

LIVESTOCK RAISING IN THE AMANÃ SUSTAINABLE DEVELOPMENT RESERVE, AMAZONAS STATE

A PECUÁRIA NA RESERVA DE DESENVOLVIMENTO SUSTENTÁVEL AMANÃ, AMAZONAS

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KEY WORDS:

Buffalo;
Cattle;
Protected area;
Amazonia.

ABSTRACT

Livestock activities in the Amanã Sustainable Development Reserve (RDSA) involve the production of cattle and buffalo in an extensive system, and are aimed at raising income and savings. As an expanding activity with high environmental impact potential, livestock is a focus of current discussion in this protected area. This study aimed to characterize livestock ranching activities and ranchers in the RDSA, highlighting key factors of production and management dynamics, as well as key impact indicators. For this purpose, we conducted semi-structured questionnaires with all 58 ranchers and geo-referenced their grazing areas. Areas of natural fields used as pasture were calculated through the use of satellite images. The main impact indicators identified for local livestock activity include: cultivated field growth, the increased use of várzea grasslands, and buffalo herd growth. To control the expansion of this activity, we suggest the development of regulations to guide herd management and the use of productive environments involved in ranching activities.

PALAVRAS - CHAVE:

Búfalo;
Bovino;
Unidade de conservação;
Amazônia.

RESUMO

A pecuária na Reserva de Desenvolvimento Sustentável Amanã (RDSA) é uma atividade voltada para arrecadação de capital e reserva de bem, envolvendo a criação de bovinos e bubalinos em sistema extensivo. Por se tratar de uma atividade em expansão e com alto potencial de impacto ambiental, a pecuária é um dos focos de discussão nesta unidade de conservação. Objetivou-se com este estudo realizar a caracterização da pecuária na RDSA, destacando os principais fatores de produção, a dinâmica do manejo dos rebanhos e os principais indicadores de impacto. Para tanto, foram aplicados questionários semi-estruturados com perguntas abertas e fechadas para todos os 58 criadores e georreferenciadas suas respectivas unidades de pastejo. A complementação dos dados coletados em campo foi realizada a partir da mensuração por imagens de satélite da área dos campos da natureza utilizados como pastagem. Os principais indicadores de impacto identificados para a pecuária local foram: o crescimento das áreas de campos cultivados, a intensificação do uso dos campos nativos da várzea e o crescimento do rebanho bubalino. Para o controle da expansão da atividade, sugere-se a elaboração de normas que orientem a utilização dos ambientes produtivos e o manejo dos rebanhos.

INTRODUCTION

The history of ranching in the Amazon region began around 250 years ago, primarily with cattle raising (OHLY; HUND, 1996). Only at the beginning of the twentieth century were buffalo introduced, starting at the Amazon Delta (OHLY, 1986); they reached Central Amazonia around thirty years ago (OHLY; HUND, 1996).

The introduction and expansion of livestock ranching in Central Amazonia is closely linked to the history of the occupation of the Amazon basin in the last two centuries (OHLY; HUND, 2000). From the beginning, this activity was established on the native pastures of the *várzea* (BATES; WALLACE, 1979; SPIX; MARTIUS, 1981) and predominated in this environment due to the nutritional superiority of the grass species native to the *várzea* area over the species cultivated on dry land (OHLY; HUND, 1996).

In the area where the Amanã Sustainable Development Reserve (ASDR) is located, in the Middle Solimões region, cattle raising began between the 1930s and 1940s, alongside extraction activities (*Sorbus spp.* and rubber), which were dominant at that time (ALENCAR, 2006). Some families who began this activity in that era continue to practice it today, having become a local reference for other ranchers. Other families sought a promising income alternative in ranching during these years, starting and abandoning this activity various times. The first shipment of buffalo arrived in Amanã in 1990 from the Lower Amazon region (personal communication, Edilson Vicente da Silva, March 2010¹), and the herd rapidly

grew until it surpassed the number of cattle approximately fifteen years later (ARAÚJO, 2006).

In 1998, through Decree 19,021/98, the Government of the State of Amazonas created the RDSA, an area of 2,313,000 ha located between the Rio Negro and the lower Rio Japurá, including land in the municipalities of Maraã, Coari, Barcelos and Codajás. Through an agreement with the State of Amazonas, the Mamirauá Institute for Sustainable Development (IDSM) became a joint manager of this conservation unit. The Sustainable Development Reserve is a natural area which is home to traditional populations. Its basic objective is to preserve nature and, at the same time, guarantee the conditions and the means necessary for social reproduction, improvement of the ways and quality of life for traditional populations, as well as to value, conserve, and improve the knowledge and techniques for environmental management developed by these populations (BRASIL, 2000).

Since the reserve was created, there has been a need to establish zoning for the areas used by the population, as well as to regulate agricultural and ranching activities and the use of natural resources. In this context, ranching is a main focus of discussion among the various parties involved: ranchers, other members of the community, and government representatives.

The objective of this project is to describe livestock raising activities and the profile of the ranchers in the RDSA. In this way, it seeks to evaluate the performance of this activity between 2005 and 2010, identifying its socio-economic importance and the possible threats to the conservation of

¹ Edilson Vicente da Silva lives in the RDSA and his family have raised livestock since 1930

biodiversity. This is done in a way that supports discussion of the consequences of this activity in this conservation area, and the strategy utilized by the IDSM's rural outreach group in working with the ranchers.

MATERIAL AND METHODS

Ranching in the RDSA began to be characterized in 2005, starting with a primary survey, which was supplemented and updated with a second survey in 2010. Information was collected in July and August of 2005 and March and April of 2010, with 30 days in the field for each of the expeditions. In both cases, the objective was to cover the entirety of the ranching production units located in the area where IDSM focuses its activities in the RDSA².

The data were obtained by applying a semi-structured questionnaire with open and closed questions to 58 livestock-raising families, involving the collection of quantitative and qualitative data. When authorized, the interview was recorded as audio to register some oral statements related to the occupation of the area and the development of ranching in the region.

Furthermore, the fields cultivated for livestock raising were geo-referenced to define their location, limits, and total area in hectares, while the areas of native *várzea* fields were determined and measured through remote sensing using images from the LANDSAT 5 satellite. Data relevant to impact on conservation by production category were analyzed through canonical discriminant analysis and analysis of variance (ANOVA) using Infostat software (2011).

² The area in which IDSM focuses its activities in the RDSA includes the Amanã, Coraci, and São José sectors.

RESULTS AND DISCUSSION

Productive system

Livestock raising in the RDSA is extensive and non-specialized, involving the raising of mainly cattle and buffalo for slaughter. The herds do not undergo zootechnical selection, and generally the animals contained therein are not of any specific breed and have low productivity rates.

The activity is conducted using family-based labor, and its main objectives are to generate income and preserve assets. However, other relationships with this work are also observed, such as partnerships between large and small ranchers (sharing) and hiring of day laborers. Formal labor relationships were not observed in any of the livestock production units in the RDSA.

Resource management is conducted without the use of machinery and with low use of inputs, which are mainly mineral supplements and other veterinary products. Finally, the absence of specialized technical assistance is evident in local ranching, where it falls to more experienced ranchers to suggest management practices and guide the other ranchers.

Herd

In 2010, the RDSA had a total herd of 735 animals, comprised of 289 cattle and 446 buffalo. The fact that the herd does not have a defined breed standard, for both species, is evidence of the ranchers' lack of concern with pursuing specific breeds or characteristics in the animals. In general, the animals are medium to large in size, as the buffalo are slightly heavier than the cattle, weighing 500-800 kg and 400-700 kg adult live weight, respectively.

The evolution of the herd for the five-year period 2005-2010 showed a reduction of 3.4% in the number of animals, falling from 761 to 735 animals (Figure 1). This reduction, however, is largely due to the high mortality registered in 2009 (25% mortality rate; 246 animals died, mainly due to starvation and drowning), when the region was affected by very severe flooding. Mortality rates of 3% and 1%, respectively, for calves and adult animals are considered acceptable for good herd development (MARQUES, 2006). Before the flood in 2009, the herd was estimated to contain approximately 981 animals, 22.1% more than the herd numbers registered in 2005, showing an increasing trend.

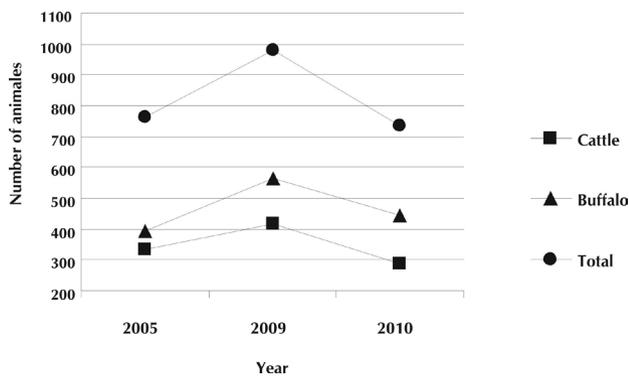


Figure 1 - Herds in the RDSA in 2005, 2009, and 2010. *Herd estimate based on the 2010 population, subtracting the 2009 fatalities.

Despite the overall reduction of the herd between 2005 and 2010, there was an increase in buffalo in the area, a trend which had been noted since the first survey (ARAÚJO, 2006). In 2005, the buffalo herd was 395 animals (from nine ranchers), surpassing the cattle herd, which at that time contained 366 head. In 2010, 446 head of buffalo (from 16 ranchers) were registered, which represents an increase of 11.4% in relation to the herd counted in the first survey, and an even more accentuated precedence over the cattle herd. Furthermore, in estimating the buffalo herd prior to the 2009 flood, a total of 565 animals

was obtained, which represents a 43% increase compared to the herd seen in 2005. These data demonstrate the rapid development of the breeding stock in the RDSA since the introduction of the first specimens of the species in 1990, and confirm the tendency to increase the herd, as well as the gradual substitution of the bovine herd.

The expansion of the buffalo herd, as well as the substitution of the cattle herd, is based on the productive potential of the buffalo in areas that flood. This species presents greater weight gain, higher weight at slaughter, earlier sexual maturity, less food selectivity, greater resistance to parasite-borne illness (HOPF; MUCHOW, 2000; OHLY; HUND, 2000; SHEIKH et al., 2006), as well as greater hardiness; they enter the forest in times of scarcity to seek food, which makes them more resistant to adverse situations such as floods, according to the ranchers. Sometimes, these ranchers comment that the “white steers” (“o boi branco”), as they call the cattle, “don’t progress” (“não vão pra frente”), exhibiting deficient development and significant mortality rates, while the “buffalo steers” (“boi búfalo”) develop more quickly and provide a higher financial return.

Ranchers

The traditional population in the RDSA is typically ribeirinha³, and agriculture is the main economic activity, followed by fishing and, on a much smaller scale, extractive activities (Pereira, 2006). Livestock raising fits into this context as a source of income and a secure place to preserve assets (Figure 2), similar to that encountered by Siegmund-Schultze et al. (2007) in the Bragantina

³ Ribeirinho is the term used to designate residents of rural Amazonia, generally living near or along water courses, who have traditionally maintained a peasant economic mode of production.

region of Pará, where the high liquidity of the livestock was identified as a major reason for investment in raising livestock.

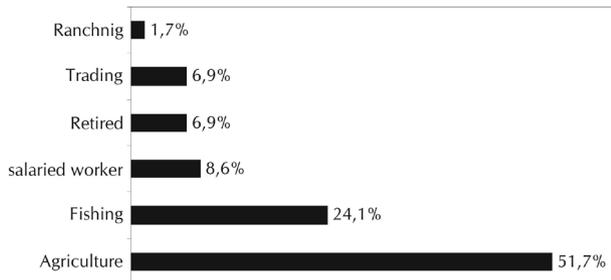


Figure 2. Main economic activity of livestock ranchers in the RDSA.

Currently, ranching is conducted by 58 families (14.4% of the total), involving the systematic raising of cattle and buffalo. This activity is done almost exclusively by men between 20 and 80 years of age, the majority of whom have low levels of education (grade school incomplete). The majority of the ranchers own the animals they raise, except for those cases of sharing (raising the animals in partnership with another rancher) and other links, such as family connections or a “sponsor system”⁴. There is also the right of “land ownership”⁵ and, according to Alencar (2006), this right can be acquired in various manners: through inheritance, by the fact of having “opened” the land, by having requested the right to use the land from the municipal authorities, or having obtained land concessions from others.

⁴This was based on strengthening an already-existing relationship by commercial trades between an agricultural producer who intends to begin ranching and a trader, who gives the producer one or more heads of livestock.

⁵According to SEUC/Amazonas, the community of residents in a Sustainable Development Reserve receives the right to use the land, which grants them the right to access the land and natural resources in the areas of common use in the Conservation Unit, according to the zoning and the norms of the Management Plan.

Livestock raising has been present in the RDSA area for around seventy years. Nevertheless, the largely transitory nature of the producers who conduct this activity has been observed. This dynamic can be seen in comparing the participation of 52 families in ranching in 2005 and 58 families in 2010; 39 (67.2%) of these families have ranched since the first survey and 19 (32.8%) families began to practice this activity over the last five years (Table 1). Historically, this activity appears to be maintained by a few families who have been raising livestock for at least three generations, as the RDSA herd today tends to be concentrated in the hands of these ranchers.

Table 1 - Number of ranchers according to herd size in 2005 and 2010

Year	Nº of ranchers	Ranchers with < 10 head	Ranchers with 10 - 60 head	Ranchers with > 100 head
2005	52	43	8	2
2010	58	47	9	2

The herd is concentrated in large operations as it has been observed that 81% of the ranchers have herds containing 10 or fewer animals; a large part of this group owns up to two animals. This scenario was seen in 2010, following the same pattern seen in the 2005 survey.

Although it is an important source of income for some of these families, none of them are exclusively dedicated to ranching, and they maintain other forms of income (production of flour, fishing, non-wood extractive activities, trading⁶, pensions,

⁶This commercial activity is very common in the Amazonian interior, where the trader travels by boat, selling merchandise and purchasing extractive, agricultural, or artisanal products.

and salaries). In this context, different intentions are identified among the ranchers, which have an impressive influence on productive rationale and on interaction with the means of production. By analyzing the different rationales for ranching in the RDSA, Araújo (2006) identified three main categories of ranchers, according to their intended production and the practices they adopt.

The first and most frequent category refers to those people who relate cattle with financial security. Selling an animal, which is sporadic for this category, allows them to cover more urgent expenditures, such as health care costs or acquisition of more expensive material assets. Ranching appears as another one of the family's activities, with little work time dedicated to its upkeep. In many cases, these ranchers' herds remain static for years, with no sales or acquisition of new animals, and not even breeding of these animals. Sarmiento et al. (2010) identified this production strategy among ranchers in the Lower Amazon region, which is known as the strategy of "keeping the herd alive" in conditions allowing sale at any time, thus allowing only partial exploitation of the livestock's productive potential. Generally, ranching in this category of ranchers is located in community areas, where occasionally more than one rancher maintains his animals. In 2010, 37 ranchers were classified in this category (63.8% of the total), holding small herds which vary from 0 to 6 animals (Table 2), adding up to 81 animals, or 11% of the total.

Among the ranchers in the first category, three (8.1%) raise animals in partnership with another rancher, through an agreement known as sharing or "half raising". This form of partnering, in which

a large rancher leaves part of his herd under the care of another community member in exchange for a young animal or a portion of the calves born on the partner's property, is widely used in the region to disperse the herds during the flood season. This strategy is directly related to the need to obtain larger pasture areas to maintain the stock during flooding, and has been quite historically important to the dynamics of ranching in the RDSA. Of the three ranchers who "half raise", two had no animals at the time of the interview, as they had not received their portion according to the agreement signed with the other rancher, which referred to the maintenance of the animals during the flood of 2009. Even so, these ranchers expressed the desire to maintain the partnership to "try their luck at raising livestock" (*"tentar a sorte na criação de gado"*).

The second category identified includes those who gave more importance to ranching activity and dedicated more time to working in this area. The family lands which had previously been dedicated to planted fields or fallow fields are now partly transformed into pasture. Depending on the rancher's strategy, new areas are incorporated by the family. This category is marked by a concern with finding new areas of land to open, even if their pastures already hold their animals, arising from a desire to increase the herd. A tendency for these families to move to more remote areas of the community was observed; this allowed them to raise their animals in more isolated areas which are theoretically less subject to conflicts with other residents. In 2010, 17 ranchers were classified in this category (29.3% of the total), with herds of 6 to 26 animals, adding up to 193 head, which represents 26% of the total.

The last category of ranchers is that which most closely approximates the mentality of commercial ranching. These ranchers have larger herds (28 to 206 animals, totaling 461 head in 2010, which represents 63% of the total herd), more than one pasture area, and selling the animals for slaughter represents an important share of the annual family income, at times classifying ranching as the family's main activity. In this context, some statements were registered, such as:

"Ranching is my way of life, because it is something that yields much more, it's not like you are working in the fields." (Livestock rancher, RDSA, age 44)

["A pecuária é o meu meio de vida, porque é uma coisa que dá muito mais, não é como tu tá na roça."]

"My trips (trading) pay my expenses and my family's expenses; my livestock is my savings account, my profit." (Livestock rancher, RDSA, age 61)

["A minha viagem (regateio) defende a minha despesa e da minha família, o meu gado é a minha poupança, o meu lucro."]

Table 2. Number of ranchers and total herd by category of ranchers in the RDSA in 2010.

Category of rancher	N° of ranchers	Total herd
1	37	81
2	17	193
3	4	461

Besides the sharing partnership described above, another form of involvement with large ranchers

(whose manner of livestock raising was identified as Category 3) was identified with certain farmers: the "sponsor system". In this case, there is a previously-established relationship where the larger rancher, who is also a trader, purchases flour. The farmers then seek him out to request one or more animals to begin their own livestock operations, and receive a "gift" animal or are sold with extremely long terms of payment. In this way, the rancher strengthens the bond already established by the purchase of cassava flour, now directly with livestock, depending on these farmers during the flood season to maintain part of their own herd.

The components of the last category are known in the region as ranchers and not as farmers, which is the case with the other categories. The recognition of these as ranchers promotes different feelings among the local population, most notably admiration of their success in this activity and the wish to "have the same luck". The association of raising livestock with the accumulation of wealth and economic ascension fills the imagination of many local farmers, and sometimes is used by large ranchers as a propaganda tool for seeking new partners.

Resource Management

Ranching in the RDSA has been adapted over time to overcome difficulties and take advantage of the environment in which it is located, which is strongly influenced by the water cycle, reaching a mean annual flood of 10.6m (RAMALHO et al., 2009). The strategies adopted by the ranchers conform to individual resource management styles, with three main landscapes: natural fields, cultivated dryland fields, and cultivated fields in the várzea. The location of the pasture in one

of these environments, which present variations in terrain elevation and the degree of flooding, and the combined use of more than one of these landscapes determine different management practices throughout the year.

Some cultivated fields are used year-round, while others are prepared to hold the animals only during the floods, the most critical period of the year. Furthermore, the pasture units vary with regards to location, and can be located within the community, in isolated fields, or on farms (isolated fields where the rancher establishes residence).

Natural fields

Natural fields or *natural pastures*, as they are called by the locals raising livestock, are large extensions of floodable land near lakes and isolated tributaries where a large diversity of aquatic and land plants develops. Among this community of vegetation are grasses and other plants which are highly nutritional for cattle and buffalo (OHLY; HUND, 1996; FURCH; JUNK, 1997), as well as species with a high production of dry material (PIECADE et al., 1991).

For the RDSA, the natural fields in the eight lakes (Itanga, Seringa, Urini, Castanho, Capitão, Teodora, Piranha and Lagão) and their surroundings are occupied by herds of cattle and buffalo, with a total area of 2,711 ha. These fields are utilized by 26 livestock raisers (44.8%), among them the producers with the largest herds, which means that the majority of the reserve herd, around 525 head (71.4%), is maintained in these areas for most of the year. The animals occupy natural pastures for 8 to 9 months of the year, while the water does not totally cover the pasture. Each of these areas is utilized at different levels of intensity, mainly with

relation to animal density, which on average is 0.2 head/ha (Table 3).

Table 3. Natural fields in the RDSA and their utilization

Natural field	Area (ha)	Herd (n° head)	Animal Density (head/ha)
Seringa	760	261	0.34
Itanga	695	134	0.19
Urini	167	25	0.15
Castanho	98	10	0.1
Capitão	14	2	0.14
Teodora	28	12	0.43
Lagão	503	17	0.03
Piranha	446	64	0.14
Total	2711	525	0.19

The native pastures are used by the ranchers mainly as an area to fatten the cattle and buffalo so that the animals can be sold for slaughter before the total inundation of these fields. Furthermore, these pastures are greatly important to the recovery of weak animals after the flood season, when the majority of the cultivated fields cannot support a high animal density. The people raising livestock consider the use of this environment to be fundamental to the success of their operations, especially the larger ranchers, seeing that this practice entails the use of extensive areas with a high availability of good-quality pasture and requires no investments in labor. This characteristic, in turn, determines that the natural fields are shared by herds belonging to various operators. According to McGrath et al. (1993), the natural fields are common property, with their perimeters based on the river or lake banks.

A peculiarity of the natural fields is the better performance of buffalo in this environment, due to

their greater hardiness and their adaptation to areas that flood. The buffalo consume a larger variety of grass species than the cattle in the várzea and are able to move around flooded areas, consuming floating vegetation during the flood period (OHLY; HUND, 2000). These are some of the main factors which have influenced the expansion of the herd and the dissemination of this species among livestock producers in the reserve.

Further, as the animals are not pastured in these areas and are at liberty to move between the natural fields and the adjacent cultivated fields, the buffalo have an advantage in being able to occupy the natural fields for more time during the year, including when the water level makes access impossible for cattle. According to research conducted in native várzea fields in the Lower Amazon region, buffalo remain in these areas for 24% longer, on average, than cattle (SHEIKH et al., 2006).

Some of the lakes used for livestock in the RDSA are also occupied by groups of fishermen managing populations of pirarucu and tambaqui. The simultaneous use of these areas generates conflict between the fishermen and ranchers, principally with regards to the buffalo herd. The fishermen allege that the buffalo, by grazing in the water, scatter the fish and eat the grasses that protect the young fish. The livestock raisers, in turn, defend their usage, alleging that there are many fish where they raise their animals, and even use the fact that these areas are managed by the fishermen as an argument to confirm this idea. Another conflict identified in these areas occurs between livestock raising and cultivation of beach areas (to produce corn, beans, watermelon, etc.), which at times is abandoned by farmers due to pasturing of and trampling by animals in the cultivated areas.

Cultivated fields

Historically, the fields used for ranching in Amazonia have been made up of areas deforested by man (ARIMA et al., 2005; FERREIRA et al., 2005). In the RDSA, this deforestation may have been directly intended to form the field (20%) or indirectly intended (80%), in the case of previous use of the area to plant cassava, banana groves, fruit orchards, or to establish community spaces or other uses (ARAÚJO, 2006). The cultivation of exotic grasses is frequent in these areas, with African species of the genus *Brachiaria* predominating.

The cultivated pastures in the RDSA exhibit different degrees of degradation, due to inadequate management and overgrazing during the flood season. As a consequence of this process, there is gradual invasion of the pastures by species that cause soil degradation and substitution of the planted grasses with Pacuã grass (*Paspalum conjugatum* Berg.), a species of native grass which predominates in fields in the RDSA. The undesirable species are combatted by the ranchers, typically by manual weeding, but some livestock raisers do use herbicides to control these plants.

Degradation of the cultivated fields, associated with overcrowding during the flood season, creates a food deficit for the herds in this period. This situation often ends in conflict between ranchers and farmers, as cattle and buffalo invade planted fields and farms. As the pasture becomes scarcer, the animals begin the search for food, entering the forest and, not uncommonly, finding the solution to their hunger in neighboring plantations. The destruction of planted fields by neighboring herds is feared by farmers in the RDSA, as the majority of the fields in the region are not surrounded by fencing, allowing the animals to circulate freely.

The cultivated fields occupy two very different environments: dry land and *várzea*. The location of the pasture in one of these environments and the strategy for its use throughout the year result in different seasonal dynamics.

Cultivated dryland fields

The combination of natural fields and fields on dry land during the annual productive cycle is an important strategy adopted by the livestock raisers in the RDSA. Around 75% of the total reserve herd occupies the dryland fields during the flood season. Transferring the herd to dry land during this period, when the natural pastures are completely flooded, was the medium-to-large ranchers' solution to maintaining their animals in the period when food is scarce on the *várzea*.

The dryland fields are used in three different ways during the year. The majority of these fields are used exclusively during the floods, while the rest are used throughout the year. Among the latter group, a portion of these fields that has a variable density of animals throughout the year can be seen; they hold more animals during the flood season.

Between 2005 and 2010, the total area of dryland fields grew from 131.5 ha (20 fields) to 219.8 ha (32 fields), an increase of 67%. This expansion refers mainly to the fields used exclusively during the flood season, which increased from 34.4 ha (8 fields) to 95.1 ha (14 fields), an increase of 176%. Along with this, the area of fields used throughout the year with more intensive use during the floods increased from 49 ha (2 fields) to 67.4 ha (3 fields), an increase of 37.5%. This change is strongly linked to the need, mainly on the part of the larger ranchers, to increase the area of pasture used

during the floods, due to the herd's growth over these years.

The acquisition of these areas for ranching does not take place continuously as it is common for some fields to be abandoned, though this occurs on a smaller scale. These fields are normally abandoned when ranchers do not continue to raise livestock, whether because their efforts were unsuccessful or they moved to the city. Between 2005 and 2010, 6 dryland fields were abandoned, a total of 10.7 ha. Meanwhile, during this period 19 new areas were acquired, and 5 old fields were expanded, creating a total of 99.1 ha destined for ranching in the dryland environment in a 5-year period.

In this context, it can be seen that part of the areas cleared for farming are already targeted for future ranching uses after one or two cassava production cycles. This strategy is common in other regions of Amazonia (MACHADO et al., 2003), and is used by some ranchers to establish new pastures and expand existing pastures when the fields are located adjacent to these pastures.

According to the seasonal dynamic of activities, the fields used during the floods are occupied for 3 to 4 months of the year, during the time when the rivers and lakes are at their highest water level. During the rest of the year, when the animals occupy the natural fields, these areas remain at rest, being conserved for the next winter period. Currently, of the dryland fields used throughout the year without variation in animal density, 57.3 ha are distributed among 15 grazing units, holding 62 head (8.4% of the total herd). The fields used exclusively in the flood season hold 331 head (45% of the total herd) during this specific period of the year.

The dryland fields used throughout the year which have seasonal variation in animal density hold a herd which increases from 72 head (9.8% of the total herd) to 222 head (30.2% of the total herd) during the flood season. The variation in density in these fields is due to some ranchers maintaining a portion of the herd in the natural fields during the time when the waters rise and recede, while the other portion occupies the dryland field. This strategy requires the rancher to transfer the entire herd to dry land during the most critical period of flooding.

Cultivated várzea fields

Cultivated fields in the *várzea* are of great importance to livestock raising in the RDSA, mainly when discussing small operators' grazing units. At the same time, some of the *várzea* fields are part of the management dynamic of medium and large ranchers, operating as support areas adjacent to the natural fields.

Normally, the fields cultivated in the *várzea* are used throughout the year, and are the livestock raiser's only grazing unit. Nevertheless, some of these fields are unusual in being used exclusively during the flood season or with a greater density of animals during this period, due to the reduction of area available for grazing which occurs alongside the advancing floodwaters.

The total area of *várzea* fields fell from 99 ha (25 fields) to 76.7 ha (24 fields) between 2005 and 2010. Even with the addition of 4 new areas for ranching activity (6.6 ha), this reduction occurred due to the abandonment of 5 fields mapped in 2005 (29 ha), causing a decrease in the number of grazing units and total area of fields in this environment.

In the *várzea* environment, a large part of the cultivated fields (58.3%) is located within the communities, which creates a conflicted relationship between the rancher and other community members. The ranchers use the pasture established in areas which were previously cleared to build the community, and release their animals to graze among the houses. While, on the one hand, the community approves livestock raising in the common area to keep the grass low and clear the brush from the areas surrounding the houses, on the other hand, residents complain about the animals' "mess" (manure) and their tendency to consume clothing and other objects. The livestock raisers also complain that the other residents are not careful with their trash, especially plastic, which is eaten by the animals when thrown out into the areas surrounding the homes. These small conflicts sometimes culminate in transferring livestock operations to isolated fields.

Management of livestock in the *várzea* fields is very dynamic, involving different decisions and practices in accordance with the amplitude of the water cycle each year. For example, some areas can be flooded in a particular year and partially or totally occupied by animals during the flood season in the following year. Few operators raising livestock in the *várzea*, especially in the case of small operators, are prepared to move their animals to dry land during the floods, and instead transfer them to high riverbank areas where they are more protected. In years when flooding is severe, the livestock raisers must build *marombas*⁷ where the animals can be kept during the months of flooding.

⁷A floating structure resembling a corral, which is commonly used in *várzea* areas of the Amazon.

In both cases, resource management involves the need to find, cut, and offer grass to the animals. This seasonal practice implies a daily search for sources of aquatic or terrestrial grasses in higher areas, which can be located far from the productive unit. The grasses are transported by canoe, one or more times per day, and sometimes when the opportunity arises, the ranchers tow large “balls” of grass down the river on barges. Seasonal management during the flood season in várzea areas is reported by livestock raisers to be one of the greatest difficulties, or the main difficulty, in raising livestock.

Sales

Livestock sold in the RDSA is destined for slaughter in the city of Tefé, the regional center. The animals from this conservation unit are sold directly to a dealer (butcher) who is responsible for the slaughter, processing, and sale of meat in the different commercial units in the city, mainly the Municipal Market. Until today, slaughter operations in this city area are conducted clandestinely, as there is no appropriate space for this activity which has been inspected by the official agency.

The sale is previously agreed upon with the buyer, with relation to both quantity and price (in 2010, an average of BRL\$ 6.10/kg for beef carcasses and BRL\$ 6.00/kg for buffalo carcasses ⁸⁾), and is conducted directly in the city. The ranchers are responsible for transport, and bring the animals to the location of slaughter on small wooden barges. Seeing as few ranchers in the RDSA have their own barges, they hire someone to transport the animals for slaughter, paying the barge owner a fee

to transport them. Another way for these ranchers to ship out their production is to sell the animal directly to the barge owner, paying only after the animal is slaughtered and the carcass weighed.

Animals are mainly sold in the months preceding the flood season, primarily April and May, when the animals are fat after grazing in the natural fields. Selling at this moment is also part of the livestock raisers’ strategy to reduce the density of animals during the flood period. This logic is common among the large and medium operators, who plan to sell a certain number of animals per year. Smaller operators do not fit into this context, because they sell their animals at any time during the year when they may need funds, which normally happens at greater intervals.

Around 100 animals are sold yearly by the RDSA ranchers for slaughter in Tefé. This number is hardly significant in the local meat trade, where around 250 animals are slaughtered monthly; most of the animals slaughtered to feed the city come from the Lower Amazon region. However, for those raising livestock on the reserve, the sale of these animals is very important economically, generating a gross annual income of approximately BRL\$ 180,000.

Impacts of ranching on the conservation of biodiversity

Because it is an expanding activity with high impact potential, livestock raising is one of the main points in discussing conservation in the RDSA. Consequently, it is necessary to identify the main ways that this activity impacts the environment in order to establish a monitoring system and construct norms to guide the use of productive environments and manage the herds. Although this study focuses on characterization (and not the assessment of environmental impact) of livestock activities, the information gathered to

⁸ Carcass is the term defining the animal which was been slaughtered, skinned, and eviscerated.

perform the study can be used to identify some relevant trends.

In this context, each category of livestock raising represents a certain threat to conservation, exerting different degrees of pressure on the environment according to their respective production strategies (Table 2). To assess how the ranchers in each category behave with relation to the potential environmental impact of their activity, a canonical discriminant analysis was conducted, considering the following indicators: number of fields cleared and area deforested in the last five years, the area of cultivated fields on dry land, the size of the

herd, the number of buffalo, the number of cattle, the change in the total herd (cattle and buffalo) between 2005 and 2010, the area of natural fields used, and the use of fences. In Figure 3, a distinction can be observed along canonical axis 1, between producer groups 1 and 3 (the 95% prediction circles do not overlap), representing different degrees of potential impact on the environment. Categories 1 and 3 have the profiles representing the least and greatest impact on the environment, respectively, a result which was reinforced by the ANOVA analyses (Fisher's LSD $p < 0.0001$) shown in Table 4.

Table 4. Mean values for the indicators of environmental impact for each category of livestock ranchers.

Category	N° ranchers	Total herd	Cattle herd	Buffalo herd	Change in total herd 2005-2010	Area of dryland fields (ha)	Area of natural fields used (ha)
1	37	2.19 ^a	1.81 ^a	0.38 ^a	0.76 ^a	1.06 ^a	27.73 ^a
2	17	11.35 ^a	7.29 ^b	4.06 ^a	7.41 ^b	4.62 ^a	231.29 ^b
3	4	115.25 ^b	24.5 ^c	90.75 ^b	23 ^c	26.7 ^b	942.75 ^c

Values in columns with different letters indicate significant differences at $p < 0.0001$.

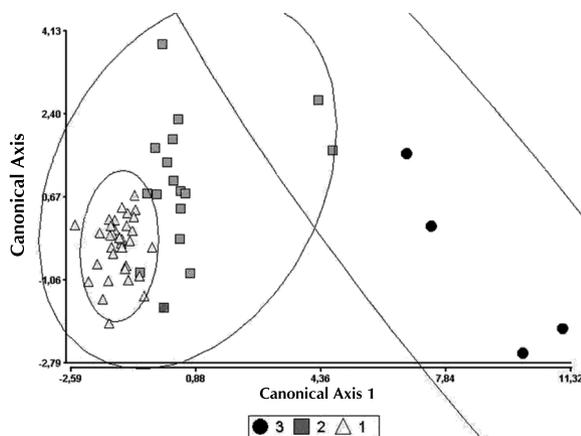


Figure 3 - Canonical discriminant analysis of the three categories of ranchers according to their potential impact on conservation of biodiversity, where category 1: n=37, category 2: n=17, and category 3: n=4.

Category 3 uses the largest area of dryland pasture, has the largest total herd, the largest buffalo herd, the greatest evolution of the buffalo herd, and the largest area of natural fields used. On the other hand, the group of ranchers in category 2 is characterized by fluctuation between the two extremes. Within this category are those ranchers who more closely approach the impact caused by category 1, and others who resemble the impact profile for category 3; this suggests a gradient of potential impact according to the growing movement towards commercialization. The visualization of this scenario is an important tool to define the portion of the ranching population

which potentially may exert greater environmental impact through its activities, and then, from that point, provide support for decision-making by managers regarding ranching activity in the RDSA. At the same time, this same portion of ranchers is that which will be directly affected by the regulation of this activity and consequently should receive more attention in outreach efforts to improve the constructed norms. Within the RDSA, this portion consists of the large ranchers who make up category 3 and the medium-sized operators (category 2) whose profile shows expansion of activities, currently a total of six ranchers.

Among the impact indicators selected for analysis, three stand out in representing potential relevance for conservation in the RDSA: 1) area of cultivated fields on dry land, 2) area used in natural fields, and 3) growth of the buffalo herd. The identification of these as relevant points for conservation in the RDSA suggests that they may be the focus for regulation of this activity.

The area of fields cultivated on dry land is one of the main indicators of the impact of livestock raising, as it directly deals with the conversion of forest habitat into pasture. Due to its importance in seasonal management of the herds, these areas have increased in number and size over recent years. The expansion of the total area of pasture units on dry land between 2005 and 2010 represents an increase of 75.4% and an average rate of land clearing of almost 20 ha per year. The clearing of forest or post-burn regrowth areas differs from areas cleared for agriculture because, in the former case, it is used constantly, while local agriculture is traditionally migratory.

Category 3 is directly responsible for only 14.7 ha of deforestation in this period. However, around 50% of the deforested area belongs to these producers' partners; in other words, these lands are part of the seasonal management of large operators. This dynamic demonstrates the importance of partnership relationships between large and small ranchers in livestock raising in the RDSA.

Furthermore, the absence of adequate management of the cultivated pastures also generates problems for conservation, seeing that the drop in yield from these pastures influences the decision to expand field areas. The degradation of cultivated pastures is common in dryland fields in the RDSA; exposed soil can frequently be seen, as can spontaneous substitution of cultivated pasture by less-nutritious herbaceous species. Meanwhile, the recovery of degraded pastures is very infrequent in the local production system.

The use of natural fields, in turn, is the main strategy for ranching activity in the RDSA, especially for medium and large operators. Large swaths of native *várzea* pasture are used throughout most of the year, making this area the ranchers' most important means of production. While these fields have a low density of animals in the dry season, an average of 0.2 head/ha⁻¹, this rate rises with the floodwaters, increasing grazing pressure on the areas that remain above water. Consequently, grazing pressure on the natural fields varies as a function of the water cycle, which results in increased trampling and reduced biomass as the flood grows.

There have been few experiments with adequate management in the native *várzea* fields and few studies about these fields' capacity to support herds (OHLY, 1987). However, due to the importance of herbaceous plants in the dynamic of flood areas due to the multiple ecological functions they perform (PIE DADE et al., 2005), the use of natural fields should be guided by the RDSA management plan. In the Lower Amazon, changes in the *várzea* vegetation resulting from grazing by buffalo are of concern to researchers (SMITH et al., 1995; GOUDING, 1996; ARIMA; UHL, 1997). According to Conserva et al. (1998), during a 10-year period when a *várzea* pasture was used for a number of buffalo exceeding the support capacity, a 50% reduction was seen in the herbaceous species of the *várzea*.

The lakes in the *várzea* have the greatest diversity and abundance of fish in the Amazon basin (HENDERSON; KREMPTON, 1997). In this environment, the aquatic macrophytes form an important habitat which functions as a nursery for various species of fish (SÁNCHEZ-BOTERO; ARAÚJO-LIMA, 2001). According to these researchers, the introduction of livestock to flooded planes has a devastating effect on communities of macrophytes, which can affect the conservation of local fishery stocks. In the RDSA, some of the natural fields used for grazing are located in lakes which are part of the fishing management of the local communities, namely Lake Seringa, which is reserved for the reproduction of the pirarucu (*Arapaima gigas*).

Finally, uncontrolled growth of the herd could represent a serious threat to conservation, as the

cause for clearing new fields and increasing the intensity of use in natural fields. In this context, the growth of the buffalo herd deserves emphasis; it has shown greater intensity due to its better productive performance in comparison with cattle. The dissemination of the buffalo herd has occurred thanks to large operators, who introduced the species to the region two decades ago and currently hold just over 80% of the herd.

CONCLUSION

Livestock is raised in the RDSA by 58 families in an extensive and non-specialized manner, using few inputs, raising mostly mixed-breed cattle and buffalo for slaughter. This activity has been practiced since the middle of the twentieth century, mainly with family labor, with the main objectives of generating income and preserving assets.

The size of the total herd is susceptible to climatic extremes, such as the great flood of 2009, and was calculated to be 735 animals in 2010. The main areas of pasture used to raise livestock in the Amanã Reserve are the natural fields and fields planted on dry land, the use of which varies according to the level of flooding throughout the year.

Among the population raising livestock in the RDSA, it is possible to identify three distinct categories of ranchers, according to their intentions in practicing this activity, which in turn is reflected in the size of the herd. For the period under study (2005-2010), an increase in the growth of the total herd was observed, with an emphasis on the buffalo herd belonging to large producers. The potential

environmental impact of livestock raising in the RDSA was seen to vary according to the category of the rancher. Large and medium operators had greater potential for environmental impact, mainly with reference to: a) area of fields cultivated on dry land, b) area of natural fields used, and c) growth of the buffalo herd. These three indicators are shown in this study to be the most relevant to guiding regulation of ranching activity in order to conserve biodiversity in the RDSA.

FINAL CONSIDERATIONS

Livestock raising in the RDSA has grown more rapidly in the last decade with the introduction of the buffalo herd to the region. This species' adaptation to the local productive environment has stimulated the growth of the total herd. In this context, the commercial profile of the large ranchers could propel the expansion of this activity locally, with relation to the number of ranchers involved and the size of the herd, as well as the amount of deforested area and more intense use of natural fields.

At this time, we do not have information about the scale of the current RDSA herd's impact on environmental conservation and biodiversity. To this end, the points indicated in this study are those which are potentially important to regulation and monitoring of impacts.

In this way, the construction of norms which make up the management plan of this conservation unit should be accompanied by rural outreach initiatives and technical assistance in agro-ecological management, which allow for the improvement of management and productivity of the pastures currently in use. Furthermore, it is important to stress participation by the ranchers in

constructing these norms in order to bring them closer to the local reality, and consequently make compliance feasible.

Finally, conducting biological and ecological studies specifically concerning the effects of the herd's presence and grazing in the aquatic and macrophyte communities is very important in order to obtain evaluations of impact and to fine-tune regulation.

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