Modeling future potential distribution of Buff-bellied Hummingbird (*Amazilia yucatanensis*) under climate change: Species vs. subspecies

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Supplementary materials

**Table S1.** Bioclimatic variables used in MaxEnt for the modeling of current and future distribution of habitat suitability of *Amazilia yucatanensis* and subspecies.

| Code  | Description                                                        | Unit                      |
|-------|--------------------------------------------------------------------|---------------------------|
| BIO1  | Annual Mean Temperature                                            | Degree Celsius (°C)       |
| BIO2  | Mean Diurnal Range (Mean of monthly (max temp-min temp))           | Degree Celsius (°C)       |
| BIO3  | Isothermality ((BIO2/BIO7)*100)                                    | Percentage (%)            |
| BIO4  | Temperature Seasonality (standard deviation*100)                  | Percentage (%)            |
| BIO5  | Maximum Temperature of Warmest Month                              | Degree Celsius (°C)       |
| BIO6  | Min Temperature of Coldest Month                                  | Degree Celsius (°C)       |
| BIO7  | Temperature Annual Range (BIO5-BIO6)                              | Degree Celsius (°C)       |
| BIO8  | Mean Temperature of Wettest Quarter                               | Degree Celsius (°C)       |
| BIO9  | Mean Temperature of Driest Quarter                                | Degree Celsius (°C)       |
| BIO10 | Mean Temperature of Warmest Quarter                               | Degree Celsius (°C)       |
| BIO11 | Mean Temperature of Coldest Quarter                               | Degree Celsius (°C)       |
| BIO12 | Annual Precipitation                                              | Millimeter (mm)          |
| BIO13 | Precipitation of Wettest Month                                    | Millimeter (mm)          |
| BIO14 | Precipitation of Driest Month (Coefficient of Variation)          | Millimeter (mm)          |
| BIO15 | Precipitation Seasonality                                         | Percentage (%)            |
| BIO16 | Precipitation of Wettest Quarter                                  | Millimeter (mm)          |
| BIO17 | Precipitation of Driest Quarter                                   | Millimeter (mm)          |
| BIO18 | Precipitation of Warmest quarter                                  | Millimeter (mm)          |
| BIO19 | Precipitation of Coldest quarter                                  | Millimeter (mm)          |
Table S2. Proportional contribution of climatic variables to each axis of the Principal Components Analysis (PCA) carried out by NicheA software. The variance explained by the first 10 axes is indicated.

|       | PC1  | PC2  | PC3  | PC4  | PC5  | PC6  | PC7  | PC8  | PC9  | PC10 |
|-------|------|------|------|------|------|------|------|------|------|------|
| BIO1  | 0.336| 0.031| 0.407| -0.675| 0.174| 0.015| -0.152| -0.016| 0.157| -0.428|
| BIO3  | 0.391| 0.060| 0.121| -0.314| -0.074| -0.002| -0.031| -0.011| -0.275| 0.804|
| BIO4  | 0.285| 0.323| -0.389| 0.112| 0.688| 0.411| -0.013| -0.066| -0.028| -0.007|
| BIO7  | -0.181| 0.573| -0.098| -0.125| -0.040| -0.419| 0.007| -0.659| 0.024| 0.004|
| BIO9  | 0.334| -0.293| -0.134| 0.159| 0.373| -0.772| 0.021| 0.114| 0.091| 0.008|
| BIO11 | -0.175| 0.579| -0.110| -0.148| -0.036| -0.219| -0.066| 0.738| -0.012| 0.000|
| BIO13 | 0.375| 0.081| -0.235| 0.200| -0.387| 0.041| -0.700| -0.033| 0.334| -0.023|
| BIO14 | -0.389| -0.074| 0.171| -0.075| 0.308| 0.050| -0.132| 0.007| 0.723| 0.410|
| BIO15 | -0.380| -0.139| 0.137| -0.000| 0.306| -0.072| -0.679| -0.036| -0.504| 0.002|
| BIO17 | 0.196| 0.328| 0.723| 0.567| 0.085| -0.005| 0.011| 0.014| -0.005| -0.001|
**Table S3.** Predicted increase or decrease (%) in the extent of suitable areas (km\(^2\)) for *Amazilia yucatanensis* and its subspecies under CCSM4 climate-change scenarios (RCPs) for the years 2050 and 2070.

| Model | A. yucatanensis | A. y. yucatanensis | A. y. cerviniventris | A. y. chalconota |
|-------|------------------|---------------------|----------------------|------------------|
|       | Km\(^2\)        | %                   | Km\(^2\)        | %                   | Km\(^2\)        | %                   |
| Current area | 384,838         | -                   | 162,793         | -                   | 132,238         | -                   |
| RCP 2.6 2050 | 70,029          | 18.19               | 69,843          | 42.90               | 22,547          | 17.05               | -43,321          | -36.87           |
| RCP 4.5 2050 | 61,350          | 15.94               | 70,150          | 43.09               | 19,103          | 14.44               | -39,816          | -33.88           |
| RCP 6.0 2050 | 61,350          | 15.94               | 79,943          | 49.10               | 5,920           | 4.47                | -30,584          | -26.03           |
| RCP 8.5 2050 | 80,346          | 20.87               | 53,376          | 32.78               | 8,108           | 6.13                | -56,714          | -48.27           |
| RCP 2.6 2070 | 72,473          | 18.83               | 63,073          | 38.74               | 14,723          | 11.13               | -44,036          | -37.48           |
| RCP 4.5 2070 | 39,686          | 10.31               | 70,791          | 43.48               | -11,647         | -8.80               | -59,134          | -50.33           |
| RCP 6.0 2070 | 53,546          | 13.91               | 77,494          | 47.60               | -8,941          | -6.76               | -76,951          | -65.49           |
| RCP 8.5 2070 | 50,145          | 13.03               | -20,980         | -12.88              | -9,723          | -7.35               | -81,363          | -69.25           |
Table S4. Predicted increase or decrease (%) in the extent of suitable areas (km²) for *Amazilia yucatanensis* and its subspecies under HadGEM2-ES climate-change scenarios (RCPs) for the years 2050 and 2070.

| Model    | *A. yucatanensis* | *A. y. yucatanensis* | *A. y. cerviniventris* | *A. y. chalconota* |
|----------|-------------------|----------------------|------------------------|-------------------|
|          | Km²               | %        | Km²                   | %        | Km²                   | %        | Km²                   | %        |
| Current area | 384,838          | -       | 162,793               | -       | 132,238               | -       | 117,488               | -       |
| RCP 2.6 2050 | 64,014           | 16.63   | 29,077                | 17.86   | 3,947                 | 2.98    | -66,314               | -56.44  |
| RCP 4.5 2050 | 47,992           | 12.47   | 28,586                | 17.55   | -10,277               | -7.77   | -43,829               | -37.30  |
| RCP 6.0 2050 | -5,929           | -1.54   | 23,866                | 14.66   | -927                  | -0.70   | -68,599               | -58.38  |
| RCP 8.5 2050 | 103,869          | 26.99   | -52,316               | -32.13  | 8,108                 | 6.13    | -85,124               | -72.45  |
| RCP 2.6 2070 | 71,715           | 18.63   | 27,469                | 16.87   | 15,175                | 11.47   | -51,773               | -44.06  |
| RCP 4.5 2070 | 132,757          | 34.49   | 3,890                 | 2.38    | 80,691                | 61.02   | -59,472               | -50.61  |
| RCP 6.0 2070 | 174,657          | 45.38   | -45,507               | -27.95  | 113,100               | 85.52   | -58,687               | -49.95  |
| RCP 8.5 2070 | 194,735          | 50.60   | -125,754              | -77.24  | 125,685               | 95.04   | -99,753               | -84.90  |
Table S5. Predicted increase or decrease (%) in the extent of suitable areas (km²) for *Amazilia yucatanensis* and its subspecies under MIROC5 climate-change scenarios (RCPs) for the years 2050 and 2070.

| Model   | A. yucatanensis | A. y. yucatanensis | A. y. cerviniventris | A. y. chalconota |
|---------|------------------|--------------------|----------------------|------------------|
|         | Km²  | %     | Km²  | %     | Km²  | %     | Km²  | %     |
| Current area | 384,838 | -   | 162,793 | -   | 132,238 | -   | 117,488 | -   |
| RCP 2.6 2050 | 73,380 | 19.06 | 48,920 | 30.05 | 25,841 | 19.54 | -64,152 | -54.60 |
| RCP 4.5 2050 | 101,558 | 26.38 | 10,933 | 6.71 | 55,374 | 41.87 | -90,909 | -77.37 |
| RCP 6.0 2050 | 111,481 | 28.96 | -3,824 | -2.34 | 63,504 | 48.02 | -77,491 | -65.95 |
| RCP 8.5 2050 | 105,419 | 27.39 | -9,270 | -5.69 | 78,443 | 59.31 | -87,408 | -74.39 |
| RCP 2.6 2070 | 174,206 | 45.26 | 45,725 | 28.08 | 87,369 | 66.06 | -75,353 | -64.13 |
| RCP 4.5 2070 | 123,167 | 32.00 | 3,890 | 2.38 | 115,251 | 87.15 | -99,985 | -85.10 |
| RCP 6.0 2070 | 108,276 | 28.13 | -45,507 | -27.94 | 66,974 | 50.64 | -90,410 | -76.95 |
| RCP 8.5 2070 | 222,710 | 57.87 | -88,535 | -54.38 | 233,514 | 176.58 | -94,205 | -80.18 |
Table S6. Ecological niche comparisons for *Amazilia yucatanensis subspecies*. Niche overlap values are presented. The value of \( D \) ranges between 0, when two species have no overlap in the environmental space, and 1 when two species share the same environmental space.

| Subspecies       | A. y. yucatanensis | A. y. cerviniventris | A. y. chalconota |
|------------------|---------------------|----------------------|-----------------|
| A. y. yucatanensis | 1                   | 0.186                | 0.021           |
| A. y. cerviniventris | -                  | 1                    | 0.227           |
| A. y. chalconota   | -                   | -                    | 1               |
Figure S1. Calibration area used to model the potential distribution of *Amazilia yucatanensis* and their subspecies. (A) Calibration area used to model current area. Presence points (Black dots), belong to *A. yucatanensis* (see figure 1). (B) Area used to project models to the future.
Figure S2. Response curve of *Amazilia yucatanensis* to bioclimatic variables obtained carrying out a MaxEnt current model. Mean value = red line; Standard deviation = blue line.
Figure S3. Response curve of *Amazilia yucatanensis yucatanensis* to bioclimatic variables obtained carrying out a MaxEnt current model. Mean value = red line; Standard deviation = blue line.
Figure S4. Response curve of *Amazilia yucatanensis cerviniventris* to bioclimatic variables obtained carrying out a MaxEnt current model. Mean value = red line; Standard deviation = blue line.
**Figure S5.** Response curve of *Amazilia yucatanensis chalconota* to bioclimatic variables obtained carrying out a MaxEnt current model. Mean value = red line; Standard deviation = blue line.
Figure S6. Predicted distribution of *Amazilia yucatanensis* under four climate changes scenarios and three GCMs (glacier blue), CCSM4 (yellow), HadGEM2-ES (dark blue) and MIROC (sky blue).
Figure S7. Predicted distribution of *Amazilia y. yucatanensis* under four climate changes scenarios and three GCMs (glacier blue), CCSM4 (yellow), HadGEM2-ES (dark blue) and MIROC (sky blue).
Figure S8. Predicted distribution of *Amazilia y. cerviniventris* under four climate changes scenarios and three GCMs (glacier blue), CCSM4 (yellow), HadGEM2-ES (dark blue) and MIROC (sky blue).
Figure S9. Predicted distribution of *Amazilia y. chalconota* under four climate changes scenarios and three GCMs (glacier blue), CCSM4 (yellow), HadGEM2-ES (dark blue) and MIROC (sky blue).
Figure S10. Predicted distribution of *Amazilia yucatanensis* under four climate changes scenarios and three Global Circulation Models.
Figure S11. Predicted distribution of *Amazilia y. yucatanensis* under four climate change scenarios and three Global Circulation Models.
Figure S12. Predicted distribution of *Amazilia y. cerviniventris* under four climate changes scenarios and three Global Circulation Models.
Figure S13. Predicted distribution of *Amazilia y. chalconota* under four climate changes scenarios and three Global Circulation Models.
Figure S14. Multivariate environmental similarity surfaces (MESS) analysis for GCMs of *Amazilia yucatanensis*. MESS analysis measures climate similarity to training range when projecting a model. Negative values indicate low similarity and therefore high climate novelty, while positive values indicate a high similarity and low novelty. Red indicates high dissimilarity and blue show the environmental similarity between variables in the calibration area and the transfer area. In regions with dissimilarity, one or more variables have values not present in the calibration area, so in these regions the prediction should be taken with caution.
Figure S15. Multivariate environmental similarity surfaces (MESS) analysis for GCMs of *Amazilia yucatanensis*. MESS analysis measures climate similarity to training range when projecting a model. Negative values indicate low similarity and therefore high climate novelty, while positive values indicate a high similarity and low novelty. Red indicates high dissimilarity and blue show the environmental similarity between variables in the calibration area and the transfer area. In regions with dissimilarity, one or more variables have values not present in the calibration area, so in these regions the prediction should be taken with caution.
Figure S16. Multivariate environmental similarity surfaces (MESS) analysis for GCMs of *Amazilia y. cerviniventris*. MESS analysis measures climate similarity to training range when projecting a model. Negative values indicate low similarity and therefore high climate novelty, while positive values indicate a high similarity and low novelty. Red indicates high dissimilarity and blue show the environmental similarity between variables in the calibration area and the transfer area. In regions with dissimilarity, one or more variables have values not present in the calibration area, so in these regions the prediction should be taken with caution.
Figure S17. Multivariate environmental similarity surfaces (MESS) analysis for GCMs of *Amazilia y. chalconota*. MESS analysis measures climate similarity to training range when projecting a model. Negative values indicate low similarity and therefore high climate novelty, while positive values indicate a high similarity and low novelty. Red indicates high dissimilarity and blue show the environmental similarity between variables in the calibration area and the transfer area. In regions with dissimilarity, one or more variables have values not present in the calibration area, so in these regions the prediction should be taken with caution.