Shifts in habitat suitability and the conservation status of the Endangered Andean cat *Leopardus jacobita* under climate change scenarios

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SUPPLEMENTARY MATERIAL 1 Sources of presence data of the Andean cat *Leopardus jacobita*

Andean Cat Alliance database

BARBRY, T. & GALLARDO, G. (2006) First camera trap photos of the Andean cat in the Sajama National Park and Natural Area of Integrated Management, Bolivia. *Cat News*, 44, 23.

COSSÍOS, D., MADRID, A., CONDORI, J.L. & FAJARDO, U. (2007) Update on the distribution of the Andean cat *Oreailurus jacobita* and the pampas cat *Lynchailurus colocolo* in Peru. *Endangered Species Research*, 3, 313–320.

COSSÍOS, E., WALKER, R., LUCHERINI, M., RUIZ-GARCÍA, M. & ANGERS, B. (2012) Population structure and conservation of a high-altitude specialist, the Andean cat *Leopardus jacobita*. *Endangered Species Research*, 16, 283–294.

DELGADO, E., VILLALBA, L., SANDERSON, J., NAPOLITANO, C., BERNA, M. & ESQUIVEL, J. (2004) Capture of an Andean cat in Bolivia. *Cat News*, 40, 2.

LUCHERINI, M., HUARANCA, J.C., SAVINI, S., TAVERA, G., LUENGOS VIDAL, E. & MERINO, M.J. (2004) New photographs of the Andean cat in Argentina: Have we found a viable population? *Cat News*, 41, 4–5.

LUCHERINI, M., LUENGOS VIDAL, E. & MERINO, M.J. (2008) How rare is the rare Andean cat? *Mammalia*, 72, 95–101.

MARINO, J., BENNETT, M., COSSIOS, D., IRIARTE, A., LUCHERINI, M., PLISCOFF, P. et al. (2011) Bioclimatic constraints to Andean cat distribution: a modelling application for rare species. *Diversity and Distributions*, 17, 311–322.

NAPOLITANO, C., BENNETT, M., JOHNSON, W., O'BRIEN, S., MARQUET, P., BARRÍA, I. & IRIARTE, A. (2008) Ecological and biogeographic inferences on two sympatric and enigmatic Andean cat species using genetic identification of fecal samples. *Molecular Ecology*, 17, 678–690.

PEROVIC, P, WALKER, S. & NOVARO, A. (2003) New records of the Endangered Andean mountain cat in northern Argentina. *Oryx*, 37, 374–377.

REPPUCCI, J., GARDNER, B. & LUCHERINI, M. (2011) Estimating detection and density of the Andean cat in the high Andes. *Journal of Mammalogy*, 92, 140–147.

SANDERSON, J. (1999) Andean mountain cats (*Oreailurus jacobita*) in northern Chile. *Cat News*, 30, 25–26.

SORLI, L.E., MARTINEZ, F.D., LARDELLI, U. & BRANDI, S. (2006) Andean cat in Mendoza, Argentina. Furthest south and at lowest elevation ever recorded. *Cat News*, 44, 24.

TORRICO, O. (2009) *Distribución, abundancia relativa de rastros y dieta de carnívoros altoandinos en dos zonas de la Reserva Eduardo Avaroa, potosí-Bolivia*. Tesis de grado. Universidad Mayor de San Andrés, La Paz, Bolivia.

VILLALBA, L. (2002) Andean cat photographed in Southwest Bolivia. *Cat News*, 36, 19–20.

VISCARRA, M.E. (2008) *Distribución, densidad y dieta de carnívoros en cuatro tipos de habitats en un área de la Provincia Sud Lípez, Potosí, Bolivia*. Tesis de grado. Universidad Mayor de San Andrés, La Paz, Bolivia.

WALKER, R.S., NOVARO, A., PEROVIC, P., PALACIOS, R., DONADIO, E., LUCHERINI, M. et al. (2007) Diet of the Andean and pampas cats (*Leopardus jacobita* and *L. colocolo*) and culpeos (*Lycalopex culpaeus*) in high-altitude deserts of Argentina. *Journal of Mammalogy*, 88, 519–525.

Global Biodiversity Information Facility, contributors to the mountain viscacha *Lagidium viscacia* database (GBIF, www.gbif.org; accessed in May 2014).

Administración de Parques Nacionales, Argentina: Vertebrados de valor especial en Áreas Protegidas de la Argentina.

Administración de Parques Nacionales, Argentina: Plan de vertebrados de la Patagonia

Administración de Parques Nacionales, Argentina: Avistajes de espcies de valor especial en áreas protegidas del noreste de Argentina

LSUMZ Mammals Collection

Natural History Museum of Los Angeles County: LACM Vertebrate Collection

California Academy of Sciences: CAS Mammalogy (MAM)

UMMZ Mammal Collection

Mammal Research Institute, Polish Academy of Sciences: Mammal Collection

Varied sources. Individual references may be obtained from website (paleodb.org)

iNaturalist.org: iNaturalist research-grade observations

Conservation International: Rapid Assessment Program (RAP) Biodiversity Survey Database

MMNH Mammal Collection

Yale Peabody Museum, (c) 2009. Specimen data records available through distributed digital resources.

MHP Mammal Collection

Museum of Vertebrate Zoology (MVZ), University of California, Berkeley

Yale Peabody Museum, (c) 2009. Specimen data records available through distributed digital resources.

Royal Ontario Museum: Mammalogy Collection - Royal Ontario Museum

ROM mammal collection

Royal Ontario Museum: Mammalogy Collection - Royal Ontario Museum

University of Wyoming Museum of Vertebrates

SBMNH Vertebrate Collection

Field Museum: Field Museum of Natural History (Zoology) Mammal Collection

Museo Argentino de Ciencias Naturales: Colección Nacional de Mastozoología - Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia'

Natural History Museum, University of Oslo: Mammal collection, Natural History Museum, University of Oslo

TTU Mammal Collection

Ruedi M. Mammals housed at MHNG, Geneva. Muséum d'histoire naturelle de la Ville de Genève

South Australian Museum: South Australian Museum Australia provider for OZCAM

University of Washington Burke Museum. Mammal Collection. Seattle, Washington.

Royal Belgian Institute of Natural Sciences: RBINS collections

Division of Mammals, Museum of Southwestern Biology (MSB)

Museum of Comparative Zoology, Harvard University: Museum of Comparative Zoology, Harvard University

Administración de Parques Nacionales, Argentina: Registros biológicos en áreas protegidas obtenidos de documentos impresos

SNOMNH Mammal Collection

Yale Peabody Museum, (c) 2009. Specimen data records available through distributed digital resources.

MSU Vertebrate Collection
AMNH Mammal Collection
Museum of Vertebrate Zoology (MVZ), University of California, Berkeley

SUPPLEMENTARY MATERIAL 2 Spatial autocorrelation

Results of Moran's indexes to detect autocorrelation amongst predictors.

Predictors	Moran's index	z-score	P
Precipitation of Coldest Quarter (bio19)	0.116	0.268	0.789
Precipitation Seasonality (bio15)	1.254	2.069	0.038
Annual Precipitation (bio12)	0.947	1.562	0.118
Min. Temperature of Coldest Month (bio6)	0.203	0.346	0.729
Temperature Seasonality (bio4)	0.956	1.562	0.118
Mean Diurnal Range (bio2)	1.785	2.895	0.004

SUPPLEMENTARY MATERIAL 3 Candidate models of Andean cat habitat suitability.

Description of Maxent candidate models, performance and habitat thresholds

		Training dataset			Testing dataset			Threshold	
No. of predictors	Predictors	Regularized gain	AUC	SD	Test gain	AUC	SD	Restricted	Unrestricted
2	bio6 & bio15	1.9414	0.945	0.003	1.948	0.9428	0.031	0.1464	0.0072
4	* bio1, bio2, bio12 & bio19	1.7956	0.941	0.003	1.8096	0.938	0.029	0.2123	0.0022
4	bio2, bio6, bio15 & bio19	1.9807	0.947	0.002	2.0058	0.9432	0.025	0.1752	0.0073
6	** bio2, bio4, bio6, bio12, bio15, bio19	2.13	0.959	0.002	2.1624	0.9566	0.016	0.0211	0.0532
11	bio2, bio4, bio5, bio6, bio7, bio8, bio12, bio15, bio17, bio18 & bio19	2.2459	0.964	0.001	2.2532	0.9586	0.016	0.0511	0.0347

Predictors

bio1 = Annual Mean Temperature
bio2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
bio4 = Temperature Seasonality (standard deviation *100)
bio6 = Min Temperature of Coldest Month
bio7 = Temperature Annual Range (bio5–bio6)
bio8 = Mean Temperature of Wettest Quarter
bio12 = Annual Precipitation
bio15 = Precipitation Seasonality (Coefficient of Variation)
bio17 = Precipitation of Driest Quarter
bio18 = Precipitation of Warmest Quarter
bio19 = Precipitation of Coldest Quarter

Model parameters

Training dataset n = 113 (80%, random)
Testing dataset = 12 (20%, random)
Features = linear, quadratic and products
Regularization, ß multiplier = 1
Iterations = 1,000
Replicates = 10
Background sample: 10,000, random

SUPPLEMENTARY MATERIAL 4 Andean cat Maxent model.

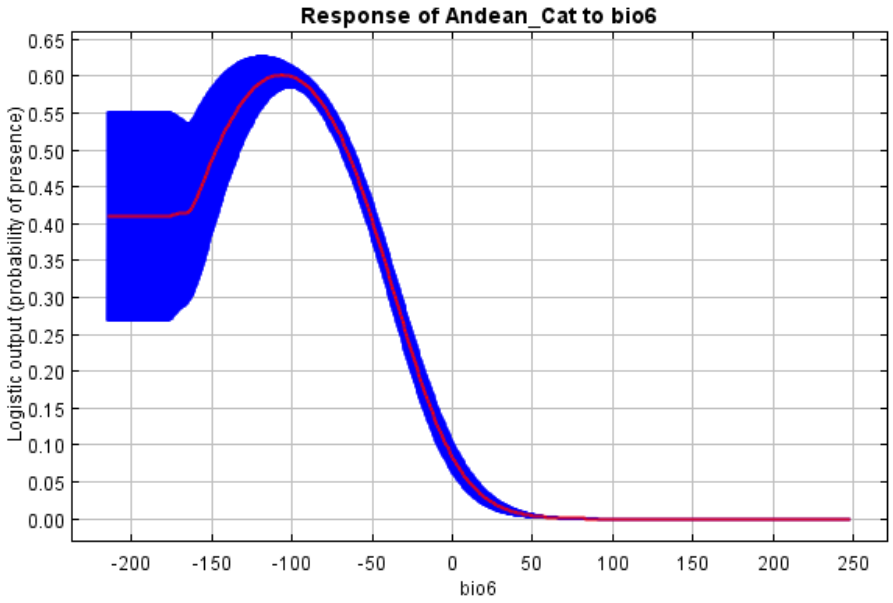
Climatic predictors and their heuristic contributions to habitat suitability models for Andean cats.

	Variable	Percent contribution	Permutation importance
Andean cat	Precipitation Seasonality	57.7	27.7
	Min Temperature of Coldest Month	27.1	37.5
	Temperature Seasonality	4.7	5.4
	Mean Diurnal Range	4.1	1.7
	Precipitation of Coldest Quarter	3.9	19.1
	Annual Precipitation	2.6	8.5

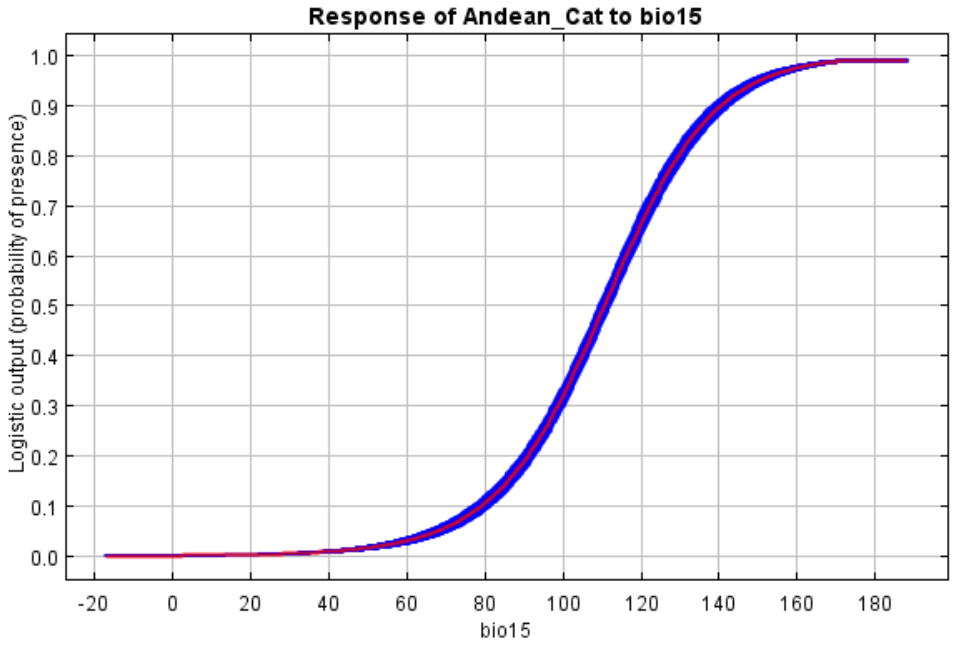
Response curves: Andean cat model

The curves show how the MaxEnt prediction varies as the main climatic variables change, while maintaining the others at their mean value.

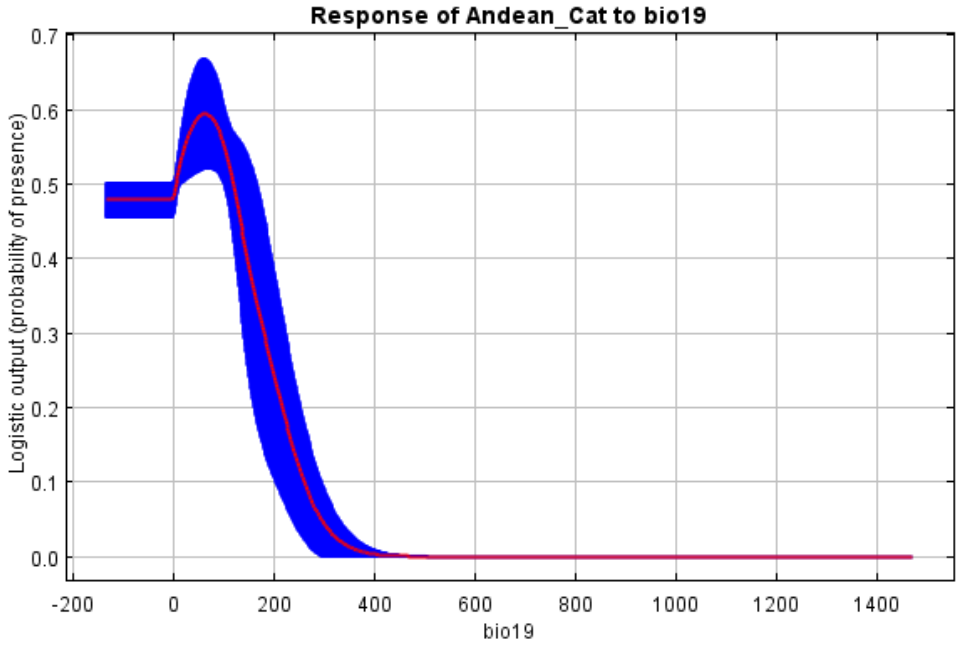
Min. Temperature of Coldest Month (bio6) (ºC*10)



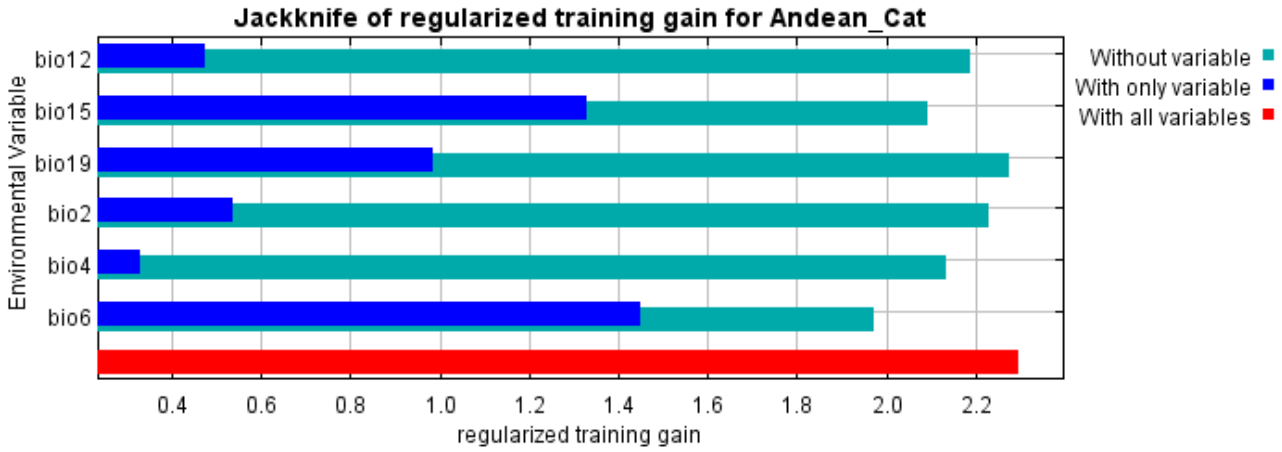
Precipitation Seasonality (bio15)



Precipitation of Coldest Quarter (bio19) (mm)



Jackknife test: Andean cat model



Supplementary Material 5 Mountain viscacha Maxent model.

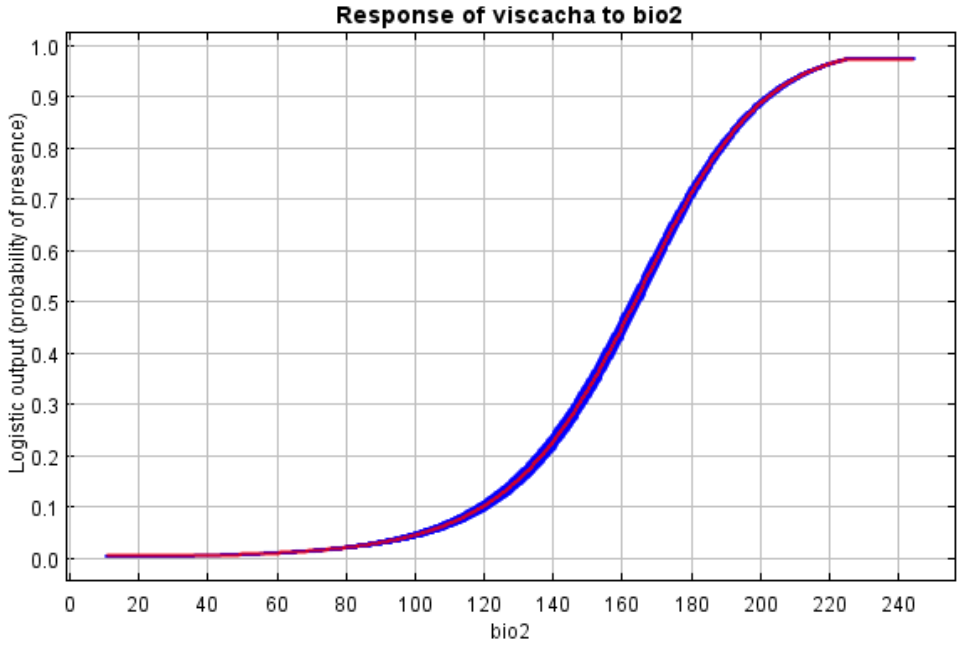
Climatic predictors and their heuristic contributions to habitat suitability models for mountain viscachas.

	Variable	Percent contribution	Permutation importance
Mountain viscacha	Temperature Mean Diurnal Range	56.2	34.9
	Mean Temperature of Wettest Quarter	35.6	53.6
	Temperature Seasonality	5.3	9.9
	Min. Temperature of Coldest Month	1.8	0.1
	Precipitation of the warmest quarter	1	1.5

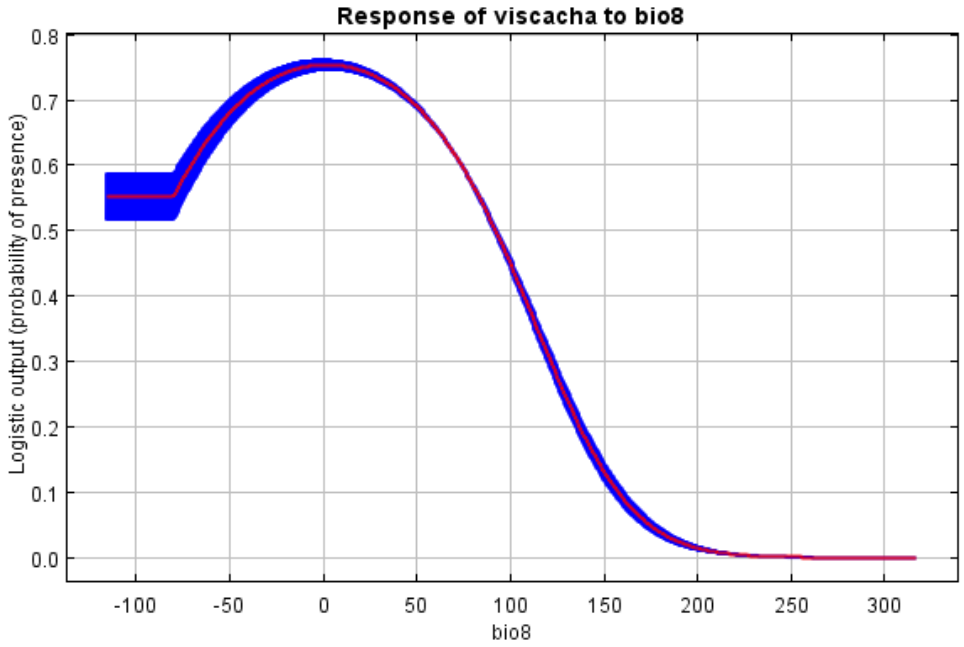
Response curves: Mountain viscacha model

The curves show how the MaxEnt prediction varies as the main climatic variables change, while maintaining the others at their mean value.

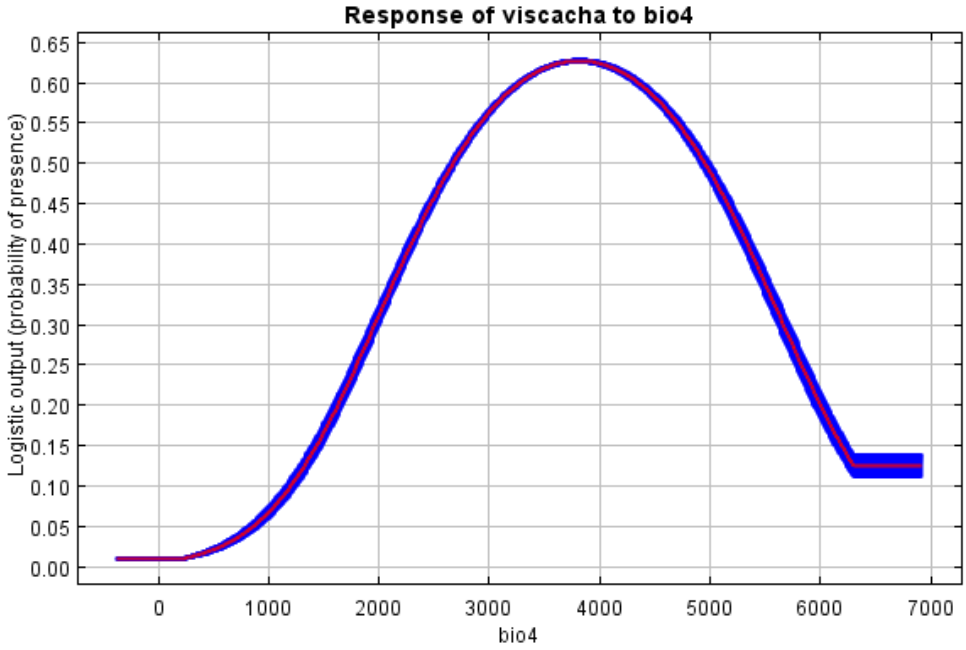
Temperature Mean Diurnal Range (bio2) (ºC*10)



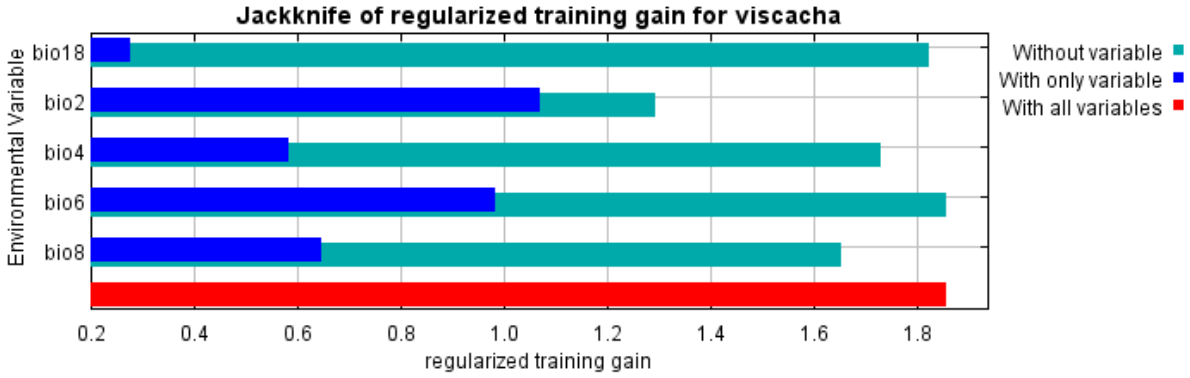
Mean Temperature of Wettest Quarter (bio8) (ºC*10)



Temperature Seasonality (bio4)



Main response curves of the viscacha model showing how the MaxEnt prediction varied as the main climatic variables changed (maintaining the others at their mean value).



SUPPLEMENTARY MATERIAL 6 Multivariate environmental similarity surfaces.

Multivariate environmental similarity surfaces (MESS; Elith et al. 2010) output generated by Maxent, comparing current and future climates, using all variables in the selected model.