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Approximations of the Buffalloes' under populations numbers (*Syncerus caffer* Sparrman 1779) by total hike inventory method in the central and Southern parts of Benin

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Abstract

The approximation of the numbers of big mammals in general and the buffalo in particular, is done in the Southern and central parts of Benin. The technique used is the method of total hike inventory. The choice of this technique is justified by the fact that the number of contacts recorded during a hike census by transect is often problematic within the framework of obtaining satisfactory approximations of the densities of some species. It is the case of under - populations of the Buffalo (*Syncerus caffer* Sparrman 1779) in the Southern and central parts of Benin. In this study, it is tried out the total hike method. It is shown that under the ecological conditions of the sector of study, this method makes it possible to obtain not very satisfactory approximations. In June 2011 and December 2012, the estimations were respectively 17 and 21 individuals. This method supports also the study of the structure of age and sex of the numbers.

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Introduction

There are about 6000 m² forests per person all over the world. Each year, this vital area is lessened of 12 m2 (facts and figures 2001). Just as 25 % of mammals, 11 % of birds species; 34 % of fishes and 20 % of reptiles are threatened with extenguishment (Kpera 2002). These figures show how confronted the humanity is, with the thorny problem of natural resources protection. Why making inventory of animals? Sutherland (1999) answers the question: '' To determine the importance of a site; the numbers of the some species populations, the use of habitats per species; the reason of a population decline. It is also to know if the applied management policy is successful or, to check over populations' dynamic". If the reason of counting is numerous; so are the different methods (Seber 1973; Norton-Griffiths 1978; van Hensbergen & White 1995; et Jachmann, 2001 for a recent revew). The choice of the method depends on the objective. In fact; most of the biological problems (long term evolution of population; use of habitats; spreading out; populations' management; the growth rate of the population…) don't require exact approximations of the number of animals. But they can be only comprehended with relative values of density. We then; talk about sufficient index of abundance; to determine the tendency of population over time (Norton-Griffiths 1978; Anon 1991; Maillard and *al.* 2001). This study is aiming at evaluate the under populations numbers of buffalo and to comprehend populations' structures from the another approach. The total hike inventory.

The study area

This study is carried out in the South and in the Center of Benin. The area of survey is respectively limited at the West and the East between Togo Republic and the Federal Republic of Nigeria. It is limited by the Atlantic Ocean at the South and by the second parallel at the North. From the South to the North, the vegetation of the prospected zone is made up of coastal formations such as mangrove; marshy formations; dense; dry and semi deciduous forests, guinean wooded savannas; grasslands and plantations. The climate of the administrative divisions crossed is the Sudano guinean one. With four seasons: 2 dry seasons and 2 rainy seasons. The utmost temperatures recorded during this year at Save, Bohicon and Cotonou are respectively (19,9 °C and 40,6 °C), (20,4 °C and 40,3 °C) and (22,1 °C and 34,6 °C). The rainfall varies from 1300 mm in the Southern administrative divisions (Oueme, Plateau, Litoral and Atlantique to 1100 mm/year in the central administrative divisions (Collines, Couffo, Mono and Zou). The Southern and the Central administrative divisions of Benin are flowed through the water of two main drainage areas. The first one is the network of coastal lagoons of almost 60 km long between Togbin; and Grand popo and about 200 m wide of average the hydraulic characteristics of which depend on Mono and Oueme Rivers and the Atlantic Ocean. The second main drainage area is the Atlantic Southern basin traversed by three main waterways which come down from the North to the South in order to water the Benin lagoon system. Mono (350 km), Couffo (125km) and Oueme (450km).

Materials and methods

Buffaloes inventory methodology

The demoecologic characterization of buffaloes' underpopulations is to know the structure of herds (size and composition of the herds). It is studied with the method of total pedestrian inventory. The pedestrian census principle consists in walking through a given area in order to count the animals livining in. This method helps tracking animals and pursuing them on a long distance so as to note the vegetable species that are consumed, the behavior and the age and sex structure of the group. To make it possible, each team was in charge of seeking the animals, starting from the traces, and the indications of presence observed from the water points or during the hike. During their displacement inside the block which was attributed to them, the team could also meet buffaloes at random. This method is partially connected with total air counting by dividing the surface of study in blocks described by Northon-Griffiths (1978) and widely used in intertropical

Africa (Omondi *and al.* 2002 ; Bouche *and al.* 2004a and b; Ouedrago *and al.* 2009). But instead of being flown over by helicopter or plane, the definite blocks are crossed by foot. In addition; transects linear were not determined neither for the whole zone, nor for each block. The mode of displacement is rather similar to transects of reconnaissance (recce transects). The blocks were delimited on the basis of the natural limits existing (rivers, tracks, peripheral limits of protected forests) and also; from the information on the usual distribution of the buffaloes; provided by the preceding inventories.

Protocol implementation

Within the limits of each block, the team had to write down the numbers of the herd, the structure of age and sex, the ecological characteristics of the station, the food characteristic as well as the geographical coordinates of the points of observation of the herd. These are also noted: indices of human presences (traps, domestic animals, corpses of animals, hides, blows of rifle heard and hunters). The whole of the inventoried zone is traversed at the same period by every team. During census, the targeted species is the buffalo (*syncerus caffer* sparrman). The herds of buffaloes are observed by pairs of binoculars when they are perceived far away by the team; in order to note in a precise way theirs numbers and to better cop reprehend the structure of the herd.

Identification of double countings

During the census, the same herd can be registered in different zones and blocks. The geographical coordinates of the herd while dealing with the inventory, the numbers of the herds, the structure of age and sex, the structure of the coats of some animals of the group, make it possible to identify the possible double countings. A high density of the herds in the zone of study is a restrictive factor, because it increases the risks of double counting.

Data analysis

With the method of total pedestrian inventory, all the animals, occupying the zone of study during the census, are supposed to be identified and counted. In actual practice, we suppose that, it is not very likely to return in liaison with all the herds and the solitaries. We try to identify the herds having a relatively significant numbers, knowing that some animals or herds will go unnoticed during the inventory. This source of error is unavoidable. At the end of the census, we have a total number of animals which represents a minimum value of the real numbers present in the studied zone. Two inventories are carried out in June 2011 and December 2012. The two targeted periods represents two different ecological realities. The dry season (December) corresponds to a period of food gap, when the herds remain grouped around the water points. In rainy season (June) the fodder and the drench water are abundant. The vital space of the buffaloes extends and the mobility of the herds is marked. The results will make it possible to do a comparison during the same year, and between two years successive, namely 2011 and 2012. The software Excel 2010 is used for the statistical analyses. The cartography will be carried out with the software ARC GIS. The distribution of buffalo's densities is obtained by the method of distances Kernels (Worton 1989). The density of the nucleus or "Kernel" is a non parametric method of approximation of an uncertain variable density. It is based on a sample of a statistical population and makes it possible to estimate the density in any point of the stand. The running of this method is carried out as follow:

If x1, x2…,xn f is a example of a random variable, then the non-parametric appreciator by the method of density of the nucleus is (number of the equation)

$$\hat{f}_h(x) = \frac{1}{Nh}\sum_{i=1}^{N} K\left(\frac{x - x_i}{h}\right)$$

where K is a nucleus (kernel) and H a parameter named window which controls the degree of smoothing of the approximation. The interest of this

method is that , it carries out a polishing of data (cleaning of the mosaic) to represent them in the form of a continuous plan. Thus, this method offers a reading of the total distribution of the buffaloes on the surface of study by strongly reproducing the reality of the landscape. A grid, modelled in ArcGIS, is represented by cells called "meshs". The variable "object" of each cell is distributed after smoothing in each mesh of the scale by the application of a function of distribution of the type "Kernel Density ". The value smoothed on a mesh corresponds to the sum of the contributions balanced by the distance received from each mesh. That consists in placing a symmetrical function on each point then; to make the sum of all these functions of each mesh. The smoothing of the distribution is related to the choice of scale, the ray of research and the unit of measurement (km) on the surface of study. The choice of scale and the ray of research are considered downward for each application. The unit of measurement is chosen according to the unit of projection (km).

The method of density of the core starts with the principle that, the density of a cell is indissociable among the one of its neighbors. The algorithm carries out a smoothing of the data ("cleaning" of the mosaic). Thus, a cell, surrounded by cells of strong densities, will have its density reinforced by this calculation. Conversely, an isolated zone with strong density will be maintained if, this density is equal or much more significant than the one of its neighbors. Thus, this calculation makes it possible, to reveal continuities of tendency in space (Fig. 3).

For more visibility of the results, we considered the office plurality of the observations and the numbers obtained in 2011 and 2012.

Results

Observed numbers in the sector of study

The table 1 shows the numbers observed in each village during the inventories of 2011 and 2012. From the analysis of the table, it arises that, the number of the herds in 2011 varied from 4 animals (Agoua) to 8 animals (Wari Maro). Whereas, in 2012 the number varies from 3 animals (Agoua) to 13 animals (Mount kouffe), indicating a rise of numbers especially at Wari Maro.

Table 1. Numbers of the herds by site.

	Agoua		Mount kouffè		Wari Maro		Atcherigbe	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
A number of herds	2	1	3	2	3	4	0	0
Average size	1.2	0.75	0.89	0.63	0.89	1.25	0	0
Standard deviation	1.22	1.30	0.86	1.11	1.29	1.64	0	0
Extremes	0 - 3	0 - 3	0 - 2	0 - 3	0 - 3	0 - 4	0	0
Total number	4	3	5	5	8	13	0	0
ratio sex	0.2	0.2	0.28	0.2	0.2	0.325	0	0

The nonparametric test of Kruskal-Wallis carried out because of the non normality of the data, indicates that the differences due to these variations between the sites of inventory are not significant (Prob > 0, 05). However, these variations are more significant within the zones (Prob < 0, 05).In addition, it is useful to emphazise that, the main part of the herds of buffalo of the center of Benin was observed in Mont kouffe and Wari Maro where, maximum values of numbers of the herds were also recorded.

On the extent of the exploited zone, the total numbers recorded in 2011 and 2012 are respectively 17 and 21 animals (Table 2). These numbers are particularly low

in 2011. The variations in terms of numbers and average size of the herds between 2011 and 2012 are not really significant (Prob <0, 05).

Table 2. Total numbers recorded by inventory on all the sites.

Parameter	2011	2012
A number of herds	8	7
size average	0,77	0,95
Standard deviation	1,13	1,43
Extremes	0 - 3	0 - 4
Total numbers	17	21
Sex ratio	0,22	0,25

In 2012, one notes a light rise of complements. These variations are mainly due to the seasonal migrations of buffaloes under the influence of several factors such as fodder availability and the drench water, the agropastoral occupation of the space which modifies the routes, and sometimes the poaching. The herds return to the zone in small groups so that, a census at a time given represents only part of the population of the zone. Indeed, it happens that the observations are very few in the zone. The herds either are dispersed in the vicinity of the cultivated zones, or in the course of migration. Table II presents the total numbers recorded by inventory.

Buffalo's structure of the populations

(Fig. 1) relates to the current structure on the scale of listed numbers.

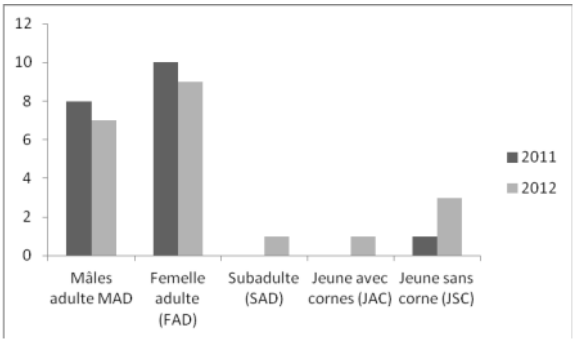

Fig. 1. Herds' structures.

It reveals that the adult females (ADF) are better represented with an average of 10 % of numbers whereas the proportion of the adult males (ADM) is about 08 %. In addition, the young without horn (YWH) are very little represented with a proportion lower than 05 %. The subadultes and the young with horns absent in 2011, appear in 2012 with less than 02 %. This showed a light reproduction because of the prevailing number of the adult females.

Numerical structure of herds

(Fig. 2) has the numerical structure of herds in the sector of study.

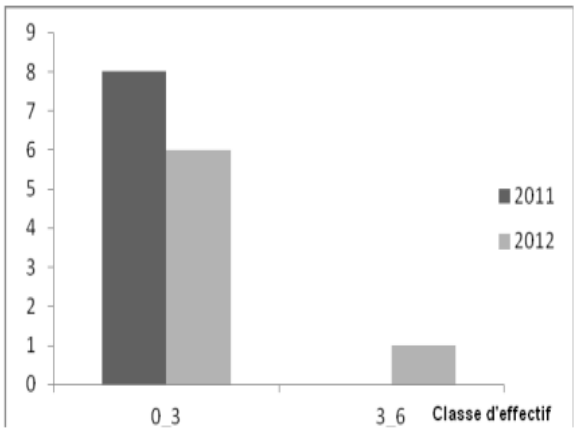

Fig. 2. Current numerical structure of herds.

Currently, the herds of zero to three animals are better represented. The most significant herd observed was found in Wari Maro and is composed of 4 animals. The recluses were observed. In addition, the young ones were not recorded. But it should be noticed that, in all the recorded herds, the females are distinctly better represented.

Densities analysis

As soon as we go towards the high latitudes, the density of the subpopulations of buffalo increases. Thus; apart from Atchérigbe (Djidja), a herd of approximately four animals migrate seasonally. It does not exist in all the other ecosystems of South. Then we have the protected forest of Agoua where small sizes of under – populations exist. The highest densities of buffaloes are at Wari Maro and Mont Kouffe and the size of the populations can reach six and more (Fig.3).These variations in temperature are due to the strong demographic growth which consequences are the anthropic pressure (poaching,

agriculture, exploitation of the saw log... etc) and the urbanization.

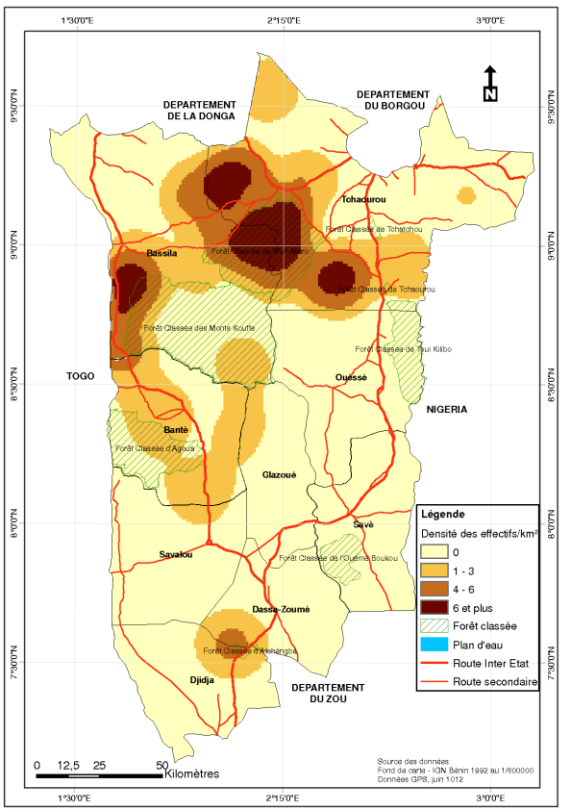

Fig. 3. Density of buffaloes herds in the surface of study.

The inventory helps delimiting the zones of concentration of buffalo (Fig. 4) and their habitat, in the surface of study. Thus we can retain that only the females and the adult male are well represented.

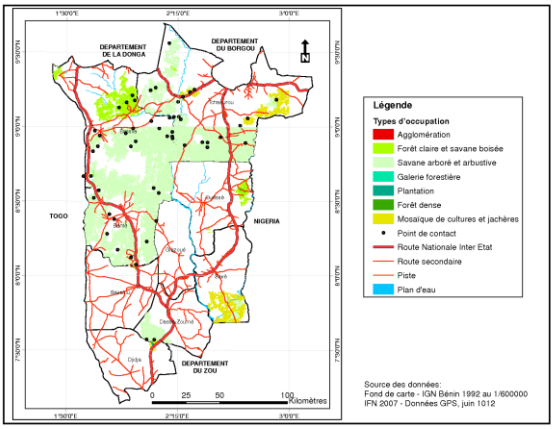

Fig. 4. Distribution of buffaloes' herds on the whole surface of study.

Discussion

On the whole studied zone, the recorded numbers are 17 animals in June 2011 and 21 animals in December 2012.With this difference, a principal reason can be put forwards: the mobility of the buffaloes. Indeed, in the air of study, the buffaloes move according to the spatialization of the water points and the fodder availability. Herds of buffalo can be well at the time of the counting, apart from the space of air of study. The results of counting, respectively 17 and 21 animals, confirm this mobility of the buffaloes. However the factor of mobility of the animals alone can not explain this result. It can be due to the poaching. Thus, the fluctuations of animals populations numbers, look like the resultant of the climate impact on the vegetation modulated by their food strategies, graze specialists or general practitioners. In addition to the influence of the dryness, the decreasing in the graze specialists impact on the herbaceous zone, could emphasize the covering of the zone with bushes and the regression of the meadows of the plains floods. Thus, this reduces more, the food resources of graze specialists (Galat *et al.,* 2009). Indeed, annual precipitations condition the primary production, the distribution and the perennity of the water points. For these factors, it is necessary to add the human occupancy of the space which more and more becomes a structuring factor of the routes, the mobility and the distribution of the buffaloes. It is also advisable to point out that, the spatial distribution of buffaloes in period of farming will be different. During this period, the buffaloes actually visit the fields in the search of crops, on foot.

The average size of the herd calculated is of 0,77 ± 1,4 in June 2011 and 0,95 ± 1,6 in December 2012.These results confirm the mobility of the buffaloes involving of the periods of strong animal densities alternating with periods of low densities according to the ecological factors, we already evoked. On the level of the structure of the populations, we noticed that the adult females (ADF) are represented better with an average higher than 60 % of numbers whereas, the proportion of the adult males (ADM) is approximately 30 %. In addition, the young people without horn

(YWH) are very little represented with a proportion lower than 05 %. The subadultes and the young people with horns absent in 2011 appear in 2012 with less than 02 %.

Conclusion

The results on buffaloes confirm that the total pedestrian method tested for the first time on the buffalo in the southern and central Benin, can be used successfully to other species. The low number of herds of the studied site makes it possible to avoid double counting. In the zones with relatively reduced surface, if financial and logistic means do not permit the total air census, the resort to this method, allows obtaining reliable approximations of numbers and to better approach the structure of the herd. The method of total pedestrian inventory remains however less effective when the animal densities become significant or when the zones concerned cover vast surfaces. In this case, double countings will be difficult to identify. Its application must remain limited to the gregarious species for which the census methods by transects do not give satisfactory results.

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