Below the canopy: global trends in forest vertebrate populations and their drivers.

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Supplementary Material
S1. Number of species and populations in the forest specialist index by realm and taxonomic class

| Species  | Afrotropical | Indopacific | Nearctic | Neotropical | Palearctic |
|----------|--------------|-------------|----------|-------------|------------|
| Species  |              |             |          |             |            |
| Populations |              |             |          |             |            |
| **Birds** | 1            | 1           | 27       | 44          | 45         |
|           |              |             |          |             | 47         |
|           |              |             |          | 60          | 75         |
|           |              |             |          |             | 8          |
|           |              |             |          | 42          |            |
| **Mammals** | 27          | 49          | 19       | 32          | 6          |
|           |              |             |          | 32          | 31         |
|           |              |             |          | 54          | 6          |
|           |              |             |          | 14          |            |
| **Reptiles and amphibians** | 5          | 5           | 7        | 11          | 4          |
|           |              |             |          | 11          | 27         |
|           |              |             |          | 37          | 0          |
|           |              |             |          | 0           |            |
## S2. Specifications of some global tree cover datasets with continuous vegetation fields

| Dataset name                  | Definition of tree cover                                                                                                                                                                                                 | Spatial resolution | Temporal coverage/cadence                                                                 | Reference               |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------|-------------------------|
| Landsat Global Forest Change  | Canopy closure for all vegetation taller than 5 meters in height.                                                                                                                                                         | 30 m               | Fractional tree cover available for 2000 and 2010 only; tree cover loss available for 2001-2017 | Hansen et al (2013)     |
| Landsat VCF (GLCF)            | The percentage of horizontal ground in each 30-m pixel covered by woody vegetation greater than 5 meters in height                                                                                                       | 30 m               | 2000, 2005, 2010                                                                          | (Sexton et al., 2013)   |
| MEASURES VCF5KYR              | The proportion of the ground covered by the vertical projection of tree crowns. Trees are defined as all vegetation taller than 5 meters in height.                                                                          | 0.05 degree (5600 m) | 1982-2016, annual                                                                       | Song et al (2018)       |
| MODIS VCF                    | Percent of the pixel covered by tree canopy equal to or greater than 5 m in height.                                                                                                                                       | 250 m              | 2000-2015, annual                                                                        | (DiMiceli et al., 2015) |
S3. Calculation of 5-km radius

Range size estimates were not known for every species, but body mass estimates were available (see Additional drivers of forest population change in main text). We calculated the correlation between body mass and range size (both log-10 transformed) for the species with both estimates available, and found a strong positive relationship (Pearson correlation coefficient = 0.87, p < 0.001). We therefore used body mass to predict range size for all populations using the ‘predict.lm’ function in the ‘stats’ package (R Core Team, 2018) and calculated the mean range size across all populations as 58.5 km², equivalent to a circle with a radius of 4.32 km. We rounded this up and fitted buffers with a 5-km radius around the central coordinates of each forest population.
Number of forest populations (generalists and specialists) and forest specialist populations per realm included in analyses using long-term and short-term tree cover datasets.

| Analysis          | Realm          | All forest populations | Forest specialist populations |
|-------------------|----------------|------------------------|------------------------------|
| Long-term (Song)  | Afrotropical  | 365                    | 36                           |
|                   | Australasia   | 64                     | 3                            |
|                   | Indo-Malayan  | 98                     | 20                           |
|                   | Nearctic      | 321                    | 14                           |
|                   | Neotropical   | 315                    | 76                           |
|                   | Oceania       | 30                     | 12                           |
|                   | Palearctic    | 475                    | 14                           |
| Short-term (Hansen)| Afrotropical | 172                    | 12                           |
|                   | Australasia   | 42                     | 3                            |
|                   | Indo-Malayan  | 52                     | 10                           |
|                   | Nearctic      | 96                     | 2                            |
|                   | Neotropical   | 127                    | 43                           |
|                   | Oceania       | 0                      | 0                            |
|                   | Palearctic    | 196                    | 4                            |
Number of forest populations (generalists and specialists) and forest specialist populations per taxonomic class included in analyses using long-term and short-term tree cover datasets.

| Analysis        | Taxa          | All forest populations | Forest specialist populations |
|-----------------|---------------|------------------------|------------------------------|
| Long-term (Song)| Amphibians    | 154                    | 19                           |
|                 | Birds         | 701                    | 73                           |
|                 | Mammals       | 767                    | 78                           |
|                 | Reptiles      | 46                     | 5                            |
| Short-term (Hansen)| Amphibians | 52                     | 2                            |
|                 | Birds         | 251                    | 33                           |
|                 | Mammals       | 348                    | 34                           |
|                 | Reptiles      | 34                     | 5                            |
S6. Number of species trends in the FSI annually, with proportions of positive and negative annual trends
S7. Percentage of annual species trends which are positive or negative for birds (A), mammals (B) and herptiles (C)
S8. Number of average declining, increasing and stable (less than 5% change in abundance) species trends in tropical and temperate realms (A) and biomes (B). Nine species were not located in a forest biome (where forest is the dominant habitat type), so were not included in B.

| A Realm     | Decline | Increase | Stable |
|-------------|---------|----------|--------|
| **Temperate realms** |         |          |        |
| Nearctic    | 22      | 28       | 4      |
| Palearctic  | 3       | 7        | 3      |
| **Total**   | 25      | 35       | 7      |
| **Tropical realms** |         |          |        |
| Afrotropical| 18      | 13       | 2      |
| Neotropical | 53      | 48       | 13     |
| Indo-Pacific| 28     | 22       | 4      |
| **Total**   | 99      | 83       | 19     |

| B Biome                      | Decline | Increase | Stable |
|------------------------------|---------|----------|--------|
| **Temperate forest biomes**  |         |          |        |
| Boreal forests / taiga       | 2       | 10       |        |
| Mediterranean forests, woodlands and scrub | 1 | 1 | |
| Temperate broadleaf and mixed forests | 21 | 24 | 7 |
| Temperate coniferous forests | 5       | 4        |        |
| **Total**                    | 29      | 39       | 7      |
| **Tropical forest biomes**   |         |          |        |
| Mangroves                    | 1       | 2        |        |
| Tropical and subtropical coniferous forests | 2 | 1 | |
| Tropical and subtropical dry broadleaf forests | 9 | 1 | 5 |
| Tropical and subtropical moist broadleaf forests | 77 | 72 | 14 |
|-----------------------------------------------|----|----|----|
| Total                                         | 89 | 76 | 19 |
S9. Average rate of forest population change regressed on fixed predictor effects with a random effect of location: mixed effects model results for forest vertebrate populations (generalists and specialists). Populations had at least 2 years of data covering at least a 5 year period from 1982-2016. Tree cover variables calculated using the Song et al (2018) dataset. N = 1668.

| Fixed effect            | Estimate  | CI              | AIC       | ΔAIC to null model |
|-------------------------|-----------|-----------------|-----------|--------------------|
| NULL                    | NA        | NA              | -4113.666 | 0                  |
| Tree cover trend        | 1.09 x 10^-2 | 8.43 x 10^-4  | -4107.464 | +6.202             |
| Body mass               | 3.92 x 10^-3 | 1.44 x 10^-3  | -4109.732 | +3.934             |
| Mean tree cover         | -1.91 x 10^-3 | -7.45 x 10^-3 | -4102.222 | +11.444            |
| Mean bare ground        | 8.79 x 10^-4 | -8.66 x 10^-3 | -4102.885 | +10.781            |
| Exploitation (Y)        | 1.87 x 10^-3 | -1.26 x 10^-2 | -4103.753 | +9.913             |
|                | HPD               | Road density         | Mean travel time         |
|----------------|-------------------|----------------------|--------------------------|
|                | $3.69 \times 10^{-3}$ | $-2.30 \times 10^{-5}$ | $-1.22 \times 10^{-3}$   |
|                | $-1.25 \times 10^{-3}$ | $-3.85 \times 10^{-4}$ | $-7.58 \times 10^{-3}$   |
|                | $-8.63 \times 10^{-3}$ | $-3.39 \times 10^{-4}$ | $-5.14 \times 10^{-3}$   |
|                | $-4103.674$       | $-4096.325$          | $-4102.185$              |
|                |                   |                      |                          |
|                | +9.992            | +17.341              | +11.481                  |
S10. Average rate of forest population change regressed on fixed predictor effects with a random effect of location: mixed effects model results for forest vertebrate populations (specialists only). Populations had at least 2 years of data covering at least a 5 year period from 1982-2016. Tree cover variables calculated using the Song et al. (2018) dataset. N = 175.

| Fixed effect         | Estimate         | CI               | AIC      | ΔAIC to null model |
|----------------------|------------------|------------------|----------|--------------------|
| NULL                 | NA               | NA               | -461.632 | 0                  |
| Tree cover trend     | 1.86 x 10^{-2}   | -5.19 x 10^{-3} - 4.25 x 10^{-2} | -454.989 | +6.643             |
| Body mass            | -4.03 x 10^{-3}  | -1.17 x 10^{-2} - 3.69 x 10^{-3} | -451.438 | +10.194            |
| Mean tree cover      | -1.82 x 10^{-2}  | -6.40 x 10^{-2} - 2.76 x 10^{-2} | -454.560 | +7.072             |
| Mean bare ground     | 2.37 x 10^{-2}   | -1.99 x 10^{-2} - 6.72 x 10^{-2} | -454.991 | +6.641             |
|                          | Exploitation (Y) | HPD       | Road density | Mean travel time |
|--------------------------|------------------|-----------|--------------|------------------|
|                          | -8.79 x 10²      | -6.68 x 10³ | -1.08 x 10³  | 1.34 x 10⁻²      |
|                          | -1.38 x 10⁻¹     | -2.48 x 10⁻² | -3.18 x 10⁻³ | -9.01 x 10⁻³     |
|                          | -3.74 x 10⁻²     | -1.15 x 10⁻² | -1.00 x 10⁻³ | -3.58 x 10⁻²     |
|                          | -465.041         | -452.625   | -448.816     | -453.894         |
|                          | -3.409           | +9.007     | +12.816      | +7.738           |
S11. Model results from mixed effects models of average rate of population change of forest generalists and specialists regressed on fixed predictor effects with a random effect of location. Populations had at least 2 years of data covering at least a 5 year period from 2000-2015. Tree cover variables calculated using the Hansen dataset. N = 685.

| Fixed effect                        | Estimate       | CI              | AIC    |
|-------------------------------------|----------------|-----------------|--------|
| NULL                                | NA             | NA              | -1479.421 |
| Tree cover 2000                     | -1.50 x 10^{-3}| -1.15 x 10^{-2} – 8.54 x 10^{-3} | -1468.794 |
| Total tree loss                     | 8.60 x 10^{-4} | -4.13 x 10^{-3} – 5.85 x 10^{-3} | -1467.425 |
| Tree cover change 2000-2010         | -2.77 x 10^{-3}| -2.70 x 10^{-2} – 2.15 x 10^{-2} | -1470.524 |
| Body mass                           | 4.82 x 10^{-3} | 7.34 x 10^{-4} – 8.90 x 10^{-3} | -1472.199 |
| Exploitation (Y)                    | 1.59 x 10^{-2} | -1.09 x 10^{-2} – 4.27 x 10^{-2} | -1472.025 |
| HPD                                 | 9.34 x 10^{-3} | 1.31 x 10^{-3} – 1.75 x 10^{-2} | -1473.445 |
| Road density                        | 1.87 x 10^{-4} | -5.26 x 10^{-4} – 9.03 x 10^{-4} | -1463.679 |
| Mean travel time                    | -6.97 x 10^{-3}| -1.85 x 10^{-2} – 4.49 x 10^{-3} | -1470.392 |
S12. Model results from mixed effects models of average rate of population change of forest specialists regressed on fixed predictor effects with a random effect of location. Populations had at least 2 years of data covering at least a 5 year period from 2000-2015. Tree cover variables calculated using the Hansen dataset. N = 74.

| Fixed effect                       | Estimate | CI               | AIC     |
|------------------------------------|----------|------------------|---------|
| NULL                               | NA       | NA               | -158.048|
| Tree cover 2000                    | -1.90 x 10^-3 | -6.88 x 10^-2 – 2.97 x 10^-2 | -151.075|
| Total tree loss                    | 2.58 x 10^-3 | -1.36 x 10^-2 – 1.75 x 10^-2 | -148.242|
| Tree cover change 2000-2010        | 6.14 x 10^-2 | -2.73 x 10^-1 – 3.96 x 10^-1 | -154.474|
| Body mass                          | -1.27 x 10^-3 | -1.30 x 10^-2 – 1.07 x 10^-2 | -147.690|
| Exploitation (Y)                   | -5.43 x 10^-2 | -1.17 x 10^-2 – 8.55 x 10^-3 | -153.850|
| HPD                                | -2.14 x 10^-4 | -1.75 x 10^-2 – 1.98 x 10^-2 | -148.417|
| Road density                       | -1.07 x 10^-3 | -3.43 x 10^-3 – 1.29 x 10^-3 | -145.234|
| Mean travel time                   | 1.37 x 10^-3 | -2.90 x 10^-2 – 2.97 x 10^-2 | -149.413|
S13. Abundance index for 74 species from the FSI with data present throughout all decades from 1970 to 2014 (these are primarily birds from the Nearctic)
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