Appendix 11. Full model results for the intra-city urbanization gradient analysis, for four biodiversity variables (i.e., species richness, Shannon diversity, abundance, and phylogenetic diversity). Model results are presented both for (1) analyses which only investigated the relationship between a smoothed urbanization level; and (2) parametric models where urbanness was included as a parametric term, as well as other macro-ecological predictors.

Table A1. Model results from a GAM, showing the relationship between species richness at a checklist level with a continuous measure of urbanization (VIIRS night-time lights).

```
Family: poisson
Link function: log

Formula:
species_richness ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    s(urbanness) + s(season2, bs = "cc", k = 4) + s(city,
    bs = "re")

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  2.84117    0.04893   58.06   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                          edf Ref.df    Chi.sq p-value
s(DURATION_MINUTES)      9.000      9 8.025e+06  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.999      9 1.606e+06  <2e-16 ***
s(LATITUDE,LONGITUDE)   98.903     99 3.424e+14  <2e-16 ***
s(urbanness)             8.998      9 7.857e+04  <2e-16 ***
s(season2)               2.000      2 1.159e+09  <2e-16 ***
s(city)               1577.420   1580 9.218e+05  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.497   Deviance explained = 50.8%
fREML = 1.6384e+07  Scale est. = 1         n = 6076500
```

Table A2. Model results from a GAM, showing the relationship between Shannon diversity at a checklist level with a continuous measure of urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
shannon_diversity ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    s(urbanness) + s(season2, bs = "cc", k = 4) + s(city,
    bs = "re")

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.89902    0.01452   130.8   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                          edf Ref.df         F p-value
s(DURATION_MINUTES)      8.996      9 1.472e+05  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.990      9 1.477e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)   97.890     99 4.991e+08  <2e-16 ***
s(urbanness)             8.971      9 2.367e+03  <2e-16 ***
s(season2)               2.000      2 3.324e+06  <2e-16 ***
s(city)               1541.735   1580 8.879e+01  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.383   Deviance explained = 38.4%
fREML = 5.3111e+06  Scale est. = 0.38907   n = 5603387
```

Table A3. Model results from a GAM, showing the relationship between total abundance of individuals at a checklist level with a continuous measure of urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
log(abundance) ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    s(urbanness) + s(season2, bs = "cc", k = 4) + s(city,
    bs = "re")

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   4.0993     0.1147   35.73   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                         edf Ref.df         F p-value
s(DURATION_MINUTES)     8.998      9 7.955e+04  <2e-16 ***
s(EFFORT_DISTANCE_KM)   8.988      9 2.456e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)  98.628     99 4.846e+11  <2e-16 ***
s(urbanness)            8.964      9 9.795e+02  <2e-16 ***
s(season2)              2.000      2 9.809e+06  <2e-16 ***
s(city)              1573.661   1580 1.989e+02  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.301   Deviance explained = 30.1%
fREML = 8.7524e+06  Scale est. = 1.3276    n = 5603387
```

Table A4. Model results from a GAM, showing the relationship between phylogenetic diversity at a checklist level with a continuous measure of urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
log(PD) ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) + s(LATITUDE,
    LONGITUDE, bs = "sos", m = 2, k = 100) + s(urbanness) +
    s(season2, bs = "cc", k = 4) + s(city, bs = "re")

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.58032    0.03367   195.4   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                          edf Ref.df         F p-value
s(DURATION_MINUTES)      8.998      9 2.068e+05  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.996      9 4.586e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)   98.391     99 9.296e+10  <2e-16 ***
s(urbanness)             8.980      9 2.701e+03  <2e-16 ***
s(season2)               2.000      2 1.563e+07  <2e-16 ***
s(city)               1571.699   1580 1.409e+02  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.468   Deviance explained = 46.9%
fREML = 3.6742e+06  Scale est. = 0.19575   n = 6076500
```

Table A5. Model results from a GAM, showing the relationship between species richness at a checklist level with macro-ecological parametric predictors, including urbanization (VIIRS night-time lights).

```
Family: poisson
Link function: log

Formula:
species_richness ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    urbanness + proportion_water.list + tree_mean.list + mean_EVI.list +
    s(season2, bs = "cc", k = 4) + s(city, bs = "re")

Parametric coefficients:
                       Estimate Std. Error z value Pr(>|z|)
(Intercept)           2.9361525  0.0479038   61.29   <2e-16 ***
urbanness            -0.0432929  0.0001579 -274.18   <2e-16 ***
proportion_water.list -0.0056681  0.0002066  -27.43   <2e-16 ***
tree_mean.list       -0.0428026  0.0002894 -147.91   <2e-16 ***
mean_EVI.list        -0.0129561  0.0001691  -76.64   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                         edf Ref.df    Chi.sq p-value
s(DURATION_MINUTES)     8.999      9 8.053e+06  <2e-16 ***
s(EFFORT_DISTANCE_KM)   8.999      9 1.596e+06  <2e-16 ***
s(LATITUDE,LONGITUDE)  98.859     99 3.134e+14  <2e-16 ***
s(season2)              2.000      2 1.147e+09  <2e-16 ***
s(city)              1577.204   1580 9.003e+05  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.497   Deviance explained = 50.8%
fREML = 1.637e+07  Scale est. = 1         n = 6075827
```

Table A6. Model results from a GAM, showing the relationship between Shannon diversity at a checklist level with macro-ecological parametric predictors, including urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
shannon_diversity ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    urbanness + proportion_water.list + tree_mean.list + mean_EVI.list +
    s(season2, bs = "cc", k = 4) + s(city, bs = "re")

Parametric coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)            1.9304848  0.0159807 120.801   <2e-16 ***
urbanness             -0.0257760  0.0003969 -64.939   <2e-16 ***
proportion_water.list -0.0056932  0.0005201 -10.945   <2e-16 ***
tree_mean.list        -0.0007556  0.0007178  -1.053    0.293
mean_EVI.list          0.0441099  0.0004382 100.668   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                           edf Ref.df         F p-value
s(DURATION_MINUTES)      8.996      9 1.468e+05  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.993      9 1.498e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)   98.169     99 8.927e+08  <2e-16 ***
s(season2)               2.000      2 3.521e+06  <2e-16 ***
s(city)               1546.749   1580 8.931e+01  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.384   Deviance explained = 38.4%
fREML = 5.3103e+06  Scale est. = 0.38901   n = 5602803
```

Table A7. Model results from a GAM, showing the relationship between total abundance of individuals at a checklist level with macro-ecological parametric predictors, including urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
log(abundance) ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) +
    s(LATITUDE, LONGITUDE, bs = "sos", m = 2, k = 100) +
    urbanness + proportion_water.list + tree_mean.list + mean_EVI.list +
    s(season2, bs = "cc", k = 4) + s(city, bs = "re")

Parametric coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)           3.7067059  0.0913758   40.57   <2e-16 ***
urbanness            -0.0950208  0.0007349 -129.30   <2e-16 ***
proportion_water.list 0.0120495  0.0009665   12.47   <2e-16 ***
tree_mean.list       -0.1874052  0.0013242 -141.52   <2e-16 ***
mean_EVI.list        -0.1638313  0.0008069 -203.05   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                          edf Ref.df         F p-value
s(DURATION_MINUTES)      8.998      9 8.216e+04  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.990      9 2.413e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)   98.653     99 1.846e+11  <2e-16 ***
s(season2)               2.000      2 5.527e+06  <2e-16 ***
s(city)               1571.761   1580 1.877e+02  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.311   Deviance explained = 31.1%
fREML = 8.7106e+06  Scale est. = 1.3086    n = 5602803
```

Table A8. Model results from a GAM, showing the relationship between phylogenetic diversity at a checklist level with macro-ecological parametric predictors, including urbanization (VIIRS night-time lights).

```
Family: gaussian
Link function: identity

Formula:
log(PD) ~ s(DURATION_MINUTES) + s(EFFORT_DISTANCE_KM) + s(LATITUDE,
    LONGITUDE, bs = "sos", m = 2, k = 100) + urbanness +
    proportion_water.list + tree_mean.list + mean_EVI.list +
    s(season2, bs = "cc", k = 4) + s(city, bs = "re")

Parametric coefficients:
                         Estimate Std. Error  t value Pr(>|t|)
(Intercept)             6.5698424  0.0296853  221.317  < 2e-16 ***
urbanness              -0.0413206  0.0002725 -151.657  < 2e-16 ***
proportion_water.list -0.0026749  0.0003599   -7.433 1.06e-13 ***
tree_mean.list         -0.0516058  0.0004922 -104.844  < 2e-16 ***
mean_EVI.list          -0.0122104  0.0002979  -40.992  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                           edf Ref.df         F p-value
s(DURATION_MINUTES)      8.998      9 2.083e+05  <2e-16 ***
s(EFFORT_DISTANCE_KM)    8.997      9 4.545e+04  <2e-16 ***
s(LATITUDE,LONGITUDE)   98.494     99 5.810e+10  <2e-16 ***
s(season2)               2.000      2 1.197e+07  <2e-16 ***
s(city)               1570.062   1580 1.375e+02  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.469   Deviance explained = 46.9%
fREML = 3.6708e+06  Scale est. = 0.19558   n = 6075827
```