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MEDIUM TO LARGE-SIZED MAMMALS IN A HUMAN-MODIFIED AREA IN THE STATE OF SÃO PAULO, BRAZIL

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Abstract: Habitat modification is a major threat to biodiversity, in which the savanna-like Cerrado biome has been under high disturbances for the last decades. In Brazil, São Paulo state contains few native remnants of Cerrado surrounded by anthropogenic matrix. Here we report the medium and large-sized mammal species found in a private property of a rural area of São Paulo. Using camera trapping, we surveyed mammals from 2013 to 2018, and recorded 21 species of which five were exotic. The observed and estimated species richness were alike in the first year of sampling, but from 2014 onwards, the differences in richness increased. The most recorded species was the coati (*Nasua nasua*), followed by the puma (*Puma concolor*) and the giant anteater (*Myrmecophaga tridactyla*). The presence of exotic species indicates anthropogenic influence. Small natural remnants in private lands might work as ecological corridors, highlighting their importance in the southern domain of the Cerrado.

Keywords: fauna monitoring, camera trap, Cerrado, mammals, species list.

The Cerrado biome is typically constituted by open vegetation (Sano *et al.* 2010) and it is considered the most biodiverse savanna worldwide (Myers *et al.* 2000, Mittermeier *et al.* 2011). Due to a history of anthropogenic activities that promoted habitat loss (Durigan *et al.* 2007, Scaramuzza *et al.* 2017) only 40% of its original vegetation remains (Sano *et al.* 2010). Protected areas cover about 8% of the biome (Strassburg *et al.* 2017, De Marco & Nóbrega 2018), therefore natural remnants within private lands may play an important role in protecting the local biodiversity (Lima *et al.* 2021).

Mammals are a diverse group that play important roles in the ecosystems (Reis *et al.* 2010). In the state of São Paulo, where the vegetation is highly fragmented (Durigan *et al.* 2007, Scaramuzza *et al.* 2017), 231 mammal species can be found (Vivo *et al.* 2011). Some mammal populations persist in those fragments (Dotta & Verdade 2011, Magioli *et al.* 2016), demonstrating that these areas retain relevant biodiversity (Magioli *et al.* 2016) and therefore it becomes essential to monitor wildlife in modified habitats. Although mammal inventories have already been conducted in many

areas, private lands are poorly assessed. Here we report the medium and large-sized mammals recorded in a private property in a rural landscape in the Cerrado in the São Paulo State. Our aim is to provide a species list and an overview of the annual mammal richness for the study area.

This study was conducted at Bom Jesus Ranch (21°14'20.7''S, 48°32'11.8''W), in Monte Alto municipality in the state of São Paulo, Southeast of Brazil. The rural area has 38 ha and has cattle ranching as the main activity. About a quarter of the property (26.3%; 10 ha) holds semideciduous forest being protected by the Vegetation Protection Law (NVPL), which is in rough terrain (< 45°; Figure 1), and the surroundings consist of remnants immersed in pasture and agricultural fields. The NVPL, nº 12.651 (Brasil 2012) is the main regulation for protecting natural vegetation by moderating human use in Brazil (Covre *et al.* 2017, Tavares *et al.* 2019). The Permanent Preservation Areas (Áreas de Preservação Permanente – APPs in Portuguese) are intended to preserve water resources, landscapes, geological stability, biodiversity, and the soil (Brasil 2012, Silva *et al.* 2015). The Restricted Use Areas (Áreas de Uso Restrito – AURs in Portuguese) are considered environmentally sensitive such as the areas with slope between 25º and 45º, where human activities must be sustainable and changes in land use are prohibited. Both areas aim to preserve biodiversity and natural resources (Brasil 2012, Silva *et al.* 2015).

Camera trapping was used to sample mammal species, and surveys were conducted from (I) June 2013 to June 2017 using two Moultrie Trail® cameras placed randomly in the patch, and from (II) July to October 2018 deploying systematically five Bushnell® (Trophy Cam). The sampling stations consisted of one passive infrared camera placed approximately 40 cm – 50 cm above the ground programmed to operate continuously (24h/day) and to record at an interval of 30 seconds. We considered independence between each record at an interval of 60 minutes (Sollmann 2018). Species richness was estimated in the *software* EstimateS version 9.1.0 and the sample sufficiency was calculated using Jackknife 1 (McIntosh 2016). We also calculated the relative frequencies of the species recorded in 2018, for which a systematic sampling was made.

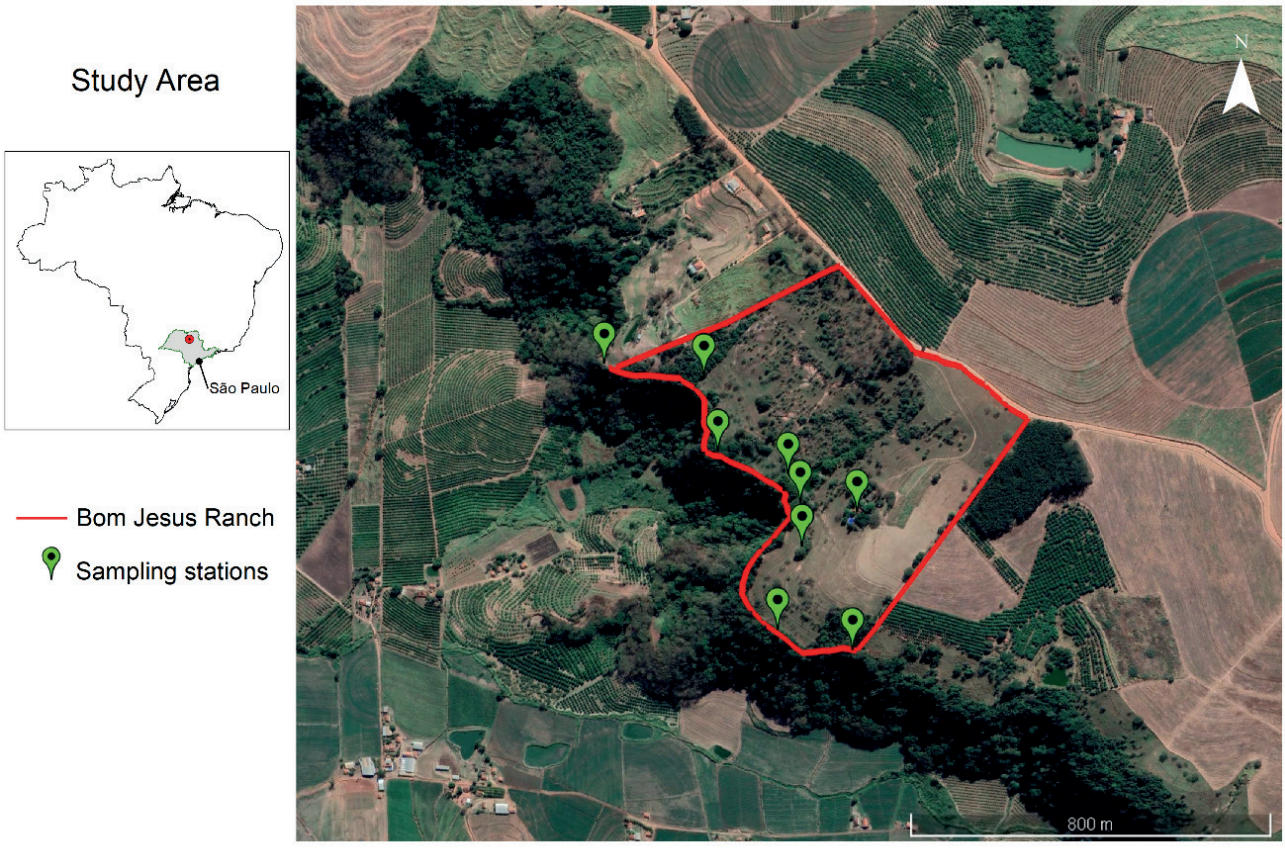

Figure 1. Study site located in the municipality of Bom Jesus Ranch, São Paulo, Brazil.

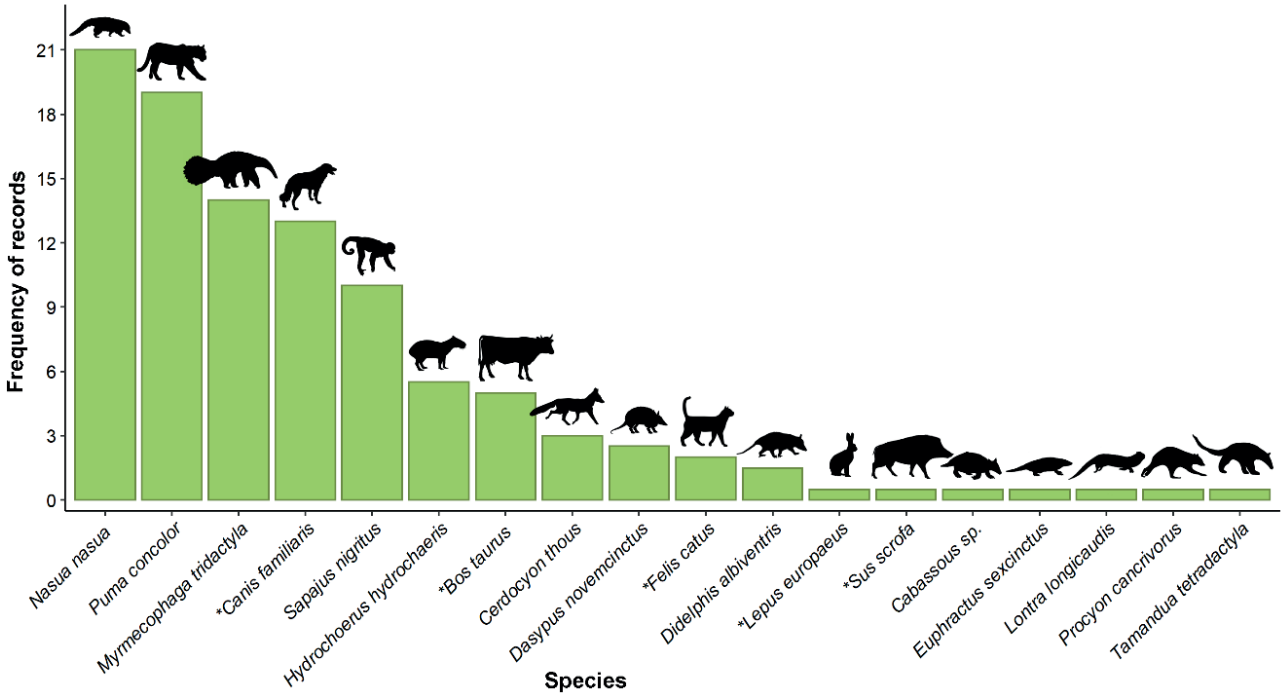

Figure 2. Relative frequencies of the mammalian records at Bom Jesus Ranch, São Paulo, Brazil, for the year 2018. The asterisk (*) indicates exotic species.

Figure 3. Camera trap records of mammals in Bom Jesus Ranch, São Paulo, Brazil: (a) coati (*Nasua nasua*), (b) puma (*Puma concolor*), (c) giant anteater (*Myrmecophaga tridactyla*), (d) domestic dog (*Canis familiaris*), (e) black capuchin monkey (*Sapajus nigritus*), (f) capybara (*Hydrochoerus hydrochaeris*).

During the 6-year monitoring, we recorded 21 species from 13 families and eight orders, being five exotic species (Appendix 1). About 28% of the species were detected in all sampled years whereas 23% were detected only once in the whole period. The most recorded species in 2018 was the coati (*Nasua nasua*), followed by the puma (*Puma concolor*), the giant anteater (*Myrmecophaga tridactyla*), the domestic dog (*Canis familiaris*), and the black capuchin monkey (*Sapajus nigritus*, Figure 2 and Figure 3). The observed and Jackknife1 species richness showed little variation in the first sampled year (Figure 4) showing the highest difference in 2018 (Figure 4). The accumulation curves show that the number of new species recorded continues ascending over time. Additionally, we provide a species register table showing presence/absence by years (2013-2018, Figure 5).

Camera trapping is a valuable method to record elusive species, including mammals, without human interference (O'Connell *et al.* 2011). Overall, we were able to estimate the diversity of medium and large-sized mammal species present at Bom Jesus Ranch during six years. Our observed and estimated richness are similar to the ones found in other rural areas in São Paulo (Chiarello 2000, Dotta & Verdade 2011). In human-modified landscapes, like our study site, we could find habitat generalist and human-tolerant species that might use the matrix as part of their territories (Martin *et al.* 2012). The coati (see Figure 3a) is a highly adaptable species that can prosper in such habitats (Barros & Frenedozo 2010, Ferreira *et al.* 2013). This carnivore was the most frequently recorded species, being registered in all sampled years (Figure 2 and Figure 5). The second most recorded species was the puma (Figure 2). We registered a female with two cubs, indicating that this species uses altered areas as habitat (Magioli *et al.* 2016). We further registered five exotic species: the domestic dog and cat, cattle, the European hare, and the wild boar, indicating anthropogenic influence over the area. The domestic dog was the most recorded exotic species being registered during the whole sampling (Figure 2 and Figure 5), which is expected once dogs integrate the

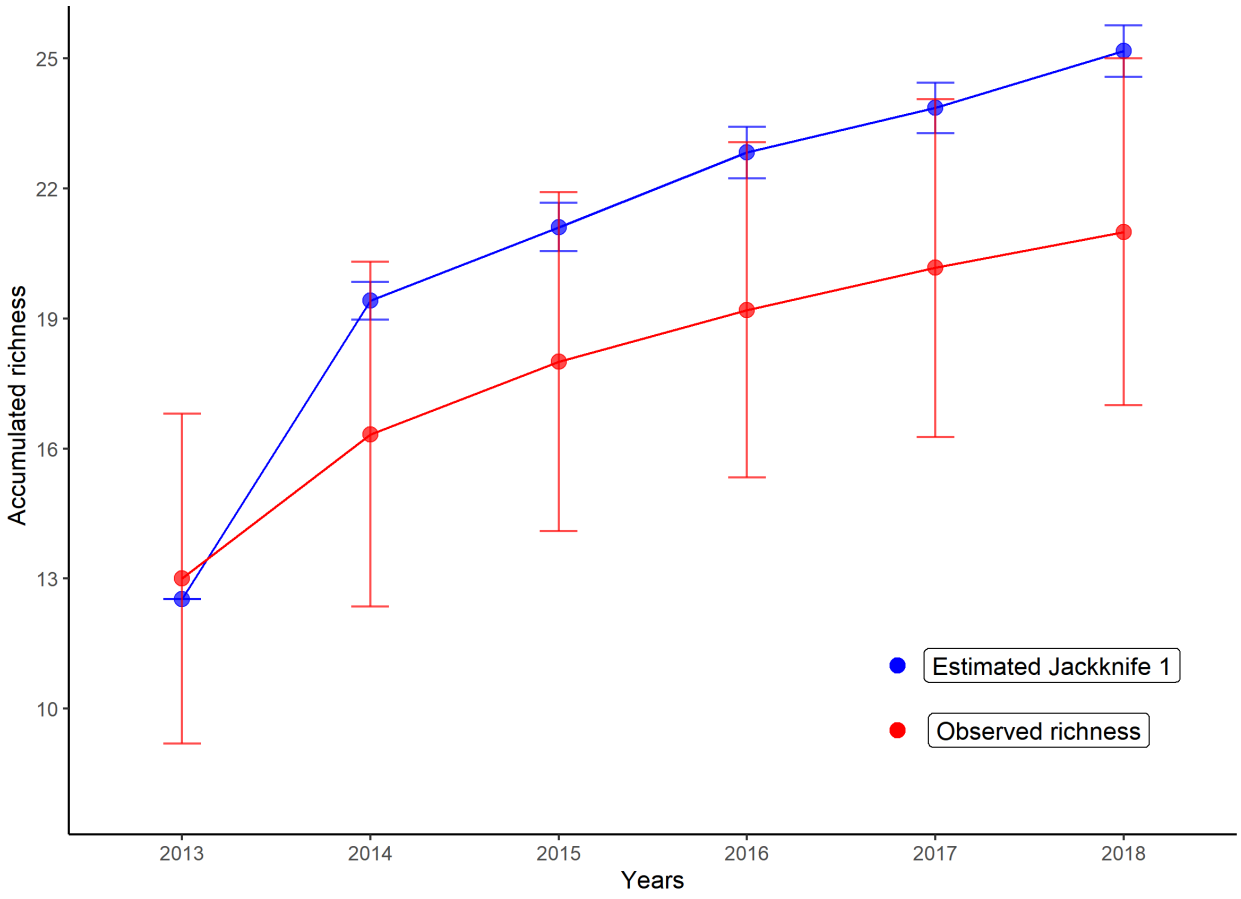

Figure 4. Accumulated mammalian species richness at Bom Jesus Ranch, São Paulo, Brazil. In blue is the estimated Jackknife richness and in red the observed richness for the six years surveyed.

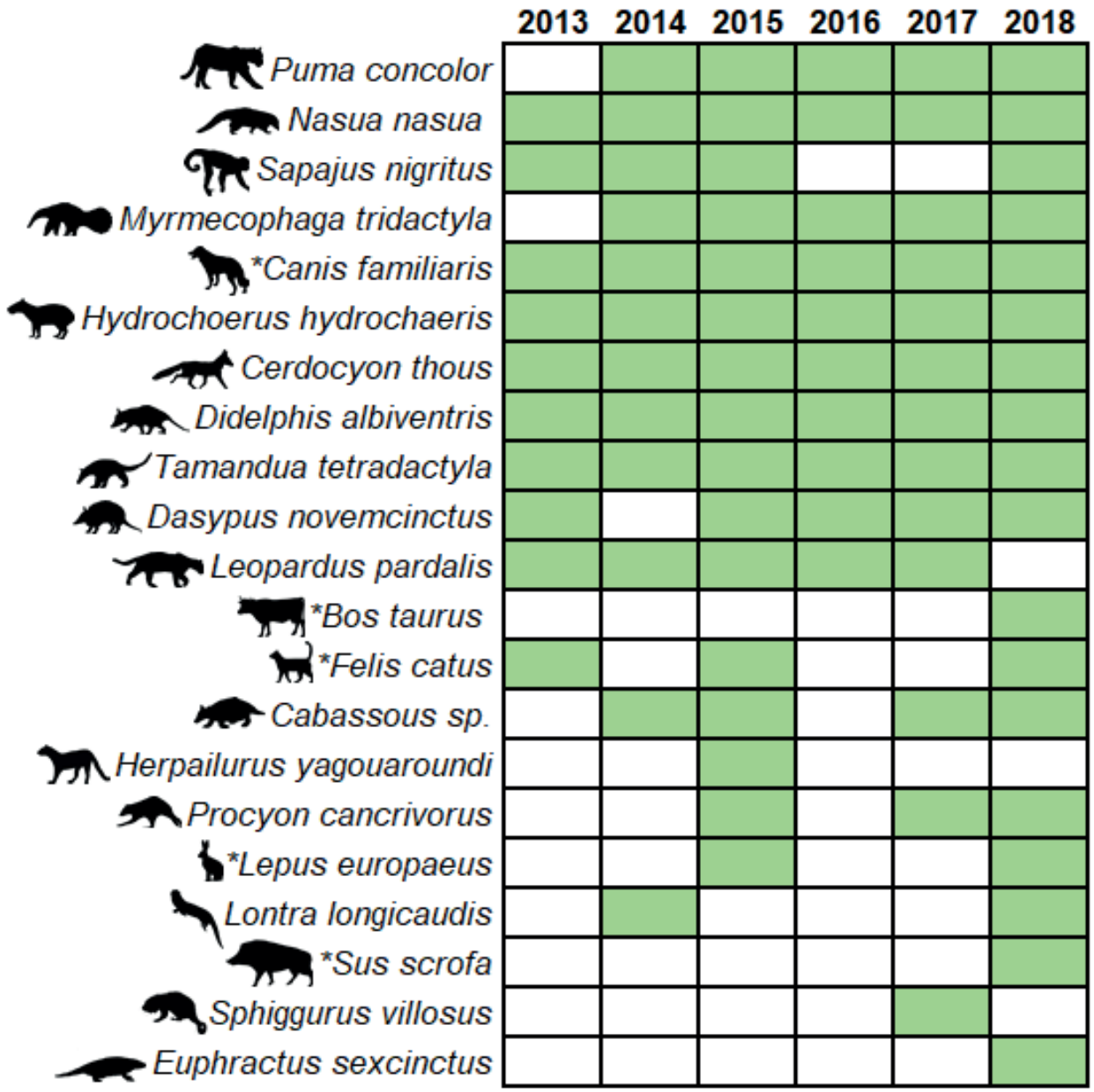

Figure 5. Presence/absence of each mammal species for each of the surveyed years at Bom Jesus Ranch, São Paulo, Brazil. The * indicates exotic species. The green rectangles denote the species presence of the respective year.

lifestyle of Brazilian farmers (Rieth *et al.* 2016). The wild boar and the hare are also invasive species, and both have great adaptive success over the introduced habitats, allowing them to establish populations (Bonino *et al.* 2010, Salvador & Fernandez 2017). We call attention to the fact that domestic animals are potential competitors and disease transmitters to wildlife (Sepúlveda *et al.* 2014, Carusi *et al.* 2017).

Between 2016 and 2017, there were no records for the black capuchin monkey (Figure 5), period concurrent with an outbreak of Yellow Fever in São Paulo, a viral primate disease transmitted by mosquitoes (Cunha *et al.* 2019). The local population of these monkeys was possibly affected by deaths of individuals, decreasing their abundance as well as the chances of detection. Neighboring municipalities recorded dead *Sapajus* spp. due to the disease (Siconelli *et al.* 2019). Except during this period, the species was frequently recorded (Figure 2).

Vulnerability of threatened mammals of the Cerrado has been assessed, it was demonstrated that habitat loss is primarily driven by land use

changes and that suitable climate areas for those mammals overlay the highest modified landscapes in southern Cerrado (Carvalho *et al*. 2009, De Marco *et al*. 2020). Thus, our results highlight the importance of small remnants, as assessed before (Magioli *et al*. 2016, 2021, Volenec & Dobson 2020, Lima *et al*. 2021). De Marco *et al*. (2020) exposed how important monitoring and conservation programs are for the survival of populations within modified landscapes. Rural landowners must adapt their properties to the minimal required native vegetation cover by NVPL, committing themselves to keep and recover their vegetation deficit (Brancalion *et al*. 2016).

Camera trapping is an effective method for assessing medium and large mammals and monitoring invasive/exotic species. Our study highlights the importance of small remnants in rural properties for local biodiversity. Once the landowners are compliant with the law keeping the APPs and the AURs, it enables the persistence of local populations and landscape dynamics. Additionally, the knowledge of local species and their threats is vital for management strategies and policy development. Local scale checklists are invaluable tools that can address knowledge gaps and contribute to practical conservation efforts.

DATA AVAILABILITY

Additional data from this research are available at: https://doi.org/10.5281/zenodo.7035878

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SUPPLEMENTARY MATERIAL

Appendix 1. List of medium to large-sized mammals recorded in Bom Jesus Ranch, São Paulo, Brazil. The conservation status of each native species according to the assessments made by the Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio (https://salve.icmbio.gov.br/#/) and the IUCN Red List of threatened species (https://www.iucnredlist.org/): Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), and Not Evaluated (NE).

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