Supplemental Figures for: Can existing data on WNV infection in birds and mosquitos explain strain replacement?

Morgan P. Kain[1†], Benjamin M. Bolker[1,2]

[1]Department of Biology, McMaster University, 1280 Main St. West, Hamilton, ON, Canada, L8S 4K1

[2]Department of Mathematics and Statistics, McMaster University, 1280 Main St. West, Hamilton, ON, Canada, L8S 4L8

[†]Correspondence author.
LSB-215
1280 Main St. West
Hamilton, ON
L8S 4K1
E-mail: kainm@mcmaster.ca

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(1) Model for mosquito titer to mosquito transmission

Due to a lack of publications that explicitly measured transmission from mosquitos after X days following infection with WNV, we fit a model to transmission with titer as a predictor used data from (Moudy et al., 2007) to obtain data from papers that only measured titer temporally and not transmission. To do so we fit a parameterization of a logistic cdf to transmission using non-linear least squares with the nlxb package (Nash and Nash, 2012).

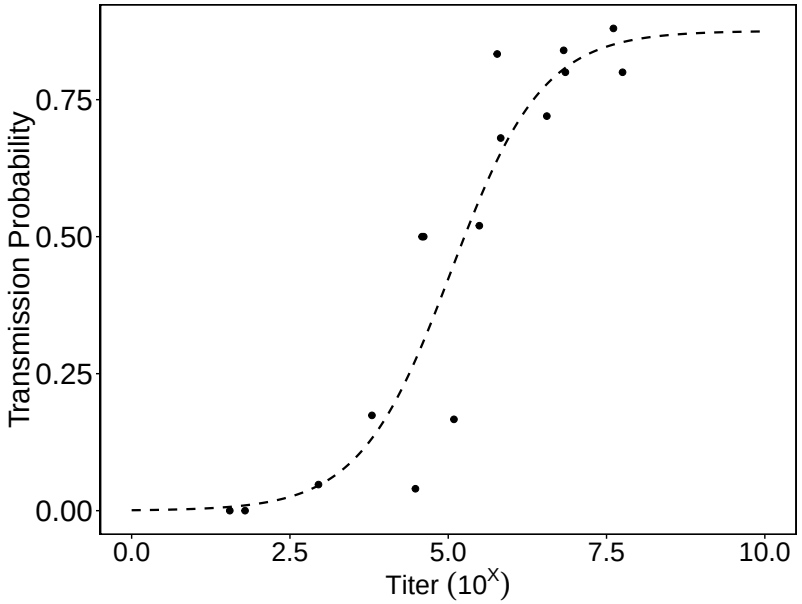

Figure S1: Relationship between Titer and Transmission from Moudy et al. 2007.

(2) Model for mosquito survival

We used data from (Andreadis et al., 2014) to fit a logistic model to mosqutio longevity. In our data analysis we used median survival at each temperature to calculate R_0. We appreciate that this study took place in Greece, far from the transmission events we are interested in, but it includes the most complete data on temperature dependent *Culex* survival that we could find.

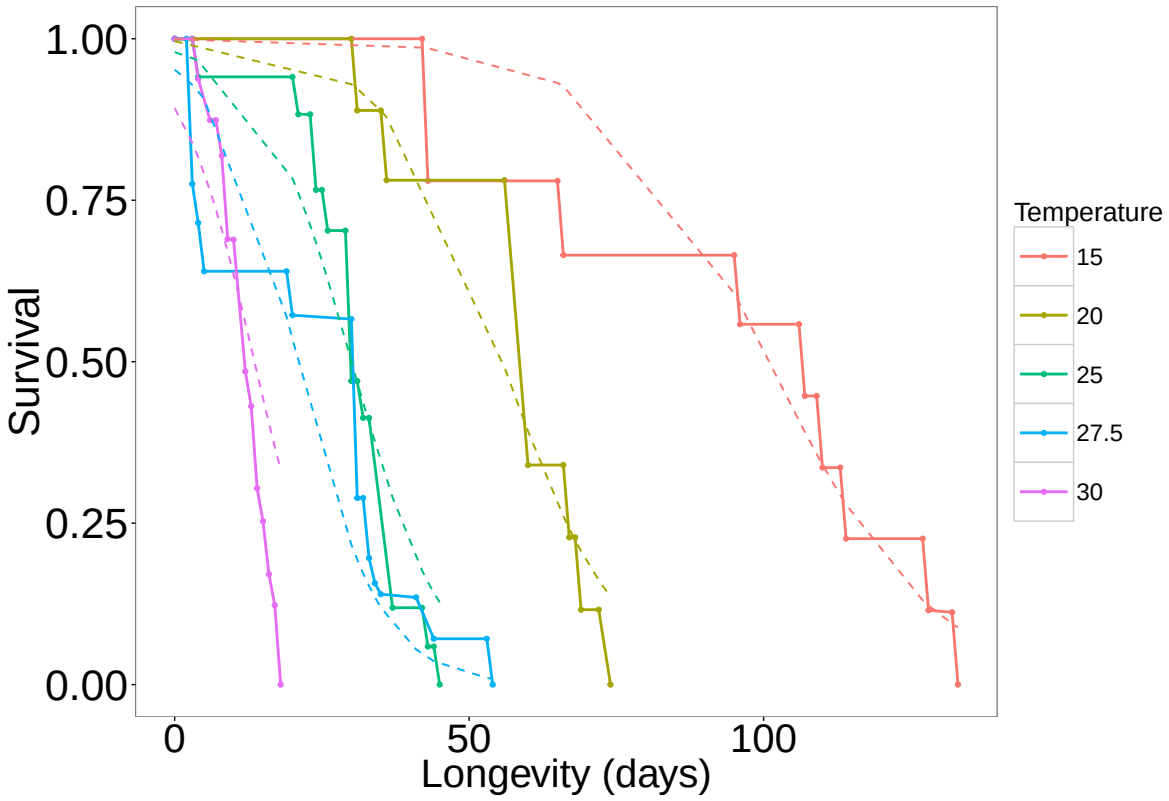

Figure S2: Relationship between Mosqutio Survival Probability and Days. Colored solid lines are extracted data from Andreadis et al. 2014 Figure 1C. Colored dashed lines are model estimates.

(3) Titer and Survival for "Other" Birds

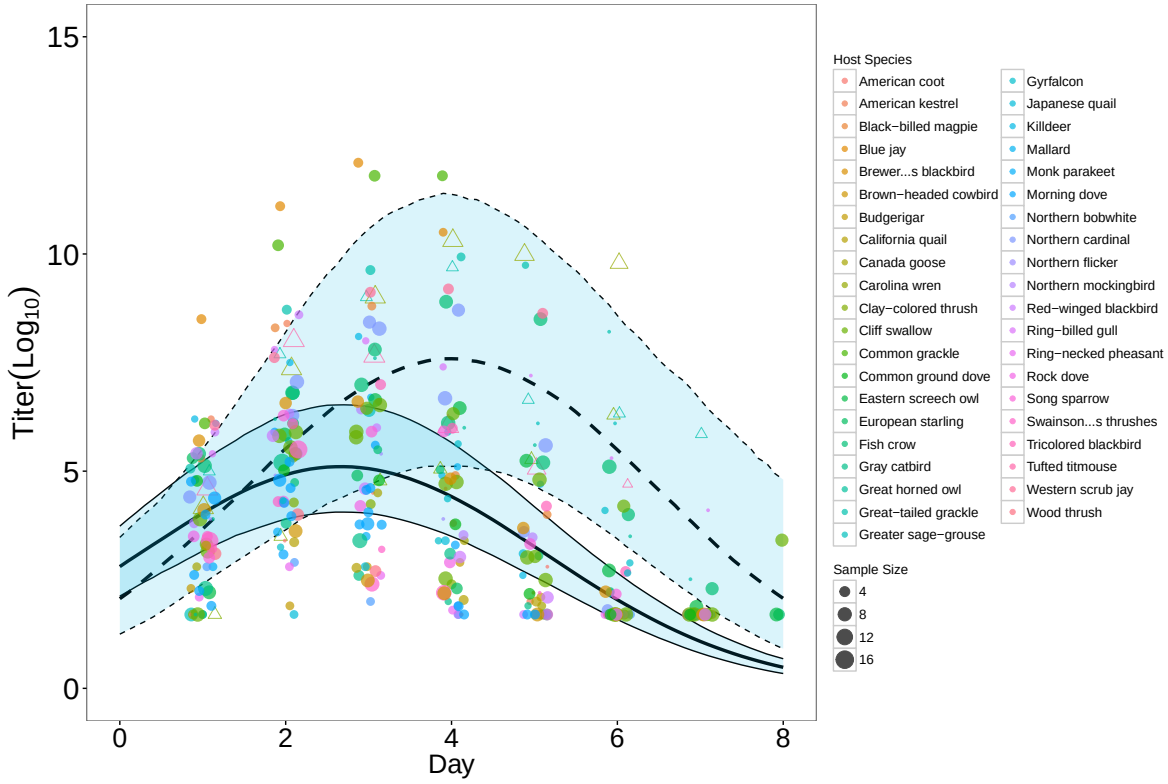

Figure S3.1: Titer Profiles for all other birds.

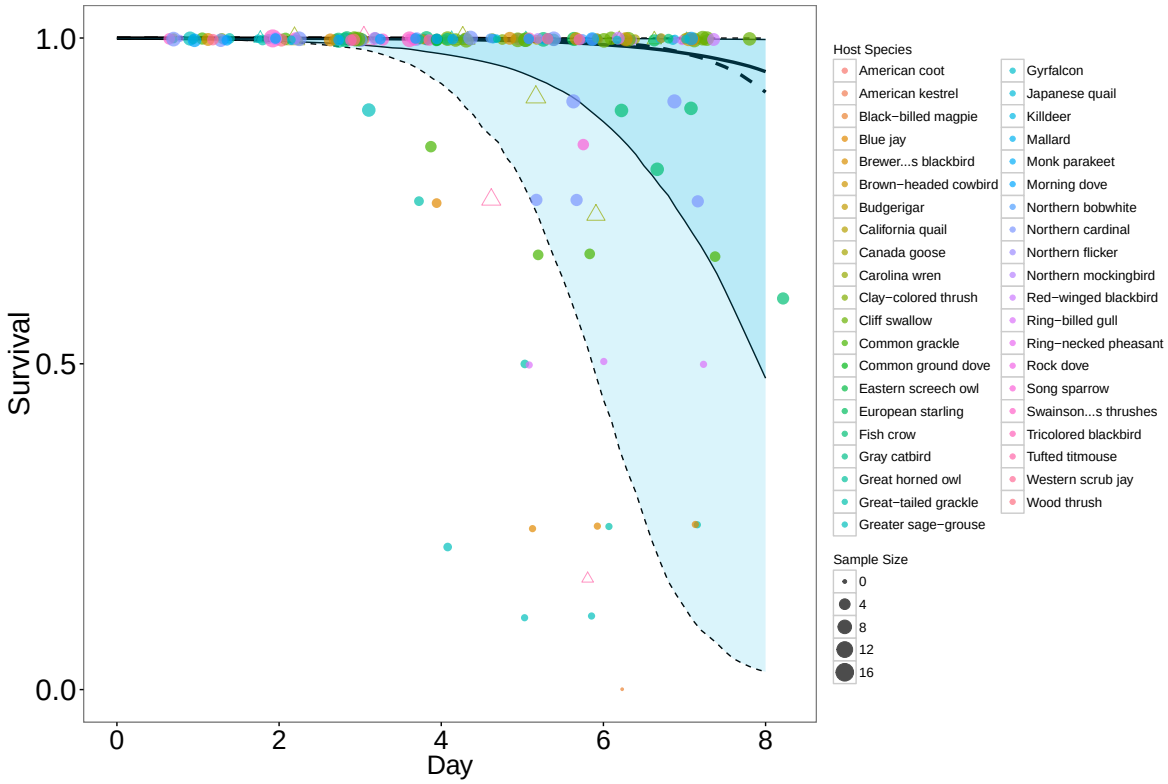

Figure S3.2: Survival for all other birds.

(4) Mosquito to bird transmission adjustments

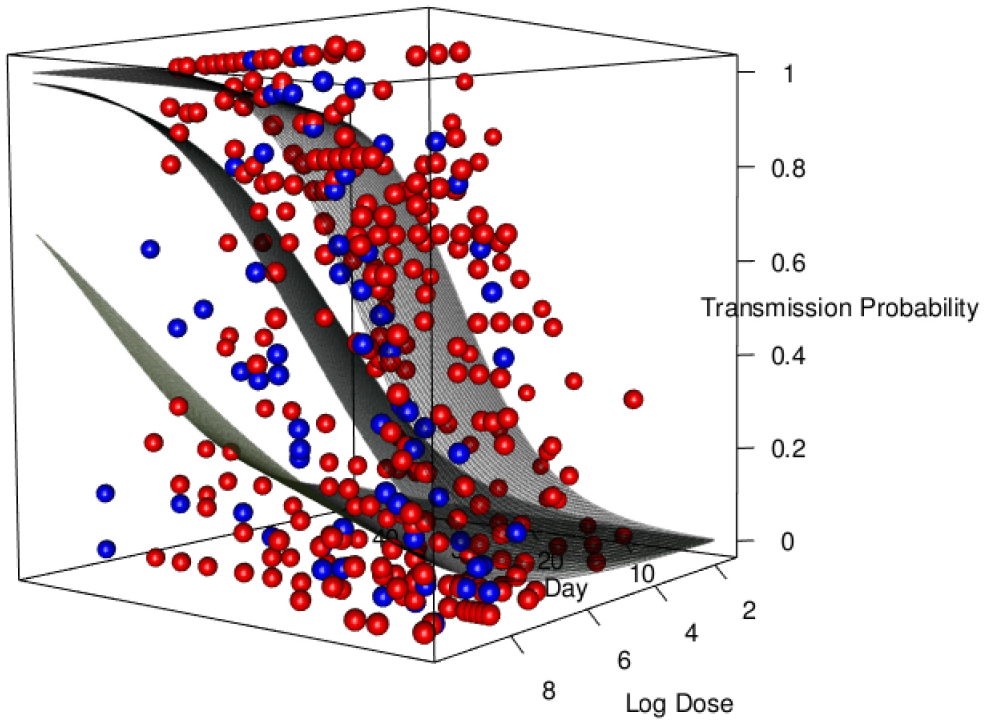

Figure S4.1: 3d figure of Mosquito to Bird model fit to raw data for *NY99 with JEV data*. Red points are NY99 data, blue points are WN02 data. Surfaces are predicted probabilities of transmission from an infected mosquito to a naive bird (Z-axis) *for NY99 with JEV data*. X-axis is days from 1-40, y-axis is Log Dose from 2 to 8. Light green surface is fitted surface at 16 degrees Celcius, darker green surface is 20 degrees Celcius, and black surface is 24 degrees Celcius.

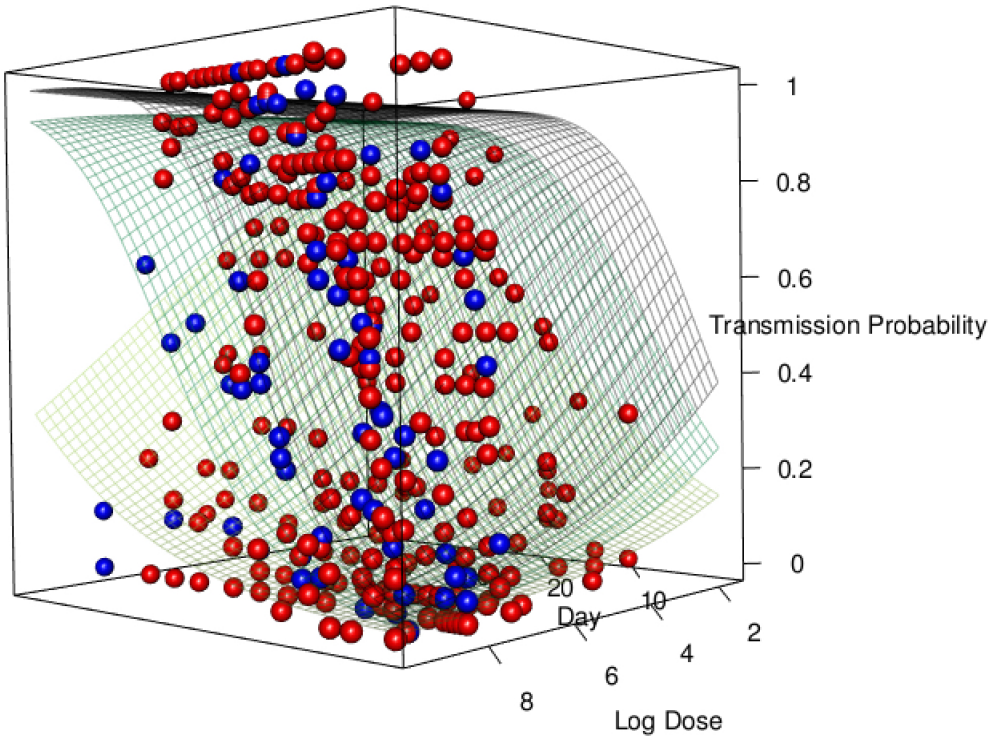

Figure S4.2: 3d figure of Mosquito to Bird model fit to raw data for *WN02 with JEV data*. Red points are NY99 data, blue points are WN02 data. Surfaces are predicted probabilities of transmission from an infected mosquito to a naive bird (Z-axis) *for WN02 with JEV data*. X-axis is days from 1-40, y-axis is Log Dose from 2 to 8. Light green surface is fitted surface at 16 degrees Celcius, darker green surface is 20 degrees Celcius, and black surface is 24 degrees Celcius.

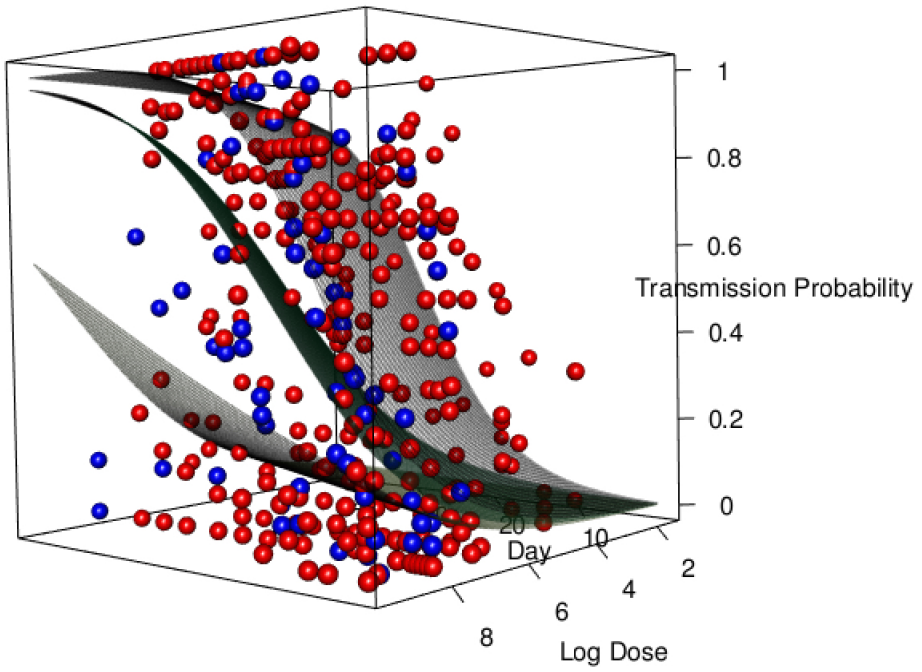

Figure S4.3: 3d figure of Mosquito to Bird model fit to raw data for *NY99 without JEV data*. Red points are NY99 data, blue points are WN02 data. Surfaces are predicted probabilities of transmission from an infected mosquito to a naive bird (Z-axis) *for NY99 without JEV data*. X-axis is days from 1-40, y-axis is Log Dose from 2 to 8. Light green surface is fitted surface at 16 degrees Celcius, darker green surface is 20 degrees Celcius, and black surface is 24 degrees Celcius.

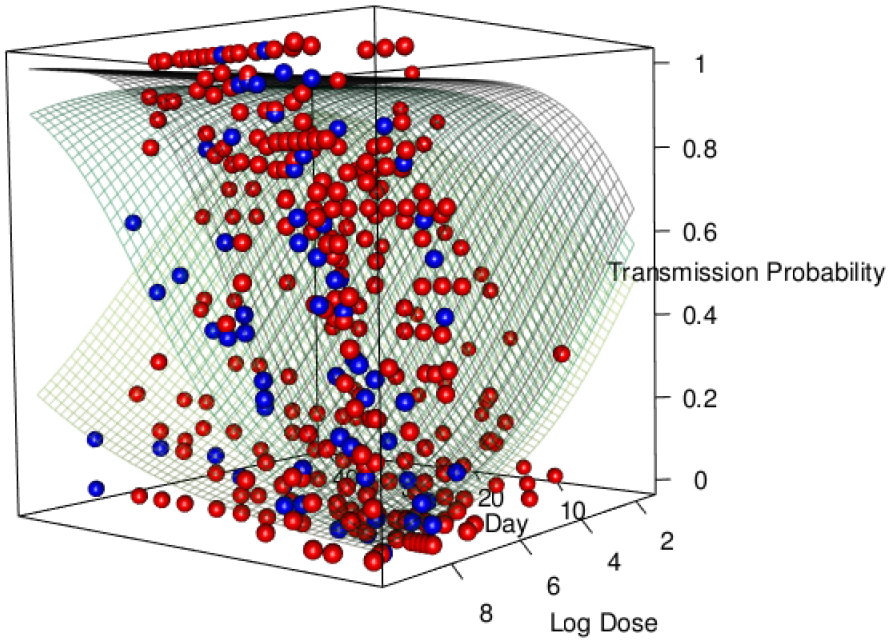

Figure S4.4: 3d figure of Mosquito to Bird model fit to raw data for *WN02 without JEV data*. Red points are NY99 data, blue points are WN02 data. Surfaces are predicted probabilities of transmission from an infected mosquito to a naive bird (Z-axis) *for WN02 without JEV data*. X-axis is days from 1-40, y-axis is Log Dose from 2 to 8. Light green surface is fitted surface at 16 degrees Celcius, darker green surface is 20 degrees Celcius, and black surface is 24 degrees Celcius.

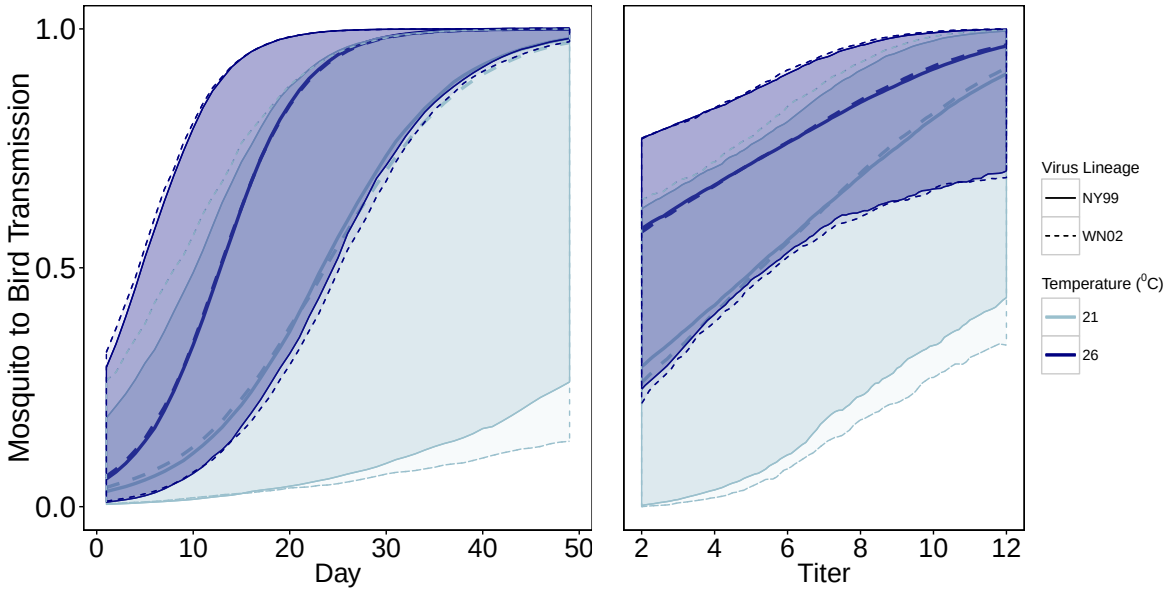

Figure S4.5: Figure 4a from the main text without encorporating mosquito survival

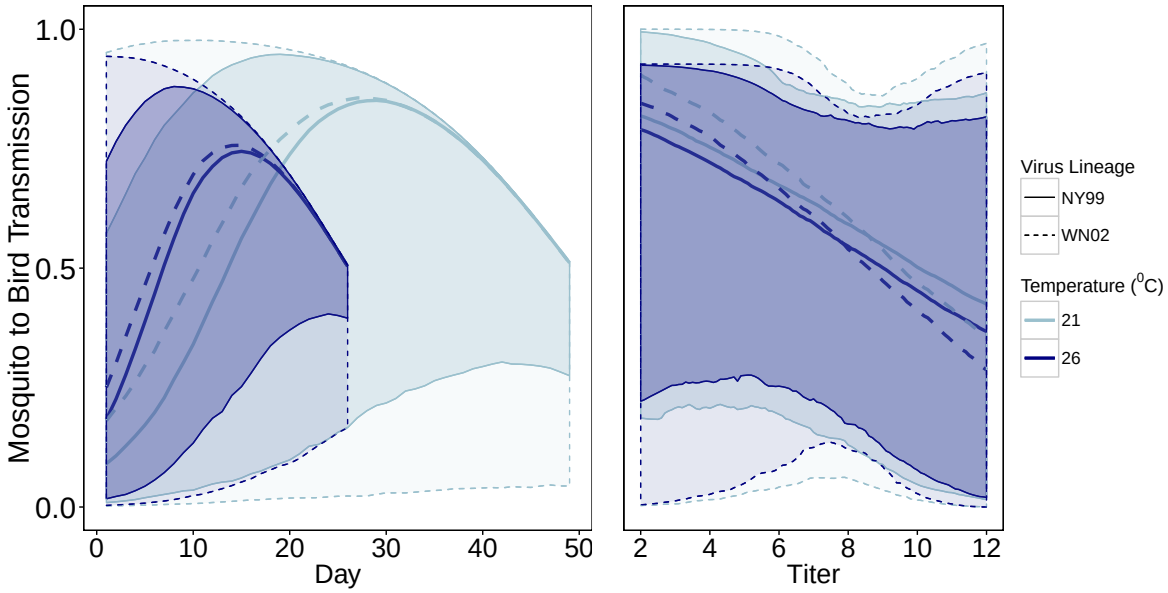

Figure S4.6: Figure 4a, b from the main text without JEV data. See Section 5 for coefficient plots for mosquito to bird transmission without JEV data.

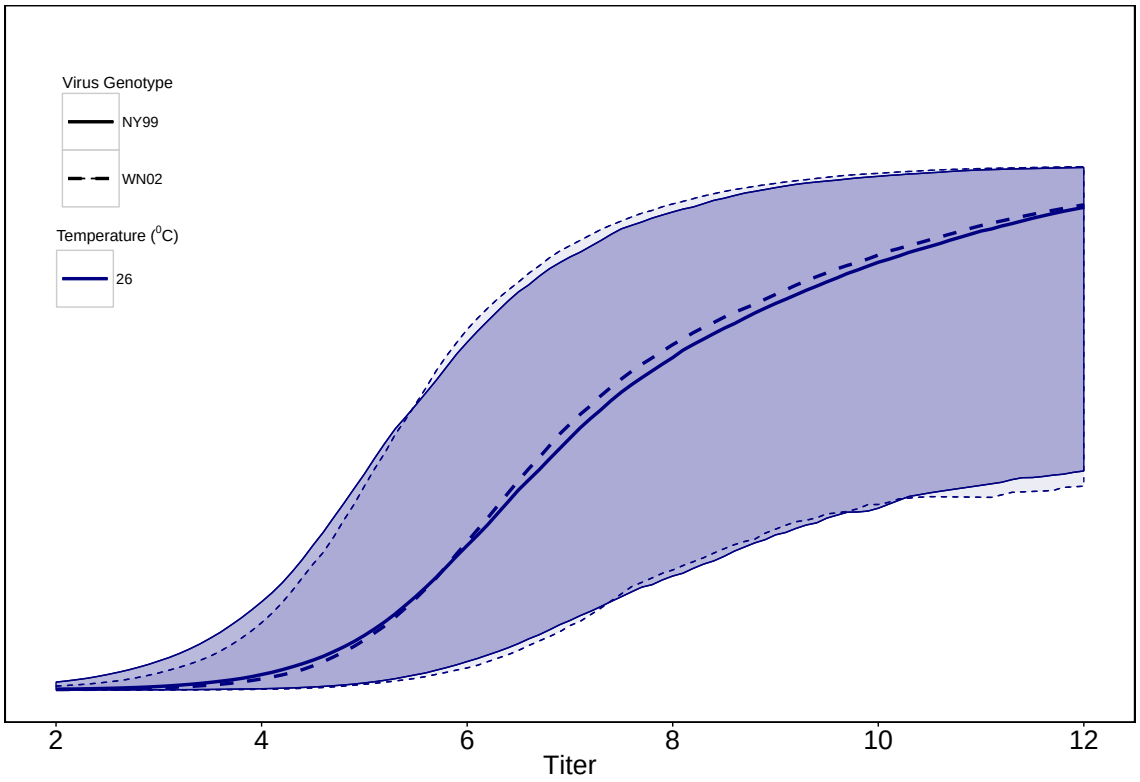

Figure S4.7: Vector-Competence for NY99 and WN02. Vector Competence at 26 Degrees Celcius, generated by combining Bird-to-Mosquito and Mosquito-to-Bird transmission (conditioning Mosquito-to-Bird transmission on all mosquitos that fed on an infected blood sample).

(5) R_0 Caculations without Japanese Encephalitis Virus (JEV) data

Here we present the analysis presented in the primary manuscript removing all "prior information" on mosquito transmission at lower titers using transmission of the closely realted JEV virus. Here we present parameter estimates for the Mosquito to Bird transmission model and R_0 estimates with and without the JEV transmission data.

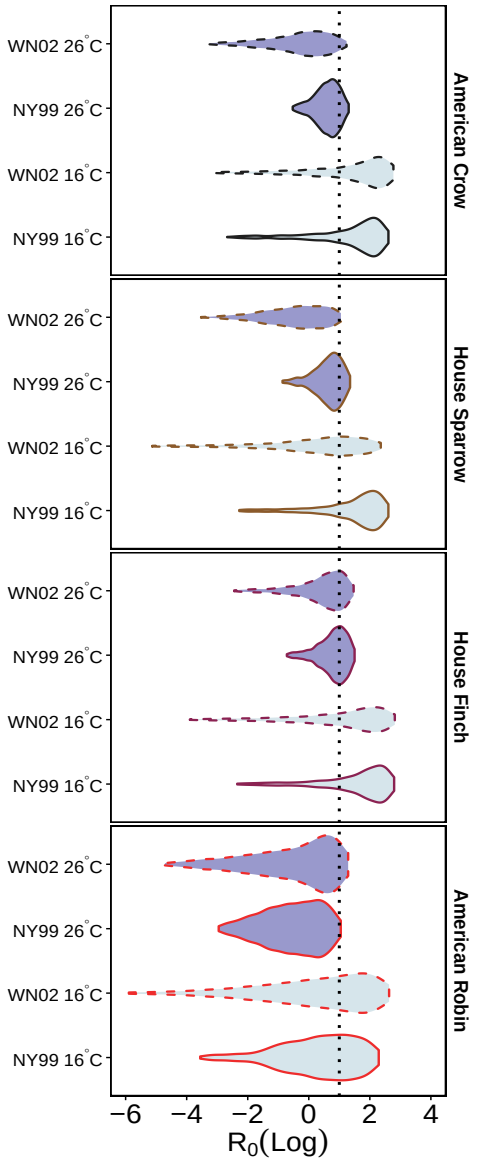

Figure S5: R_0*without* JEV data. Panels correspond to Figure 5 in the main text.

Community R_0s without JEV

In the Chicago, IL community *with* "other" birds median R_0 for NY99 was greater than WN02, but credible intervals overlap:

NY99 at 16^0C, Median: 0.83, CI: 0.02-3.06;

WN02 at 16^0C, Median: 1.54, CI: 0.01-4.93;

NY99 at 26^0C, Median: 0.30, CI: 0.07-0.88;

WN02 at 26^0C, Median: 0.55, CI: 0.06-1.33.

In the Chicago, IL community *without* "other" birds median R_0 WN02 was greater than NY99, but credible intervals also overlap:

NY99 at 16^0C, Median: 1.18, CI: 0.03-5.70;

WN02 at 16^0C, Median: 1.06, CI: 0.002-7.38;

NY99 at 26^0C, Median: 0.42, CI: 0.08-1.63;

WN02 at 26^0C, Median: 0.49, CI: 0.02-1.96.

(6) Coefficient plots for all models

In this section we include all coefficient plots for the fixed effects, random effects, and for the linear predictors from one of the random effects of our choice for each model.

Titer

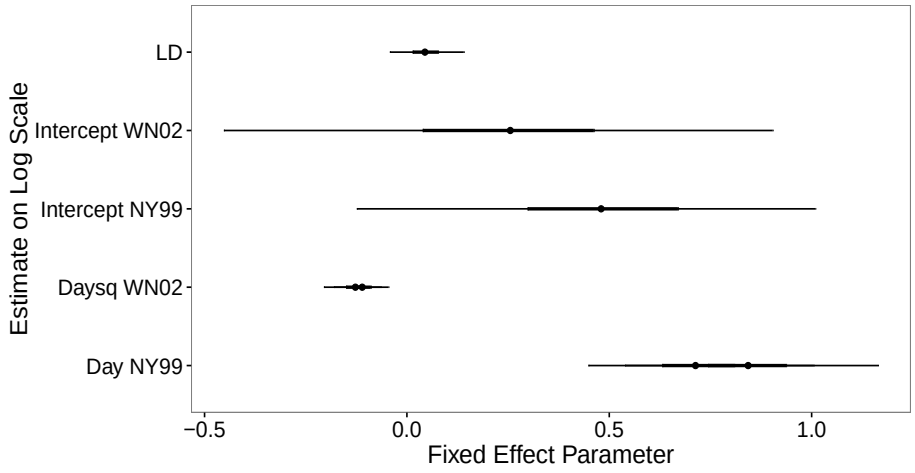

Figure S6.1: Fixed Effects

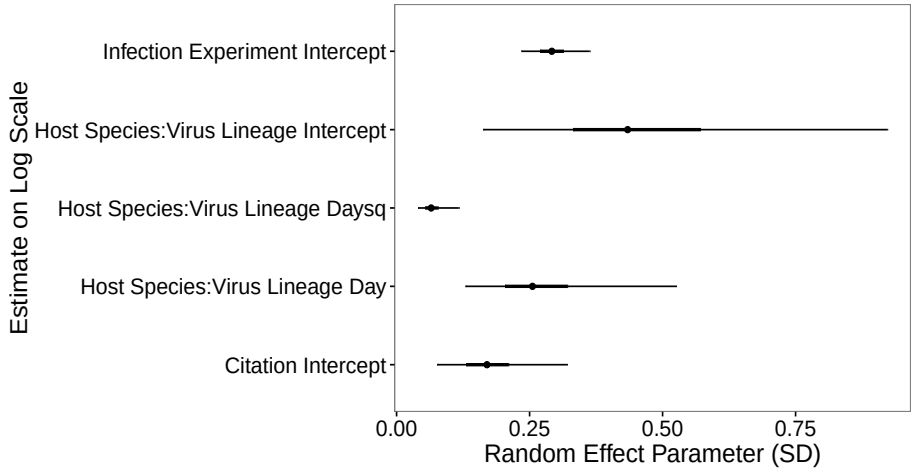

Figure S6.2: Random Effects

Survival

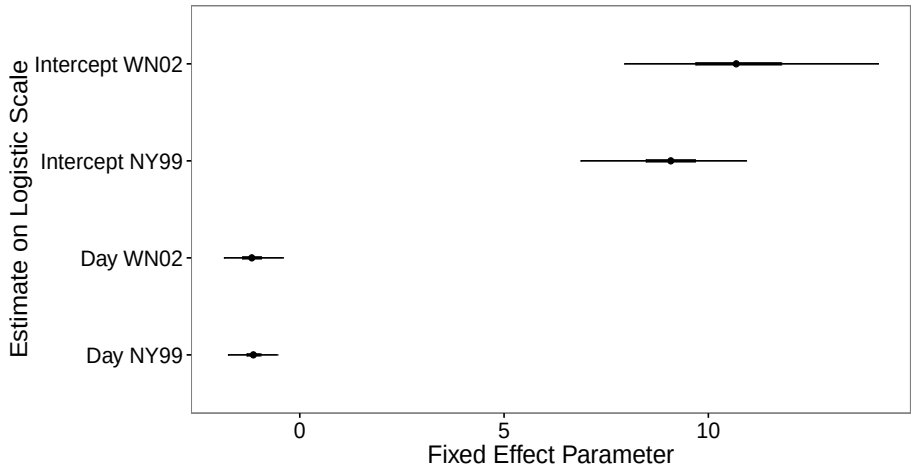

Figure S6.3: Fixed Effects

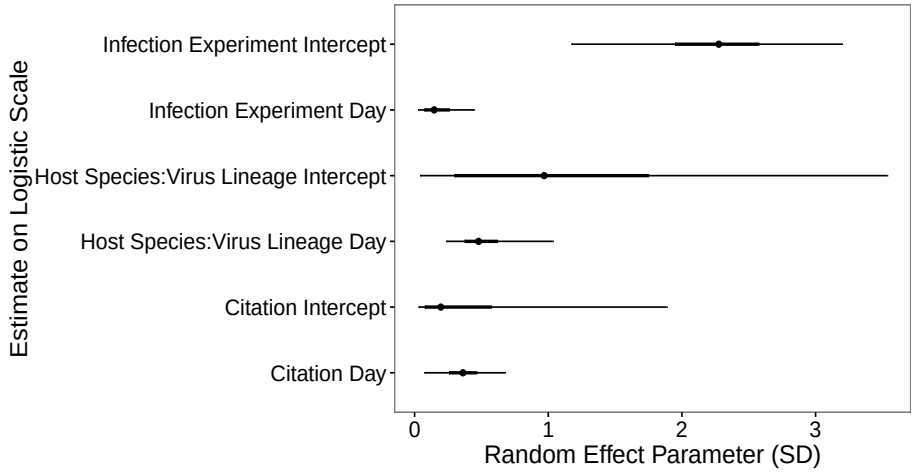

Figure S6.4: Random Effects

Bird to Mosquito Transmission

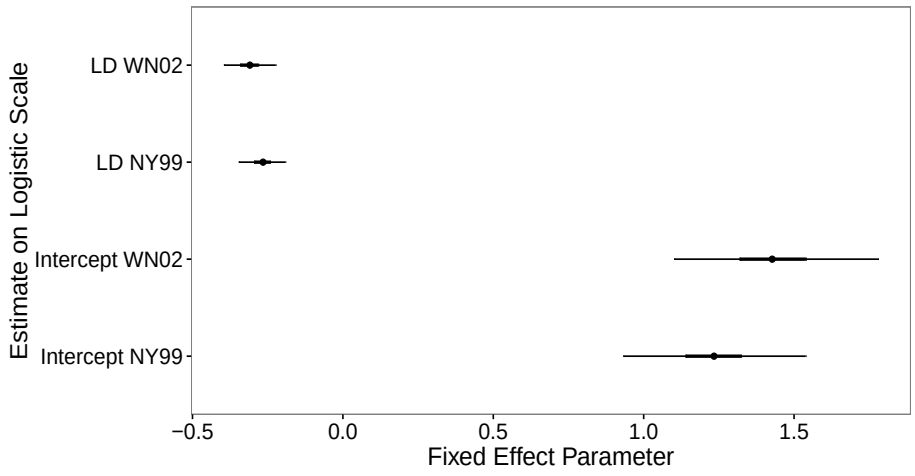

Figure S6.5: Fixed Effects

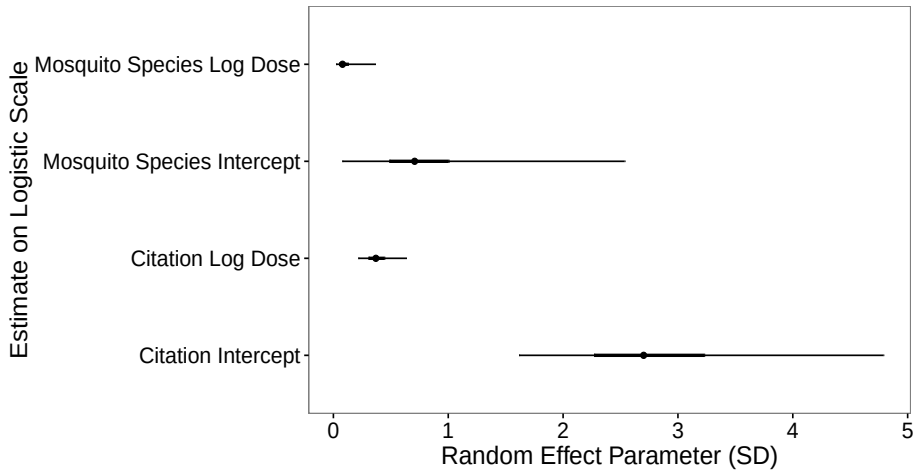

Figure S6.6: Random Effects (no intercept displayed)

Mosquito to Bird Transmission: *With* JEV

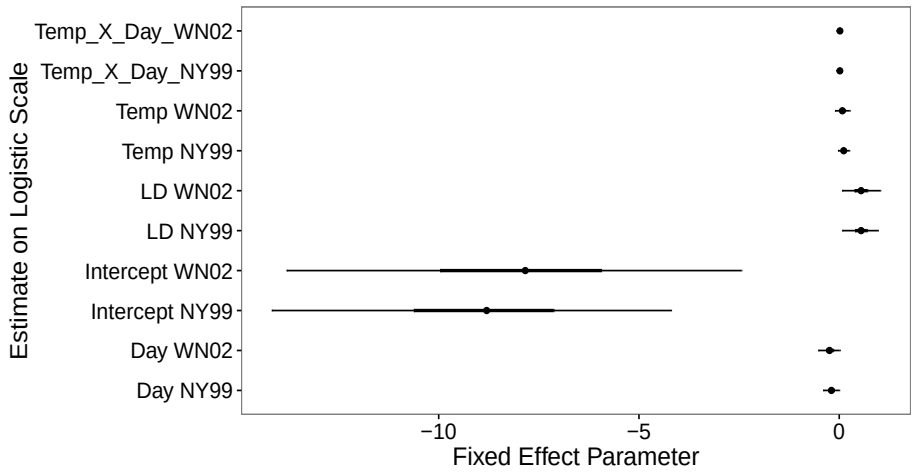

Figure S6.7: Fixed Effects

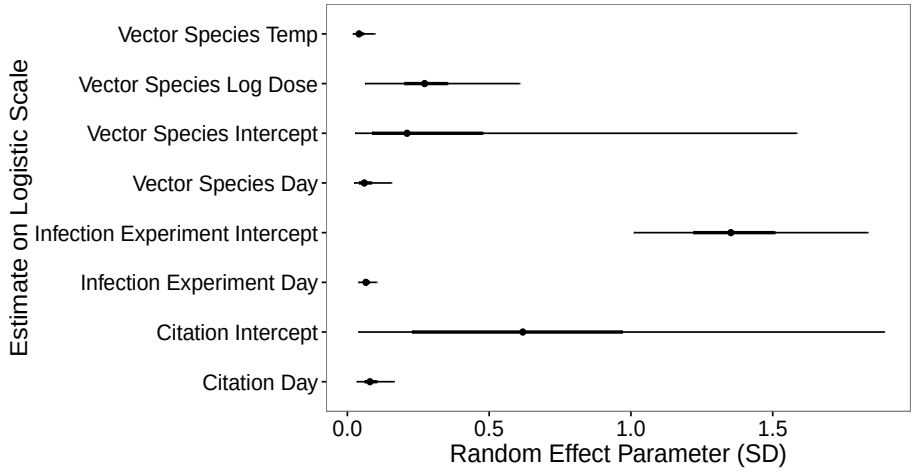

Figure S6.8: Random Effects

Mosquito to Bird Transmission: *Without* JEV

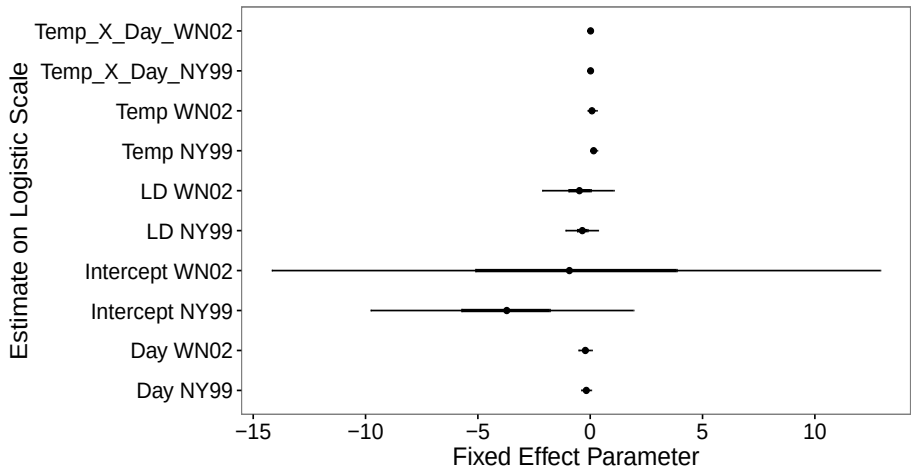

Figure S6.9: Fixed Effects

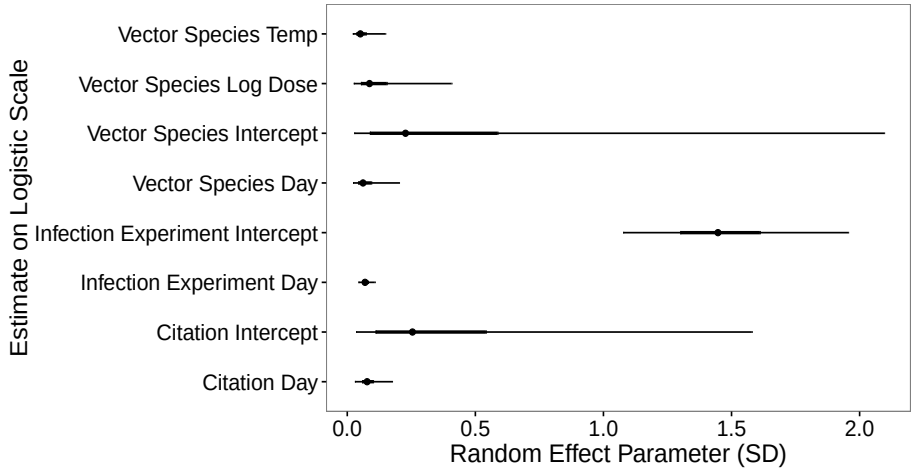

Figure S6.10: Random Effects

(7) Amplification Fraction Table

```
##          Species        Lower       Median       Upper
## 1  American Crow 5.897167e-05 0.0002654346 0.003462375
## 2  House Sparrow 8.917860e-02 0.5514002264 0.939438128
## 3    House Finch 4.388876e-03 0.0310894843 0.222416533
## 4 American Robin 1.741246e-02 0.3913833886 0.891619716
```

(8) Stan model notes

All stan models are available as .stan files in the online supplement and in the Github repository `https://github.com/morgankain/WNV_Synthesis.git`

For the titer profiles model, fixed effect parameters were given uninformative cauchy priors: intercepts were given cauchy(0, 10) priors and slopes were given cauchy(0, 2.5) priors. Variance parameters with positive constraints were given uninformative inverse gamma priors.

For the bird survival model, bird to mosquito transmission, and mosquito to bird transmission models parameters without constraints such as intercept or slope coefficients, were given normal(0.0, 1.0E3) priors. Variance parameters with positive constraints were given gamma(1.0E-3, 1.0E-3) priors.

References

Andreadis, S., O. Dimotsiou, and M. Savopoulou-Soultani 2014. Variation in adult longevity of *Culex pipiens f. pipiens*, vector of the West Nile Virus. *Parisitology Research 113*(11), 4315–4319.

Moudy, R. M., M. A. Meola, L.-L. L. Morin, G. D. Ebel, and L. D. Kramer 2007. A newly emergent genotype of West Nile virus is transmitted earlier and more efficiently by *Culex* mosquitoes. *The American Journal of Tropical Medicine and Hygiene 77*(2), 365–370.

Nash, J. C. and M. J. C. Nash 2012. Package âĂŸnlmrtâĂŹ.