**Priority areas for jaguar *Panthera onca* conservation in the Cerrado**

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Supplementary Table 1 Occurrence records of the jaguar *Panthera onca* in the Cerrado of Brazil for 2000–2009, from the National Predators Research Center ([Desbiez et al., 2013](#b16)), used in species distribution modelling (coordinates are based on SAD69).

|  |  |
| --- | --- |
| ID | Coordinates |
| 1 | 13°36'57" S, 58°37'55" W |
| 2 | 15°39'14" S, 57°11'50" W |
| 3 | 15°17'54" S, 55°53'09" W |
| 4 | 15°30'24" S, 55°15'26" W |
| 5 | 14°37'21" S, 54°22'14" W |
| 6 | 17°41'59" S, 53°22'17" W |
| 7 | 22°13'20" S, 57°01'58" W |
| 8 | 21°16'29" S, 56°41'51" W |
| 9 | 20°49'57" S, 56°44'48" W |
| 10 | 21°30'34" S, 53°10'20" W |
| 11 | 21°14'51" S, 52°07'25" W |
| 12 | 22°23'40" S, 51°08'37" W |
| 13 | 19°02'07" S, 44°30'46" W |
| 14 | 16°01'46" S, 43°04'59" W |
| 15 | 14°57'03" S, 51°55'26" W |
| 16 | 14°54'28" S, 52°16'34" W |
| 17 | 14°23'49" S, 52°14'43" W |
| 18 | 14°23'28" S, 51°41'09" W |
| 19 | 9°18'35" S, 49°57'17" W |
| 20 | 10°26'55" S, 50°06'23" W |
| 21 | 11°10'06" S, 50°30'29" W |
| 22 | 12°14'37" S, 50°45'12" W |
| 23 | 12°12'41" S, 51°19'11" W |
| 24 | 13°03'53" S, 51°16'48" W |
| 25 | 14°59'25" S, 49°57'41" W |
| 26 | 14°47'17" S, 51°33'32" W |
| 27 | 14°45'47" S, 48°55'27" W |
| 28 | 13°38'26" S, 49°49'29" W |
| 29 | 13°52'09" S, 48°19'33" W |
| 30 | 14°04'12" S, 47°39'17" W |
| 31 | 13°50'05" S, 47°25'18" W |
| 32 | 10°55'57" S, 46°45'19" W |
| 33 | 10°24'21" S, 45°50'16" W |
| 34 | 10°16'52" S, 46°10'54" W |
| 35 | 8°51'47" S, 45°18'43" W |
| 36 | 9°53'58" S, 45°30'49" W |
| 37 | 9°04'38" S, 46°21'37" W |
| 38 | 7°42'48" S, 46°00'22" W |
| 39 | 7°34'29" S, 46°17'06" W |
| 40 | 7°01'15" S, 47°02'02" W |
| 41 | 7°00'11" S, 48°00'13" W |
| 42 | 10°26'55" S, 48°30'18" W |
| 43 | 12°33'18" S, 49°07'30" W |
| 44 | 5°29'02" S, 45°14'49" W |
| 45 | 5°45'22" S, 46°22'40" W |
| 46 | 17°36'37" S, 53°17'27" W |
| 47 | 18°06'27" S, 52°54'51" W |
| 48 | 18°15'58" S, 52°53'38" W |
| 49 | 18°04'26" S, 52°43'21" W |
| 50 | 15°16'17" S, 45°47'16" W |
| 51 | 14°58'33" S, 46°19'13" W |
| 52 | 15°37'45" S, 46°25'13" W |
| 53 | 14°33'19" S, 44°37'50" W |
| 54 | 15°04'18" S, 44°28'06" W |
| 55 | 16°00'40" S, 43°02'32" W |
| 56 | 6°22'11" S, 44°53'19" W |
| 57 | 6°28'43" S, 44°43'41" W |
| 58 | 8°51'49" S, 43°31'54" W |
| 59 | 3°42'02" S, 43°22'47" W |
| 60 | 14°19'20" S, 44°22'36" W |
| 61 | 15°07'17" S, 44°14'51" W |
| 62 | 16°15'39" S, 46°39'58" W |
| 63 | 17°48'36" S, 43°46'04" W |
| 64 | 15°26'19" S, 46°37'57" W |
| 65 | 14°25'15" S, 46°10'18" W |
| 66 | 14°57'35" S, 45°50'43" W |
| 67 | 14°58'39" S, 45°50'02" W |
| 68 | 15°38'43" S, 45°38'26" W |
| 69 | 15°00'15" S, 45°27'47" W |
| 70 | 15°21'55" S, 45°29'30" W |
| 71 | 14°49'45" S, 44°57'59" W |
| 72 | 15°13'51" S, 44°58'39" W |
| 73 | 14°49'37" S, 44°58'00" W |
| 74 | 15°13'39" S, 44°58'36" W |
| 75 | 14°36'08" S, 45°15'32" W |
| 76 | 10°24'11" S, 50°05'57" W |
| 77 | 14°01'03" S, 45°13'29" W |
| 78 | 15°01'00" S, 44°25'56" W |
| 79 | 10°25'42" S, 46°41'38" W |
| 80 | 15°22'32" S, 43°57'15" W |
| 81 | 14°47'52" S, 43°44'57" W |
| 82 | 14°23'50" S, 43°55'34" W |
| 83 | 14°44'31" S, 44°24'39" W |
| 84 | 14°28'51" S, 44°28'00" W |
| 85 | 15°02'15" S, 44°36'55" W |
| 86 | 19°53'56" S, 57°13'33" W |
| 87 | 19°48'58" S, 57°08'11" W |
| 88 | 19°49'12" S, 57°01'50" W |
| 89 | 19°57'34" S, 57°17'55" W |
| 90 | 13°13'39" S, 51°39'33" W |
| 91 | 14°29'53" S, 52°28'35" W |
| 92 | 14°27'31" S, 52°24'29" W |
| 93 | 13°51'10" S, 52°23'05" W |
| 94 | 13°49'21" S, 52°22'22" W |
| 95 | 13°49'27" S, 52°14'38" W |
| 96 | 9°04'53" S, 44°21'28" W |
| 97 | 9°34'04" S, 45°28'03" W |
| 98 | 8°49'11" S, 44°08'44" W |
| 99 | 9°20'39" S, 45°26'48" W |
| 100 | 13°30'33" S, 44°27'10" W |
| 101 | 8°55'15" S, 44°08'59" W |
| 102 | 7°13'58" S, 44°38'28" W |
| 103 | 11°05'34" S, 43°08'55" W |
| 104 | 9°49'59" S, 50°10'00" W |
| 105 | 5°49'00" S, 46°07'59" W |
| 106 | 5°30'S S, 13'59"00" W |
| 107 | 6°19'59" S, 45°00'00" W |
| 108 | 7°40'00" S, 46°00'00" W |
| 109 | 9°04'59" S, 46°10'00" W |
| 110 | 9°55'00" S, 45°28'00" W |
| 111 | 12°28'00" S, 49°07'00" W |
| 112 | 7°43'00" S, 46°15'00" W |
| 113 | 9°04'59" S, 46°04'00" W |
| 114 | 7°32'57" S, 44°42'31" W |
| 115 | 7°58'58" S, 45°24'53" W |
| 116 | 7°53'20" S, 45°40'51" W |
| 117 | 7°54'26" S, 45°42'06" W |
| 118 | 7°57'56" S, 45°25'20" W |
| 119 | 20°05'57" S, 56°42'40" W |
| 120 | 20°07'01" S, 56°41'44" W |
| 121 | 20°04'48" S, 56°42'37" W |
| 122 | 20°06'47" S, 56°41'50" W |
| 123 | 20°04'58" S, 56°42'58" W |
| 124 | 20°04'27" S, 56°43'30" W |
| 125 | 9°04'49" S, 43°24'45" W |
| 126 | 8°55'11" S, 43°27'04" W |

Supplementary Table 2 Correlation among 13[?]OK environmental variables, selected for their functional relevance for the jaguar’s occurrence. Correlated layers (P ≥ 0.5) are in bold.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Environmental variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **1. EVI\_rainy season** | 1 | 0.738447 | 0.947235 | 0.57104 | 0.659447 | -0.10395 | -0.00249 | -0.00847 | 0.031876 | 0.044981 | -0.00889 | -0.10379 | 0.261656 |
| **2. EVI\_maximum** | 0.738447 | 1 | 0.645227 | 0.122897 | 0.361414 | 0.000624 | -0.00188 | -0.01581 | 0.027867 | 0.016178 | -0.05225 | 0.000669 | 0.196724 |
| **3. EVI\_mean** | 0.947235 | 0.645227 | 1 | 0.680397 | 0.863029 | -0.17041 | -0.00375 | -0.00394 | 0.022976 | 0.092928 | 0.025164 | -0.17023 | 0.277897 |
| **4. EVI\_minimum** | 0.57104 | 0.122897 | 0.680397 | 1 | 0.699701 | -0.1431 | -0.00173 | 0.003528 | 0.015421 | 0.064452 | 0.066416 | -0.14291 | 0.143673 |
| **5. EVI\_dry season** | 0.659447 | 0.361414 | 0.863029 | 0.699701 | 1 | -0.23679 | -0.00491 | 0.003855 | 0.004325 | 0.147276 | 0.072465 | -0.23661 | 0.243679 |
| 6. Slope | -0.10395 | 0.000624 | -0.17041 | -0.1431 | -0.23679 | 1 | 0.003793 | -0.03241 | 0.119849 | -0.15944 | -0.1389 | 0.199684 | -0.21982 |
| 7. Euclidean distance from urban areas | -0.00249 | -0.00188 | -0.00375 | -0.00173 | -0.00491 | 0.003793 | 1 | -0.00057 | 0.000445 | 0.003463 | <0.0001 | 0.003794 | 0.004458 |
| 8. Density of drainage | -0.00847 | -0.01581 | -0.00394 | 0.003528 | 0.003855 | -0.03241 | -0.00057 | 1 | -0.15937 | 0.021319 | 0.017513 | -0.0324 | 0.008836 |
| 9. Euclidean distance from water | 0.031876 | 0.027867 | 0.022976 | 0.015421 | 0.004325 | 0.119849 | 0.000445 | -0.15937 | 1 | -0.11106 | -0.03298 | 0.119837 | -0.09789 |
| **10. Mean annual temperature** | 0.044981 | 0.016178 | 0.092928 | 0.064452 | 0.147276 | -0.15944 | 0.003463 | 0.021319 | -0.11106 | 1 | 0.12019 | -0.85934 | 0.244497 |
| 11. Ruggedness | -0.00889 | -0.05225 | 0.025164 | 0.066416 | 0.072465 | -0.1389 | <0.0001 | 0.017513 | -0.03298 | 0.12019 | 1 | -0.13885 | 0.027584 |
| **12. Elevation** | -0.10379 | 0.000669 | -0.17023 | -0.14291 | -0.23661 | 0.199684 | 0.003794 | -0.0324 | 0.119837 | -0.85934 | -0.13885 | 1 | -0.21982 |
| 13. Mean annual rainfall | 0.261656 | 0.196724 | 0.277897 | 0.143673 | 0.243679 | -0.21982 | 0.004458 | 0.008836 | -0.09789 | 0.244497 | 0.027584 | -0.21982 | 1 |

Supplementary Table 3 Additional occurrence records of jaguars in the Cerrado for 2007–2017, from the National Predators Research Center, used for validation of species distribution models (datum SAD69).

|  |  |
| --- | --- |
| ID | Coordinates |
| 1 | 18°34'01" S, 52°56'28" W |
| 2 | 9°21'36" S, 50°01'48" W |
| 3 | 19°56'31" S, 56°17'46" W |
| 4 | 9°04'26" S, 44°21'32" W |
| 5 | 10°02'10" S, 45°41'28" W |
| 6 | 9°18'00" S, 50°03'00" W |
| 7 | 9°04'48" S, 43°24'47" W |
| 8 | 18°04'44" S, 52°45'14" W |
| 9 | 14°57'07" S, 45°45'36" W |
| 10 | 15°15'50" S, 45°19'16" W |
| 11 | 14°40'12" S, 45°23'02" W |
| 12 | 19°57'04" S, 56°18'04" W |
| 13 | 19°58'01" S, 56°16'26" W |
| 14 | 19°55'37" S, 56°15'04" W |
| 15 | 19°57'14" S, 56°17'42" W |
| 16 | 22°18'54" S, 49°04'16" W |
| 17 | 14°59'06" S, 45°47'20" W |
| 18 | 14°56'28" S, 45°45'18" W |
| 19 | 15°54'22" S, 48°28'41" W |
| 20 | 16°00'25" S, 48°41'20" W |
| 21 | 16°40'19" S, 49°22'19" W |
| 22 | 13°25'52" S, 50°39'50" W |
| 23 | 15°27'40" S, 47°46'16" W |

Supplementary Material 1 Cerrado land-cover map update

The map was based on the map of PROBIO I (MMA, 2004a,b), updated with Landsat images for 2002. The map features 36 land-cover classes (Table 1), with a detailed description of the vegetation according to IBGE (1992). This map was updated in the project PROBIO II (MMA, 2009) for 2009. This updated map was then compared to the new human-use land cover mapped in 2010 (Bayma et al., 2011) in a geographical information system, erasing the vegetation information and updating for new human-use land cover.

Table 1 Land-cover classes in the Cerrado, Brazil.

|  |  |
| --- | --- |
| Category | Land-cover class |
| Forest | Open evergreen alluvial |
| Seasonal deciduous upper plains |
| Seasonal deciduous highlands |
| Closed evergreen upper plains |
| Closed evergreen alluvial |
| Seasonal semi-deciduous lower plains |
| Seasonal semi-deciduous highlands |
| Open evergreen upper plains |
| Seasonal semi-deciduous alluvial |
| Seasonal semi-deciduous upper plains |
| Seasonal deciduous lower plains |
| Mixed evergreen highlands |
| Savannah with gallery forest | Forested grassland savannah |
| Shrubland savannah |
| Arboreal savannah |
| Savannah park |
| Grassland savannah |
| Arboreal grassland savannah |
| Forested savannah |
| Savannah without gallery forest | Shrubland savannah |
| Arboreal savannah |
| Savannah park |
| Grassland savannah |
| Arboreal grassland savannah |
| Forested savannah |
| Human-use land cover | Cultivated areas |
| Reforestation areas |
| Pastures |
| Mining influence |
| Urban influence |
| Other | Secondary vegetation |
| Pioneer vegetation type 1 |
| Pioneer vegetation type 2 |
| Pioneer vegetation type 3 |
| Vegetation refuges |
| Water |

References

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Supplementary Material 2 Model selection

We generated 24 models (Table 1) with various combinations of uncorrelated layers (c. 250 m resolution) in *Maxent* to identify the best combination of environmental variables for jaguar occurrence. We set runs with 500 iterations, 10,000 background points, auto features, jackknife to measure variable importance, response curves, and random seed. We generated models with 10 replicates, using bootstrapping methods, with 80% of the points for training and 20% for testing (Blach-Overgaard et al., 2009; Trabucco et al., 2010). We compared the area under the receiver operating curve (AUC), ∆AICc, omission error and binomial probability of three thresholds for all models (Table 2). The 10 percentile training presence logistic threshold was chosen for model comparison (Morato et al., 2014), with the best balance between omission error andan intermediate threshold value. For model selection we ranked models according to AUC and chose the one with the highest AUC, smaller ∆AICc and low omission error (Pearson, 2010). Only six models had an acceptable AUC (≥ 0.75) and a low omission error (< 0.25). Model seven (Table 2 and 3) was considered to be the best because of its higher AUC value and smaller ∆AICc when compared to models with lower omission error.

Table 1 Models used for jaguar distribution in the Cerrado. All models had four fixed environmental layers (land-use cover, vegetation height, Euclidean distance from urban areas, mean annual rainfall).

|  |  |
| --- | --- |
| Model | Complementary environmental layers |
| 1 | EVImax, EVImin, elevation, density of drainage, ruggedness |
| 2 | EVImax, EVImin, elevation, Euclidean distance from water, slope |
| 3 | EVImax, EVImin, elevation, Euclidean distance from water, ruggedness |
| 4 | EVImax, EVImin, elevation, density of drainage, slope |
| 5 | EVImax, EVImin, temperature, density of drainage, ruggedness |
| 6 | EVImax, EVImin, temperature, Euclidean distance from water, slope |
| 7 | EVImax, EVImin, temperature, Euclidean distance from water, ruggedness |
| 8 | EVImax, EVImin, temperature, density of drainage, slope |
| 9 | EVImax, EVIdry, elevation, density of drainage, ruggedness |
| 10 | EVImax, EVIdry, elevation, Euclidean distance from water, slope |
| 11 | EVImax, EVIdry, elevation, Euclidean distance from water, ruggedness |
| 12 | EVImax, EVIdry, elevation, density of drainage, slope |
| 13 | EVImax, EVIdry, temperature, density of drainage, ruggedness |
| 14 | EVImax, EVIdry, temperature, Euclidean distance from water, slope |
| 15 | EVImax, EVIdry, temperature, Euclidean distance from water, ruggedness |
| 16 | EVImax, EVIdry, temperature, density of drainage, slope |
| 17 | EVImax, EVIdry, temperature, density of drainage, slope, ruggedness |
| 18 | EVImax, EVIdry, temperature, Euclidean distance from water, slope, ruggedness |
| 19 | EVImax, EVIdry, elevation, density of drainage, slope, ruggedness |
| 20 | EVImax, EVIdry, elevation, Euclidean distance from water, slope, ruggedness |
| 21 | EVImax, EVImin, elevation, density of drainage, slope, ruggedness |
| 22 | EVImax, EVImin, temperature, Euclidean distance from water, slope, ruggedness |
| 23 | EVImax, EVImin, temperature, density of drainage, slope, ruggedness |
| 24 | EVImax, EVImin, elevation, Euclidean distance from water, slope, ruggedness |

Table 2 Statistical model selection indices. Best performance shown in bold.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model | AUC test | AUC SD | AICc | ∆AICc | Minimum training presence | | | 10 percentile | | | Maximum sensitivity plus specitivity | | |
| Threshold | Omission | P | Threshold | Omission | P | Threshold | Omission | P |
| 7 | 0.81 | 0.05 | 4,165.00 | 228.50 | 0.06 | 0.01 | 0.12 | 0.27 | 0.21 | < 0.001 | 0.35 | 0.23 | < 0.001 |
| 24 | 0.80 | 0.0448 | 4,051.66 | 115.16 | 0.07 | 0.08 | 0.02 | 0.27 | 0.28 | 0.0001 | 0.30 | 0.24 | 0 |
| 21 | 0.80 | 0.045 | 6,473.04 | 2536.54 | 0.08 | 0.04 | 0.03 | 0.27 | 0.23 | 0.0003 | 0.32 | 0.20 | 0 |
| 22 | 0.79 | 0.0472 | 4,208.02 | 271.52 | 0.08 | 0.08 | 0.04 | 0.29 | 0.28 | 0.005 | 0.37 | 0.28 | 0 |
| 9 | 0.79 | 0.05 | 4,304.54 | 368.04 | 0.07 | 0.04 | 0.15 | 0.28 | 0.21 | < 0.001 | 0.33 | 0.21 | < 0.001 |
| 13 | 0.78 | 0.05 | 4,257.25 | 320.75 | 0.09 | 0.04 | 0.06 | 0.25 | 0.19 | < 0.001 | 0.36 | 0.24 | < 0.001 |
| 11 | 0.78 | 0.05 | 4,536.10 | 599.60 | 0.08 | 0.03 | 0.13 | 0.28 | 0.24 | < 0.001 | 0.34 | 0.23 | < 0.001 |
| 23 | 0.78 | 0.0495 | 4,680.44 | 743.94 | 0.07 | 0.08 | 0.06 | 0.28 | 0.29 | 0.0002 | 0.36 | 0.33 | 0 |
| 2 | 0.78 | 0.05 | 4,713.10 | 776.60 | 0.07 | 0.05 | 0.18 | 0.25 | 0.24 | 0.01 | 0.37 | 0.29 | < 0.001 |
| 20 | 0.78 | 0.05 | 8,856.94 | 4920.44 | 0.07 | 0.04 | 0.11 | 0.31 | 0.31 | < 0.001 | 0.33 | 0.28 | < 0.001 |
| 12 | 0.77 | 0.06 | 4,005.42 | 68.92 | 0.10 | 0.06 | 0.11 | 0.28 | 0.25 | < 0.001 | 0.41 | 0.30 | < 0.001 |
| 1 | 0.77 | 0.05 | 4,888.71 | 952.21 | 0.09 | 0.03 | 0.20 | 0.29 | 0.29 | 0 | 0.37 | 0.29 | < 0.001 |
| 17 | 0.76 | 0.06 | **3,936.50** | 0.00 | 0.10 | 0.06 | 0.06 | 0.28 | 0.31 | 0.01 | 0.38 | 0.31 | < 0.001 |
| 8 | 0.76 | 0.06 | 3,948.09 | 11.59 | 0.08 | 0.06 | 0.11 | 0.27 | 0.29 | < 0.001 | 0.33 | 0.28 | < 0.001 |
| 14 | 0.76 | 0.05 | 3,986.58 | 50.08 | 0.09 | 0.05 | 0.10 | 0.27 | 0.25 | < 0.001 | 0.35 | 0.27 | < 0.001 |
| 6 | 0.76 | 0.05 | 4,082.94 | 146.44 | 0.09 | 0.06 | 0.09 | 0.30 | 0.29 | 0.01 | 0.35 | 0.26 | < 0.001 |
| 5 | 0.76 | 0.06 | 4,247.35 | 310.85 | 0.08 | 0.05 | 0.10 | 0.27 | 0.27 | < 0.001 | 0.35 | 0.25 | < 0.001 |
| 19 | 0.75 | 0.06 | 4,186.49 | 249.99 | 0.07 | 0.07 | 0.18 | 0.25 | 0.27 | < 0.001 | 0.30 | 0.28 | < 0.001 |
| 16 | 0.74 | 0.05 | 3,968.18 | 31.68 | 0.11 | 0.04 | 0.09 | 0.28 | 0.30 | 0.03 | 0.34 | 0.28 | < 0.001 |
| 10 | 0.74 | 0.06 | 4,400.31 | 463.81 | 0.09 | 0.05 | 0.18 | 0.27 | 0.34 | 0.03 | 0.43 | 0.35 | < 0.001 |
| 3 | 0.74 | 0.06 | 4,596.94 | 660.44 | 0.08 | 0.06 | 0.18 | 0.29 | 0.32 | 0.01 | 0.35 | 0.30 | < 0.001 |
| 18 | 0.73 | 0.06 | 4,057.60 | 121.10 | 0.09 | 0.06 | 0.17 | 0.30 | 0.37 | 0.05 | 0.33 | 0.31 | < 0.001 |
| 15 | 0.73 | 0.06 | 4,151.96 | 215.46 | 0.09 | 0.07 | 0.22 | 0.27 | 0.30 | 0.02 | 0.38 | 0.31 | < 0.001 |
| 4 | 0.71 | 0.06 | 4,059.45 | 122.95 | 0.09 | 0.09 | 0.23 | 0.25 | 0.30 | 0.06 | 0.38 | 0.36 | < 0.001 |

Table 3[Not cited above. Now cited] Parameter values of models, jaguar core conservation areas (JCCAs) and jaguar conservation units (JCUs).

|  |  |
| --- | --- |
| Parameters | Values |
| AUC | 0.805 ± SD 0.046 |
| Omission error | 0.209 |
| P value | 0.002 |
| Median suitability value | 0.614 |
| Suitable area (km²) | 687,059 |
| No. of JCCAs | 62 |
| Area of JCCAs (km²) | 555,796 |
| No. of JCUs | 427 |
| Area of JCUs (km²) | 219,100 |
| Area of JCUs inside protected areas (km²) | 23,662 |

References

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Supplementary Material 3 Relationships between probability of jaguar presence and significant environmental predictors of presence.

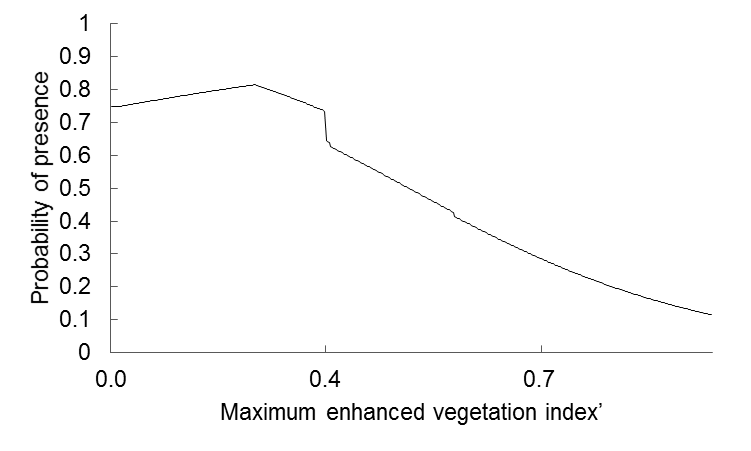


Fig 1 Marginal response curve[Meaning? We explained better in the methods the name of this graph, an output of Maxent] for maximum enhanced vegetation index.

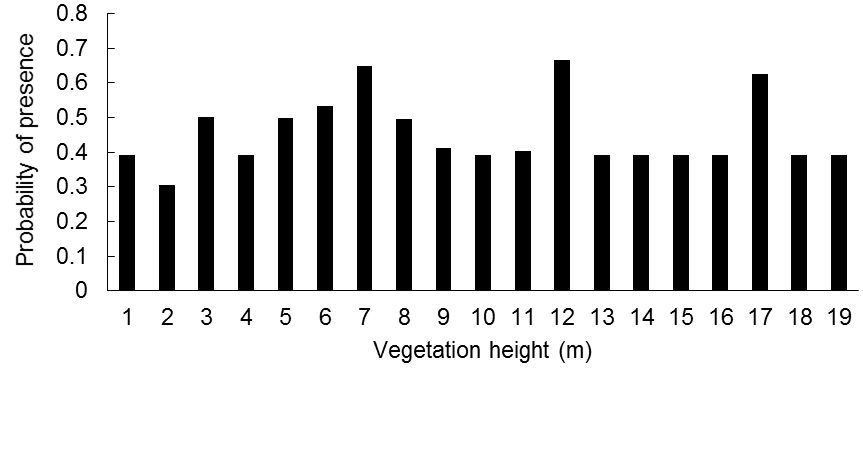


Fig. 2. Relationship between probability of jaguar presence and vegetation height.

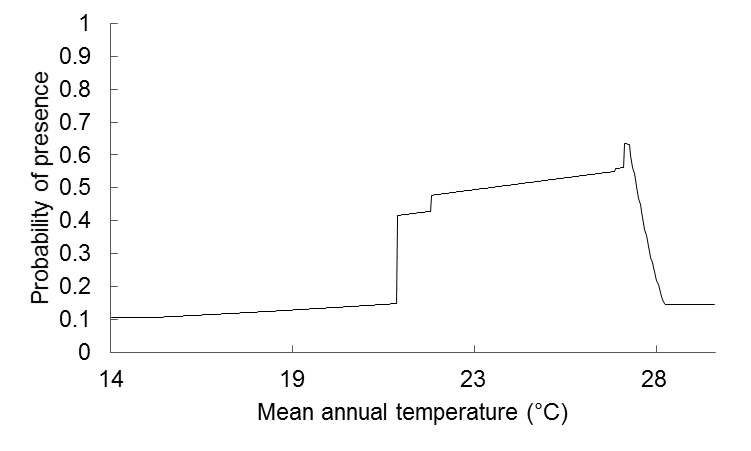


Fig. 3 Marginal response curve We explained better in the methods the name of this graph, an output of Maxent for mean annual temperature.