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Population size & population density of rhesus monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban conservation reserve forest in district Jind, Haryana (India)

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Abstract
The Rhesus Macaque which is a "Least Concern" species (IUCN, 2012) has been put in the Schedule-II category by the Wildlife Protection Act of India, 1972 (amended in 2002). Direct sighting method and line transect method was used during fortnightly periodic visits from December, 2015 to November, 2016 to record population density of Rhesus Monkey *Macaca mulatta* (Zimmermann, 1780). Monthly variation of total numbers of Rhesus Monkey varied from a minimum of 205 individuals (102.50±1.50 average numbers) in month of March to a maximum of 284 individuals (142.00±0.00 average numbers) in month of October with an average of 252.41± 5.28 individuals. Seasonal variation in total numbers (with average number) of Rhesus Monkey, varied from a minimum of 717 individuals (239.00±1.70 average number) in summer season to a maximum of 781 individuals (260.33±1.28 average number) in autumn season with an average of 757.25±14.08 individuals. The monthly variation in population density/Km^2 of Rhesus Monkey varied from a minimum of 401.96 individuals/Km² (200.98±2.94 average population density/Km^2) in month of March to a maximum of 556.86 individuals/Km² (278.43±0.00 average population density/Km^2) in month of October with an average of 494.92±10.35 individuals/Km². Seasonal variation of population density/Km^2 of Rhesus Monkey varied from a minimum of 1405.88 individuals/Km² (468.59±33.33 average population density/Km^2) in summer season to a maximum of 1531.37 individuals/Km² (510.44±25.12 average population density/Km^2) in autumn season with an average of 1484.31 ±27.61 individuals/Km². Various type of minor variation in the total number and population density of Rhesus Monkey in various months as well as seasons (winter, summer, monsoon and autumn) may be due to the effect of searching of food items toward road side (Because people through food items on Jind- Hansi road), Man- Monkey conflict with their domestic animals, *i.e.*, Dogs, Holy temple nearby the forest area, particular day (Tuesday); increase humans activities in forest area and less water resources available in forest area.

Keywords: rhesus monkey, population density, Bir Bara Ban, conservation reserve forest, Haryana

Introduction
Rhesus Monkey (*Macaca mulatta*) is the well-known species among the old world Monkeys. The mega-biodiversity country, India supports eight species of macaques (out of the total ten species) found in South-Asia [1]. Rhesus Macaques are found throughout mainland of Asia; from Afghanistan to India and Thailand to southern China [2]. The Rhesus Macaque is known to occur north of rivers 'Tapti' on West and 'Godavari' on East, to the entire northern India. In India the sub-species of Rhesus Macaques are *Macaca mulatta villosa* and *Macaca mulatta mulatta*. The *Macaca mullatta villosa* is found in the Kashmir and Punjab region of India (the northern part of the country), Pakistan, and Afghanistan. Whereas, *Macaca mulatta mulatta* is found in India, Bhutan, Burma, Nepal, Bangladesh, Thailand, Laos, and Vietnam [3, 2].

The endangered and 22 charismatic primate species of the region like Hoolock gibbon (*Hoolock hoolock* and *Hoolock leuconedys*) and Golden langur (*Trachypithecus geei*) have got maximum attention in all the recent distributional and demographic studies [4, 5, 6, 7, 8, 9, 10]. Yet, there is very few information about the status of the Rhesus Macaques in various protected areas in India. The Rhesus Macaque which is a "Least Concern" species [11] has been put in the Schedule-II category by the Wildlife Protection Act of India, 1972 (amended in 2002). Less and scanty information are available on the various aspects of population density of Rhesus Monkey, *Macaca mulatta* in Haryana, particular. Hence, the present study was planned to record the population size and population density of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India).

Study Area and Methodology
Study Area
Bir Bara Ban Conservation Reserve Forest (29º17' N latitude and 76° 16' E longitude) is located on 5 Km away from Jind city on Jind-Hansi road in district Jind of Haryana (India). It is spread over an area of 419.26 hectares. Haryana government notified this area as conservation reserve forest on October 11,. Dominant animal species, *i.e.*, Neelgai or Blue bull

(*Boselaphus tragocamelus*), Jackel (*Canis aureus*) and Rhesus Monkey (*Macaca mullata*); dominant birds species, *i.e.*, Blue peafowl (*Pavo cristatus*), Rufous treepie (*Dendrocitta vagabunda*), Greater coucal (*Centropus sinensis*), Indian grey hornbill (*Ocyceros birostris*) and Jungle babbler (*Turdoides striata*); dominant tree species, *i.e.*, Kikar (*Acasia nilotica),* Neem (*Azadirachata indica*), Shisham (*Dalbergia sissoo)* and Safeda (*Eukalyptus hybrid*) and dominant herbs and shrubs species, *i.e.*, Bansa (*Adhatoda vasica*), Kandai (*Aegemone maxicana*), Kair (*Capparis desidua*) and Bathua (*Chenopodium album*) are major supported in Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India).

Methodology

Direct sighting method [7] and line transect method [12] was used during fortnightly periodic visits from December, 2015 to November, 2016 to record population size and population density of Rhesus Monkey *Macaca mulatta* (Zimmermann, 1780). Four transects namely T-I, T-II, T-III and T-IV covering an area of 0.51 Km^2 were selected in study site (Fig. 1). Different age classes of sighted individuals *viz.*, all male, all female, juveniles and infants were identified following age-sex wise classification of Rhesus Monkey given by Kent *et al*., 1994 and Kumar, 2015. The population density was calculated by the following formula which is given below:

$$\text{Population density} = \frac{n}{L \times 2 \times B}$$

n = Number of individuals sighted

L= Length of transect

B= Perpendicular visual distance along each transect (a distance of 50 meter was scanned in each side of all selected transects).

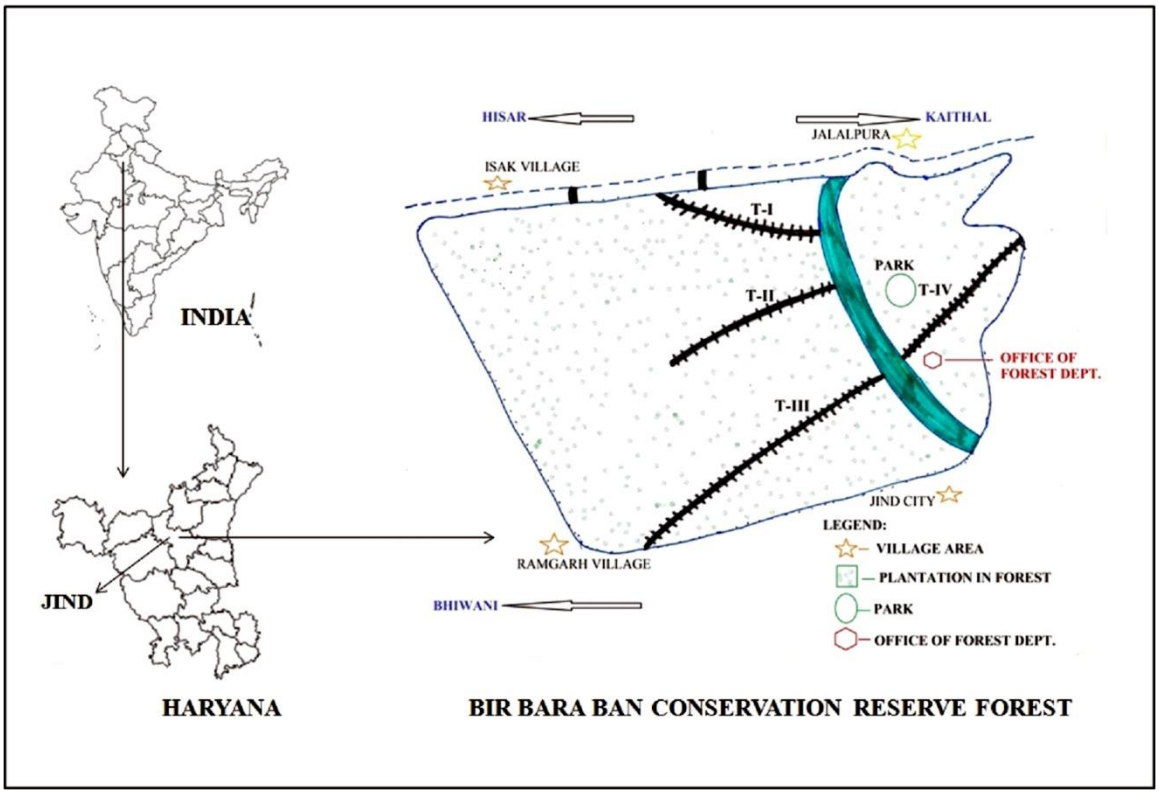


Fig 1: Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India).

Results and Discussion

Rhesus Monkey, *Macaca mulatta* is found mostly in the villages, urban and forest areas [16]. A total numbers of 445 individuals of Rhesus Monkey, distributed in 21 groups were observed through direct sighting method in the Chakrashila Wildlife Sanctuary of Assam from December, 2006 and January, 2007 [7]. Also, 84 groups of Rhesus Monkeys comprising of 4051 individuals were observed in different types of habitats in the district Aligarh, Uttar Pradesh with group size ranging from minimum 15 individuals to maximum 155 individuals with an average of 48 individuals [17].

In Saraswati Plantation Wildlife Sanctuary, 173 individuals of all male, 706 individuals of all female, 140 individuals of juvenile and 148 individuals of infant of Rhesus Monkey; while in Bir Sonti Reserve Forest, 170 individuals of all male, 760 individuals of all female, 134 individuals of juvenile and 114 individuals of infant of Rhesus Monkey, respectively were observed [15, 18]. In the present study, a total numbers of 3029 individuals of Rhesus Monkey were observed in study area (434 individuals of all male, 1749 individuals of all female, 630 individuals of juvenile and 216 individuals of infant) (Table 1).

According to Kumar (2015) in Saraswati Plantation Wildlife Sanctuary, total numbers of sighted Rhesus Monkeys varied from a minimum of 65 individuals (July, 2008; December, 2008) to a maximum of 132 individuals (April, 2008) with an

average of 95.58 individuals. Similarly, in the present study, the monthly variation in total numbers of all male Rhesus Monkey varied from a minimum of 32 individuals (16.00±1.00 average numbers) in month of March to a maximum of 41 individuals (20.50±0.50 average numbers) in month of October with an average of 36.16±0.79 individuals; total numbers of all female of Rhesus Monkey varied from a minimum of 128 individuals (64.00±1.00 average numbers) in month of June to a maximum of 167 individuals (83.50±0.50 average numbers) in month of October with an average of 145.75±3.29 individuals; total number of juveniles of Rhesus Monkey varied from a minimum of 31 individuals (15.50±0.50 average numbers) in month of March to a maximum of 67 individuals (33.50±2.50 average numbers) in month of June with an average of 52.50±2.95 individuals and the total number of infants of Rhesus Monkey varied from a minimum of 11 individuals (5.50±0.50 average numbers) in month of March to a maximum of 24 individuals (12.00±0.00 average numbers) in month of June with an average of 18.00±0.99 individuals (Table 1). Monthly variation of total numbers of Rhesus Monkey varied from a minimum of 205 individuals (102.50±1.50 average numbers) in month of March to a maximum of 284 individuals (142.00±0.00 average numbers) in month of October with an average of 252.41± 5.28 individuals (Table 1). In the present study, the minimum individuals of Rhesus Monkey were recorded in the month of March because maximum individuals of Rhesus Monkey spent more time for feeding in agriculture areas nearby the forest. As well as in the month of October of study year the maximum individuals of Rhesus Monkey were recorded because it is crop harvested month by the farmers in agriculture area nearby the forest. So it is the main reason for minor difference in monthly variation in the numbers of Rhesus Monkey.

Seasonal variation in total numbers (with average number) of Rhesus Monkey, varied from a minimum of 717 individuals (239.00±1.70 average number) in summer season to a maximum of 781 individuals (260.33±1.28 average number) in autumn season with an average of 757.25±14.08 individuals (Fig. 2a & b). The seasonal variation in total number of all male Rhesus Monkey varied from a minimum of 103 individuals (34.33±1.20 average number) in summer season to a maximum of 117 individuals (39.00±1.15 average number) in autumn season with an average of 108.50±3.09 individuals; seasonal variation in total numbers of all female Rhesus Monkeys varied from a minimum of 414 individuals (138.00±4.04 average number) in summer season to a maximum of 472 individuals (157.33±5.48 average number) in autumn season with an average of 437.25±13.6 individuals; seasonal variation in total number of juveniles of Rhesus Monkeys varied from a minimum of 144 individuals (48.00±5.13 average number) in autumn season to a maximum of 176 individuals (58.66±5.23 average number) in monsoon season with an average of 157.50±7.12 individuals and seasonal variation in total number of infants of Rhesus Monkeys varied from a minimum of 48 individuals (16.00±1.15 average number) in autumn season to a maximum of 62 individuals (20.66±1.76 average number) in monsoon season with an average of 54.00±3.02 individuals (Fig. 2a & b).

Ragmi and Kandel, (2008) encountered a total number of 213 individuals of Assamese Macaques in 9 groups. The average group size was 23.66 individuals/group. The group density was 0.0790 groups/Km² with a population density of 1.8691 individuals/Km². Mehlman (1989) studied the six group of Barbary Macaques comprises of 162 individuals inhabiting the Ghomaran fir forests of the Moroccan Rif mountains had a density of 6.73 individuals/Km². Kumar and Kadian, (2015) observed monthly variation in population density/Km^2 of sighted rhesus macaques varied minimum of 90.27 individuals/Km² (July, 2008; December, 2008) to a maximum of 183.33 individuals/Km² (April, 2008) with an average of 132.63±5.95 individuals/Km² in Saraswati Plantation Wildlife Sanctuary. Also Kumar (2017) encountered monthly variation in population density of Rhesus Monkey varied from a minimum of 154.76 individuals/Km^2 (November) to a maximum of 347.61 individuals/Km^2 (April) with an average of 234.71±4.97 individuals/Km^2.

Similarly in the present study, the monthly variation in population density/Km^2 of all male Rhesus Monkey varied from a minimum of 62.74 individuals/Km² (31.37±1.96 average population density/Km^2) in month of March to a maximum of 80.39 individuals/Km² (40.19±0.98 average population density/Km^2) in month of October with an average of 70.90±1.56 individuals/Km²; population density/Km^2 of all female Rhesus Monkey varied from a minimum of 250.98 individuals/Km² (125.49±1.96 average population density/Km^2) in month of June to a maximum of 327.45 individuals/Km² (163.72±0.98 average population density/Km^2) in month of October with an average of 285.78±6.46 individuals/Km²; population density/Km^2 of Juveniles of Rhesus Monkey varied from a minimum of 60.78 individuals/Km² (30.39±0.98 average population density/Km^2) in month of March to a maximum of 131.37 individuals/Km² (65.58±4.90 average population density/Km^2) in month of June with an average of 102.94±5.79 individuals/Km² and population density/Km^2 of infants of Rhesus Monkey varied from a minimum of 21.56 individuals/Km² (10.78±0.98 average population density/Km^2) in month of March to a maximum of 47.05 individuals/Km² (23.52±0.00 average population density/Km^2) in month of June with an average of 35.29±1.94 individuals/Km² (Table 2). The monthly variation in population density/Km^2 of Rhesus Monkey varied from a minimum of 401.96 individuals/Km² (200.98±2.94 average population density/Km^2) in month of March to a maximum of 556.86 individuals/Km² (278.43±0.00 average population density/Km^2) in month of October with an average of 494.92±10.35 individuals/Km² (Table 2).

Also, the seasonal variation of population density/Km^2 of Rhesus Monkey varied from a minimum of 1405.88 individuals/Km² (468.59±33.33 average population density/Km^2) in summer season to a maximum of 1531.37 individuals/Km² (510.44±25.12 average population density/Km^2) in autumn season with an average of 1484.31 ±27.61 individuals/Km² (Fig. 3a & b). The seasonal variation in population density/Km^2 of all male Rhesus Monkey varied from a minimum of 201.96 individuals/Km² (67.31±2.35 average population density/Km^2) in summer season to a maximum of 229.41 individuals/Km² (76.47±2.26 average population density/Km^2) in autumn season with an average of

212.74±6.06 individuals/Km²; population density/Km² of all female Rhesus Monkey varied from a minimum of 811.76 individuals/Km² (270.58±2.35 population density/Km²) in summer season to a maximum of 925.49 individuals/Km² (308.49±10.76 average population density/Km²) in autumn season with an average of 857.25±26.75 individuals/Km²; population density/Km² of Juveniles of Rhesus Monkey varied from a minimum of 282.35 individuals/Km² (94.11±10.06 average population density/Km²) in autumn season to a maximum of 345.09 individuals/Km² (115.01±10.27 average population density/Km²) in monsoon season with an average of 308.82±13.96 individuals/Km² and population density/Km² of infants of Rhesus Monkey varied from a minimum of 94.11 individuals/Km² (31.37±2.26 average population density/Km²) in autumn season to a maximum of 121.56 individuals/Km² (40.50±3.45 average population density/Km²) in monsoon season with an average of 105.88±5.93 individuals/Km² (Fig. 3a & b). During the study period, various type of minor variation in the total number and population density of Rhesus Monkey in various months as well as seasons (winter, summer, monsoon and autumn) may be due to the effect of searching of food items toward road side (Because people through food items on Jind- Hansi road), Man- Monkey conflict with their domestic animals, *i.e.*, Dogs, Holy temple nearby the forest area, particular day (Tuesday); increase humans activities in forest area and less water resources available in forest area. Similar finding were recorded by Chopra and Kumar 2009; Kumar 2015 and Kumar 2016.

Dancan's multiple range test (DMRT) result reveals that there was not significant difference (pd<0.05) recorded in average numbers and average population density of sighted individuals of all male, all female, juveniles and infants of Rhesus Monkey in different month of study year. However, Dancan's multiple range test (DMRT) results of average number as well as average population density of Rhesus Monkey of sighted individuals of all female, juveniles and infants is slightly difference (average number<0.05 or >0.05; population density<0.05 or >0.05) in the months july, march and march, respectively.

Table 1: Monthly variation in total numbers (average number) of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India) from December, 2015 to November, 2016.

Months of year	Total numbers (average number ± S.E.) of individuals sighted/visits				Total number
	All male	All female	Juveniles	Infants	
December, 2015	36(18.00±1.00)^{A}	151(75.50±4.50)^{A}	47(23.50±0.50)^{A}	17(8.50±0.50)^{A}	251(125.50±5.50)^{A}
January, 2016	38(19.00±0.00)^{A}	148(74.00±3.00)^{A}	53(26.50±2.50)^{A}	18(9.00±0.00)^{A}	257(128.50±0.50)^{A}
February, 2016	35(17.50±0.50)^{A}	147(73.50±3.50)^{A}	61(30.50±2.50)^{A}	20(10.00±0.00)^{A}	263(131.50±0.50)^{A}
March, 2016	32(16.00±1.00)^{A}	131(65.50±1.50)^{A}	31(15.50±0.50)^{AB}	11(5.50±0.50)^{AB}	205(102.50±1.50)^{A}
April, 2016	36(18.00±1.00)^{A}	145(72.50±2.50)^{A}	57(28.50±0.50)^{A}	18(9.00±0.00)^{A}	256(128.00±3.00)^{A}
May, 2016	35(17.50±.50)^{A}	138(69.00±1.00)^{A}	61(30.50±1.50)^{A}	22(11.0±0.00)^{A}	256(128.00±0.00)^{A}
June, 2016	33(16.50±0.50)^{A}	128(64.00±1.00)^{AB}	67(33.50±2.50)^{A}	24(12.00±0.00)^{A}	252(126.00±1.00)^{A}
July, 2016	33(16.50±0.50)^{A}	134(67.00±1.00)^{A}	60(30.00±2.00)^{A}	20(10.00±0.00)^{A}	247(123.50±3.50)^{A}
August, 2016	39(19.50±0.50)^{A}	155(77.50±2.50)^{A}	49(24.50±1.50)^{A}	18(9.00±0.00)^{A}	261(130.50±0.50)^{A}
September, 2016	39(19.50±0.50)^{A}	157(78.50±0.50)^{A}	45(22.50±0.50)^{A}	16(8.00±0.00)^{A}	257(128.50±0.50)^{A}
October, 2016	41(20.50±0.50)^{A}	167(83.50±0.50)^{A}	58(29.00±0.00)^{A}	18(9.00±0.00)^{A}	284(142.00±0.00)^{A}
November, 2016	37(18.50±0.50)^{A}	148(74.00±0.00)^{A}	41(20.50±0.50)^{A}	14(7.00±0.00)^{A}	240(120.00±1.00)^{A}
Total numbers (Mean±S.E.)	434(36.16±0.79)	1749(145.75±3.29)	630(52.50±2.95)	216(18.00±0.99)	3029(252.41±5.28)

S.E.= Standard Error

Mean with same letter in the same row are not significantly difference (p<0.05) (Duncon, 1955)

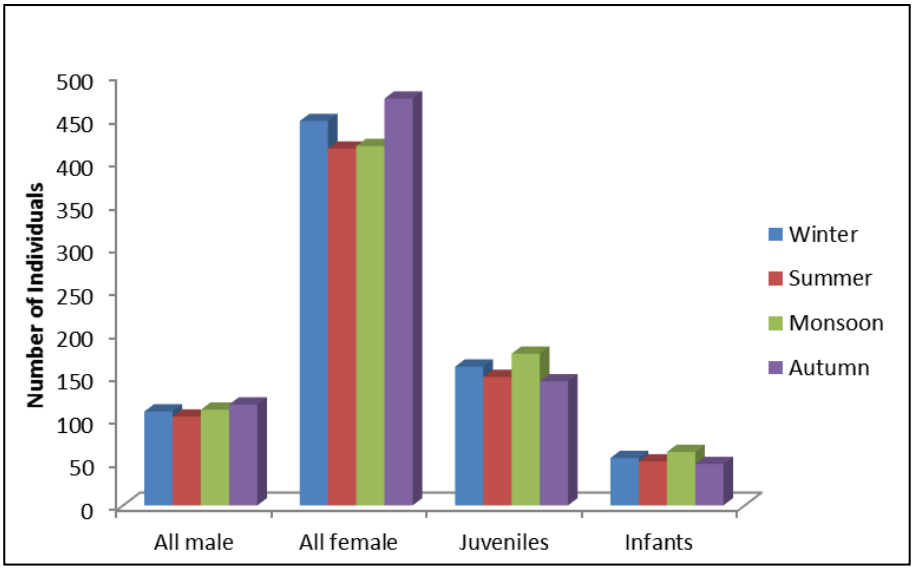


Fig 2(a)

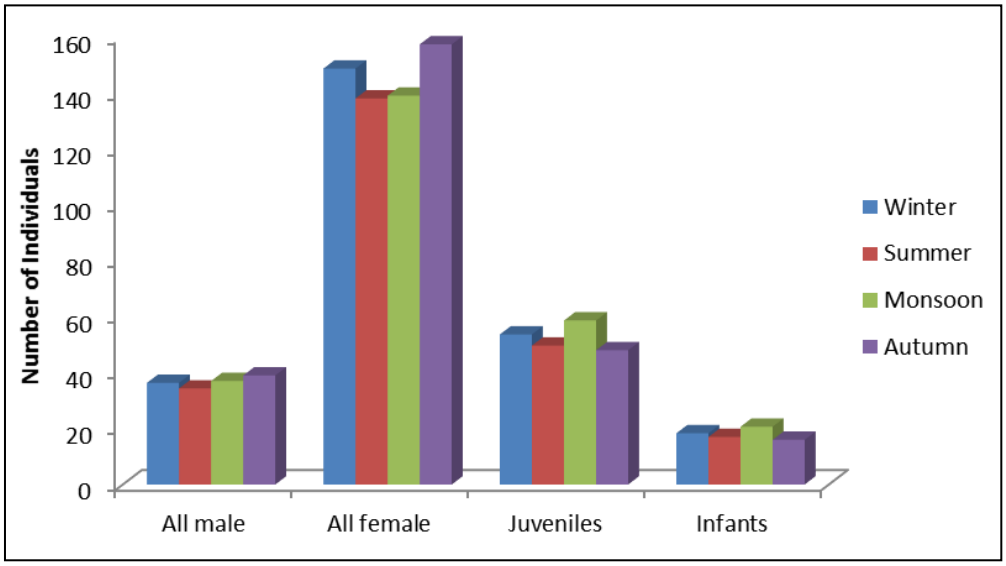


Fig 2(b)

Fig. 2 (a) Seasonally variation in total numbers and 2 (b) average numbers of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India) from December, 2015 to November, 2016.

Table 2: Monthly population density/Km^2 (average population density/Km^2) of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban Conservation Reserve Forest in district Jind, Haryana (India) from December, 2015 to November, 2016.

Months of year	Monthly population density/Km^2 (average population density/Km^2)				
	All male	All female	Juveniles	Infants	Total
December, 2015	70.58(35.29±1.96) ^{A}	296.07(148.03±8.82) ^{A}	92.15(46.07±0.98) ^{A}	33.33(16.66±0.98) ^{A}	492.15(246.07±10.78) ^{A}
January, 2016	74.50(37.25±0.00) ^{A}	290.19(145.09±5.88) ^{A}	103.92(51.96±4.90) ^{A}	35.29(17.64±0.00) ^{A}	503.92(251.96±0.98) ^{A}
February, 2016	68.62(34.31±0.98) ^{A}	288.23(144.11±6.86) ^{A}	119.60(59.80±4.90) ^{A}	39.21(19.60±0.00) ^{A}	515.68(257.84±0.98) ^{A}
March, 2016	62.74(31.37±1.96) ^{A}	256.86(128.43±2.94) ^{A}	60.78(30.39±0.98) ^{AB}	21.56(10.78±0.98) ^{AB}	401.96(200.98±2.94) ^{A}
April, 2016	70.58(35.29±1.96) ^{A}	284.31(142.15±4.90) ^{A}	111.76(55.88±0.98) ^{A}	35.29(17.64±0.00) ^{A}	501.96(250.98±5.88) ^{A}
May, 2016	68.62(34.31±0.98) ^{A}	270.58(135.29±1.96) ^{A}	119.60(59.80±2.94) ^{A}	43.13(21.56±0.00) ^{A}	501.96(250.98±0.00) ^{A}
June, 2016	64.70(32.35±0.98) ^{A}	250.98(125.49±1.96) ^{AB}	131.37(65.58±4.90) ^{A}	47.05(23.52±0.00) ^{A}	494.11(247.05±1.96) ^{A}
July, 2016	64.70(32.35±0.98) ^{A}	262.74(131.37±1.96) ^{A}	117.64(58.82±3.92) ^{A}	39.21(19.60±0.00) ^{A}	484.31(241.17±6.86) ^{A}
August, 2016	76.47(38.23±0.98) ^{A}	303.92(151.96±4.90) ^{A}	96.07(48.03±2.94) ^{A}	35.29(17.64±0.00) ^{A}	511.76(255.88±0.98) ^{A}
September, 2016	76.47(38.23±0.98) ^{A}	307.84(153.92±0.98) ^{A}	88.23(44.11±0.98) ^{A}	31.37(15.68±0.00) ^{A}	503.92(251.96±0.00) ^{A}
October, 2016	80.39(40.19±0.98) ^{A}	327.45(163.72±0.98) ^{A}	113.72(56.86±0.00) ^{A}	35.29(17.64±0.00) ^{A}	556.86(278.43±0.00) ^{A}
November, 2016	72.54(36.27±0.98) ^{A}	290.19(145.09±0.00) ^{A}	80.39(40.19±0.98) ^{A}	27.45(13.72±0.00) ^{A}	470.58(235.29±1.96) ^{A}
Mean±S.E	70.90±1.56	285.78±6.46	102.94±5.79	35.29±1.94	494.93±10.35

S.E.=Standard Error

Mean with same letter in the same row are not significantly difference ($p<0.05$) (Duncon, 1955)

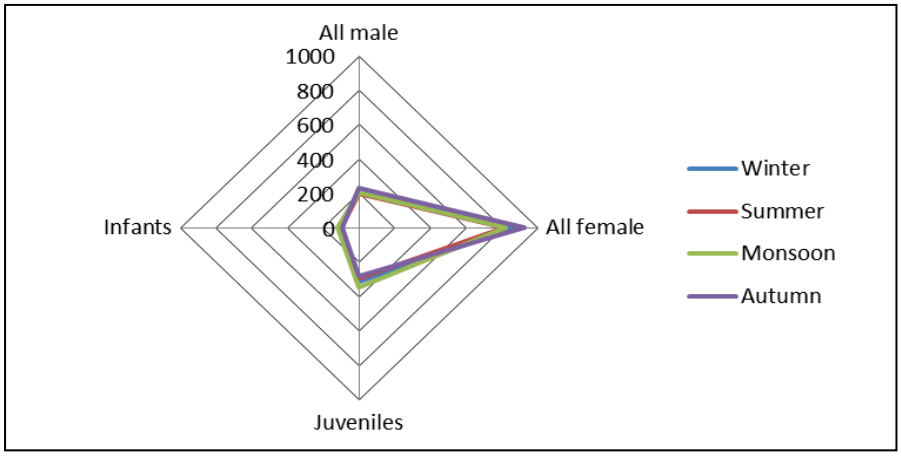


Fig 3(a)

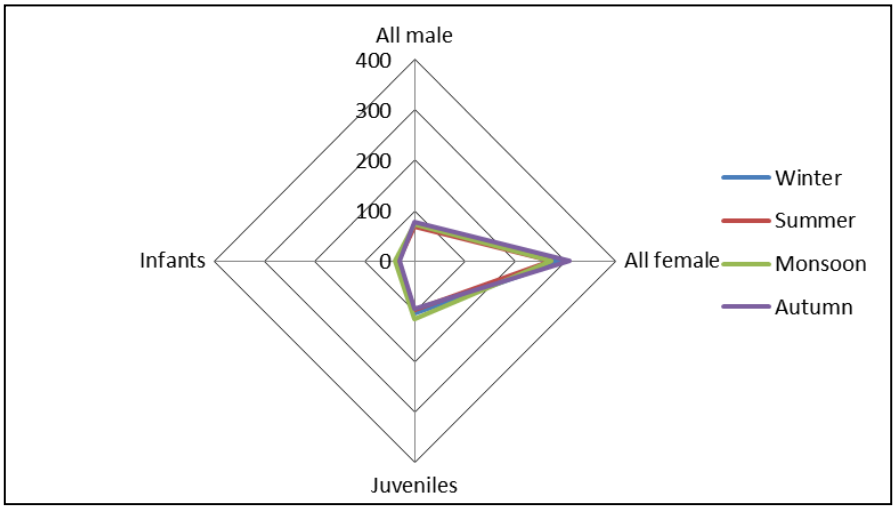
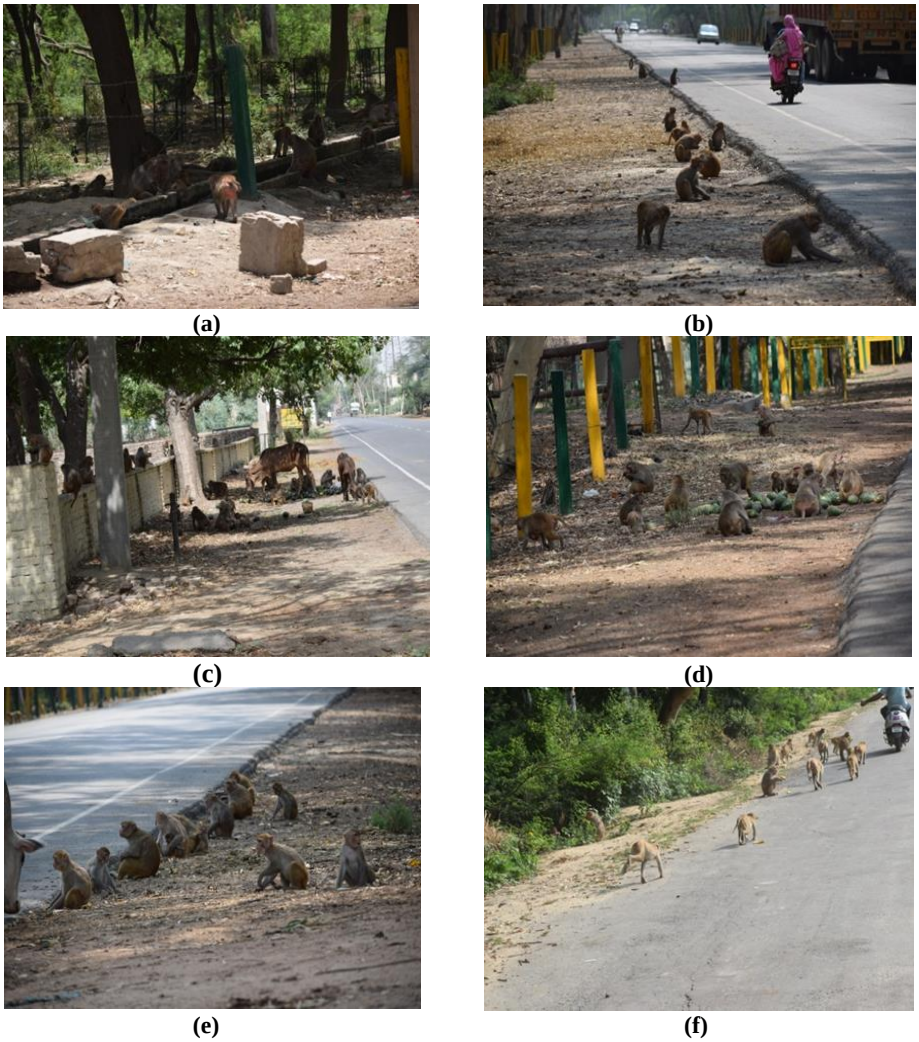


Fig 3(b)

Fig. 3(a) Seasonal population density/Km^2 and seasonal average population density/Km^2 of Rhesus Monkey, *Macaca mulatta* (Zimmermann, 1780) in Bir Bara Ban Conservation Reserve Forest in districts Jind from December, 2015 to November, 2016.



(a) **(b)** **(c)** **(d)** **(e)** **(f)**

Fig 4: (a) Rhesus Monkey drunk water outside the forest, (b) Entry of vehicle traffic in the forest, (c) searching for food items in city area nearby forest, (d), (e) & (f) searching for food items on road side outside the forest

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