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Rhea americana Distribution: Range Expansion and Introductions of America's Largest Bird

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Abstract

Species distribution is a good predictor of several important traits, including threat status. Additionally, species expanding out of their original range can become invasive and this trend must be evaluated objectively. The greater rhea (*Rhea americana*) is a flightless large-sized avian species that thrives on open landscapes of South America. The species has been affected by the conversion of their savanna habitat into cropland and pastures, as well as benefited from forest conversion into fields at neighboring ecoregions. I propose to evaluate those range expansions, contractions and extirpations, as well as to depict the current species distribution. Here I show that greater rheas have expanded their range out of the “dry lands diagonal” into degraded portions of forested ecosystems—more extensively on the Amazon Forest—while persisting in human-altered landscapes of their historical range. This suggests that the species is faring well regarding conservation, which does not justify its current status at IUCN. Additionally, the potential ecological interactions of the species in newly colonized environments must be investigated. The faunal savanization undergoing in the Neotropics accounts on many new ecological interactions, of which greater rheas are a relevant part. Future actions of management may improve the species conservation profile.

Keywords: Amazon, Arc of Deforestation, game bird, grassland, Greater rhea, restinga, savannization, soybean farming

1. Introduction

Species distribution mapping and modeling has been described as “measuring, weighting and studying the behaviour of ghosts” [1]. Subjected to natural and anthropic range contraction or expansions—besides anthropic extirpations—makes species ranges a shapeshifting subject that challenges scientific inquiry [2, 3]. The greater rhea (*Rhea americana*) is a species described as occurring in the “Neotropical Dry Diagonal” of open savanna landscapes in South America [4–6], composed by the Caatinga, Cerrado, Chaco and Pampa [4, 6]. Given that those ecosystems are under high rates of destruction [7], and that the surrounding close canopy forests are also being cleared by the expansion of cattle ranching [8, 9] leading to the savannization of their faunas [10], the understanding of greater

rhea reaction to those drivers is of great interest. For instance, other species associated with open landscapes, such as the maned wolf (*Chrysocyon brachyurus*), have expanded their distribution towards the degraded sections of Atlantic Forest and Amazon Forest [11, 12]. Greater rheas by their time are known to have successfully established populations out of their range, most notably in Germany [13].

Greater rheas are the biggest birds in the Americas averaging 1.4 m and 23 kg, reaching 40 kg in large males [14]. They lay eggs during the dry season from June to September, which hatch in the beginning of the rain season from September to November [15]. Males are polygynous while females are polyandrous: females will move around during breeding season, mating and depositing their eggs with a male, and then mating with other males [16]. Males are sedentary, incubating and raising the hatchlings on their own [16]. Each nest is thus visited by several females, containing up to 80 eggs; each female lay 5–10 eggs per breeding season [17]. The average clutch size is 26 eggs per nest, laid by seven females on average [17]. Nests are shallow depression on soil, cleaned of vegetation debris [17]. Out of the breeding season, both sexes are social, and form flocks up to a 80 individuals [18], which facilitate vigilance toward predators [19].

As many large-sized species [20], greater rheas are of ecological importance. Feeding mainly on broad-leaved herbs, they occasionally eat fruit and invertebrates [21]. They are seed predators for many plant species in Cerrado, while dispersing seeds in a few cases [22]. They are occasional prey for pumas (*Puma concolor*), jaguars (*Panthera onca*) and solitary eagles (*Buteogallus coronatus*) [23, 24], while their eggs serve as food for several armadillo species [25]. Association with pampas deer (*Ozotocerus bezoarticus*) and guanacos (*Llama guanicoe*) is common on open fields for predator vigilance [26–28]. The species is considered Near Threatened by IUCN, because of habitat loss to agriculture and cattle ranching, which makes little sense (since the species occur in both pastures and plantations) and by poaching [29]. Furthermore, greater rhea distribution as shown by IUCN is grossly mistaken, showing the species occurring all over the Atlantic Forest [29].

The greater rhea is of high cultural importance in South America. Princess Therese of Bavaria [30] mentions the species' occurrence in a public garden of northeastern Brazil as early as 1888, and greater rheas remains nowadays as ornamental wildlife in Alvorada Palace, Brazil's presidential residence [31]. Greater rhea was an important source of feathers for dusters historically [5], and name a Brazilian national park [32], inspired music and several popular expressions.

In this paper, my aim is to describe the current distribution of rheas in South America, including their range expansion, introductions and extirpations. With this, I hope to provide basis to management and conservation activities dedicated to the species. An accessible, handy, single-source database approaching the species current distribution range is still missing from scientific literature, and is of prime interest in the context of wildlife conservation in anthropic landscapes.

2. Methods

2.1 Databases

I collected records of greater rheas with geographic references for all five countries that encompass their historical distribution: Brazil, Bolivia, Paraguay, Uruguay and Argentina. I used the three Citizen Science databases to obtain the data: WikiAves.com, EBird.org and INaturalist.org, chosen by the amount of available data and ease to extract it. Since my aim is to depict the species current distribution,

I used recent records from 2003 to 2021. The greater rhea is easy to visualize and photograph, thus common in those databases. Consequently, I rarefied the data to one record per county per database (i.e. maximum of three records per county). I scrutinized the data for duplicated records, removing these. I inspected records on the southwestern limit of the species occurrence with attention for lesser rheas (*Rhea pennata*), which were removed. I did the same procedure for captive individuals labeled as wild. Individuals living in fenced or partially fenced areas such as large urban parks, if not dependent of supplementary feeding, were included in the database as wild. All records and their geographic coordinates can be found in Mendeley Data <https://data.mendeley.com/datasets/fvwcwhwt9v/1>.

2.2 Criteria for defining populations as native, introduced, or range expansion

I defined all population living within the diagonal of dry areas in South America (Caatinga, Cerrado, Chaco and Pampas domains [4, 6]) as native even if resulting from accidental or purposeful reintroductions if and only if within native range [33–35]. I made exceptions for individuals living in restingas (coastal savannahs over sand dunes) where the species did not occur historically. These populations on restingas were labeled as introduced. I used the same criteria for other populations outside of the dry area's diagonal, unless the population could result from natural emigration. Populations resulting from emigration towards forest domains—arising from forest degradation—were labeled as range expansion. Populations within ecotone areas were labeled as native, since several open-field species occur within grassland enclaves in a matrix of forest (e.g. marsh deer *Blastocerus dichotomus*, pampas deer, and greater rheas themselves [36–38]).

2.3 Mapping and vegetation cover

I collected vegetation cover maps for depicting canopy closeness from MOD44B.v006, representing areas currently covered by tall wood vegetation, not appropriated for rheas. The MOD44B.v006 image layer in the MODIS Vegetation Continuous Fields product provides a continuous, quantitative representation of global tree cover (greater rhea non-habitat) at a 250 m spatial resolution [39]. I used vegetation ecoregions from WWF categorization [40], chosen because it defines ecoregions as relatively large landscapes, each containing a distinct assemblage of species, with boundaries similar to the original extent of natural communities—prior to modern land-use change.

3. Results

I collected a total of 777 occurrences. The largest number of records came from WikiAves (496), followed by EBird (205) and then INaturalist (76). Most data are fairly recent, with the average year being 2017 and the modal year being 2019. Nine records refer to introduced populations, 68 to range expansion, and 700 to native populations. The current distribution of the greater rhea throughout the Neotropics is shown in **Figure 1**. Our map suggests that the diagonal of dry areas in South America is still a stronghold for the species. The northern Cerrado scrubland to wooded savanna macromosaic, mainly located in central Brazil, has an extensive patch of greater rhea populations. Important habitat extensions remain in Pampas (Argentina, Uruguay and Brazil), Beni savannas (Bolivia), and Caatinga arid lands in northeastern Brazil.

Figure 1. Greater rhea distribution overlapped with the canopy closeness in South America. Both areas naturally open (as the Caatinga, Cerrado, Chaco and Pampa) offer natural habitat to the species, while deforested areas within formerly forested ecoregions (as the Atlantic Forest and the Amazon Forest) are occupied by range extensions.

Introductions of greater rheas have been recorded mainly within the restingas (coastal savannas over dunes) over Brazilian coast (**Figure 2**). Although out of greater rhea native range, the species thrive on such ecosystems as they present similar characteristics of their native savannas. Some of those records present individuals within enclosed areas, while other are free ranging, and others nowadays present vanished populations.

Figure 2. Greater rhea current distribution shown overlapped with South America ecoregions. The species is frequently associated with savanna-like formations, and expanded its range towards forested regions after forests where degraded to give space to pastures and grain cultivation.

Range expansions are recorded on several savanna-forest transition zones, some of which allowed the greater rhea to expand up to 500 km towards formerly forested regions (**Figure 2**). An extensive area recently colonized by greater rheas is the southeastern section of the Arc of Deforestation, where greater rheas ride on the

expansion of soybean farming. They are also found on degraded pasture, expanding from their natural habitat in the savannas bordering the Amazon Forest.

Extinctions of greater rhea happened over much of the savannas (Cerrado ecoregion) within the state of southeastern Brazil, as Minas Gerais and São Paulo. Both states have lost their rheas populations in areas where intensive agriculture—as sugarcane, eucalyptus and other non-open field crops—have been implemented. Hundreds of years of unregulated hunting, together with poaching after Brazil established wildlife protection laws, may also have presented a role over these range contractions.

4. Discussion

Greater rheas are present over much of their historical range, successfully adapting to human-modified landscapes. This adaptability allowed greater rheas to expand their range naturally, and thrive after introductions. Citizen-science databases continue to prove their usefulness, providing up-to-date data on species distribution that would be unfeasible if provided by traditional field-collection activities. Even after trimming, hundreds of recent records of greater rheas are readily available. Those records allow us to infer that the species continues to be present over much of its historical range over South America's "diagonal of dry areas". Additionally, they have been introduced into several spots at coastal Brazil, where some populations thrive. Besides these, large-scale range expansions exist in several parts of their range, with emphasis on the Amazon Forest. Those results are of prime importance for the species management and conservation.

One first element I call into attention is about the global status of the greater rhea at IUCN: the species is currently considered Near Threatened [29]. Pointing habitat loss as a problem seems a mistake, since the species is expanding range, including both soybean plantations and degraded pastures as habitat. Evidence towards this can be drawn from the fact that the species still presents big populations even within sections of central Brazil that have been dominated by farming (as Goiás state), where greater rheas subsist between cultivated fields, pastures and private reserves (as required by Brazil forest code [41]). On the other hand, poaching in northeastern Brazil seems to have limited the populations in Caatinga [42]. Since this is one of the poorest regions of Brazil [43], and at the same time one of the arid region of highest population density on Earth [44], the underlying reasons become obvious. This is especially worrisome because these animals appear to be under relatively isolation regarding the populations on Cerrado, and have potential to represent a subspecies endemic to the arid lands of Northeastern Brazil. Whereas they have been under the name of *R. a. americana* under old-fashioned taxonomy [45], this topic deserves further attention. The species global range and threat status deserves a reevaluation.

On the other hand, greater rheas have disappeared from several important protected areas in Brazil, which have been curiously less efficient in maintaining populations than the aforementioned private lands. Some of the more emblematic examples come from: (i) Águas Emendadas Ecological Station and Brasília National Park, both well-managed protected areas in Brazil capital where feral dogs and poaching eliminated the species [46]; (ii) Serra da Capivara National Park, where poaching and woody-vegetation encroaching eliminated the species [42]; and (iii) the Itirapina Ecological Station, where the reasons also seems related with poaching and feral dogs [47]. A tantalizing historical record of the species—which have been putatively attributed to Campos dos Goytacazes—is presented on an illustration at Rugendas *Magnum Opus "Malerische Reise in Brasilien"* [48]. Campos dos Goytacazes presents open habitat enclave in within the Atlantic Forest dense

woodlands, conceptually known as Campos dos Goytacazes Gap [49]. With sandy soils and a rainfall limited to ~1000 mm/year [50], the region was originally covered by open vegetation (“campos” means field in Portuguese), and had historical attributes to hold a greater rhea populations. As described on the illustration itself, hunting may have caused the species demise in the region. Regarding modern species extirpations, the lack of management for feral dogs [51, 52] combined with the poor management of fires, lacking prescribed fires and consequently easing wild fires [53] seems to be worsening the species habitat transforming open field into encroached woodlands inside savanna protected areas.

Greater rheas present high management potential for its meat [54, 55], feathers [5, 54], hunting rights [55] and importance as a subsistence source of food [55, 56]. They should therefore be prioritized within the current discussions regarding wildlife management in Brazil [57, 58], a country that has no forms of wildlife use [59] and is watching several species of high potential to fade away through careless poaching [60]. Under the opposite paradigm, Germany has developed sustainable practices for hunting the greater rheas after few years of greater rheas invasion [13]. This can be a tool to trim the populations within the portions of the range where the species is expanding. Hunting can also stimulate reintroduction by the government or hunting associations within the former range. Similar phenomena have happened to other game bird species, such as the turkey (*Meleagris gallopavo*) [61]. Wildlife management is strongly present wherever larger wildlife is thriving [62], with South Africa, USA and Europe frequently cited as good examples.

One aspect of the species range expansion and introductions is the ecological meaning of greater rheas as seed predator and seed dispersers [22]. While the species seems strongly restricted to pastures and croplands within the Amazon, never being observed in forests or forest borders, populations in the coastal savannas probably interact extensively with native plant communities, which provide interesting research opportunities. Greater rheas and their eggs can also present a role as prey species for big cats and mesopredators on these systems. Checking out those interactions in the context of the savannization of forest ecosystems [10] may provide useful insights regarding ecological interactions of these areas. The introductions shown here may not sound as unusual as the species presence in Germany [13], but range expansions and introductions are known for several large, terrestrial paleognates such as the ostrich (*Struthio camelus*) [63] and the emus (*Dromaius novaehollandiae*) [64].

I consider the distribution presented here to be a work in progress, since I may have missed some previously documented occurrences, or listed some that are no longer considered valid since the species went locally extinct. Continuous updates of the list I provide, with subsequent editions as new information comes to researcher's attention, will provide a better basis for future work. I encourage my readers and colleagues to improve this checklist by providing information and references for any oversights or possible misinterpretations, as well as new published information as it becomes available. Another limitation is that I used the counties to prune the data and avoid crowding the map. Since county density varies widely, I emphasize that all states where the species currently occur have similar county density, except for northern Brazil (Amazonas and Pará) which are regions currently out of major rhea distribution.

5. Conclusion

In conclusion, I present evidence that greater rheas have been adapting well to man-made landscapes and is of minor relevance regarding conservation in most

of its range. Populations within Caatinga in northeastern Brazil are an exception regarding this trend. Additionally, the species have expanded its range, most expressively in the Amazon forest, with unknown consequences. Introductions in several restinga locations also exist. Additionally, the species present potential as game, and this can contribute to their conservation. Finally, the open landscapes within South America are important refuges for the greater rhea, an under-studied, emblematic species of the savannas region in the Neotropics.

Acknowledgements

I greatly appreciate the financial support of the following partners: SouthWild.com Conservation Travel System, ONF Brasil, Rainforest Biodiversity Group, Idea Wild, The Mamont Scholars Program of the Explorer's Club Exploration Fund, Cleveland Metroparks Zoo, and the Rufford Small Grants Foundation (18743-1, 23022-2 and 31091-B). I thank Marco Aurélio Crozariol and Vítor Piacentini for providing useful discussions about the species distribution, while Reginaldo Honorato and Raíssa Sepúlvida contributed with the mapping. Finally, I thank the hundreds of birdwatchers and wildlife photographers who took their personal time to contribute with popular science databases.

Conflict of interest

There is no conflict of interest to be declared.

Appendices and nomenclature

A complete list of coordinates can be found in Mendeley Data (<http://dx.doi.org/10.17632/fvwcwhwt9v1>).

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