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Spatio-temporal distribution of *Dendrocygna viduata* Linnaeus, 1766 in the River Niger valley, case of the Kandadji dam

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Abstract
The study is undertaken on the sites of Ayorou, Kandadji and Kokorou where still a significant population of *Dendrocygna viduata* remains. This study aims to know the spatiotemporal distribution of *Dendrocygna viduata* in the valley of the Niger River within the framework of the plan of installation of its valley. The methodology of the study initially consisted in cutting out each site in several circular stations of a radius of 100 m. Then observation points are set within the various types of habitat (station). Finally, the observation or the detection of the birds will be done within these stations by the listening point method which consists of counting, from a fixed point, the birds observed or heard inside an imaginary circle of fixed or unlimited radius centered on the operator. The enumeration is done out along the sites during the morning from 7:00 AM to 9:30 AM and the evening of 4:30 PM to 6:30 PM. The study made it possible to count on the whole 19191 individuals of *Dendrocygna viduata* on the whole of the sites in 16 meetings of census including, 7318 individuals in the 45 stations of Ayorou, 5613 individuals in the 35 stations of Kandadji and 6260 individuals in the 40 stations of Kokorou. *Dendrocygna viduata* is observed on all statios during all seasons of the year.

Keywords: enumeration, spatiotemporal, distribution, Niger River, Kandadji's dam

1. Introduction
Nowadays, no one is disputing the reality of the degradation of natural resources and biodiversity. That's why in Africa, the future of flora and wildlife depends on the development of a policies of protection of major areas, of sustainable development and rational use of the resources they generate (Lougbégnon, 2015) [20]. This policy can of course be implemented only due to the fundamental ecological knowledge, which are still lacking (Lougbergnon, 2004) [19]. The rate of degradation of natural resources, especially wildlife, and the threats of ecological extinction of these resources are one of international concerns in the area of sustainable environmental management (Lougbégnon, 2015) [20]. A good sustainable exploitation and ecosystem conservation can be only possible if the integration of rural communities into the sustainable management and conservation of forest resources and the new international philosophy in the field are concealing (Nguenang and Feteke, 2000) [23]. Man contribute to the modification of the landscapes. It has shaped its environment through the centuries by the use of land and natural resources (Burel and Baudry, 2003; Vomscheid, 2011) [7, 31]. This results in a serious problem with the global scale of loss and degradation of wetlands (Hecker and *et al*., 1996). Among the effects of this trend, which are already affected the inhabitants, are the decline of the fisheries, the pollution, the proliferation of toxic algae and, above all, the destruction of biodiversity (Issiaka, 2004; Costa and *et al*., 1996) [17]. As a natural resource and essential component of biodiversity, avifauna is of great interest in science and conservation (Toudjani, 2012; Soumaila, 2014) [29, 26]. In fact, birds are a zoological group that is easily usable for ecological diagnosis capable of leading to conservation strategies favorable to other species of flora and fauna (Sinsin and Kampman, 2010; Soumaila, 2014;) [26]. Water birds are important elements of the wetlands because they

have a heritage and scientific value, can be food resources and also because they can inform us about the state and operation of aquatic ecosystems (Issiaka, 2004) [17]. The rarity, even the disappearance of water birds on a wet area, may mean in some cases that plant or animal resources are rare, that worried the manager and the human populations who exploit them. We must protect them and manage them carefully. Reliable scientific data on avifauna such as its ecological requirements and its biological rhythms are major for understanding the functioning of avifauna ecosystems. These data remain indispensable tool for the manager to protect area because they allow to use information from collected data as an indication of the health condition of the ecosystem, in other words its degree of disturbance.

Due to this situation it is important as a manager to capitalize knowledge for sustainable ecological management of this species and its habitat. The aim of this study is to know the spatial distribution of *Dendrocygna viduata* in the area of the Kandadji's dam.

2. Materials and Methods

2.1 Biomaterial

The *Dendrocygna viduata* is a small duck (38-48 cm) with elegant silhouette always high on the legs. The face and throat are white, which contrasts with the black neck and the brown neck. The back is striped brown, the chest is chestnut and the flanks clearly crossed to the flight, the wings are rounded and the white of the head is visible, similar sex, white face and back of the dark head. Live next to water-bordered by vegetation, marshes and rice paddies. Sits on the edge of the lakes and rivers. Very gregarious, it is found quite often in the company of wild *Dendrocygna bicolor*. Diet essentially granivorous, it is a sedentary specie, but makes local travel according to food availability.

2.2 Study environment

The study was carried out in three municipalities in the region of Tillabéry, which are Ayorou (00°92" and 14°71' 38" N), Dessa (Kandadji) (00°99 10" E and 14°61' 34" N) and Kokorou (00°90'44" E and 14°18" N).

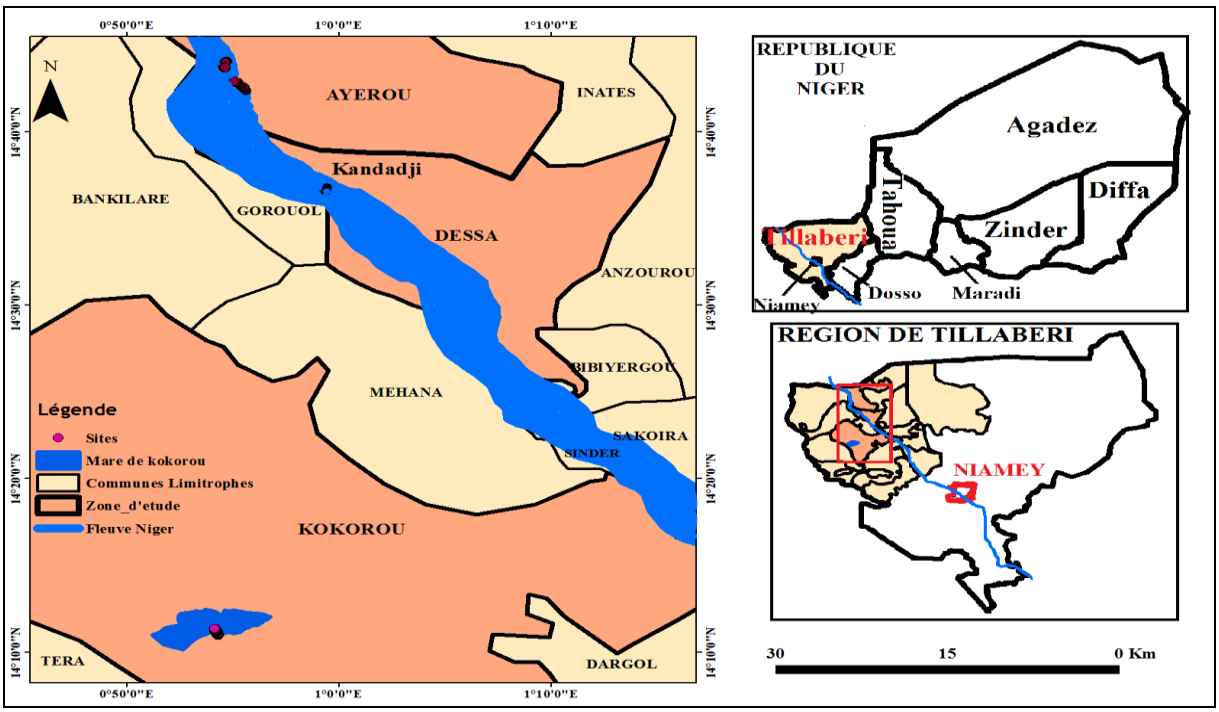


Fig 1: Study area

The temperatures in the area are very high during the day, up to 45°C in the shade, then low at night; sometimes fall below 10°C. Pluviometry is low (on average 240 mm/year) and is distributed very unevenly in time and space (Cissé, 2013) [8]. The main floristic species observed at the river level and the floodplains are*: Aeschynomene afraspera*, *Brachiaria mutica*, *Cyperus maculatus*, *Echinocloa colona*, *Echinocloa stagnina*, *Eragrostris pilosa*, *Ipomaea asarifolia*, *Nymphaea lotus*, *Oryza longistaminata*, *Panicum laetum*, *Polygonum senegalense and Vetiveria Nigeritana* (Geesing and Djibo, 2006; Tecsult, 2006) [11, 28].

The study area has an estimated population of 195288 inhabitants of which 38957 inhabitants for the rural municipality of Dessa, 115934 inhabitants for Kokorou and 40397 inhabitants for Ayorou. These three municipalities have a total area of 2629 km2. Living farming, breeding fishing, trade and logging represent the activities of the area (Cissé, 2013) [8]. Agriculture is characterized by the predominance of double-function cereals (grain and agricultural by-products for livestock) and by irrigated crops dominated by rice and the gardening (Geesing and Djibo, 2006) [11]. The area is characterized by a covering of furniture that is relatively thin, so that the rocky substratum, located near the surface, is exposed to large areas. The water resources of the area are made up of the Niger River and these tributaries including Sirba, Dargol and Goroual but also by mares such as Kokorou-Namga……

2.3. Methodology of Bird Census

The methodology used by Lougbégnon in 2015 [20] was adapted. The first step was the selection of bird census sites and then within these sites counting stations was defined cause, in the ecology of the communities, one works at the scale of the habitat. The habitat study goes through a station-wide analysis, the smallest unit in the territory where, according to a given taxon, there is a fraction of the species in

the settlement. At each station corresponds a plot inventoried. The station has an important biological significance because it is the space in which the species maintain neighborhood relationships and are among each other to share resources according to the interactions that connect them (Blondel, 1995) [5].

The bird census was carried out in a variety of sample sites. At the sites, stations and listening points of the bird was regularly explored each month.

The different types of bird census are distinguished by their purpose (Bennun, 2000) [3]. Since the studied bird is not songwriters, the ornithological census method set up is the one used by Lougbégnon in 2015 [20]. This method is intended to know the presence sites (GPS coordinates) of the species and its degree of abundance on their sites of presence. It is an ecological inventory about three key that are:

- Control of the true or tangible existence of the species on the site chosen,
- Knowledge about the facies of the environment (physiognomy or type of habitat) where the species still live,
- Abundance levels of the species in these environments.

2.4. Operating mode of bird census in the sites

The census was carried out in three locations. It is Ayorou and Kandadji, located on the Niger River and the Kokorou Mare located in the RAMSAR Kokorou-Namga site. At each locality, four (4) transects were placed on each other of the rivers.

As described above, the sites were split into different habitat types according to the physiognomies of the backgrounds. Second, observation stations were placed within different habitat types. The number of stations varied depending on the area of the habitat. These stations were 100 m radius circles and the distance between two stations was 250m. The observation or detection of birds were made within these stations by the listening point method which consists of counting, from a fixed point, the birds observed or heard inside an imaginary circle of a fixed or unlimited radius centered on the observer. And between these stations by the transect line method that consists of moving along a transect and record as much as possible of observations.

Also, in these stations, the presence of seeds, feathers, nests, eggs, nests….., as insects and seeds were collected at these stations to assess the diet of these species. The census is carried out along the sites in the morning from 7:00 AM to 9:30 AM and in the evening from 4:30 PM to 6:30.PM. During these censuses, the geographical coordinates of the different species were also recorded. This method of enumeration was used by (Issiaka, 2011; Toudjani, 2012; Soumaïla, 2014; Habiboulaye, 2015) [18, 29, 26, 14].

2.5. Data processing

The data collected on the sites during the various census sessions were collected and allowed us to calculate using Excel software, the different parameters for each site following the next:

- The general abundance Ag which is an index of dominance of the individuals of each species in a station;
- Ag = And/T
- The spatial and temporal distribution.
- The characteristics of each station

The XLSTAT.16 software allowed us to do a Main Component Analysis (ACP) to see the interrelationships between the different census stations and the different census sessions at the level of each site. And also a Correspondence Factorial Analysis (AFC) to see the trends in the characteristics of the stations.

3. Results

3.1. Characteristics of the stations

The most represented types of ecosystem in Ayorou are the rice paddy and the islands with 13 stations each. The least represented are the gardens (5 stations) and the fallows (0 stations). While the most encountered types of soils are the sandy clay soils (19 stations) followed by clay floors (15 stations). The least represented soils are the sandy soils and the silty soils with 3 stations each. In Kandadji the most experienced types of ecosystem are the banks (21 stations), the least represented are the islands and the fallows with no stations each. While the most encountered soils are the sandy clay soils, followed by sandy and clailed soils with 10 stations each. The least represented soils are the sandy silt floors (4 stations). The most experienced types of ecosystem in Kokorou are the fields (24 stations), followed by the fallows with 13 stations. The least encountered are the banks, the islands and the rice fields with no station each one. Concerning the soils, the most represented are the silty soils (16 stations), followed by sandy silt soils (15 stations). The least represented soils are clay floors with no station and sandy clay soils with 3 stations (Figure 2).

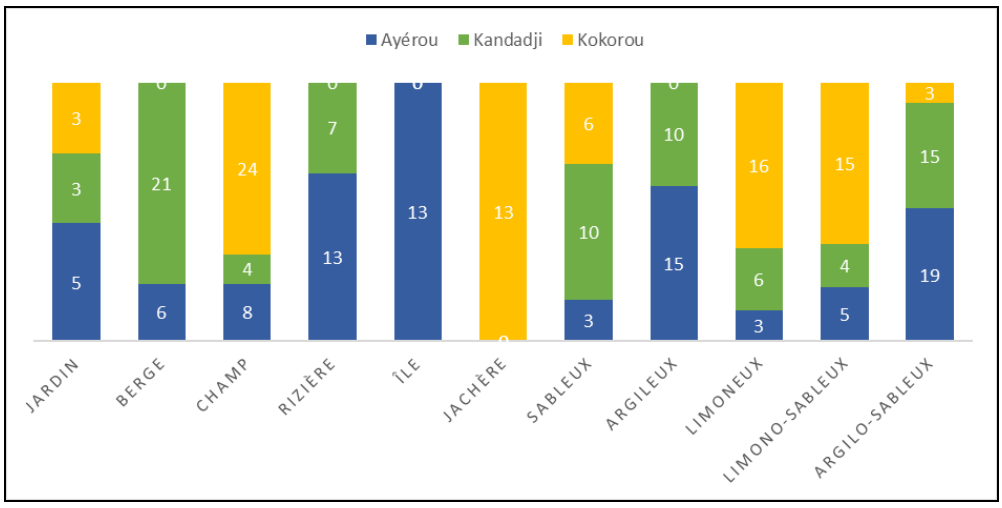


Fig 2: Station Features by Sites

Correspondence Analysis between the different characteristics of the stations allowed to make the following findings: the first two components (F1 and F2) cumulative more than 37%. Departure and other from the factorial design, the stations located in the rice paddies are characterized by clays soils, then the stations located in the gardens, in the islands and on the banks are characterized by sandy silt soils, Finally, the stations in the fields and in the fallows are characterized by sandy soils, either by soft soils or by sandy silt soils (Figure 3).

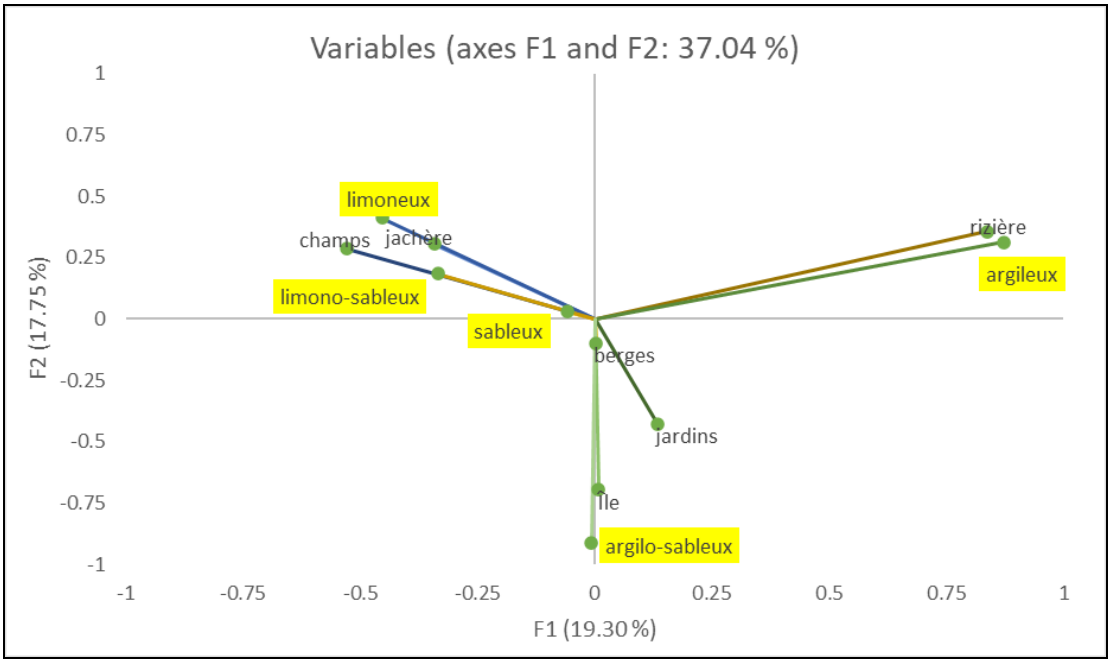


Fig 3: Factorial Analysis of the Correspondences (AFC) between the characteristics of the stations

3.2. Space distribution of the *Dendrocygna viduata* by sites

Table 1 showed that 120 stations are being explored, including 45 stations in Ayorou, 35 stations in Kandadji, and 40 stations in Kokorou for a proportion of 37.5%; 29.16% and 33.33%. On the whole of the stations and for all the observation sessions there were 7318 *Dendrocygne viduata* individuals registered for a proportion of 38.13% in Ayorou, 5613 *Dendrocygne viduata* individuals for 29.24% in Kandadji and 6260 *Dendrocygne viduata* individuals for a proportion of 32.61% in Kokorou. On the whole of the sites and for all sessions there were 19191 individuals from *Dendrocygne viduata*.

Photos 1&2: Some individuals from *Dendrocygna viduata* on sites

Table 1: Staff and proportion of *Dendrocygna viduata* per sites

Site / Effective	Ayorou	Kandadji	Kokorou	Total
Stations number	45	35	40	120
Proportion (%)	37,5	29,16	33,33	100
Species abundance	7318	5613	6260	19191
Proportion (%)	38,13	29,24	32,61	100

3.3. Time division of *Dendrocygna viduata* by sites

The most abundant number of the species was observed in Ayorou during the July 2019 meeting (663 individuals). This meeting is followed by the February 2018 meeting (535 individuals) and the January 2019 meeting (531 individuals). In Kandadji, the meeting of December 2017 was the most abundant (466 individuals), followed by the meeting of January 2019 and June 2019 with 444 individuals. Whereas in Kokorou, the meeting of September 2017 is the most abundant (681 individuals), followed by the session of July 2019 (551 individuals) and the meeting of December 2018 with 505 individuals (figure 4).

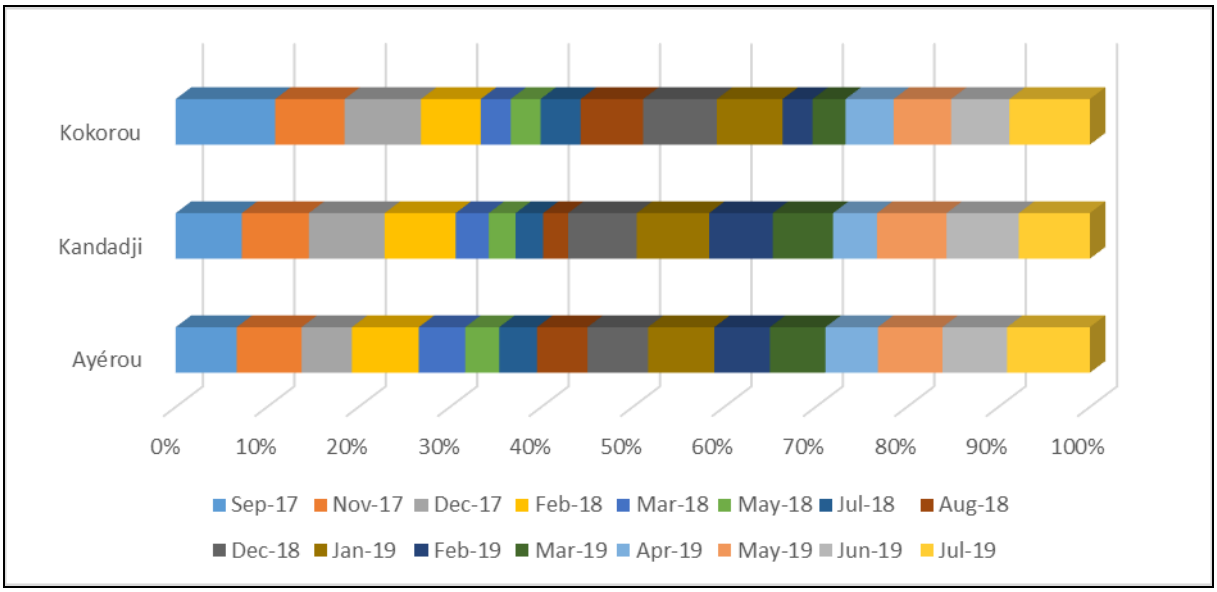


Fig 4: Time division by sites

3.4. Abundance relative general (Ag)

Table 2 showed that on the site of Ayorou, the most plentiful sessions are: sessions 16, 10 and 2 with respective Ag (0.090; 0.072 and 0.071) while the least plentiful sessions are: sessions 6, 7 and 5 with respective Ag (0.037; 0,041 and 0.050). On the Kandadji site, the most plentiful sessions are: sessions 3, 10 and 15 with respective Ag (0.083; 0.079 and 0.079) while the least plentiful sessions are: sessions 8, 6 and 7 with respective Ag (0.027; 0.029 and 0.030). On the Kokorou site, the most plentiful sessions are: sessions 1, 16 and 9 with respective Ag (0.108; 0.088 and 0.080) whereas the least plentiful are: sessions 5, 6 and 11 with a common Ag of 0.032. In general, session 16 is the most abundant on all sites, followed by sessions 1 and 2, while session 6 is the least plentiful on all sites, followed by sessions 7 and 5. But the most plentiful session in the whole of the sessions is the session 1 of the Kokorou site with an Ag of 0.108 while the less abundant is the session 8 of the site of Kandadji.

Table 2: Abundance relative genera (Ag) of the species per sessions and sites.

Sessions	Ayorou	Kandadji	Kokorou
S1	0.066	0.072	0.108
S2	0.071	0.073	0.075
S3	0.055	0.083	0.083
S4	0.073	0.077	0.065
S5	0.050	0.036	0.032
S6	0.037	0.029	0.032
S7	0.041	0.030	0.043
S8	0.055	0.027	0.068
S9	0.066	0.075	0.080
S10	0.072	0.079	0.071
S11	0.060	0.069	0.032
S12	0.060	0.065	0.036
S13	0.057	0.048	0.052
S14	0.070	0.076	0.062
S15	0.070	0.079	0.063
S16	0.090	0.077	0.088

3.5. Spatiotemporal distribution in Ayorou

3.5.1. Time division

The most plentiful session in Ayorou is the session of July 2019 with 663 individuals. It is followed by the February 2018 meeting (535 individuals) and the session of January 2019 (531 individuals). The least plentiful sessions are May session 2018 (272 individuals) and the session of July 2018 with 303 individuals (Figure 5).

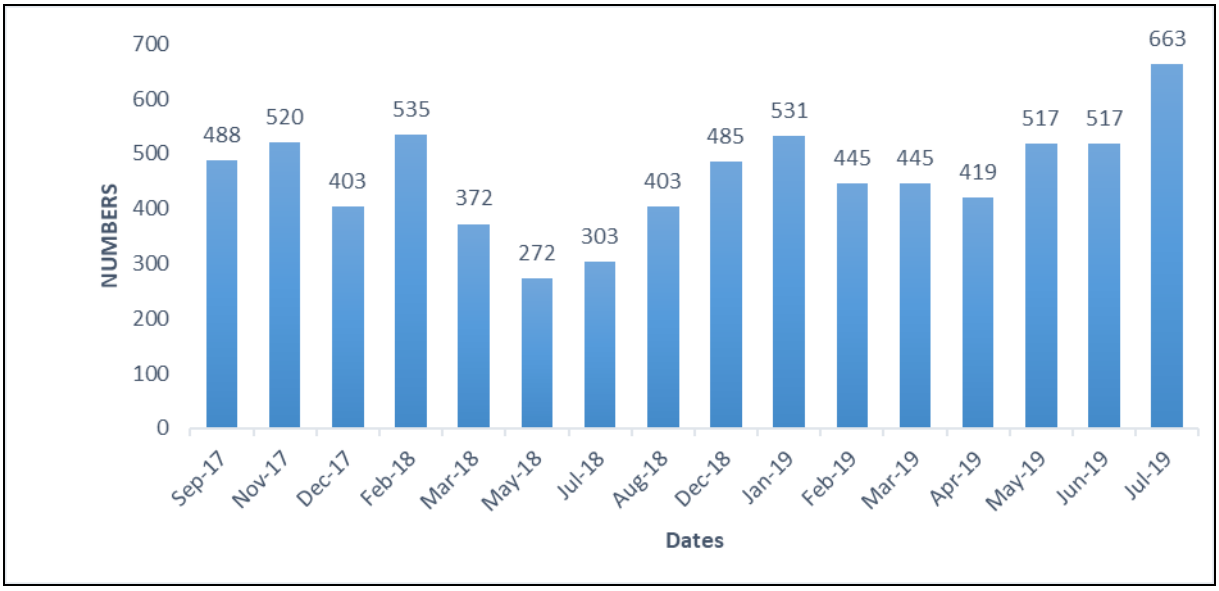


Fig 5: Time division in Ayorou

3.5.2. Space distribution

The species is more abundant on station 33 (283 individuals). Station tracking 19 (267 individuals) and station 5 (264 individuals). Stations with fewer individuals are station 21 (69 individuals). station 42 (88 individuals) and station 10 with 95 individuals (Figure 6).

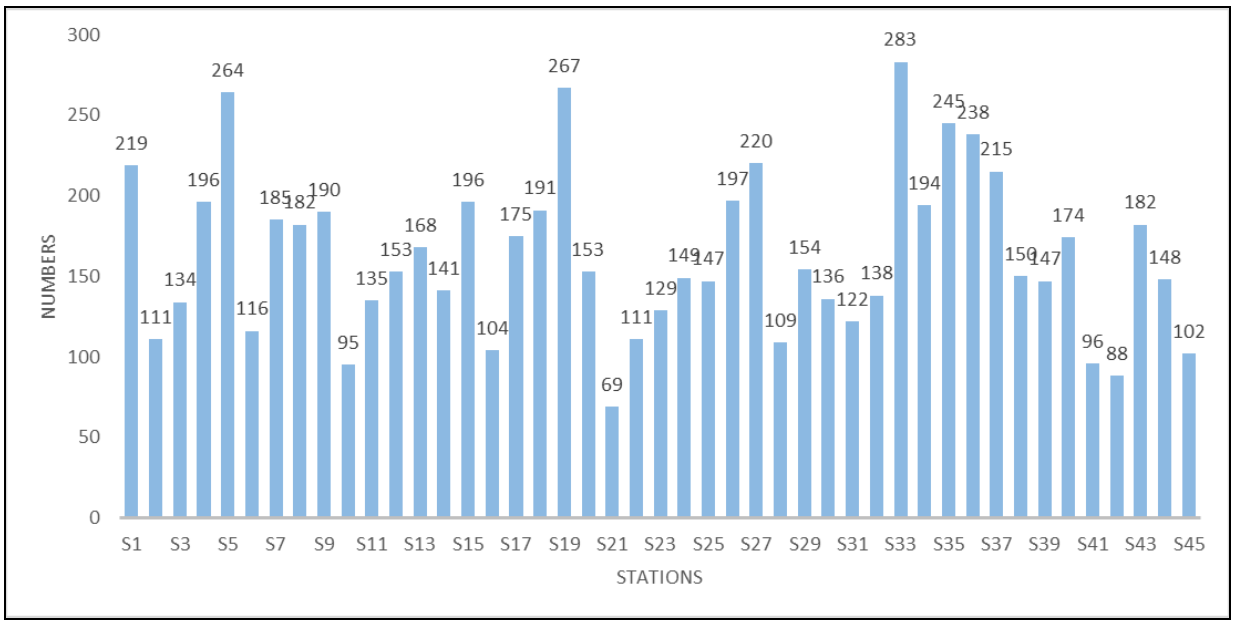


Fig 6: Space distribution in Ayorou

3.6. Spatiotemporal distribution in Kandadji

3.6.1. Time division

In Kandadji the most plentiful meeting is the meeting of December 2017 (466 individuals). It is followed by the meeting of January 2019 and the meeting of June 2019 with 444 individuals each. The least plentiful sessions are the meeting of August 2018 (153 individuals). the session of May 2018 (165 individuals) and the session of July 2018 with 169 individuals (Figure 7).

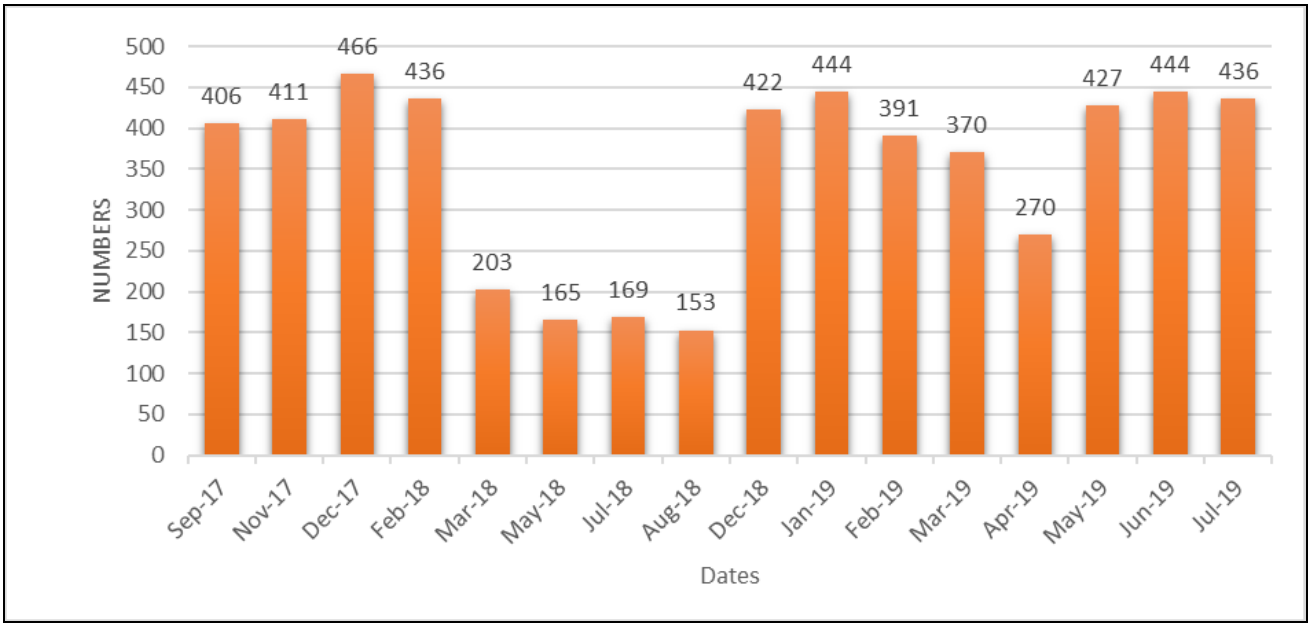


Fig 7: Time division in Kandadji

3.6.2. Space distribution

Station 2 is the station with more individuals in Kandadji with 289 individuals. It is followed by the station 9 (275 individuals) and the station 1 (270 individuals). Stations with fewer individuals are station 28 (69 individuals). station 31 (83 individuals) and station 15 with 85 individuals (Figure 8).

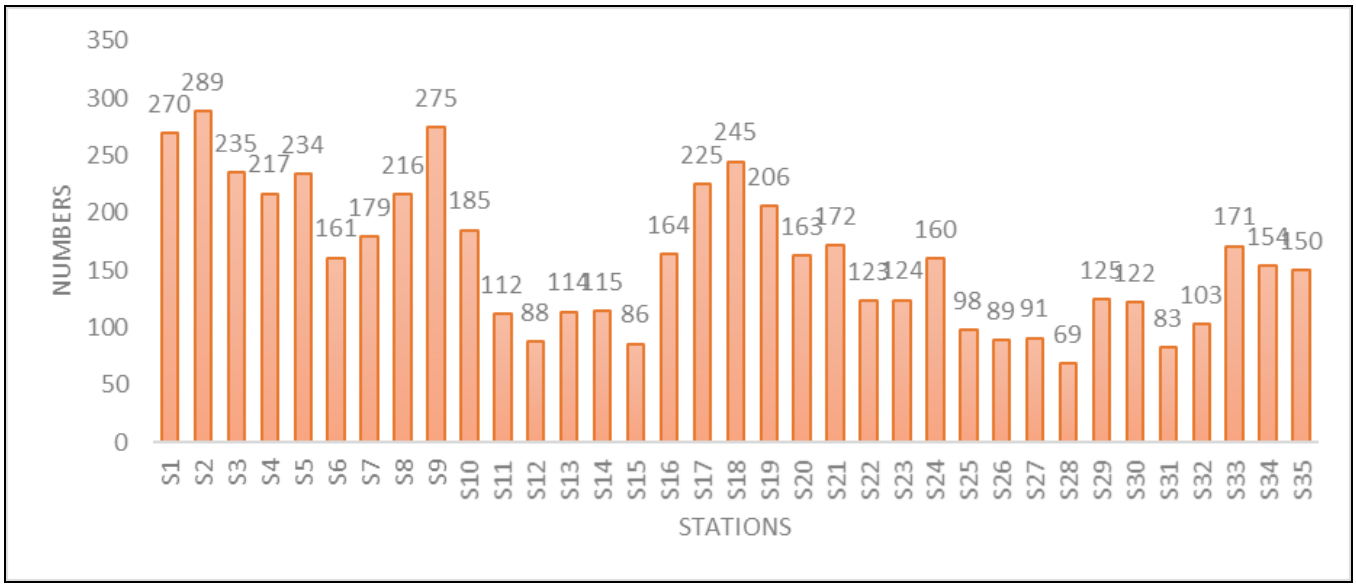


Fig 8: Space distribution in Kandadji

3.7. Spatiotemporal distribution in Kokorou

3.7.1. Time division

The most plentiful meeting in Kokorou is the meeting of September 2017 with 681 individuals. It was followed by the session of July 2019 (551 individuals) and the meeting of December 2017 (524 individuals). The least abundant sessions are the May 2018 meeting (204 individuals) of the March 2018 meeting and the February 2019 meeting with 205 individuals each (Figure 9).

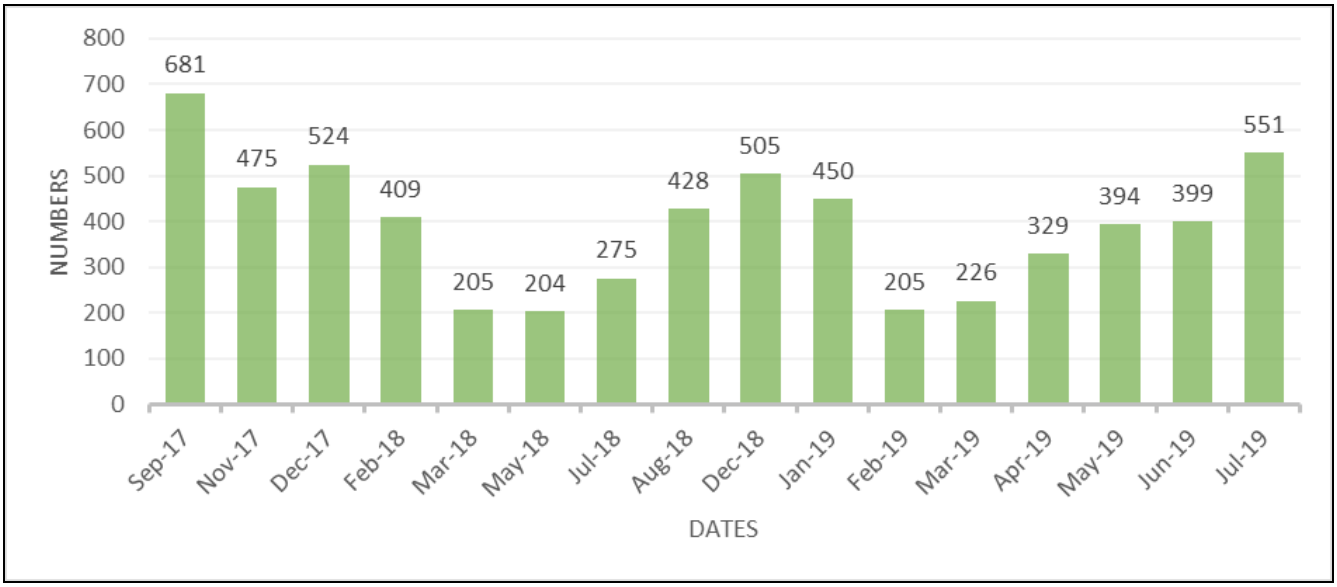


Fig 9: Time distribution in Kokorou

3.7.2. Space distribution

The species is more abundant on station 1 (311 individuals). Station 2 (269 individuals) and station 19 (225 individuals). Stations with fewer individuals are station 11 (63 individuals). station 29 (76 individuals) and station 25 with 87 individuals (Figure 10).

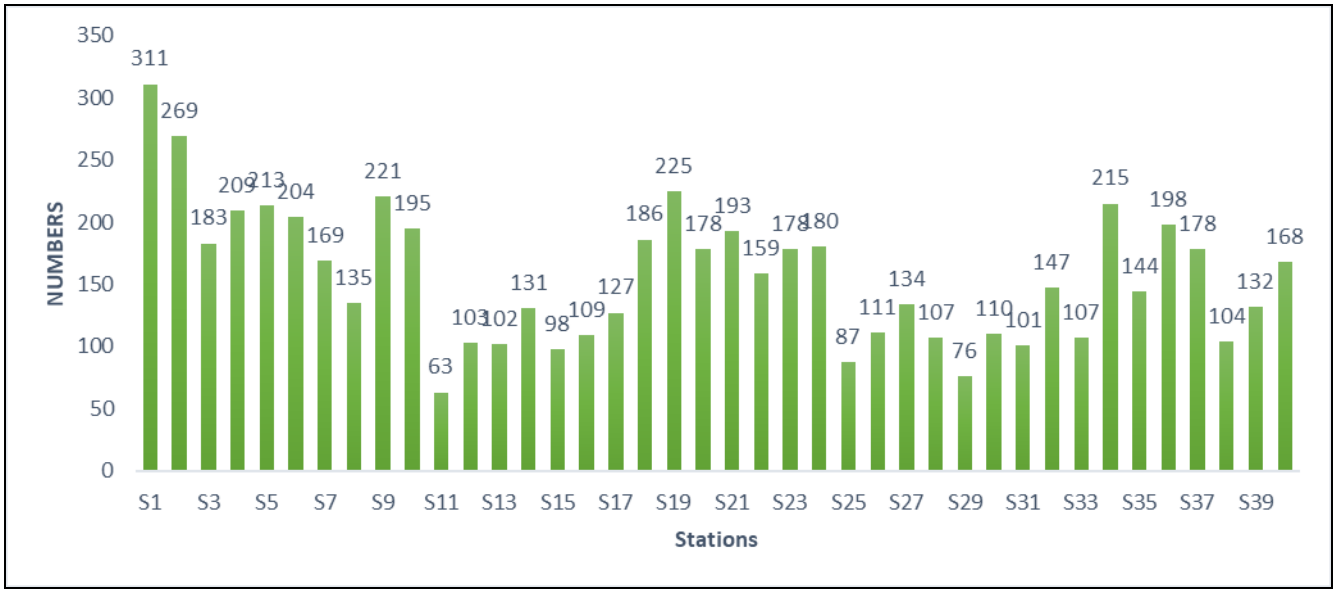


Fig 10: Space distribution in Kokorou

3.8. Interrelationship between stations and census sessions

Figure 11 showed the main correspondence analysis (ACP) between the stations of all sites and the census sessions. The factorial design of the sum of two components F1 and F2 is 38.80%. The design is divided into four sections. each characterized by the type of ecosystem and the periods of activity of the *Dendrocyna viduata*.

3.8.1 Field and fallow section (Cp-Je): This section is characterized by the entire site-level agroforestry stations. There are 38 field stations and 11 fallow stations. The analysis shows that. *Dendrocyna viduata* has a great activity in the ecosystems of agroforestry's during the months of June. July and August. This period corresponds to the period of reproduction of the species.

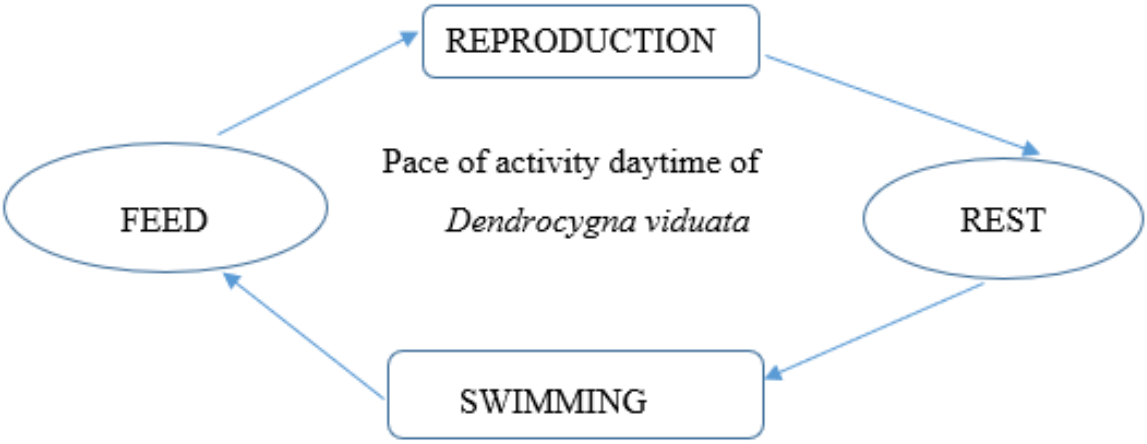
3.8.2 Island section (Ie): it is characterized by the island resorts at the site level. There are 13 island resorts. The analysis shows that the islands are an ideal ecosystem for the rest of *Dendrocyna viduata*. The latter is massively associated with these ecosystems for September. October and November. This period corresponds to the period of rest of the species after a long period of reproduction.

3.8.3 Berge section (Be): The latter is characterized by the banks' stations on the whole of the sites. These stations are found to be the widow *Dendrocyna viduata* swimming area. The species is massively observed in this ecosystem during the cold season (December. January and February). This period corresponds to the period of swimming on the whole of the sites.

3.8.4 Section of rice paddies and garden (Re-Jn): It is characterized by the whole of rice paddies and garden stations at the level of all the sites. These ecosystems are the ideal place for widower feeding. The type of ecosystem is

massively frequented by the species during the months of March. April and May. This period corresponds to the period of feed of the *Dendrocyna viduata* in the rice and gardens.

It is noted that June. July and August correspond to the reproduction period of *Dendrocyna viduata* in the fields and fallows; September. October and November at the rest period of the species in the islands; December. January and February correspond to the period of bathing on the banks and March. April. may correspond to the feeding period of *Dendrocyna viduata* in rice paddies and gardens. This gives us a closed cycle: reproduction-rest-bathing-feeding. This cycle corresponds to the rhythm of day activities of the *Dendrocyna viduata*



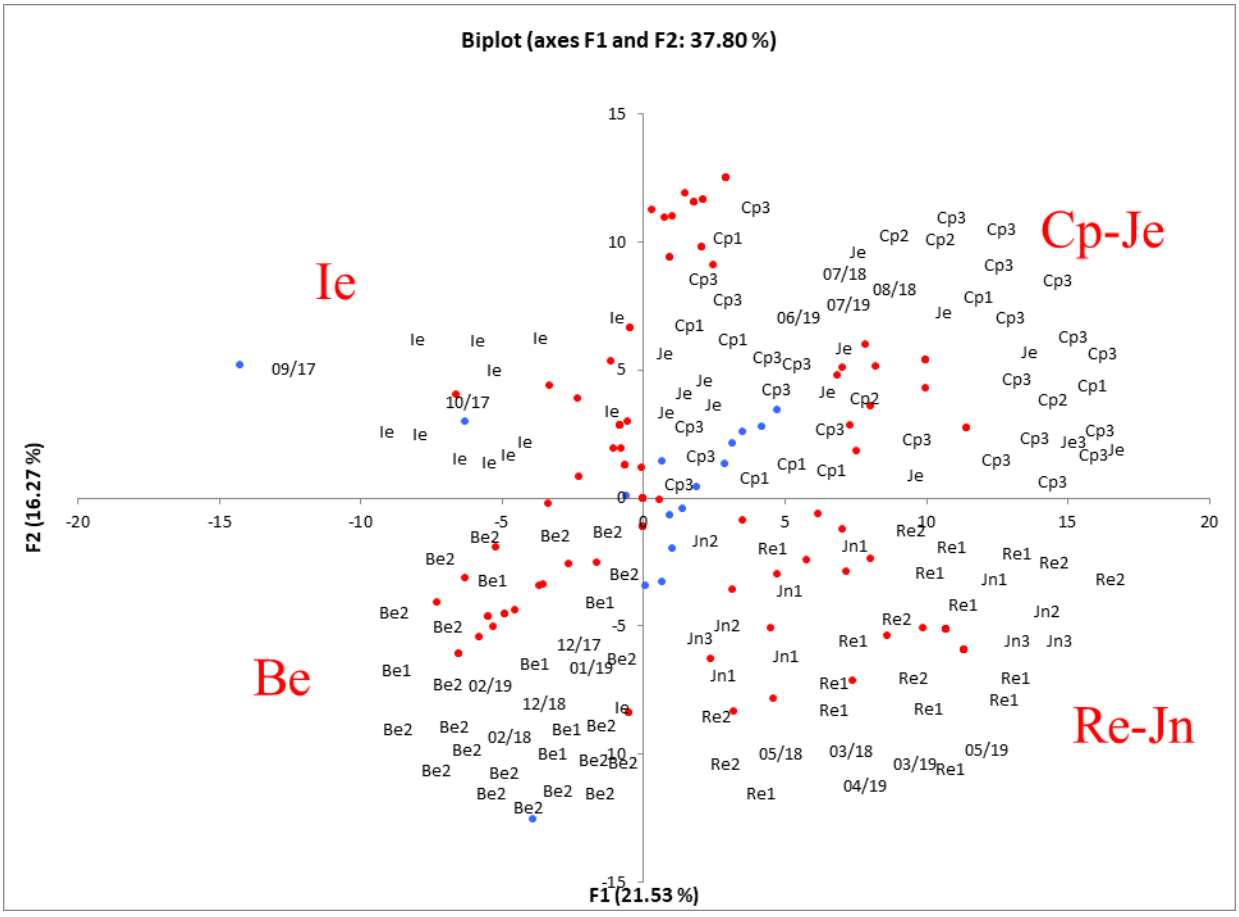


Fig 11: Interrelationship between stations and census sessions

4. Discussion

The rice fields and the islands dominate the resorts of Ayorou, the banks dominate in kandadji and the fields and fallows dominate in Kokorou. These stations are characterized by a number of soil type. This is due to the fact that *Dendreocygna viduata* is a duck of the family of anatidae who are aquatic birds that house all types of ecosystems related to the wetlands. According to Merzoug, 2016 [22]. the anatides are one of the most notable of the wetlands. It's bird family cosmopolitan areas that live in close proximity to the wetlands and their immediate surroundings. These ecosystems offer a variety of ecological habitats. promoting a great biodiversity (Isenmann and Moali. 2000) [16]. The counts show that *Dendrocygna viduata* is present throughout the year and in all the sites which gives it a status of sedentary species. This has been demonstrated in some species of the family of

the anatidae in some countries. For example, in Algeria. the counts made showed that the *Marmaronetta angustirostris* is present throughout the year. that gives it the status of sedentary species. while it has always been mentioned as a visiting visitor in all the Maghreb (GREEN. 1993; Bouzegag. 2015) [12, 6]. According to Merzoug (2016) [22]. Just as the demographer conducts censuses to know the size of the human population. the biologist must do a quantitative estimate of the populations he is studying. This estimate will be donne to a given time and space (Tamisier and Dehorter. 1999) [27]. The birds are distributed or distributed in the space according to their own modalities. Rarely randomly. this distribution meets biological and ecological criteria that characterize both the species and the site (Tamisier and Dehorter. 1999) [27]. The balancing and sharing of food resources in a way resembles the distribution of bird groups on a site (Ntiamoa-Baïïdu and *et al*.. 1998; Bensaci. 2010) [24, 4]. Many parameters related to the ecology. behavior and life history of water birds are highly influenced by local availability of food resources. Thus. the spatial distribution of the workforce. the choice of nesting sites. the intensity of interspecific interactions. the success of reproduction and diet depend mostly on the nature and abundance of the food resources available in the environment more or less close to the sites of (Ballance and *et al*.. 1997) [2].

Counting data analysis of the International Water Bird (DIOE) showed that January provide a correct estimate of population numbers and trends for the majority of ducks (Anatidae) (Deceuninck and *et al*.. 2014) [10]. But contrary to what is commonly accepted. the peak of the winter workforce is not always in January (Deceuninck and Fouc. 2010; Meziane. 2015) [9]. Monthly counts allow to apprehend the phenology of the wintering and indicate that January is not always the period when the number of ducks is the highest. They highlight that some sites. which do not host international numbers in January (RAMSAR criteria). may well exceed these thresholds in December or February. and deserve appropriate protection or management measures. So December and February sites should be considered to be of international importance for ducks in winter (Deceuninck and Fouc. 2010; Meziane. 2015) [9]. Studying animal behavior partly allows for determining their ecological needs and requirements and therefore adjusting management in certain areas and/or periods. For the manager. it is for example crucial to determine where and when the birds are resting. in order to provide them optimum conditions of tranquility where it is possible. Knowing when and in which habitats the birds are feeding can also allow for a management to encourage the abundance and accessibility of food resources (Guillemain and *et al*.. 2005) [13]. This diurnal resting place of the Anatides is a way to minimize energy expenditure (Tucakov. 2005; Maazi. 2009) [30, 21]. and on the other hand a means of the recovery and rearrangement of these reserves (Tamisier and Dehorter. 1999) [27]. Indeed. the increase in winter temperatures is known to cause adverse effects on the winter birds such as the increased evaporation of wetlands (AEWA. 2008 and Hinda. 2016) [1].

5. Conclusion

This study allowed us to understand the spatial distribution of *Dendrocygna viduata* in the River Valley of the Niger. It allowed to the counting of the total number of 19191 individuals of *Dendrocygna viduata* on all sites in 16 census sessions of which. 7318 individuals in the 45 stations of Ayorou. 5613 individuals in the 35 stations of Kandadji and 6260 individuals in the 40 stations of Kokorou. There are several reasons for bird-count. such as getting information on the monitoring and dynamics of species on different levels at local level. It also allows to estimate the size of the site. its fluctuations and the capacity to host the ecosystem or at the national level to know the importance and role of wetlands, to advocate for them the means to develop plans for action and conservation of these ecosystems. Finally, the bird count has a great international significance in the counting of the regional populations of several species and their tendency.

6. References

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