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Impact of Feral Dogs on Bird Community in Mount Abu Wildlife Sanctuary, Rajasthan

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ABSTRACT:
Study was carried out in Mount Abu Wildlife Sanctuary to assess the impact of feral dogs on various activities of different species of birds. During study, it was observed that the feral dogs could potentially affect foraging, feeding, resting, roosting and nesting activities of birds. Furthermore, feral dogs have an impact on several bird species by attempting to chase or catch them and dogs have successfully caught the birds on multiple occasions. During study, a total six types of impacts were observed on 52 bird species. Out of these, most of bird species affected by feral dogs create disturbances in their foraging and feeding activities (51 species) followed by trying to chase (43 species), disturbances in resting activities (30) and disturbances in roosting activities (12 species). It was found that feral dogs mainly attack on eight bird species namely Little Cormorant, Indian Cormorant, Indian Peafowl, White-breasted Waterhen, Common Coot, Red-wattled Lapwing, Black-winged Stilt and Rock Pigeon. Further impacts were observed on nesting and breeding behaviours of Red-wattled Lapwing and Black-winged Stilt. Frequent movement of feral dogs in different habitats had a negative impact on nesting and breeding activities of these birds. It has additionally led to an increase in alert, vigilance and anti-predatory behaviour towards the feral dogs. Time invested in vigilance and anti-predatory response, the incubation and behaviour of parental care were also influenced in birds. Additionally, with time invested in vigilance and an antipredatory response toward dogs, several times these species flied away from the dogs and left nests openly. Due to the absence of adult birds in nests, the risk of egg, hatchling and nesting predation was also increased by other predators like raptors, mongooses and snakes.

Keywords:
Feral dog, Bird, Impact, Disturbance, Prey, Nesting, Behaviour, Predators.

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INTRODUCTION

Dog (*Canis familiaris*) has lived with humans throughout the world since being domesticated and today it is the most abundant member of the Canidae family on the earth and its presence has significant impacts on the ecosystem and wildlife (Green and Gipson, 1994; Savolainen *et al.,* 2002; Driscoll and Macdonald, 2010). Dogs cause significant problems for wildlife and humans. Dogs can influence native wildlife species through various means, including competition, predation, disturbance, hybridization and they also pose a risk of disease transmission such as rabies and canine distemper (Young *et al.,* 2011).Various definitions have been proposed for the categorization of feral dogs (Causey and Cude, 1980; Daniels and Bekoff, 1989a & b). Difference between wild, stray and other free-ranging or feral dogs can often be determined to varying degrees of impacts (Nesbitt, 1975). Dogs have been categorized based on their behavioural or ecological attributes (Scott and Causey, 1973; Causey and Cude, 1980), their origins (Daniels and Bekoff, 1989 a &b), their primary range (rural vs. urban free-ranging) (Berman and Dunbar, 1983), those with unrestricted access to public property (Beck, 2002) and their level of dependency on humans (WHO, 1988). Presence of ownerless or uncontrolled dogs (dogs roaming freely) is widely seen as a significant issue for both humans and wild animals. These are referred to by various names, including feral dogs and free-ranging dogs. According to Nesbitt (1975), dogs that are allowed to roam freely outside their owner's property can become free-ranging or feral. Various studies examined varying interpretations of the terms "free-ranging" and "feral" dogs. According to Boitani *et al.* (1995) "a free-ranging dog retains a social relationship with its owner but possesses the ability to roam freely, whether or not allowed to do so. Conversely, because they may survive with little to no human interaction, feral dogs might be seen as feral." Numerous studies have documented the negative impact of feral dogs on wildlife communities including birds. It becomes a major concern when it affects endangered wild species and protected regions (Young *et al.,* 2011; Hughes and Macdonald, 2013).

Direct predation of wildlife by feral dogs has the most visible impact on the wildlife community but several dogs also chase or harass many species especially when they are in group (Young *et al.,* 2011). These conditions increase the stress levels and energy-intensive behaviour among wild species (Lenth *et al.,* 2008). Presence of dogs in certain regions can have a negative impact on the breeding success of wild species, such as ungulates (Lord *et al.,* 2001; Lenth *et al.,* 2008; Gingold *et al.,* 2009). Some studies have been carried out in tropical countries and were particularly focused on ungulates and other animals species including birds (Lord *et al.,* 2001; Manor and Saltz, 2004; Vanak and Gompper, 2009; Young *et al.,* 2011; Gehlot and Jakher, 2015; Farris *et al.,* 2016; Kumar and Paliwal, 2015; Doykin *et al.,* 2016; Chishty *et al.,* 2021; Choudhary *et al.,* 2021; Guedes *et al.,* 2021; Munoz-Pacheco and Villasenor, 2023). Feral dogs become a major problem in several places and become efficient predators or competitors for wildlife species (Feldmann, 1974). Issue of dogs without an owner or under the control of their owner but allowed to roam freely (referred to as free-ranging dogs or feral dogs) is widely acknowledged as a substantial concern, impacting both human populations and wildlife. Movement and presence of dogs in a particular area influenced various nesting, breeding, foraging and feeding activities of birds, such as dogs displaced incubating birds from nests, interrupted breeding displays and also influenced resting and roosting activities of birds (Baydack, 1986; Baydack and Hein, 1987; Yalden and Yalden, 1990; Keller, 1991; Hoopes, 1993; Choudhary *et al.,* 2021 and 2022; Choudhary and Chishty, 2023).

Numerous studies have documented the various types of disturbances causes by feral dogs, interference in nesting behaviour, reduced reproductive success, physiological effects, home range displacement and interruptions in roosting, foraging and feeding behaviours of wild animal including birds (MacArthur *et al.,* 1982; Baydack, 1986; Zanette *et al.,* 2011). Several studies also reveal that dogs negatively

influence vertebrate phyla such as reptiles (Lafferty, 2001), song birds (Banks and Bryant, 2007), waterfowl and shorebirds (Lafferty, 2001; Randler, 2006; Choudhary and Chishty, 2022; Choudhary and Chishty, 2023) and mammals including herbivores and carnivores (Lowry and McArthur, 1978; MacArthur *et al.,* 1982; Ballard *et al.,* 1999; Miller *et al.,* 2001; Lenth *et al.,* 2008; Reed and Merenlender, 2011; Silva-Rodriguez *et al.,* 2010; Silva-Rodriguez and Sieving, 2011 & 2012; Chishty *et al.,* 2021). Therefore, the present study was carried out in Mount Abu Wildlife Sanctuary (MA-WLS) Rajasthan to assess the impact of feral dogs on the bird community.

MATERIAL AND METHODS

Present study was carried out for two years from October 2021 to September 2023 to assess the impact of feral dogs on the bird community. Field surveys were carried out by direct visual observation with the help of Nikon 8x42 binoculars and photographs of the impact of feral dogs and birds were taken by a Nikon P1000 and Canon 700D cameras with a Sigma 150-500 lens. Along with direct visual observation, direct and indirect evidence methods were also used for assessing the impact of feral dogs. Additionally, focal and scan sampling methods (Altmann, 1974) were also adopted for assessing birds responses to feral dogs during the different activities such as foraging, feeding, resting, roosting, nesting, breeding, alertness, vigilance and anti-predatory behaviour. During study, impact of feral dogs on the birds was classified into six classes, namely:

A. Direct predation or killing: Dogs that potentially kill bird species were categorized as having a direct predation or killing effect.

B. Try to chase or catch: In this category, these bird species were categorized; dogs tried to chase or catch them, but they were not caught by dogs.

C. Disturbance in foraging and feeding: In this category, these bird species were categorized; dogs movements in particular habitats, *viz.,* forest, wetland and grassland, could potentially impact foraging and feeding activities. For example, the movement of dogs around the carcasses influences the foraging and feeding activities of scavenging birds such as vultures and crows.

D. Disturbance caused in resting activity: Dog movements, especially in the vicinity of wetland habitats, have the potential to impact the resting activities of various bird species. For instance, a variety of bird species, such as cormorants, egrets, ibis, storks and ducks, often spend the day sitting at the edges of water bodies after feeding. The frequent movement of dogs has the potential to influence the resting behaviour of these species.

E. Disturbance caused in roosting activity: In this category, these bird species were categorized; they typically roost on the ground in evening. At the same time, dog's movements also influenced the roosting activities of these species.

F. Disturbance caused during nesting and breeding activities: In this category, these bird species were categorized primarily as constructing nests on the ground at the edge of wetland and other habitats (for example, Red-wattled Lapwing and Black-winged Stilt). Frequent movement of dogs around the nesting habitat influenced nesting activities such as incubation and parental care of hatchlings and nestlings, and at the same time, adult birds also displayed alertness, vigilance and anti-predatory behaviour towards the dogs.

RESULTS

According to Baydack (1986), Yalden and Yalden (1990), Keller (1991) and Hoopes (1993) the movement and presence of dogs in particular areas had a variety of impacts on the bird community. Dogs can potentially affect the foraging, feeding, nesting, resting and roosting activities of birds. During study, impact of feral dogs on the birds were categorized or classified into six classes, namely: **A.** direct predation or killing; **B.** try to chase or catch; **C.** disturbance in foraging and feeding; **D.** disturbance caused in resting activity; **E.** disturbance caused in roosting activity; and **F.** disturbance caused during nesting and breeding activities. Feral dogs had an impact on a total of 52 bird species (Table 1). The most common impact of feral dogs on birds was disturbance caused during the foraging and feeding activity of birds (51 species) followed by trying to chase (43 species),

disturbance in resting activity (30 species), disturbance in roosting activity (12 species), direct predation (8 species) and two species (Red-wattled Lapwing and Black-winged Stilt) nesting and breeding activities were also affected.

Feral dogs had four types of impacts (direct predation, trying to chase, disturbance in foraging and feeding and resting activities) on three species of the Phalacrocoracidae family (Little cormorant, Indian Cormorant and Great Cormorant). Out of these, feral dogs directly killed two species of cormorants, namely Little Cormorant and Indian Cormorant. Feral dogs killed a total of 8 cormorant's individuals, of which six were Little Cormorants and two were Indian Cormorants (Figure 1). Furthermore, feral dogs also try to chase these three species during foraging, feeding and resting activities. Feral dogs also affected the thermoregulatory behaviour of cormorants. Since cormorants typically sit at the edges of water bodies, on the ground or atop rocks to perform thermoregulation, wing cleaning and wing drying activities. During this time, the movement and barking of feral dogs around the wetland habitat disturb them and makes them insecure due to which they flee from their location. Furthermore, feral dogs had three types of impacts (trying to chase, disturbance in foraging, feeding and resting activities) on bird species of Anhingidae family (Oriental Darter). Oriental Darters also faces threat of direct predation from feral dogs which was observed during the study, that the feral dogs were trying to reach near the Darter and also tried to chase them.

Table 1: Impact of feral dogs on different species of birds in MA-WLS (1= represent feral dog impact was observed on species, 0= represent feral dog impact was not observed on species)

S. No.	Name of bird species	Zoological name	Types of impacts					
			Direct predation	Try to chase or catch	Disturbance in foraging and feeding	Disturbance in resting behaviour	Disturbance in roosting behaviour	Disturbance in nesting activity
1. Family: Phalacrocoracidae								
1	Little Cormorant	*Microcarbo niger*	1	1	1	1	0	0
2	Indian Cormorant	*Phalacrocorax fuscicollis*	1	1	1	1	0	0
3	Great Cormorant	*Phalacrocorax carbo*	0	1	1	1	0	0
2. Family: Anhingidae								
4	Oriental Darter	*Anhinga melanogaster*	0	1	1	1	0	0
3. Family: Ardeidae								
5	Little Egret	*Egretta garzetta*	0	1	1	1	0	0
6	Intermediate Egret	*Ardea intermedia*	0	1	1	1	0	0
7	Cattle Egret	*Bubulcus ibis*	0	1	1	1	0	0
8	Great White Egret	*Ardeola alba*	0	1	1	1	0	0
9	Indian Pond Heron	*Ardeola grayii*	0	1	1	0	0	0
10	Grey Heron	*Ardea cinerea*	0	1	1	1	0	0
11	Purple Heron	*Ardea purpurea*	0	1	1	0	0	0

4. Family: Threskiornithidae								
12	Red-naped Ibis	*Pseudibis papillosa*	0	1	1	1	0	0
13	Black-headed Ibis	*Threskiornis melanocephalus*	0	1	1	1	0	0
14	Glossy Ibis	*Plegadis falcinellus*	0	1	1	1	0	0
15	Eurasian Spoonbill	*Platalea leucorodia*	0	1	1	1	0	0
5. Family: Ciconiidae								
16	Painted Stork	*Mycteria leucocephala*	0	1	1	1	0	0
17	Asian openbill	*Anastomus oscitans*	0	1	1	1	0	0
18	Asian Woolly-necked Stork	*Ciconia episcopus*	0	1	1	1	0	0
6. Family: Anatidae								
19	Knob billed Duck	*Sarkidiornis melanotos*	0	1	1	1	1	0
20	Indian Spot-billed Duck	*Anas poecilorhyncha*	0	1	1	1	1	0
21	Northern Pintail	*Anas acuta*	0	1	1	1	1	0
22	Northern Shoveler	*Spatula clypeata*	0	1	1	1	1	0
23	Gadwall	*Mareca strepera*	0	1	1	1	1	0
24	Eurasian Wigeon	*Mareca penelope*	0	1	1	1	1	0
25	Common Teal	*Anas crecca*	0	1	1	1	1	0
26	Lesser Whistling Duck	*Dendrocygna javanica*	0	1	1	1	1	0
27	Bar-headed Goose	*Anser indicus*	0	1	1	1	1	0
7. Family: Accipitridae								
28	Egyptian Vulture	*Neophron percnopterus*	0	1	1	1	0	0
8. Family: Phasianidae								
29	Grey Francolin	*Ortygornis pondicerianus*	0	1	1	0	0	0
30	Aravalli Red-Spurfowl	*Galloperdix spadicea caurina*	0	1	1	0	0	0
31	Grey Junglefowl	*Gallus sonneratii*	0	1	1	0	0	0
32	Indian Peafowl	*Pavo cristatus*	1	1	1	1	0	0
9. Family: Rallidae								
33	White-breasted Waterhen	*Amaurornis phoenicurus*	1	1	1	0	0	0
	Common	*Gallinula*	0	1	1	0	0	0

34	Moorhen	*chloropus*						
35	Common Coot	*Fulica atra*	1	1	1	0	0	0
10. Family: Charadriidae								
36	Red-wattled Lapwing	*Vanellus indicus*	1	1	1	1	1	1
11. Family: Recurvirostridae								
37	Black-winged Stilt	*Himantopus himantopus*	1	1	1	1	1	1
12. Family: Laridae								
38	River Tern	*Sterna aurantia*	0	0	0	1	1	0
13. Family: Columbidae								
39	Rock Pigeon	*Columba livia*	1	1	1	0	0	0
40	Laughing Dove	*Spilopelia senegalensis*	0	1	1	0	0	0
41	Spotted Dove	*Spilopelia suratensis*	0	1	1	0	0	0
42	Eurasian Collared-dove	*Streptopelia decaocto*	0	1	1	0	0	0
14. Family: Pycnonotidae								
43	Red-vented Bulbul	*Pycnonotus cafer*	0	0	1	0	0	0
44	Rajasthan Red-Whiskered Bulbul	*Pycnonotus jocosus abuensis*	0	0	1	0	0	0
15. Family: Estrildidae								
45	Green Avadavat	*Amandava formosa*	0	0	1	0	0	0
46	Indian Silverbill	*Euodice malabarica*	0	0	1	0	0	0
47	Scaly-breasted Munia	*Lonchura punctulata*	0	0	1	0	0	0
16. Family: Sturnidae								
48	Indian Pied Starling	*Gracupica contra*	0	0	1	0	0	0
49	Common Myna	*Acridotheres tristis*	0	0	1	0	0	0
50	Bank Myna	*Acridotheres ginginianus*	0	0	1	0	0	0
17. Family: Corvidae								
51	House Crow	*Corvus splendens*	0	1	1	0	0	0
52	Large-billed Crow	*Corvus macrorhynchos*	0	1	1	0	0	0
Total number of bird species affected by feral dogs during different activity times is listed			**8**	**43**	**51**	**30**	**12**	**2**

Three types of impacts (trying to chase, disturbance in foraging and feeding and resting activities) of feral dogs were observed on different species of the Ardeidae family also. Affected bird species were the Little Egret, Intermediate Egret, Cattle Egret, Great White Egret, Indian Pond Heron, Grey Heron and Purple Heron. All these seven species had a risk of being chased by feral dogs and were also disturbed during foraging and feeding times, as these bird species are preferably foraging and feeding around wetland and agricultural areas, whereas some species, such as Cattle Egret and Indian Pond Heron are also inhabited in urban habitat. Frequent movement of feral dogs in these habitats were responsible for disturbing the foraging and feeding activities of all these bird species.

Figure 1: Feral dog kill Indian Cormorant

Four species of Threskiornithidae family (Red-naped Ibis, Black-headed Ibis, Glossy Ibis and Eurasian Spoonbill) and three species of Ciconiidae family (Painted Stork, Asian Openbill and Asian Woolly-necked Stork) were affected by feral dogs in three ways: chasing, disturbance caused during foraging or feeding time and interference in resting behaviour (Figure 2). All these bird species generally preferred wetland habitat for foraging, feeding and resting and during this period, regular movement of feral dogs disrupts their foraging, feeding and resting activities. During their resting period, these bird species tend to rest in close proximity to the open area of the wetland habitat. Movement of dogs in these locations impacted the resting behaviour of these bird species adversely.

Figure 2: Dogs move around the Painted Stork's foraging habitat

Four types of impacts of feral dogs were observed on species of the Anatidae family. These impacts were: trying to chase, disturbance in foraging and feeding activities, resting and roosting activities. Affected species were Knob-billed Duck, Indian Spot-billed Duck, Northern Pintail, Northern Shoveler, Gadwall, Eurasian Wigeon, Common Teal, Lesser Whistling Duck and Bar-headed Goose. These bird species mainly lives in the wetland habitat and while foraging and feeding, they sometimes come to the edge of the wetland to feed in shallow water and marshy areas. Movement of feral dogs near wetland areas affected their feeding activities negatively. These bird species preferably rest and roost at the edges of the wetland areas during which, the movement and barking of feral dogs affected their resting and roosting activities unfavourably.

Three type of impacts of feral dogs were found on the Egyptian Vulture (member of the Accipitridae family), *viz.,* trying to direct chasing, interfere in feeding behaviour and resting behaviour. Egyptian Vulture is a carnivore and scavenger species that mainly feeds on dead livestock and other wild animals. Studies have shown that dogs repeatedly displace Egyptian Vultures from carcasses and even attempt to attack them. Subsequently,

Egyptian Vultures sitting nearby the carcasses or performing thermoregulation behaviour were also disturbed by the feral dogs and increases alertness and vigilance in their behavioural responses.

Four species of the Phasianidae family (Grey Francolin, Aravalli Red Spurfowl, Grey Junglefowl and Indian Peafowl) were impacted by the frequent movement of feral dogs in forest habitat along the trails and tracks. Two types of impacts (trying to chase and disturbance in foraging and feeding activates) were observed on Grey Francolin, Aravalli Red-Spurfowl and Grey Junglefowl, whereas three types of impacts (direct predation or killing, trying to chase and disturbance in foraging and feeding activates) were observed on Indian Peafowl. Phasianidae family bird species are most vulnerable to direct predation by dogs when they come to roadside or trail areas in search of food. In two cases, feral dogs directly consumed the carcass of Indian Peafowl, whereas in another two cases, pug marks of feral dogs were present around the carcass of Indian Peafowl.

Three species of Rallidae (White-breasted Waterhen, Common Moorhen and Common Coot) were also impacted by the feral dogs in wetland habitat. Three types of impacts (direct predation or killing, trying to chase and disturbance in foraging and feeding activities) were observed on the White-breasted Waterhen and Common Coot, whereas two impacts (trying to chase and disturbance in foraging and feeding activates) were found on the Common Moorhen. Three individuals of White-breasted Waterhen and two individuals of Common Coots killed by feral dogs were also observed.

Red-wattled Lapwing belongs to the Charadriidae family which is resident and breeding bird of Mount Abu. It is highly impacted due to feral dog's interference and disturbance in various habitats. Red-wattled Lapwing commonly inhabit and breed in all types of habitat, including wetland, grassland, forest, rocky-sloppy mountains and around the river stream. Six types of impacts (direct predation, trying to chase, disturbance during foraging and feeding, resting, roosting and disturbance during nesting times) of dogs were observed on the Red-wattled Lapwing. Four cases of direct predation by feral dogs of Red-wattled Lapwing were observed. Furthermore, Red-wattled Lapwing eggs, hatchling, nestling and fledgling stages were also badly affected by feral dogs. Regular movements of feral dogs in various bird habitats have an adverse impact on breeding activities, including nest site selection and the incubation process of Red-wattled Lapwing. Presence of dogs around the nesting habitat, Red-wattled Lapwing exhibited anti-predatory behaviour by alertness, vocalizing and flying in various directions which results in disruption to the egg incubation period (Figure 3). In addition, the absence of adults in nests increased the risk of egg predation by various predators which ultimately impacted breeding success rate adversely.

Figure 3: Red-wattled Lapwing display anti-predatory behaviour towards dog's movement around the nest.

Similarly, member of the Recurvirostridae family, the Black- winged Stilt was also affected by feral dog's movements around the wetland habitat. Similar to the Red-wattled Lapwing, feral dogs also caused six types of adverse impacts on Black-winged Stilts. Additionally, two instances of feral dogs preying directly on Black-winged Stilts were also observed. During the breeding season, Black-winged Stilts displays higher aggression and remains near the nests even in the presence of potential predators, such as dogs, eagles, kites and mongoose (Figure 4). Black-winged Stilt actively incubate their eggs and protect their nest, even when a

dog approaches too closely (Figure 5). In such circumstances dogs frequently caught Black-winged Stilt individuals. Hatchling, nestling and fledgling of Black-winged Stilts stay quiet on the ground to avoid predators and they don't flee even when a predator gets close. As a result, they are vulnerable to attacks from dogs.

Figure 4: Dog movement around the Black-winged Stilt's nesting area

Figure 5: Dog try to close the proximity of Black-winged Stilt nest in wetland habitat

Presence of feral dogs near the rocks of wetland habitat has a significant impact on the resting and roosting activities of Laridae family species River Tern. Typically, River Terns prefer to rest and roost on the rocks located in close proximity to wetland habitat. Daytime and night-time movements of feral dogs around the wetland habitat impacted the roosting and resting activities of River Terns negatively.

Columbidae family species, including Rock Pigeon, Laughing Dove, Spotted Dove and Eurasian Collared Dove have also been observed to be affected by feral dogs. Three types of impacts (direct predation, trying to chase and creating disturbance during foraging and feeding activity) were observed on the Rock Pigeons. While two types of impacts, namely trying to chase and disrupt during the foraging and feeding activities were observed on three species of doves, namely the Laughing Dove, Spotted Dove and Eurasian Collared Dove. Dogs have also been seen killing Rock Pigeons in four incidents during the study. Generally, pigeons and doves are granivore species and prefer to feed on grains and cereals. All these species are highly adapted and reside near human settlements and temple areas. Additionally, people and temple visitor's threw grains around the temple in these locations, where these pigeon and dove species generally feeds. Along with that, other food materials, like bread and biscuits were also given to dogs. Due to this, a large population of dogs also resides around temples and human residential areas. During foraging and feeding times, feral dogs create disturbances to inhabiting bird species and tried to chase and sometimes was successful to kill these bird species.

Corvidae family species (House Crow and Large-billed Crow) were impacted by the movement of feral dogs in and around residential areas, including municipal areas, dumping sites and carcasses. Both crow species reveal omnivorous feeding guild and have a preference for consuming both animal and plant matter. Both crow species also consumed the carcasses of livestock and other animals, in addition to foraging and feeding in proximity to dump sites. At the same time feral dogs often consume livestock carcasses as well as domestic waste and human derived food materials such as kitchen scraps, bread, chicken pieces and meat. Due to the almost similar food preferences of crows and dogs, interaction between dogs and crows was frequently observed. As a result, feral dogs have two significant effects on crows: they attempted to chase them and they also caused disturbances when crows were feeding on dumping sites and carcasses.

Further impact of feral dogs extends beyond large bird species to small bird species as well. For example, members of the Pycnonotidae family (Red-vented Bulbul and Rajasthan Red-Whiskered Bulbul), Sturnidae family (Indian Pied Starling, Common Myna and Bank Myna) and Estrildidae family (Green Avadavat, Indian Silverbill and Scaly-breasted Munia) were also affected by frequent movements of dogs in their entire habitat. One type of dog impact (disturbance in foraging and feeding activity) was observed on these species.

Members of Pycnonotidae and Sturnidae families are adapted to forest habitats as well as urban habitats of the Mount Abu. These species preferred to feed on plant matter (seeds, grains and berries) as well as animal matter (insects) and also consumed human-derived food materials, including bread, kitchen scraps, cooked rice and maize. Dogs also roam these habitats in search of food. Feral dogs effectively displaced these bird species from food sources, disrupting their foraging and feeding activities. Species of the Estrildidae family (Green Avadavat, Indian Silverbill and Scaly-breasted Munia) mainly use grassland habitat for foraging and feeding. Dogs freely and frequently roam in grassland habitats in search for food material, due to which the foraging and feeding behaviour of these species were frequently interrupted and they repeatedly take flight as a result of the disturbance caused by dogs.

DISCUSSION

Direct killing of wildlife is the most visible effect on, but several dogs also chase or harass wild many animal species. These conditions increase stress levels and energy-intensive behaviour among wild species including birds (Lenth *et al.,* 2008). Presence of dogs in certain regions can have a negative impact on the breeding success of wild species, especially including birds (Lord *et al.,* 2001; Lenth *et al.,* 2008; Gingold *et al.,* 2009; Choudhary and Chishty, 2023). During study, it was found that the frequent movement of feral dogs around the wetland and forest habitat negatively influences bird communities by causing a total of six types of impacts *viz.,* direct predation or killing, try to chasing, disturbance in foraging and feeding activity, disturbance in roosting and resting activities and impact on the nesting and breeding activities of birds.

Foraging and feeding activities of 51 bird species, roosting activity of 30 bird species and resting activities of 12 bird species were affected adversely by frequent feral dog movements in different habitat of MA-WLS. Woehler (2021) also found that the nesting, roosting and feeding activities of shorebirds were significantly influenced by frequent dog movements around the wetland habitat. Feral dogs trigger unnecessary anti-predatory, alarming behaviour and also displaced birds from their nests and finally negatively affecting incubation periods of birds. Similar, type of impacts were also observed on the Red-wattled Lapwing and Black-winged Stilt. Both species were negatively influenced by feral dogs during the nesting, foraging and feeding times. Lord *et al.* (2001) also asserted that the dogs walking around the wetland and marshy areas also affected the breeding of shorebirds like Northern New Zealand Dotterels. Barnett and Rudd (1983) also found that feral dogs are primarily responsible for declining prey species for wild carnivores and secondarily influencing the breeding and nesting of marine iguanas, tortoises and marine birds on Galapagos Island. Keller (1991) found that the resting and roosting activities of ducks were influenced by the dog movements. Similarly, the movement of feral dogs also influenced the resting activity of 30 bird species and the roosting activity of 12 bird species, including ducks and geese in MA-WLS (Table 1). Banks and Bryant (2007) found that the frequent movement of feral dogs were responsible for the decline in the biodiversity and faunal species abundance in the woodland areas of Hornsby-Berowra-Cowan region of North Sydney. Frequent movement of dogs along the wetland, forest trails and tracks and roadside affects the diversity of birds. Phasianidae family species such as Grey Francolin, Aravalli Red-spurfowl, Grey Junglefowl and Indian Peafowl are very shy in nature and very sensitive towards any kind of disturbance in their habitat, including humans and dogs. Dogs walking along the trails or tracks in the forest habitat increase alertness and vigilance behaviour in birds and reduce

foraging and feeding time period among these bird species. Due to dogs walking along the forest tracks and trails, these bird species escape from their habitat. Frequent movement of dogs negatively affects the foraging and feeding activities of these bird species. Campos *et al.* (2007) found that dogs are generalists and feed on a wide variety of food materials, including preying amphibians, reptiles, birds, mammals and sometimes insects also. Butler and du Toit (2002) observed the activities and diet of free-ranging domestic dogs (*Canis familiaris*) in rural Zimbabwe by direct observation method and found that the dogs were mainly feed and depended on human-derived waste and domestic animal carcasses but at the same time it was also negatively influencing vultures and wild carnivores during their feeding periods. Similarly, the movement of dogs around the animal carcasses and dumping sites also influenced the feeding of Egyptian Vulture, House Crow and Jungle Crow. Dogs repeatedly displaced vultures and crows from the carcasses and also tried to chase them. Choudhary *et al.* (2021) also found that feeding activity of Indian Vulture (*Gyps indicus*) was negatively influenced by the presence of feral dogs on the animal carcasses and also caused disturbances in their thermoregulatory activities in southern Rajasthan. Galetti and Sazima (2006) analysed the impact of feral dogs in the urban Atlantic forest region in the south-eastern region of Brazil and found that the feral dogs kill 12 vertebrate species; among these, most affected species were mammals (8) followed by amphibians (2), reptiles (1) and birds (1). They conclude that vertebrate species are highly impacted by the presence of feral dogs in the Atlantic forest region in the south-eastern region of Brazil. During study, the feral dogs killed eight species of birds, namely Little Cormorant, Indian Cormorant, Indian Peafowl, White-breasted Waterhen, Common Coot, Red-wattled Lapwing, Black-winged Stilt and Rock Pigeon and also tried to chase 43 bird species. Similarly, Guedes *et al.* (2021) found that the dogs were also involved in the activity of direct killing, chase and competing with native wild species, including birds, in the two areas of Brazilian Atlantic forest and Cerrado hotspot areas. Vishwakarma *et al.* (2023) also observed that the feral dogs tried to chase different species of sandpiper and plovers and also impacted the foraging and feeding activities of several winter migratory species at Mamachi Wadi Beach, India. Similarly, feral dogs chased 43 bird species and disturbed the foraging and feeding activities of 51 bird species in MA-WLS (Table 1).

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