NEOTROPICAL WILD CATS SUSCEPTIBILITY TO CLIMATE CHANGE

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ABSTRACT
Ongoing climate change and the human role as dominant cause behind it are undeniable and already affecting living systems around the Globe. Nonetheless, the likely consequences of climate change to Neotropical biodiversity remains poorly understood. We used species distribution modeling to evaluate the likely effects of climate change to the eight species of wild cats that are endemic to the Neotropics. We gathered (and provide) 424 species occurrence records from museum collections and the literature. We run the analysis on the ModEco software, using four modeling algorithms and projected models into 2050 using data from International Panel on Climate Change’s last Assessment Report, under a business-as-usual emission scenario (RCP 8.5), according to four Global Circulation Models. We used an ensemble-forecasting approach to reach a consensus scenario, including only models with AUC > 0.70 for the present climate dataset. We created ensembles using the majority rule. After this procedure, we ended with two final suitability models per species, one for the present and another for the future. Model performance varied among species and was related to species’ climatic suitability area (the smaller the area, the greater the model performance), and species with the smaller ranges were predicted to lose the highest percentage of their current distribution under climate change. The projections under climate change points to important contraction of climatically suitable areas for all Neotropical felids. Except for Leopardus geoffroyii, the remaining species show, in average, a 59.2% contraction of suitable areas. The three species that are already threatened under IUCN, Leopardus jacutitus, Leopardus guigna, Leopardus tigrinus, show more than 50% contraction. Among these species Leopardus jacutitus, found only in the higher elevations of the Andes, is of special concern because highland species are particularly susceptible to a warming climate.

Keywords: biodiversity; conservation; ecologic niche modeling; Felidae; species distribution modeling.

INTRODUCTION
Ongoing climate change is undeniable, with warming of the atmosphere and oceans, shrinking of glaciers and sea level rise (IPCC 2013). Since the 50’s many of the observed changes are unprecedented over decades to millennia, and it is extremely likely that anthropogenic greenhouse gas emissions is the dominant cause of this observed changes (IPCC 2013). Human-induced climate change is already affecting living systems around
the Globe (Parmesan and Yohe 2003). About two-thirds of all known species occur in the tropics (Pimm and Raven 2000), but studies on the likely effects of climate change on biodiversity focus overwhelmingly on temperate regions (Vale et al. 2009). Predictions for the Neotropics indicate with high confidence that climate change will promote the shrinkage of Andean glaciers, the increase in stream flow in sub-basins of the La Plata River, and the increase in coral bleaching in western Caribbean, and with medium confidence that it will promote changes in extreme flows in Amazon River and discharge patterns in rivers in the western Andes (IPCC 2014). With its current adaptation capacity, the regions has a high risk of shortage in water availability in semi-arid and glacier-melt-dependent regions, flooding and landslides in urban and rural areas due to extreme precipitation, and spread of vector-borne diseases (IPCC 2014).

The likely consequences of climate change to Neotropical biodiversity are still poorly understood (Vale et al. 2009). Studies, mostly based on species distribution modeling, generally predicts medium to severe contraction of species’ geographic range (e.g. Anciães and Peterson 2006, Diniz et al. 2010, Souza et al. 2011, Loyola et al. 2014), as a consequence of disappearing of extant climates under climate change (Williams et al. 2007). Indeed, the first recorded extinction of species associated with climatic changes occurred with an endemic frog from Costa Rica (Pounds et al. 2006). There is a strong bias on the studies towards plants and vertebrates, especially birds in the literature in general (Siqueira et al. 2009, Nabout et al. 2012) and for studies with Neotropical species the bias remains (Vale and Lorini 2012). There is an important gap on the likely effects of climate change on carnivores, whose loss can cause top-down ecosystem forcing, leading to trophic downgrading and changes in ecosystems functioning (Estes et al. 2011). Here we evaluate the likely effects of climate change to the seven species of wild cats endemic to the Neotropics. We use endemic species to avoid modeling response curves that can be incomplete descriptions of species’ responses to environmental predictors, because this may compromise the projection of species’ distributions in different times than those used to calibrate the models (Thuiller et al. 2004). Neotropical endemic wild cats include wide-range and restricted-range species, which can differ in sensitivity to climate change. Often, species with restricted distribution also present a narrow niche breadth and tend to be more vulnerable to climate change (Broennimann et al. 2006). We hypothesize that species with larger current climatically suitable area would be less susceptible to future climate change, because they would be tolerant to a broader spectrum of climatic conditions.

MATERIAL AND METHODS

Species occurrence and environmental data

We gathered empirical occurrence records of Felidae species endemic...
to South America from museum collections and the literature. Whenever the description of the record was precise enough, we determined the geographic coordinates of the location from four sources (in that order): (1) The literature source or museum tag, whenever available, (2) The Ornithological Gazetteers of the Neotropics (Paynter 1982, 1989a, 1989b, 1992, 1993, 1995, 1997, Stephens and Traylor 1983, 1985, Paynter and Traylor 1991, Vanzolini 1992), (3) The Directory of Cities and Towns in the World (DCTW 2008), and (4) paper or digital maps. We gathered 423 unique geo-referenced records for the eight endemic cat species (Carnivora, Felidae): 43 records of *Leopardus braccatus* (Cope, 1889), 21 of *L. colocolo* (Molina, 1782), 122 of *L. geoffroyi* (d’Orbigny and Gervais, 1844), 15 of *L. guigna* (Molina, 1782), 59 of *L. jacobitus* (Cornalia, 1865), 57 of *L. pajeros* (Desmarest, 1816), 40 of *L. tigrinus* (Schreber, 1775), and 66 of *L. guttulus* (Hensel, 1872) (Annex 1), following Wilson and Reeder (2005) for the first six species and Trigo et al. (2013) for *L. tigrinus* and *L. guttulus*.

Following Souza et al. (2011), we used a dataset of six bioclimatic variables to model species’ distributions: maximum temperature of warmest month, temperature seasonality, precipitation of the driest month, precipitation of the wettest month, precipitation seasonality, and minimum temperature of coldest month. These six variables were selected from a set of 19 available variables (Hijmans et al. 2005), on the basis of their biological relevance, and the need to: 1) reduce the number of variables, given the relatively small number of occurrence records for some species; and 2) reduce, as much as possible, collinearity in the original set of variables.

We downloaded data for the current time and future projections under climate change from WorldClim (www.worldclim.org) at a resolution of 2.5 arc-minutes. Projected data for 2050 were based on IPCC’s Fifth Assessment Report (IPCC 2013), using Representative Concentration Pathways (RCP) 8.5 (Riahi et al. 2001), according to four different Global Circulation Models (GCMs): CNRM-CM5, GFDL-CM3, GISS-E2 and MPI-ESM-LR. The RCP 8.5, the “business as usual” climate scenario, is a pessimistic projection, with greenhouse gas emissions stabilization post-2100, and concentrations post-2200 (Meinshausen et al. 2011).

**Analysis**

We fit species climatic suitability models in the ModEco analytical package (http://gis.ucmerced.edu/ModEco), which integrates a range of modeling methods within a Geographical Information System (Guo and Liu 2010). Because different modeling algorithms can produce very different results (Diniz-Filho et al. 2009), we used four standard and distinct algorithms, combining their results into a final ensemble forecast (Araújo and New 2007): one based on environmental envelope (BIOCLIM), a statistical Generalized Linear Model (GLM) and two machine learning based, Maximum Entropy (MAXENT) and One-class
Support Vector Machine (SVM). BIOCLIM and SVM are presence-only models, GLM and MAXENT are presence versus background data models. To run GLM and MAXENT we used 10,000 background points. We randomly selected 25% of the original presence data for testing the predictions and evaluate the performance of all models.

The ModEco interface generates an estimate of the model’s performance represented by the “Area Under the ROC curve” (AUC). The AUC varies between 0 and 1, and has an intuitive interpretation: an AUC of 0.5 characterizes a model that is as good as one generated at random, a value > 0.5 characterizes a better-than-random model prediction, and a value < 0.5 characterizes a worse-than-random model prediction. We considered models with AUC ≥ 0.70 to be fair to excellent (Swets 1988, but see Lobo et al. 2008). The AUC was generated only for the model of current distribution, which is the actual model that is later projected into the future.

We used an ensemble-forecasting approach to reach a consensus scenario, in order to produce more robust predictions and reduce the model variability owing to the SDM methods and GCMs used (Araújo and New 2007, Marmion et al. 2009, Diniz-Filho et al. 2009, 2010). At the end, 20 climatic suitability models were created for each species: four algorithms x five datasets (present plus four AOGCMs future projections). We excluded models with AUC < 0.70 for the present climate dataset from further analysis. Continuous suitability results were transformed in binary predictions using the threshold that maximizes the sum of sensitivity and specificity (Liu et al. 2013). Only binary predictions (suitable or unsuitable) were combined to generate the consensus model because continuous outputs can have different meanings for different models and cannot be simply summed together (Guo and Liu 2010). We created ensembles in ArcGIS 10.1 using the majority rule, i.e. selecting as suitable only the cells defined as suitable for at least half of the models used in the ensemble (Diniz-Filho et al. 2010). After this procedure, we ended with two final suitability models per species, one for the present and another for the future. In addition, to visualize the variability of the results, we created two sets of ensembles for each species: 1) ensemble of results from different algorithms for each dataset, and 2) ensemble of GCMs based on previous ensembles for the future projections. Final climatic suitability models were projected using Albers Equal Area Projection in ArcGIS, and the area (km²) of current and future suitability calculated.

We also investigated the relationship of species range characteristics and model prediction accuracy. We run a regression analysis between current predicted suitable area and model AUC values in order to evaluate whether models fitted for species with larger climatically suitable areas would show better performance. If that is the case, then the distributions of the restricted-range species are likely more regulated by climate, and therefore they might be more susceptible to climate change.
RESULTS

Model performance, as measured by AUC values, varied greatly among algorithms, with BIOCLIM performing best, followed by SVM and GLM, and MAXENT showing very poor performance (Table 1). Model performance also varied among species (Table 1), and was negatively related to species’ suitability area for BIOCLIM and SVM: the smaller the area, the greater the model performance (Figure 1). Disregarding MAXENT AUC values for it poor results, L. colocolo, L. jacobitus, L. guigna had the best model performance (average AUC > 0.9), followed by L. geoffroyi and L. guttulus (average AUC > 0.8), and L. braccatus, L. tigrinus and L. pajeros (average AUC > 0.7). The projections under climate change points to important contraction of climatically suitable areas for all Neotropical felids, except for L. geoffroyii. The remaining species show, in average, a 59.2% contraction of suitable areas, with L. tigrinus, L. braccatus, L. jacobitus, L. guttulus and L. guigna, showing more than 50% contraction (Table 2, Figure 2).

DISCUSSION

Our study suggests that climate change could negatively affect Neotropical wild cats by eliminating a vast extent of climatically suitable areas. As expected, distribution models for species with larger climatically suitable areas showed lower predictive accuracy. This has been shown before (Thuiller et al. 2004, Hernandez et al. 2006, Syphard and Franklin 2010, but see Zank et al. 2014) and is likely because species with large geographic ranges should be tolerant to a broader spectrum of climatic conditions, and its distribution cannot be determined by climate alone. On the other hand, species with smaller geographic ranges should likely be more

| Species     | N   | BIOCLIM | SVM  | GLM  | MAXENT |
|-------------|-----|---------|------|------|--------|
| L. colocolo | 21  | 0.995   | 0.909| 0.951| 0.678  |
| L. jacobitus | 59  | 0.967   | 0.911| 0.733| 0.807  |
| L. guigna   | 15  | 0.958   | 0.842| 0.842| 0.502  |
| L. geoffroyi| 122 | 0.906   | 0.871| 0.721| 0.618  |
| L. guttulus | 66  | 0.946   | 0.928| 0.498| 0.491  |
| L. braccatus| 43  | 0.896   | 0.800| 0.522| 0.500  |
| L. tigrinus | 40  | 0.793   | 0.701| 0.538| 0.503  |
| L. pajeros  | 57  | 0.760   | 0.690| 0.538| 0.503  |

Table 1. Number of occurrence records (N), and AUC value for models of current climatically suitability of the four different algorithms used (BIOCLIM, SVM, GLM, MAXENT). Only models with AUC ≥ 0.7 were included in final ensemble distribution models (shown in bold) and projected into the future. Species presented in decreasing order of average model performance.
Table 2. Modeled distribution range size of Neotropical felids under current climate and future (2050) climate change conditions. Species presented in decreasing order of range size contraction.

| Species            | Current Area Ensemble (km²) | Future Area Ensemble (km²) | Area Lost (%) | Area Gain (%) | Area Change (%) |
|--------------------|-----------------------------|----------------------------|---------------|---------------|-----------------|
| *Leopardus tigrinus* | 10,031,197.1               | 1,323,776.4                | 86.8          | 0.6           | -86.2           |
| *Leopardus braccatus* | 6,224,047.9               | 4,794,244.6                | 77            | 2.5           | -74.5           |
| *Leopardus jacobitus* | 3,453,507.3               | 1,414,818.0                | 62.1          | 0.3           | -61.8           |
| *Leopardus guttulus* | 2,434,186.5               | 1,051,940.8                | 56.8          | 2.7           | -54.1           |
| *Leopardus guigna* | 355,928.1                  | 171,205.1                  | 54.3          | 2.4           | -51.9           |
| *Leopardus colocolo* | 624,735.0                  | 333,780.3                  | 47            | 0.5           | -46.5           |
| *Leopardus pajeros* | 13,600,721.1              | 8,194,719.2                | 40.2          | 0.5           | -39.7           |
| *Leopardus geoffroyi* | 4,740,710.6               | 4,636,930.3                | 21.7          | 19.5          | -2.2            |

Figure 1. Relationship between AUC values and size of species’ current climatically suitable areas for different distribution modeling algorithms: BIOCLIM ($r^2 = 0.941$), SVM ($r^2 = 0.779$), GLM ($r^2 = 0.416$) and MAXENT ($r^2 = 0.1283$).

regulated by climate and, therefore, more susceptible to climate change. However, because all the Neotropical cat species have relatively large geographic ranges (> 1,000,000 km², except for *L. guigna* and *L. colocolo*), climate change alone is unlikely to reduce their extent of occurrence to the 20,000 km²
threshold size that characterizes threat under the International Union for Nature Conservation criteria (IUCN 2001). It is important to note, however, that our estimates of climatically suitable areas does not equate to species’ geographic range, being generally larger than the estimated extent of occurrence of the IUCN. For *L. guigna*, for example, we predicted 356,000 km$^2$ of climatically
suitable areas at present time, while its estimated extent of occurrence is just 177,000 km² (Acosta and Lucherini 2008). Future extent of occurrence, therefore, would likely be much smaller than the figures shown in Table 2.

Climate change can act in synergy with other stressors – habitat loss and fragmentation – which represent the main threat to the three already threatened species in our study: *L. jacobitus*, *L. guigna*, *L. tigrinus*, plus *L. guttulus* that in IUCN is still taxonomically within *L. tigrinus*. We considered *L. tigrinus* and *L. guttulus* as distinct species following Trigo et al. (2013). The authors found consistent evidence for genetic differentiation between NE and SSE populations of *L. tigrinus* that strongly indicate the absence of current or recent gene flow between these units, supporting the recognition of *L. tigrinus* (Schreber 1775) for NE Brazil and *L. guttulus* (Hensel 1872) for SSE Brazil as distinct biological species. Although much of the taxonomic confusion involving the genus *Leopardus* has been clarified in recent decades, some issues remain. One such issue is the taxonomic status of the *L. tigrinus* group, until now recognized as a single species (*L. tigrinus*), but for which contradictory data and hypotheses have been suggested in the past (Trigo et al. 2013). Besides the distinctiveness between *L. tigrinus* and *L. guttulus*, previous genetic studies (Johnson et al. 1999, Trigo et al. 2008) have indicated that populations from Central America (representing *L. t. oncilla*) were very distinct from those sampled in South America (now recognized as *L. guttulus*). Therefore, there is the possibility that populations of NE Brazil, Amazon and Central America actually comprise a species complex. This could be the reason for the poor performance of the *L. tigrinus* model, with mean AUC = 0.6 (Table 1) and a broad suitable area, likely overpredicted. Also, we predicted for *L. tigrinus* a contraction of 86.2% of suitable areas in the future, the highest value among the all species. We should be cautions with this result, considering that taxonomic uncertainties has a significant effect on spatial models (Elith et al. 2013). We agree with Trigo et al. (2013) that resolving the taxonomic uncertainty surrounding *L. tigrinus* group should be a priority that should involve compiling and synthesizing genetic, morphological and ecological information about these felids across their ranges in South and Central America.

Our study also shows that *L. jacobitus* and *L. guigna* are likely to lose more than 50% of currently suitable areas due to climate change. *Leopardus guigna* has already lost most of its native temperate forest habitat in Chile and Argentina due to extensive conversion to pine forest plantations, being considered Vulnerable to extinction by IUCN (Acosta and Lucherini 2008). *Leopardus jacobitus*, found only in the higher elevations of the Andes, is of special concern because highland species are particularly susceptible to a warming climate (Pounds et al. 1999, Williams et al. 2003, Pounds et al. 2006). The species preferred habitat is naturally fragmented by deep valleys and the patchy distribution of its preferred prey,
the mountain vizcachas (*Lagidium* spp.) (Acosta et al. 2008), and it is considered Endangered due to the loss of prey base and habitat and the persecution for traditional ceremonial purposes (Acosta et al. 2008).

Our findings are consonant with predictions of likely impacts of climate change on other wild cats. The Iberian Lynx (*Lynx pardinus*), the World’s most endangered cat, may be extinct in the wild in the next 50 years, due to climate change induced range contraction and asynchrony with the redistribution of prey base, the European rabbit (*Oryctolagus cuniculus*) (Fordham et al. 2013). Similarly, the World’s larger population of tigers (*Panthera tigris*), in India’s Sundarban islands, may disappear in the next 50 years due to climate change induced sea level rise (Loucks et al. 2010).

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REFERENCES

Acosta, G., and M. Lucherini. 2008. *Leopardus guigna*. The IUCN Red List of Threatened Species. Version 2014.2. http://www.iucnredlist.org/details/15311/0. Downloaded on 30 July 2014.

Acosta, G., D. Cossios, M. Lucherini and L. Villalba. 2008. *Leopardus jacobita*. The IUCN Red List of Threatened Species. Version 2014.2. http://www.iucnredlist.org/details/15452/0. Downloaded on 30 July 2014.

Anciães, M., and A. T. Peterson. 2006. Climate change effects on Neotropical manakin diversity based on ecological niche modeling. The Condor 108:778-791, http://dx.doi.org/10. 1650/0010-5422 (2006)108 [778:CCEONM]2.0.CO;2

Araújo, M., and M. New. 2007. Ensemble forecasting of species distributions. Trends in Ecology and Evolution 22:42-47, http://dx.doi.org/10.1016/j.tree.2006.09.010

Bromannman, O., W. Thuiller, G. Hughe, G. F. Midgley, J. M. R. Alkemade and A. Guisan. 2006. Do geographic distribution, niche property and life form explain plants’ vulnerability to global change? Global Change Biology 12:1079-1093, http://dx.doi.org/10.1111/j.1365-2486.2006.01157.x

Diniz-Filho, J. A. F., J. C. Nabout, L. Bini, R. D. Loyola, T. F. Rangel, M. B. Araújo. 2009. Partitioning and mapping uncertainties in ensembles of forecasts of species turnover under climate change. Ecography 32:897-906, http://dx.doi.org/10.1111/j.1600-0587.2009.06196.x

Diniz-Filho, J. A. F., J. C. Nabout, L. Bini, R. D. Loyola, T. F. Rangel, D. Nogues-Bravo and M. B. Araújo. 2010. Ensemble forecasting shifts in climatically suitable areas for *Tropidacris cristata* (Orthoptera: Acridoidea: Romaleidae). Insect Conservation and Diversity 3:213–221, http://dx.doi.org/10.1111/j.1752-4598.2010.00090.x

Elith, J., C. H. Graham, R. P. Anderson, M. Dudik, S. Ferrier, A. Guisan, R. J. Hijmans, F. Huettmann, J. R. Leathwick, A. Lehmann, J. Li, L. G. Lohmann, B. A. Loiselle, G. Manion, C. Moritz, M. Nakamura, Y., Nakazawa, J. M. M. Overton, A. T. Peterson, S. J. Phillips, K. Richardson, R. Scachetti-Pereira, R. E. Schapire., J. Soberón, S. Williams, M. S. Wisz and N. E. Zimmermann. 2006. Novel methods improve prediction of species’ distributions from occurrence data. Ecography 29:129-151, http://dx.doi.org/10.1111/j.2006.0906-7590.04596.x

Elith J., J. Simpson, M. Hirsch and M. A. Burgman. 2013. Taxonomic uncertainty
and decision making for biosecurity: spatial models for myrtle/guava rust. Australasian Plant Pathology 42:43-51, http://dx.doi.org/10.1007/s13313-012-0178-7

Estes, J. A., J. Terborgh, J. S. Brashares, M. E. Power, J. Berger, W. J. Bond, S. R. Carpenter, T. E. Essington, R. D. Holt, J. B. C. Jackson, R. J. Marquis, L. Oksanen, T. Oksanen, R. T. Paine, E. Pikitch, W. J. Ripple, S. A. Sandin, M. Scheffer, T. W. Schoeno, J. B. Shurin, A. R. E. Sinclair, M. E. Soulé, R. Virtanen, R. and D. A. Wardle. 2011. Trophic downgrading of planet Earth. Science 333:301-306, http://dx.doi.org/10.1126/science.1205106

Fordham, D. A., H. R. Akçakaya, B. W. Brook, A. Rodriguez, P. C. Alves, E. Civantos, M. Triviño, M. J. Watts and M. B. Araújo. 2013. Adapted conservation measures are required to save the Iberian lynx in a changing climate. Nature Climate Change 3:899-903, http://dx.doi.org/10.1038/nclimate1954

Guo, Q., and Y. Liu. 2010. ModEco: Integrated Software for Species Distribution Analysis and Modeling. Version 2.00. 2010, http://gis.ucmerced.edu/ModEco

Hernandez, P.A., C.H. Graham, L.L. Master and D. L. Albert. 2006. The effect of sample size and species characteristics on performance of different species distribution modeling methods. Ecography 29:773-785, http://dx.doi.org/10.1111/j.0906-7590.2006.04700.x

Hijmans, R. J., S. E. Cameron, J. L. Parra, P.G. Jones and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25:1965-1978, http://dx.doi.org/10.1002/joc.1276.

IPCC (Intergovernmental Panel on Climate Change). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stockert, T.F., D. Qin, G.K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgeley (eds.)]. Cambridge University Press, Cambridge. 950p.

IPCC (Intergovernmental Panel on Climate Change). 2014. Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge. 1150p.

IUCN (International Union for Conservation of Nature). 2001. 2001 IUCN Red List Categories and Criteria version 3.1. http://www.iucnredlist.org/apps/redlist/static/categories_criteria_3_1. Downloaded on 30 July 2014.

Johnson, W.E., J. P. Slattery, E. Eizirik, J. H. Kim, N. M. Raymond, C. Bonacic, R. Cambre, P. Crawshaw, A. Nunes, H. N. Seuánez, M. A. Moreira, K. L. Seymour, F. Simon, W. Swanson and S. J. O'Brien. 1999. Disparate phylogeographic patterns of molecular genetic variation in four closely related South American small cat species. Molecular Ecology 8:79-92, http://dx.doi.org/10.1046/j.1365-294X.1999.00796.x

Liu, C., M. White and G. Newell. 2013. Selecting thresholds for the prediction of species occurrence with presence-only data. Journal of Biogeography 40:778-789, http://dx.doi.org/10.1111/jbi.12058

Lobo, J. M., A. Jiménez-Valverde and R. Real. 2008. AUC: a misleading measure of the performance of predictive distribution models. Global Ecology and Biogeography 17:145−151, http://dx.doi.org/10.1111/j.1466-8238.2007.00358.x

Loucks, C., S. Barber-Meyer, M. A. A. Hossain, A. Barlow and R. M. Chowdhury. 2010. Sea level rise and tigers: predicted impacts to Bangladesh’s Sundarbans mangroves. Climatic Change 98:91-298, http://dx.doi.org/10.1007/s10584-009-9761-5

Loyola, R. D., P. Lemes, F. T. Brum, D. B. Provete and L. D. S. Duarte. 2014. Clade-specific consequences of climate change to amphibians in Atlantic Forest protected areas. Ecography 37:65-72, http://dx.doi.org/10.1111/j.1600-0587.2013.00396.x

Marmion, M., M. Parviainen, M. Luoto, R. K. Heikkinen and W. Thuiller. 2009.
Evaluation of consensus methods in predictive species distribution modelling. Diversity and Distributions 15:59-69, http://dx.doi.org/10.1111/j.1472-4642.2008.00491.x.

Meinshausen, M., S. J. Smith, K. V. Calvin, J. S. Daniel, M. L. T. Kainuma, J. F. Lamarque, K. Matsumoto, S. A. Montzka, C. S. B. Raper, K. Riahi, A. M. Thomson, G. J. M. Velders, and D. van Vuuren. 2011. The RCP Greenhouse Gas Concentrations and their Extension from 1765 to 2300. Climatic Change 109:213-241. http://dx.doi.org/10.1007/s10584-011-0156-z

Nabout, J. C., P. Carvalho, M. U. Prado, P. P. Borges, K. B. Machado, K. B., Haddad, T.S. Michelan, H. F. Cunha and T. N. Soares. 2012. Trends and biases in global climate change literature. Natureza & Conservaçao 10:45-51, http://dx.doi.org/10.4322/natcon.2012.008

Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42. http://dx.doi.org/10.1038/nature01286

Paynter, R. A. Jr. 1982. Ornithological Gazetteer of Venezuela. 245p., 1st ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. 1989a. Ornithological Gazetteer of Paraguay. 59p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. 1989b. Ornithological Gazetteer of Uruguay. 111p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. 1992. Ornithological Gazetteer of Bolivia. 185p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. 1993. Ornithological Gazetteer of Ecuador. 247p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. 1995. Ornithological Gazetteer of Argentina. 1043p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. and M.A. Jr. Traylor. 1997. Ornithological Gazetteer of Colombia. 537p., 2nd ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Paynter, R. A. Jr. and M.A. Jr. Traylor. 1991. 788p., 1st ed. Ornithological Gazetteer of Brazil. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Pimm, S. L., and P. Raven. 2000. Biodiversity: extinction by numbers. Nature 403:843-845, http://dx.doi.org/10.1038/35002708.

Pounds, J. A., M. P. L. Fogden and J. H. Campbell. 1999. Biological response to climate change on a tropical mountain. Nature 398: 611-615. http://dx.doi.org/10.1038/19297

Pounds, A. J., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. L. Fogden, P. N. Foster, E. Lamarca, K. L. Masters, A. Merino-Viteri, R. Puschendorf, S. R. Ron, G. A. Sanchez-Azofeifa, C. J. Still and B. E. Young. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439:161-167, http://dx.doi.org/10.1038/nature04246.

Riahi, K., V. Krey, S. Rao, V. Chirkov, G. Fischer, P. Kolp, G. Kindermann, N. Nakicenovic and P. Rafai. 2011. RCP-8.5: exploring the consequence of high emission trajectories. Climatic Change 109:33-57, http://dx.doi.org/10.1007/s10584-011-0149-y

Siqueira, T., A. A. Padial and L. M. Bini. 2009. Mudanças climáticas e seus efeitos sobre a biodiversidade: um panorama sobre as atividades de pesquisa. Megadiversidade 5:17-26.

Souza, T. V., M. L. Lorini, M. A. S. Alves, P. Cordeiro and M. M. Vale. 2011. Redistribution of threatened and endemic Atlantic Forest birds under Climate Change. Natureza & Conservaçao 9:214-218, http://dx.doi.org/10.4322/natcon.2011.028

Stephens, L., and M. A. Jr. Traylor. 1985. Ornithological Gazetteer of the Guianas. 121p., 1st ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Stephens, L., and Traylor, M. A. Jr. 1983. Ornithological Gazetteer of Peru. 271p., 1st ed. Museum of Comparative Zoology/Harvard University, Harvard, MA.

Swets, J. A. 1988. Measuring the accuracy of diagnostic systems. Science 240:1285-1293, http://dx.doi.org/10.1126/science.3287615

Thuiller, W., L. Brotons, M. B. Araujo and S. Lavorel. 2004. Effects of restricting environmental range of data to project current
and future species distributions. Ecography 27:165-172, http://dx.doi.org/10.1111/j.0906-7590.2004.03673.x

Trigo, T. C., A. Schneider, T. G. de Oliveira, L. M. Lehugeur, L. Silveira, T. R. Freitas and E. Eizirik. 2013. Molecular data reveal complex hybridization and a cryptic species of neotropical wild cat. Current Biology 23:2528-2533, http://dx.doi.org/10.1016/j.cub.2013.10.046

Trigo, T. C., T. R. O. Freitas, G. Kunzler, L. Cardoso, J. C. R. Silva, W. E. Johnson, S. J. O’Brien, S. L. Bonatto, and E. Eizirik. 2008. Inter-species hybridization among Neotropical cats of the genus Leopardus, and evidence for an introgressive hybrid zone between L. geoffroyi and L. tigrinus in southern Brazil. Molecular Ecology 17:4317-4333, http://dx.doi.org/10.1111/j.1365-294X.2008.03919.x

Vale, M. M., and M. L. Lorini. 2012. Análise de publicações científicas existentes sobre impactos das mudanças climáticas sobre a biodiversidade. Relatório Técnico. Fundação Grupo Boticário de Proteção à Natureza, Corumbá. http://www.fundacaogrupoboticario.org.br/PT-BR/Documents/StaticFiles/Relatorio_final_para_site_FGB.pdf. Downloaded on 16 December 2013.

Vale, M. M., M. A. S. Alves, and M. L. Lorini. 2009. Mudanças climáticas: desafios e oportunidades para a conservação da biodiversidade brasileira. Oecologia Brasiliensis 13:518-535, http://dx.doi.org/10.4257/oeco.2009.1303.07

Vanzolini, P. E. 1992. A Supplement to the Ornithological Gazetteer of Brazil. 252p., 1st ed. Museu de Zoologia/Universidade de São Paulo, São Paulo, SP.

Williams, S. E. E., E. Bolitho and S. Fox. 2003. Climate change in Australian tropical rainforests: an impending environmental catastrophe. Proceedings of the Royal Society of London Series B 270:1887-1892, http://dx.doi.org/10.1098/rspb.2003.2464

Williams, J. W., S. T. Jackson, and J. E. Kutzbach. 2007. Projected distributions of novel and disappearing climates by 2100 AD. Proceeding of the National Academy of Science 104:5738-5742, http://dx.doi.org/10.1073/pnas.0606292104

Wilson, D. E., and D. M. Reeder. 2005. Mammal Species of the World: a taxonomic and geographic reference. 2142p., 3rd ed. Johns Hopkins University Press, Baltimore, MD.

Zank, C., F. G. Becker, M. Abadie, D. Baldo, R. Maneyro, and M. Borges-Martins. 2014. Climate Change and the Distribution of Neotropical Red-Bellied Toads (Melanophryniscus, Anura, Amphibia): how to Prioritize Species and Populations? PlosOne 9:e94625, http://dx.doi.org/10.1371/journal.pone.0094625.

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Annex 1: Gazetteer of 423 unique geo-referenced records used to model climatically suitable areas for seven Felidae species endemic to the Neotropics. Geographic coordinates presented in decimal degrees. Complete dataset with record source available in spreadsheet format upon request.

| Locality                              | Latitude | Longitude |
|---------------------------------------|----------|-----------|
| *Leopardus braccatus*                 |          |           |
| Aquidauana - Mato Grosso do Sul - Brazil | -20.467  | -55.800   |
| Arroyo Limetas - Conchillas - Colonia - Uruguay | -34.183  | -58.100   |
| Arroyo Perdido (rincón de Perdido y Curupí) - Soriano - Uruguay | -33.383  | -57.367   |
| Assunción - Paraguay                  | -25.267  | -57.667   |
| Asunción - Dpto. Central - Paraguay   | -25.250  | -57.667   |
| banãdos Playa Pascual - San José - Uruguay | -34.750  | -56.583   |
| Bopicua - Río Negro - Uruguay         | -33.100  | -58.017   |
| Boquerón - Porto Pinasco - Paraguay   | -22.717  | -57.833   |
| Cachoeira - Piauí - Brazil            | -7.333   | -44.350   |
| Cachoeira do Sul - Rio Grande do Sul - Brazil | -30.033  | -52.883   |
| Chamizo - Dpto. San José - Uruguay    | -34.250  | -55.933   |
| Chapada dos Guimarães - MT - Brazil   | -15.433  | -55.750   |
| Conchillas - Colonia - Uruguay        | -34.250  | -58.067   |
| Córrego São Manuel - Goiás - Brazil   | -16.400  | -50.150   |
| Cuiabá - Mato Grosso - Brazil         | -15.583  | -56.083   |
| Descalvados - Mato Grosso - Brazil    | -16.733  | -55.717   |
| Descalvados - Río Paraguay (upper) - Mato Grosso - Brazil | -16.750  | -57.700   |
| Encruzilhada do Sul - Rio Grande do Sul - Brazil | -30.533  | -52.517   |
| Encruzilha do Sul - Rio Grande do Sul - Brazil | -30.333  | -52.000   |
| Faz. Piquí - Aquidauana - Mato Grosso do Sul - Brazil | -20.467  | -55.700   |
| Fazenda Piquí - Aquidauana - Mato Grosso do Sul - Brazil | -20.467  | -55.747   |
| Fortín Juan de Zalazar - Dpto. Presidente Hayes - Paraguay | -23.100  | -59.300   |
| Hacienda Herminia - Parque San Gregorio - Dpto. San José - Uruguay | -34.683  | -56.833   |
| Júlio de Castilho - Río Grande do Sul - Brazil | -29.217  | -53.667   |
| Maracajú - Mato Grosso do Sul - Brazil | -21.633  | -55.167   |
| Maracajú - Mato Grosso do Sul - Brazil | -21.633  | -55.150   |
| Martín Chico - Est Juan Escoto - Colonia - Uruguay | -34.167  | -58.217   |

continued...
| Location                                      | Latitude | Longitude |
|----------------------------------------------|----------|-----------|
| Miranda - Mato Grosso do Sul - Brazil        | -19.850  | -56.700   |
| Palmas - Tocantins - Brazil                  | -10.167  | -48.333   |
| Parque Nacional das Emas - Goiás - Brazil    | -18.264  | -52.893   |
| Paso del Pelado - Arroyo Miguelete - Colonia - Uruguay | -34.867  | -56.217   |
| Rio Paranã - Tocantins - Brazil              | -12.667  | -48.000   |
| Rondonópolis - MT - Brazil                   | -16.467  | -48.050   |
| San Gregorio - San José - Uruguay            | -33.950  | -56.750   |
| São Luis de la Sierra - Dpto. Concepción - Paraguay | -22.417  | -57.450   |
| São Desidério - BA - Brazil                  | -12.350  | -44.967   |
| São Lourenço - Rio Grande do Sul - Brazil    | -31.367  | -51.967   |
| São Lourenço do Sul - Rio Grande do Sul - Brazil | -31.350  | -51.967   |
| Taguatinga - Distrito Federal - Brazil       | -15.817  | -44.350   |
| Tarariras - Dpto. Cerro Largo - Uruguay      | -32.467  | -55.017   |
| Três Lagoas - Mato Grosso do Sul - Brazil    | -20.800  | -51.717   |
| Tupanciretã - Mato Grosso do Sul - Brazil    | -19.483  | -56.367   |
| Zápica - Dpto. Lavelleja - Uruguay           | -33.517  | -54.917   |

**Leopardus colocolo**

| Location                                      | Latitude | Longitude |
|----------------------------------------------|----------|-----------|
| Camarones river - Pcia. Tarapacá - Chile     | -19.017  | -69.867   |
| Cauquenes - Pcia. Maule - Chile              | -35.967  | -72.350   |
| Cerro de la Campana - Quillota - Pcia. Valparaíso - Chile | -32.950  | -71.133   |
| Cerro Llai-Llai - Pcia. Valparaíso - Chile    | -32.833  | -71.267   |
| Colina - Chile                               | -33.200  | -70.683   |
| Hai-Llai - Chile                             | -33.833  | -71.000   |
| Limache - Pcia. Valparaíso - Chile           | -33.000  | -71.267   |
| Malacará - Pcia. Valparaíso - Chile          | -33.000  | -71.083   |
| Malacara opposite Quillota - Chile          | -33.833  | -71.833   |
| Marquesa - Pcia. Cochimbo - Chile            | -29.967  | -71.000   |
| montains above Catapilco lake - Pcia. Aconcagua - Chile | -32.567  | -71.283   |
| Lago Catapilco montains - Pcia. de Aconcagua - Patagonia - Argentina | -31.433  | -70.717   |
| Punta Caraumilla - Pcia. Valparaíso - Chile  | -33.100  | -71.733   |
| Putre - Tacna - Pcia. Tarapacá - Chile       | -18.200  | -69.583   |
| Santiago - Pcia. Santiago - Chile            | -33.450  | -70.667   |
| Termas de Cauquenes - Chile                  | -34.250  | -70.567   |
| Termas de Cauquenes - Peia. O’Miggins - Chile | -35.250  | -70.567   |

*continued...*
| Location Description                                               | Latitude  | Longitude |
|-------------------------------------------------------------------|-----------|-----------|
| Tiltil - Chile                                                    | -33.083   | -70.933   |
| Vegas de Curacavi - Pcia. Santiago - Chile                       | -33.400   | -71.150   |
| Viña del Mar - Pcia. Valparaíso - Chile                          | -33.033   | -71.583   |
| Vina del Mar - Valparaiso - Chile                                | -33.033   | -71.567   |

*Leopardus geoffroyi*

| Location Description                                               | Latitude  | Longitude |
|-------------------------------------------------------------------|-----------|-----------|
| Achiri - Dpto. La Paz - Bolivia                                   | -17.200   | -69.000   |
| Aguaray - Salta - Argentina                                       | -22.267   | -63.733   |
| Ajo - Buenos Aires - Argentina                                     | -36.400   | -56.967   |
| vicinity of the city of Jujuy - Pcia. Jujuy - Argentina           | -24.183   | -65.300   |
| Angostura - near river Caraparí - Pcia. Salta - Argentina         | -22.133   | -63.717   |
| Arambáu - Camaquã - Rio Grande do Sul - Brazil                    | -30.850   | -51.817   |
| Arazatí - San José - Uruguay                                       | -34.567   | -57.000   |
| Arroyo Cuaró - Paso Campameno Artigas Artigas - Uruguay           | -30.767   | -56.800   |
| Arroyo Cuaró - paso Campamento - Artigas - Uruguay                | -31.917   | -55.217   |
| Arroyo del Perdido - Soriano - Uruguay                            | -33.383   | -57.367   |
| Arroyo Limetas - Colonia - Uruguay                                | -34.183   | -58.100   |
| Arroyo Malo - Cortinas - Tacuarembó - Uruguay                     | -31.867   | -58.200   |
| Arroyo Mandiyú - Artigas - Uruguay                                | -30.483   | -57.833   |
| Arroyo Perdido (rincón de Perdido y Curupí) - Soriano - Uruguay   | -33.383   | -57.367   |
| Arroyo Porongos - Flores - Uruguay                                | -33.533   | -56.900   |
| Arroyo Tigre - near Conchillas - Colonia - Uruguay                | -34.250   | -58.067   |
| Arroyo Tres Cruces Chico - Artigas - Uruguay                      | -30.467   | -56.750   |
| Arroyo Tres Cruces Grande - Artigas - Uruguay                    | -30.283   | -57.200   |
| Asunción - Paraguay                                              | -25.267   | -57.667   |
| Atahona - Dpto. Simoca - Tucumán - Argentina                      | -27.417   | -65.283   |
| Atlántida - Canelones - Uruguay                                   | -34.767   | -55.750   |
| Bahia Blanca - Mar del Plata - Argentina                          | -38.717   | -62.283   |
| Balcarce (25 Km SE of) - Las Peditras - Buenos Aires Province - Argentina | -37.833   | -58.250   |
| Balneario Kiyú (sobre el Río de la Plata) - San José - Uruguay    | -34.833   | -56.667   |
| Bañado Tropa Vieja - Canelones - Uruguay                          | -34.700   | -56.450   |
| banâdo Tropa Vieja (Arroyo Pando) - Canelones - Uruguay           | -34.783   | -55.867   |
| Barra Arroyo Caracoles Grande (Rincón de las Gallinas, 17Km al S SW Fray Bentos) - Río Negro - Uruguay | -33.333   | -58.333   |

*continued...*
| Location                                      | Longitude  | Latitude  |
|-----------------------------------------------|------------|-----------|
| Barra de Los Arroyos Salsipuedes Grande y Salsipiedes Chico - Tacuarembo - Uruguay | -32.17     | -56.63     |
| Barra del Arroyo Caracoes Grande - 17Km SSW de Fray Bento - Uruguay                 | -33.267    | -58.350    |
| Barra del Arroyo Itapebi - Salto Grande - Salto - Uruguay                            | -31.233    | -57.917    |
| Barra del Infernillo - Tacuarembo - Uruguay                                           | -31.383    | -56.167    |
| Barra del Rio San Salvador - Soriano - Uruguay                                        | -33.483    | -58.383    |
| Bialet Massé (oeste de) - Cordoba - Argentina                                         | -31.300    | -64.467    |
| Bolsón de Pipanaco - Pcia. Catamarca - Argentina                                      | -28.117    | -66.417    |
| Cabo Polonio - Rocha - Uruguay                                                        | -34.400    | -53.783    |
| Colonia Alrear - Mendonza - Argentina                                                  | -34.967    | -67.700    |
| Colonia San Gregorio – coast of Río Uruguay - Artiga - Uruguay                       | -30.550    | -57.867    |
| Concepción - Dpto. Chinchigasta - Tucumán - Argentina                                   | -27.333    | -65.583    |
| Cortaderas - Pcia. de San Luis - Argentina                                             | -32.500    | -65.000    |
| Cruz del Eje - Pcia. Córdoba - Argentina                                               | -30.733    | -64.800    |
| Dpto. Burruyacú - Tucumán - Argentina                                                 | -26.500    | -64.917    |
| Dragones (vicinities of) - Salta - Argentina                                           | -23.250    | -63.350    |
| El Mantial - Dpto. Lules - Tucumán - Argentina                                         | -26.850    | -65.283    |
| Famatina - La Rioja - Argentina                                                       | -28.917    | -67.517    |
| Fazenda Timbaúva - Rosário do Sul - Rio Grande do Sul - Brazil                       | -30.450    | -51.383    |
| Gruta de Salamanca - Maldonado - Uruguay                                              | -34.167    | -54.667    |
| Hualfín (14km S of) - Pcia. Catamarca - Argentina                                      | -27.233    | -66.833    |
| Isla Mala - Florida - Uruguay                                                         | -34.189    | -56.339    |
| José Pedro Varela - Trienta y Tres - Uruguay                                          | -33.450    | -54.533    |

*continued...*
| Location Description | Latitude  | Longitude  |
|----------------------|-----------|------------|
| Juan Zalazar - left bank to 4Km N Río Verde - Paraguay | -23.100 | -59.300 |
| Junta de Los Ríos - San Pedro de Colalao - Dpto. Trancas - Tucumán - Argentina | -26.233 | -65.483 |
| La Florencia - Junto el río Tereco - Formosa - Argentina | -24.200 | -62.017 |
| La Ramada - Depto. Burruyacú - Tucumán - Argentina | -26.700 | -64.950 |
| Lago Martín - Río Negro - Argentina | -41.533 | -71.700 |
| Lago Nahuel Huapi - Argentina | -40.967 | -71.500 |
| Las Viboras - Dpto. de Anta - Salta - Argentina | -25.033 | -64.650 |
| Leales - Leales - Tucumán - Argentina | -27.200 | -65.300 |
| Lihue Calel National Park - Pcia. La Pampa - Argentina | -38.000 | -65.583 |
| Los Hoyos - Córdoba - Argentina | -29.867 | -64.117 |
| Los Palmares - Dpto. Santa Cruz - Bolivia | -15.750 | -61.000 |
| Los Yngleses - Ajo - Buenos Aires - Argentina | -36.517 | -56.883 |
| Loventuel - La Pampa - Argentina | -36.183 | -65.300 |
| Mar del Plata - Buenos Aires - Argentina | -38.000 | -57.550 |
| Monte Ombúes (Laguna de Castillos) - Rocha - Uruguay | -34.333 | -53.900 |
| Monteagudo (2Km SW of) - Dpto. Chuquisaca - Bolivia | -19.817 | -63.967 |
| Nahuel Huapi (frontier S of) - Patagonia - Argentina | -41.050 | -71.150 |
| Noetinger - FCCA - Pcia. de Córdoba - Argentina | -32.367 | -62.317 |
| Paraná - Entre Ríos - Argentina | -31.733 | -60.533 |
| Parque Nacional Torres del Paine - 142Km N Puerto Natales - Chile | -51.017 | -72.900 |
| Parque Santa Teresa - Rocha - Uruguay | -33.983 | -53.533 |
| Patquía - La Rioja - Argentina | -30.050 | -66.883 |
| Perforación - 50Km S of Cerro Colorado - Dpto. Santa Cruz - Bolivia | -19.917 | -62.550 |
| Pico Salamanca - Chubut - Argentina | -45.417 | -67.417 |
| Piedra Tendida - 12Km WNW Burruyacú - along Río Cajón - Dpto. Burruyacú - Tucumán - Argentina | -26.500 | -64.867 |
| Pirarajá Río Cebollati - Lavalleja - Uruguay | -33.733 | -54.750 |
| Pozo de Maza - Fortuna - Argentina | -23.567 | -61.700 |
| Pozo Hondo - Dpto. Graneros - Tucumán - Argentina | -27.817 | -65.333 |
| Puerto Ibanez, Coyhaique - Aysen Province - Chile | -46.300 | -71.933 |
| Pulque - Dpto. Chuquisaca - Bolivia | -19.233 | -65.217 |
| Punta del Arroyo Laureles -Tacuarembó - Uruguay | -31.367 | -55.783 |
| Punta San Gregório - San José - Uruguay | -34.683 | -56.833 |

*continued...*
| Location                                                                 | Latitude  | Longitude |
|-------------------------------------------------------------------------|-----------|-----------|
| Puntas del Río Olimar - Lavalleja - Uruguay                             | -33.267   | -53.867   |
| Quebrada de Los Matos - Dpto. Trancas - Tucumán - Argentina             | -26.333   | -65.367   |
| Quebrada de la Angostura - Dpto. Trancas - Tucumán - Argentina          | -26.200   | -65.517   |
| Río Arapey - 4Km SW de las Termas del Arapey - Salto - Uruguay          | -30.967   | -57.533   |
| Río Cachimayo - Dpto. Potosí - Bolivia                                  | -19.300   | -66.200   |
| Río de la Plata - 3Km al E de Martín Chico - Colonia - Uruguay          | -34.167   | -58.217   |
| Río Negro - 7Km agua arriba de la barra com el Tacuarembó - Uruguay     | -32.417   | -55.483   |
| Río Negro - frente a las islas Lobo y Del Vizcaíno - Soriano - Uruguay  | -33.383   | -58.383   |
| Río Negro - Uruguay                                                    | -33.400   | -58.367   |
| Río Olimar Chico - Trienta y Tres - Uruguay                            | -33.233   | -54.517   |
| Río Santa Lúcia Chico – 5 km from the city of Florida - Florida - Uruguay| -34.350   | -56.333   |
| San Lorenzo - Dpto. Tarija - Bolivia                                   | -21.433   | -64.783   |
| San Rafael - Mendonza - Argentina                                       | -34.600   | -68.333   |
| Santa Bárbara - Jujuy - Argentina                                      | -23.600   | -65.067   |
| Santana do Livramento - Rio Grande do Sul - Brazil                     | -30.883   | -55.517   |
| São Lourenço - Rio Grande do Sul - Brazil                               | -31.367   | -51.950   |
| Sargento Rodríguez (bolivian border near) - Paraguay/Bolivia           | -20.550   | -62.283   |
| Sierra de La Ventana - Pcia. Buenos Aires - Argentina                  | -38.050   | -62.250   |
| Soriano - Uruguay                                                      | -33.400   | -58.317   |
| Teniente Ochua - Paraguay                                              | -21.700   | -61.033   |
| Tiraqui - Dpto. Cochabamba - Bolivia                                   | -17.417   | -65.717   |
| Toay - La Pampa - Argentina                                            | -36.667   | -64.350   |
| Trancas - Trancas - Tucumán - Argentina                                | -26.217   | -65.283   |
| Valle de Los Reartes - Córdoba - Argentina                             | -31.917   | -64.583   |
| Valle Edén - Tacuarembó - Uruguay                                      | -31.833   | -56.150   |
| Victoria - La Pampa - Argentina                                        | -36.217   | -65.450   |
| Villa Dolores - Córdoba - Argentina                                    | -31.933   | -56.200   |
| Villa Hayes (Chaco Experimental Station, 295 km NW de) - Dpto. Presidente Hayes - Paraguay | -25.100   | -57.567   |
| Villa Unión - La Rioja - Argentina                                      | -29.300   | -68.200   |
| Vipos - Dpto. Trancas - Tucumán - Argentina                            | -26.483   | -65.367   |
| Zapican - Lavalleja - Uruguay                                          | -33.517   | -54.917   |

*continued...*
**Leopardus guigna**

Alto Río Simpson - near Loya de la Laguna Blanca - Chubut - Argentina

Angol - Chile

Ercilla - Pcia. Malleco - Chile

Lago Cayutuá - Pcia. Llanquihue - Chile

Lago Todos los Santos - Cayute - Chile

Limache - Valparaiso - Chile

Peninsula de Tumbes - Pcia. Concepción - Chile

Rinue - Valdivia - Chile

Río Inio - Ilha Chiloé - Chile

Sierra Nahuelbuta - Malleco - Angol - Chile

Talcahuano - Pcia. de Concepción - Chile

Temuco - Pcia. Cantía - Chile

Termas de Cauquenes - Pcia. O’Miggins - Chile

Valle del Lago Blanco - Chubut - Patagonia - Argentina

Vina del Mar - Valparaiso - Chile

**Leopardus jacobitus**

Abra del Acay - Salta - Argentina

Abra Iruya - Salta - Argentina

Acaray - Salta - Argentina

Aguilar - Jujuy - Argentina

Arequipa (57Km ENE de) - Pcia. Arequipa - Dpto. Arequipa - Peru

Arica - Tarapaca Province - Chile

Auzangate - Canchis - Cuzco - Peru

Azul Pampa - Jujuy - Argentina

Camino a San Francisco - Pcia. Catamarca - Argentina

Canchayllo - Jauja - Junín - Peru

Catamarca - Pcia. Catamarca - Argentina

Challapata area - Dpto. Oruro - Bolivia

Chichillapi - Chucuito - Puno - Peru

Coyaguaima - Jujuy - Argentina

Cuesta Blanca - Jujuy - Argentina

Cumbres Calchaquies - Dpto. Tafi Viejo - Tucumán - Argentina

continued...
Cusi Cusi Limitayoc - Jujuy - Argentina  -22.233 -66.650
El Collao - Puno - Peru  -17.136 -69.699
El Collao - Puno - Peru  -16.710 -69.727
El Toro - Jujuy - Argentina  -22.167 -65.467
El Toro - Jujuy - Argentina  -23.000 -66.717
Huactapa - Arequipa - Peru  -14.989 -72.715
Huayhuash - Bolognesi - Ancash - Peru  -10.224 -76.954
Kallapuma - Tarata - Tacna - Peru  -17.318 -69.731
Khastor - Dpto. Potosí - Bolivia  -22.283 -67.017
Khastor (3Km NE of) - Dpto. Potosí - Bolivia  -22.200 -66.967
Koyajo - Arequipa - Peru  -15.434 -72.686
Laguna Blanca - Catamarca - Argentina  -26.583 -66.943
Laguna Blanca - Cerro Colorado - Catamarca - Argentina  -26.645 -66.971
Laguna Blanca - Quebrada Tranca - Catamarca - Argentina  -26.732 -67.020
Laguna Helada - NO of Corral Quemado - Pcia. Catamarca - Argentina  -27.083 -67.150
Laguna Huaca Huasi - Cumbres Calchaquíes - Dpto. Tafi Viejo - Tucumán - Argentina  -26.683 -65.733
Lampa - Puno - Peru  -15.258 -70.461
Laraos - Yauyos - Lima - Peru  -12.333 -75.783
Morro del Zarzo - Dpto. Tafi del Valle - Tucumán - Argentina  -27.000 -65.900
near Jijuaña - El Collao - Puno - Peru  -17.231 -69.894
near Kovire - El Collao - Puno - Peru  -17.183 -69.914
near Pisacoma - Chucuito-Puno - Peru  -16.917 -69.484
Ojo de Beltra´n - Catamarca - Argentina  -25.752 -67.357
Pachacpata - Abancay - Apurimac - Peru  -13.597 -72.969
Pillones - Arequipa - Arequipa - Peru  -15.935 -71.246
Pozuelos - Cerro Medano - Jujuy - Argentina  -22.333 -65.850
Pozuelos - Quera - Jujuy - Argentina  -22.283 -65.850
Pozuelos - Sta.Catalina - Jujuy - Argentina  -22.117 -65.767
Purmamarca Lipa´n - Jujuy - Argentina  -23.733 -65.533
S.A. de los Cobres - Salta - Argentina  -24.067 -66.067
Sajama (8 km ESE of the village of) - Pcia. Sajama - Dpto. Oruro - Bolivia  -18.150 -68.900
Sajama (8 km NW of the village of) - Pcia. Sajama - Dpto. Oruro - Bolivia  -18.083 -69.067

continued...
Salinas Grandes - Jujuy/Salta - Argentina  -23.717 -66.700  
Saya - Dpto. La Paz - Bolivia -16.633 -67.450  
Tacalaya - Candarave - Tacna - Peru -17.102 -70.397  
Tacjata - Tarata - Tacna - Peru -17.174 -69.970  
Tanta - Yauyos -Lima - Peru -12.117 -76.017  
Tanta - Yauyos - Lima - Peru -12.069 -75.948  
Tintay - Sucre - Ayacucho - Peru -14.079 -73.865  
Unión - Arequipa - Peru -15.123 -72.666  
Vilama, Cerro Tinte - Jujuy - Argentina -22.483 -66.800  
Vilama, Granada - Jujuy - Argentina -22.700 -66.600  
Vilama, Pululo - Jujuy - Argentina -22.550 -66.783  

*Leopardus pajeros*

Aguaray - Peı. Salta - Argentina -22.267 -63.733  
Ambo - Dpto. Huánuco - Perú -10.083 -76.117  
Andalgalá - Peıa Camarca - Argentina -27.600 -66.333  
Antofogasta de la Sierra - Peıa. Camarca - Argentina -26.067 -67.417  
between Catán - Lil and las Coloradas - Peıa. Neuquén - Argentina -39.650 -70.600  
Cabo Tres Puntas - Peıa. Santa Cruz - Argentina -47.100 -65.550  
Catamarca - Peıa. Catamarca - Argentina -28.467 -65.783  
Ccapana - Ocongate - Cuzco - Peru -13.467 -71.417  
Cerro Antisana - Oriente - Equador -0.500 -78.133  
Cerro Antisana E side - Peıa. Napo - Equador -0.500 -78.133  
Cerro Castillo - Peıa. Magallanes - Chile -51.267 -72.350  
Cerro Pichincha, NE side - Peıa. Pichincha - Equador -0.167 -78.550  
Chorrillos Mt. - Peıa. Salta - Argentina -24.183 -66.350  
Chorrillos (Alto de) - Peıa. de Salta - Argentina -24.900 -65.483  
Collón-Curá - Peıa. Neuquén - Argentina -40.117 -70.733  
Comanche - Dpto. La Paz - Bolivia -16.967 -68.483  
Concepción - Dpto. Chicligasta - Peıa. Tucumán - Argentina -27.333 -65.583  
Condechaca - Dpto. Amazonas - Peru -5.500 -78.533  
Depto. Cale-Caleu - Peıa. La Pampa - Argentina -38.583 -64.000  
Estancia El Retoño - General San Martin - Peıa. La Pampa - Argentina -38.300 -63.650  
Estancia Huanu-luan - Peıa. Río Negro - Argentina -41.367 -69.867  

*continued...*
| Location Description                                      | Latitude  | Longitude |
|-----------------------------------------------------------|-----------|-----------|
| Estancia San José - Pcia. Buenos Aires - Argentina        | -40.133   | -62.917   |
| Hacienda Calacala – 7mi SW Patina - Dpto. Puno - Peru     | -15.233   | -70.550   |
| Hacienda Pairumani - Ilava (24MI S) - Dpto. Puno - Peru   | -16.083   | -69.667   |
| Huariaca - Dpto. Pasco - Peru                            | -14.550   | -69.800   |
| Huariaca - Dpto. Puno - Peru                             | -10.450   | -76.117   |
| Khumo - Potosí - Bolivia                                  | -22.290   | -67.070   |
| La Atrevesada - Dpto. de Audalgalá - Catamarca - Argentina| -24.367   | -64.333   |
| Lihue Calel National Park - Pcia. La Pampa - Argentina   | -38.000   | -65.583   |
| Los Totumu - Dpto. Beni - Bolivia                        | -14.000   | -63.833   |
| Maquinchao - Pcia. Río Negro - Argentina                 | -41.250   | -68.733   |
| Ministro Ramos Mexía - Pcia. Río Negro - Argentina       | -40.500   | -67.283   |
| Nahuel Huapí lake (southern border of) - Pcia. Río Negro -| -40.967   | -71.500   |
| Argentina                                                |           |           |
| Pampa - Central Argentina                                | -37.750   | -65.000   |
| Parque Nacional Torres del Paine - 142 km N Puerto       | -52.017   | -73.917   |
| Natales - Chile                                          |           |           |
| Picotani - Dpto. Puno - Peru                             | -14.550   | -69.800   |
| Picotani - Peru                                          | -0.217    | -78.500   |
| Puelches - Pcia. La Pampa - Argentina                    | -38.150   | -65.917   |
| Puerto Prat - Ultima Esperanza Inlet - Pcia. Magallanes -| -51.633   | -72.633   |
| Chile                                                    |           |           |
| Putina - Dpto. Puno - Peru                               | -14.917   | -69.867   |
| Quito - Pcia. Pichincha - Equador                        | -0.217    | -78.500   |
| Río Abiseo Nationa Park - Dpto. San Martin - Peru        | -7.083    | -76.150   |
| Río Gallegos - Pcia. Santa Cruz - Argentina              | -51.633   | -69.217   |
| Río Senguerr - Pcia. Chubut - Argentina                  | -45.533   | -68.900   |
| Río Senyer (or “Senguer”) - Chubut - Argentina           | -41.050   | -71.150   |
| Salinas de Serrezuela - Córdoba - Argentina              | -30.633   | -65.383   |
| San Blas (20mi S of) - Pcia. Buenos Aires - Argentina    | -40.550   | -62.250   |
| San Francisco de Las Pampas - Reserva La Otonga -        | -0.433    | -78.967   |
| Cotopaxi - Equador                                       |           |           |
| San Pedro de Colalau - Dpto. Trancas - Tucumán - Argentina| -26.233   | -65.483   |
| Santa Ana Reserva Provincial - Río Chico y J. B. Alberti -| -27.500   | -65.917   |
| Tucumán - Argentina                                      |           |           |
| Sierra de Santa Victoria - Pcia. Jujuy - Argentina       | -22.383   | -65.283   |
| Sierra Velasco - Pcia. La Rioja - Argentina              | -29.083   | -67.083   |
| Tarata (10 mi S) - Pcia. Tarata - Dpto. Tacna - Peru     | -17.467   | -70.033   |

*continued...*
| Location Description | Latitude | Longitude |
|----------------------|----------|-----------|
| Telén - La Pampa - Argentina | -36.267 | -65.500 |
| Tiraqui - Dpto. Cochabamba - Bolivia | -17.417 | -65.717 |
| Toay - La Pampa - Argentina | -36.667 | -64.350 |
| Toya - Pcia. La Pampa - Argentina | -36.667 | -64.350 |
| Victoria - Pcia. La Pampa - Argentina | -36.217 | -65.450 |
| Viedma - Río Negro (near) - Argentina | -40.800 | -63.000 |
| Villa Unión - La Rioja - Argentina | -29.300 | -68.200 |

**Leopardus tigrinus**

| Location Description | Latitude | Longitude |
|----------------------|----------|-----------|
| Acevedo - San Adolfo - Huila - Colombia | 1.617 | -75.983 |
| Aldeia do Porto - Rio Mearim - Maranhão - Brazil | -6.117 | -45.150 |
| Andalucia - Huila - Colombia | 1.900 | -75.667 |
| Barreiras - Bahia - Brazil | -12.133 | -45.000 |
| Caiena - French Guiana | 4.933 | -52.333 |
| Carnaubeira - Pernambuco - Brazil | -8.317 | -38.750 |
| Chingaza - Colombia | 4.517 | -73.750 |
| Crato - Serra do Araripe - Ceará - Brazil | -7.217 | -39.400 |
| Cuiaté - Paraíba - Brazil | -6.500 | -36.167 |
| Cundinamarca - Bogotá - Colombia | 4.600 | -74.083 |
| Dadanawa (40 mi W) - Rupununi - Guyana | 2.833 | -59.500 |
| E. Heller - Pozuzo - Peru | -10.067 | -75.533 |
| Engenho Riachão - Quebrangulo - Alagoas - Brazil | -9.333 | -36.400 |
| Estrada Campo Verde - Porto Platon - Amapá - Brazil | 0.700 | -51.450 |
| Faz. São Miguel - Viçosa - Alagoas - Brazil | -9.367 | -36.233 |
| Hacienda paty NE Carpish Tunnel (trail to) - Dpto. Huánuco - Peru | -9.667 | -76.083 |
| Hato La Florida - Caicara (63 km SE) - Bolívar - Venezuela | 7.417 | -65.650 |
| Ipú - Ceará - Brazil | -4.333 | -40.700 |
| Jalapão - Tocantins - Brazil | -10.471 | -46.307 |
| Jima - Pcia. de Azuay - Equador | -3.200 | -78.950 |
| Juazeirinho - Paraíba - Brazil | -7.070 | -36.580 |
| Los Patos - El Manteco (25Km SE) - Bolívar - Venezuela | 7.183 | -62.367 |
| Malvata - Cauca - Colombia | 2.483 | -76.300 |
| Mérida (near) - Venezuela | 8.600 | -71.133 |
| Parque Ecológico Municipal Professor Vasconcelos Sobrinho - Brejo dos Cavalos - Caruaru - Pernambuco - Brazil | -8.3664 | -36.0267 |

*continued...*
| Location Description | Latitude | Longitude |
|----------------------|-----------|-----------|
| Parque Nacional da Serra da Capivara - Piauí - Brasil | -8.433 | -42.317 |
| Pico Ávila - Caracas (6 km NNW) - Dpto. Federal - Venezuela | 10.550 | -66.867 |
| Ponte Rio Oricó - BR 101 km 397 - Bahia - Brazil | -14.017 | -39.450 |
| Represa Guri (2 Km NO) - Alcabala Obra (1 Km E) - Bolívar - Venezuela | 7.650 | -62.833 |
| Rio Chili - S of Manzales - Colombia | 4.117 | -75.267 |
| Rio Chili - S of Manzales - Colombia | 4.143 | -75.546 |
| Rio Putumayo drainage - Puerto Leguizamo - Amazonas - Colombia | -0.200 | -74.767 |
| Rupunani - Rupunani - Guyana | 3.000 | -58.500 |
| San Carlos de Río Negro (aprox. 3Km S) - Amazonas - Venezuela | 1.917 | -67.067 |
| San Francisco de Las Pampas - Reserva La Otonga - Cotopaxi - Equador | -0.433 | -78.967 |
| San Gabriel - Río Negro - AM - Brasil | -0.133 | -67.083 |
| San Juan - Tambopata - Dpto. Puno - Peia. Sandia - Perú | -14.117 | -71.667 |
| São Benedito - Macapá - CE | -4.883 | -40.883 |
| Senhor do Bonfim - Bahia - Brasil | -10.450 | -40.183 |
| Villa Vecencia - Meta - Colombia | 4.150 | -73.617 |

**Leopardus guttalus**

| Location Description | Latitude | Longitude |
|----------------------|-----------|-----------|
| Águas Mornas - Santa Catarina - Brazil | -27.694 | -48.824 |
| Angostura - (near river) Caraparí - Pcia. Salta - Argentina | -22.133 | -63.717 |
| Angra dos Reis - Rio de Janeiro - Brazil | -23.000 | -44.317 |
| Anitápolis - Santa Catarina - Brazil | -27.902 | -49.129 |
| Arambáu - Mun. Camaquã - Rio Grande do Sul - Brazil | -30.850 | -51.817 |
| Araguaí - Santa Catarina - Brazil | -26.370 | -48.722 |
| Bagé - Rio Grande do Sul - Brazil | -31.333 | -54.100 |
| Biguacu - Santa Catarina - Brazil | -27.494 | -48.656 |
| Blumenau - Santa Catarina - Brazil | -26.919 | -49.066 |
| Camboriú - Santa Catarina - Brazil | -27.025 | -48.654 |
| Campestre - Lins - São Paulo - Brazil | -22.767 | -47.717 |
| Campos do Jordão - São Paulo - Brazil | -22.733 | -45.583 |
| Colatina - Espírito Santo - Brazil | -19.533 | -40.617 |
| Colonia Hansa - Santa Catarina - Brazil | -26.433 | -49.233 |
| Conchas - São Paulo - Brazil | -23.017 | -48.000 |

continued...
| Location                                                                 | Latitude | Longitude |
|-------------------------------------------------------------------------|----------|-----------|
| Corupá - Santa Catarina - Brazil                                        | -26.425  | -49.243   |
| Dom Pedrito - Rio Grande do Sul - Brazil                                | -30.983  | -54.667   |
| Engenheiro - Espírito Santo - Brazil                                     | -20.767  | -41.467   |
| Engenheiro Reever - Espírito Santo - Brazil                             | -20.767  | -41.467   |
| Estrada da Faxina - Itapuã - Viamão - Rio Grande do Sul - Brazil         | -30.267  | -51.017   |
| Faz. Boa Fé - Teresópolis - Rio de Janeiro - Brazil                     | -22.383  | -42.867   |
| Fazenda Lapa, Mangaratiba - Rio de Janeiro - Brazil                     | -22.950  | -44.033   |
| Floresta da Capela - São Brás - Santa Tereza - Espírito Santo - Brazil  | -19.933  | -40.600   |
| Franca - São Paulo - Brazil                                             | -20.533  | -47.400   |
| Ilha Grande - Agra dos Reis - Rio de Janeiro - Brazil                   | -23.152  | -44.229   |
| Iporanga - Lajeado - São Paulo - Brazil                                 | -24.583  | -48.583   |
| Itapoá - Santa Catarina - Brazil                                        | -26.117  | -48.616   |
| Itararé - São Paulo - Brazil                                             | -24.117  | -49.333   |
| Itatiba - São Paulo - Brazil                                            | -23.000  | -46.850   |
| Ituverava - São Paulo - Brazil                                          | -20.333  | -47.783   |
| Jaraguá do Sul - Santa Catarina - Brazil                                | -26.486  | -49.067   |
| Joinville (near) - Santa Catarina - Brazil                             | -26.000  | -49.000   |
| Lagoa Santa-Minas Gerais - Brazil                                       | -19.633  | -43.883   |
| LinharEspírito Santo - Reserva Florestal da CVRD - Espírito Santo - Brazil | -19.500  | -42.517   |
| Lins - São Paulo - Brazil                                               | -21.667  | -49.750   |
| Nova Friburgo - Rio de Janeiro - Brazil                                 | -22.267  | -42.533   |
| Nova Teutonia - Rio Grande do Sul - Brazil                              | -27.050  | -52.400   |
| Nova Treanto - Santa Catarina - Brazil                                  | -27.286  | -48.930   |
| Nova Wurtemberg - (near) Cruz Alta - N de Santa Maria da Boca do Monte - Rio Grande do Sul - Brazil | -28.650  | -53.600   |
| Núcleo Santa Virgínia - Parque Estadual da Serra do Mar - São Luís do Paraitinga - São Paulo - Brazil | -23.333  | -45.117   |
| Paranapiacaba - São Paulo - Brazil                                      | -23.783  | -46.317   |
| Passo Fundo - Rio Grande do Sul - Brazil                                | -28.250  | -52.400   |
| Piedade - São Paulo - Brazil                                            | -23.783  | -47.417   |
| Ponte Serrada - Santa Catarina - Brazil                                 | -26.872  | -52.016   |
| Rancho Queimado - Santa Catarina - Brazil                               | -27.673  | -49.022   |
| Reserva Florestal da Companhia do Vale do Rio Doce - Linhares - Espírito Santo - Brazil | -19.200  | -40.033   |

continued...
| Location | Latitude  | Longitude |
|----------|-----------|-----------|
| Ribeirão Fundo - São Paulo - Brazil | -24.250 | -47.750 |
| Rio Caparaó - Serra do Caparaó - Minas Gerais - Brazil | -20.633 | -41.917 |
| Rio de Janeiro - Rio de Janeiro - Brazil | -22.900 | -43.233 |
| Rio Grande - São Paulo - Brazil | -23.883 | -46.417 |
| Rio Ipiranga (Tamanduá) (near) Juquiá - São Paulo - Brazil | -24.367 | -47.833 |
| Rio Yuqueri - Paraguay | -25.250 | -55.650 |
| Santa Isabel - São Lourenço do Sul - Rio Grande do Sul - Brazil | -32.117 | -52.617 |
| Santa Teresa - Bairro do Eco - Espírito Santo - Brazil | -19.917 | -40.600 |
| Santa Teresa - Espírito Santo - Brazil | -19.917 | -40.600 |
| Santo Amaro - São Paulo - Brazil | -23.550 | -46.333 |
| São Francisco - Jacarepaguá - Rio de Janeiro - Brazil | -22.950 | -43.317 |
| São Joaquim - Santa Catarina - Brazil | -28.294 | -49.932 |
| São Ludgero - Santa Catarina - Brazil | -28.317 | -49.177 |
| Sede do Parque Nacional de Itatiaia - Rio de Janeiro - Brazil | -22.383 | -44.633 |
| Serra de Macaé - Rio de Janeiro - Brazil | -22.317 | -42.333 |
| Serra do Itatins - Rio das Pedras - Iguape - São Paulo - Brazil | -24.367 | -47.217 |
| Sete Lagoas - Minas Gerais - Brazil | -19.450 | -44.233 |
| Teresópolis - Rio de Janeiro - Brazil | -22.417 | -42.967 |
| Ubatuba - São Paulo - Brazil | -23.433 | -45.067 |
| Valparaíso - São Paulo - Brazil | -21.217 | -50.850 |
| Viçosa - Minas Gerais - Brazil | -20.750 | -42.883 |
| Vidal Ramos - Santa Catarina - Brazil | -27.392 | -49.353 |