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Can landscape units map help the conservation of Spix´s Macaw (*Cyanopsitta spixii*)?

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Abstract

Several studies suggest that *Cyanopsitta spixii* occurs mainly in *Tabebuia caraiba* (Mart.) Bureau gallery woodlands of northern Bahia (Brazil). The recently creation of two Protected Areas (2018) is combining efforts to ensure the reintroduction and conservation of this "Critically Endangered (Possibly Extinct in the Wild)" macaw. Achieving species conservation requires the definition of priority conservation areas and habitat recovery and the landscape cartography can be a relevant tool for this purpose. This research aimed to verify if there is a correlation between Landscape Units map and the Spix's macaw occurrence. Here the Protected Areas landscape is described in three main components: land cover, landforms and surficial geology and then overlapped to occurrence map of Spix's macaw and its most similar syntopic parrot, *Primolius maracana*. Spatial correlation revealed a correspondence of 85.48% for the group of landscapes of dry rivers Caatingas and both parrot occurrence, indicating the importance to prioritize fluvial Landscapes conservation, combined with conservation strategies that must include the local population, since this are important territories for their survival.

Keywords: Protected Areas; Endangered species; Landscape cartography; Caatinga.

Resumo

Vários estudos sugerem que a ararinha-azul (*Cyanopsitta spixii*) ocorre principalmente em florestas de galeria de *Tabebuia caraiba* (Mart.) Bureau do norte da Bahia (Brasil). A recente criação de duas Áreas Protegidas (em 2018) está combinando esforços para garantir a reintrodução e conservação desta arara "Criticamente Ameaçada (Possivelmente Extinta na Natureza)". Conseguir a conservação das espécies requer a definição de áreas de conservação prioritárias e recuperação de habitats, e a cartografia de paisagens pode ser uma ferramenta relevante para este propósito. Esta pesquisa teve como objetivo verificar se há correlação entre o mapa das Unidades de Paisagem e a ocorrência de ararinha-azul. Aqui, a paisagem das Áreas Protegidas é descrita em três componentes principais: cobertura da terra, relevo e geologia superficial e, em seguida, sobreposta pelo mapa de ocorrência da ararinha-azul e sua ave sintópica mais semelhante, a *Primolius maracana*. A correlação espacial considerando a ocorrência de ambas as espécies revelou uma correspondência de 85,48% para o grupo de paisagens de Caatingas de rios secos, indicando a importância de priorizar a conservação de paisagens fluviais, combinada com estratégias de conservação que devem incluir a população local, pois são territórios importantes para sua sobrevivência.

Palavras-chave: Áreas Protegidas; Espécie ameaçada; Cartografia de paisagem; Caatinga.

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I. Introduction

The Spix's macaw (*Cyanopsitta spixii*) is one of the most critically endangered parrots in the world with the last known wild individual seen between 1990 and 2000 (VERRALL, 1994; BUTCHART et al., 2018). Accordingly to the BirdLife International (2018), if there is a remaining population it is likely to be tiny (fewer than 50 individuals) and therefore it is treated as Critically Endangered (Possibly Extinct in the Wild).

Currently there are approximately 129 individual Spix's macaws all in captivity (ICMBIO, 2018). In 2012 the Chico Mendes Institute for Biodiversity Conservation (ICMBio) published the National Action Plan for Spix's macaw *Cyanopsitta spixii* (PAN Ararinha-Azul) in order to increase the population managed in captivity and the habitat restoration of historical occurrence of the species, aiming its reintroduction into the wild (BARROS et al., 2012; ICMBIO, 2018).

Achieving the species conservation requires the definition of priority conservation areas and habitat recovery (BARROS et al., 2012). A mandatory management tool for Brazilian protected areas is the creation of internal zoning in order to establish the management plan (LAW 9.985, 2000). During the zoning process, the most fragile areas are identified and decided which are more relevant to conservation and to recovery (IBAMA, 1992). Accordingly to BRUGGEMAN et al (2015), the effectiveness of land use zoning depends on methods that control spatial selection biases, whereas land zones are not subject to homogeneous deforestation and degradation pressures. The identification and characterization of potentially significant patches within a landscape are important steps in developing an understanding of ecosystem processes within a given landscape (TONGWAY et al., 1989).

Thus, the landscape cartography can be a relevant tool to avoid biases of selecting land units, whereas it is a methodology to recognize and represent the main environmental differences in a territory (CAVALCANTI, 2017). This set of procedures to describe and represent landscapes is defined by territory differentiation into homogenous areas also known as Landscape Units.

A Landscape Unit can be defined as a territory portion distinguished mainly by its structure, reflecting details of natural processes operational index (such as radiation balance, water balance, primary productivity) (ISACHENKO, 2007). Processes that leads to landscape structure development are affected in different levels by climate and land conditions, including geomorphometrics (elevation, exposure, position, slope, curvature) and lithology (chemical composition, depth, permeability, water storage capacity, water permanence in the

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substrate). These conditions generally reflect the geomorphological and climatic history and its geological conditions.

Land conditions has influence on plant succession and pedogenesis processes development. Nevertheless, local disturbance has more influence on these processes than general land configuration (SILVA; SOUZA, 2018). Different disturbances (deforestation, fire, erosion and mass movements, overgrazing, prolonged drought) impact the properties of soils and vegetation with distinct magnitudes.

The cartography of landscapes deals with the delimitation of homogeneous areas for the decision-making on the territory. Landscapes are composed of several different attributes and choosing some of them to delimit units is still a major mapping problem (KHOROSHEV, 2016). Three questions are essential to solve the problem of delimitation: functional representativeness, accuracy and precision. Landscape units need to be representative of ecological and environmental functioning. The boundaries need to be defined correctly and be clear enough to allow and aid the decision.

Climatic and bioclimatic variables are useful to explain different environmental conditions of plant and animals as well some geomorphic and pedogenic processes (ZOMER et al., 2008; FICK; HIJMANS, 2017). However, the use of geo-statistics to unveiling the limits of climatic and bioclimatic variables reduce limits precision and classification accuracy.

On the other hand, land cover is an important component to circumscribe landscape units because they can be represented as geographic objects with clear boundaries. Land cover as biophysical classification of terrain are widely recognized as a factor affecting climate and ecological processes (OTTERMAN, 1974; ALLEN; HOLLING, 2002). Classifications based on remote sensing products and geoprocessing are used to implement land cover mapping.

Nevertheless, landscapes are more complex than simply biophysical cover. The effects of topography and surficial geology on morpho-dynamic, pedogenesis, and ecology are still recognized as important features of landscapes (SWANSON et al., 1988; STALLINS, 2006). These attributes have been mapped through Classifications of elevation data modified by numerical terrain models and geology defined by aero geophysics (EVANS, 2012; RIBEIRO; MANTOVANI; LOURO, 2013).

Therefore, landscape structure description should consider climate, land conditions and its pedological and vegetation cover, considering the impacts due to local disturbances. When applying landscape cartography methods, the landscape description includes natural and/or anthropic contrasts observations (CAVALCANTI, 2017; CAVALCANTI, 2018).

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Here the landscape cartography is applied to test if there is a correlation between the landscape units and *Cyanopsitta spixii* occurrence. We tested the following hypotheses: (i) Spix's macaw occurrence is related to Landscape units; (ii) The relation between occurrence and Landscape units can indicate priority areas to conservation and habitat recovery. The focus on this species occurrence is justified by the dearth of its distributional knowledge (JUNIPER; YAMASHITA, 1991; BARROS et al., 2012). The results are expected to be helpful to zoning and management of both protected areas owing to its integrative nature whereas the landscape structure.

II. MATERIAL AND METHODS

2.1 Study site

In 1990, the Brazilian government established a Permanent Committee for Spix's macaw recovery, which was dissolved after 12 years due to internal conflicts. In 2005, the Brazilian Institute of Environment and Renewable Natural Resources (in Portuguese its acronym is IBAMA) formalized a work group and, in 2010, the National Action Plan for Spix's macaw *Cyanopsitta spixii* was elaborated (BARROS et al., 2012). In June 2018, all these efforts has culminate in creation of two Protected Areas (PA) located in the northern Bahia, semiarid inland of northeastern Brazil (DECREE N° 9.402, 2018).

The smaller one (about 30,000 ha), a Wildlife Refuge (hereafter its Portuguese acronym REVIS) is where the reintroduction will be held. This PA is a strictly protected area with its equivalent category III of the International Union for Conservation of Nature (IUCN) (MMA, 2018a). The other is a surrounding area called Environmental Protection Area (hereafter its Portuguese acronym APA) of more than 90,000 ha and meant to ensure a land use compatible with the species conservation. This PA is a sustainable use reserve with its equivalent category V of the International Union for Conservation of Nature (IUCN) (MMA, 2018b).

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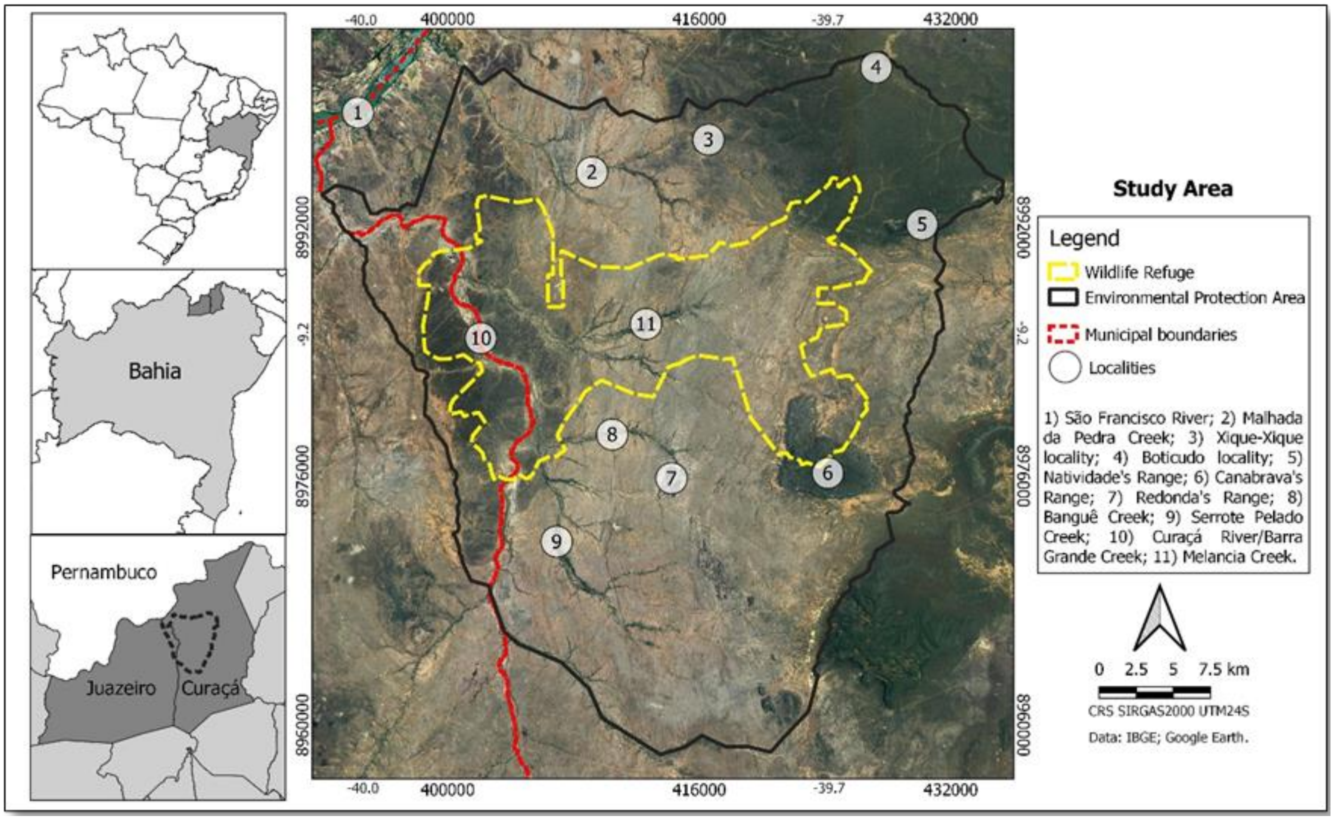

Figure 1. Location map of the Spix's macaw Wild Refuge (yellow) and Environmental Protection Area (black), highlighting the main localities.

Both PA are located in the species endemic historical region: the south bank of the São Francisco river in the semiarid of Bahia state in northeastern Brazil (HAMMER; WATSON, 2012). It covers two municipalities: Curaçá and Juazeiro (580 km far from the state capital Salvador). Accordingly to Worldclim data this region has one of the lowest Aridity Index in Brazilian semiarid (0.21), characterized by its low rainfall index and the rain irregularity. Due to this condition, the gallery woodland dominated by caraiba trees (*Tabebuia caraiba* [Mart.] Bureau) apparently required to Spix's macaw nesting (JUNIPER; YAMASHITA, 1991; BIRDLIFE INTERNATIONAL, 2018) is also a required landscape unit for human livelihoods.

One of the main human disturbances to the Caatinga's ecosystem is chronic impacts caused by continuous overexploitation of the native vegetation, such as slash-and-burn agriculture, fuelwood harvesting, and browsing by livestock (SILVA et al., 2018). In the PA region, it is not different, especially during long dry periods, when the woodlands tend to be the last water reserve for biotic community and growing of subsistence crops and pastures to land users (JUNIPER; YAMASHITA, 1991).

The majority of local population depends on the agricultural activity for its survival and suffer from poor support at all political and administrative levels and infrastructure, mainly water supply (SAVE BRASIL,

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2013). Thus, the habitat on which the species apparently depend on is also of great value to the local population.

The APA creation is extremely important to the REVIS maintenance, whereas it goal is to restore the regnant ecosystem known as Caatinga and reduce local conflicts by integrating people of the region into the conservation process and highlighting its benefits to them (ICMBIO, 2018). Thus, the further methodology was applied to both Protected Areas (approximately 120,000ha).

2.2 Data collection

The correlation between Spix's macaw occurrence and Landscape Units was evaluate from (i) a cartographic model of Landscape Units and (ii) the *Cyanopsitta spixii* Distribution map and its records frequencies by Landscape Units (Figure 2).

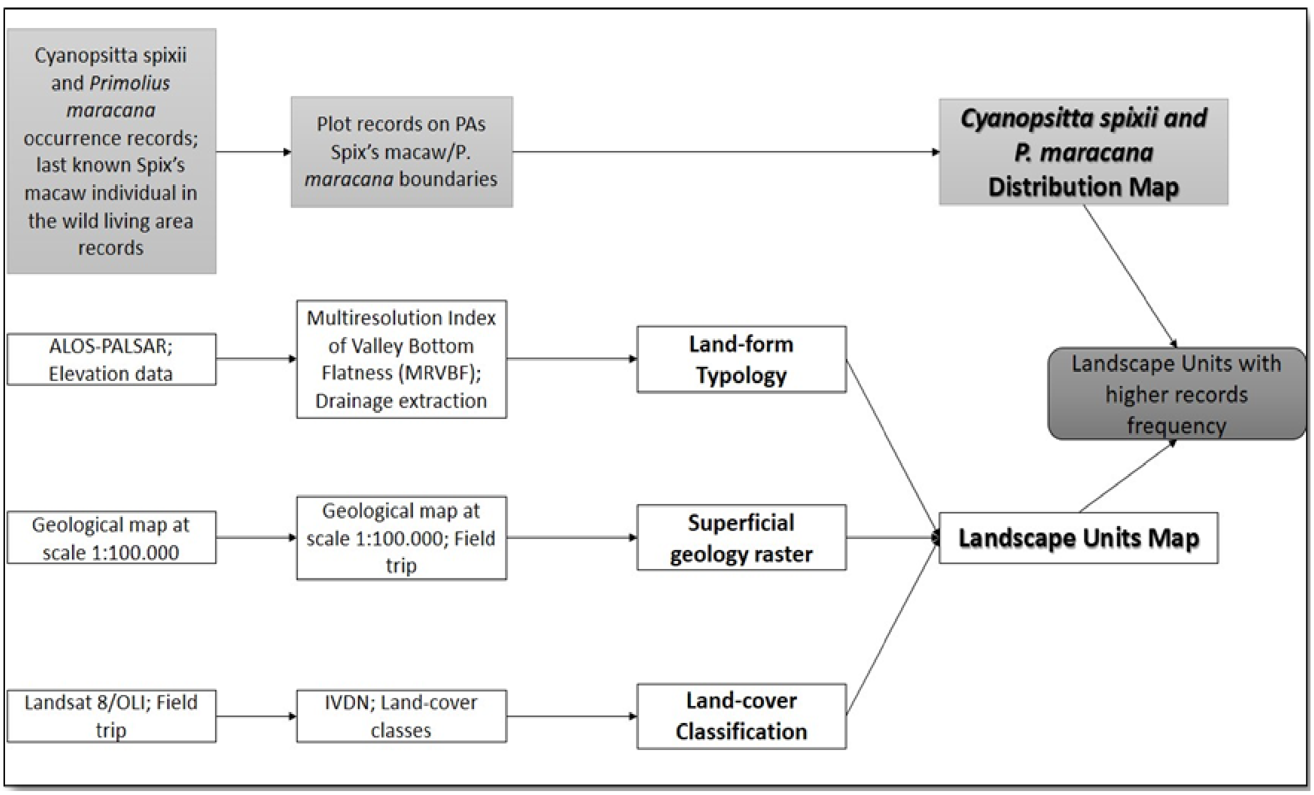

Figure 2. Methodological research phases.

The cartographic model assumes the idea of geographic objects as being more useful for differentiation and mapping of landscape units, based on three main components: (i) land cover, (ii) landforms and (iii) surficial geology. These three features allow precise boundaries and functional representativeness thus improving support of spatial decision making (CAVALCANTI, 2017).

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The land cover classification was determined with the auxiliary of the LANDSAT 8/OLI image of a dry season. Since this area has a low population density and the main land use is extensive livestock (SAVE BRASIL, 2013), the land cover contrasts were determined by Normalized Difference Vegetation Index – NDVI (ROUSE et al., 1974), aiming to emphasize vegetation contrasts. In addition, fieldwork was held to the area in the following periods: January 2017, July 2017 and February 2018. Based on the field observations three plant physiognomy patterns were identified: shrub-arboreal open to sparse formation; dense shrub formation; and open to close arboreal formation. These formation limits were geocoded with the support of a GPS receptor and, afterwards, used to the NDVI image classification.

The landforms differentiation followed the detailed landform typology for the Brazilian semiarid (CAVALCANTI; LIRA; CORRÊA, 2016). The terrain differentiation was performed using numerical modeling based on ALOS-PALSAR data with spatial resolution of 12.5 m (ASF DAAC, 2015). The data were compiled by the Multiresolution Index of Valley Bottom Flatness – MRVBF (GALLANT; DOWLING, 2003), which allowed to highlight the alluvial plains contour, as well as the definition of slope, pediments, peak and levels environment. The MRVBF method did not highlight fluvial network details. Thus, to distinguish the stream by smaller spatially expression, it was necessary to extract the drainage network from the elevation data using the D8 model (WANG; LIU, 2006; O'CALLAGHAN; MARK, 1984).

Surficial geology was based on 1:100,000 geological map of Barro Vermelho sheet (SANTOS-SOBRINHO, 2018). This portable document file was georeferenced (SIRGAS 2000; UTM 24S) and the contour lines were digitized on the computer screen. Fieldwork allowed to aggregate information for interpretation of the predominant texture in soils derived from different mapped lithotypes. After the scan, the file was rasterized.

The *Cyanopsitta spixii* distribution map was composed with three main data sources: (i) Last recorded sightings of wild Spix's macaw; (ii) Spix's macaw records from different sources; (iii) Spix's most similar syntopic parrot, *Primolius maracana* records. These locations were plotted on a map and were clipped by the Spix's macaw PAs boundaries.

2.3 Maps and data analyses

The landform and land cover matrix files were reclassified and added to the lithotypes. The result was converted to vector format (vectorization), creating a previous file of landscape units (UPs). It was verified that the UP file contained more than 180,000 polygons and that most of them had a not representative area for presentation in the final map (1 km²). These smaller polygons (slivers) were eliminated using specific

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geoprocessing module. Another problem encountered was the fact that the units contours inherited the rectangular shape of the pixel from the satellite and radar images (pixelated or pixelated character). It was necessary to smooth the contours using a polygon smoothing tool to improve cartographic quality.

Subsequently, the attribute table was edited to include only essential landscape information. Since landforms have direct relationship with surficial geology (ISACHENKO, 2007, BESTELMEYER et al., 2003), in the legend it was decided to indicate: geomorphological unit (conjugating form and surficial geology) and the cover of the land, e.g. alluvial plains with open and closed arboreal caatinga.

For layout composition, warm contrast hue (in the sense of ITTEN, 1970) were preferably chosen for slope areas, slopes and tops of mountain ranges and inselbergs and cold shades for pediments, glacis and drainage channels. Geomorphological units with different types of cover were colored with variations of value and/or chroma. The open to closed tree cover was represented with more saturated chrome and higher brightness values; sparse vegetation with low chroma; low dense shrub cover with intermediate values and chroma. However, the final choice was subjugated to the harmony of the set of map colors.

The application of the MRVBF, NDVI, the reclassification, addition and vectorization of the files were performed in SAGA GIS 6.4 (CONRAD et al., 2015). The georeferencing, editing of the attributes table, area calculation, waste elimination, polygon smoothing and map layout were performed in QGIS 2.18 (QGIS, 2016).

In sense of verify the relation of Spix's macaw occurrence to Landscape units, the distribution map was overlapped to the Landscape Units map. It was determined the occurrences frequencies for each Landscape Unit and tested if the result corroborate indicate habitat for Spix's macaw in the literature (JUNIPER; YAMASHITA, 1991; BARROS et al., 2012; BIRDLIFE INTERNATIONAL, 2018).

III. RESULTS AND DISCUSSION

Landscapes groups

The Landscape mapping allowed the definition of 24 landscape units clustered into four main groups: (1) Caatinga of Pediplains; (2) Caatinga of Desert Pavements; (3) Caatinga of Dry River Environments; (4) Caatinga of Residual Landforms (Figure 3).

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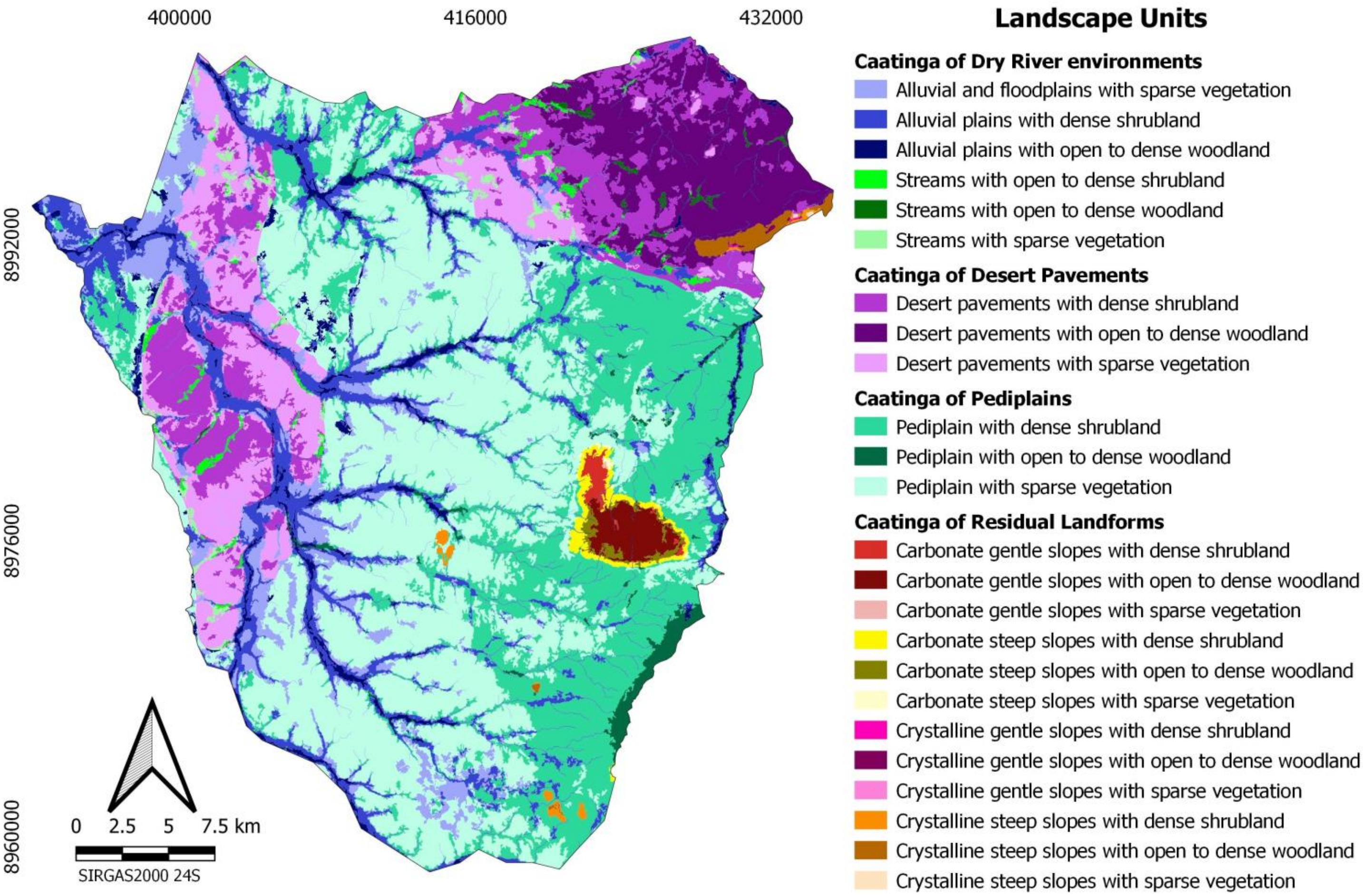

Figure 3. Landscape Units Map of Spix's macaw Protected Area in Curaçá and Juazeiro (Bahia – Brazil). Three main elements defined the units limit: Landforms, Geology cover and Land Cover.

Caatinga of Pediplains is the predominant coverage group (54.02%). The Pediplain with sparse vegetation (Fig. 4 E) represents one of the Landscape Units. Caatinga of Desert Pavements and Caatinga of Dry River Environments cover almost the same area (23% and 19.59%). The Desert pavement with open to dense woodland (Figure 4 B; D) is one example of Desert Pavements. Floodplain with sparse vegetation (Figure 4 D) and Alluvial plain with open to dense woodland (Figure 4 F) are example of Dry River Environment. Caatinga of Residual Landforms cover the smaller area (2.66%) and Gneiss slope with sparse vegetation (Figure 4 A) is an example of this group Landscape Unit.

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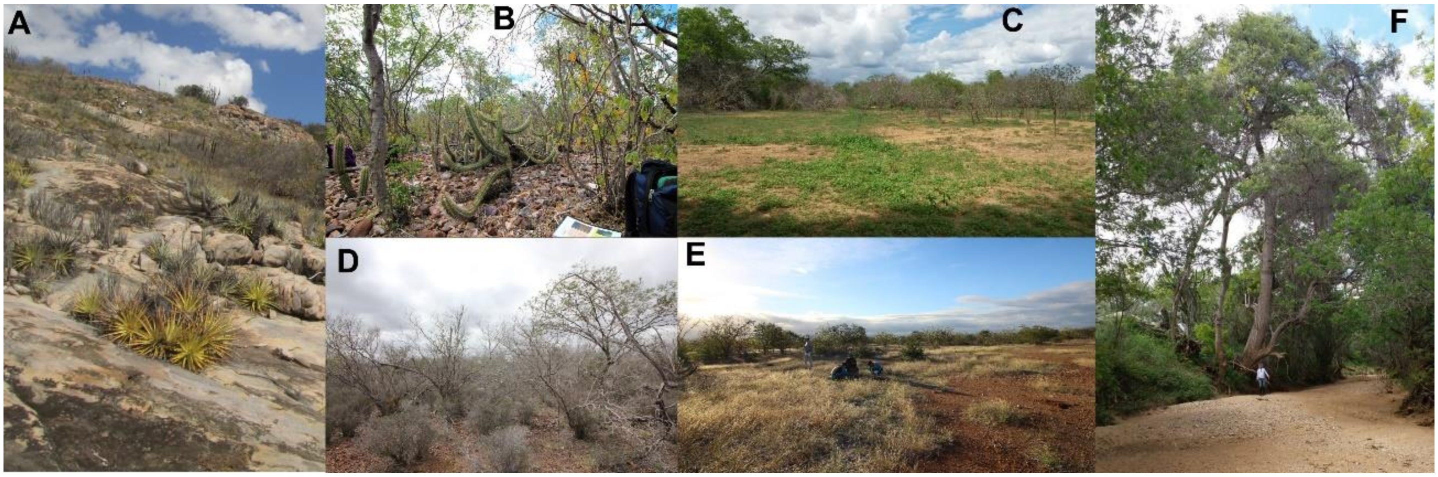

Figure 4. Examples of Landscape Units: A) Gneiss slope with sparse vegetation; B) Desert pavement with open to dense woodland; C) Deforested Floodplain with sparse vegetation; D) Desert pavement with open to dense woodland; E) Pediment of the Pediplain with sparse vegetation; F) Alluvial plain with open to dense woodland.

Caatinga of Dry Rivers Environment

Covering PAs 236 km², this group includes from dissected surfaces in which the moisture gradient favors a dense vegetation cover to alluvial plains and terraces deeply incised (> 2 m) along the Curaçá Creek and its main tributaries, such as Melancia Creek. This deep alluvial plains and terraces, with a width of up to 1 km, are usually sandy or with intercalations of sandy and medium texture, common to alluvial deposits.

In lower fluvial stream order, water, sediment and nutrients from slope and pediments supply the plain. They configure zone of transports, with shallower sediment cover, often sandy bars or narrow terraces (<20m). Braúna (*Schinopsis brasiliensis* Engl.) is a common element of the emergent flora. Usually marmeleiro e velame (*Croton* spp.) and catingueira (*Cenostigma pyramidale* [Tul.] Gagnon & G.P.Lewis) dominate the lower woody stratum.

The predominant cover is deciduous forest, with less recurrent patterns of subdeciduous forests, where the presence of lianas is an indicator of greater humidity (COSTA et al., 2007). A highlight is the Caraibeira (*Tabebuia caraiba* [Mart.] Bureau) that reach 20m height. They occur in the Landscape Unit of Alluvial plain with open to dense woodland (Figure 4 C) and are referred in the literature as the probably single habitat where the *C. spixii* occurs, also reported as the *T. caraiba* gallery woodlands (JUNIPER; YAMASHITA, 1990; BARROS et al., 2012).

Other common floristic elements include marizeiro (*Geoffroea spinosa Jacq.*), quixabeira (*Sideroxylon obtusifolium* [Humb. Ex Roem. & Schult.] T.D. Penn.) and juazeiro (*Sarcomphalus joazeiro* (Mart.) Hauenschild). Generally, these are subject to suppression of vegetation for crop/pasture lands, whereas they have deep soils

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and greater possibility of water storage (SAVE Brasil, 2013). In the deforested areas one can find invaders like the algaroba (*Prosopis spp.*). It is important to highlight that these areas do not have large spatial expression. Generally, they are patches of less than 0.01 km².

Caatinga of Desert Pavements

This is another common group of landscapes that covers 286 km² of the PAs. It is a planation surface very similar to Caatinga of Pediplains, except that a layer of poorly selected detrital material with variable thickness covers the surface, often exceeding 0,5 m.

The pedogenesis is incipient and difficult to distinguish due to the pronounced stone presence. In the quartz-rich schists and phyllites (in APA western and northeastern regions), the relief is weakly dissected (gentle to moderate) and with an extremely stone presence cover that extends for approximately 85 km² (locality of Boticudo - in APA northeastern region). Occasionally, there is a slight melanization below the cover, not exceeding 2cm.

The vegetation cover is dense, presenting an extensive deciduous forest whose prominent floristic elements are braúna, umbuzeiro (*Spondias tuberosa* Arruda), imburana-de-cheiro (*Amburana cearensis* AC Smith), imburana-de-cambão (*Commiphora leptophloeos* [Mart.] JBGillet), marmeleiro and velame (*Croton* spp.) and catingueira. In some cases, the shrub pattern is more common, highlighting the low shrubs of carqueja (*Calliandra depauperata* Benth) that are interspersed with jurema preta (*Mimosa tenuiflora* [Wild.] Poir.) or with dwarf forests of favelas (*Cnidoscollus quercifolius* Pohl) and xique-xiques (*Pilosocereus gounellei* FAC Weber ex K.Schum).

The excess of stone presence may have contributed to the preservation of the Caatinga in this group of landscape, once the agricultural potential is restricted. Areas of less presence of stone, as well as the edges of buried pediplain are influenced by deforestation, as in Xique-Xique locality (in APA northeastern region).

Caatinga of Pediplains

This group of landscapes is the most common and covers 651 km² of PAs. Generally, with a slope <10°, they truncate slightly altered rocks that form shallow soils to slightly depth (<1m), occasionally with bedrocks. This Landscape is divided between those truncating hardened rocks (rocky pediments) or phyllites and metacarbonates (erosion glacis).

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Recurrent pedogenetic processes are argilluviation and pedoturbation associated with neoformation of expansive clays manifesting crack dynamics of shrink-swell and reduction colors (vertic character). On the other hand, melanization and the presence of A horizon is uncommon, which may suggest strong environmental degradation (IBGE, 2007). In some places, the remobilization of the sediments through the laminar flow generates thin colluvial lobes (30 cm) of red-yellow coloration and in general stones or rocks presence are few.

The vegetation is usually sparse and grows grouped in assemblies and the important floristic elements are aroeira (*Myracrodruon urundeuva* M. Allemão), pereiro (*Aspidosperma pyrifolium* Mart.), C. quercifolius, C. pyramidale and pião (*Jatropha* spp.). The presence of graminoids is common mainly *Aristida adscensionis* L. and *Aristida elliptica* (Nees) Kunth and may indicate that this is a highly degraded environment, given the effects of overgrazing to absent of the grassy vegetation. The graminoids have expressive presence in isolated fences areas and scarce cover in grazing areas.

The cattle introduction in the region around 1640 may have been followed by repeated fires used to overcome the Caatinga density (LOPES, 2000), which has already been pointed out as a possible degrading agent (SILVA et al., 2018). Also, one of the main population sources of income is the livestock husbandry, especially extensive breeding of goats and sheep. During the dry season, the animal influence area expands to Caatinga fragments (SAVE BRASIL, 2013), intensifying the impacts to the Caatinga dry forest.

Caatinga of Residual Landforms

Covering the smaller zone of the Spix's macaw PAs (32 km²), it consists of residual relief, arising from differential erosion or as evidence of erosion advance. They usually form areas with moderate to strong relief in sienitic inselbergs (Redonda range - in APA central region) or granitoids (Natividade range - in APA northeastern region), but also occur in metacarbonate (Canabrava range - in APA eastern region).

It presents a mosaic of patches, with the following characteristics: (i) bedrock with bromeliads of *Encholirium spectabile* Mart. Ex Schult. & Schult.f.. Also, some sparse woody individual and other herbaceous (e.g.: Vellozia Vand.). (ii) Step like surfaces in shallow to slightly depth colluvial/eluvial deposits with deciduous angico forest (*Anadenanthera colubrina* (Vell.) Brenan) and other prominent species such as *S. tuberosa*, imbiruçú (*Pseudobombax simplicifolium* A. Robyns) and C. *leptophloeos*.

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The slopes base may retain a talus and/or lower slope colluvial occasionally with dense arboreal vegetation that may exceed 10 m height. Dominant floristic elements may still include the angico de *A. colubrina*, *S. obtusifolium, S. joazeiro* and carcarazeiro (*Pithecellobium diversifolium* Benth).

Correlation between Landscape Units map and Spix's/Blue-winged macaw occurrence

The comparison of Spix's/Blue-winged macaw occurrence records presented higher spatial correlation with the Caatinga of dry rivers environment group. In terms of frequency, 41 of the 62 valid records (66.13%) coincided with the referred group.

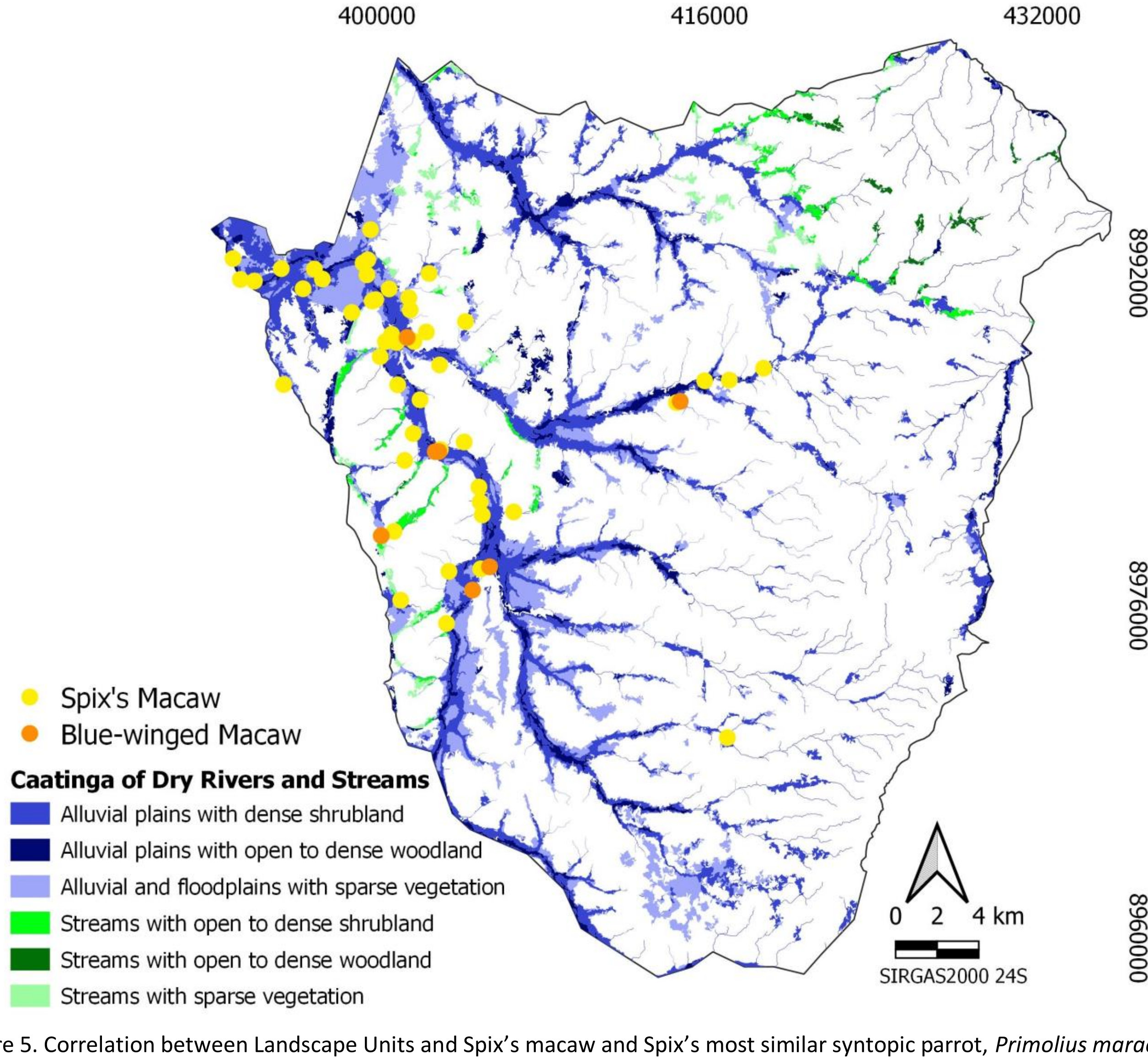

Figure 5. Correlation between Landscape Units and Spix's macaw and Spix's most similar syntopic parrot, *Primolius maracana*. Evidence of the Caatinga of dry rivers environments as Landscape group more likely related to the *Cyanopsita spixii* occurrence.

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The discordant records are significant and have been assessed on a case-by-case basis. Although 21 records (33.87%) coincided with other Landscape groups, any of those records has a distance greater than 709m in relation to the fluvial channels. The mean distance from Caatinga Dry Rivers to species records was 144m (Tab. 1). The high-resolution satellite image observation allowed to define that 12 of the 21 records coincided with channel areas that were not detected by the MRVBF in the process of segmentation of the elevation data and the drainage extraction. Probably the ALOS-PALSAR spatial resolution (12.5 m) lead to this limitation.

This means that despite 21 records were not circumscribed in the Caatinga of Dry Rivers group, 53 (85.48%) are related to the river landscape context. Thus, the results corroborate this as the habitat suggested to Spix's and Blue-winged macaw occurrence (JUNIPER; YAHASHITA, 1991; BARROS et al., 2012; BIRDLIFE INTERNATIONAL, 2018).

Table 1. Occurrence of Spix's and Blue-winged macaws by landscapes ("Caatinga of Dry Rivers" and "others") and their distance from Caatinga of dry rivers, considering Minimum, Maximum and Average distance.

OCCURRENCE			DISTANCE FROM CAATINGA OF DRY RIVERS (METERS)		
Landscapes	**Absolute**	**Relative (%)**	**Min**	**Max**	**Mean**
Caatinga of Dry Rivers	41	67.2	0	0	0
Others	21	32.8	21	709	144
Total	62	100	-	-	-

If landscape patterns are persistent, ecological processes will have a tendency to condition patterns of attributes of animals (behavioral and morphological). They will continue to adapt the discontinuities in landscape patterns (ALLEN; HOLLING, 2002). Thus, the Caatinga patterns persistence, associated to an increase in the humidity gradient, typical of the fluvial environment, can favor the maintenance the macaws behavioral choices and the patterns of species occurrence will be conditioned to the landscape pattern.

IV. CONCLUSION

The Spix's/Blue-winged macaw occurrence appear to be related to de Landscape Units mapping, more over to the alluvial plain context. This type of plain is a system sustained by stream, water, sediment and

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nutrients from slope and pediments. As seen, 85.48% of the occurrence records were spatially related to this Landscape.

Thus, to priority areas conservation and habitat recovery this correlation can be relevant, given that suggests the efforts should be concentrating in maintenance not only the *T. caraiba*, but in dry river environments, meaning the conservation of species habitat but also of natural processes such as fluvial and pedogenetic.

In this sense, the integration of Spix's macaw Protected Areas with the recovery and revitalization of the São Francisco River Basin projects becomes a natural path. Also, strategies for conservation or restoration must try to compensate and/or integrate the local population, whereas they are highly dependent on.

Finally, it was seen that landscape cartography, based on relief information, surface materials and land cover, is a useful tool for identifying spatial patterns that are relevant to the biota.

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