# Model3c_diagnostic_plots.pdf Document Contents


−Calibration Site Maps for User−Selected Attributes

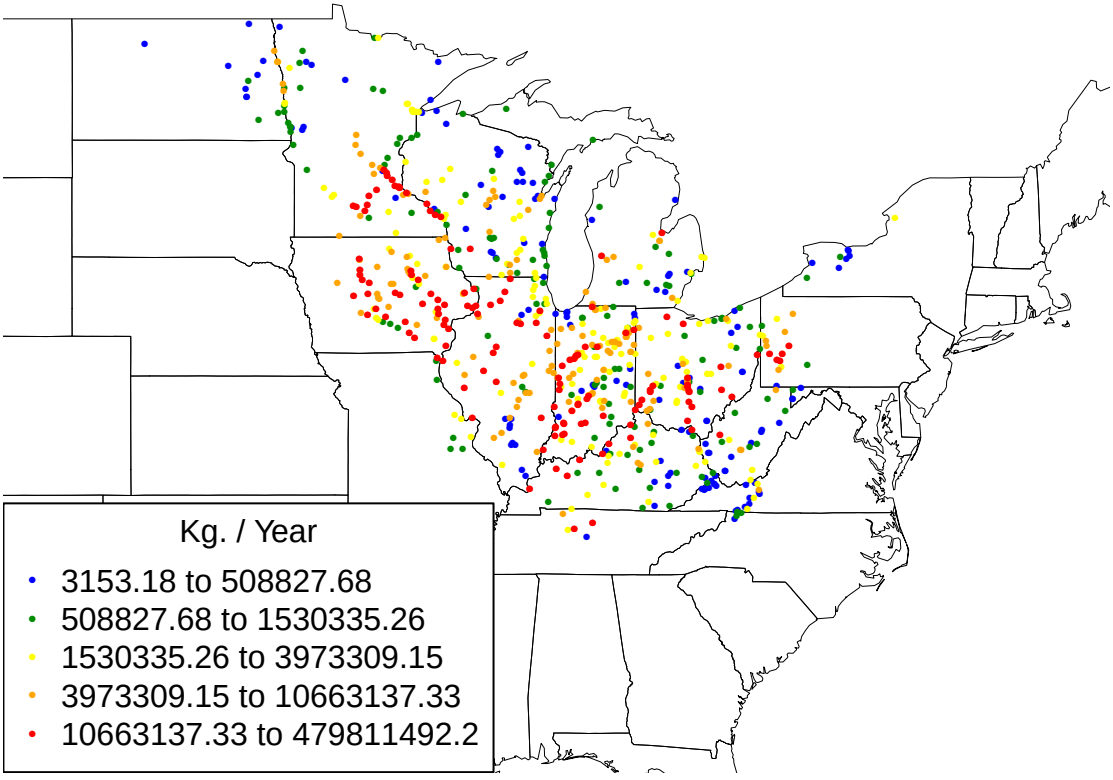
−Model Estimation Performance Diagnostics

−Model Simulation Performance Diagnostics

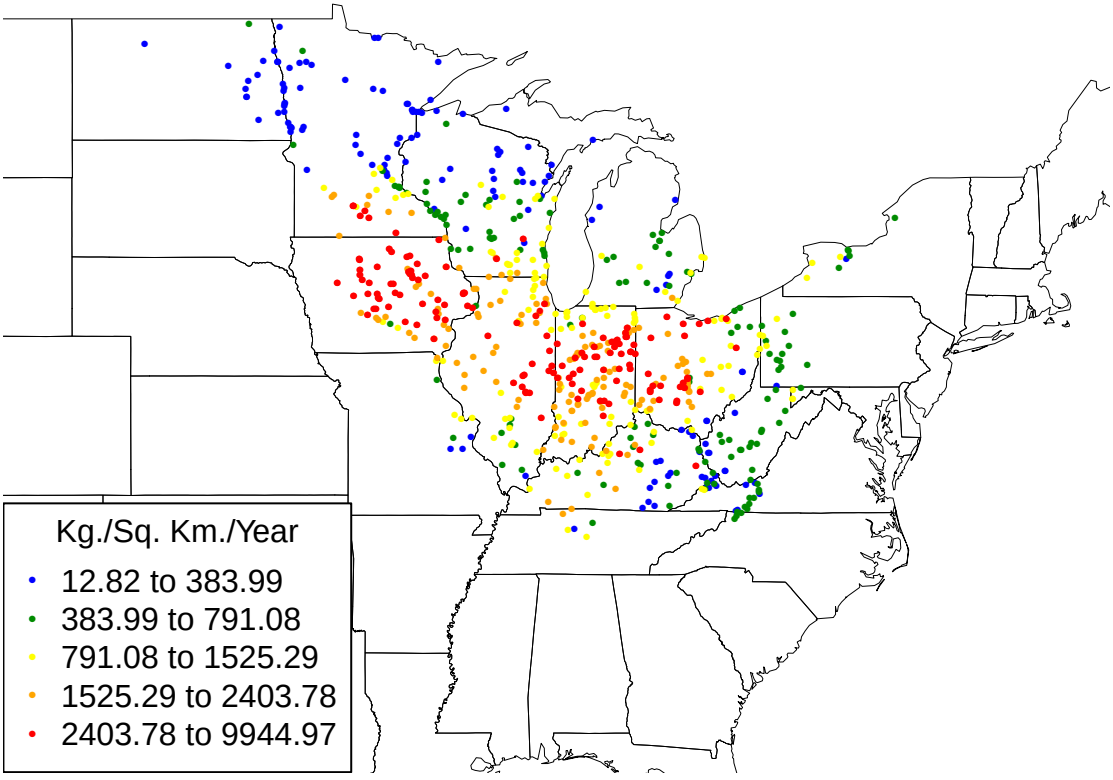
−Maps of Model Residuals and Observed to Predicted Ratios
for the Calibration Sites

# Calibration Site Maps for User−Selected Attributes

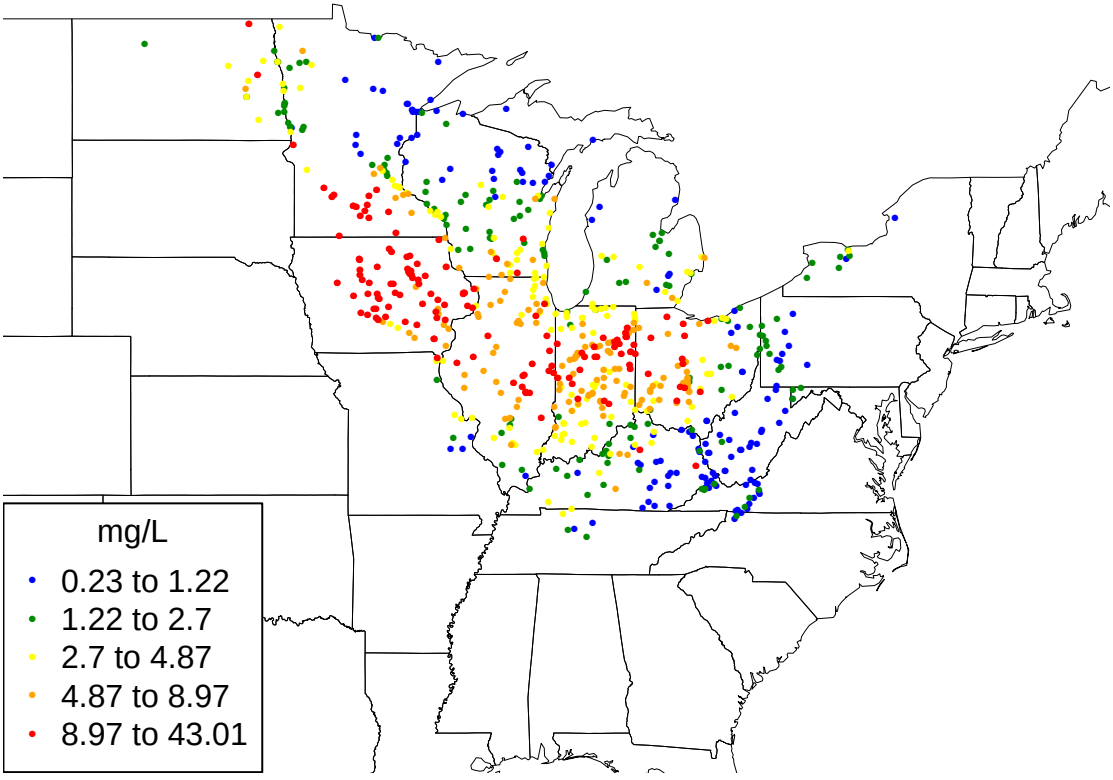
# Mean Annual Load at Calibration Sites



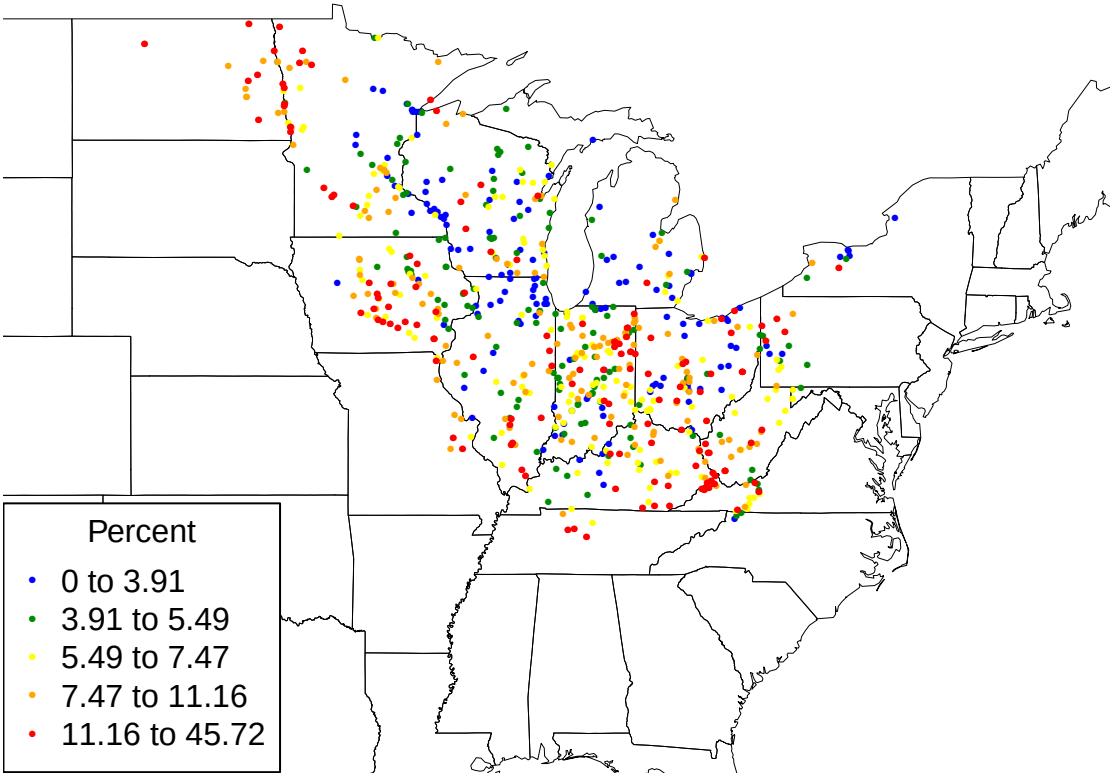
# Mean Annual Yield at Calibration Sites



# Mean Annual Flow−Weighted Concentration at Calibration Sites



# Percent Error in Mean Annual Load at Calibration Sites

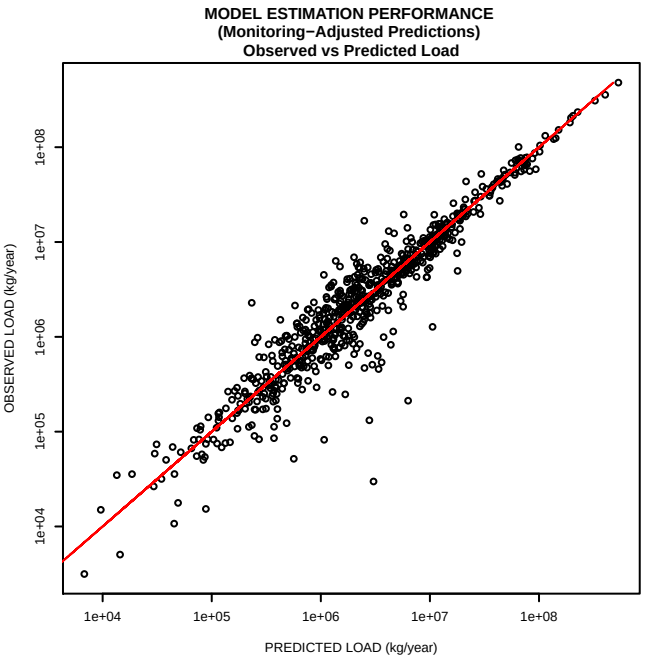


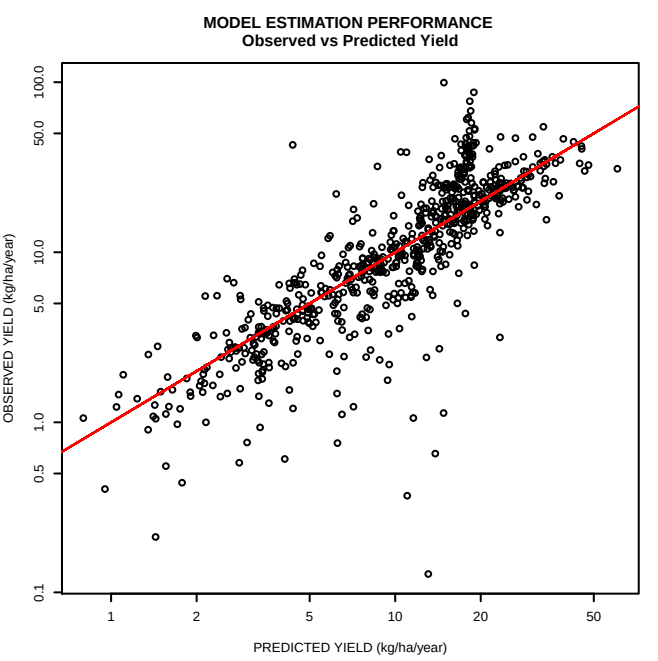
# Model Estimation Performance Diagnostics

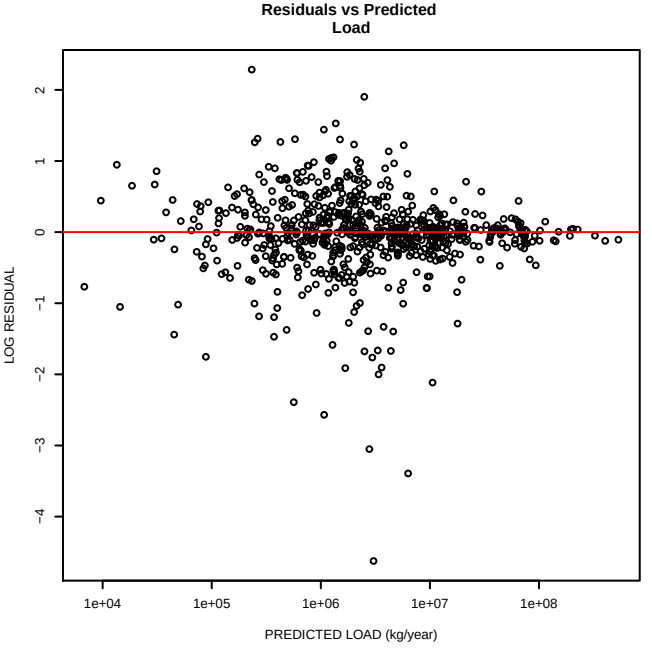
Diagnostics are based on the use of conditioned (monitoring−adjusted) predictions. These predictions provide the most accurate reach predictions for use in calibrating the model. The associated residuals and observed to predicted ratios shown in the following section provide the most relevant measures of the accuracy of the model fit to observed loads.

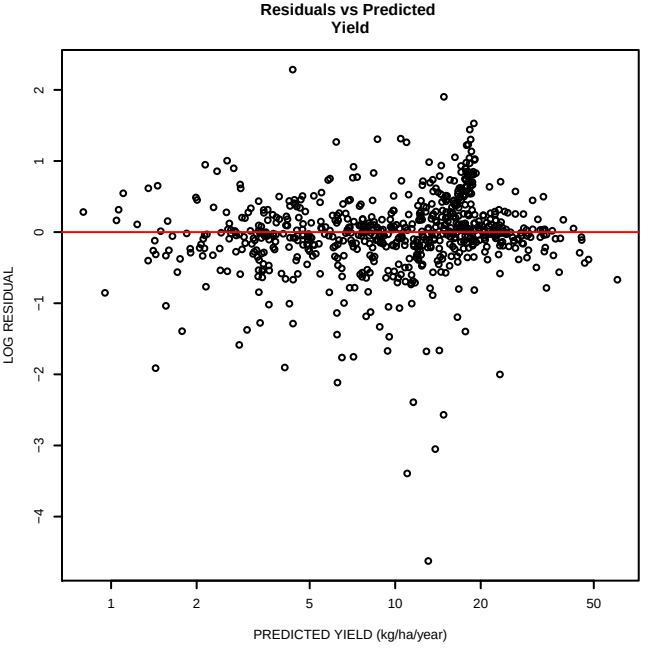
The diagnostic plots include:

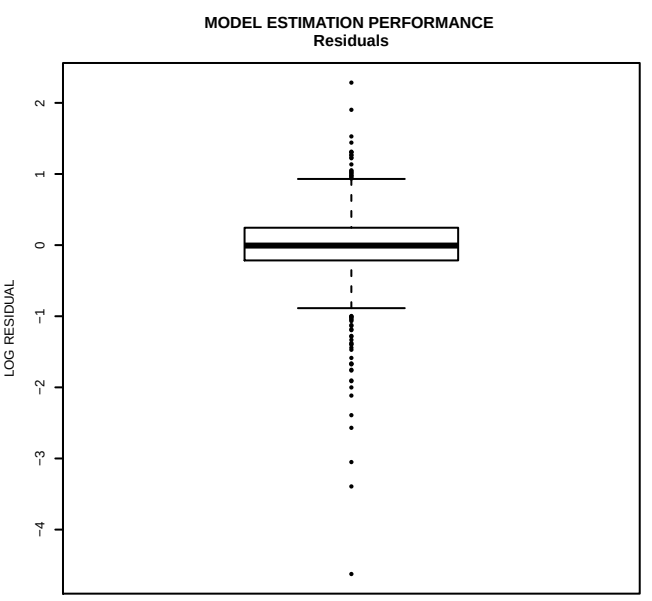
- −Four−plot panel for observed vs. predicted for loads and yields, and log residuals vs. predicted loads and yields
- −Four−plot panel for boxplots of residuals and observed/predicted ratios, normal quantile plot of standardized residuals, and plot of squared residuals vs. predicted loads
- −Plot of conditioned prediction loads vs. unconditioned (simulated) prediction loads
- −Plots of the observed to predicted ratio vs. the area−weighted mean values of the user−selected explanatory variables for the incremental areas between calibration sites (output only if control setting if_corrExplanVars<−'yes' selected and a value of 1 entered for 'parmCorrGroup' column in the 'parameters.csv' file)
- −Boxplots of the observed to predicted loads vs. the decile classes of the total drainage area for the calibration sites
- −Boxplots of the observed to predicted loads vs. the contiguous spatial classes specified by users in the 'classvar' control setting (e.g., HUC−4)
- −Boxplots of the observed to predicted loads vs. the deciles of the land−use class variable specified by users in the 'class_landuse' control setting, with the land−use classes expressed as a percentage of the incremental drainage area extending from the calibration site to the nearest upstream site locations.
- −Four−plot panels reported separately for each of the contiguous spatial classes specified for the first variable entry for the 'classvar[1]' control setting. The panels include: observed vs. predicted loads, observed vs. predicted yields, log residuals vs. predicted loads, and log residuals vs. predicted yields

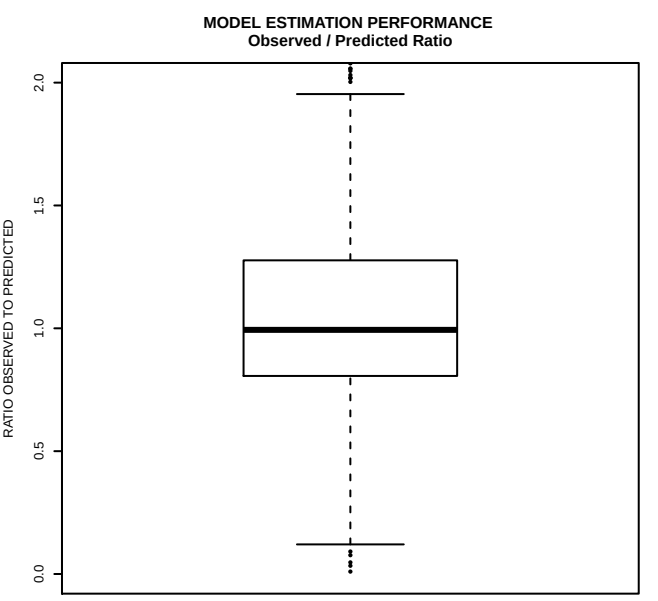

MODEL ESTIMATION PERFORMANCE
(Monitoring−Adjusted Predictions)
Observed vs Predicted Load
OBSERVED LOAD (kg/year)
PREDICTED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08

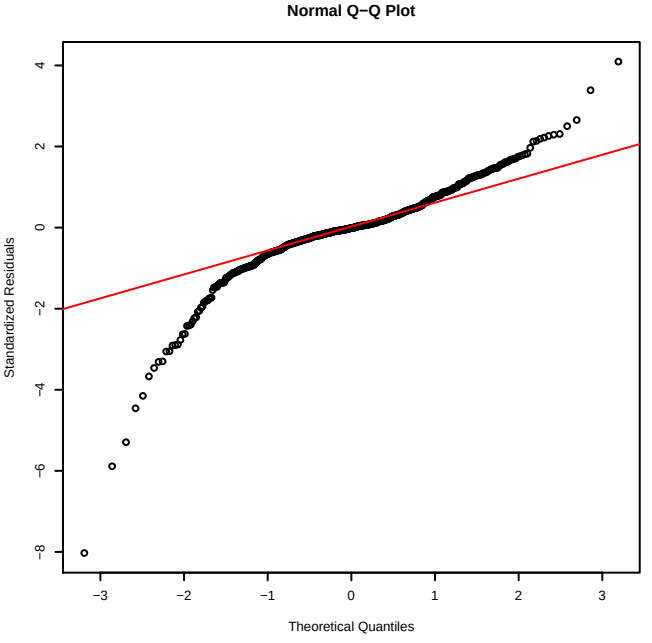

MODEL ESTIMATION PERFORMANCE
Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
PREDICTED YIELD (kg/ha/year)
0.1
0.5
1.0
5.0
10.0
50.0
100.0
1
2
5
10
20
50

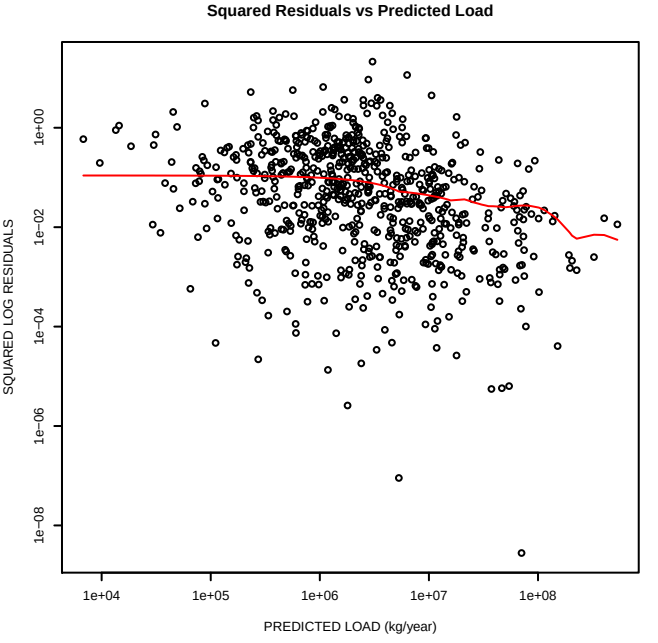

Residuals vs Predicted
Load
LOG RESIDUAL
PREDICTED LOAD (kg/year)
−4
−3
−2
−1
0
1
2
1e+04
1e+05
1e+06
1e+07
1e+08

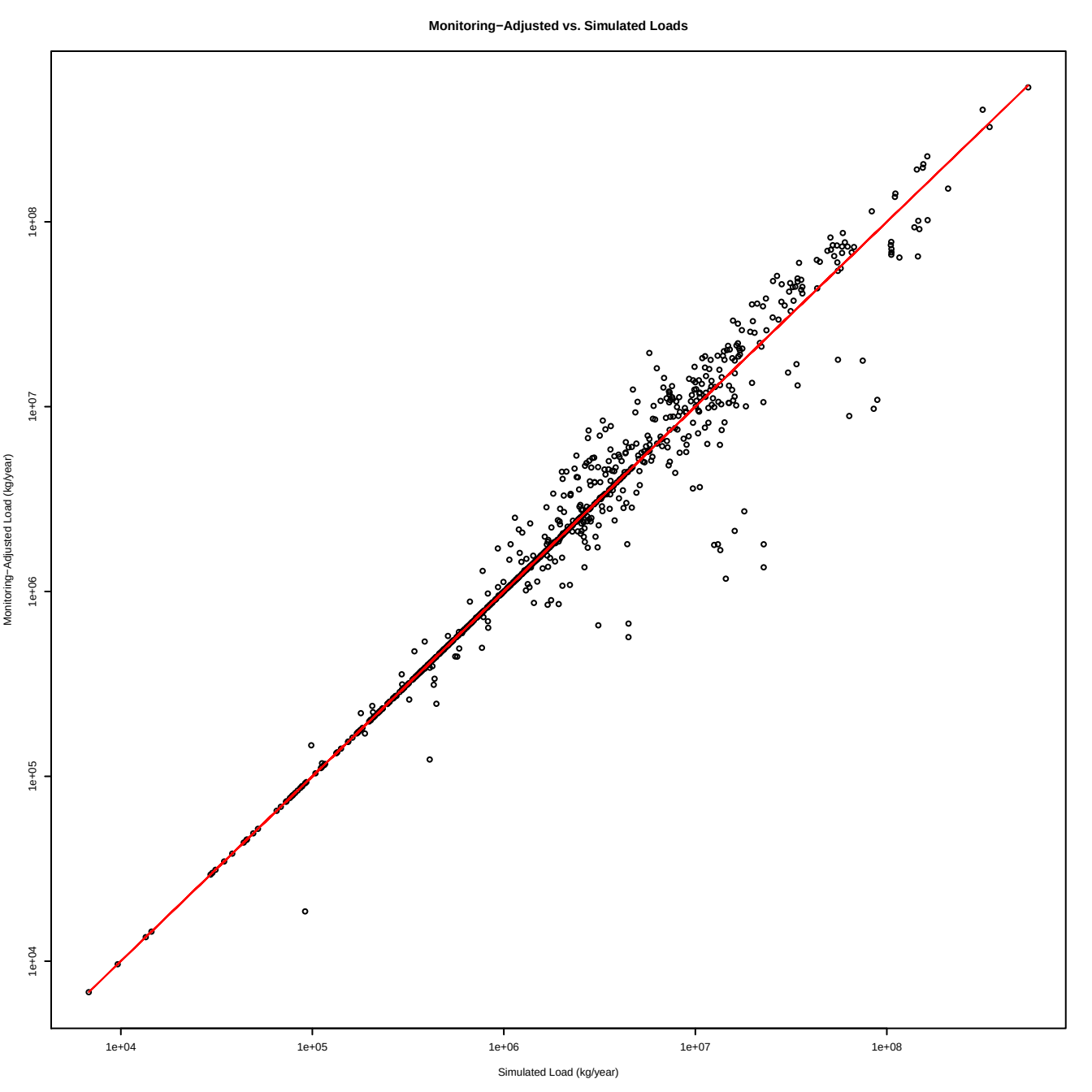

Residuals vs Predicted
Yield
LOG RESIDUAL
PREDICTED YIELD (kg/ha/year)
−4
−3
−2
−1
0
1
2
1
2
5
10
20
50

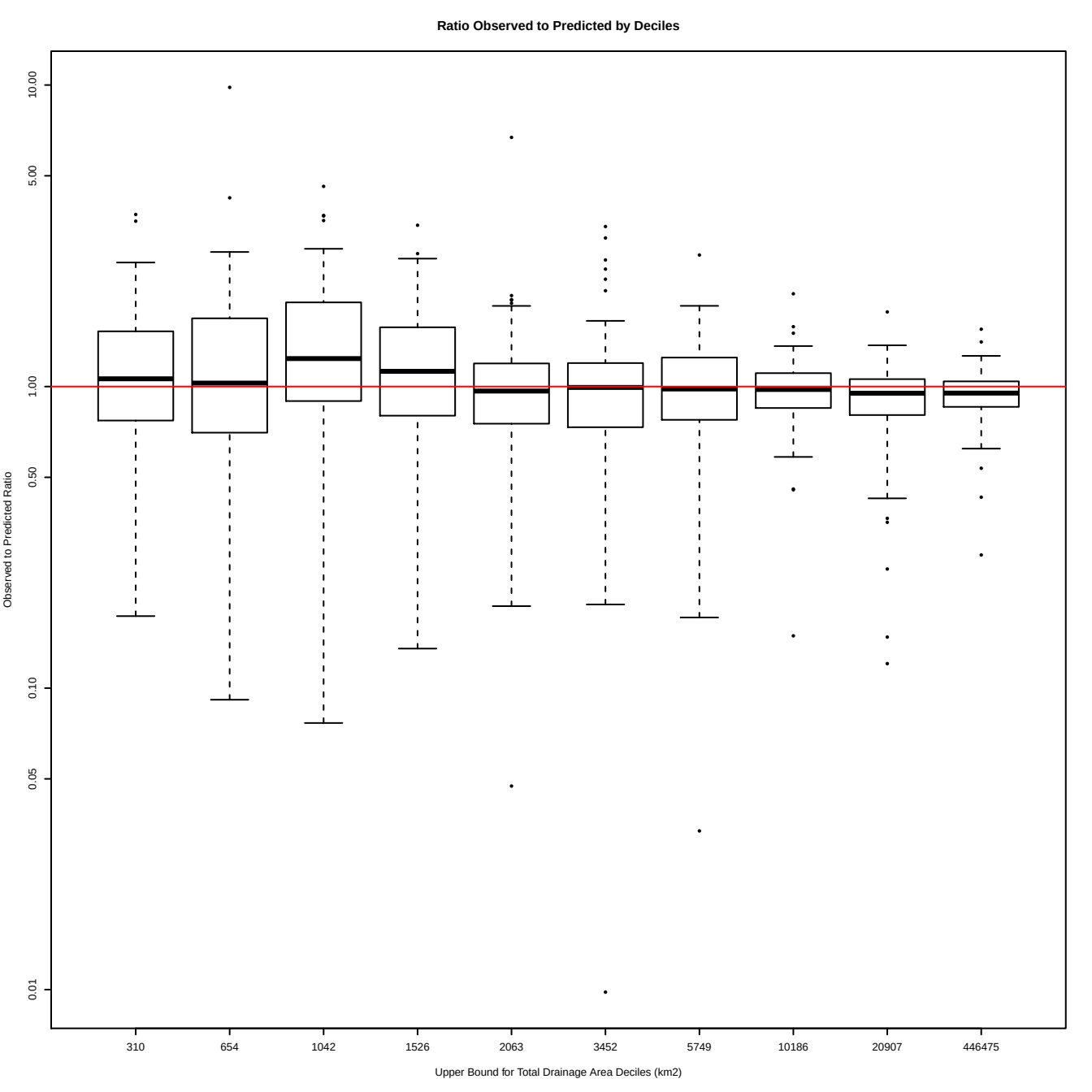

MODEL ESTIMATION PERFORMANCE
Residuals
LOG RESIDUAL
2
1
0
−1
−2
−3
−4

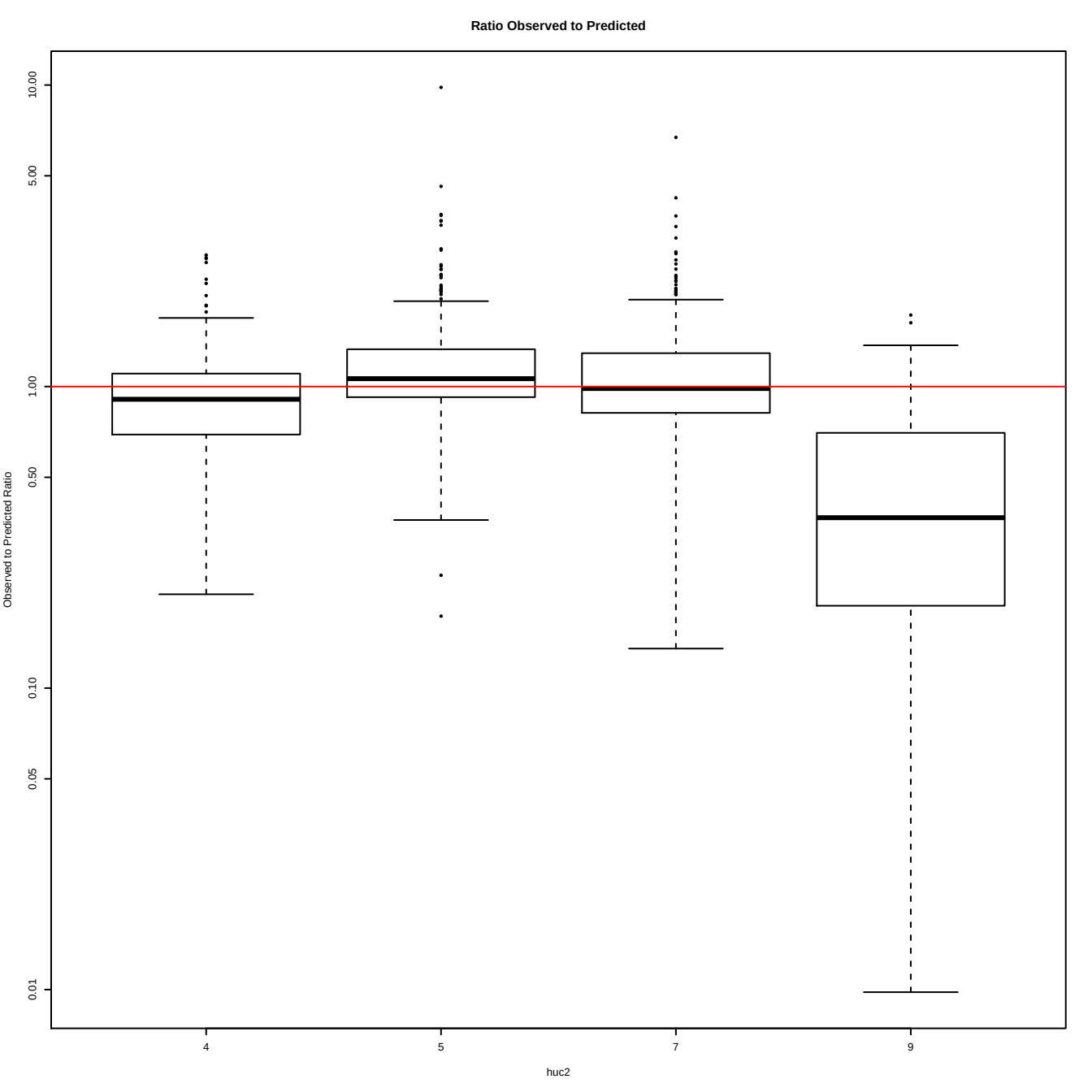

MODEL ESTIMATION PERFORMANCE
Observed / Predicted Ratio
RATIO OBSERVED TO PREDICTED
2.0
1.5
1.0
0.5
0.0

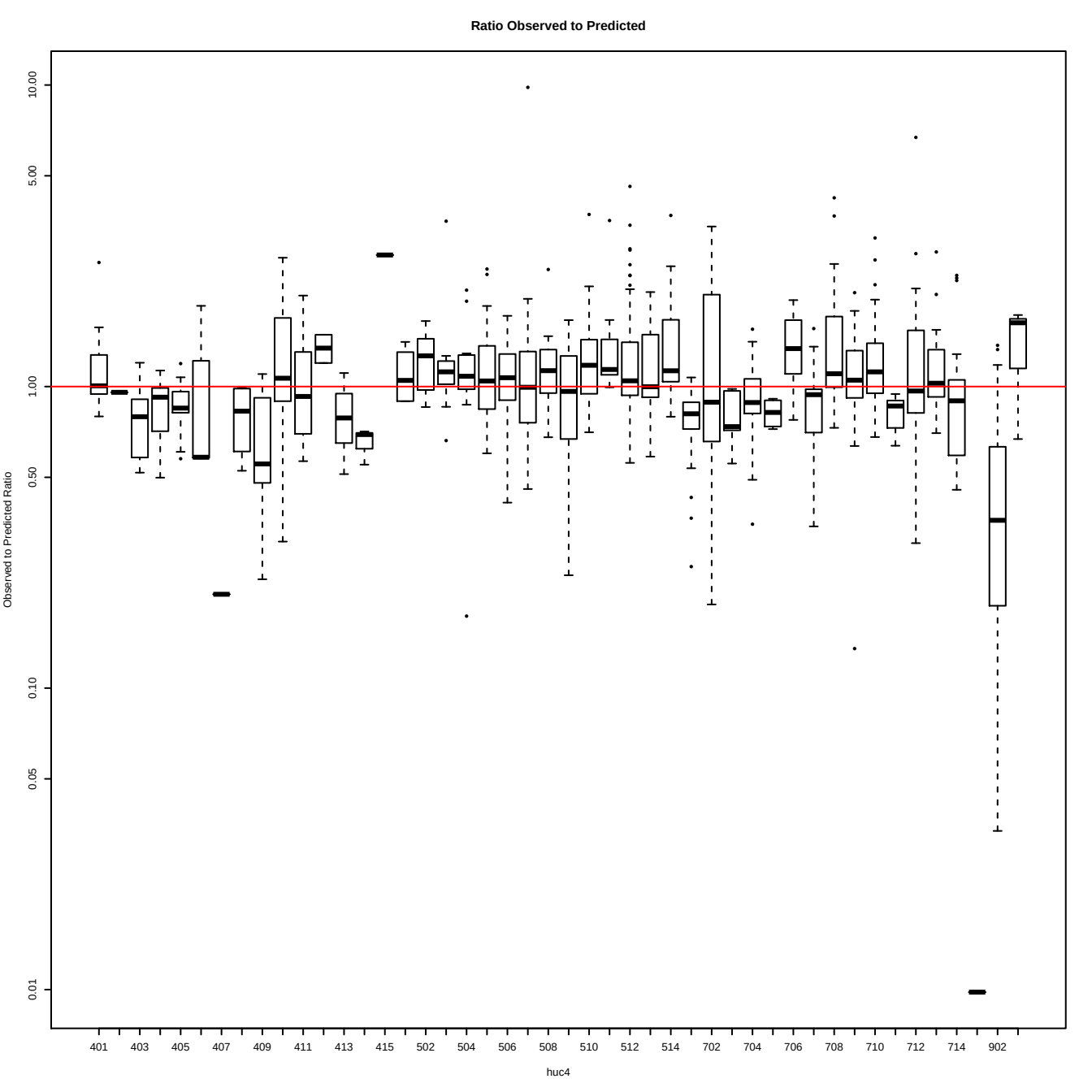

Normal Q−Q Plot
Standardized Residuals
4
2
0
−2
−4
−6
−8
−3
−2
−1
0
1
2
3
Theoretical Quantiles

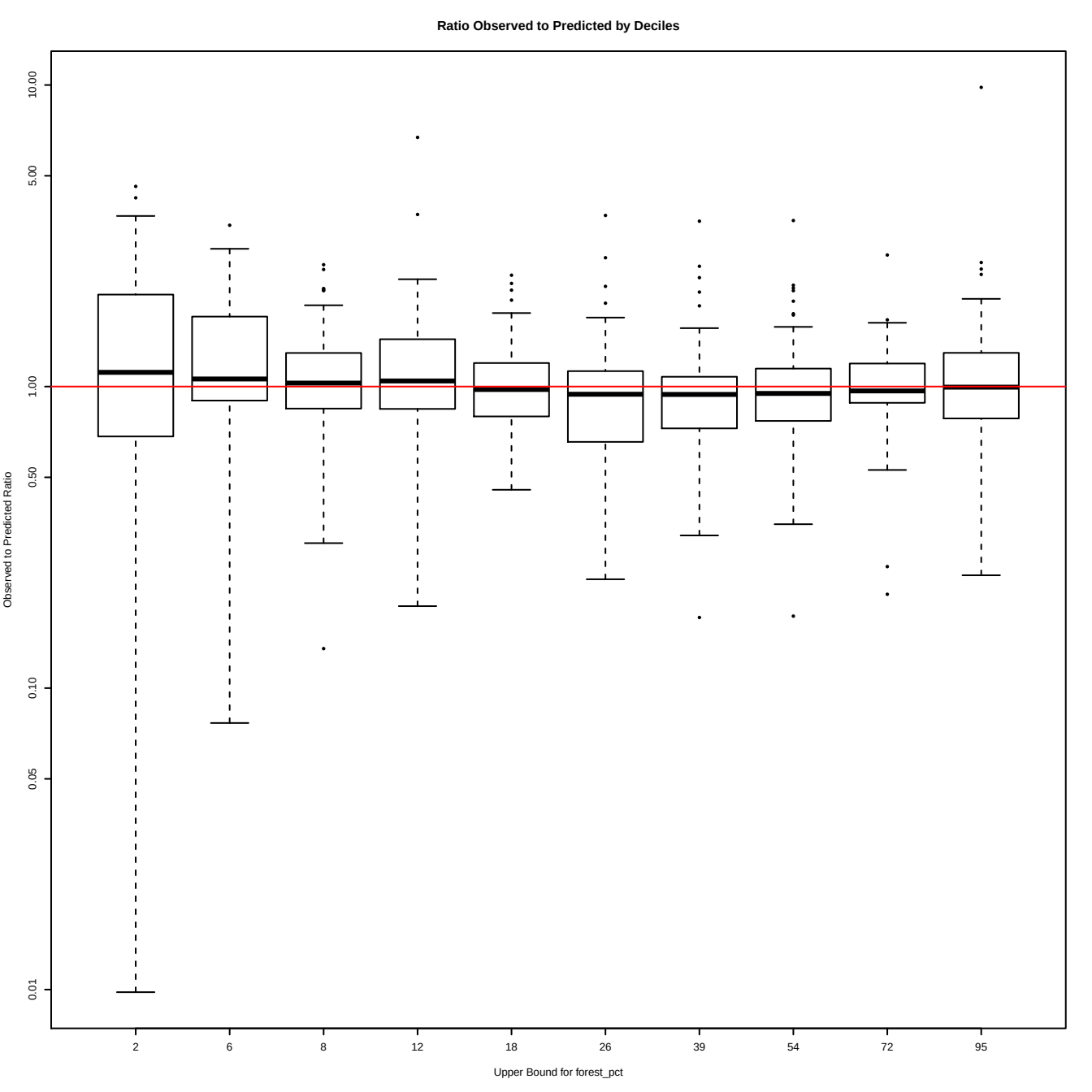

Squared Residuals vs Predicted Load
SQUARED LOG RESIDUALS
1e+00
1e−02
1e−04
1e−06
1e−08
1e+04
1e+05
1e+06
1e+07
1e+08
PREDICTED LOAD (kg/year)

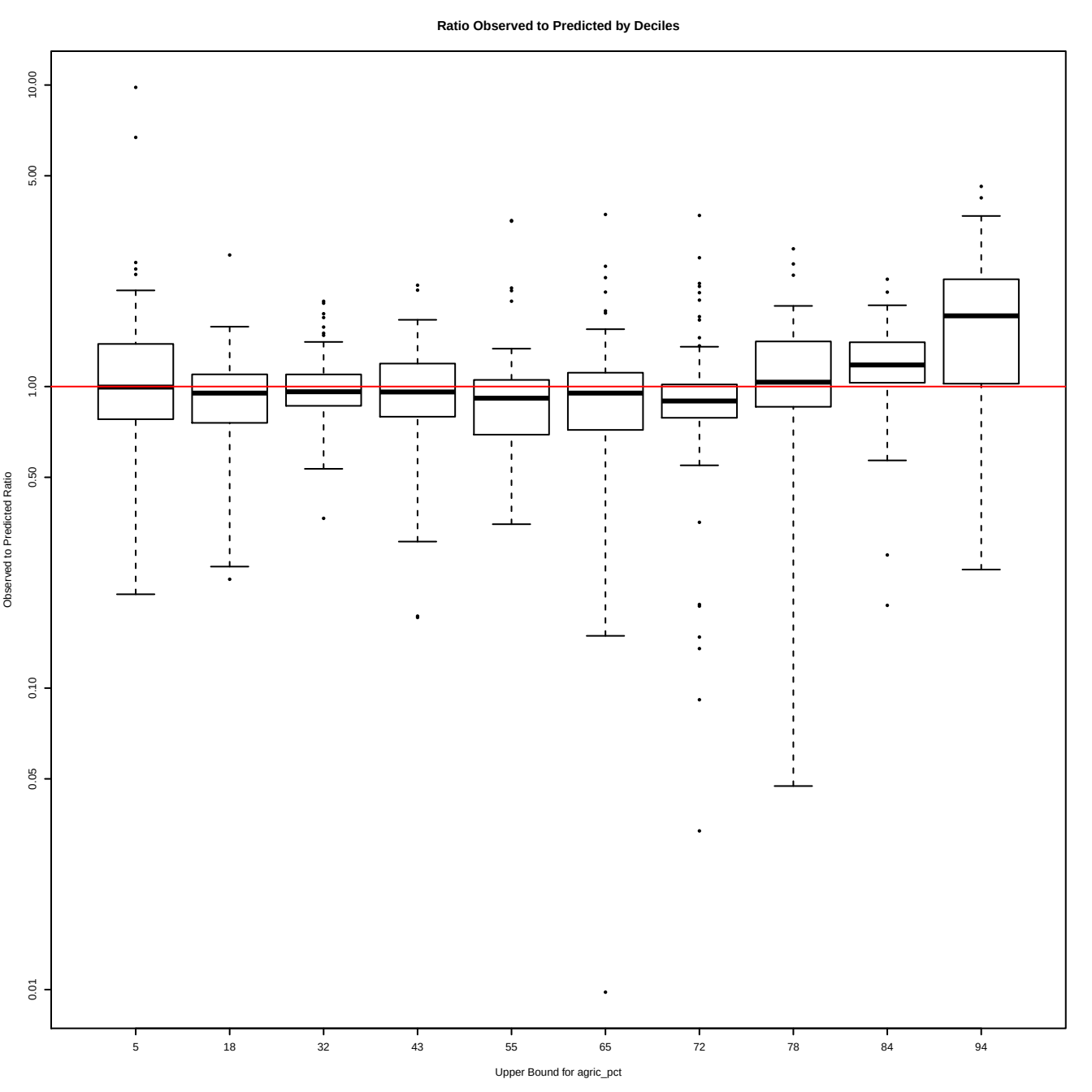

Monitoring−Adjusted vs. Simulated Loads
Monitoring−Adjusted Load (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08
Simulated Load (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08

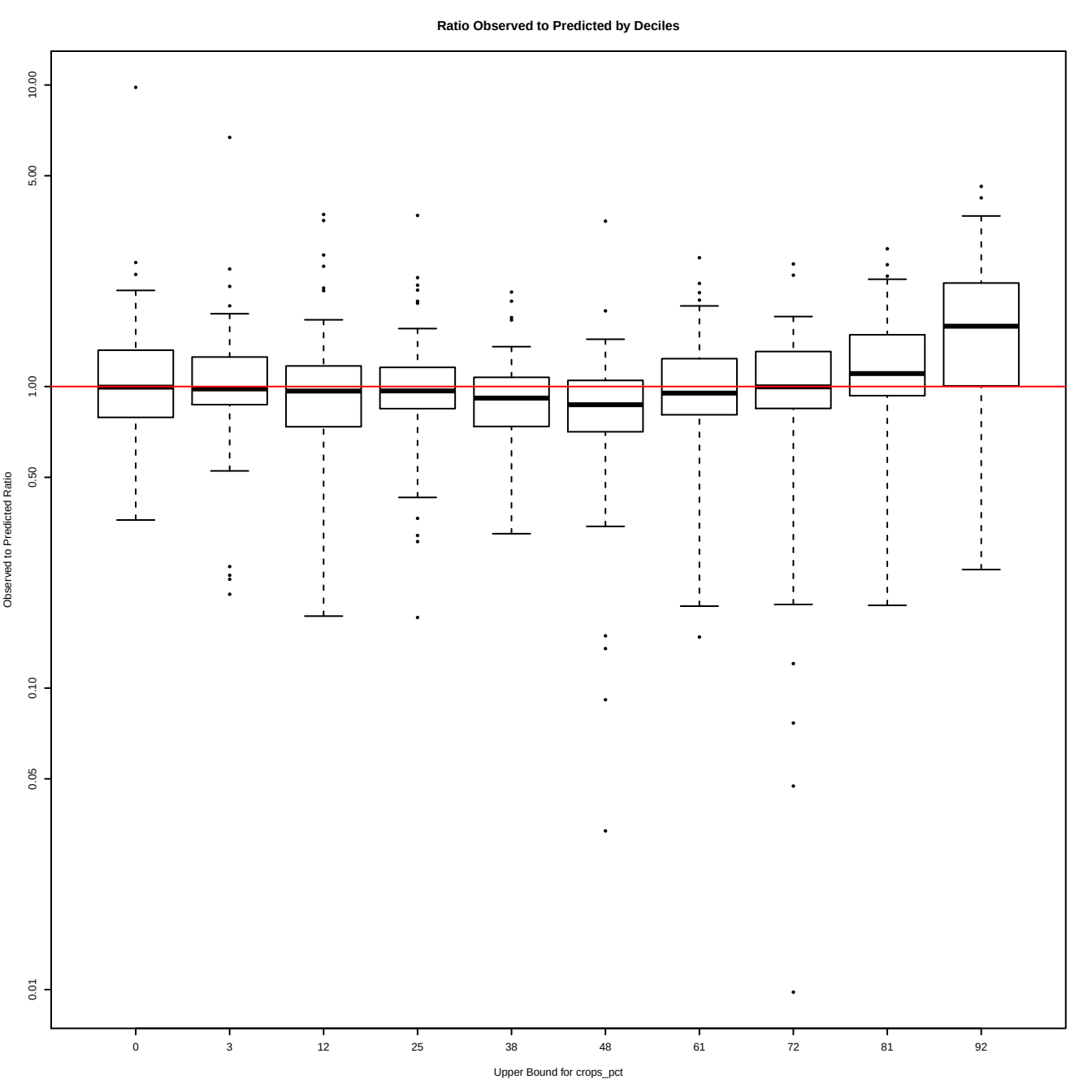

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
310
654
1042
1526
2063
3452
5749
10186
20907
446475
Upper Bound for Total Drainage Area Deciles (km2)

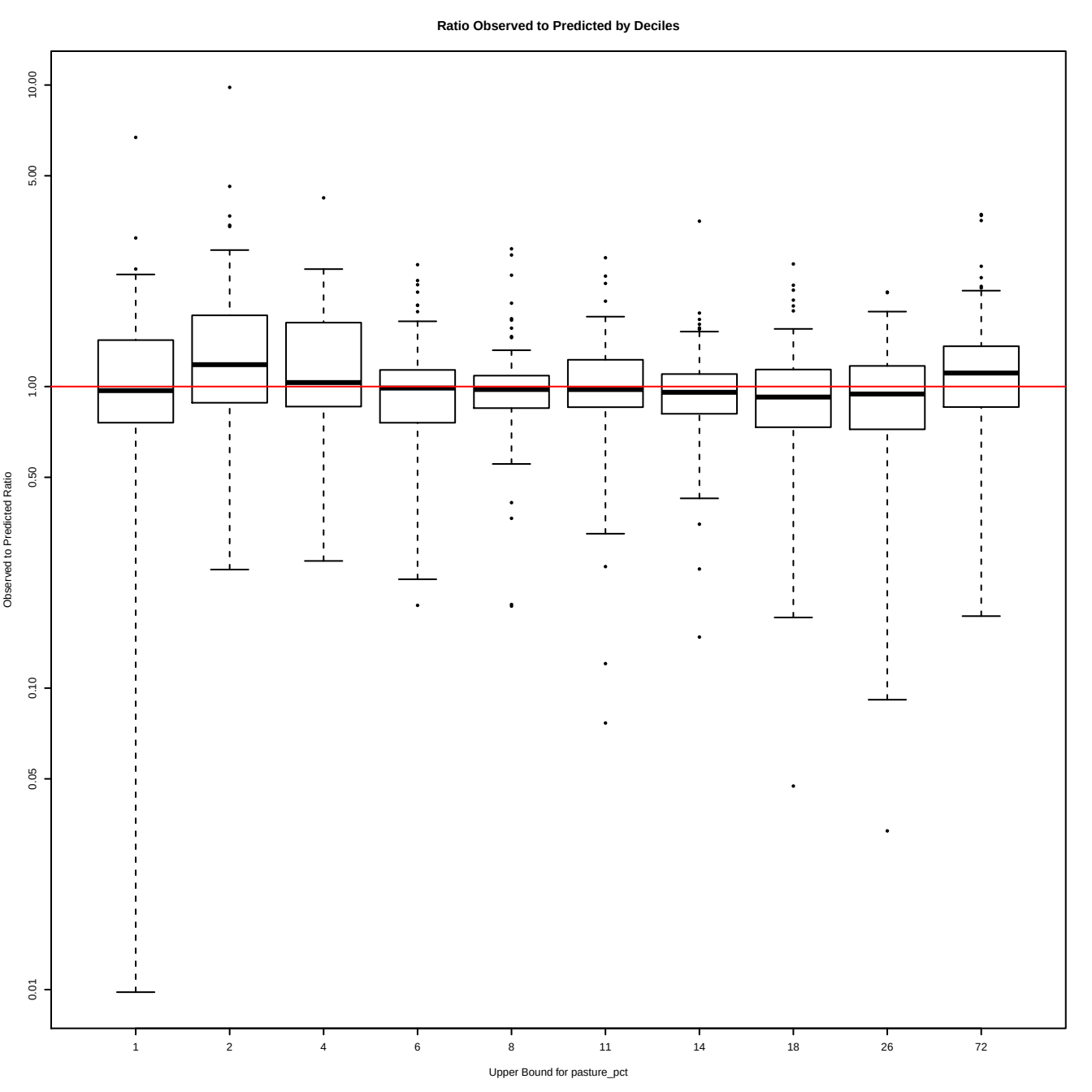

Ratio Observed to Predicted
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
4
5
7
9
huc2

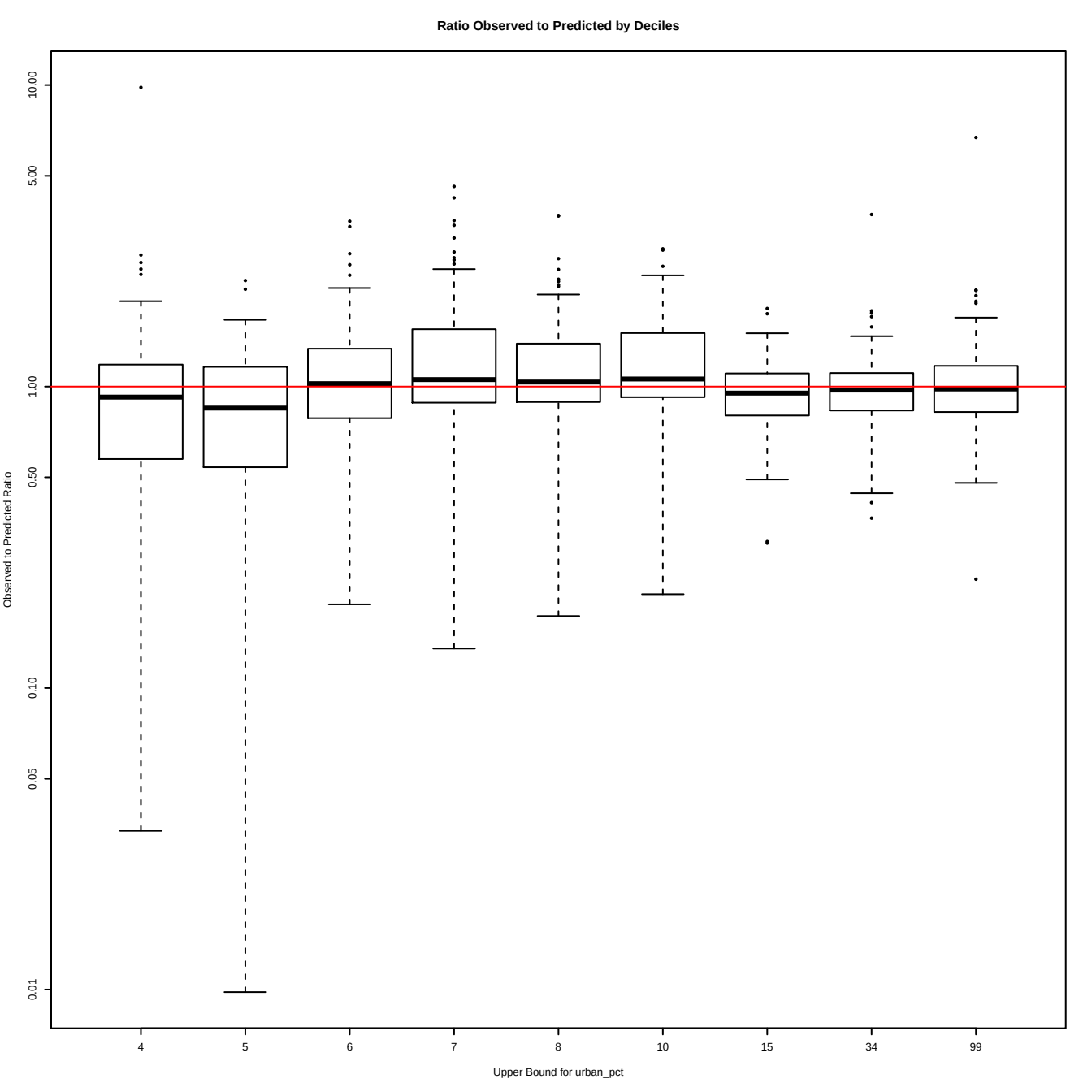

Ratio Observed to Predicted
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
401
403
405
407
409
411
413
415
502
504
506
508
510
512
514
702
704
706
708
710
712
714
902
huc4

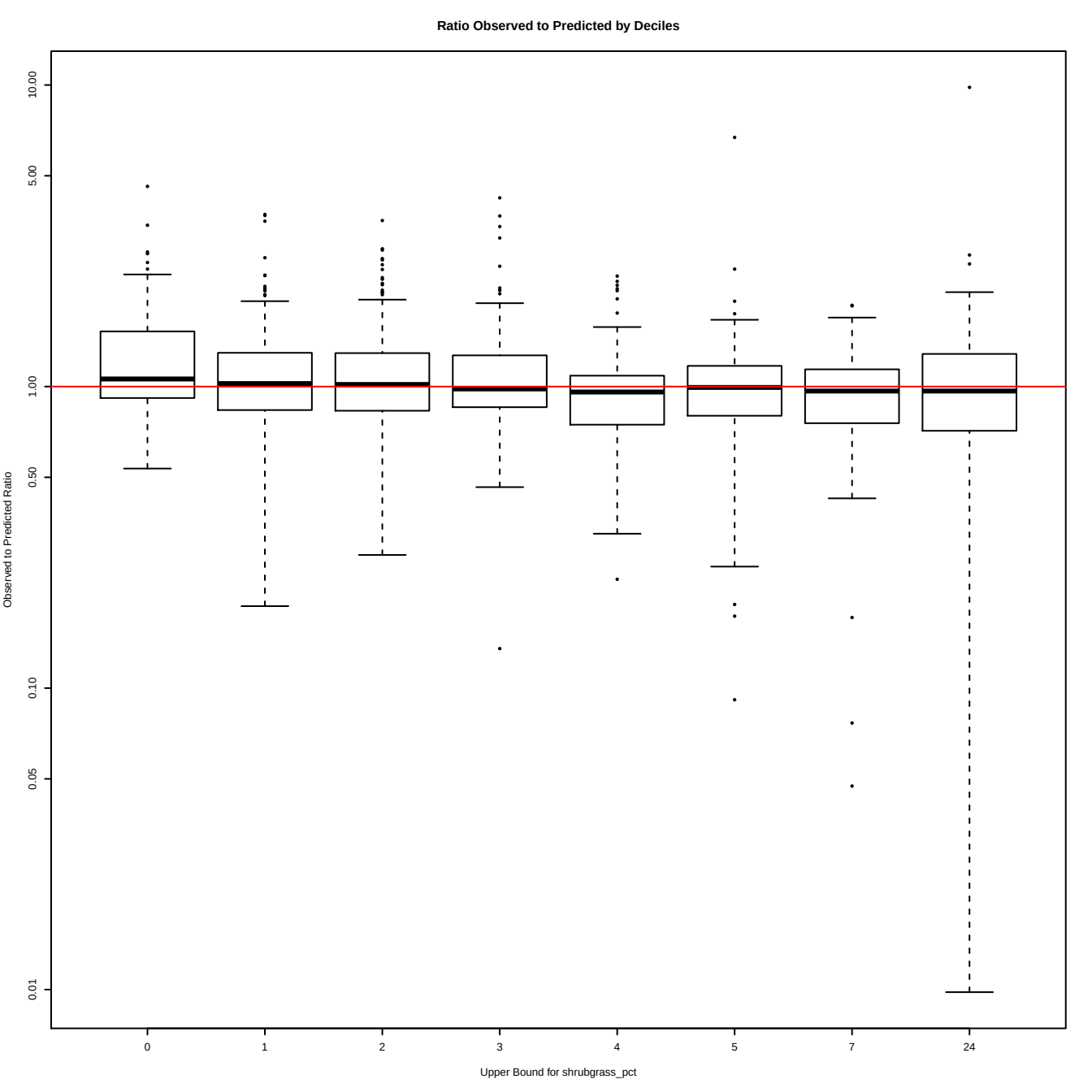

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
2
6
8
12
18
26
39
54
72
95
Upper Bound for forest_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
5
18
32
43
55
65
72
78
84
94
Upper Bound for agric_pct

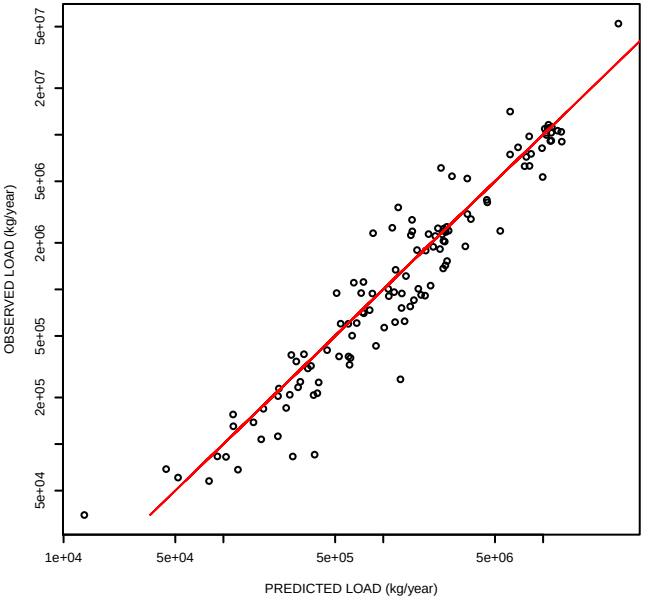

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
0
3
12
25
38
48
61
72
81
92
Upper Bound for crops_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
1
2
4
6
8
11
14
18
26
72
Upper Bound for pasture_pct

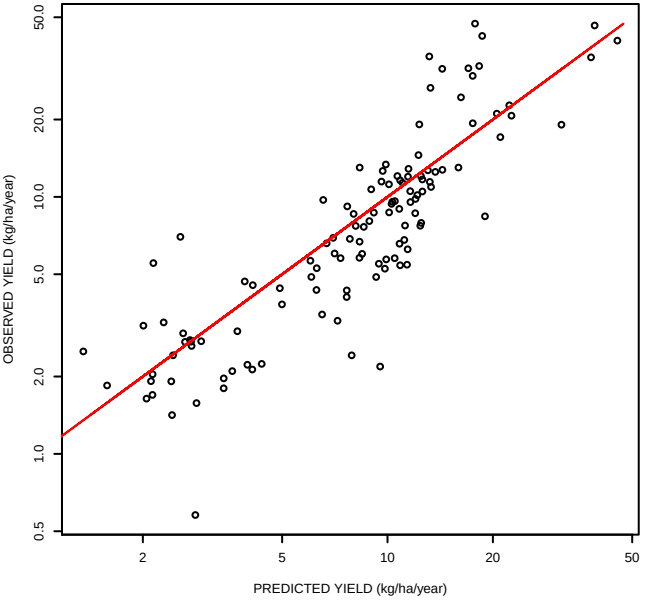

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
4
5
6
7
8
10
15
34
99
Upper Bound for urban_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
0
1
2
3
4
5
7
24
Upper Bound for shrubgrass_pct

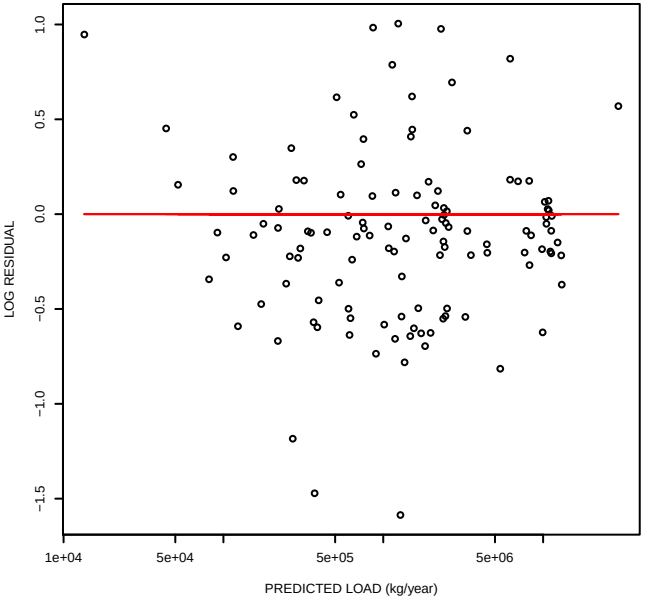
Observed vs Predicted Load
CLASS Region = 4(n=121)



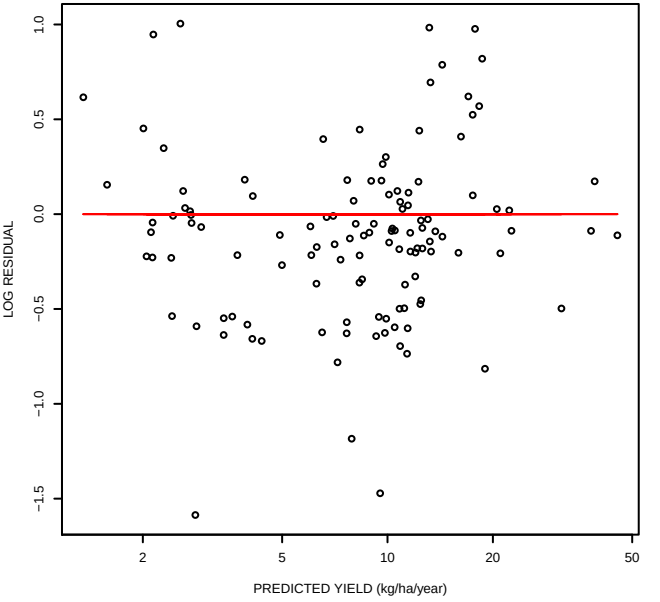

**Observed vs Predicted Yield**

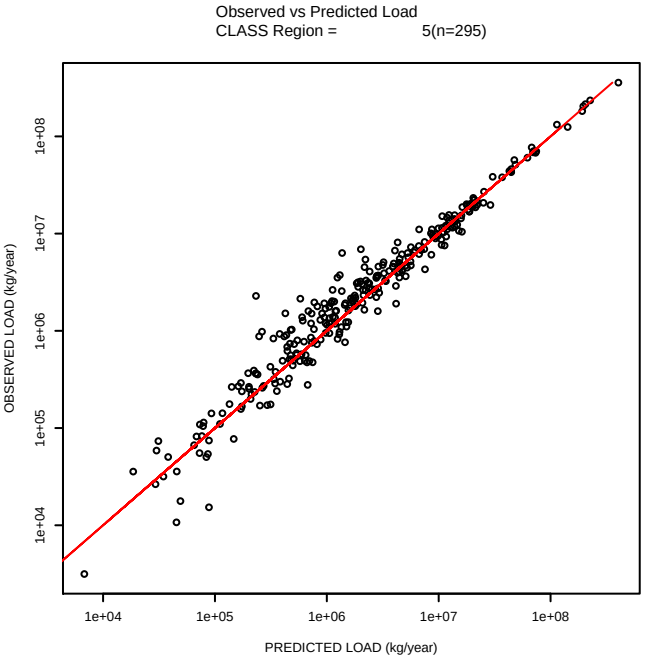


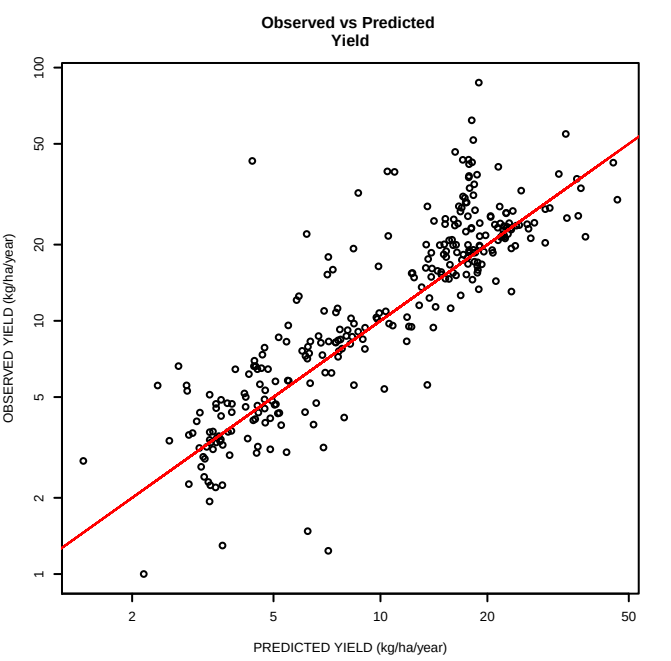

**Residuals vs Predicted Load**

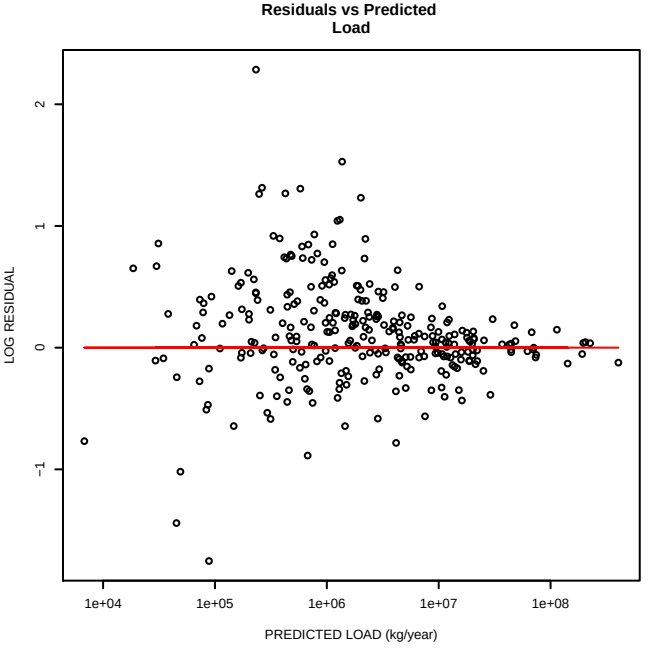


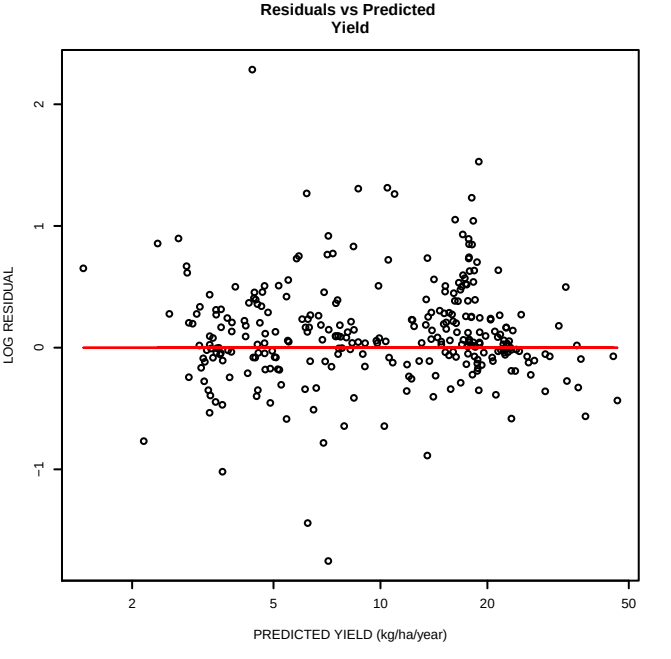

**Residuals vs Predicted Yield**

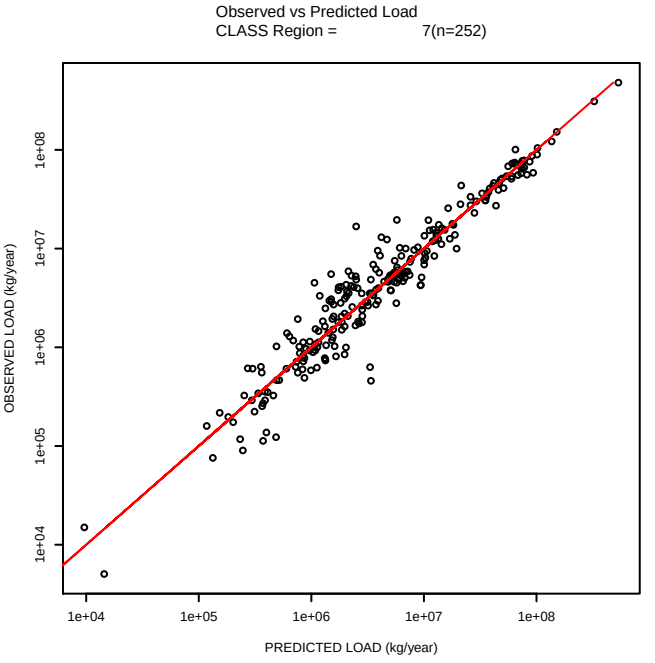


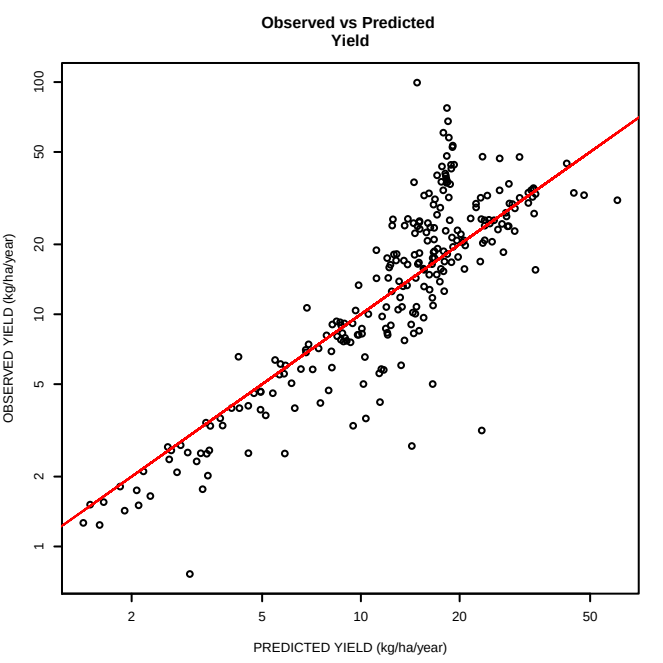

Observed vs Predicted Load
CLASS Region = 5(n=295)
OBSERVED LOAD (kg/year)
PREDICTED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08

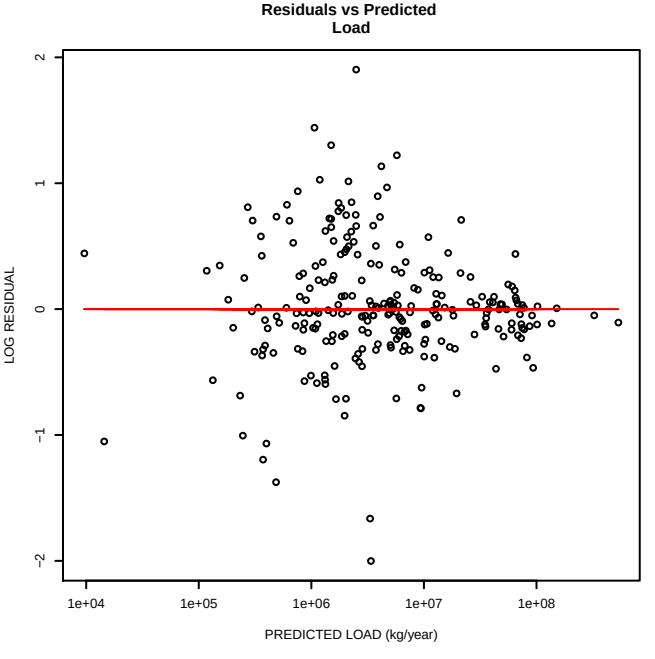

Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
PREDICTED YIELD (kg/ha/year)
1
2
5
10
20
50
100

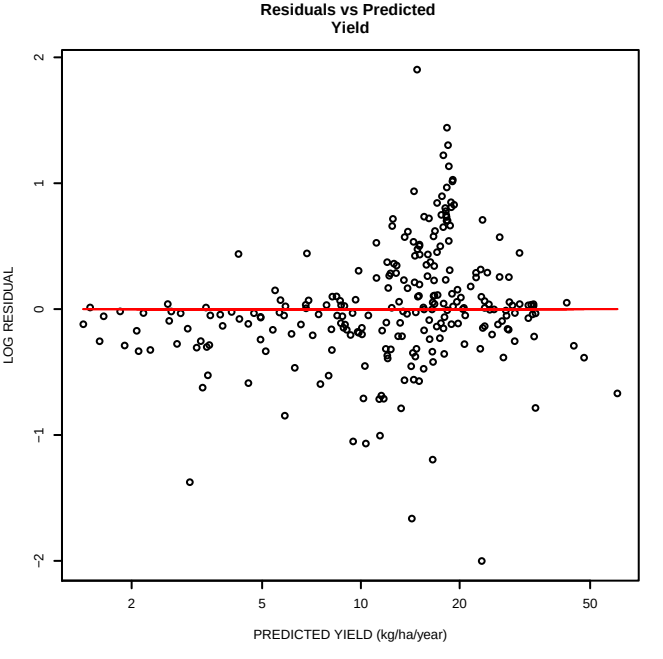

Residuals vs Predicted Load
LOG RESIDUAL
PREDICTED LOAD (kg/year)
−1
0
1
2
1e+04
1e+05
1e+06
1e+07
1e+08

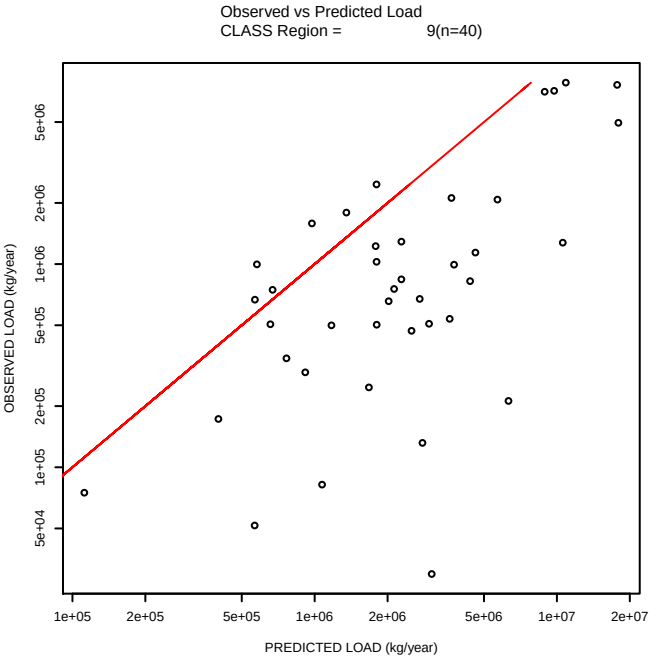

Residuals vs Predicted Yield
LOG RESIDUAL
PREDICTED YIELD (kg/ha/year)
−1
0
1
2
2
5
10
20
50

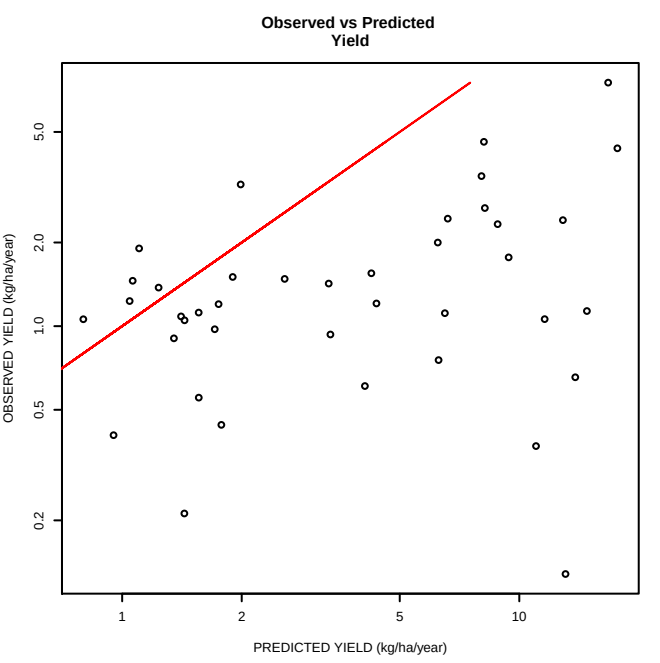

Observed vs Predicted Load
CLASS Region = 7(n=252)
OBSERVED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08
PREDICTED LOAD (kg/year)

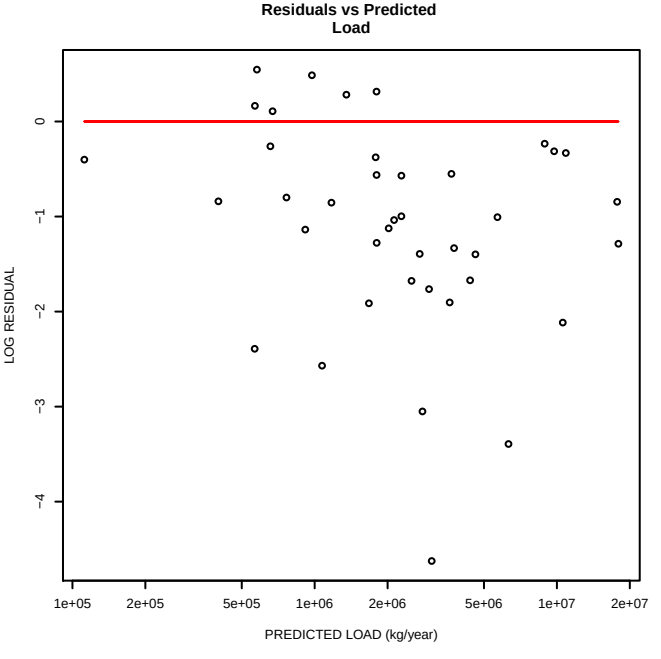

Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
1
2
5
10
20
50
100
PREDICTED YIELD (kg/ha/year)

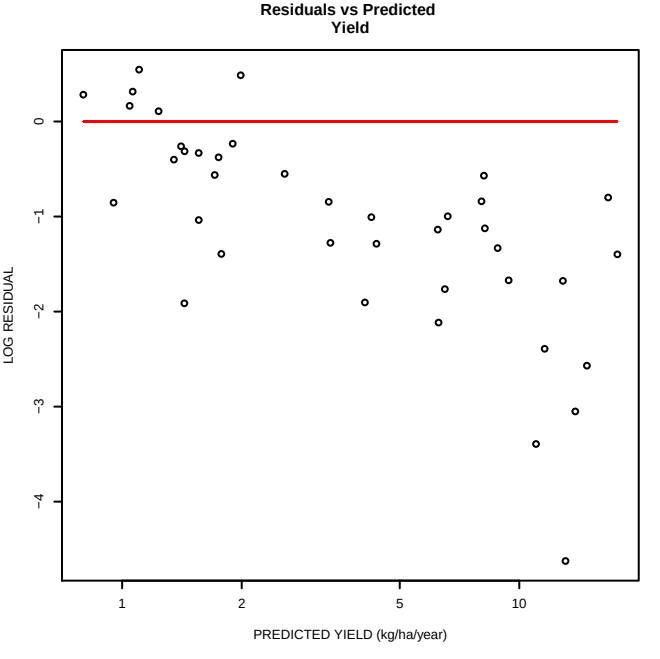

Residuals vs Predicted Load
LOG RESIDUAL
−2
−1
0
1
2
1e+04
1e+05
1e+06
1e+07
1e+08
PREDICTED LOAD (kg/year)


Residuals vs Predicted Yield
LOG RESIDUAL
−2
−1
0
1
2
2
5
10
20
50
PREDICTED YIELD (kg/ha/year)


Observed vs Predicted Load
CLASS Region = 9(n=40)
OBSERVED LOAD (kg/year)
PREDICTED LOAD (kg/year)
5e+04
1e+05
2e+05
5e+05
1e+06
2e+06
5e+06
1e+07
2e+07


Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
PREDICTED YIELD (kg/ha/year)
0.2
0.5
1.0
2.0
5.0
1
2
5
10


Residuals vs Predicted Load
LOG RESIDUAL
PREDICTED LOAD (kg/year)
0
−1
−2
−3
−4
1e+05
2e+05
5e+05
1e+06
2e+06
5e+06
1e+07
2e+07

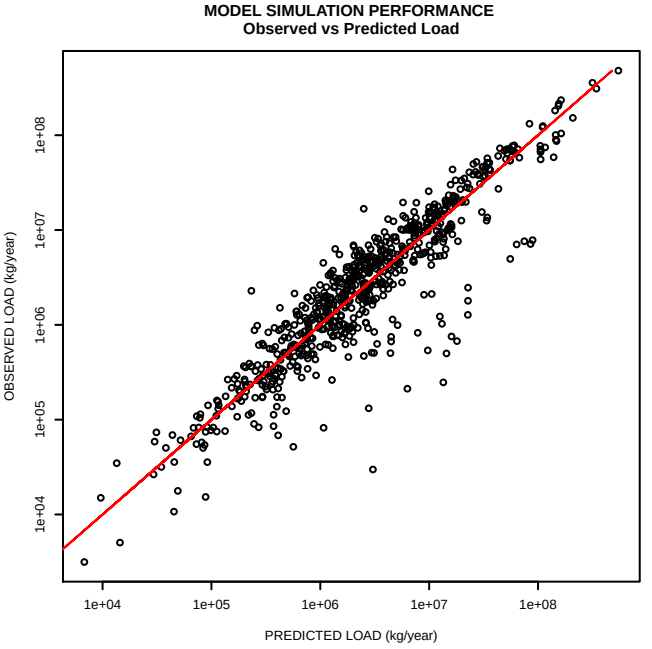

Residuals vs Predicted Yield
LOG RESIDUAL
PREDICTED YIELD (kg/ha/year)
0
−1
−2
−3
−4
1
2
5
10

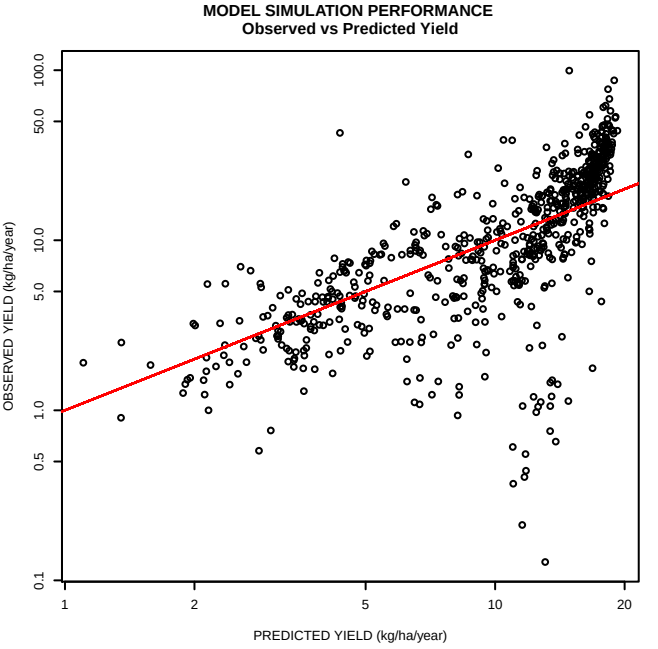
# Model Simulation Performance Diagnostics

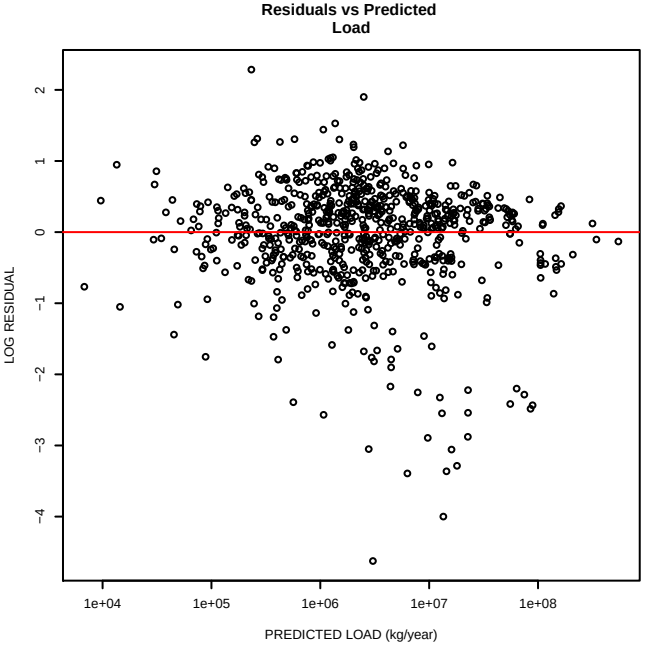
Diagnostics are based on the use of unconditioned predictions (i.e., predictions that are not adjusted for monitoring loads). These predictions (and the associated residuals and observed to predicted ratios shown in the following section) provide the best measure of the predictive skill of the estimated model in simulation mode. The simulated predictions are computed using mean coefficients from the NLLS model estimated with monitoring−adjusted (conditioned) predictions.

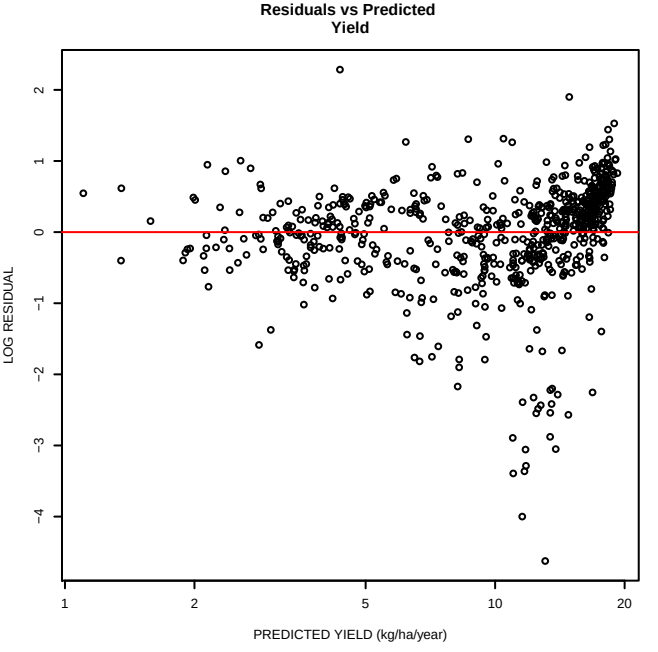
The diagnostic plots include:

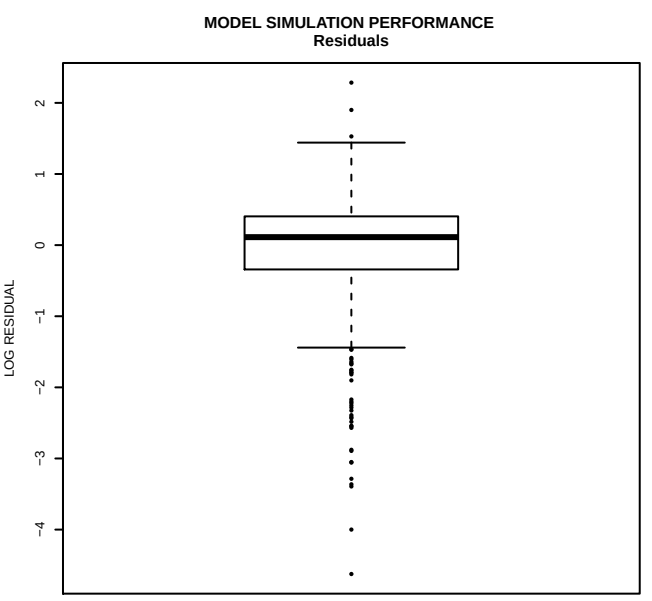
- −Four−plot panel for observed vs. predicted for loads and yields, and log residuals vs. predicted loads and yields
- −Four−plot panel for boxplots of residuals and observed/predicted ratios, normal quantile plot of standardized residuals, and plot of squared residuals vs. predicted loads
- −Plot of conditioned prediction loads vs. unconditioned (simulated) prediction loads
- −Plots of the observed to predicted ratio vs. the area−weighted mean values of the user−selected explanatory variables for the incremental areas between calibration sites (output only if control setting if_corrExplanVars<−'yes' selected and a value of 1 entered for 'parmCorrGroup' column in the 'parameters.csv' file)
- −Boxplots of the observed to predicted loads vs. the decile classes of the total drainage area for the calibration sites
- −Boxplots of the observed to predicted loads vs. the contiguous spatial classes specified by users in the 'classvar' control setting (e.g., HUC−4)
- −Boxplots of the observed to predicted loads vs. the deciles of the land−use class variable specified by users in the 'class_landuse' control setting, with the land−use classes expressed as a percentage of the incremental drainage area extending from the calibration site to the nearest upstream site locations.
- −Four−plot panels reported separately for each of the contiguous spatial classes specified for the first variable entry for the 'classvar[1]' control setting. The panels include: observed vs. predicted loads, observed vs. predicted yields, log residuals vs. predicted loads, and log residuals vs. predicted yields

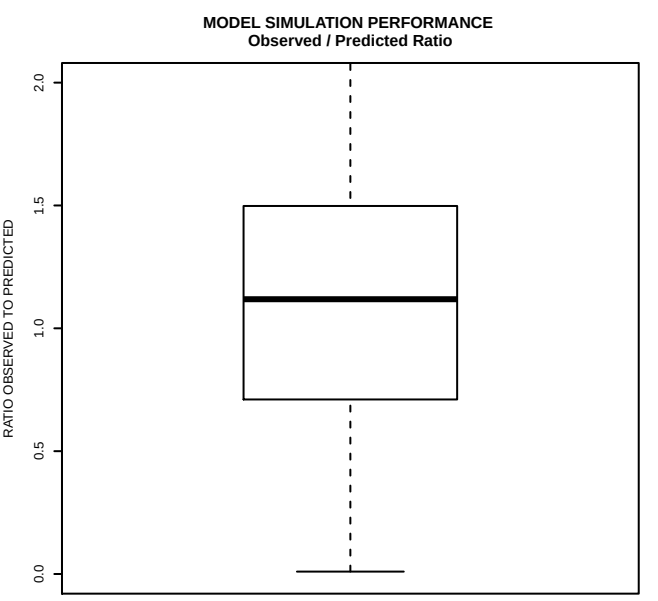

MODEL SIMULATION PERFORMANCE
Observed vs Predicted Load
OBSERVED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08
PREDICTED LOAD (kg/year)

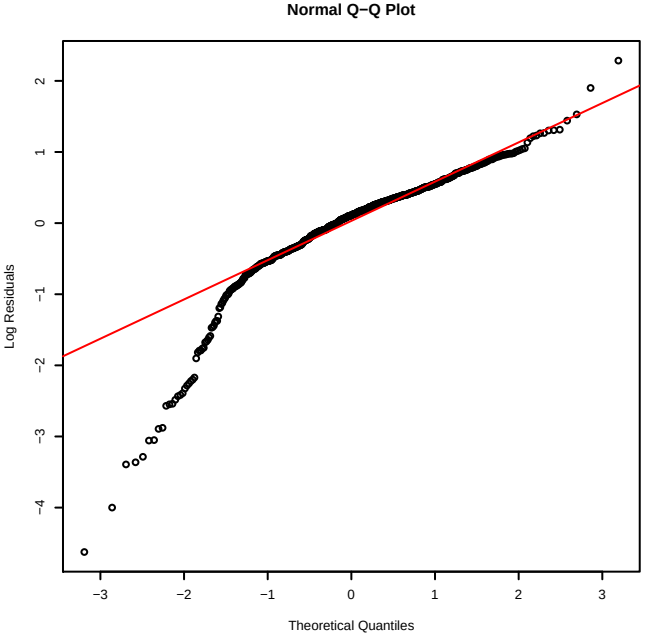

MODEL SIMULATION PERFORMANCE
Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
0.1
0.5
1.0
5.0
10.0
50.0
100.0
1
2
5
10
20
PREDICTED YIELD (kg/ha/year)

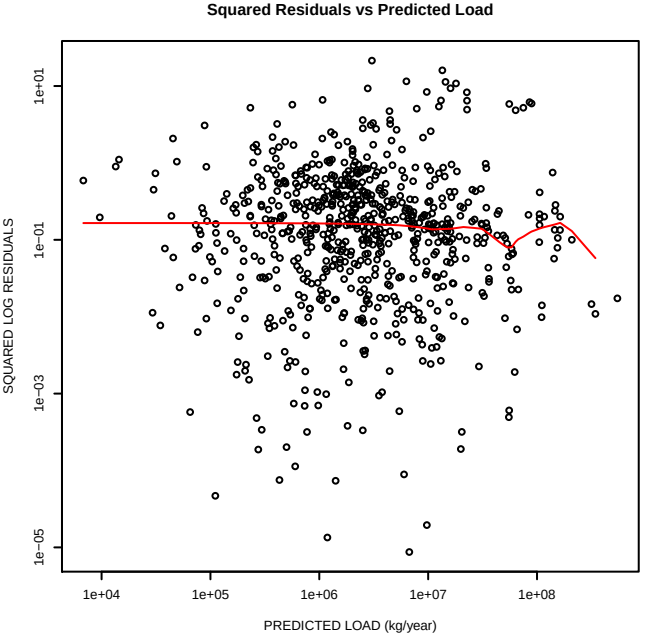

Residuals vs Predicted
Load
LOG RESIDUAL
2
1
0
−1
−2
−3
−4
1e+04
1e+05
1e+06
1e+07
1e+08
PREDICTED LOAD (kg/year)

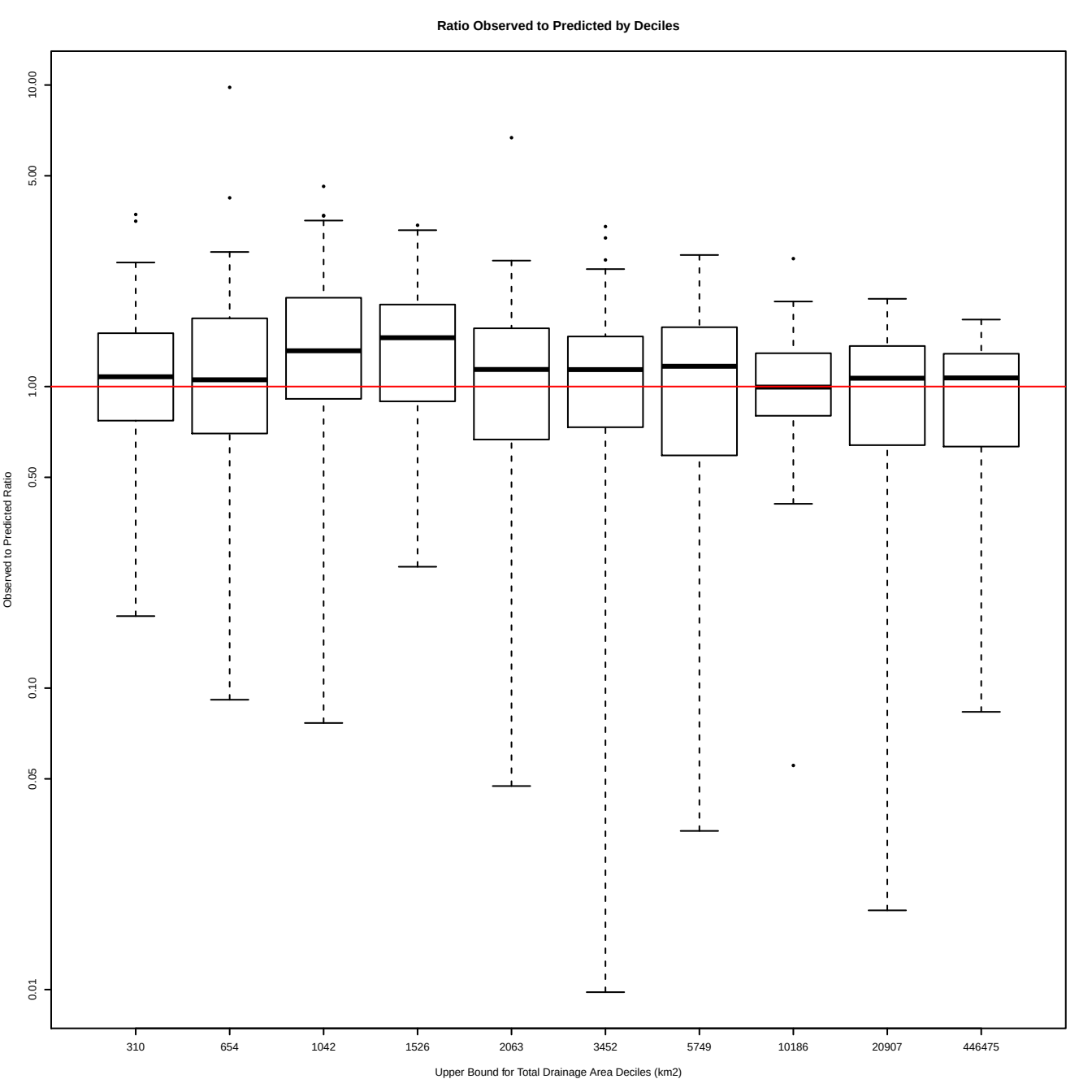

Residuals vs Predicted
Yield
LOG RESIDUAL
2
1
0
−1
−2
−3
−4
1
2
5
10
20
PREDICTED YIELD (kg/ha/year)

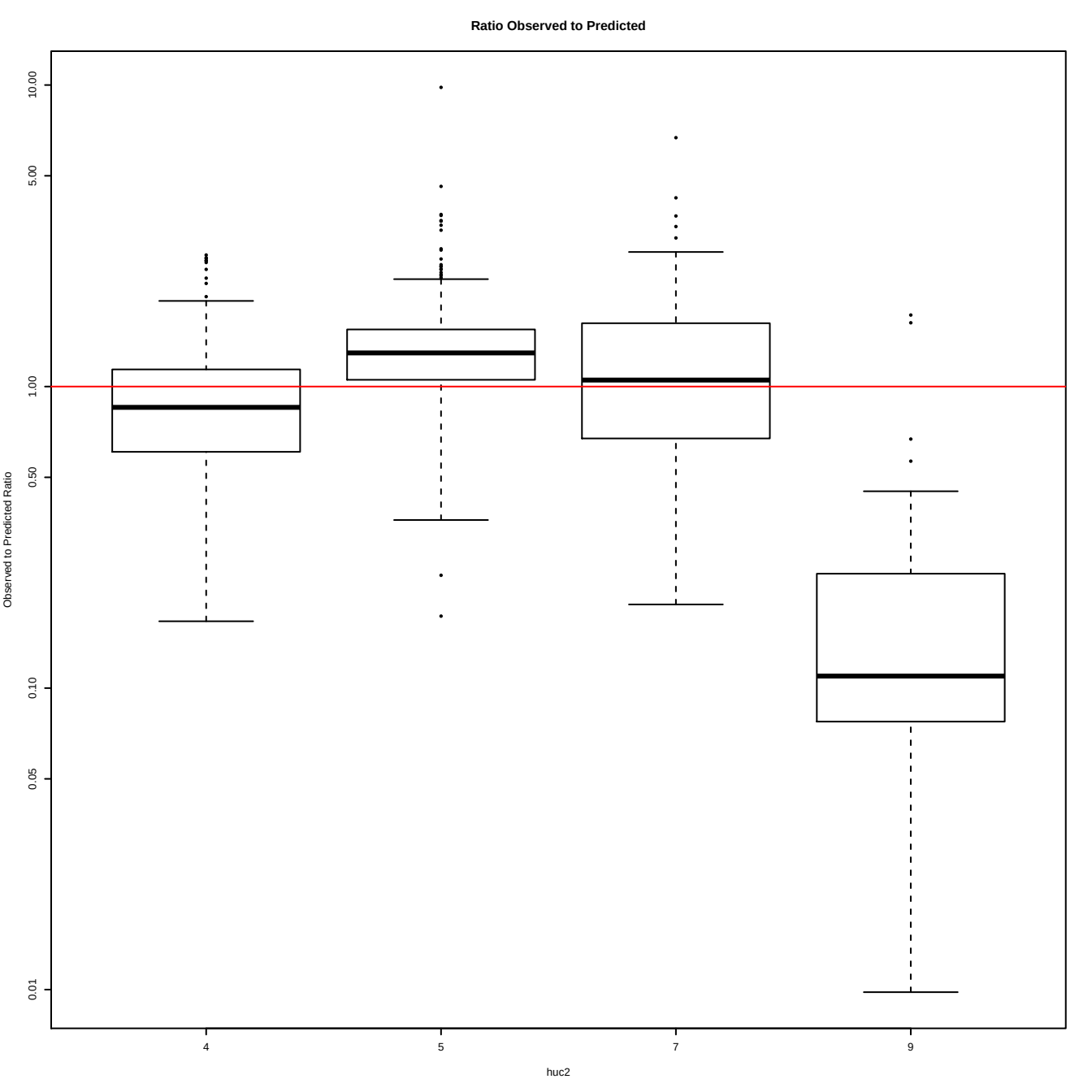

MODEL SIMULATION PERFORMANCE
Residuals
LOG RESIDUAL
2
1
0
−1
−2
−3
−4

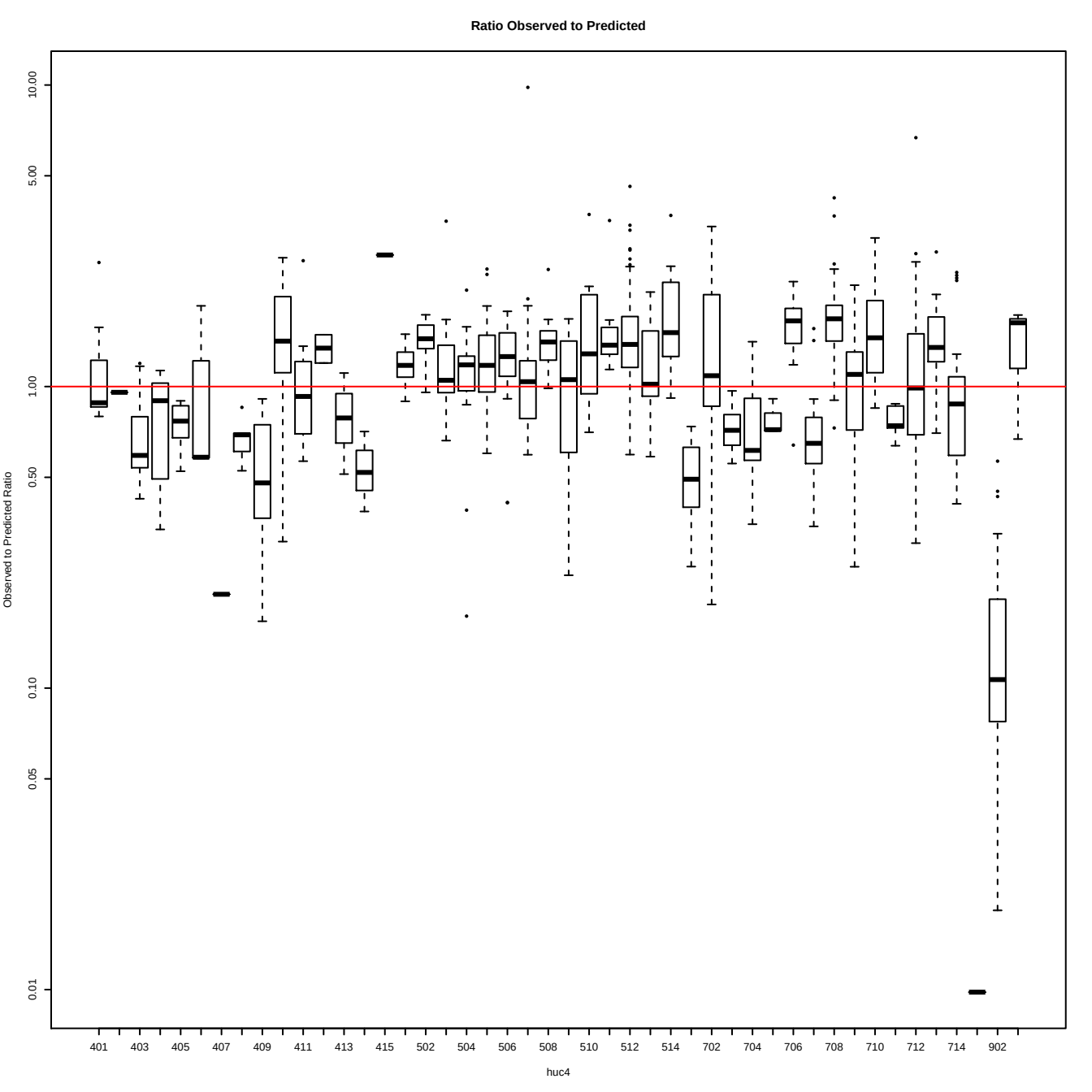

MODEL SIMULATION PERFORMANCE
Observed / Predicted Ratio
RATIO OBSERVED TO PREDICTED
2.0
1.5
1.0
0.5
0.0

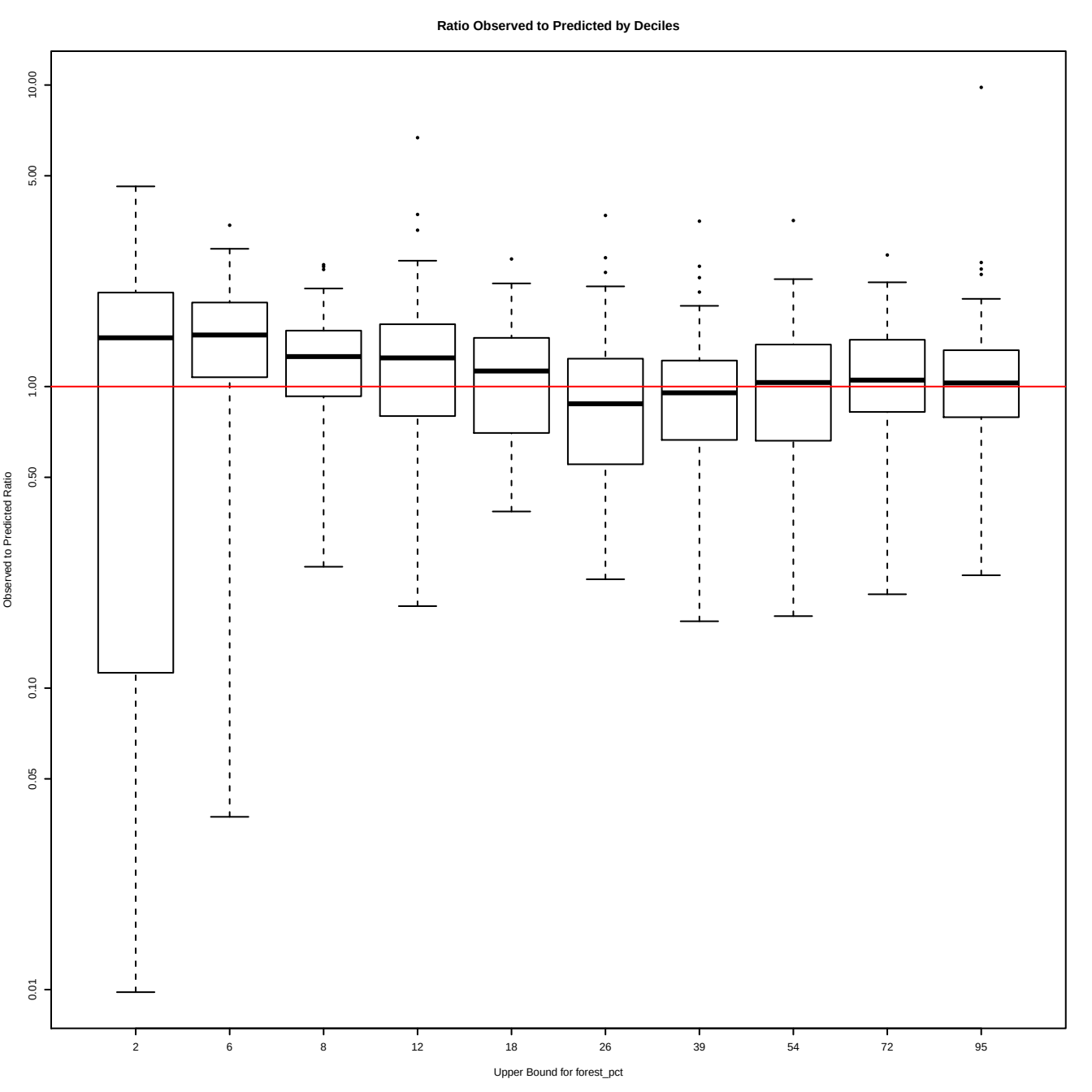

Normal Q−Q Plot
Log Residuals
Theoretical Quantiles
2
1
0
−1
−2
−3
−4
−3
−2
−1
0
1
2
3

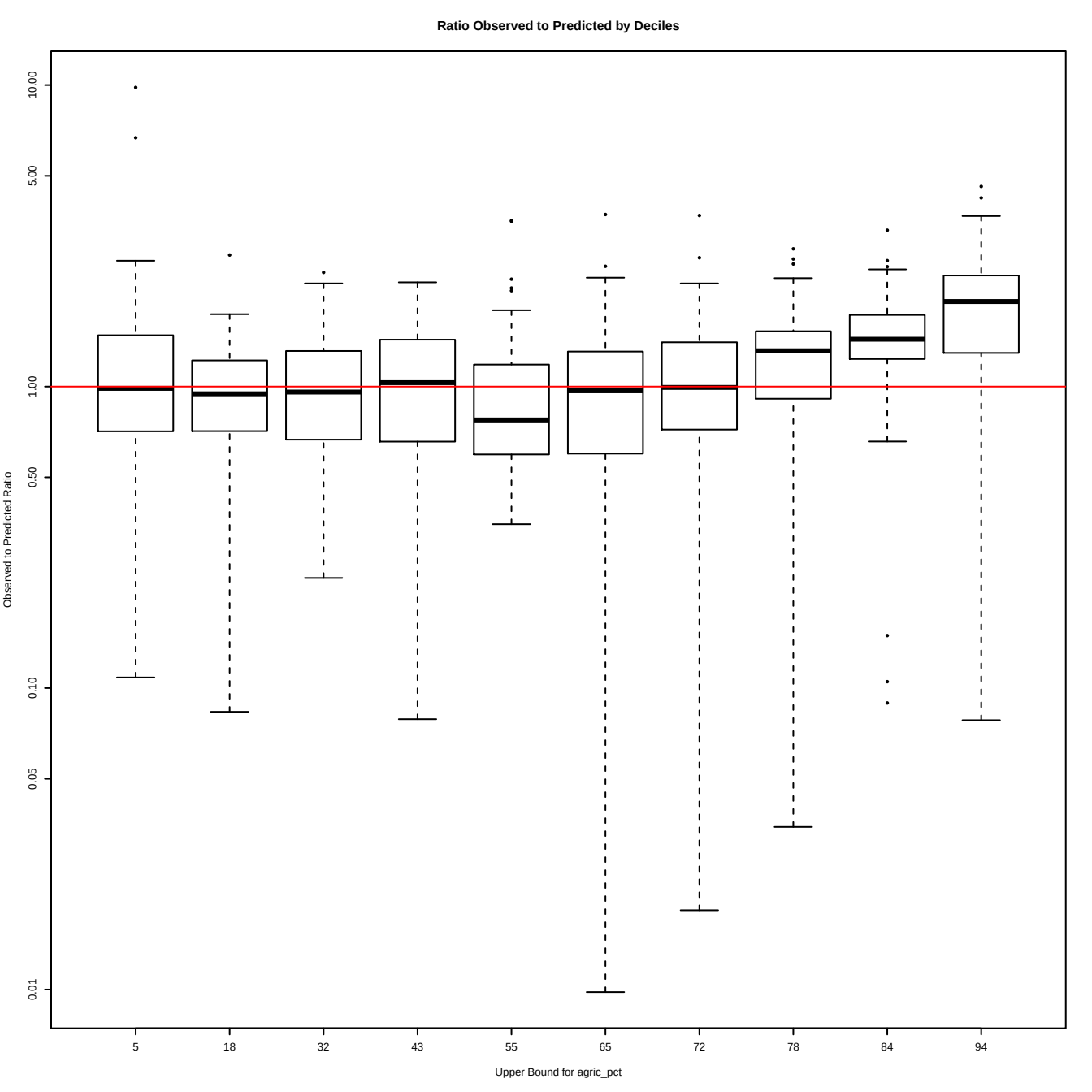

Squared Residuals vs Predicted Load
SQUARED LOG RESIDUALS
PREDICTED LOAD (kg/year)
1e+01
1e−01
1e−03
1e−05
1e+04
1e+05
1e+06
1e+07
1e+08

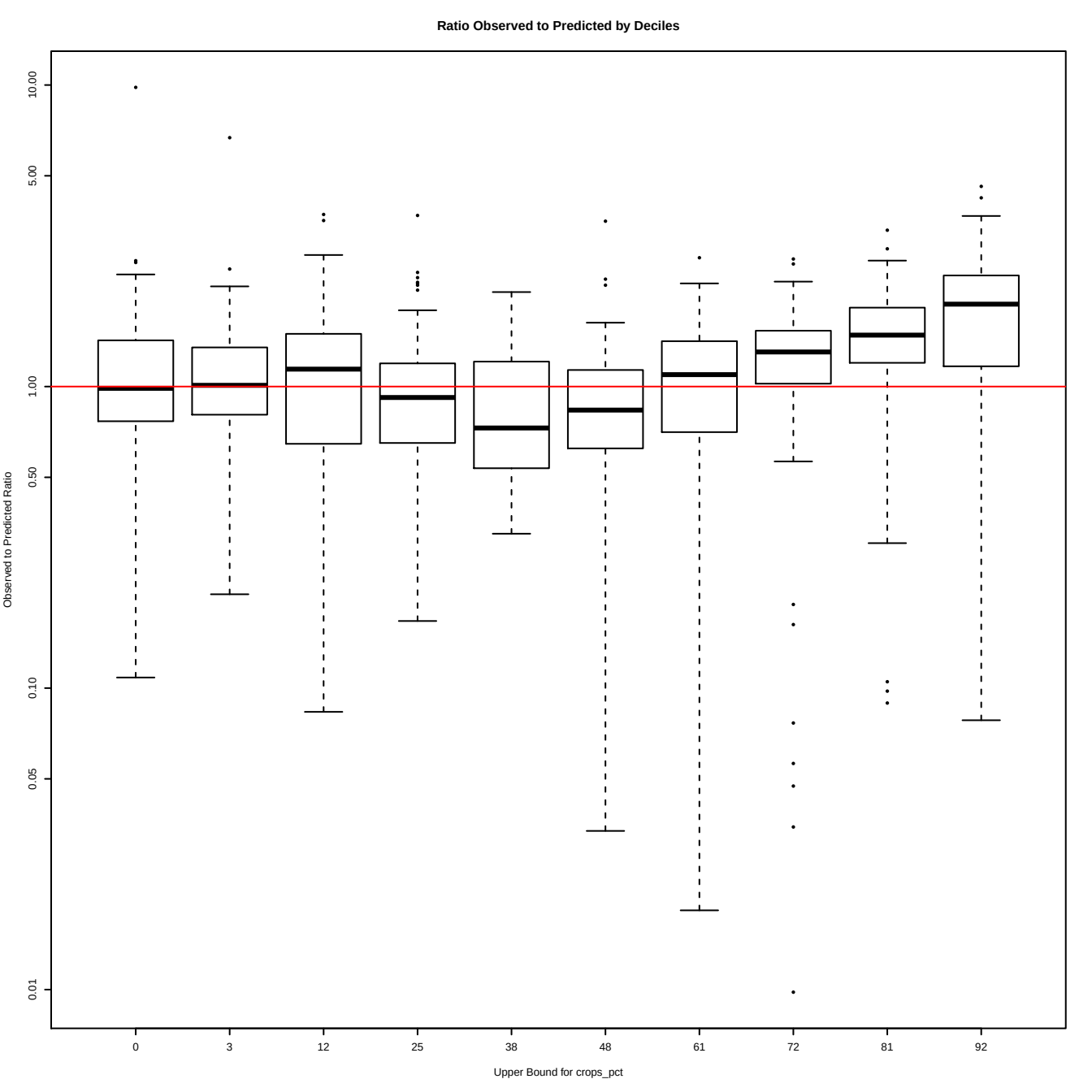

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
310
654
1042
1526
2063
3452
5749
10186
20907
446475
Upper Bound for Total Drainage Area Deciles (km2)

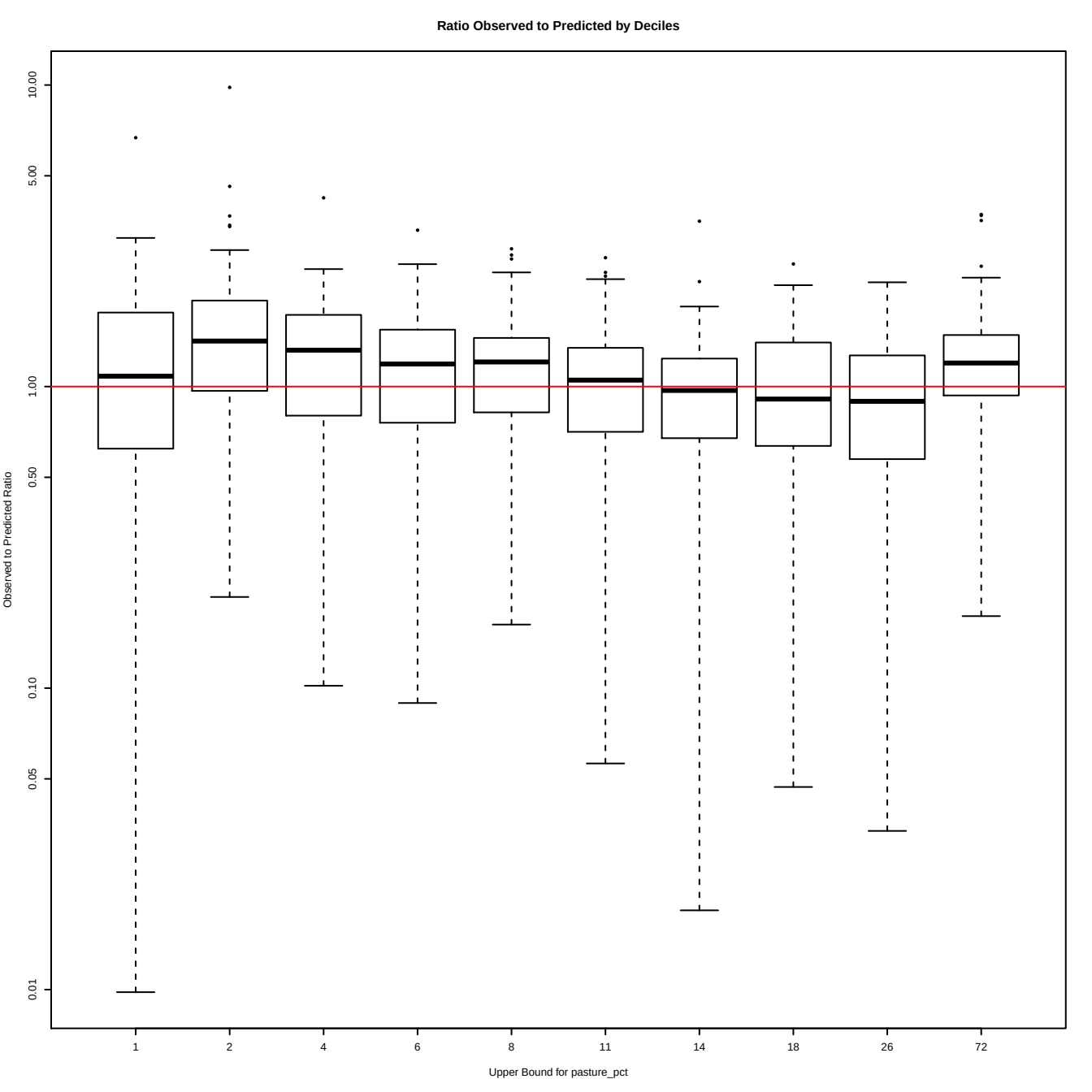

Ratio Observed to Predicted
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
4
5
7
9
huc2

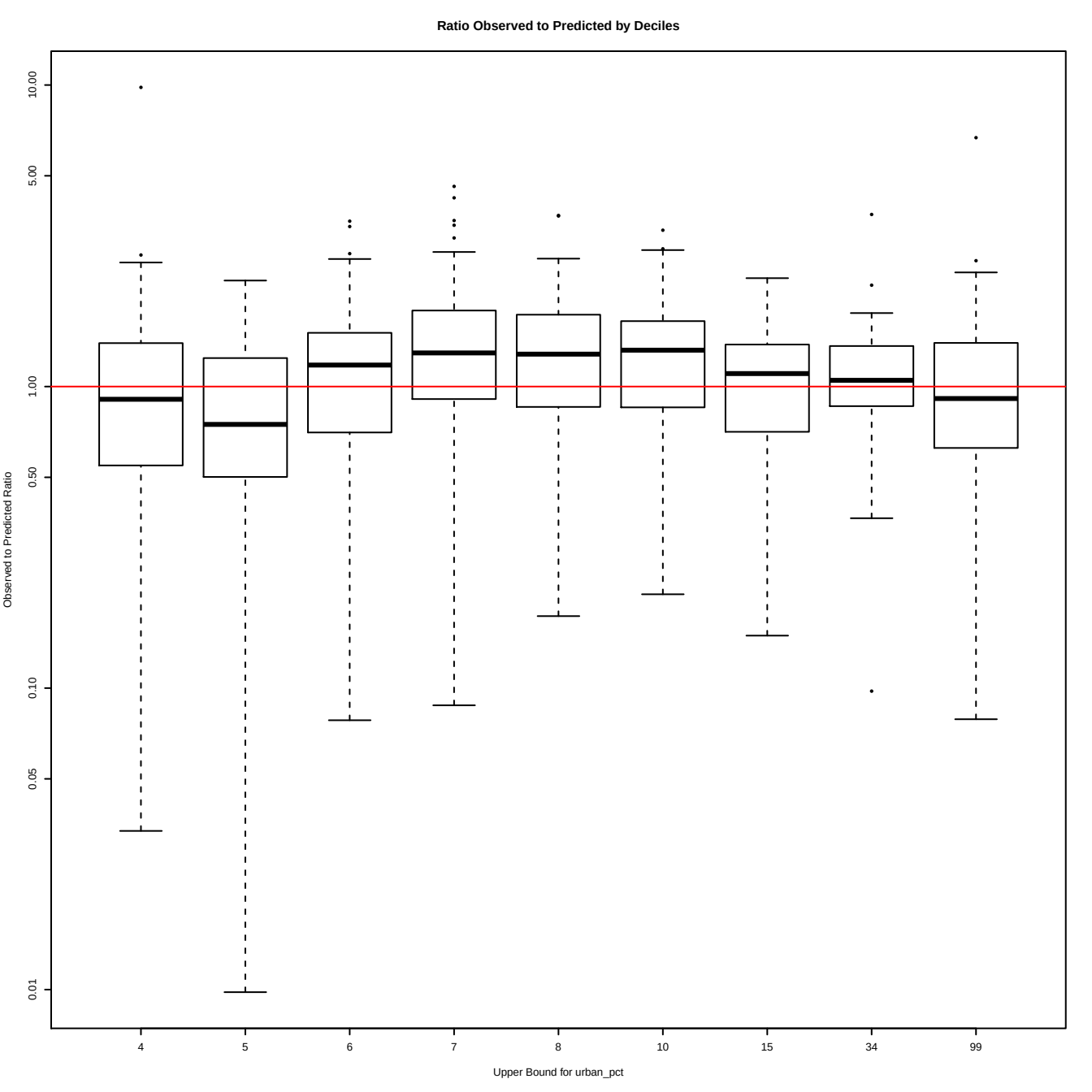

Ratio Observed to Predicted
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
401
403
405
407
409
411
413
415
502
504
506
508
510
512
514
702
704
706
708
710
712
714
902
huc4

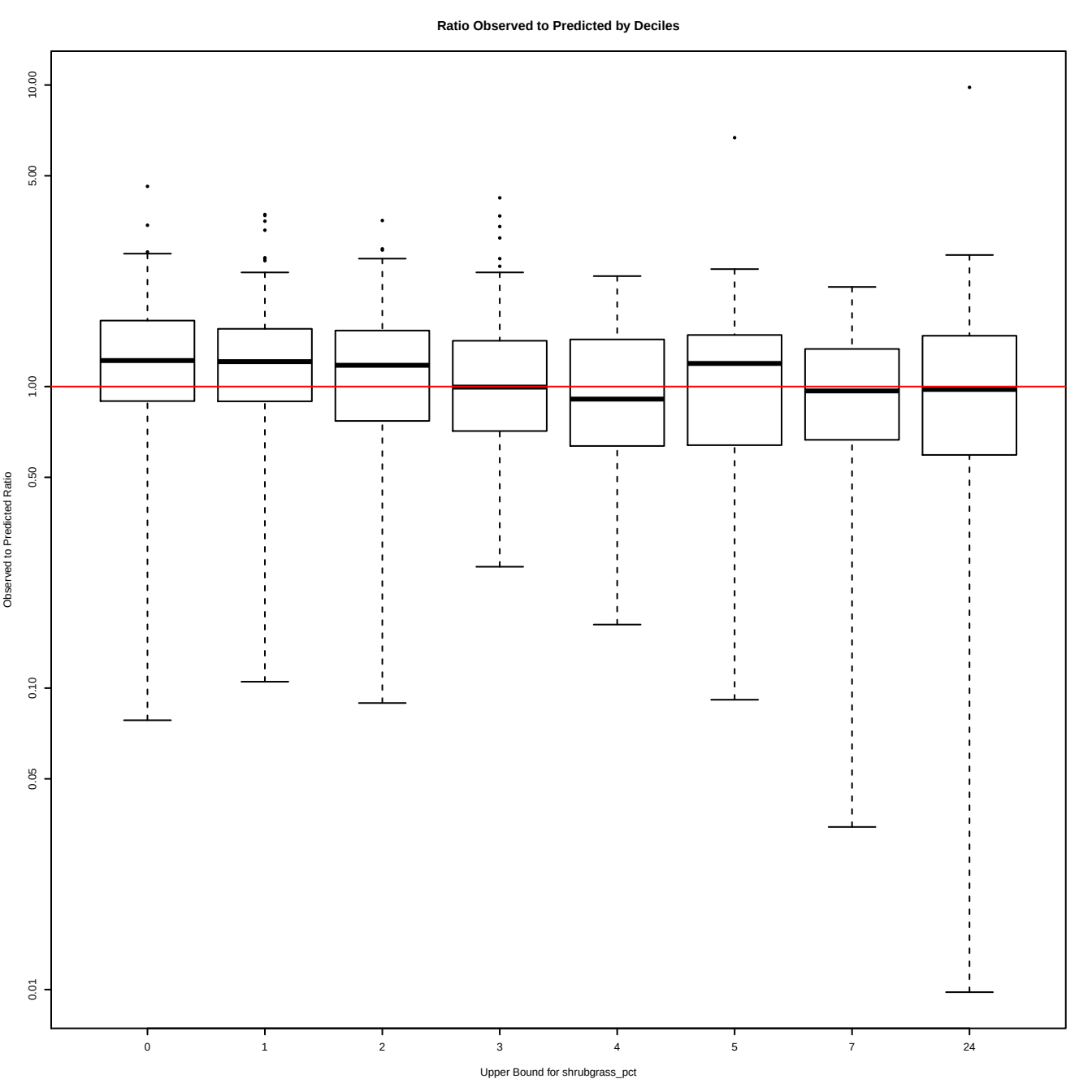

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
2
6
8
12
18
26
39
54
72
95
Upper Bound for forest_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
5
18
32
43
55
65
72
78
84
94
Upper Bound for agric_pct

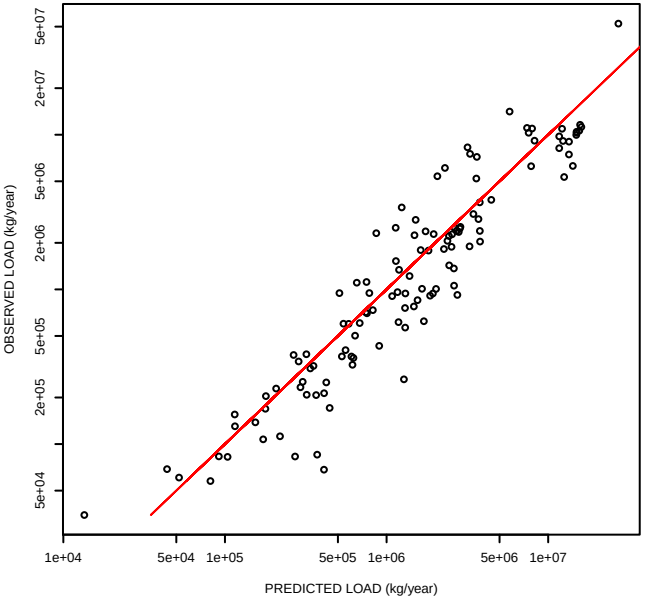

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
0
3
12
25
38
48
61
72
81
92
Upper Bound for crops_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
1
2
4
6
8
11
14
18
26
72
Upper Bound for pasture_pct

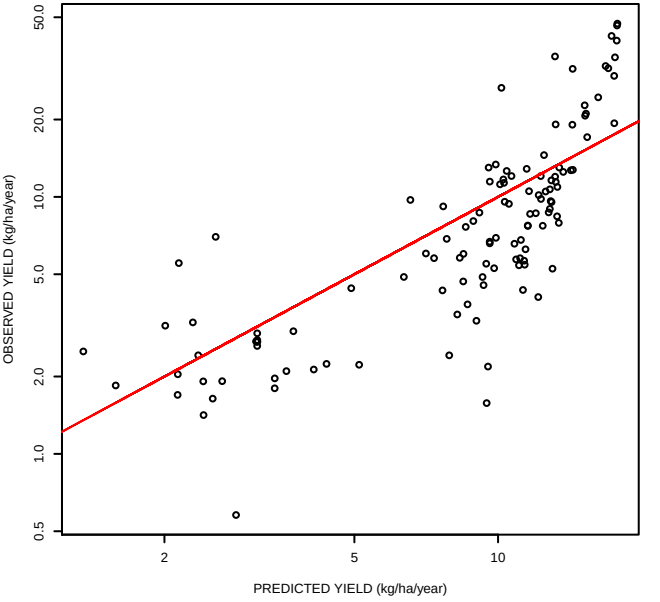

Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
4
5
6
7
8
10
15
34
99
Upper Bound for urban_pct


Ratio Observed to Predicted by Deciles
Observed to Predicted Ratio
10.00
5.00
1.00
0.50
0.10
0.05
0.01
0
1
2
3
4
5
7
24
Upper Bound for shrubgrass_pct

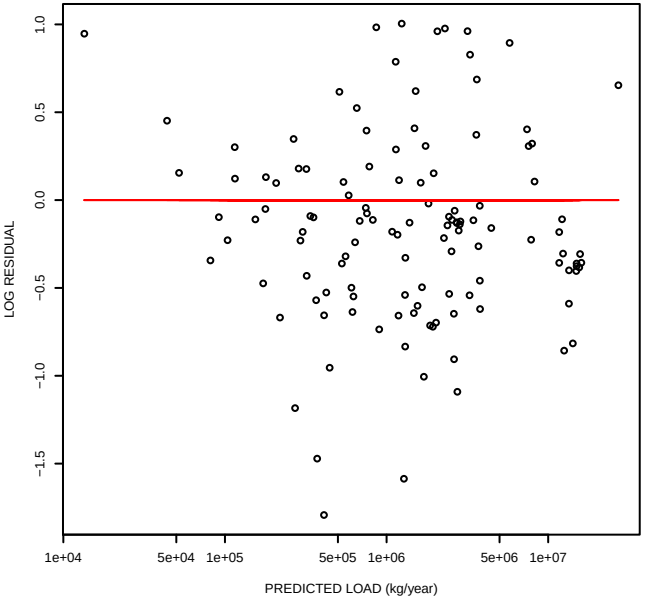
Observed vs Predicted Load
CLASS Region = 4(n=121)



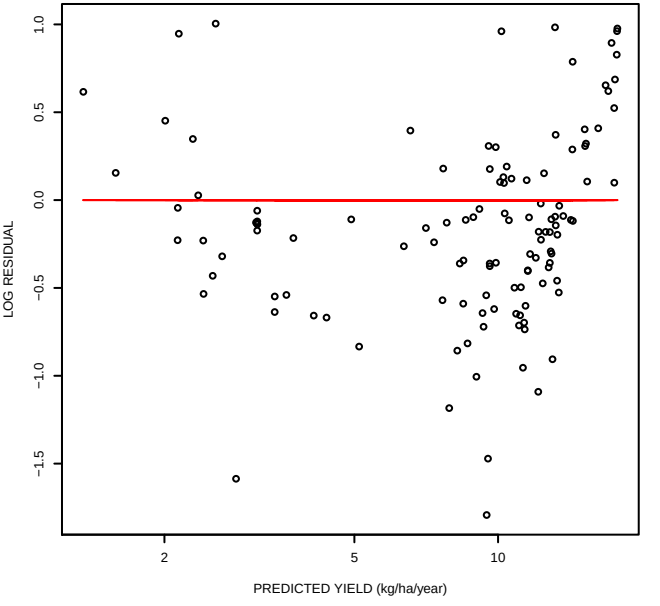

**Observed vs Predicted Yield**

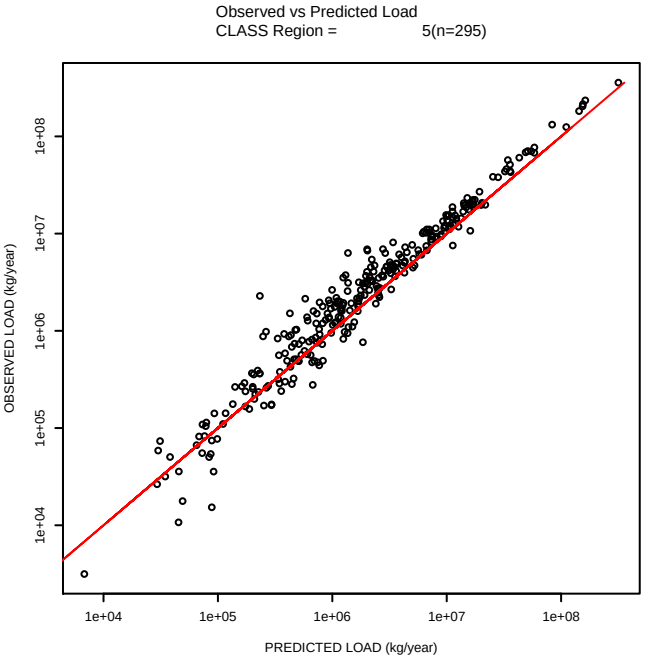


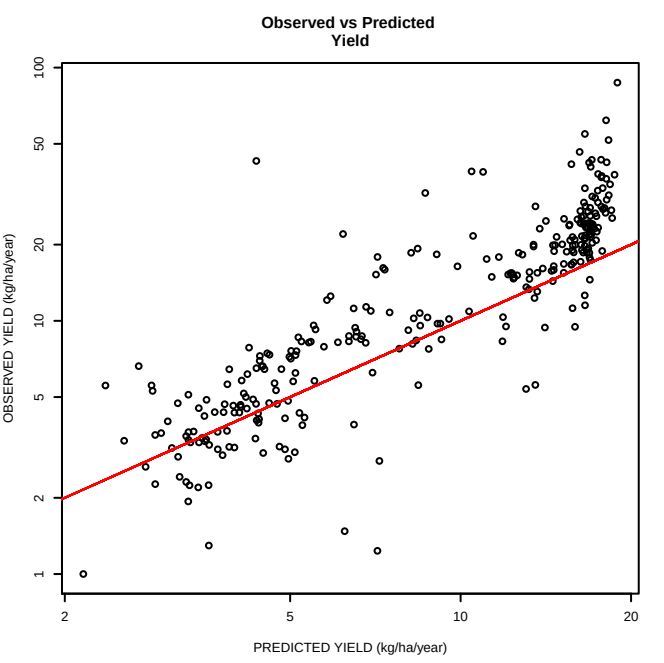

**Residuals vs Predicted Load**

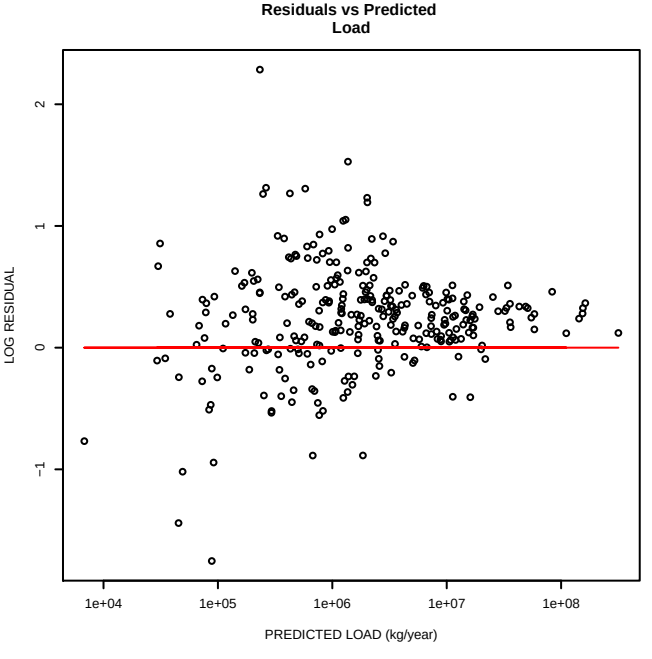


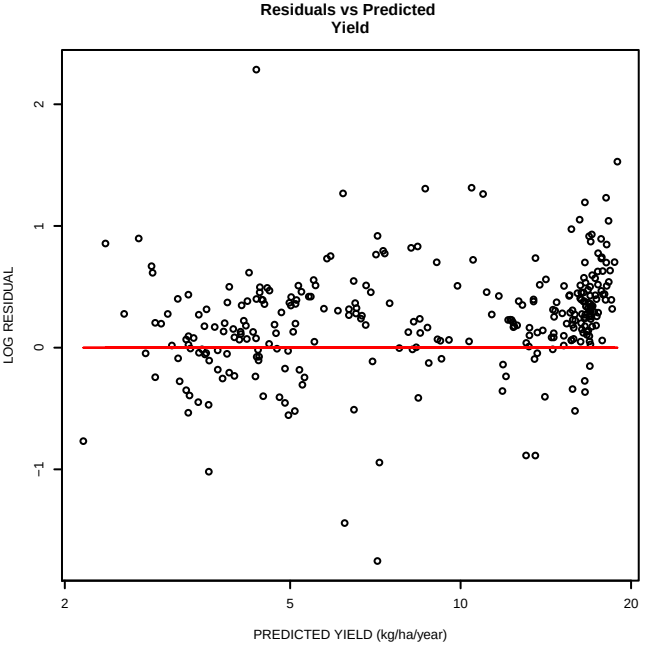

**Residuals vs Predicted Yield**

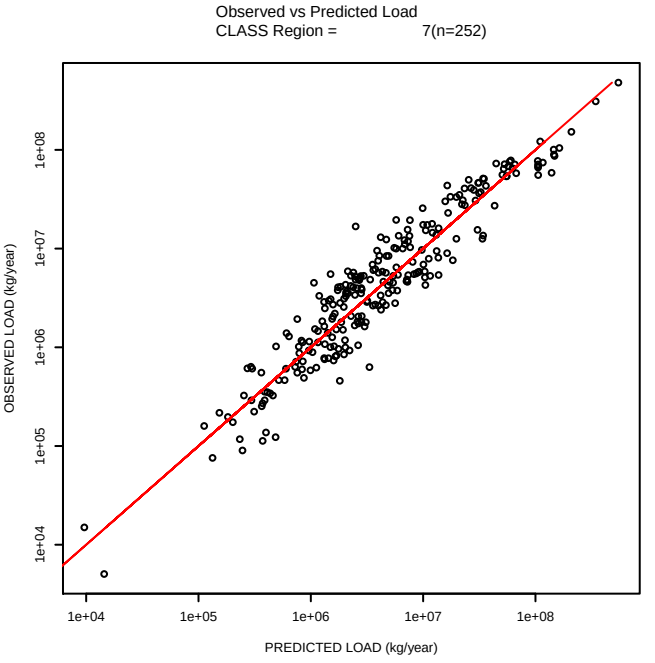


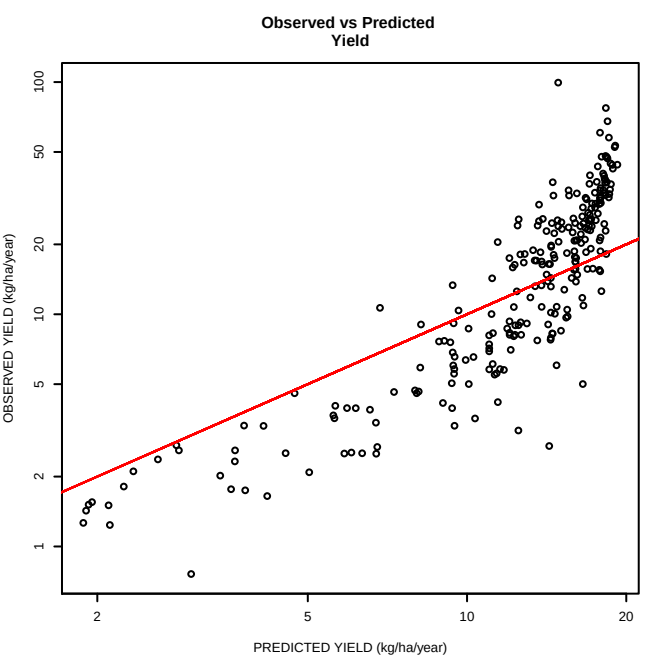

Observed vs Predicted Load
CLASS Region = 5(n=295)
OBSERVED LOAD (kg/year)
PREDICTED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08

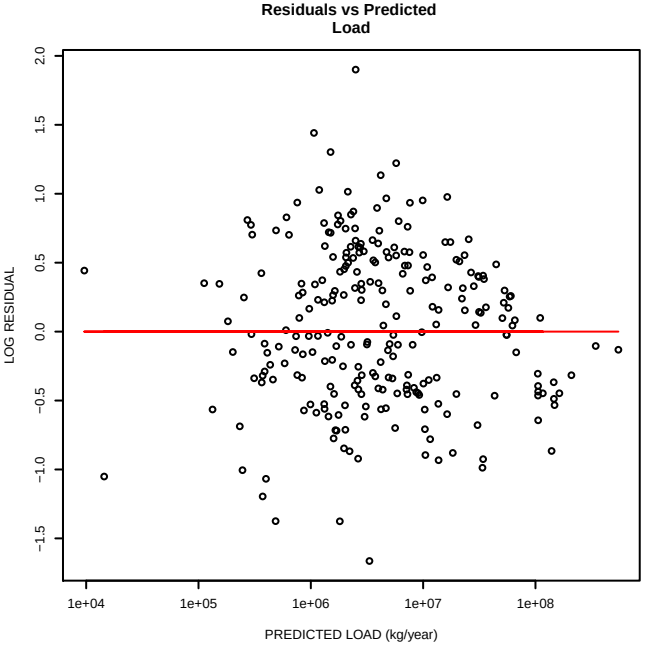

Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
PREDICTED YIELD (kg/ha/year)
1
2
5
10
20
50
100

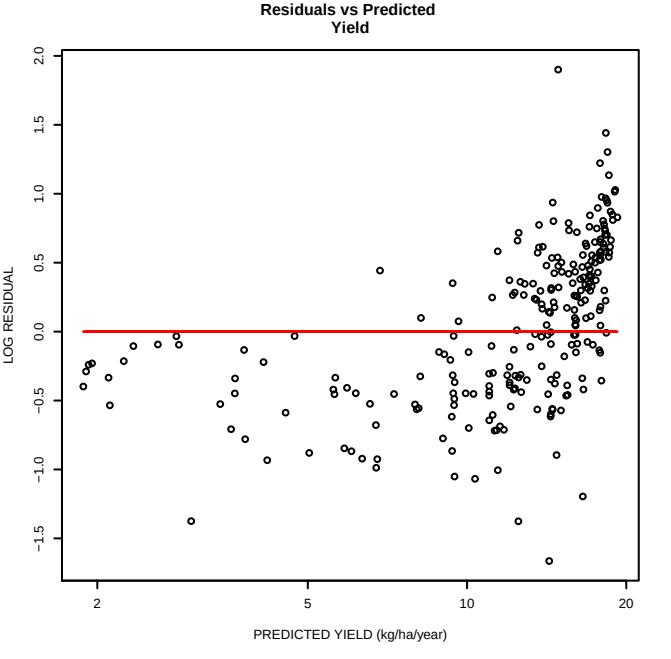

Residuals vs Predicted Load
LOG RESIDUAL
PREDICTED LOAD (kg/year)
−1
0
1
2
1e+04
1e+05
1e+06
1e+07
1e+08

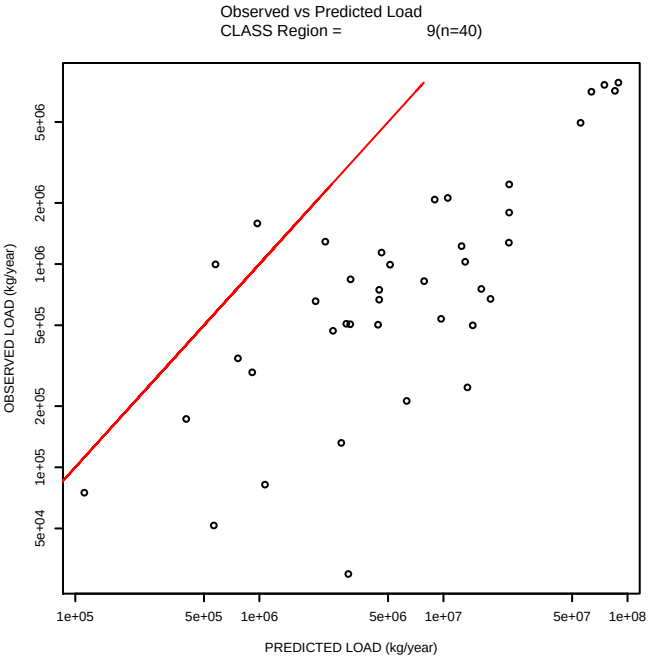

Residuals vs Predicted Yield
LOG RESIDUAL
PREDICTED YIELD (kg/ha/year)
−1
0
1
2
2
5
10
20

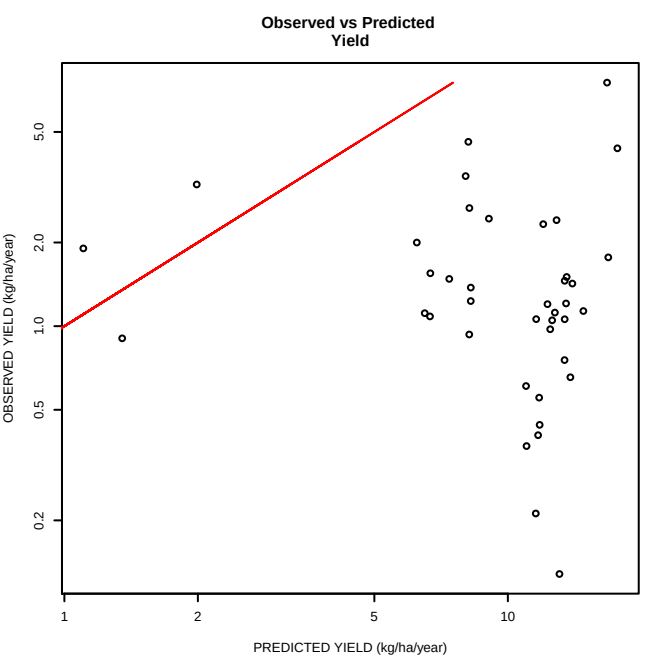

Observed vs Predicted Load
CLASS Region = 7(n=252)
OBSERVED LOAD (kg/year)
PREDICTED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08

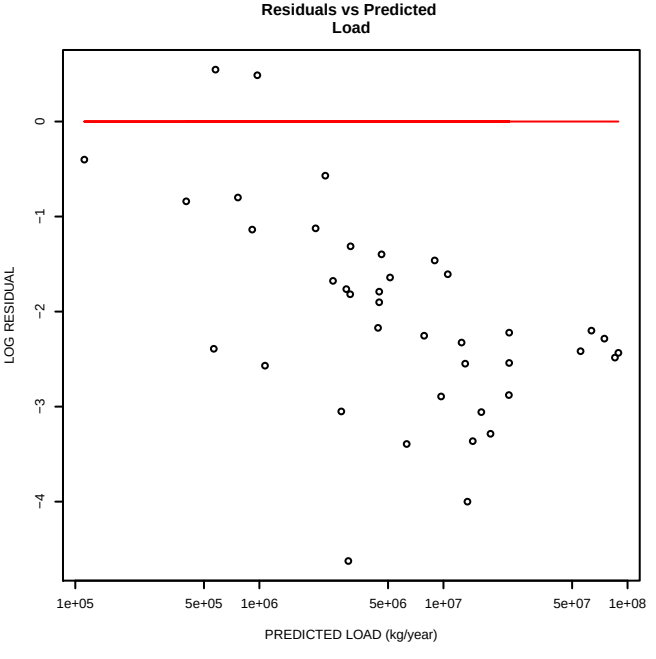

Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
PREDICTED YIELD (kg/ha/year)
1
2
5
10
20
50
100

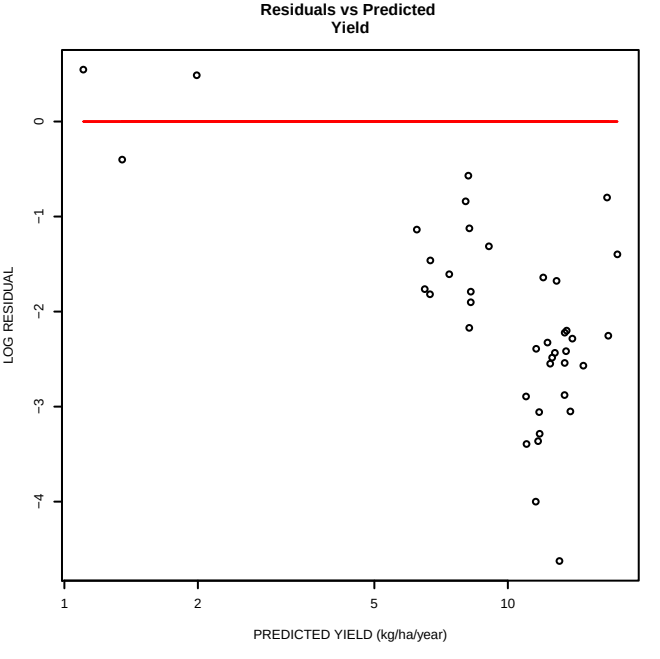

Residuals vs Predicted Load
LOG RESIDUAL
PREDICTED LOAD (kg/year)
1e+04
1e+05
1e+06
1e+07
1e+08
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Residuals vs Predicted Yield
LOG RESIDUAL
PREDICTED YIELD (kg/ha/year)
2
5
10
20
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Observed vs Predicted Load
CLASS Region = 9(n=40)
OBSERVED LOAD (kg/year)
5e+04
1e+05
2e+05
5e+05
1e+06
2e+06
5e+06
1e+05
5e+05
1e+06
5e+06
1e+07
5e+07
1e+08
PREDICTED LOAD (kg/year)


Observed vs Predicted Yield
OBSERVED YIELD (kg/ha/year)
0.2
0.5
1.0
2.0
5.0
1
2
5
10
PREDICTED YIELD (kg/ha/year)

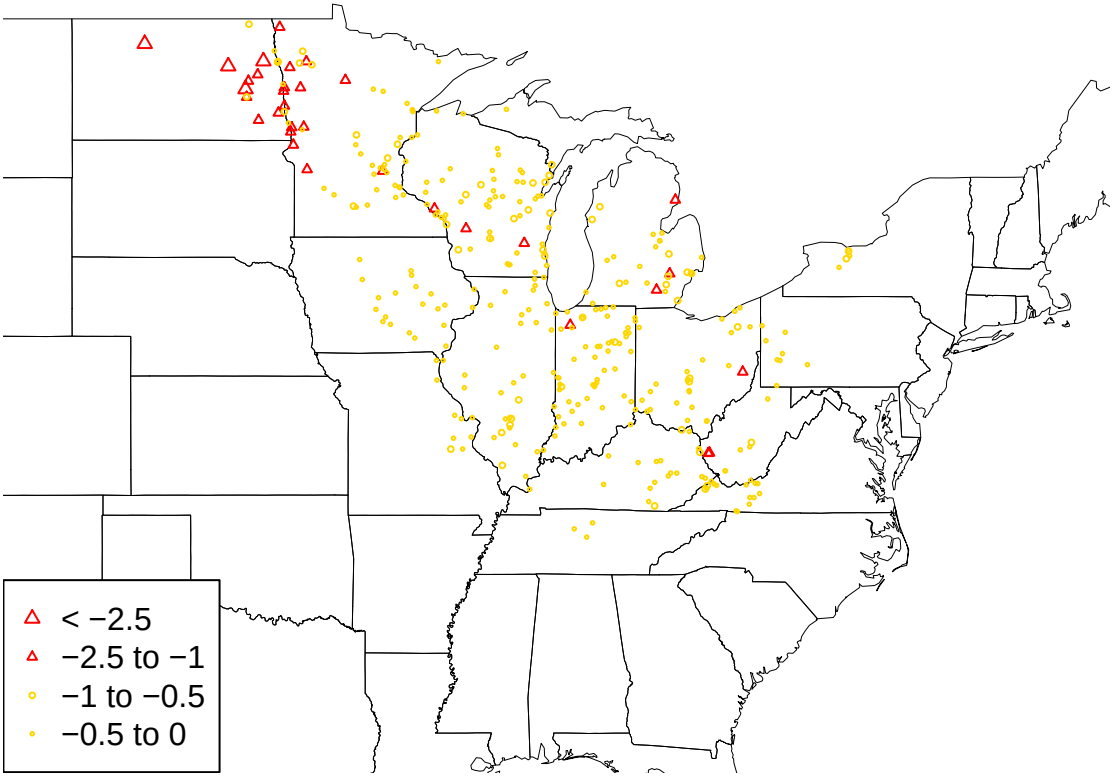

Residuals vs Predicted Load
LOG RESIDUAL
0
−1
−2
−3
−4
1e+05
5e+05
1e+06
5e+06
1e+07
5e+07
1e+08
PREDICTED LOAD (kg/year)


Residuals vs Predicted Yield
LOG RESIDUAL
0
−1
−2
−3
−4
1
2
5
10
PREDICTED YIELD (kg/ha/year)

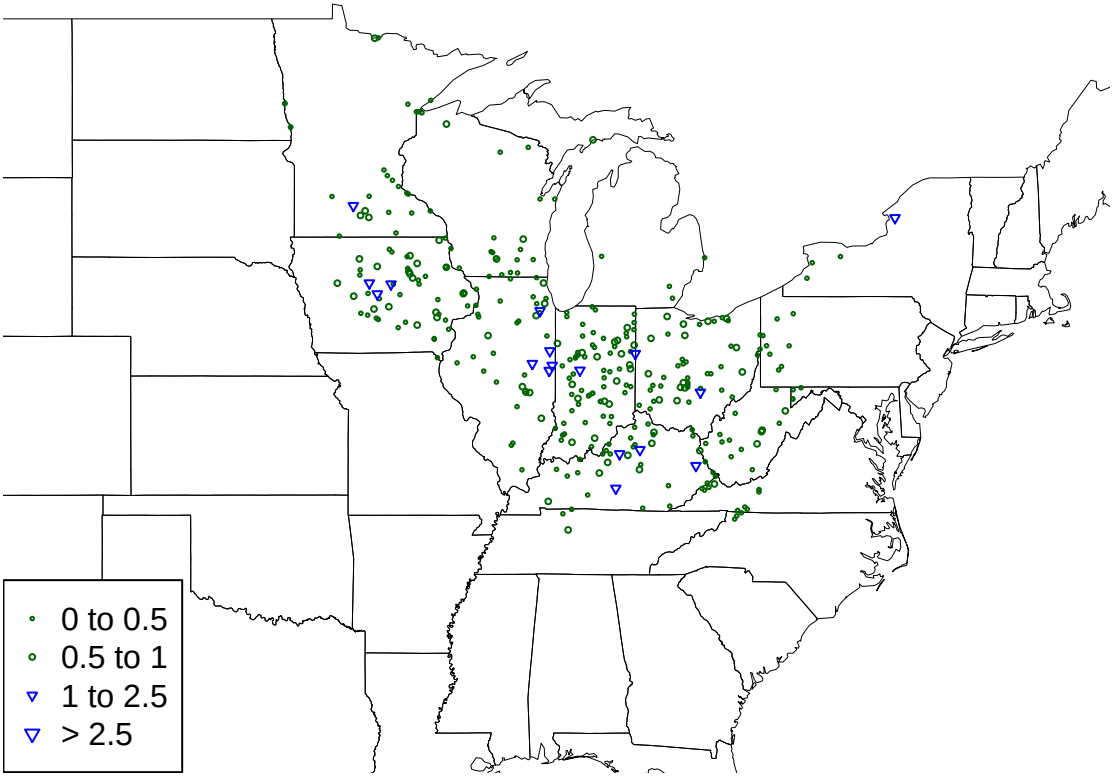
# Maps of Model Residuals and Observed to Predicted Ratios for the Calibration Sites

The maps include:
−Log residuals, based on monitoring conditioned predictions (i.e., model estimation residuals)
−Log residuals, based on the unconditioned predictions (i.e., model simulation residuals)
−Standardized residuals based on the monitoring conditioned predictions
−Ratio of observed to predicted loads for the conditioned predictions (i.e., model estimation ratio)
−Ratio of observed to predicted load for the unconditioned predictions (i.e., model simulation ratio)

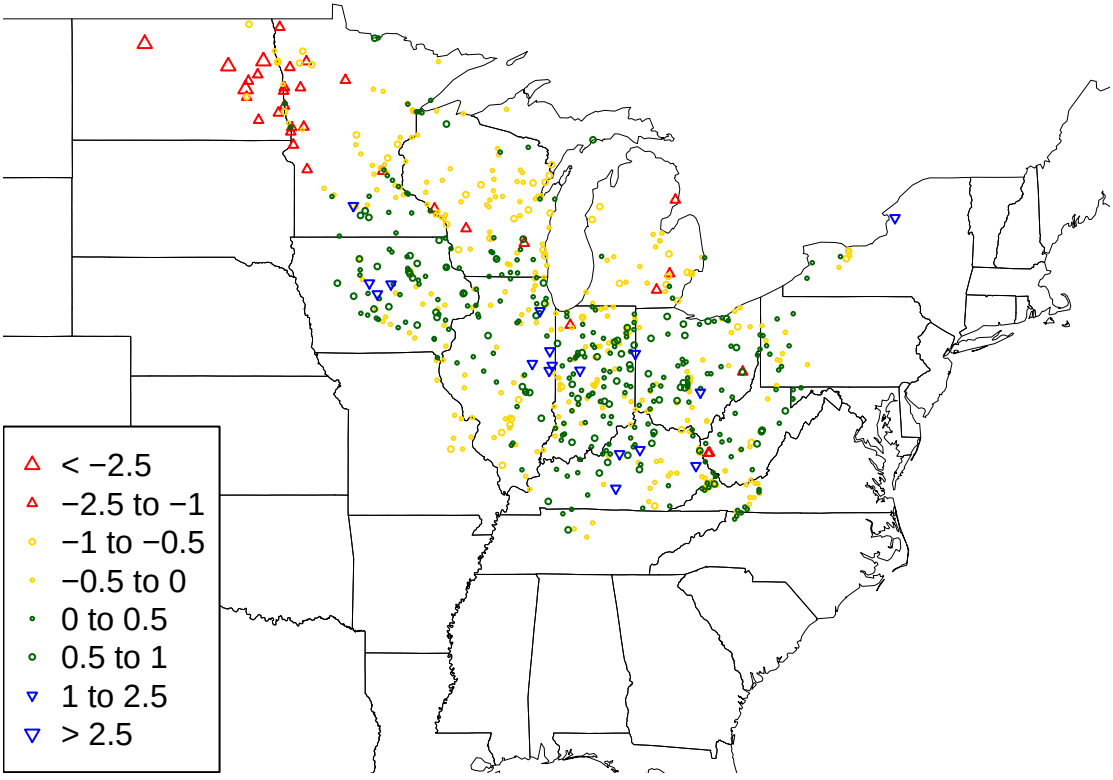
Model Estimation Log Residuals − Over Predictions − n=364



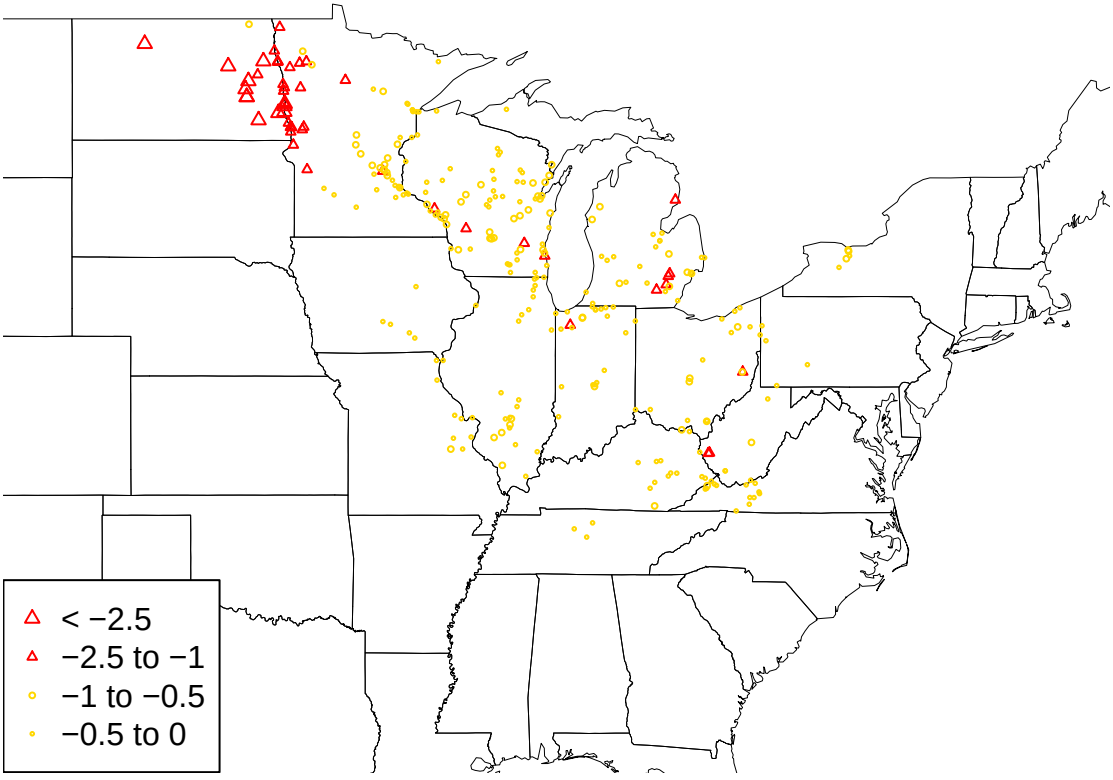
Model Estimation Log Residuals − Under Predictions − n=344



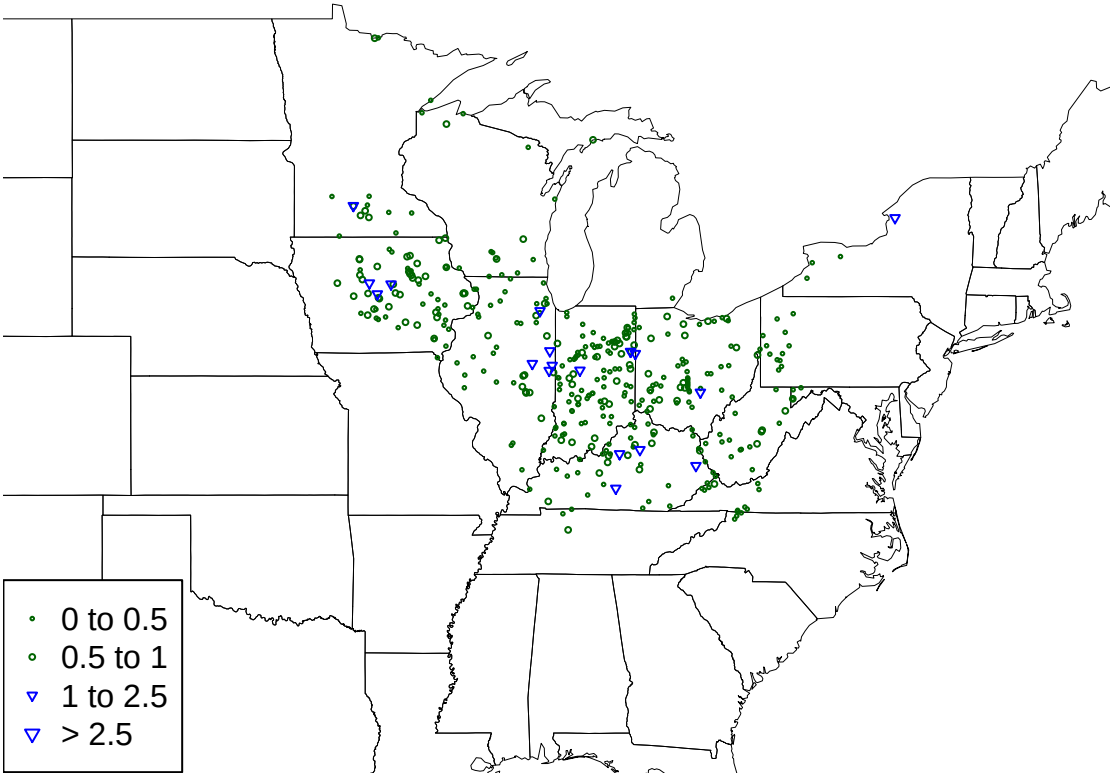
# Model Estimation Log Residuals



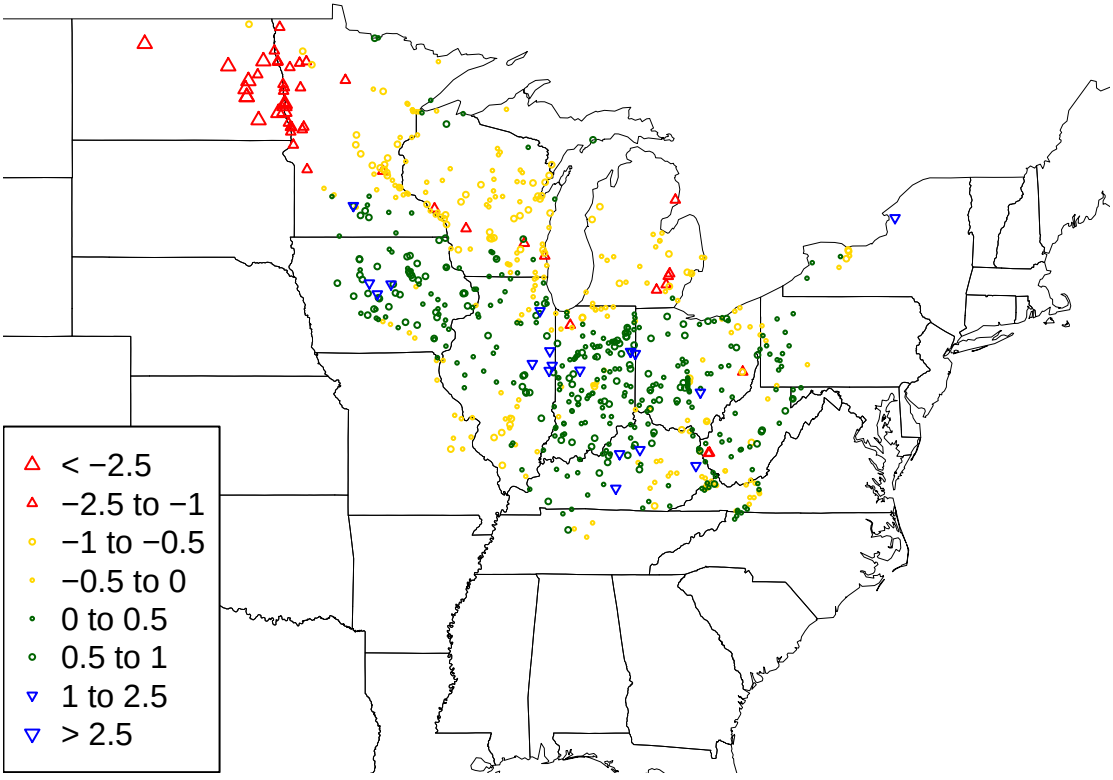
Model Simulation Log Residuals − Over Predictions − n=306



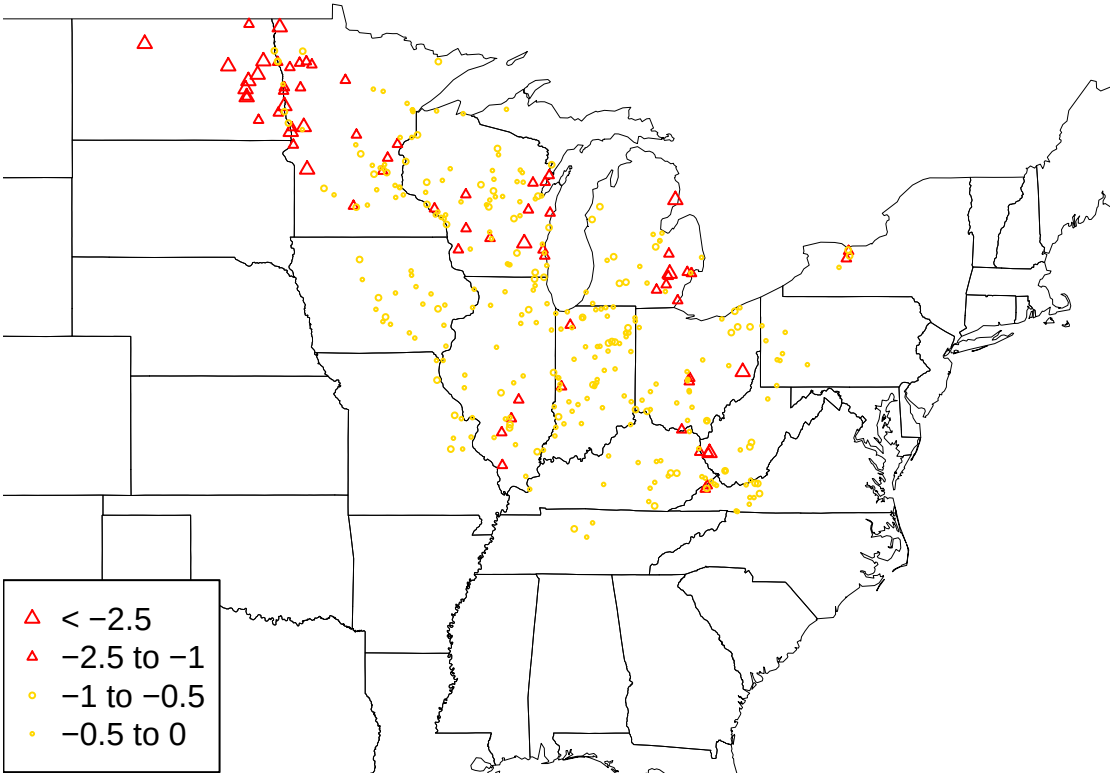
Model Simulation Log Residuals − Under Predictions − n=402



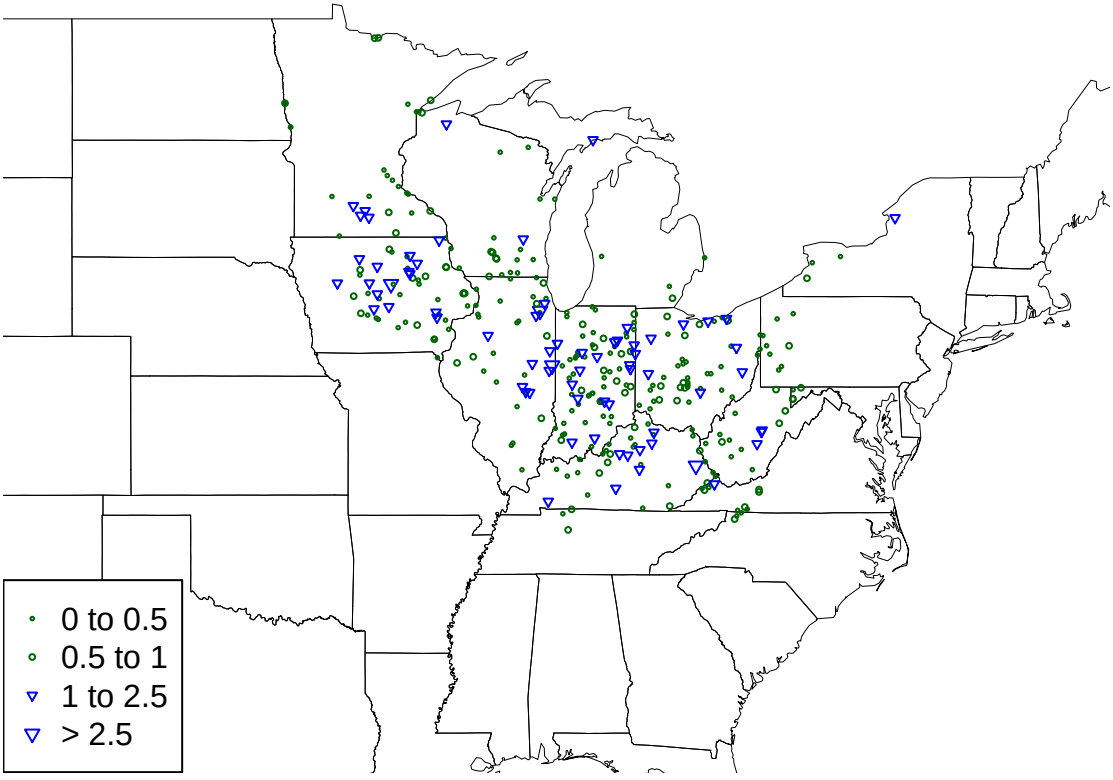
# Model Simulation Log Residuals



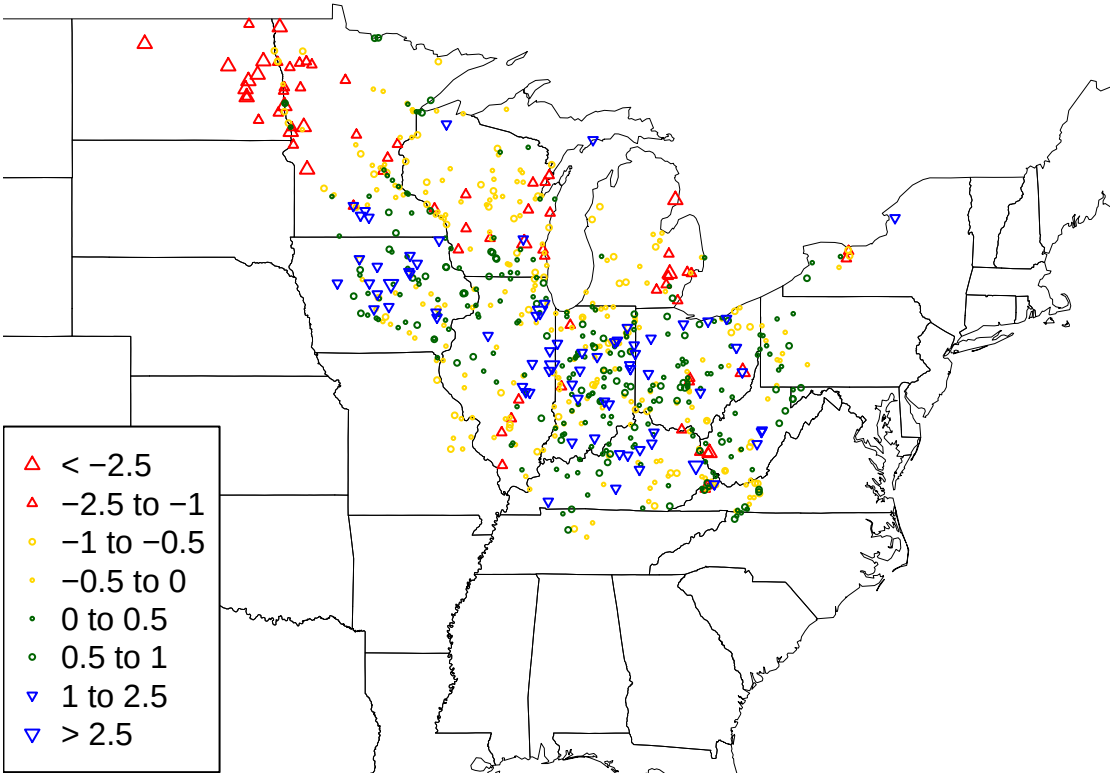
Model Estimation Standardized Residuals − Over Predictions − n=364



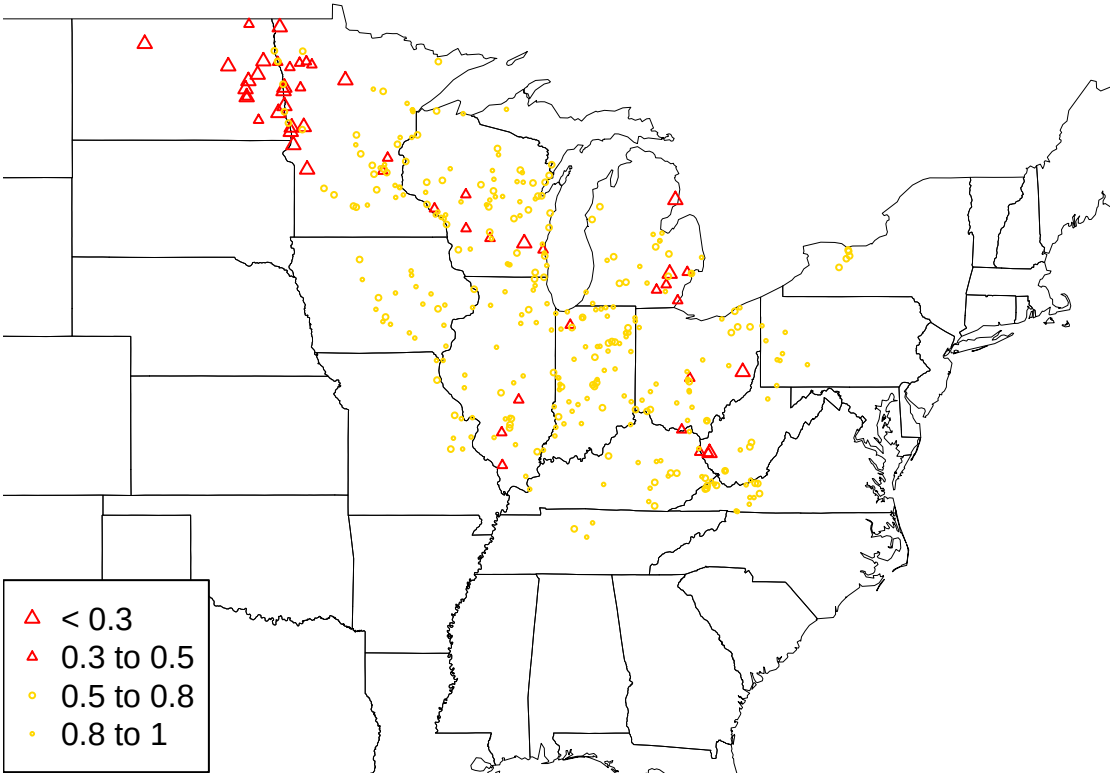
Model Estimation Standardized Residuals − Under Predictions − n=344



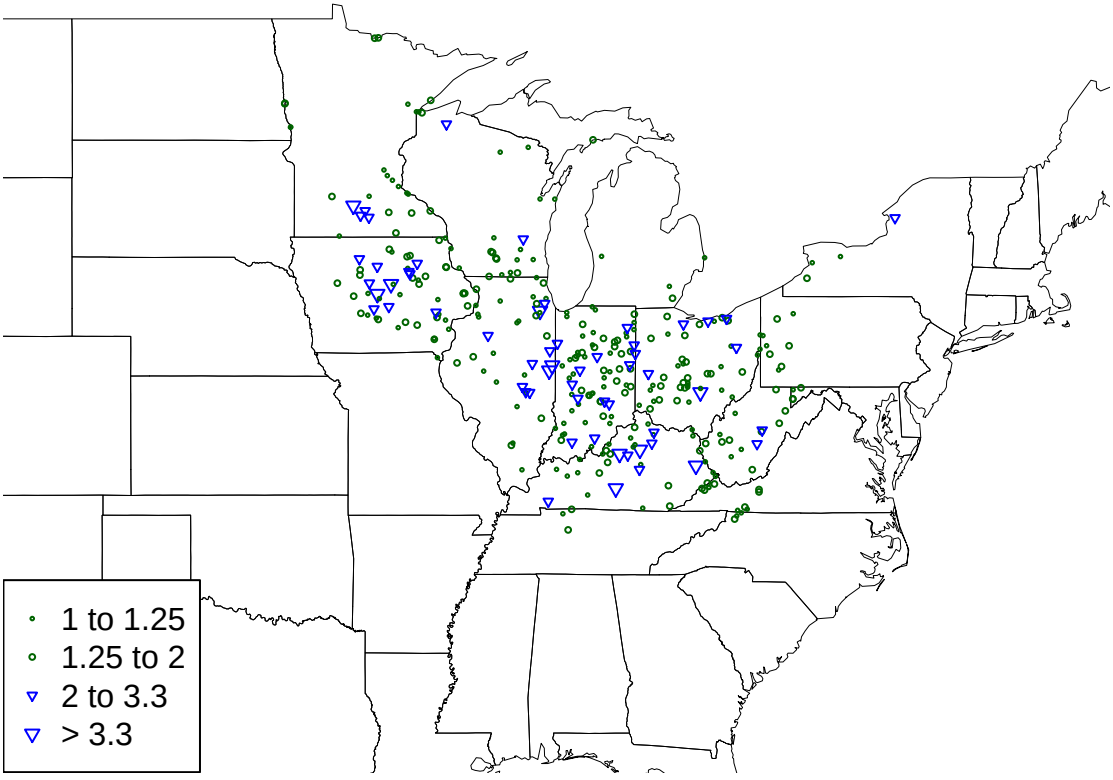
# Model Estimation Standardized Residuals



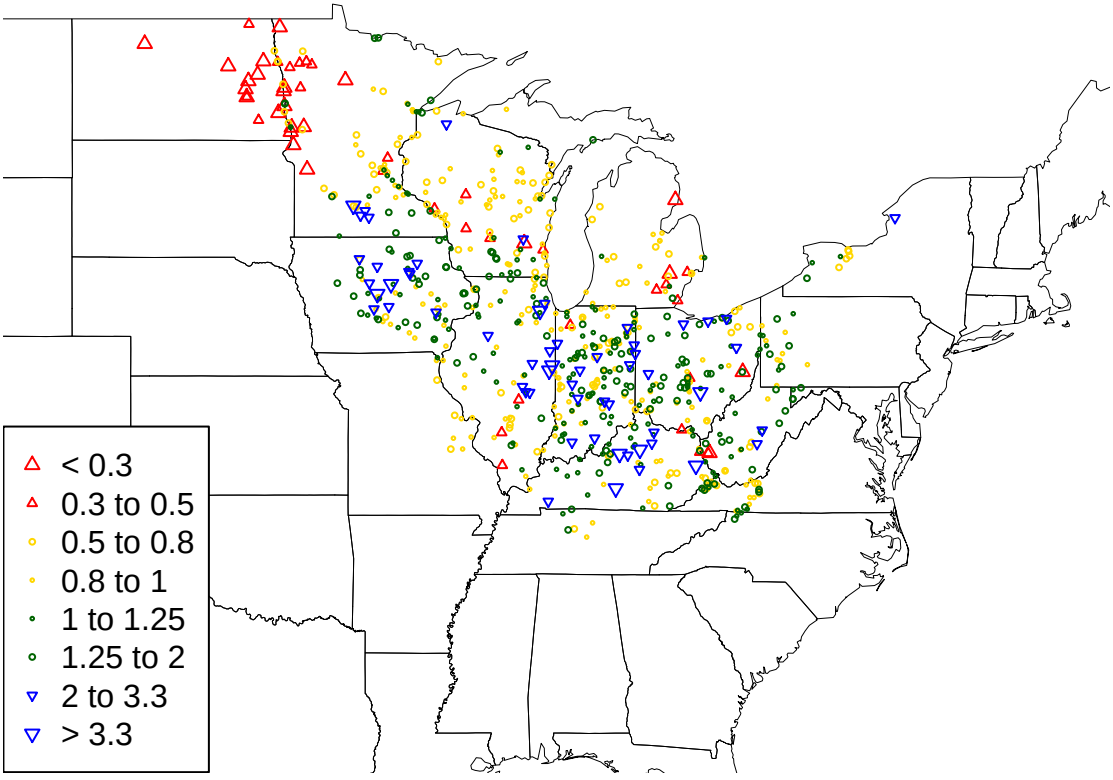
Model Estimation Obs/Pred Ratio − Over Predictions − n=364



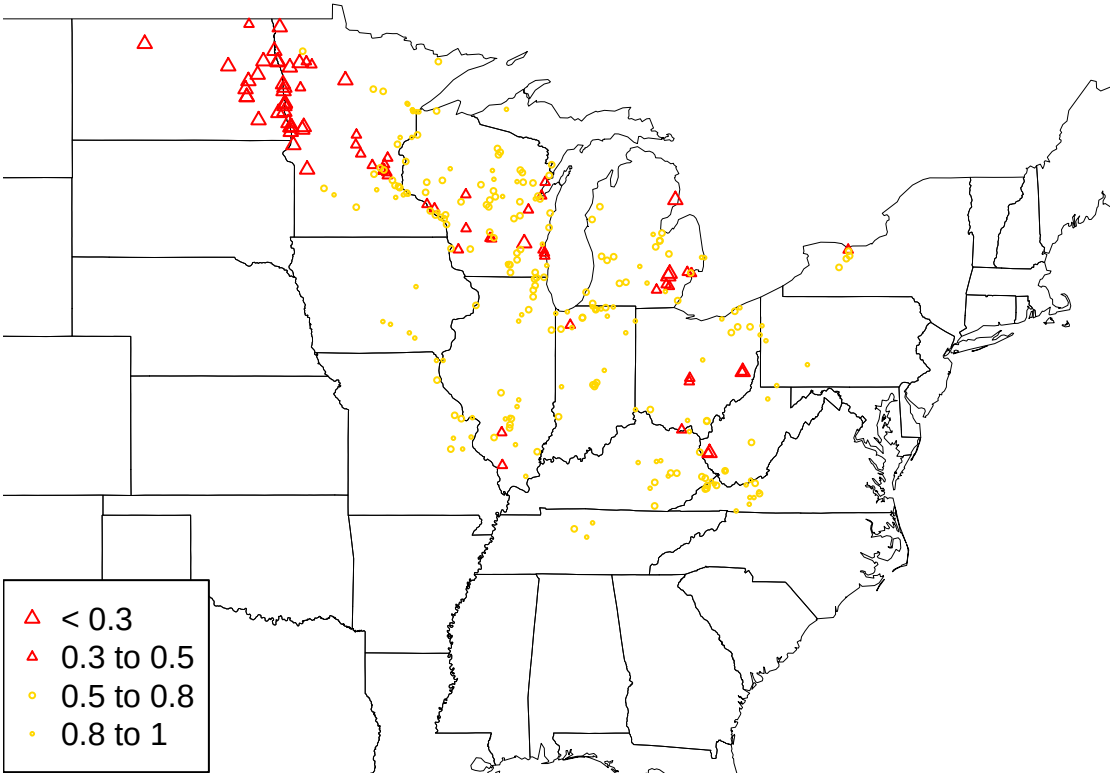
Model Estimation Obs/Pred Ratio − Under Predictions − n=344



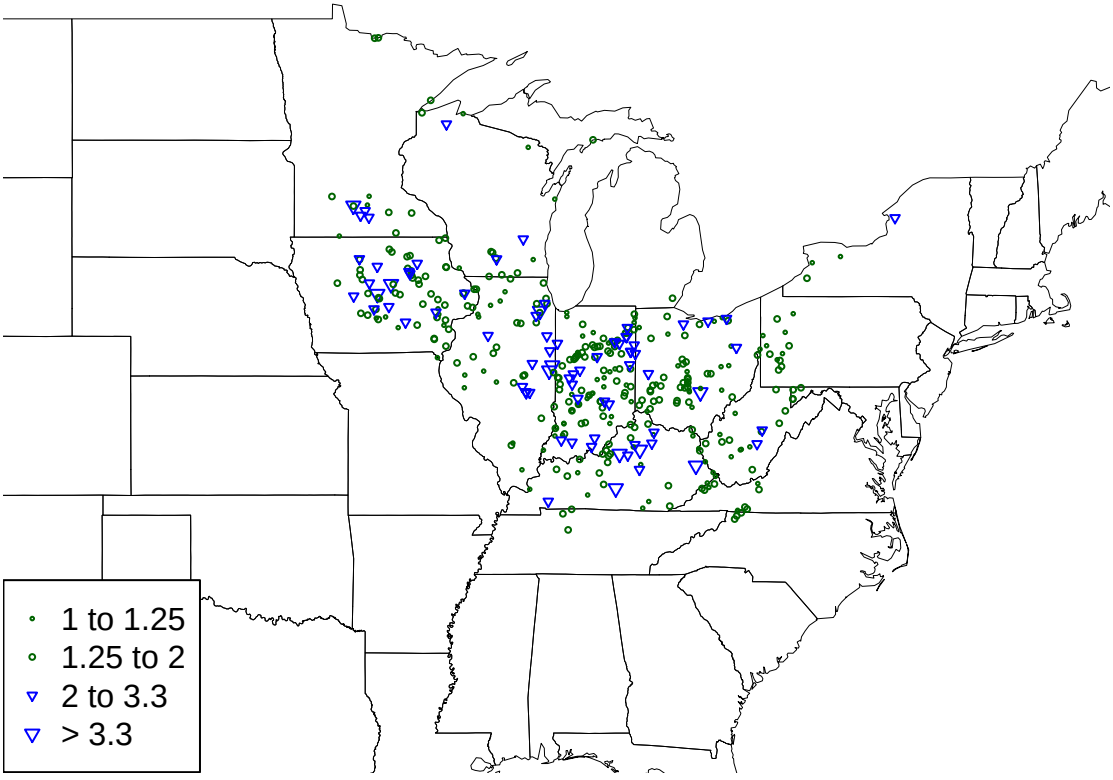
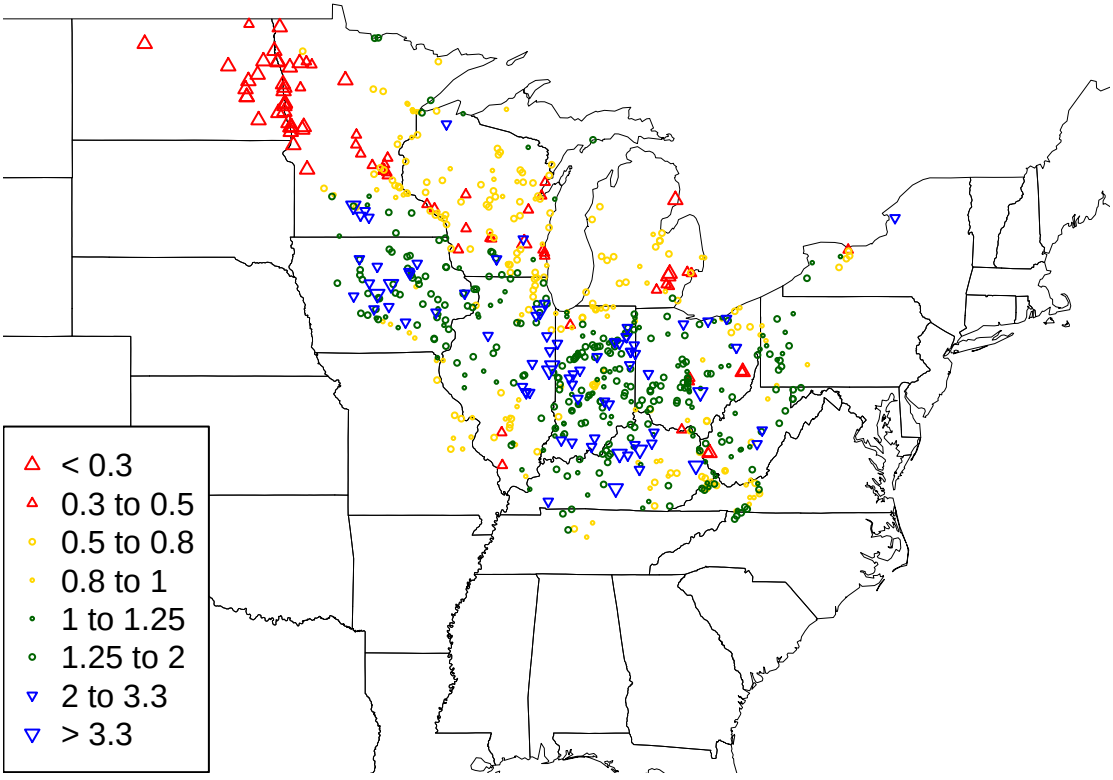
# Model Estimation Obs/Pred Ratio



Model Simulation Obs/Pred Ratio − Over Predictions − n=306



Model Simulation Obs/Pred Ratio − Under Predictions − n=402



# Model Simulation Obs/Pred Ratio