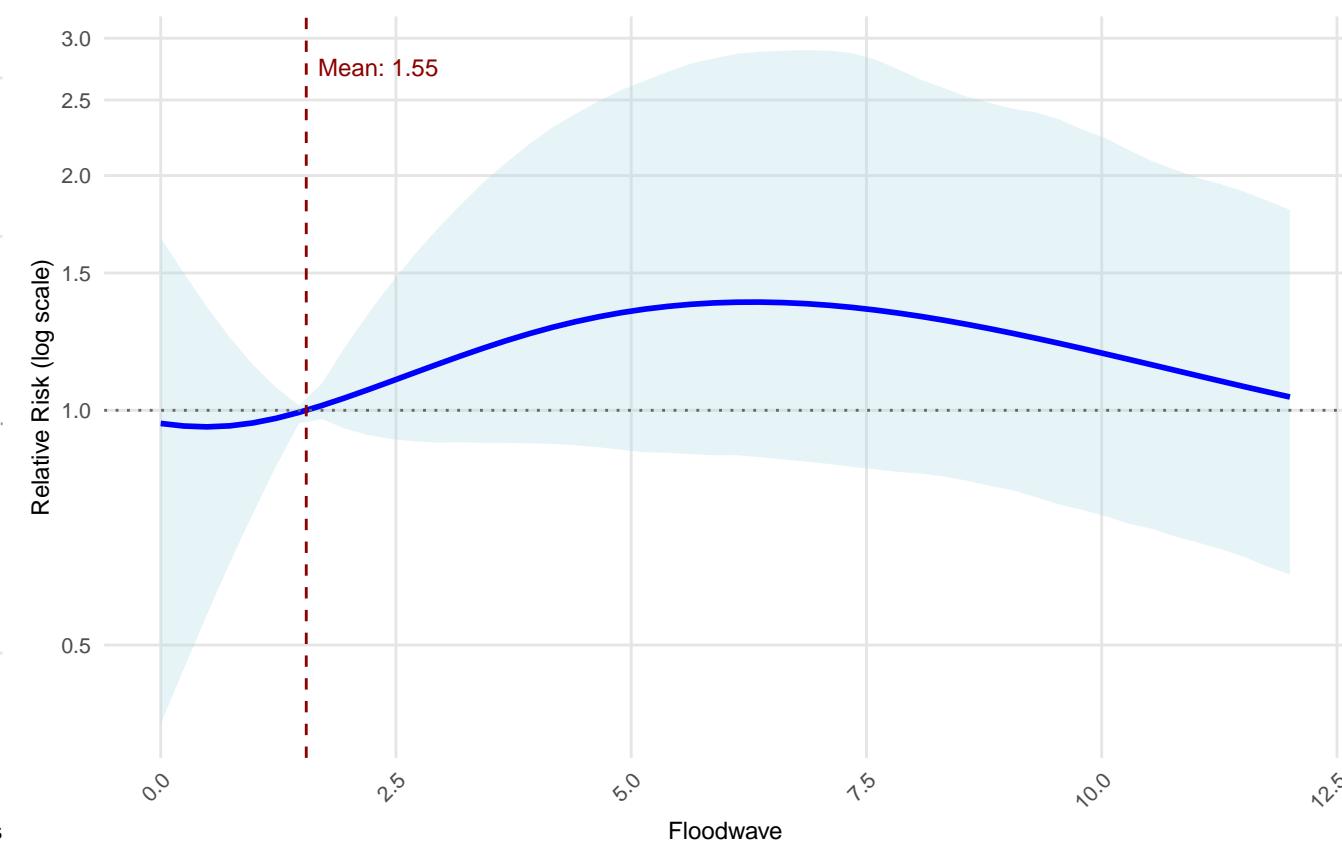
Northern NSW – Model Time Series

Effect of Floodwave



Northern Sydney – Model Time Series

Effect of Floodwave



Note: Simplified curve due to basis matrix issues

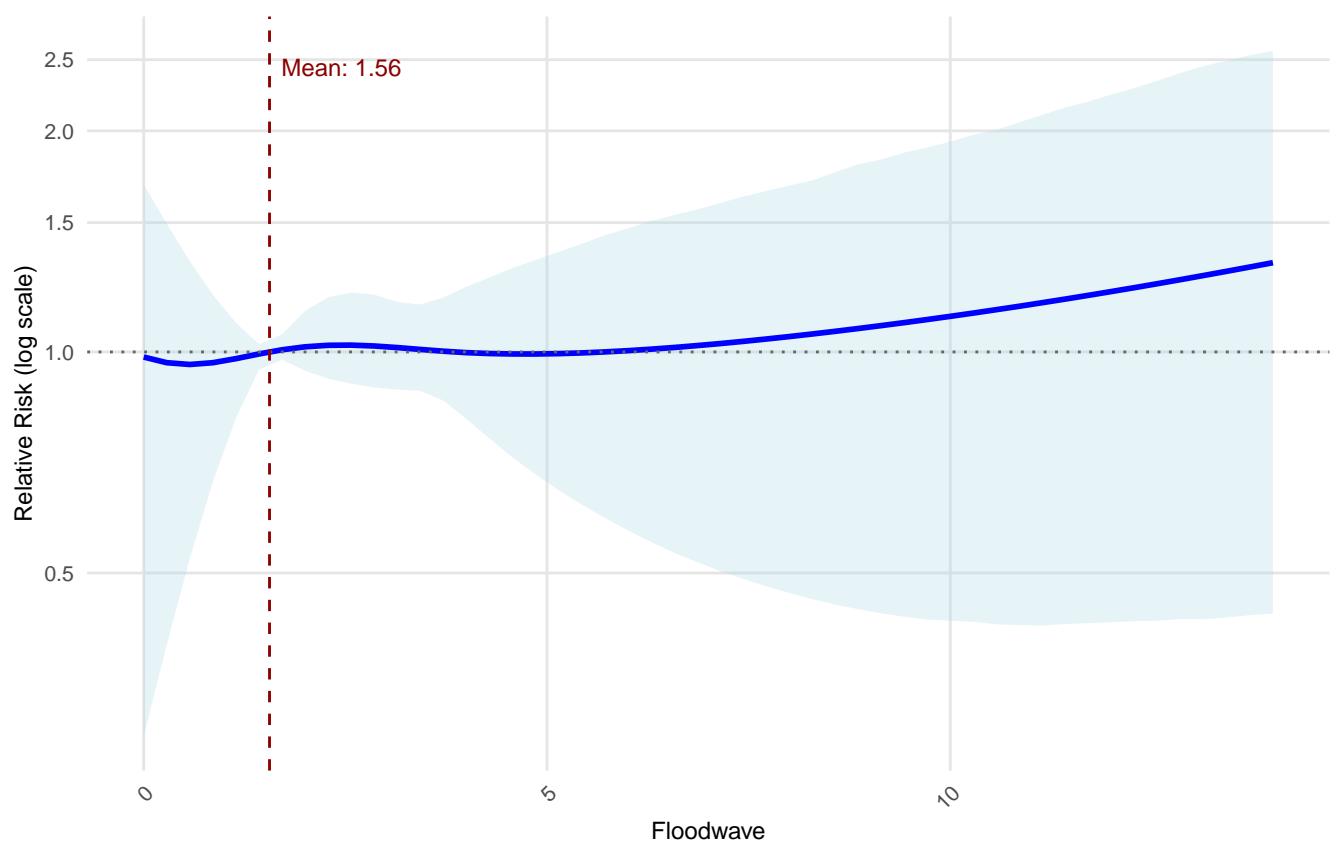
Note: Simplified curve due to basis matrix issues

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FLOOD – Time Series– SB-DLNM

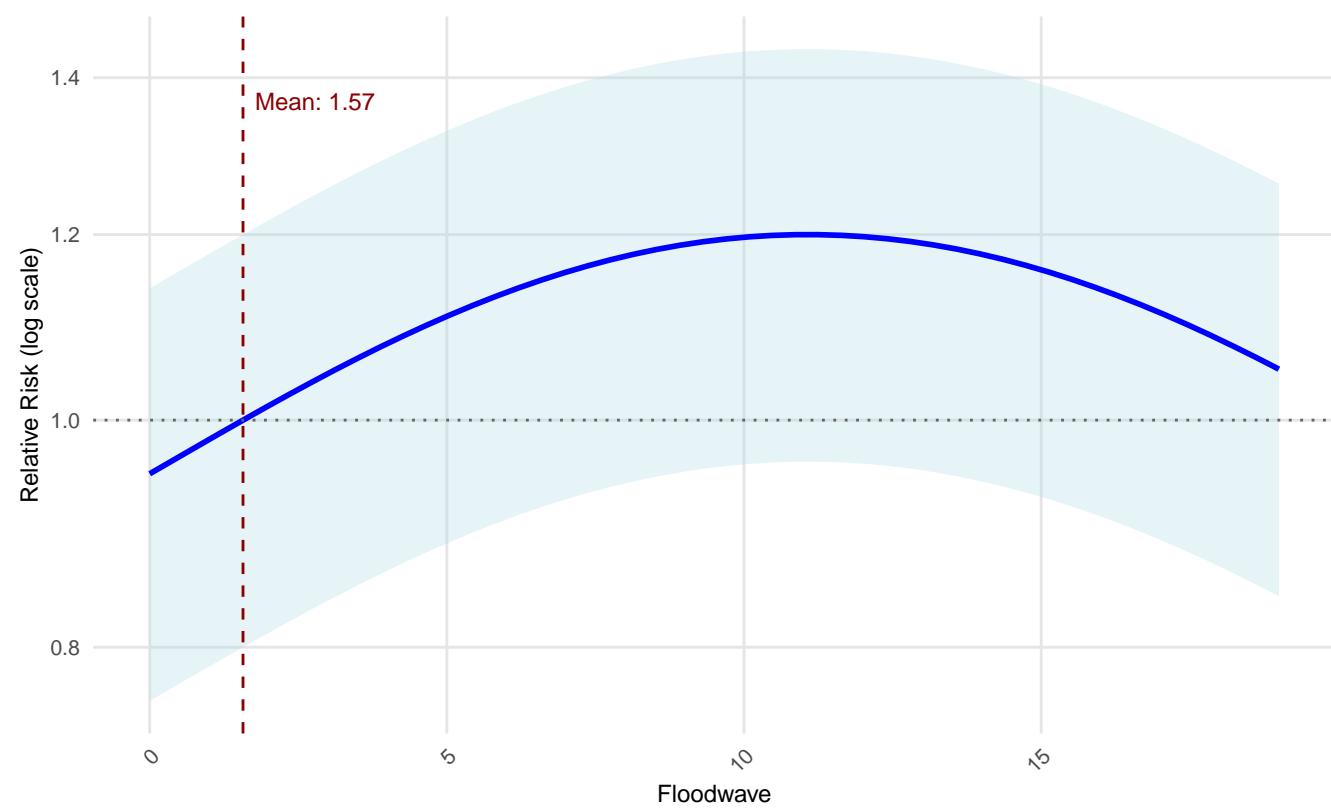
South Eastern Sydney – Model Time Series

Effect of Floodwave



South Western Sydney – Model Time Series

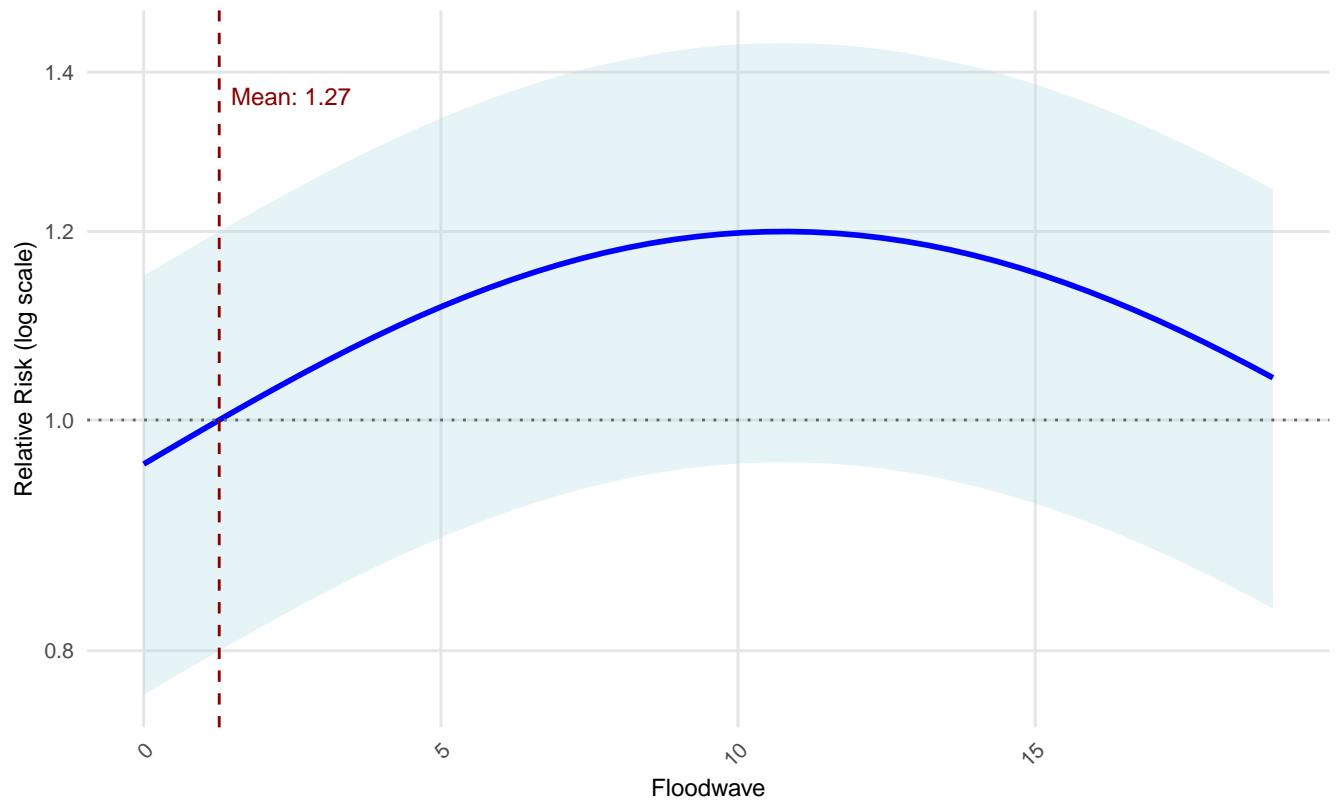
Effect of Floodwave



Note: Simplified curve due to basis matrix issues

Southern NSW – Model Time Series

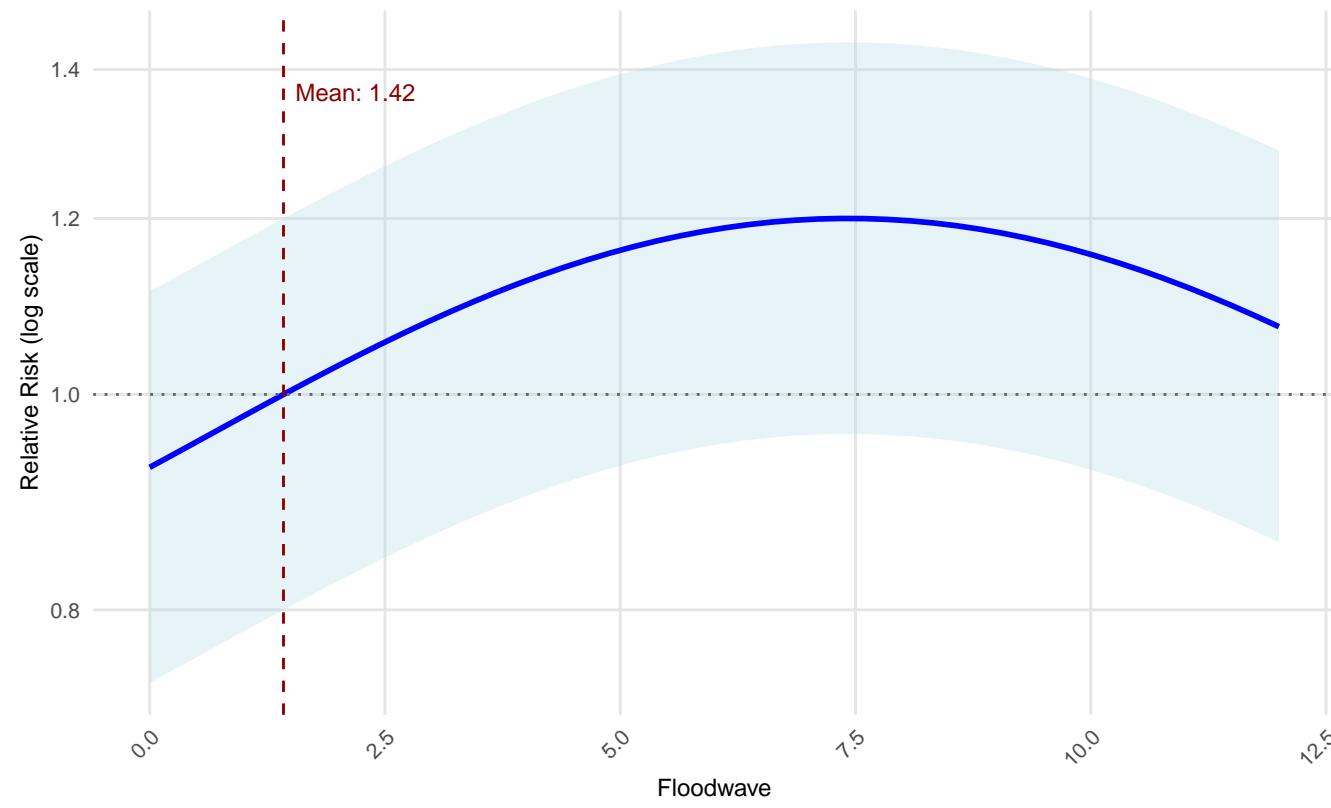
Effect of Floodwave



Note: Simplified curve due to basis matrix issues

Sydney – Model Time Series

Effect of Floodwave

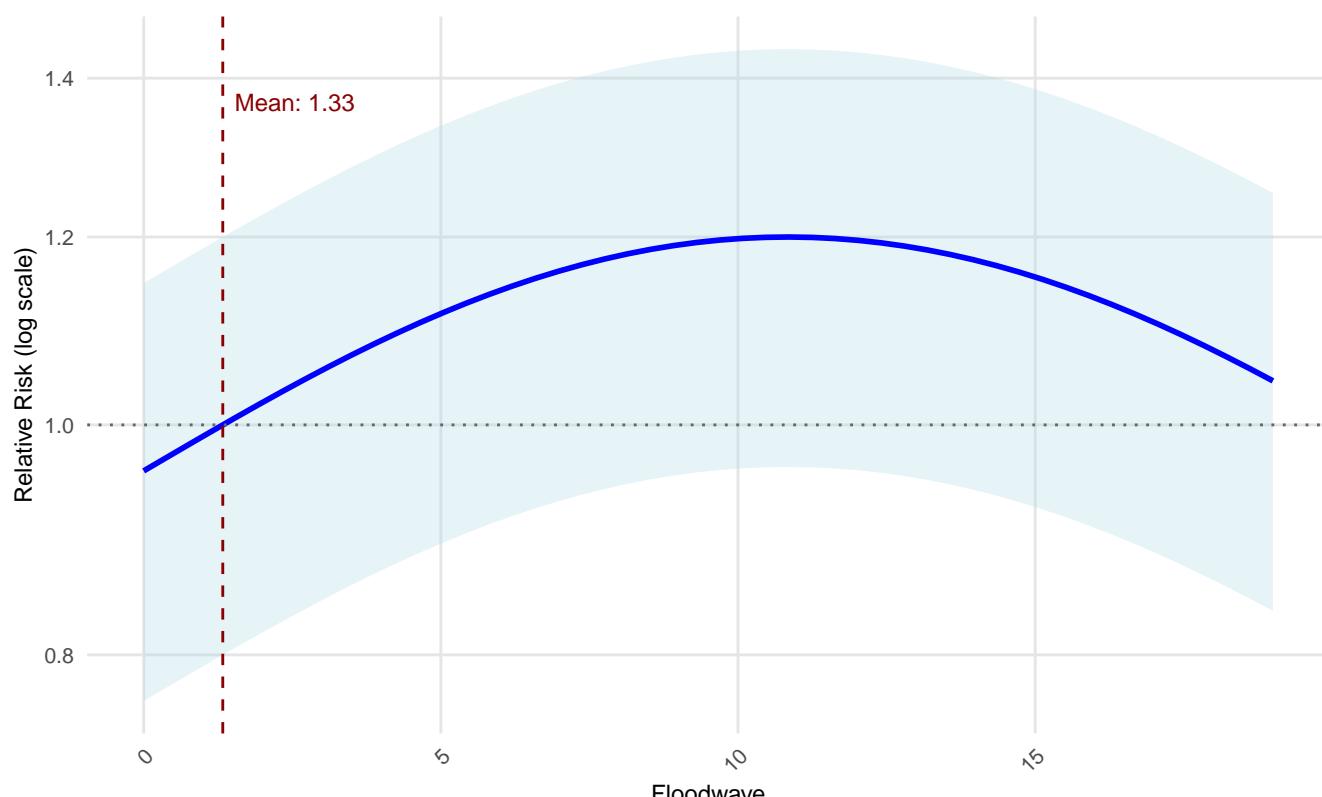


Note: Simplified curve due to basis matrix issues

FLOOD – Time Series– SB-DLNM

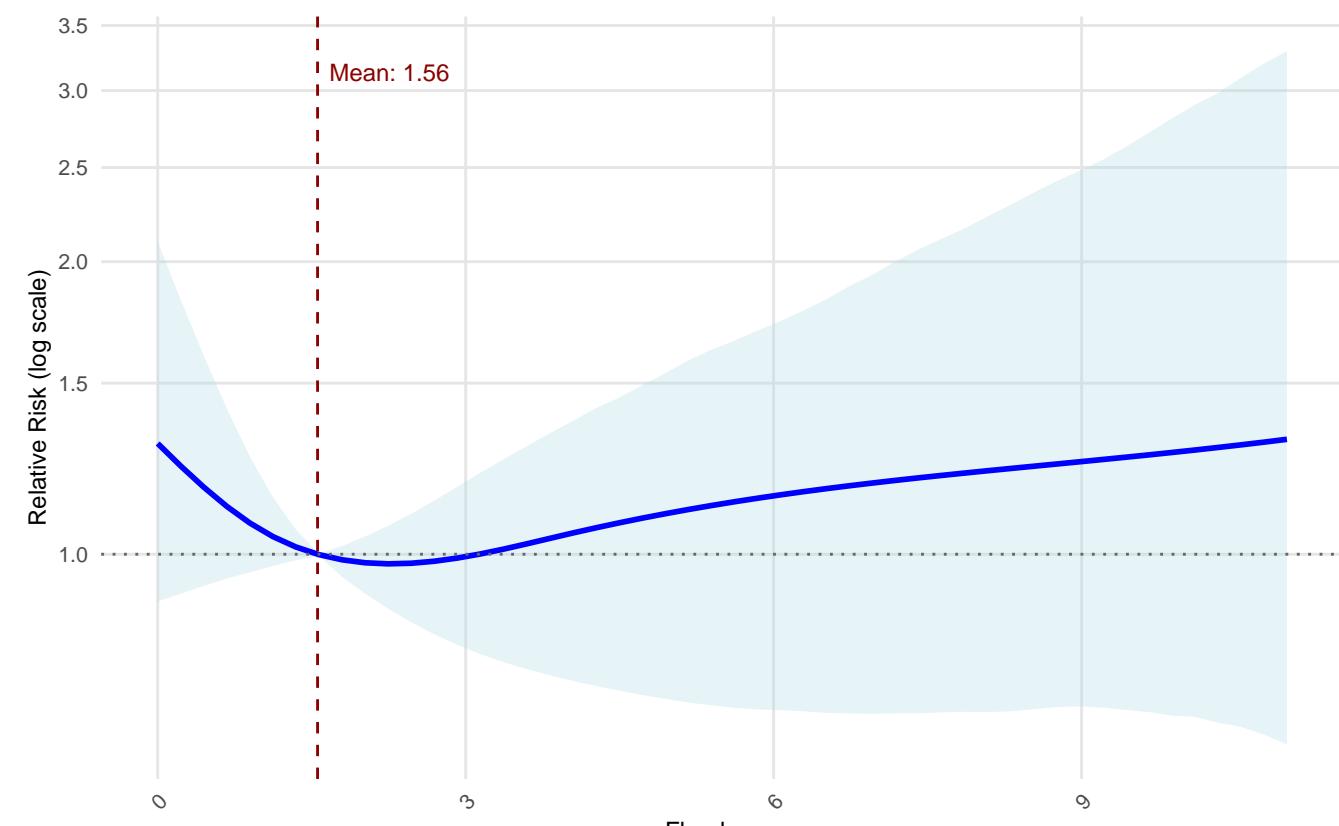
Western NSW – Model Time Series

Effect of Floodwave



Western Sydney – Model Time Series

Effect of Floodwave

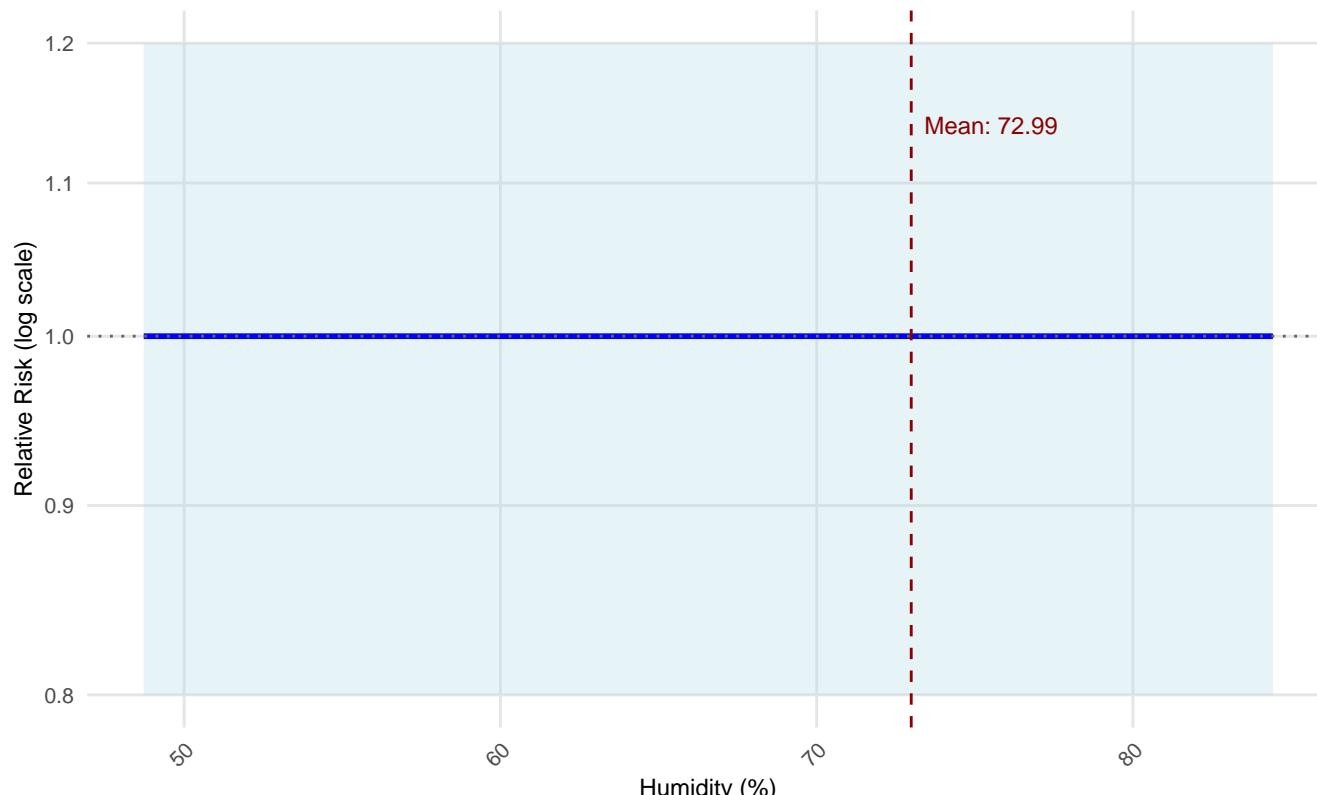


Note: Simplified curve due to basis matrix issues

HUMID – Time Series– SB-DLNM

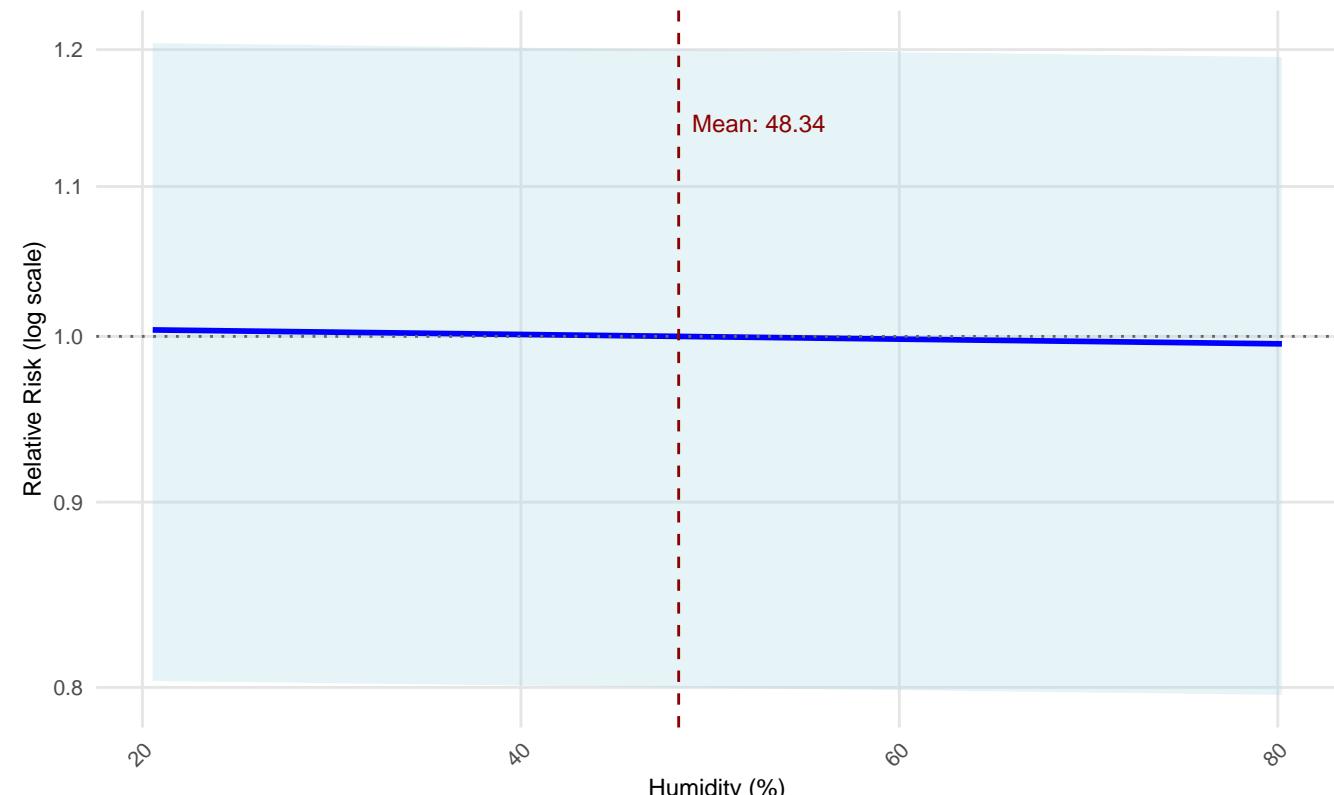
Central Coast – Model Time Series

Effect of Humidity (%)



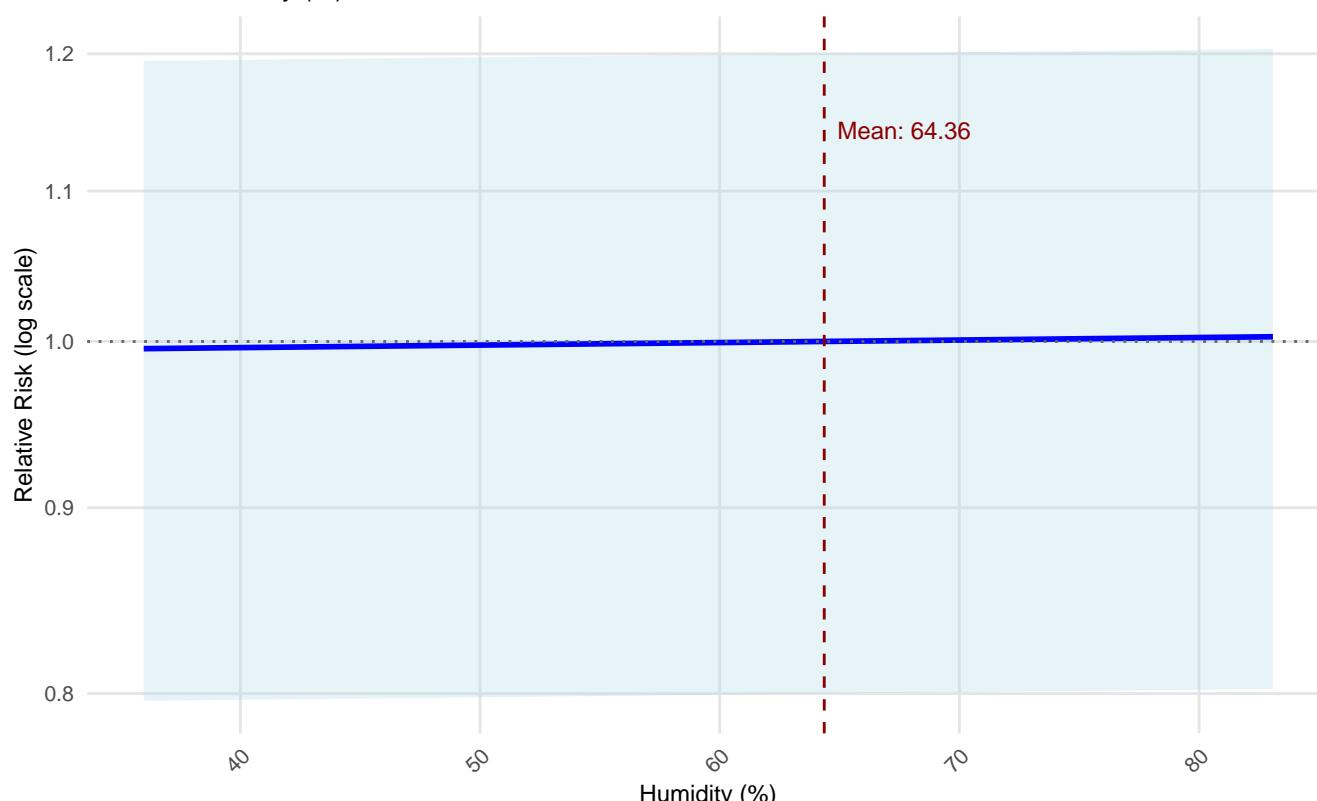
Far West – Model Time Series

Effect of Humidity (%)



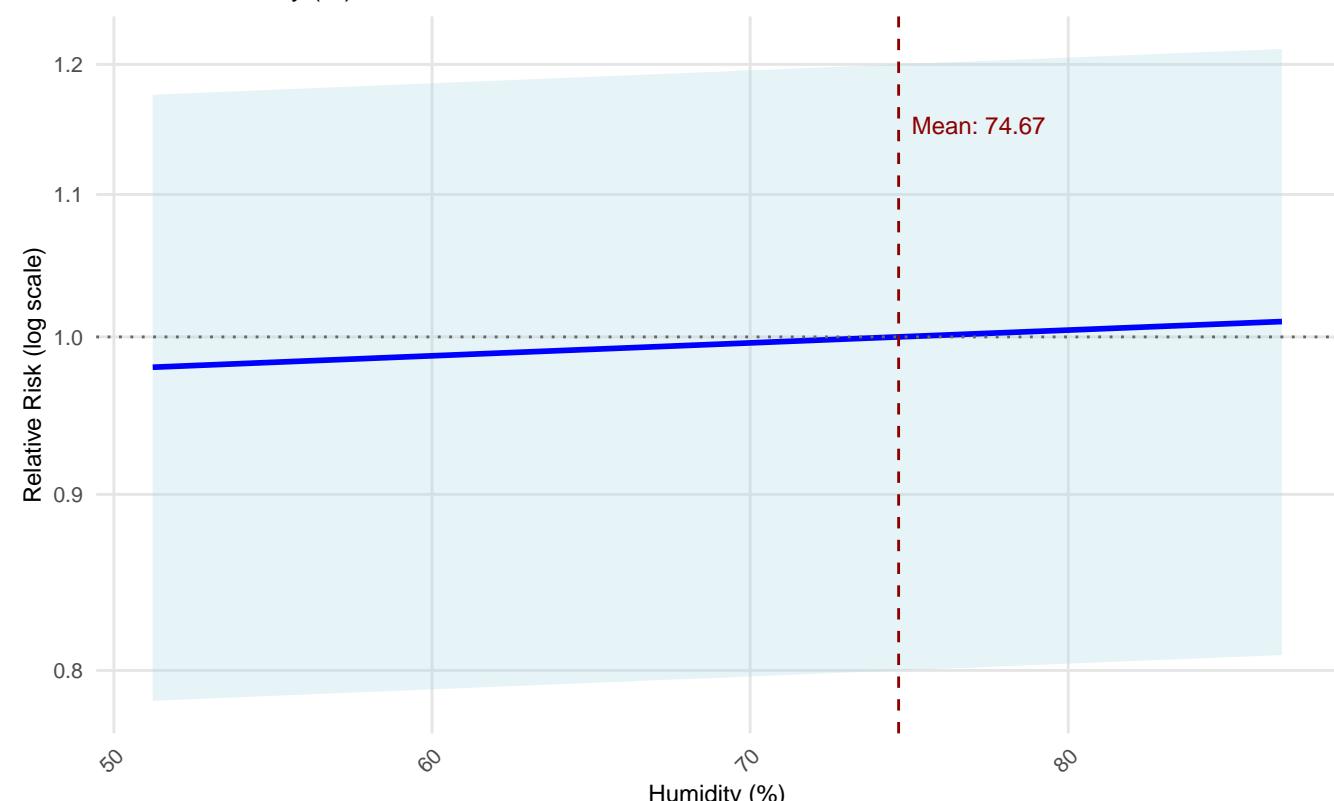
Hunter New England – Model Time Series

Effect of Humidity (%)



Illawarra Shoalhaven – Model Time Series

Effect of Humidity (%)



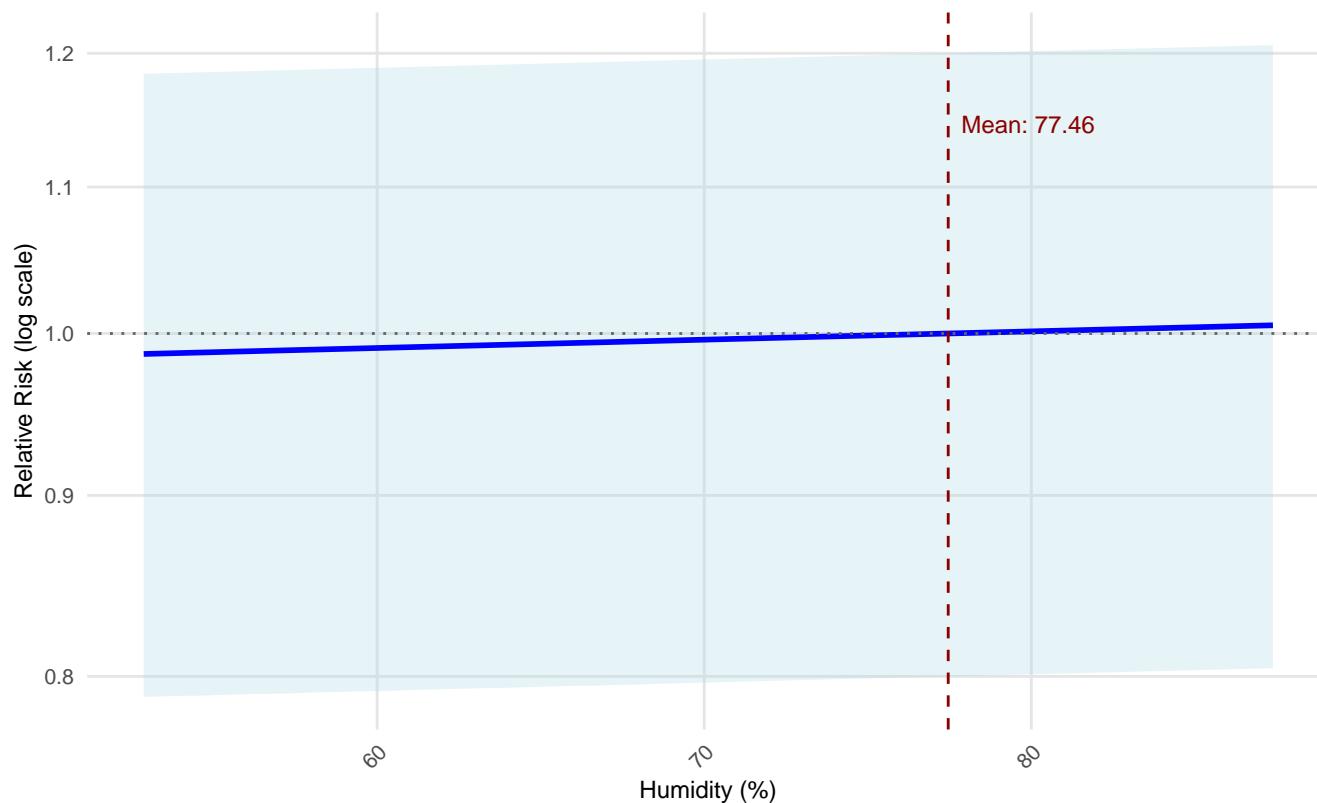
Note: Simplified curve due to basis matrix issues

Note: Simplified curve due to basis matrix issues

HUMID – Time Series– SB-DLNM

Mid North Coast – Model Time Series

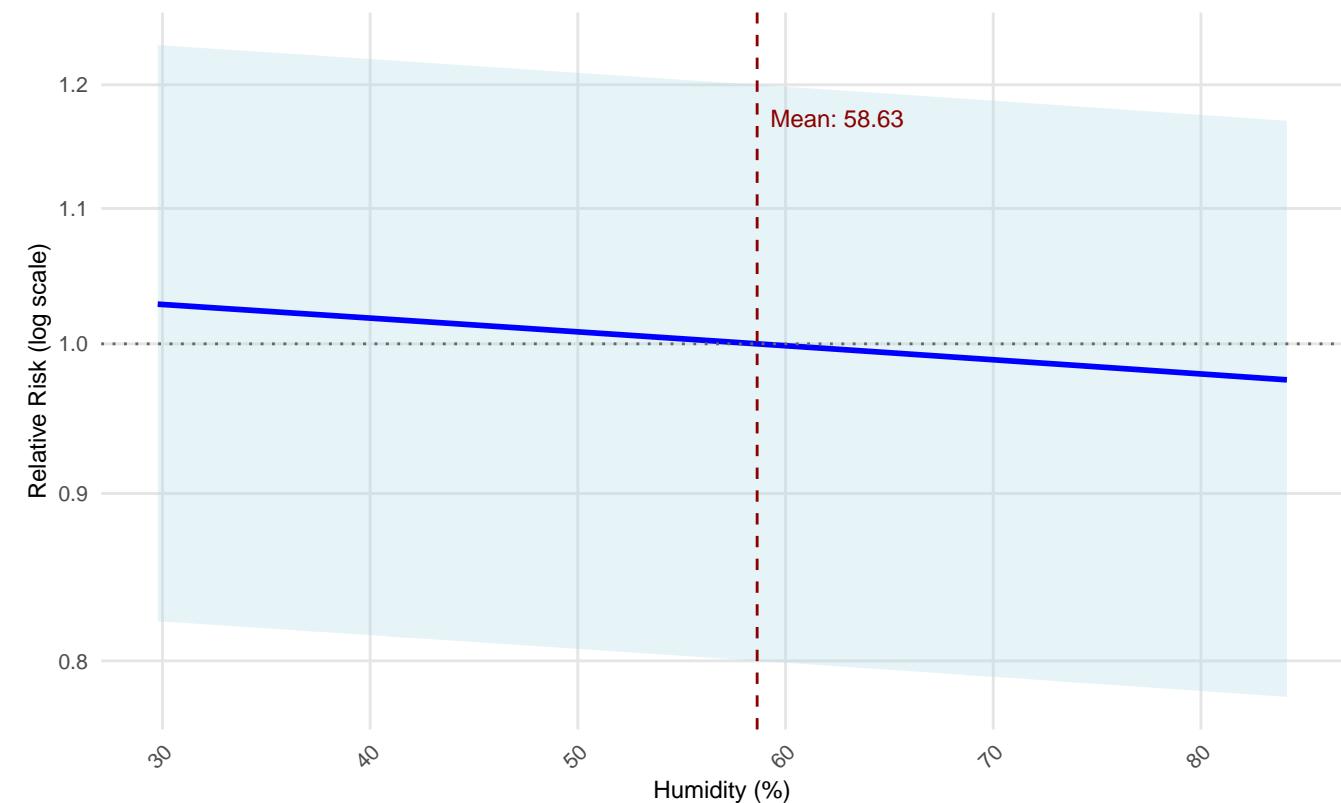
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Murrumbidgee – Model Time Series

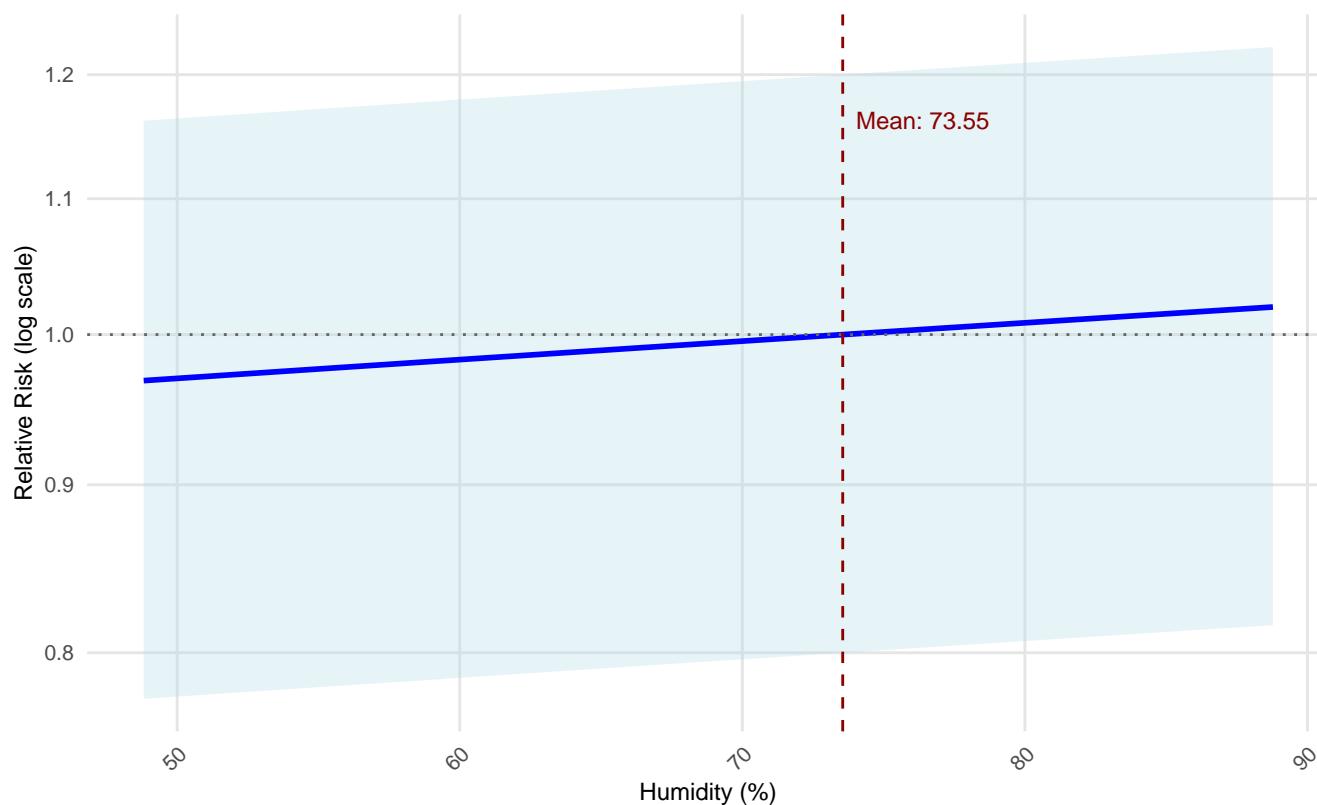
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Nepean Blue Mountains – Model Time Series

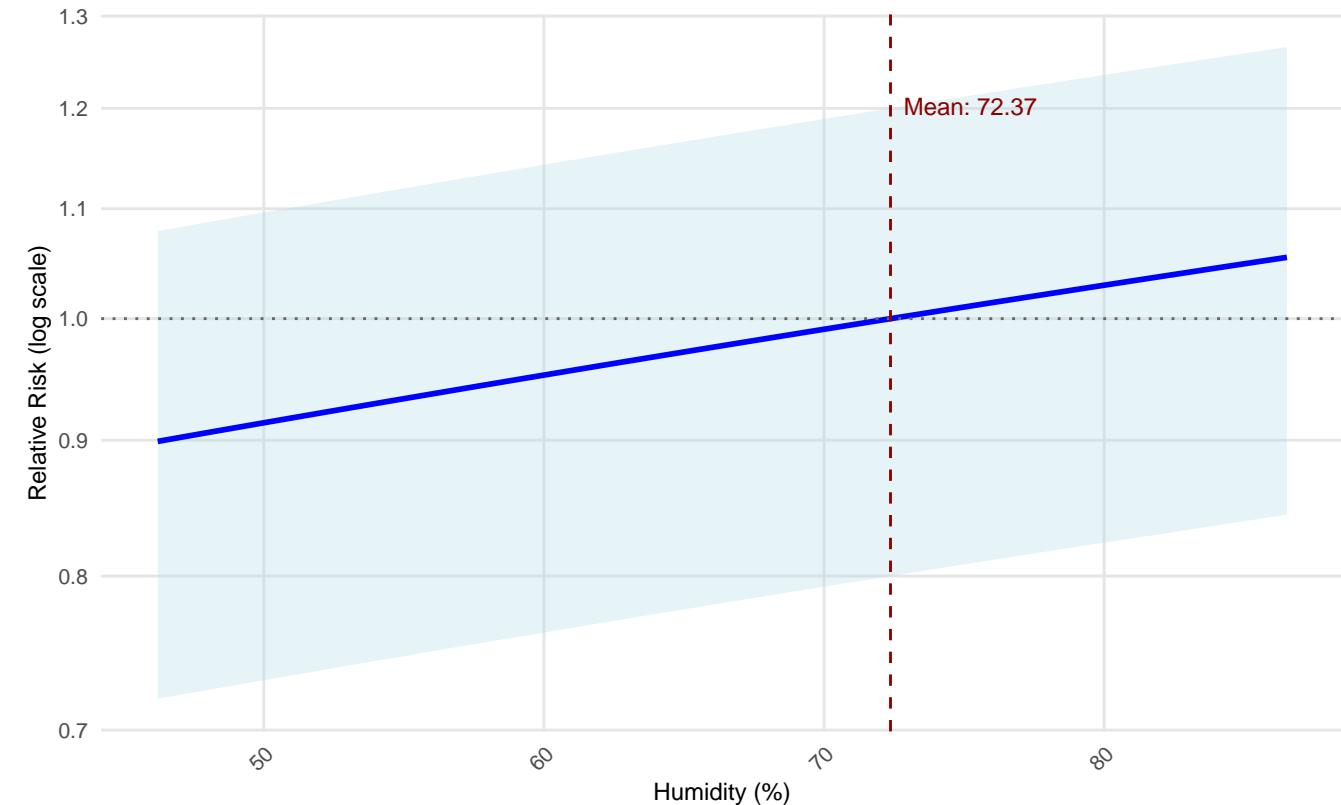
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Northern NSW – Model Time Series

Effect of Humidity (%)

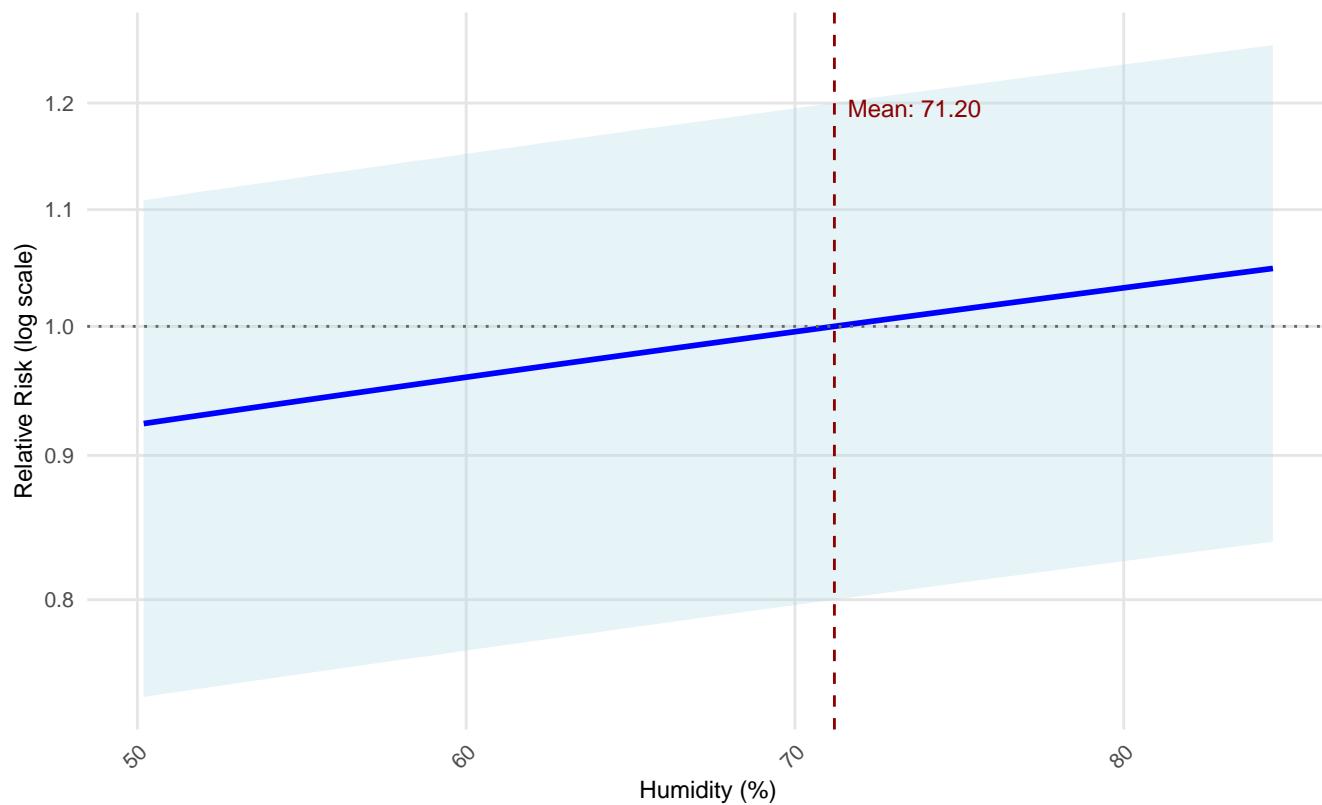


Note: Simplified curve due to basis matrix issues

HUMID – Time Series– SB-DLNM

Northern Sydney – Model Time Series

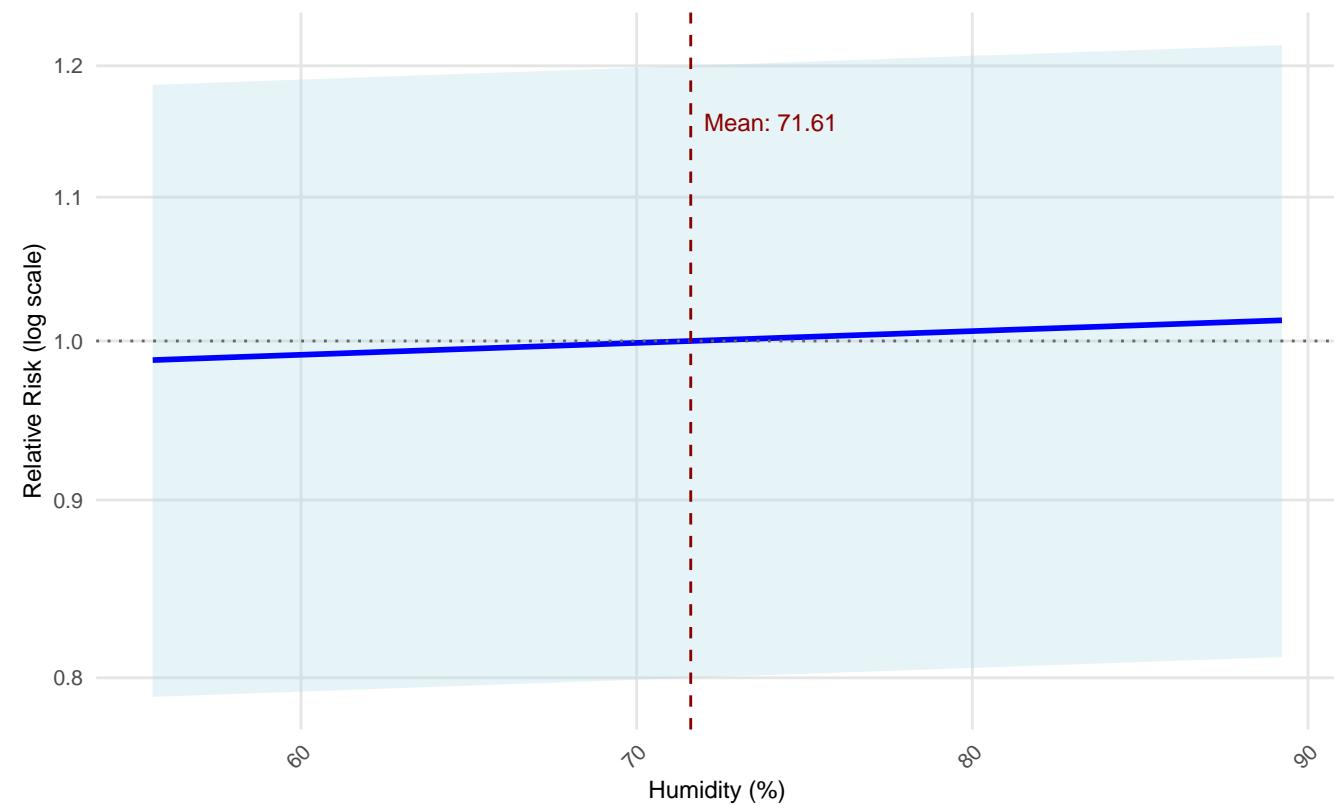
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

South Eastern Sydney – Model Time Series

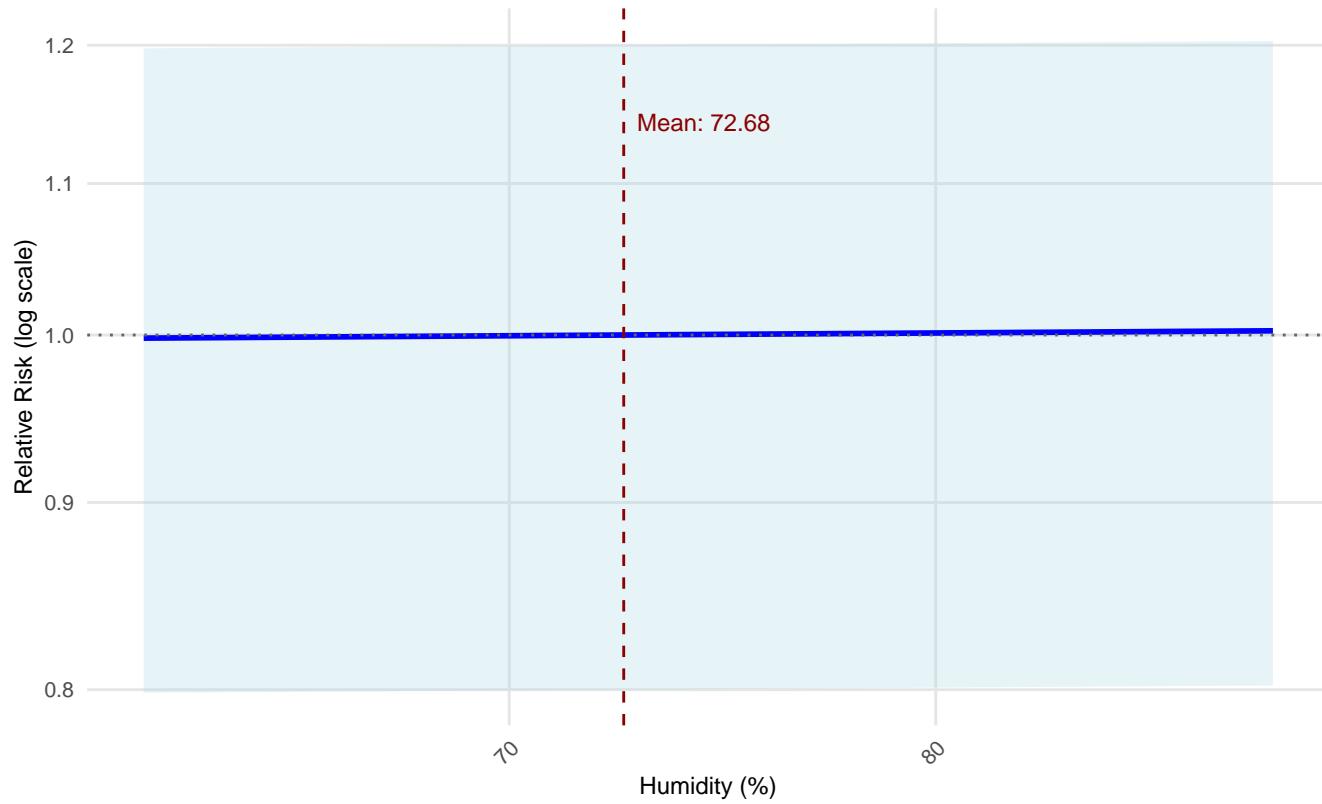
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

South Western Sydney – Model Time Series

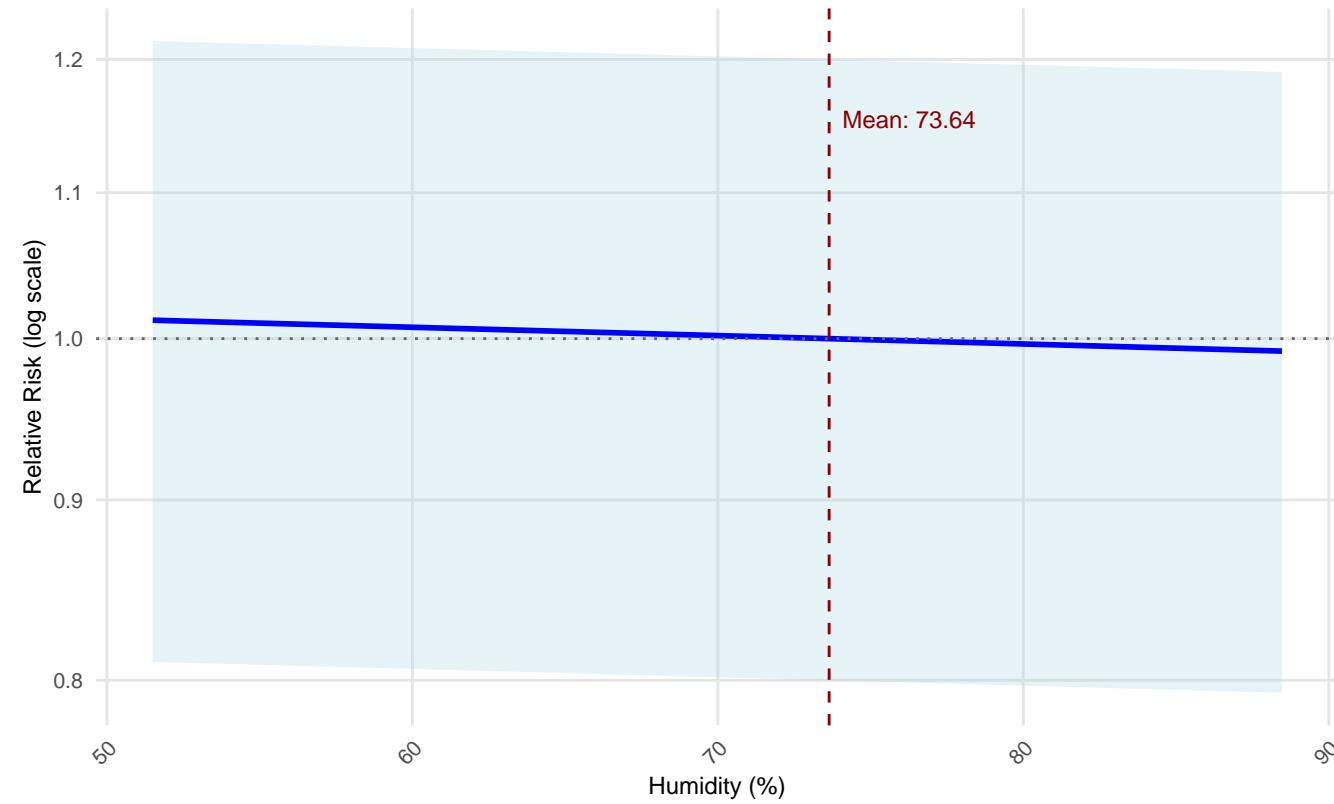
Effect of Humidity (%)



Note: Simplified curve due to basis matrix issues

Southern NSW – Model Time Series

Effect of Humidity (%)

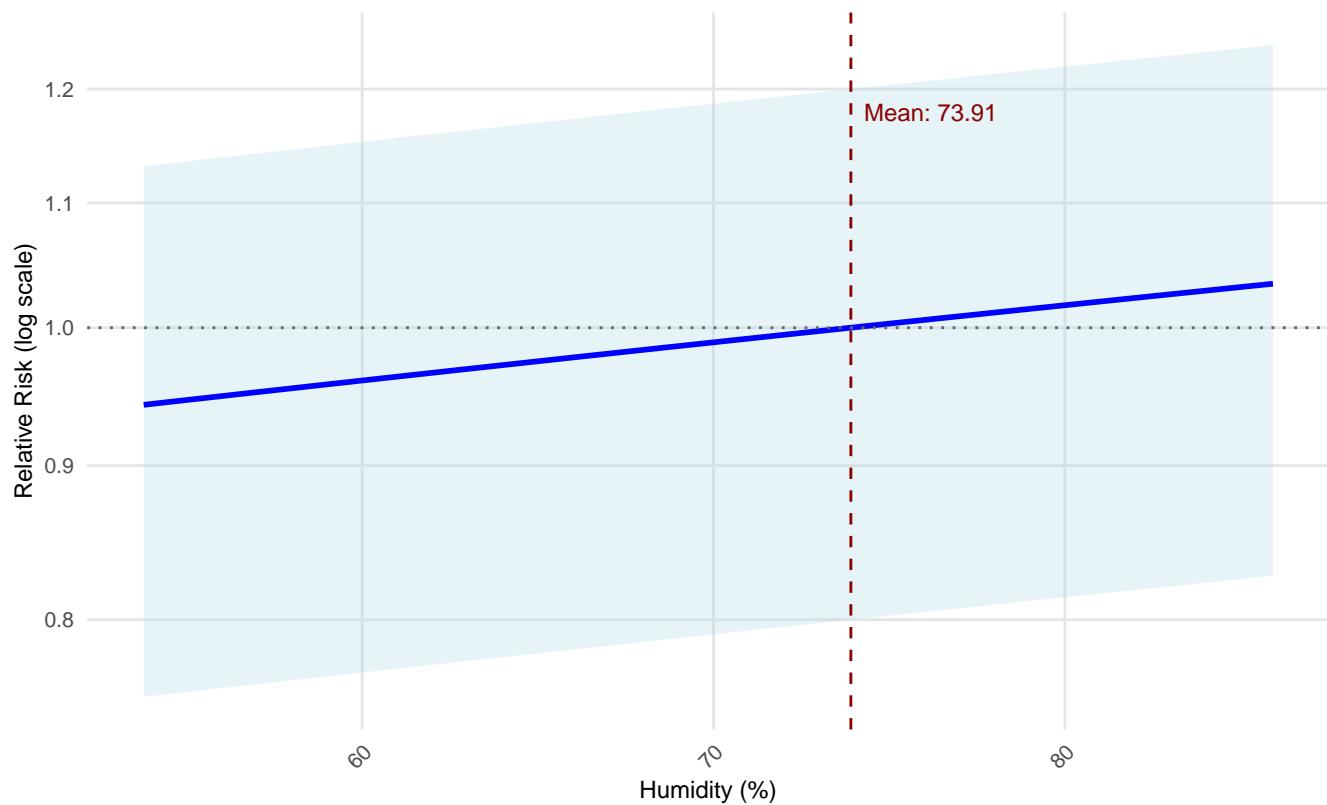


Note: Simplified curve due to basis matrix issues

HUMID – Time Series– SB-DLNM

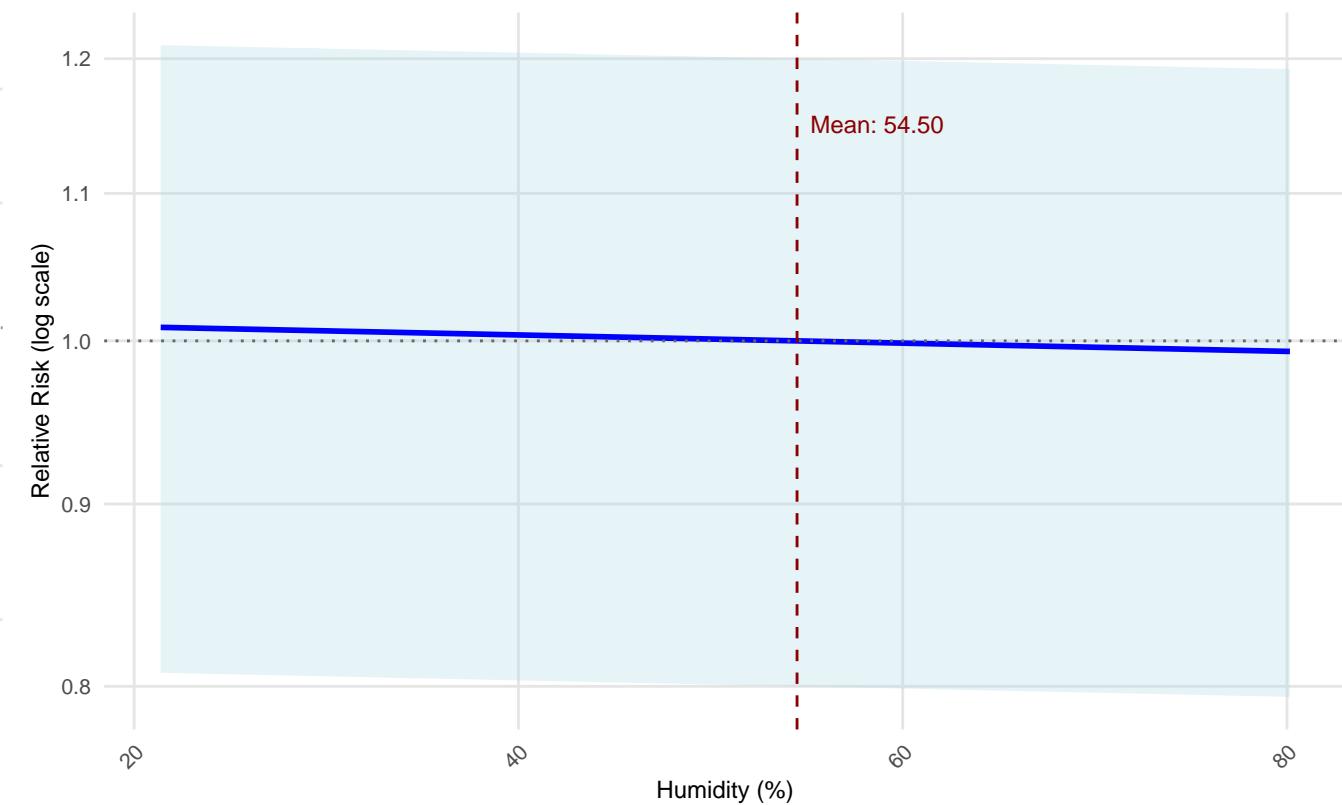
Sydney – Model Time Series

Effect of Humidity (%)



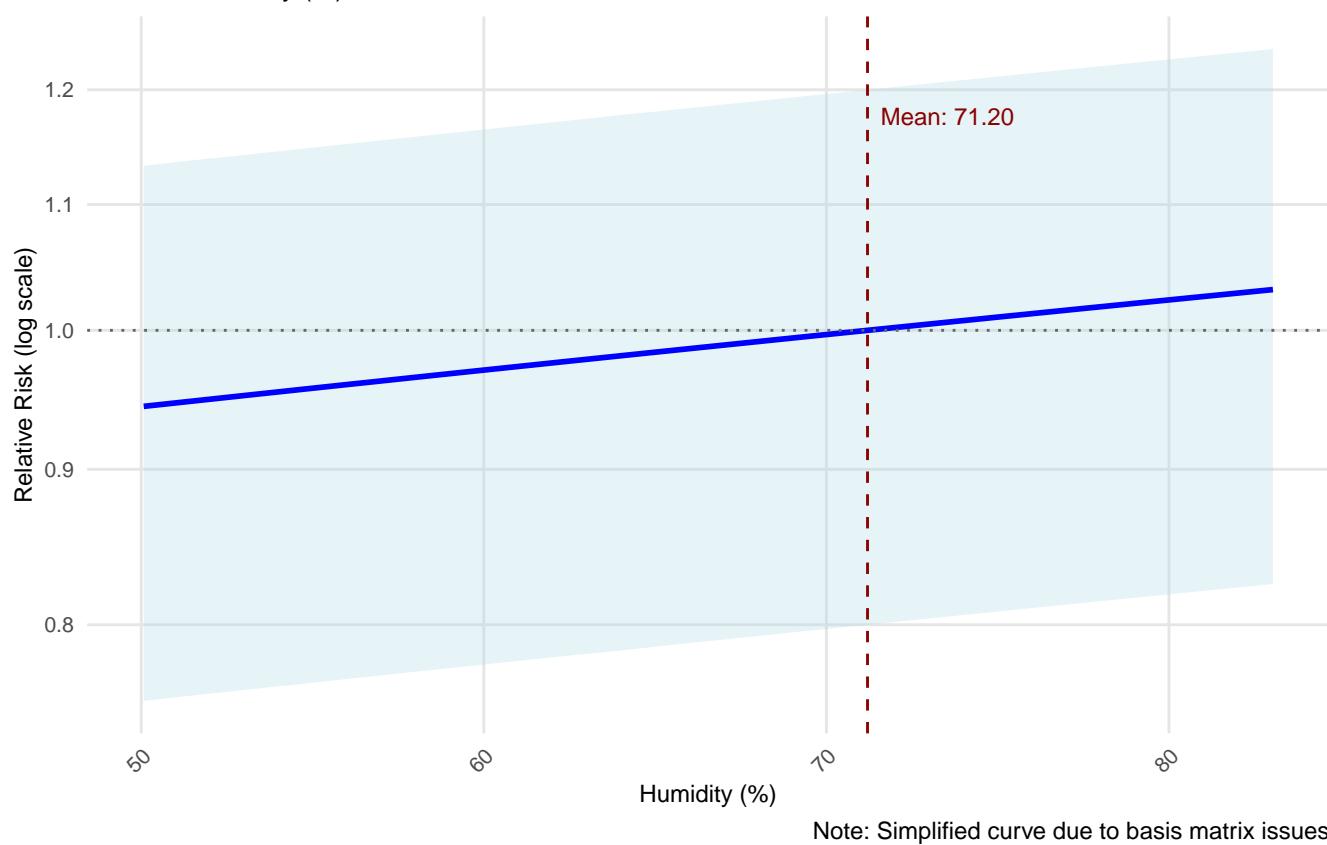
Western NSW – Model Time Series

Effect of Humidity (%)



Western Sydney – Model Time Series

Effect of Humidity (%)



623 **S.3 Probability maps for case-crossover DLNM (CC)**

624 Posterior probability that relative risk (RR) exceeds certain thresholds across NSW for
 625 Case-crossover DLNM.

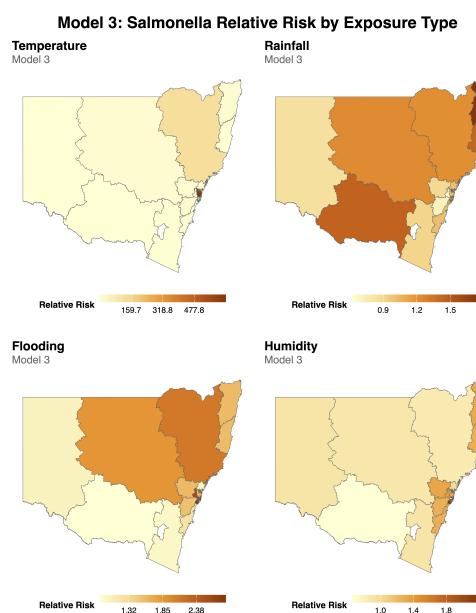


Figure S.6: Posterior probability map illustrating $P(\text{RR} > 1.0, 1.2, 1.5)$ under CC DLNM for different climate exposures. Darker colours indicate higher confidence that the relative risk surpasses the chosen threshold. Some LHDs exhibit distinct vulnerability to temperature, while others are more concerned with rainfall or flooding.

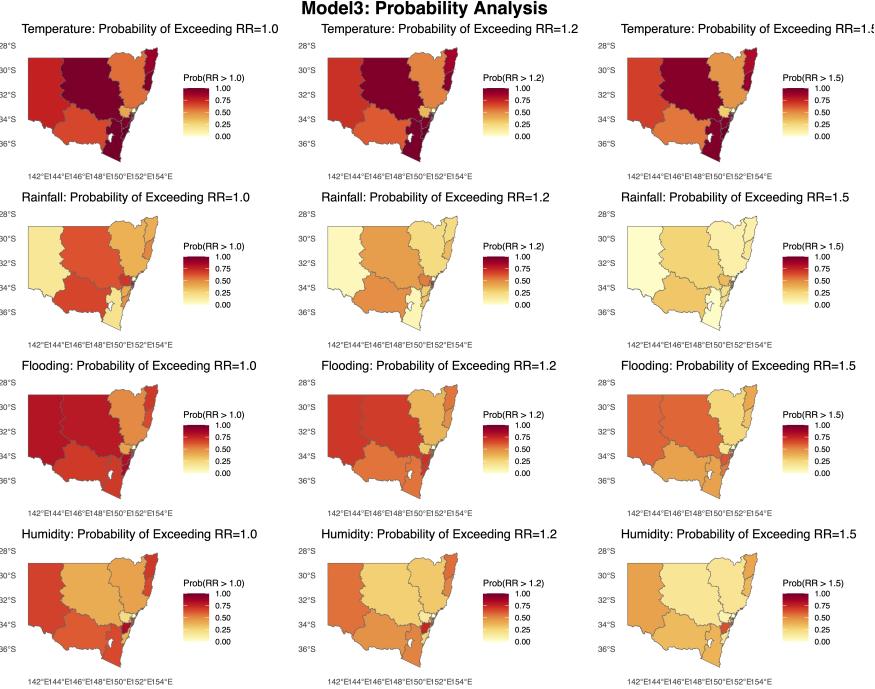


Figure S.7: An alternative or complementary probability map under CC-DLNM, possibly at different thresholds or for a different variable subset. These maps highlight localised patterns of exceedance risk, guiding targeted interventions in high-probability regions.