Appendix I. Summary of important environmental variables and future range projections per species from previous studies. dem = digital elevation model. Bio 3 – 19 are defined in table 2.

|  |  |  |  |
| --- | --- | --- | --- |
| Class | Scientific Name | Environmental Variable | Distribution Range Prediction |
| Amphibia | *A. loloensis* |  | Range reduction (1) |
|  | *B. londongensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *B. pinchonii* | Bio 3, 8, 14, 15, 18 (2) | Range expansion (1). Species specific, scenario and model dependent (2). |
|  | *B. tibetanus* | Bio 3, 8, 14, 15, 18 (2) | Range expansion (1). Species specific, scenario and model dependent (2) |
|  | *L. boringii* | Bio 3, 8, 14, 15, 18 (2) | Range reduction (1). Species specific, scenario and model dependent (2). |
|  | *M. nankiangensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *O. multipunctatus* | Bio 3, 8, 14, 15, 18 (2) | Range loss (1). Species specific, scenario and model dependent (2). |
|  | *O. nanjiangensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *O. puxiongensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *S. liupanensis* | Elevation, humidity, water pH, water velocity, vegetation cover (3,4), water temperature (3), grass cover, distance to road (4) |  |
|  | *S. muliensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *S. pingwuensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *S. tuberculatus* | Bio 3, 8, 14, 15, 18 (2) | Range loss (1). Species specific, scenario and model dependent (2). |
|  | *T. taliangensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
|  | *T. wenxianensis* | Bio 3, 8, 14, 15, 18 (2) | Species specific, scenario and model dependent (2) |
| Aves | *A. rufipectus* | Bio 4, dem (5,6), bio 1, 2, 8, 9, 12, 15, 18, 19 (6), 17 (5) | Range reduction (1). RCP2.6 - shift northwest; RCP8.5 - shift northeast (6). No dispersal - range reduction and fragmentation, shift northwards; Full dispersal - range expansion (5). |
|  | *G. sukatschewi* | Bio 3, 4, 9, 12, 14, 15, 19, dem (6) | Southeast shift (6) |
|  | *L. lhuysii* | Bio 5, dem (6,7), bio 2, 3, 4, 9, 12, 14, 15, 18, 19 (6), 17, annual maximum of EVI, base level values of EVI, slope, distances to residential locations and to roads (7) | Range expansion (1). RCP2.6 - southwest shift; RCP8.5 - southeast shift (6). Higher latitude and altitude, range reduction, fragmentation and degradation (8). |
|  | *L. omeiensis* | Bio 1, 2, 3, 4, 8, 9, 12, 14, 15, 18, 19, dem (6) | Northwest shift (6) |
|  | *P. internigrans* | Bio 12, dem (6,9), bio 2, 3, 4, 5, 9, 15, 18, 19 (6), 7, forest cover (9). | RCP2.6 - shift southeast; RCP8.5 - shift northeast. (6). Range reduction, northwards and upwards shift, further fragmentation (9). |
|  | *S. reevesii* | Bio 3, 4 (6,10), 2, 8, 9, 12, 14, 15, 18, dem (6), bio 5, 6, 16, 17 (10) | Range reduction (1,10). RCP2.6 - shift slightly southeast; RCP8.5 - shift northeast (6). Shift northwest and upslopes (10). |
|  | *S. zappeyi* | Bio 1, 2, 3, 4, 5, 9, 12, 14, 15, 18, 19, dem (6) | RCP2.6 - shift northeast; RCP8.5 - shift southeast. (6) |
| Mammalia | *A. melanoleuca* |  | Range reduction (1) |
|  | *R. rex* | Elevation, bio12 (11) |  |
|  | *R. roxellana* | Human footprint index, bio 10, 11, 15 (12) | Range reduction (1,12), upslope shift (12) |
| Reptilia | *E. perlacea* |  | Range reduction (1) |

Appendix II. Maxent Models and Model Statistics. For each species, three model fitting runs generated three series of models. One model per model fitting run was selected for projection. The three selected models from three model fitting runs must contain the same predictors which are listed as Environmental Variables. The most important variables (in bold) have “1- correlation” value > 20% across three model fitting runs. The correlation coefficients were evaluated based on Pearson correlation between the fitted values and the predictions when the focal variable was randomly permutated 5 times (13,14). The Average AUC is the mean of AUC values of the three selected models from three model fitting runs. The projections of the three selected models were visually checked to assess if species suitability maps for now and for the future are comparable.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | Scientific Name | Sample Size | Environmental Variables | Average  AUC | Comparable Projections |
| Amphibia | A. loloensis | 1188 | **secdf, secma**, bio4 | 0.83 | Yes |
|  | B. londongensis | 999 | **bio17, c4ann, bio7**, distance2road | 0.80 | Yes |
|  | B. pinchonii | 1193 | **bio6, secdn, bio15, distance2lake** | 0.77 | Yes |
|  | B. tibetanus | 1197 | **bio6, bio15**, secdf, lith | 0.81 | Yes |
|  | L. boringii | 1192 | **bio15, secma**, primn, lith, distance2lake | 0.84 | Yes |
|  | M. nankiangensis | 1107 | **bio11, bio17** | 0.85 | Yes |
|  | O. chuanbeiensis | 1078 | **primn**, c3ann, distance2lake, secdn | 0.83 | Yes |
|  | O. kuangwuensis | 930 | **bio17, bio18, lith, secma, distance2road** | 0.88 | Yes |
|  | O. liangbeiensis | 15 | **distance2road**, bio11, c3ann, bio13, bio15, primn, secdn, urban, c4per, range, lith | 0.61 | Yes |
|  | O. multipunctatus | 1080 | **c3nfx**, secma, bio17, bio7, range | 0.82 | No |
|  | O. nanjiangensis | 76 | bio17, bio11, bio4, c3per, aspect, slope, tpi | 0.61 | yes for future |
|  | O. omeimontis | 1023 | **distance2lake**, secdf | 0.83 | Yes |
|  | O. pingii | 982 | **c3nfx**, bio10, bio17, c4per, bio12, bio2, primn, secdn, urban, pastr, range, secmb, distance2road, distance2river, aspect, slope, tpi | 0.84 | yes for future |
|  | O. puxiongensis | 872 | **c3nfx**, bio11, bio17, secdf, primn, secdn, urban, c4per, range, distance2river, aspect, slope, tpi | 0.87 | No |
|  | P. puxiongensis | 23 | bio11, distance2lake, aspect | 0.49 | No |
|  | S. chintingensis | 1092 | **primf, c4per, lith, distance2lake,** bio17 | 0.86 | Yes |
|  | S. jiulongensis | 996 | **c4ann, pastr**, bio15 | 0.78 | Yes |
|  | S. liupanensis | 1003 | **pastr, c3nfx, bio11** | 0.83 | Yes |
|  | S. muliensis | 1034 | **secdf, range** | 0.83 | Yes |
|  | S. pingwuensis | 1071 | **bio9, urban**, primn, secdf, c4per, distance2road, distance2river, aspect, slope, tpi | 0.74 | Yes |
|  | S. tuberculatus | 1157 | **c3ann, c4per** | 0.81 | Yes |
|  | S. wanglangensis | 1051 | **bio11, secmb** | 0.83 | Yes |
|  | T. pseudoverrucosus | 480 | **secma, c4per** | 0.79 | yes |
|  | T. taliangensis | 1185 | **bio4, c4ann, secma** | 0.80 | No |
|  | T. wenxianensis | 1190 | **bio17, distance2lake, secma** | 0.84 | Yes |
| Aves | A. rufipectus | 1131 | **bio17, secma, lith** | 0.85 | Yes |
|  | G. sukatschewi | 52 | **c3nfx, lith** | 0.90 | No |
|  | L. lhuysii | 1194 | **bio6, bio15**, urban, secma, distance2lake | 0.84 | Yes |
|  | L. omeiensis | 1141 | **bio17, c3ann, secma**, lith | 0.86 | Yes |
|  | P. internigrans | 1195 | **bio17, c3per,** bio6 | 0.80 | Yes |
|  | S. przewalskii | 1185 | **primn, bio10** | 0.81 | no for future |
|  | S. reevesii | 1199 | **secmb**, bio6, c3per, bio15, secma, slope, distance2lake | 0.82 | Yes |
|  | S. variegaticeps | 1191 | **bio5**, bio7, bio16 | 0.87 | Yes |
|  | S. zappeyi | 1175 | **bio6, secmb, bio4** | 0.86 | Yes |
| Mammalia | A. melanoleuca | 1181 | **bio11**, c3per, bio15, c3nfx | 0.87 | Yes |
|  | P. bedfordi | 1121 | **primn, distance2lake**, bio17, urban, distance2road | 0.77 | Yes |
|  | R. rex | 1199 | **secmb**, bio6, c3per, secma, | 0.67 | Yes |
|  | R. roxellana | 426 | **c3ann**, bio3 | 0.91 | Yes |
| Reptilia | E. perlacea | 1192 | **bio15, lith**, slope, bio17, secdf, pastr, range | 0.80 | Yes |
|  | H. metusium | 993 | **lith, distance2lake** | 0.84 | Yes |

Appendix III. Projection of future distribution ranges per species. Low-confidence projections are due to low AUC score (*O. liangbeiensis, O. nanjiangensis, P. puxiongensis, R. rex*) and less consistent projections from three simulation runs (*O. multipunctatus, O. puxiongensis, P. puxiongensis, T. taliangensis, G. sukatschewi, S. przewalskii*). Range losses > 80% are in red and range losses between 15% and 80% are in amber.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | Scientific Name | Range size change under SSP2-4.5 (%) | Range size change under SSP3-7.0 (%) | Range size change under SSP5-8.5 (%) | Confidence level |
| Amphibia | A. loloensis | 50 | 87 | 95 | High |
|  | B. londongensis | -100 | -100 | -99 | High |
|  | B. pinchonii | -100 | -100 | -100 | High |
|  | B. tibetanus | -100 | -100 | -100 | High |
|  | L. boringii | -90 | -88 | -83 | High |
|  | M. nankiangensis | -100 | -100 | -100 | High |
|  | O. chuanbeiensis | -95 | -94 | -100 | High |
|  | O. kuangwuensis | -99 | -99 | -100 | High |
|  | O. liangbeiensis | -100 | -100 | -100 | Low |
|  | O. multipunctatus | 528 | 1,766 | 191 | Low |
|  | O. nanjiangensis | -100 | -100 | -100 | Low |
|  | O. omeimontis | 59 | 76 | 52 | High |
|  | O. pingii | -100 | -100 | -100 | High |
|  | O. puxiongensis | -82 | -100 | -96 | Low |
|  | P. puxiongensis | -39 | -17 | 51 | Low |
|  | S. chintingensis | 5 | 6 | 22 | High |
|  | S. jiulongensis | -100 | -100 | -100 | High |
|  | S. liupanensis | 137 | 50 | 111 | High |
|  | S. muliensis | 39 | 51 | 26 | High |
|  | S. pingwuensis | -100 | -100 | -100 | High |
|  | S. tuberculatus | 3 | -3 | 9 | High |
|  | S. wanglangensis | 48 | 49 | 50 | High |
|  | T. pseudoverrucosus | -14 | -67 | -100 | High |
|  | T. taliangensis | -71 | -57 | -50 | Low |
|  | T. wenxianensis | -8 | -15 | 3 | High |
| Aves | A. rufipectus | -98 | -99 | -96 | High |
|  | G. sukatschewi | -8 | -29 | 34 | Low |
|  | L. lhuysii | -100 | -100 | -100 | High |
|  | L. omeiensis | -60 | -60 | -61 | High |
|  | P. internigrans | -99 | -98 | -100 | High |
|  | S. przewalskii | -100 | -100 | -100 | Low |
|  | S. reevesii | -100 | -100 | -100 | High |
|  | S. variegaticeps | -100 | -100 | -100 | High |
|  | S. zappeyi | -90 | -100 | -98 | High |
| Mammalia | A. melanoleuca | -100 | -100 | -100 | High |
|  | P. bedfordi | -51 | -36 | -55 | High |
|  | R. rex | -71 | -69 | -78 | Low |
|  | R. roxellana | -100 | -100 | -100 | High |
| Reptilia | E. perlacea | -100 | -100 | -100 | High |
|  | H. metusium | 0 | 0 | 0 | High |

**References**

1. Li X, Tian H, Wang Y, Li R, Song Z, Zhang F, et al. Vulnerability of 208 endemic or endangered species in China to the effects of climate change. Reg Environ Change. 2013 Aug;13(4):843–52.

2. Chen Y. Amphibian distributions and extinction risk in China under climate and land use change [Doctor of Philosophy thesis]. University of Alberta; 2017.

3. Zuo J. The population ecology and species conservation of Scutiger liupanensis [Internet]. Northwest Normal University; 2018 [cited 2021 Oct 20]. Available from: https://cdmd.cnki.com.cn/Article/CDMD-10736-1018158965.htm

4. Zuo J, Pang D, Li L, Huang Q. Spring habitat characteristics of Scutiger liupanensis in Liupanshan National Forest Park, Ningxia. In: Collection from the 13th National Wildlife and Resource Conservation Academic Seminar and the 6th Zoology of Western China Academic Seminar [Internet]. 2017 [cited 2021 Oct 20]. Available from: https://cpfd.cnki.com.cn/Article/CPFDTOTAL-DWLP201710001127.htm

5. Lei J, Xu H, Cui P, Guang Q, Ding H. The potential effects of climate change on suitable habitat for the Sichuan hill partridge (Arborophila rufipectus, Boulton): Based on the maximum entropy modelling. Pol J Ecol [Internet]. 2014 Dec 1 [cited 2021 Sep 20];62(4):771–87. Available from: https://bioone.org/journals/polish-journal-of-ecology/volume-62/issue-4/104.062.0419/The-Potential-Effects-of-Climate-Change-on-Suitable-Habitat-for/10.3161/104.062.0419.full

6. Hu R, Gu Y, Luo M, Lu Z, Wei M, Zhong J. Shifts in bird ranges and conservation priorities in China under climate change. PLoS One [Internet]. 2020 Oct 1 [cited 2021 Oct 5];15(10):e0240225. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0240225

7. Wang B, Xu Y, Ran J. Predicting suitable habitat of the Chinese monal (Lophophorus lhuysii) using ecological niche modeling in the Qionglai Mountains, China. PeerJ [Internet]. 2017 Jul 5 [cited 2021 Sep 20];5(7). Available from: https://peerj.com/articles/3477

8. Xu Y, Wang B, Zhong X, yang biao, Zhang J, Zhao C, et al. Predicting range shifts of the Chinese monal (Lophophorus lhuysii) under climate change: Implications for long-term conservation. Glob Ecol Conserv. 2020 Jun 1;22.

9. Lu N, Jing Y, Lloyd H, Sun YH. Assessing the distributions and potential risks from climate change for the Sichuan jay (Perisoreus internigrans). Condor [Internet]. 2012 May 1 [cited 2021 Sep 16];114(2):365–76. Available from: https://academic.oup.com/condor/article/114/2/365/5152772

10. Feng X, Lin C, Qiao H, Ji L. Assessment of climatically suitable area for Syrmaticus reevesii under climate change. Endanger Species Res [Internet]. 2015 May 13 [cited 2021 Sep 20];28(1):19–31. Available from: https://www.int-res.com/abstracts/esr/v28/n1/p19-31/

11. Liang J. The relationship between the spatial pattern of pterodactyl species diversity and environmental factors in Guizhou Province [Internet] [Master degree thesis]. Guizhou Normal University Master Degree Thesis. Guizhou Normal University; 2019 [cited 2021 Sep 17]. Available from: http://cdmd.cnki.com.cn/Article/CDMD-10663-1019860395.htm

12. Li X, Zhao X, Li M. Future effects of climate change and human footprint on the geographical distribution of three snub-nosed monkeys in China. Acta Theriologica Sinica [Internet]. 2021 May 27 [cited 2021 Sep 16];41(3):310–21. Available from: http://www.mammal.cn/EN/10.16829/j.slxb.150513

13. Thuiller W, Lafourcade B, Engler R, Araújo MB. BIOMOD - A platform for ensemble forecasting of species distributions. Ecography. 2009 Jun;32(3):369–73.

14. Naimi B, Araújo MB. sdm: a reproducible and extensible R platform for species distribution modelling. Ecography [Internet]. 2016 Apr 1 [cited 2021 Oct 14];39(4):368–75. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/ecog.01881