"DENSITY ASSESSMENT OF TOTALLY URBANIZED BIRD SPECIES FERAL PIGEONS AND THEIR RELATIONSHIP WITH HUMANS"

A

DISSERTATION THESIS SUBMITTED TO

B. R. D. SCHOOL OF BIOSCIENCES

SARDAR PATEL UNIVERSITY

VALLABH VIDYANAGAR

GUJARAT, INDIA

FOR THE PARTIAL FULFILLMENT FOR DEGREE OF MASTER OF SCIENCE IN

ZOOLOGY

SUBMITTED BY

UMANG SUTARIYA

EXAMINATION NO.: 23

JULY 2020

UNDER THE GUIDANCE OF

PROF. UJJVAL B. TRIVEDI &

DR. RUPAL VASANT

B. R. D. SCHOOL OF BIOSCIENCES

SARDAR PATEL UNIVERSITY, VALLABH VIDYANAGAR

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GUJARAT.

DECLARATION

I hereby declare that the dissertation work which is being submitted for the degree of Master of Science (M. Sc.) in Zoology of Sardar Patel University was carried out under the guidance of Prof. Ujjval B. Trivedi and Dr. Rupal Vasant at B. R. D. School of Biosciences, Vallabh Vidyanagar, Gujarat. This is an original work and has not been submitted previously for degree/diploma of any other institute.

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I. INTRODUCTION…

AVES

Aves are subphylum's that successfully combine bipedal traits with flight. They are land vertebrates that have wings to fly and feathers covering all of its body. In this way they are a bit different from their ancestor, Reptiles. Feather which defines birds are important for them to fly. (Hildebrand, 1984) or as defined by Attenborough : Birds are a group of warm-blooded vertebrates constituting the class Aves, characterized by feathers, toothless beaked jaws, the laying of hard-shelled eggs, a high metabolic rate, a four-chambered heart, and a strong yet lightweight skeleton. Birds live worldwide and are seen in various sizes from the smallest humming birds (2 inch) to the giant flightless ostriches (9ft). There are about ten thousand living species (Attenborough, 1998).

Birds tend to live and reproduce on every continent of earth, even in the most extreme conditions such as the snow petrels having their breeding colony inland 440Km in the Antarctica. Many species of birds migrate annually over great distances and across oceans, among which several families of birds have adapted to life both on the world's oceans and a few seabird species come ashore only to breed, while some penguins have been recorded diving up to 300 meters (980 ft.) deep (Schreiber *et al*., 2001).

Compared with other vertebrates, birds possess several adaptations necessary for them in flight. The skeleton consists of light-weight bones helpful to reduce weight. They have large air-filled cavities called pneumatic cavities which are connected with

the respiratory system. The skull bones in adults are fused and do not show cranial sutures. The wings are more or less developed diverse in different species. Moa and elephant bird are the only known group which lost their wings. Feathers being a characteristic feature of birds, not only facilitate birds in flight but aids in thermoregulation and are used for display, camouflage and signaling (Gill, 1995).

Different types of feathers are present in different birds each serving its purpose. Feathers are epidermal growths attached to the skin which arise only in specific tracts of skin called pterylae. The arrangement and appearance of feathers on the body are called plumage which may vary in individuals within the species by age, social status and sex (Belthoff *et al.,* 1994).

The digestive system of birds is also modified with a crop for storage of food and a thick walled structure called gizzard that contains swallowed stones for grinding and mechanical breakdown of food, that compensate for the lack of teeth. Most birds are highly adapted for rapid digestion which aids them to lower the weight during flight (Gionfriddo *et al.,* 1995).

As it is observed in reptiles, the birds are primarily uricotelic, that is, instead of excreting urea or ammonia, they excrete in the form of uric acid. Except for the ostriches, Birds do not have a urinary bladder or external urethral opening and uric acid is excreted along with faces as a semisolid waste (Tsahar *et al.,* 2005).

The avian circulatory system consists of a four-chambered myogenic heart covered in a pericardial sac.The sinoatrial node located on the right atrium possesses the

pacemaker cells which controls the hearts pace it being myogenic. As the birds have a ten times greater surface area for gaseous exchange volume than mammals, so they have a higher efficiency of diffusing oxygen into blood. As a result, birds have more blood in their capillaries per unit of volume of lung than a mammal (Hoagstrom, 2002).

Birds migrate against global seasonal temperatures and optimize the availability of food sources and breeding habitat. Migrations vary from species to species. Usually the length of the daylight and the weather conditions provides a signal to many land birds, shorebirds, and water birds to undertake annual long-distance migrations. These birds are characterized by a non-breeding season in the tropical regions or opposite hemisphere and breeding season spent in the temperate or Polar Regions. As certain hibernating animals do, the birds too before migration substantially increase body fats and reserves and reduce the size of some of their organs (Klaassen, 1996). Migration is high energy demanding task, particularly as they need to cross deserts and oceans without refueling. Average flight range of land birds is around 2,500 km and that of shorebirds is up to 4,000 km (Gill, 1995).

Ecologically birds provide a wide range of positions. As it varies in different species, some birds are generalist's while others are highly specialized in their habitat or food requirements. Niches occupied by different species of birds vary even within a single habitat such as the forest, with some species feeding in the forest canopy, others beneath the canopy, and still others on the forest floor. Forest birds may be insectivores, frugivores, and nectarivores. While the diet of aquatic birds consist

majority of fish eating, plant eating or kleptoparasitism. Predatory birds specialize in hunting mammals or other birds, while vultures are specialized scavengers (Sekercioglu & Hakki, 2006).

Birds are one of the most common and eye-catching animals, which is one of the reasons why humans have had a relationship with them since the dawn of the man (Bonney *et al.,* 2004). A variety in the extent of the relationship can be observed such as the mutualism between honey-gathering among honeyguides and African peoples such as the Borana (Dean *et al.,* 1990). While many of the human activities have been detrimental to several species of birds sometimes species such as the house sparrow have been benefited from human activities (Singer & Yom-tov, 1988). Several bird species have become commercially significant agricultural pests, and some birds pose an aviation hazard. From time to time birds have been seen to act as vectors for spreading diseases such as psittacosis, salmonellosis, campylobacteriosis, mycobacteriosis, avian influenza, giardiasis over long distances. Several among those diseases are zoonotic that can also be transmitted to humans (Reed *et al*., 2003).

Urbanization and its effect on avian fauna

Humans are social species that rapidly increases, we colonize virtual wilderness, settle small towns, and build sprawling metropolis through our industrial ability. There is virtually no place on Earth where humans are not settled and wherever we go; we significantly transform the natural habitats (Berry 1990; Meyer & Turner, 1992; Houghton, 1994; Marzluff & Hamel, 2001).

The process of human settlement which leads to the transformation of unpopulated wildlands into lands which includes some degree of relatively permanent human presence is known as urbanization. The widely spaced agricultural and recreational homesteads are transformed into a concrete and steel heart of a large metropolitan area through a continuous process that produces a range of settlement densities (Alberti *et al.*, 2001; Marzluff, 2001).

Increased urbanization causes the wild portions on earth to disappear and humans are increasingly shifting from rural to urban regions, as a result, the world's urban population multiplied ten folds last century. It is estimated by the United Nations that by 2050, the global urban population will equal today's total population (Brockerhoff, 1998). Urbanization dramatically transforms natural environments while the habitat loss and fragmentation is perpetuating worldwide, which not only cause severe changes in the original flora and fauna, but also concentrating resources and energy (Wagner, 2008).

Near the end of last century, human dwellings occupied 1-6% of the Earth's surface;

human agriculture covered another 12% .About 40% of the net primary productivity on earth is used by humans which shows our dominance (Vitousek *et al*., 1986). Consider it to be human settlement or agriculture or the use of natural resources or recreational opportunities needed to sustain the flourishing human population, virtually all lands have been impacted by human settlement. Models suggest that over the last three centuries saw a lost in forest cover by 19%, grasslands have declined 8%, while there is an increase in cropland by over 400% (Matthews, 1983; Richards, 1990; Meyer & Turner, 1992; Marzluff & Hamel, 2001).

Urbanization leads to complex direct and indirect effects on native flora and fauna. As suggested by Marzluff (1997) there are five changes caused by human settlement that affects avian fauna: I) ecosystem processes, 2) habitat, 3) food, 4) predators and competitors, and 5) disease. Those effects mentioned above can cause significant changes in the structure and composition of bird communities. Species able to take advantages of the urban environments may flourish and develop dense and stable populations because of ameliorated climate, abundant food and water, reduced predators, and increased nest sites allow for lengthened breeding seasons, increased survival, and increased productivity (Gehlbach, 1988).

While some species thrive due to human settlement, many native species may decline with urbanization because of the scarcity of natural habitat, increases in predators, parasites, or competitors, or intolerance of human activity. As a result, though they are described as richer (more species) and larger (greater biomass), urban bird communities are less evenly distributed communities dominated by a few, very

abundant and non-native species (Emlen, 1974; Beissinger & Osborne, 1982; Mills *et al*., 1989).

Urbanization possesses major challenges to bird communities because some species are favored and others are reduced by human settlement. As it commonly observed the factors that favor the species are simpler than those declining species, Primary among factors identified to favor species is increasing availability of food. Some of the species benefited due to increased food are urban tits, pigeons and doves, sparrows, thrushes, gulls, waterfowl, and corvids (Earle, 1988; Dabert, 1987; Brittingham & Temple, 1992; Jozkowica & Gorska-Klerk, 1996). Factors such as the increase in small raptors and non-native predators reduce the Survivorship of birds in urban areas e.g. domestic cats (Batten, 1972).

Urbanization leads to Increase in exposure to diseases and toxins among birds (Walcott, 1974; Schmidt, 1988), and decline in arthropod population that are important dietary source for birds (Ruszczyk *et al.*, 1987), all of which many reduce survival and fecundity.

Synanthropic species dominates bird communities as a result of increase in human settlement. Most commonly these include small raptors, corvids, mynas, pigeons and doves, weavers, thrushes, swallows, swifts, and starlings. Excluding a few especially successful species that dominate urban avian fauna, such as the rock dove, European starling and house sparrow, majority of the species in urban areas are synanthropic native species (Johnston & Janiga, 1995).

INTRODUCTION TO PIGEONS:

The pigeon is a member of the bird family Columbidae consisting of doves and pigeons. The scientific name of pigeon is *Columba livia*, and there are 12 subspecies of it (Gibbs *et al*., 2010). While it is surprising to know that there are 315 breeds of domestic pigeons, all originating "from one wild source, the rock dove". The great naturalist Darwin (1883), himself kept domesticated pigeons, and argued that the Columba Livia is the ancestor of all modern domestic pigeons, noting that Bodio added, "the evidence that all the domestic races of pigeons are descended from one source is far clearer than with any other anciently domesticated animal" (Bodio, 1990).

Scientific classification (Gmelin, 1789):

Kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Columbiformes

Family: Columbidae

Genus: Columba

Species: *C. livia*

The ancestral rock dove is also commonly known as the rock pigeon. This calls attention to the fact that a “dove” and a “pigeon” are biologically the same animal and the difference between the both is a baseless social construction. Ornithologists draw no substantive behavioral or physical distinctions between the two. The distinction is a matter of convention whereby the larger members of species have usually been called pigeons while the smaller members have been called doves. “Some languages do not even have separate words for pigeons and doves” (Green-Armytage, 2003).

Morphology:

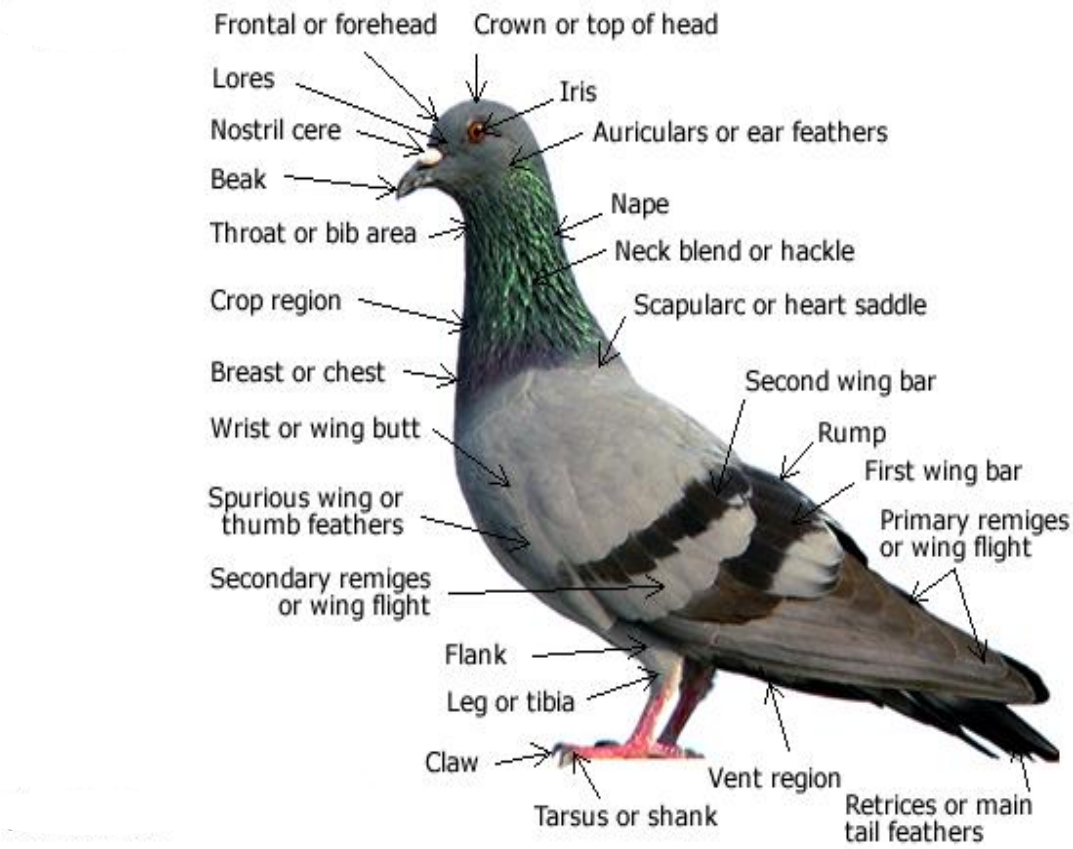

Fig. 1 Pigeon Morphology (www.pigeoncontrolresourcecentre.org)

The average length of an adult of the nominate subspecies of the rock dove is about 29 to 37 cm (11 to 15 in) with a wingspan of 62 to 72 cm (24 to 28 in) (Shah, 2008). Though overfed domestic and semi domestic individuals can exceed normal weights, the weight for wild or feral pigeons ranges from 238g to 380g (Cornell, 2008). Among standard measurements, the length of wing chord is around 22.3 cm, the tail is around 9.5 to 11 cm long, and the bill is around 1.8 cm (Gibbs *et al*., 2010).

The head, neck, and chest of the adult rock dove is bluish-grey while its neck and wing feathers show glossy yellowish, greenish, and reddish-purple iridescence. The species show almost no sexual dimorphism, but the iridescence on female's neck is less intense and more restricted to the rear and sides, whereas that on the breast is often very unclear. The bare skin round the eye is bluish-grey while the iris is orange, red, or golden with a paler inner ring. The beak is grey-black in color with a conspicuous white cere and the feet are purplish-red in color (Gibbs *et al*., 2010).

Reproduction and Nesting:

The nesting sites are selected by males as their most important components of territories. The site maybe empty of any nesting material or have an old nest in place and the male will spend a significant amount of time on the site. The courting male calls from the site or may fly to the site in nest-demonstration display. Females may accept the site or may choose a different site in the male's territory. Thus, almost all the mated pairs of pigeons will already have a nest site, as will some unmated males; unmated females do not have such sites.

The rock dove, domestic pigeons and feral pigeons readily breed at any time of the year, but the peak time is spring and summer. The nesting material includes a platform of straw and sticks, while the nesting site varies from cliff faces of mountains to the artificial cliff faces created in apartments and their window ledges (Cornell Laboratory, 2008).

The male rock pigeon interested in mating will start off with advertising song to

another bird entering its territory; the male does not know its sex, it will determine the gender of the newcomer by its responses to aggression, if the newcomer is a male it will tend to be aggressive in return and if it is a female she would not be aggressive, if she is reproductively oriented (Jhonston & Janiga, 1995).

The male would start its ritual of singing and dancing around her doing the boo-coo. This ritual includes standing tall, inflating its crop and bringing its head and neck slowly down while singing - coo, roo-c'too-coo. (Goodwin 1983). Simultaneously it maintains a strutting walk, periodically circling around and fanning its tail. If the female continues to observe the male, she will apparently accept the male for mating (Jhonston & Janiga, 1995).

Two eggs are laid; clear white in color and the incubation period lasts from 17 to 19 days which is shared by both the parents (Levi, 1963). The newly hatched squabs are dull yellow down and show little luster while the beak is flesh-colored with dark bands. The squabs are feed by both the parents for few days, mainly though crop milk or pigeon milk, which is produced by both the sexes in all the species of pigeons and doves (Shah, 2008).

PIGEONS: Being more symbolic than any other bird.

Historical function, Domestication, food and fertilizer, messenger, metaphor…

Historical function & Domestication:

Historical evidence suggests that pigeons are among the first of all birds, and among the first of all the animals, to be domesticated (Sossinka, 1982). Records and carvings of doves to be found are around 5000 years old (Glover & Beaumont, 2004). Earliest dates are yet to be known but several archeological records such as terra cotta figures found in present-day Turkey dates back up to the fifth century B.C. While a Greek gravestone depicting a man affectionately holding two pigeons dates back from 500 B.C. - as evidence of the early domestication (Levi, 1963).

From Homer to Socrates (469-400 B.C.) to Aristotle (384-322 B.C.), the Greeks displayed knowledge of the pigeon's habits and abilities and wrote about issues of selective breeding and domestication (Levi, 1963). The religious offering of 57810 pigeons by the Egyptian king Ramses to the priest of god Amon was done 3200 years ago, the great number of birds suggests that by then the Egyptians were adept to domestic pigeon husbandry (Breasted, 1906).

Pigeon as Food:

The oldest documented use of pigeons comes from areas in and around the Middle East and North Africa. About 12000-year-old pigeon bones were found in the human dwelling from Israel, which indicates the ancient hunters, used wild pigeon as a food

source (Johnson & Janiga, 1995). The grain farmers would be the first to domesticate pigeons because soon after agriculture began in regions containing wild rock pigeons, these pigeons made their way to human settlements and foraged for grain (Johnson & Janiga, 1995). As pigeons started to inhabit near human settlements, they became a candidate for capture and domestication as a food source. Upon capturing for consumption, humans noted them for their "reproductive magic," breeding more times and for a longer season than any other bird and most other animals (Johnson & Janiga, 1995).

Fertilizer:

In places such as Egypt and Turkey, thousands of years old mud houses can still be found, build to shelter domesticated pigeons. One of the first types of fertilizer used by newly emerging agricultural societies was the nitrogen-rich guano or feces of pigeon. Pigeon meat is considered a delicacy in many parts of the world, while in some cultures it is a staple food. Young squabs are preferably eaten as the adult pigeons meat gets too hard (Levi, 1963). In France today, squab is often served in the finest of restaurants.

Metaphors & in mythology:

Metaphors and narratives have been used by almost every culture of the world to describe how they lived their life (Fine, 2003). As humans started exploiting and breeding pigeons for consumption, they tend to know that a pair of pigeons, once mated, usually remain and mate with each other. Monogamy is considered as a moral

value trait and the fact that pigeons, unlike many other animals, display this trait led to their use in rituals and shrines that celebrates love (Jerolmack, 2007).

In Mesopotamian mythology and shrines, pigeons were represented as a symbol of fertility and sex, which way back as long as 6,500 years ago (Levi, 1963). Syrians and Assyrians considered pigeons as sacred animals, while the Greeks used pigeons to represent Aphrodite; the Goddess of love; and in Hindu mythology, Kamadeva- the goddess of love- is portrayed using a dove (Patent, 1997).

Picasso was an avid pigeon fancier; it was he who cemented the status of the dove as a symbol of peace. Dove is also used as a logo of the United Nations. Some desirable qualities of Pigeon were drawn out, when Shakespeare used pigeon as a reference in literature (Levi, 1963).

Pigeon as messengers:

Relying on abilities beyond memorization, the rock dove has a naturally gifted ability to find its way "home" from long distances. This fruitful capability of pigeons was accidentally discovered by humans, when pigeons released far from home, found their way back to where they had previously lived when abandoned or traded far from home. It was not long after finding this capability, humans began to selectively breed the ablest pigeons to heighten this capability, and it is this unique ability of the pigeon that has perhaps become the most legendary (Jerolmack, 2007). Thus, the domestication of pigeons and unanticipated consequences lead to the discovery of its "homing abilities." This discovery became the foundation for increased

domestication of pigeons (Merton, 1936).

The use of pigeons for relying on messages started in the military, after their success in relying on millions of personal and strategic messages during the siege of Paris. The success of the pigeons in relying on millions of messages led to most Western armies adopting Pigeon Service divisions (Jerolmack, 2007).

The use of homing pigeons was seen at an unprecedented scale in the first "modern war," World War I, as the phone and telegraph were either destroyed or tapped by the enemy. The pigeons became so valuable or dangerous in enemy hands that the Germans ordered to destroy all the pigeons when they occupied Belgium and France (Patent, 1997). The British Army specifically trained soldiers called "pigeoneers," to take care and travel into battlefields with up to four pigeons. By 1917, pigeons were extensively used in every battle and by close of the war Britain had 22,000 pigeons in service (McCafferty, 2002).

Medals and more…

Monuments were made in Brussels and Lille that pay tribute to the efforts of the pigeons that serviced in war. Britain awarded 32 pigeons the prestigious Dickens Medal, awarded to animals that serve humans heroically (only 54 medals were awarded). This post-war medal bears the phrases "For Gallantry" and "We also serve" (McCafferty, 2002).

An American bred pigeon named G.I.Joe was one of the most famous recipients of the award, as it saved the lives of hundreds of British soldiers by arriving at the base

just minutes before the bombers took off and deliver a message to Allied bombers telling them not to attack a position that the British had just seized from the enemy (Bodio, 1990).

Hundreds of stories document the 'heroic' deeds of these birds. In 2004 the bravery of these animals was memorialized when London unveiled a sculpture of dogs, mules, elephants, and pigeons with the inscription: "Animals in War. This monument is dedicated to all the animals that served and died alongside British and Allied forces in wars and campaigns throughout time. They had no choice" (Jerolmack, 2007).

A big reason why there are so many breeds of pigeons is that for thousands of years, humans have breed pigeons for a variety of patterns and color; it has less to do with breeding for function. Just as there are dog and cat shows where judges assess the best breed based on color, pattern, size, and other features- choosing the "ideal" animal of the breed, so too are there competitive pigeon shows (Green-Armytage, 2003).

The name of many breeds of pigeons reveals their origin and how they have been bred and kept around the world: Thai Fantail, Indian Gola, Baghdad Tumbler, Texan Pioneer, Slovak Pouter, Egyptian Swift, English Magpie, Ukrainian Skycutter, Kurdistan Roller, Tunisian Owl, Syrian Dewlap, and so forth (Jerolmack, 2007).

These birds are produced purely to satisfy the aesthetic taste of the breeders. These birds are mostly "nonfunctional," and in many of the cases, they would be clearly seen as dysfunctional. Some of them cannot fly, others must be hand-fed, and some

barely stand up because of their odd proportion. These artificial and comical appearances value the same that of the breeding and valuation of a bulldog (Nash, 1989).

Feral Pigeons

Feral pigeons are not referred as a different species but only varieties of rock pigeons. However, “variety” is not a recognized taxonomic category, but it is used here because feral pigeons cannot be considered under the taxonomic group “sub-species” as they are population stemming from domesticated ancestors. Differences between the domesticated and feral pigeons are substantial, and over a period of time by inhabiting near human settlements the feral pigeons have evolved, and are not mere domesticated pigeons released into the wild (Jhonston & Janiga, 1995).

Feral pigeons also known as city pigeon or street pigeon are among the most successful avian settlers in our cities (Blechman, 2007). The average feral pigeon population in the world is around 1 pigeon per 10–20 city inhabitants, these estimates to world population between 165 million to 330 million (Jhonston & Janiga, 1995). This feral pigeons live everywhere were people do, Unlike their ultimate ancestor Rock Dove (Columba livia), who used to live in the faces of the cliffs of central and western Palearctic and north Ethiopian regions, as well as in those of the Indian Subcontinent (Goodwin, 1983). As discussed above, pigeons were one of the first animals subjected to domestication, which lead to domestic breeds of this wild population by artificial selection (Sossinka, 1982). These domesticated breed of pigeons readily went feral when released off from their captivity. So there is no doubt that the feral pigeon came from domesticated Rock pigeons and few also from synanthropic Rock Dove (Johnston & Janiga, 1995; Lever, 1987).

As stated by Johnston and Janiga (1995), “the poultry husbands’ would have never cared of the escape of domestic pigeons to live in the wild”. The domestication of pigeons and its transport let to worldwide occurrence of feral pigeons. One can image how many pigeons would have escaped into the wild as they were extensively used after domestication, be it in the form of messengers during war, or as a source of food, or in leisure and exhibition (Jhonston & Janiga, 1995).

For an instance, when the French peasants destroyed the aristocracy’s pigeon houses during the revolution, or when an enemy was vanquished in war, in both the cases pigeons were released into the wild (Jhonston & Janiga, 1995). But they would have never paid attention on the possibility of their action resulting in the existence of feral pigeons in all the cities of world today. These pigeons have adapted with the human civilization for thousands of years and have become successful to thrive even in the harsh concrete jungle of modern metropolises (Jerolmack, 2007).

Feral Pigeons as pests

The boundaries that separate companion animals, livestock, wildlife and "pest" or "nuisance" are unstable. In today's world nature is problematically related to culture, while Nature is not obliged to cope up with cultural transformations, and it may strike back at cultutral practices, maybe in the form of diseases (Nash, 1989).While it is also seen that animals which gets adapted with human communities and gets benefited from human dominated landscapes, are shifted from our conscience of them being wildlife to nuisance or pests, such as pigeons (Herda-Rapp & Goedeke, 2005).Depending on the personal cultural background, the presence of feral pigeons around human settlements can be perceived in many ways from ranging it from harmless and tame birds to harmful pests (Jerolmack, 2008; Johnston & Janiga, 1995).

Feral pigeons include all the important factors identified for becoming a pest, such as being a granivore, having an elementary storage – crop, having high reproductive rate, group foraging and colonial in habit (Johnston & Janiga, 1995). After the end of the wars, feral pigeons populated cities due to feeding by pigeon enthusiasts, food littered by humans, accidental spoilage, and on a lesser scale by seasonally occurring natural food (Simms, 1979; Haag-Wackernagel, 1995). As food supplies were ad libitum, the feral pigeons started to breed throughout the year and expanded their granivorous diet into an omnivorous diet (Murton *et al*., 1972; Johnston & Janiga, 1995; Haag, 1995).

It brings pleasure to people who feed feral pigeons on a regular basis, but the absence of predators, enemies and food leftovers, together with the large food supplies allows the expansion of pigeon population which can bring conflict between humans and bird (Haag-Wackernagel, 1993). The ubiquitous vocalization of feral pigeons in excessive population around human settlements can lead to hysteric reactions and insomnia in sensitive persons occupying nearby building (Carle, 1959).

Each feral pigeon produces about 12 kg of excrement each year (Haag-Wackernagel & Geigenfeind, 2008), spoiling various monuments, buildings and public places. Pigeon feces accumulate at areas such as their roosting and breeding areas. Growth of fungi takes place in pigeon feces, which can damage constructions made up of cement and concrete (Bassi & Chiatante, 1976). The acidity alone can cause aesthetic and structural damage to marbles and calcareous stones over a period of time. Adding to it the feces and nest materials can clog drainage systems causing internal damage to buildings. The cost of its cleaning and repairing can put strain on family and commercial businesses (Johnston & Janiga, 1995).

Feral pigeons constitute relevant damages in particular to historical sites and towns as they provide ideal sites for nesting and roosting (Giunchi et al., 2012). For instance the medieval buildings such as the churches, architectural treasures and sculptures; whose external walls constitute plenty of holes provide ideal sites for nesting. The feral pigeons fowl such places regularly and pose a threat to their conservation (Mendez-Tovar *et al*., 1995).In the U.S.A alone the feral pigeon's cause an estimated loss of 1.1 Billion dollar per year (Pimentel *et al*., 2000).

Suitable nesting sites are rare in most cities and feral pigeon's compromise to confined space which leads to intense competition and overcrowding at breeding sites, producing poor living conditions due to social stress, parasites and diseases (Johnston & Janiga, 1995).

The damages done to buildings are insignificant when compared to health concerns that pigeons impose. Another reason for considering pigeons as pests is their ability to spread diseases. Without any direct contact to pigeons, pathogens can be transmitted to humans mainly via excreta, secretions or from feather dust spread into environment (Curtis *et al.,* 2002; Geigenfeind & Haag-Wackernagel, 2010). Feral pigeons are vectors to many microorganisms that spread both allergic and infectious diseases that can turn out to be lethal. Wild-avian species possess more parasitic fauna then pigeons, but no other species lives in such close proximity to humans as pigeons do, presenting a serious health risk (Haag-Wackernagel, 2009). There are several diseases such as aspergillosis, borreliosis, coccidiosis, chlamydiosis, equine encephalitis, influenza, paramyxovirus, paratyphoid, toxoplasmosis, and tuberculosis that can be potentially transmitted to humans (Schnurrenberger & Hubbert, 1981).

According to Haag-Wackernagel, about 110 different pathogenic agents can infest human population, but only seven of them are known to infect humans. Chlamydophila psittaci and Histoplasma capsulatum are of risk to immuno-depressive persons (Haag-Wackernagel & Moch, 2004).

Feral pigeons are also source of zoonotic ectoparasites which can infect humans living nearby. About 17 ectoparasites have been known to potentially infest humans

out of which the pigeon tick Argas reflexus represents the most significant health hazard (Haag-Wackernagel & Bircher, 2009). Feral pigeons have been known to spread diseases, among other avian taxa with which they would come in contact with, such as the seabirds, penguins, raptors, other columbids and passerines (Phillips *et al.*, 2003). Feral pigeons are known to cause various accidents that range from trivial slipping on surfaces soiled with pigeon feces, to aviation hazard. Some flocks of pigeons are attracted to airports nearby cities, which lead to pigeon being listed in the most common bird-strike event (Cleary *et al.*, 2006; Dolbeer *et al.*, 2000).

Pigeons visiting countryside have been known as a source of damage to agriculture, this includes even the resident colonies of countryside. Pigeons go on damaging seeds at the moment of sowing, destroying sprouted cotyledon leaves or widely feeding on mature crops (Johnston & Janiga, 1995). Damage done by pigeons varies according to the crop present. For instance, countries cultivating mainly maize and wheat may sustain damage during crop storage (Saini & Toor, 1991), while in other cases such as sunflower fields, the damage is greater occurring at both time during sowing and before harvesting flowers (Van Niekerk, 2009).

II. Review of literature…

PIGEON STUDIES

A census of feral pigeons was conducted between July 1999 and February 2000 in Milan, Italy (a 181 Km2 area) by line transects method. The study was used to determine the relationship between the feral pigeon population and the structural features of the buildings, more preferable by them. The pigeon population was estimated at 103,650birds, with an average of 570/km2. Population of pigeons decreased significantly as moving from center of the city (2083 birds/km2) to suburbs (604birds/km2) to farmland (434birds/km2). It was also noted that the abundant pigeons were found inhabiting in old buildings constructed before 1936. Indicating they provide a better nesting and roosting site (Sacchi *et al.*, 2002).

A study conducted on the food of feral pigeons in Leeds, England, depicts how feral pigeons are urbanized and totally depend on humans for food. From the city of Leeds about 267 pigeons were shot with air-rifles from January 1963 to march 1964, the bodies were brought to laboratory and were stored in deep freeze. After dissecting the bodies later, crops were weighted and their contents were examined in white enamel plate. It was observed that much of the year pigeons were directly depended on humans, as their diet concentrated on human products such as cake and bread. Sometimes exotic seeds like Millet, Canary seed, Maize and Peanuts were also purposely provided to the birds by people. Leftovers such as cheese and bacon also constituted as their regular food items. This shows us their adaptation to urban world and dependence on humans (Murton & Westwood, 1966).

A study was carried out on the population of feral pigeon *Columba livia var.* in urban and suburban areas in the city of Jena, Germany. The study was carried out from July to December 2007 to know the difference in population in the sub-urban and urban areas. Five line transects were taken in east-west of sub-urban areas and five urban transects were taken from north-south. Census was conducted using binoculars and digital camera for four to five days per week. Plumage phenotypes were also recorded using digital camera and binoculars. It was found during the census that Feral pigeons density was higher in urban transects, 730 individual/km2 ± 199 with a total number of 2,377 (61%) pigeons, than in suburban transects, 392 individual/km2 ± 205, with a total number of 1,510 (39%) pigeons. Mean values of population of pigeons per transect were 396 in urban areas and 251 in suburban areas. While the plumage had the following variations, Blue bar (62%) was the most abundant plumage followed by Checker (19%) and T Checker (10%). Suburban areas consisted of residential houses, few shops and little traffic, while urban areas were characterized by high buildings, churches, cafés and food shops, buses and cars, which resemble rocky sea cliffs, an ideal synanthropic environment for feral pigeon settlement (Ferman *et al.*, 2010).

A study was carried out in Wellington city, New Zealand on the Limited movement of feral pigeons due to the abundance of artificial food, causing over population of pigeons which in turn increased human-nature conflict. Pigeons were caught and banded from five parks in inner Wellington; these all parks had pigeon population and artificial food provided by public feeding. 48 birds were caught and banded between June and December in Wellington City. It was found out that the average

activity area was 1.87ha and about 14 birds (70%) had an activity area less than 1ha. While the average activity of 9 birds, were less than 0.5ha. The pigeons were also loyal to their feeding site as only 2 of 48 birds were seen at parks other than where they were captured. Their small scale activity and loyalty to the feeding site suggest that food is abundant in locality, so they do not have to go further to forage. Abundance in food increases their chances of reproduction and overpopulation resulting in conflict between humans and pigeon (Ryan, 2011).

Another study in Wellington City was carried out to determine whether the natural tendency to feed wildlife affects attitudes towards feral pigeons and their control. A questionnaire was prepared which contained a multiple set of questions, reflecting on the human attitude towards feral pigeons. Questionnaires were distributed around the city at different sites. Respondents were also asked about the method they would prefer for pigeon control from various control measures. So the result suggested majority of the response was split between negative and neutral. That demonstrated the importance of perception in human-wildlife conflict, as the opinions were contrasting on the same matter. People who provided birds with food or water were less likely to have a negative approach towards birds. This relates to the fact that any type of wildlife interactions, is considered to lead to a greater appreciation of wildlife. While it was observed in the study that about 50% people had a negative approach towards the bird due to pigeon waste, this was proposed mostly by the non-feeders who visited open spaces. The control methods which were most supported were those that involved regulation rather than lethal techniques. Since the pigeons‟ main food

source came from pigeon feeders, regulation to refrain feeding would likely result in a population decrease of pigeons, human-nature conflict being of great magnitude in the city (Ryan, 2011).

A study on health hazards posed by feral pigeons on human was carried out in Basel, Switzerland. A comprehensive literature search of epidemiological studies was performed from sources not readily accessible to clinicians by standard search engine, was made possible by reading of bibliographic references in Italian, French, German and English publications. This includes the search of reports about transmission of pathogens from feral pigeons to human. It was revealed that there were 176 documented transmission of illness from feral pigeons to humans reported between 1941 and 2003. Feral pigeons harbored around 60 different human pathogenic organisms out of which, five pathogens were viruses, nine were bacteria, 45 were fungi, and one was a protozoan. Out of which five pathogens were routinely transmitted to humans. The most commonly transmitted bacteria were Chlamydophila psittaci, while the fungus Cryptococcus neoformans was the most common. Most of the pathogens infecting humans were through air-borne route. It was also noted that chances of infections through pigeons are quite low, but immunocompromised person is at 1000 time more risk than healthy individual (Haag-Wackernagel & Moch, 2003).

A similar study was conducted on ectoparasites effecting from feral pigeons to humans in Basel, Switzerland. A case study was undertaken of a young female who moved into an old carelessly renovated apartment, where the former tenant had fed a group of 8–10 feral pigeons on her balcony. After few days in the apartment, she was

later restless due to small itching papules on the legs, forearms, loin and abdomen accompanied with burning sensation. She also suffered from general symptoms such as fatigue, weakness, dizziness, tachycardia and thoracic oppression and slept against her habit more than14 h. She found some bugs and ticks roaming under the bed and in some other cranked places. Later through internet search, she came to know that they were bed bugs *Cimex lectularius* and pigeon tick *Argas reflexus.* A pest controller performed a disinfectant of the apartment and he confirmed the presence of red mites and pigeon ticks. When Haag and Wackernagel performed onsite inspection they found live ticks and dead mites in the balcony, while the bathroom and window ledges were covered with pigeon feces. This was the first case in which a patient was infested with three ectoparasites from feral pigeons, that is red mite (Dermanyssus gallinae), pigeon tick (Argas reflexus) and bed bugs (Cimex lectularius). Thus, feral pigeons residing nearby human habitation can bear a risk of parasitic infestation, which is difficult to control (Haag-Wackernagel & Bircher, 2009).

A recent study on feeding ecology of feral pigeons was conducted in Punjab, Pakistan. Both the genders of feral pigeons were sampled for a 16 month study in three provinces viz. Rawalpindi, Faisalabad and Bahawalpur of the Punjab. Medium sized nets were used to capture feral pigeons directly from fields. The pigeons were then sent to laboratory, where they were dissected dorso-ventrally. Detailed crop and gizzard analysis of the pigeons was performed and relative frequency of various food contents was determined. *Zea mays* happened to be the major food for the pigeon, while incorporation of *Hordeum vulgare, Brassica campestris, Pennsietun glaucum*

and *Sorghum vulgare* were also frequented among three habitats. It was concluded that pigeon was an important bird in the various agro-ecosystems of Punjab, Pakistan. Pigeons were proved to have quite a diversified feeding habit and majority of them roost and nest closely to the feeding resources. They proved to be tenacious to the existing food crops, as they can manage visitations in both rural and urban environment. They did more damage at the seedling stage, incurring considerable economic losses (Batoola *et al.*, 2019).

AIM & OBJECTIVES

I. To study pigeon population at different feeding spots around the city of Anand.

II. To compare the similarities and differences in pigeon population at feeding sites with the changing demographic plan of the city.

III. To study the impact of widespread pigeon feeding in increasing pigeon population.

IV. To understand the dynamic human behavior towards pigeon.

III. METHOD AND MATERIALS

STUDY AREA

ANAND

The city of Anand serves as government headquarters of Anand District in the state of Gujarat, India. The Geographical coordinates of the city are 22.57° North (Latitude) 72.93°East (Longitude), with an area of 22.7 km2 (8.8 sq. mi). Anand forms a portion of the area called as Charotar which is made up of Kheda and Anand districts. Regarded as "Golden Leaf', this region of Charotar has the maximum production of tobacco in Gujarat. Anand is famous all over India and Asia continent as the milk-city of India and Asia; for it has the privilege to accommodate and establish The Amul Dairy ', which holds the record to be the biggest co -operative milk-society.

The land of Anand district is very fertile & productive as compared to other areas of Gujarat. So, farming and agriculture remains the primary source of occupation for most of the people residing in Anand district. Major productions of Anand are banana, tobacco, groundnut, potato, cotton, papaya, mango, onion, cabbage etc.

Anand is also an industrial base for Engineering, Chemical and Food and Agriculture Products and over 950 units of small and medium enterprises are also generating large number of jobs in the district. VallabhVidyanagar which is a suburb of Anand is well known for its educational institutes, attracting students from all over Gujarat. It accommodates almost 80 colleges encompassing and offering different courses both at graduation as well as post-graduation level.

Selected site for study

To carry out the short-term study, nine different feeding sites of pigeons were identified around the city of Anand, where a flock of pigeons would gather to forage for the food items provided by pigeon feeders. These entire nine sites saw a number of pigeon feeders on a regular basis, as well as casual pigeon feeders, feeding them while passing by. Pigeon feeders from the surrounding visit these sites with certain sort of grains or artificial food items for feeding pigeons on a routine basis. Some of these sites have specially constructed "Chabutro" or pigeon towers for feeding pigeons, while a few have courtyard for feeding flocks of pigeons. These nine sites are located in three different parts of the city of Anand. Thus ultimately, three large areas were selected each having three sub-sites (pigeon feeding spots). These larger sites with their sub-sites are listed below in the table:

MAIN SITES	A. BAKROL	B. VIDYANAGAR	C. ANAND
SUB-SITES Or FEEDING SPOTS	PARTHTOWNSHIP	NANDGHAR	RANCHODRAY TEMPLE
	RADHAKRISHNA CENTRAL	GROUND	JALARAM TEMPLE
	VAISHALINAGAR	NILKANTH TEMPLE	GAMDIVAD

Table 1.1 – Study area in Anand city.

NOTE: THE NAMES GIVEN TO SUB-SITES ARE JUST FOR THE SAKE OF CONVINENCE.

Demographic plan of the area selected

The site A. (Bakrol) is a semi-rural area on the outskirts of the city. There is certainly less commotion in this area and the people are on a slower pace of life here. The old houses having many holes and the clay roofs of certain houses provide convenient space for pigeons.

The site B. (Vidyanagar) is a residential sub-urban area with colleges, parks, offices and some residential societies. The window ledges of houses and offices, as well as house tops and open grounds are favored by pigeons.

The site C. (ANAND) is a commercial urban area with lots of buildings, commercial complexes, temples, shops and high trafficked roads. The pigeons find window ledges of buildings, shops and temples as their favorable roosting and nesting sites here.

The figures given below represent the larger site with their sub-sites:

(Red circle ( ) represents the sub-sites or feeding spots)

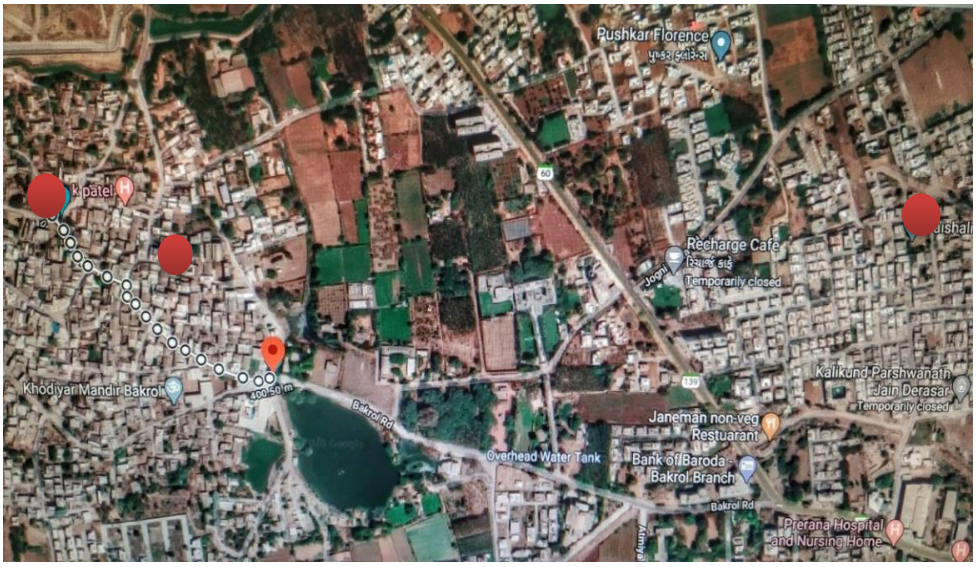

Figure 2: Map of site A. BAKROL

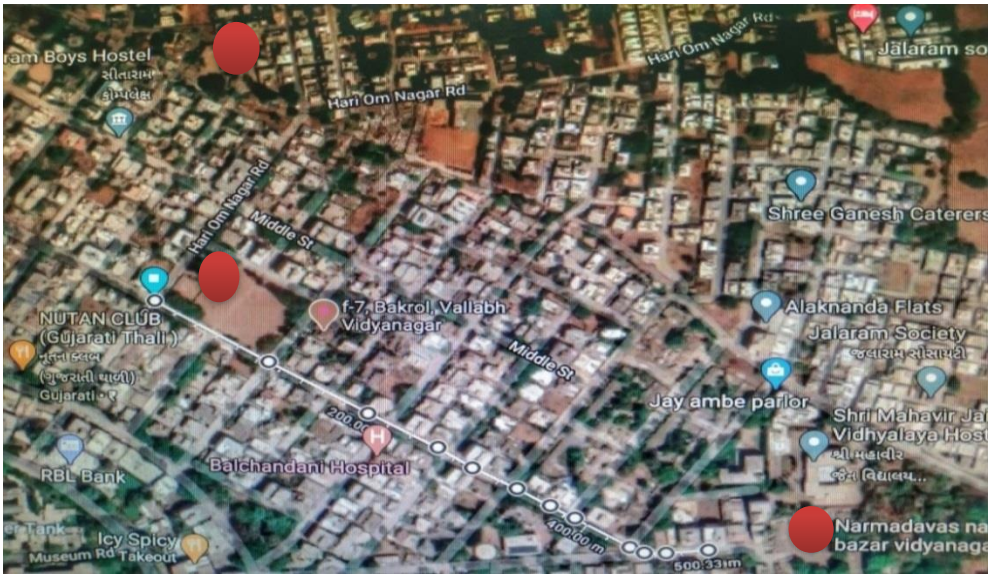

Figure 3: Map of site B. VIDYANAGAR

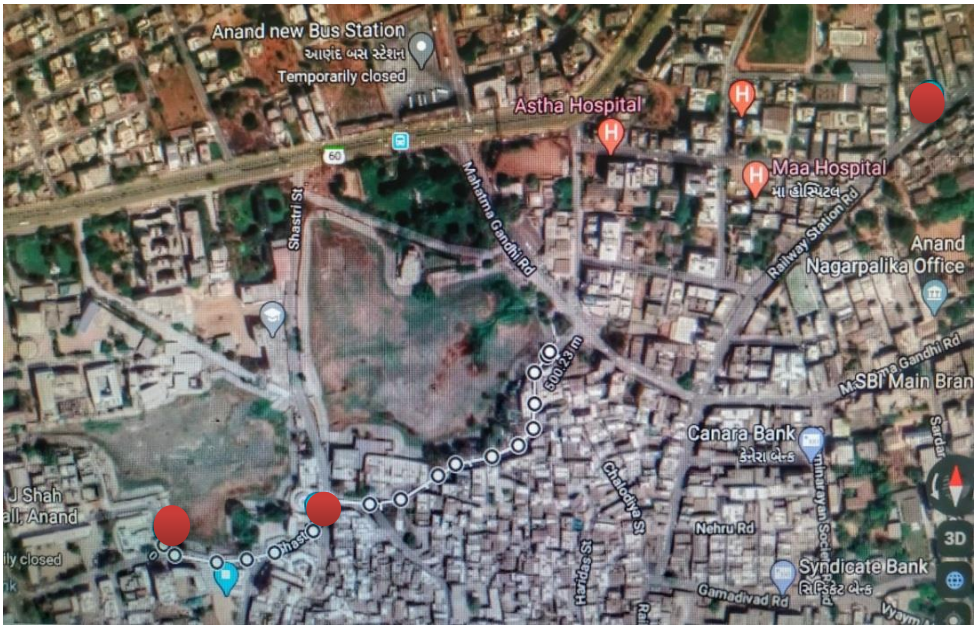

Figure 4: Map of Site C. ANAND

METHODOLOGY

The on field observation of the short-term study was carried out from December 2019 to March 2020 in the city of Anand. The density abundance of feral pigeons where assessed in and around feeding sites. Three large sites were selected around the city having different demographic plans. Out of these three sites, nine feeding spots were identified where routinely food is offered to pigeons. This spots were at minimum distance of 100m from each other. This procedure permitted selection of three representative sub-sites from each larger site. These larger sites namely, Bakrol, Vidyanagar and Anand were given the name A, B and C respectively. On each large site, the observation was carried out for a fortnight, between the morning hours of 6:30 AM and 9:30 AM and late noon between 4:00 PM and 6:00 PM. Photographic count was used as a standard method for counting birds at the foraging spots, using phone camera. Flock of pigeons was photographed arriving at the feeding spots, where the locals and passerby's provided them with artificial food. The photo is then manipulated on a computer and individual birds are marked off as they are counted. Three curved transects were also defined and measured using GOOGLE MAPS version 10.40.1 (Google Inc. 2005) as followed: 0.450 KM, 0.500 KM, and 0.500 KM on site A, B, and C respectively. The data from photographic count and transect count was statistically analyzed through a computer software PRISM 5.0.

An understanding of human relationships with wildlife is necessary for reduction of urban human-wildlife conflict. As pigeons rely much on public feeding, understanding the human-pigeon relationships is essential to limit feeding and

consequently reduce population numbers. To investigate attitudes of people towards pigeons a questionnaire was prepared containing different questions that could shed light on human-pigeon relationship.

The type of feed offered to the pigeons, the roosting and nesting sites of pigeons around the feeding sites, the birds that foraged along with the pigeons, the behavioral traits of the pigeons towards humans and vice-versa, were penned in a notepad. Behavioral activities were recorded using binocular observation on daily census during the photographic count and walking on street transects. Activities such as resting, preening, eating, nesting, roosting, drinking, sleeping, perching, and mating were also registered.

The figures given below displays the transect routes:

(The Green arrow (⟶) point at the transect routes)

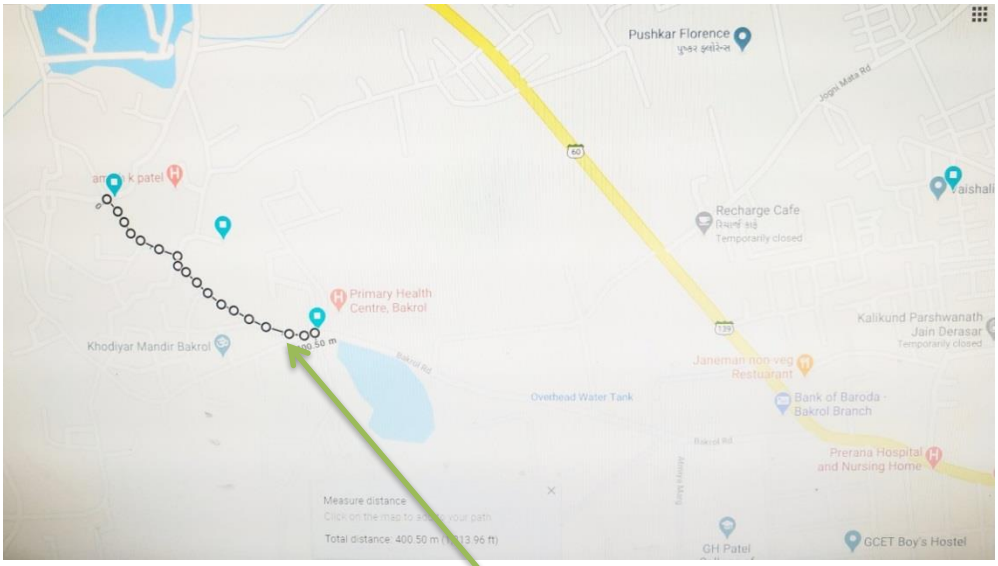

Figure 5: Map showing transect route of Site A

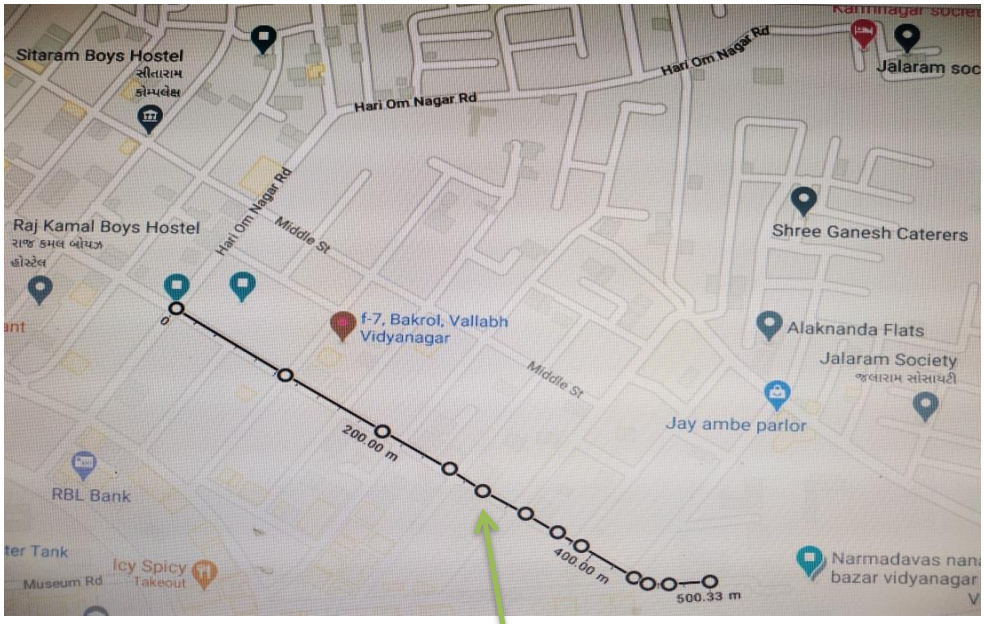

Figure 6: Map showing transect route of site B.

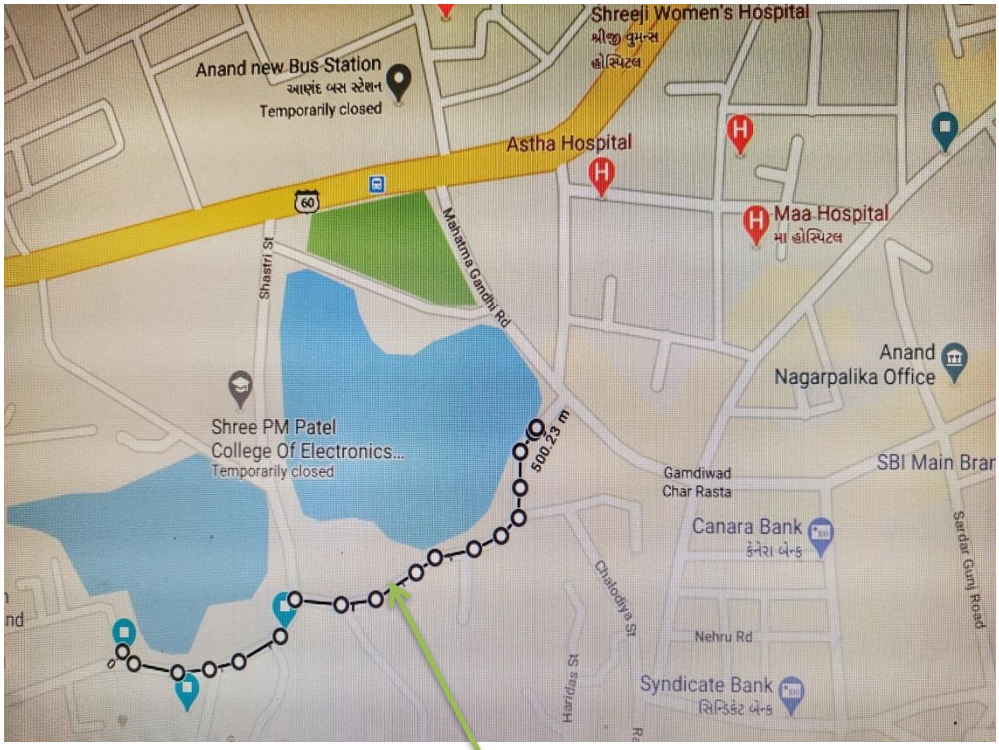

Figure 7: Map showing transect route of site C.

IV. RESULTS AND DISCUSSION…

Pigeon population at three sites of Anand

Table 2.2 – Mean pigeon population with standard error at different feeding site around Anand city.

STUDY / SITES / MONTH	A. BAKROL (MEAN/STD.ERROR)	B. VIDYANAGAR (MEAN/STD.ERROR)	C. ANAND (MEAN/STD.ERROR)
December 2019	51.20 ± 2.22	–	–
January 2020	58.44 ± 4.88	100.60 ± 7.20	–
February 2020	–	98.67 ± 17.82	87.62 ± 4.002

The mean population of the three sites suggests that a very large flock of pigeons would visit daily to the pigeon feeding spots, while a small number of individuals appear to waver to their foraging areas. A similar result was obtained in a study held in wellington, New Zealand were flocks of pigeons would visit the same feeding sites (Ryan, 2011). Statistically there was not much difference in the mean population of the pigeons feeding at different spots in Vidyanagar and Anand, a reason might the presence of temples daily visited by pigeon feeders, as well the ledges of buildings and temples providing roosting and nesting area for the pigeons.

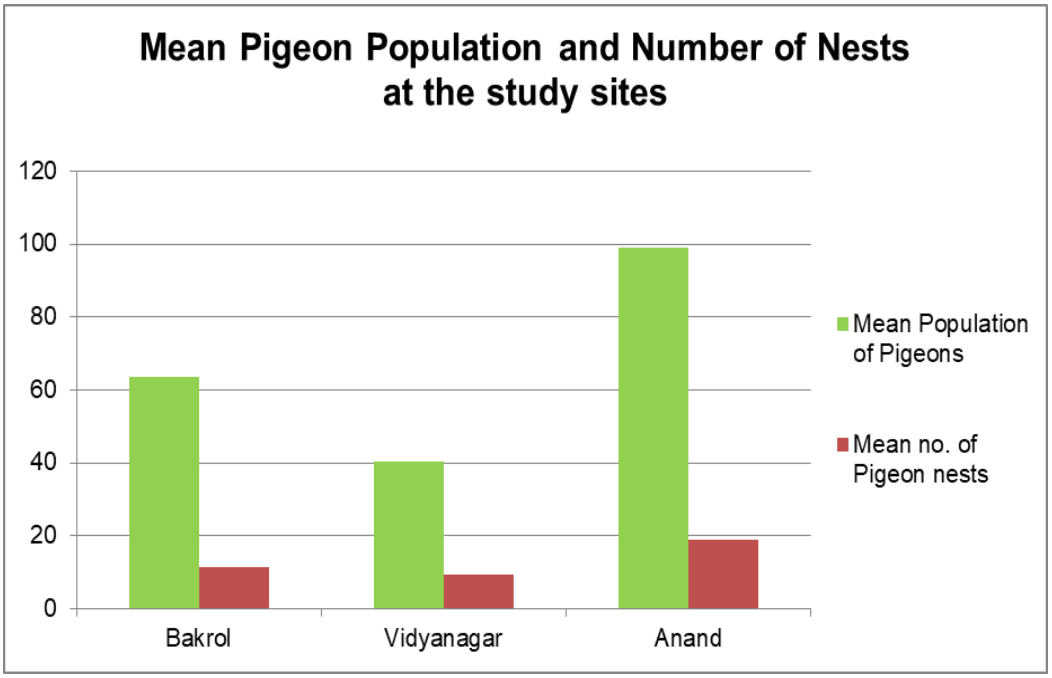

Figure 8: Mean pigeon population and the number of nests at study sites.

The transect data revealed that a number of nesting were identified at all the feeding sites during the study period. This result gives us an insight of how feral pigeons are drawn closer to areas having abundant food resources. As feral pigeons are commensals to humans they choose to be in their proximity added with enough sites such as the roof tops, window ledges and empty old constructions for their nesting (Ferman *et al.*, 2010).

Pigeon population at site A: BAKROL

Bakrol had the lowest mean pigeon population at the feeding sites when compared among the three sites, it being a semi-rural area. This correlates to a study which suggests that higher number of feeders and other supplementary food sources were recorded in urban areas than in rural areas confirming greater supplementary food available to birds in the cities (Tryjanowski *et al.*, 2015). Among the three feeding sites of Bakrol, pigeon population was more concentrated in RK central, being a hot spot for pigeon feeding and located at the center of the Bakrol site. This fact corresponds to the study that feral pigeons are concentrated mainly in central quarters or parts (Johnston & Janiga, 1995; Hetmanski *et al.*, 2011). It lured more number of pigeons as the pigeon feeders were routinely seen providing artificial feed to the pigeons.

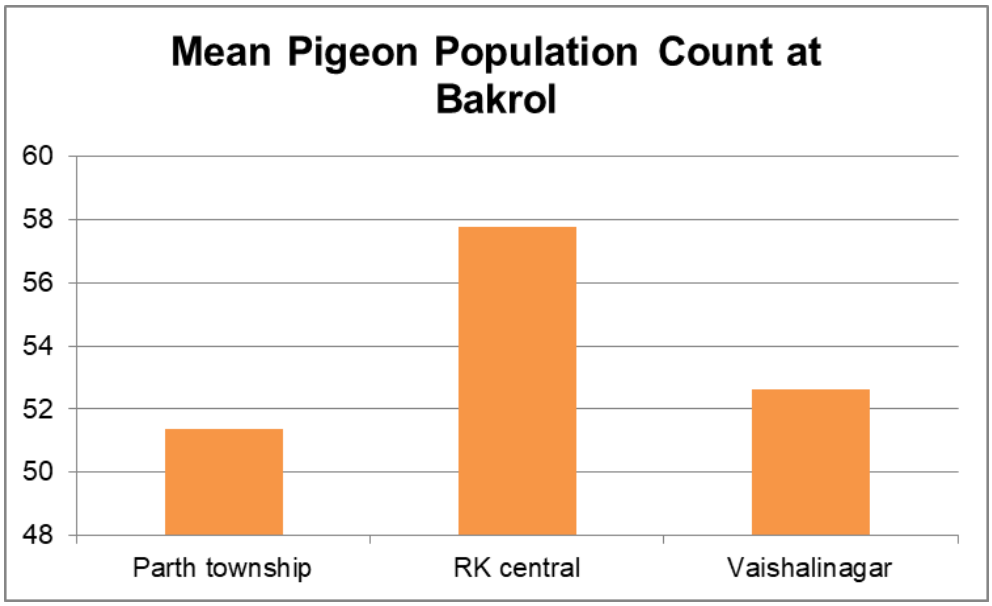

Figure 9: Mean pigeon population at site A. Bakrol

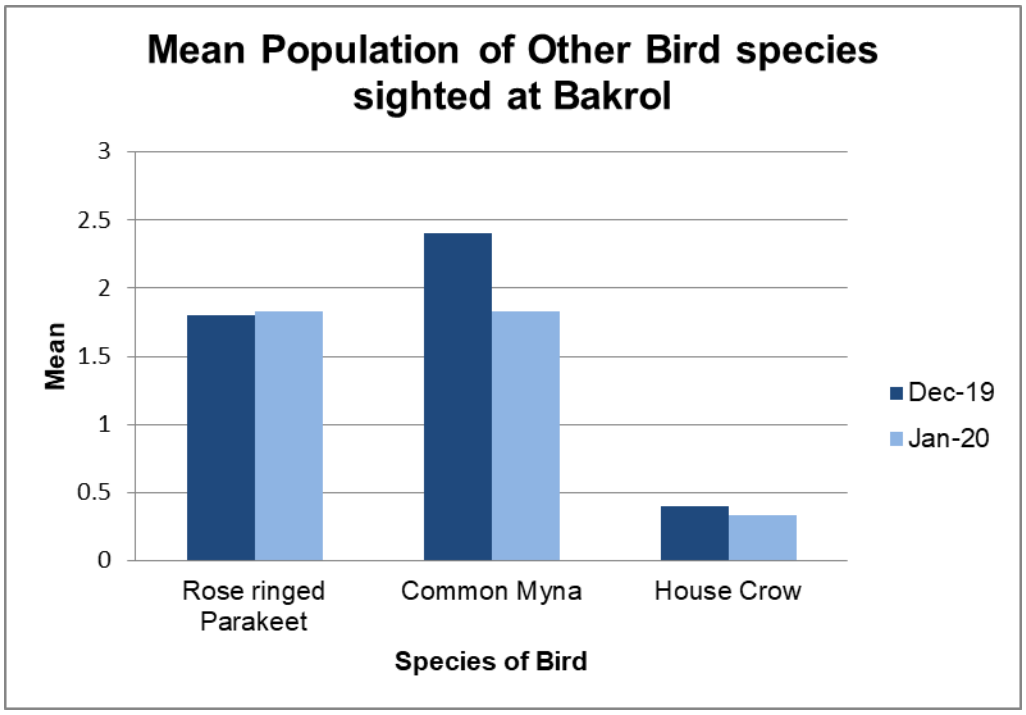

Figure 10: Mean pigeon population of other birds foraging at site A. Bakrol

Some other birds were also seen feeding along the pigeons which are shown in the graph plotted above. At no other site than Bakrol were such commensal feeding was reported. Even in Bakrol the population of other species foraging with pigeons was quite low. No substantial comparison could be concluded from it.

A. Bakrol

Figure 11: Parthtownship

Figure 12: Radhakrishna central

Figure 13: Vaishalinagar

Pigeon population at site B: Vidyanagar

The mean pigeon population was high in Vidyanagar than Bakrol. Vidyanagar being a residential area, it is more populated than Bakrol and the daily passer by feeders were accounted more here. The temple terrace saw daily pigeon feeders providing grains to the pigeon as a form of service to animals. The open ground had the maximum mean pigeon feeding population in the whole study, with on an average larger flocks visiting to the site. This was due to the fact that a high number of daily pigeon feeders provided them with the food. This result is similar to the other studies which suggest that pigeons are abundant at places having higher artificial food resources (Haag-Wackernagel, 1995; Fuller *et al.*, 2008; Ryan, 2011).

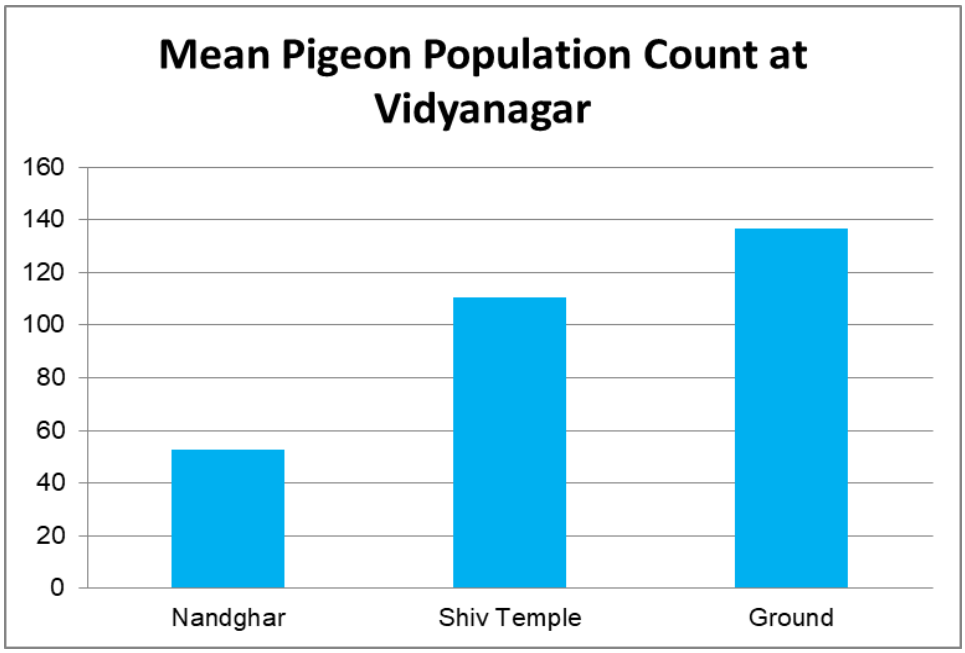

Figure 14: Mean pigeon population at site B. Vidyanagar

B. Vidyanagar

Figure 15: Nandghar

Figure 16: Ground

Figure 17: Nilkanth temple

Pigeon population at site C: Anand

The commercial space of Anand city also saw quite a high number of pigeons at feeding sites. The area studied had a number of temples nearby daily visited by several visitors, which provided them with food, some on a daily basis while some were irregular casual feeders. The flocks in this area were quiet tolerant to the traffic and didn't fear human movements. The transect count between the feeding spots suggests a higher number of nesting sites as well as high number of pigeon in this area suggesting the site loyalty of the pigeons. This correlates with various studies that pigeons are loyal to their feeding and are seen more around public places where food resources are locally abundant (Soldatini *et al.*, 2006; Ryan, 2011).

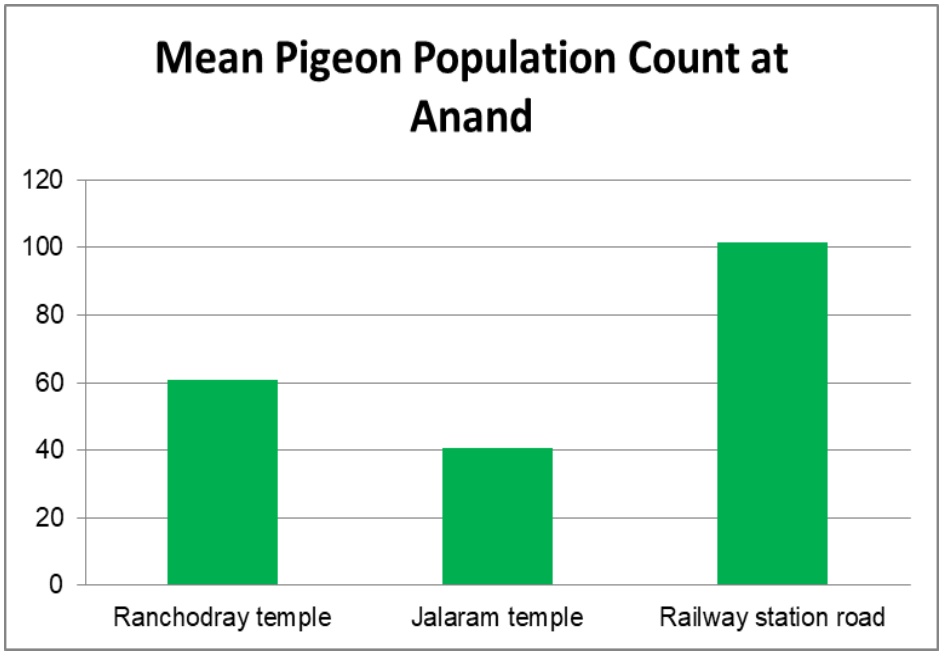

Figure 18: Mean pigeon population at site C. Anand

C. Anand

Figure 19: Ranchodray temple

Figure 20: Jalaram temple

Figure 21: Gamdivad

Human attitudes towards pigeon.

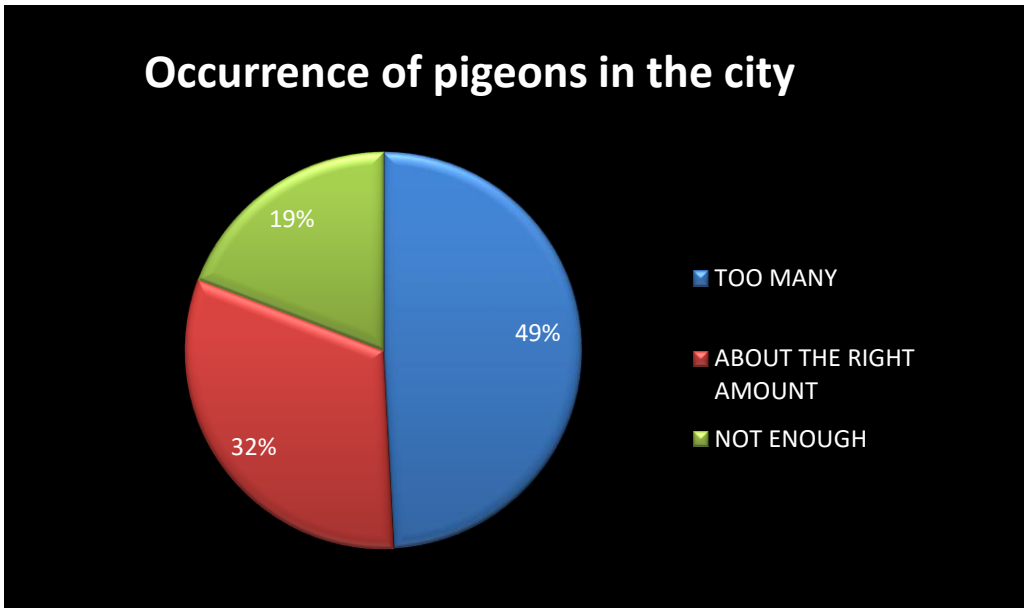

Figure 22: Occurrence of pigeon in the city according to 120 respondents'.

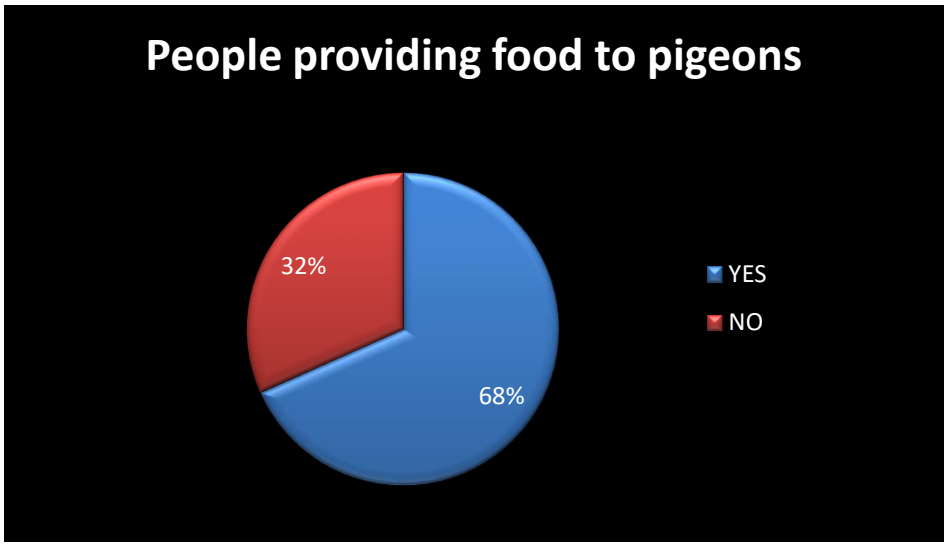

Figure 23: Percent of the people providing food to the pigeons (out of 120 people).

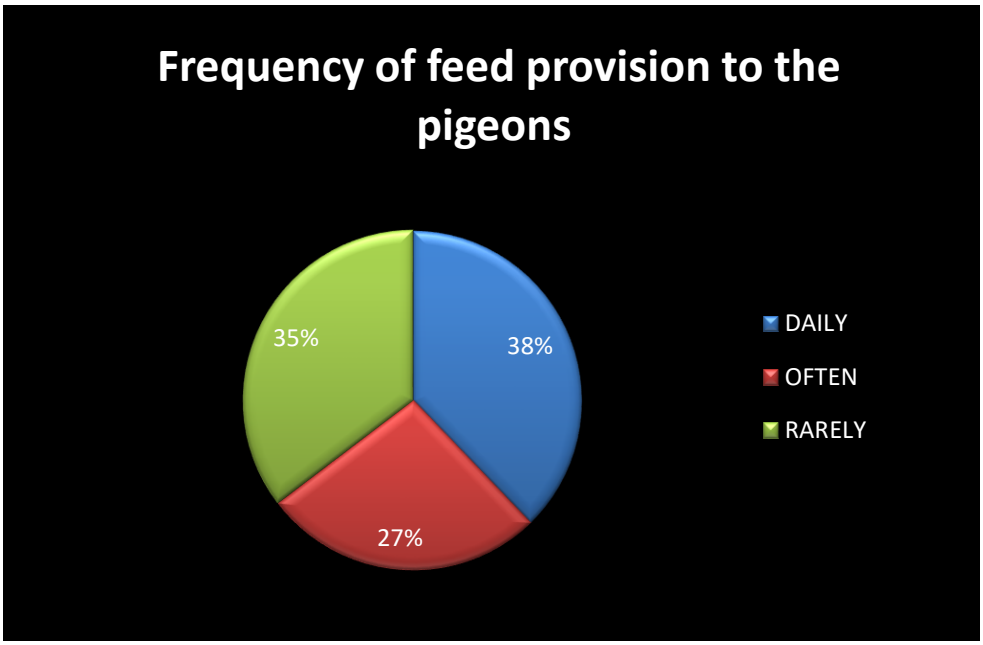

Figure 24: Frequency of feed provided by the people to the pigeons (out of 68% people providing food).

The questionnaire reveals that a large population believes that there are too many pigeons around their surroundings (Fig.24). Nonetheless about 70% of the respondents' (Fig. 24) were involved in pigeon feeding activity. Suggesting that, even a large population of pigeon did not stop people from feeding pigeon. This proves peoples positive behavior towards pigeon as a large number from those providing feed were quite consistent (Fig. 24). This is not surprising as the practice of bird feeding can be considered like any other forms of wildlife interactions, which leads to a greater appreciation of wildlife (Jones & Reynolds, 2003).

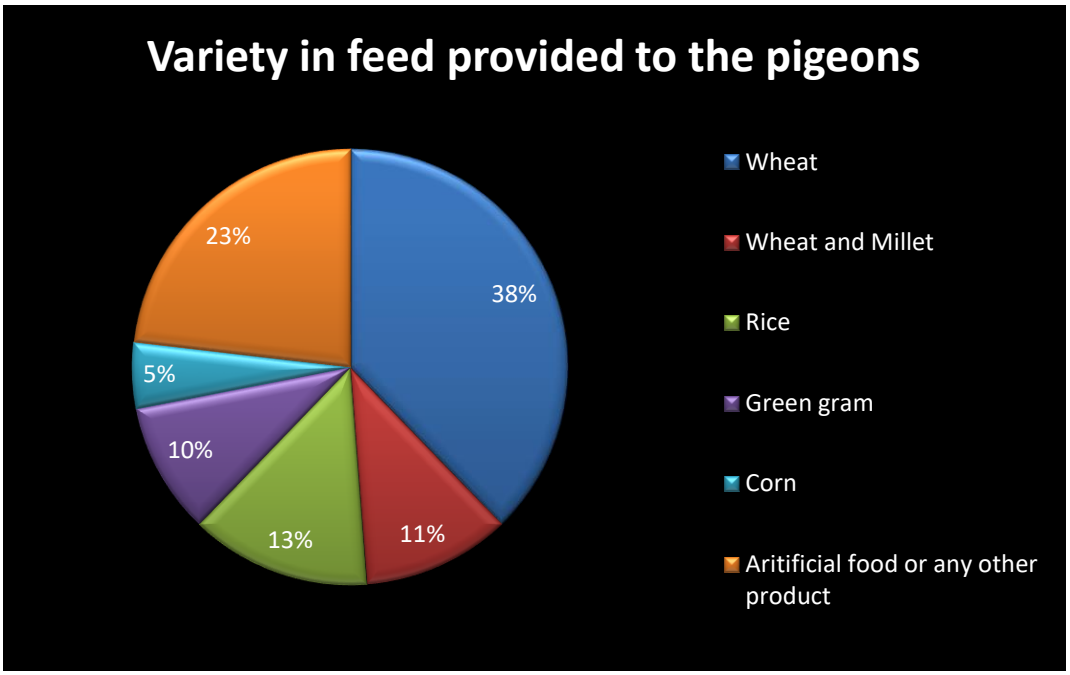

Figure 25: Different type of feed provided to the pigeons by pigeon feeders.

The chart depicts that pigeons were feed with a variety of food products consisting of grains as well as artificial food. Wheat was a primary feed for pigeons, contributing to about 38% of total food provided. While artificial food in form of domestic scraps also had a major part in pigeon's diet. Some exotic seeds likes millet and Green gram were also given to pigeons. This shows that feral pigeons are much dependent on humans for food as most of their diet contains the grains provided by people or by domestic scraps. Such dependencies on humans by feral pigeons were also noted in different studies. (Johnson & Janiga, 1995; Murton & Westwood, 1966).

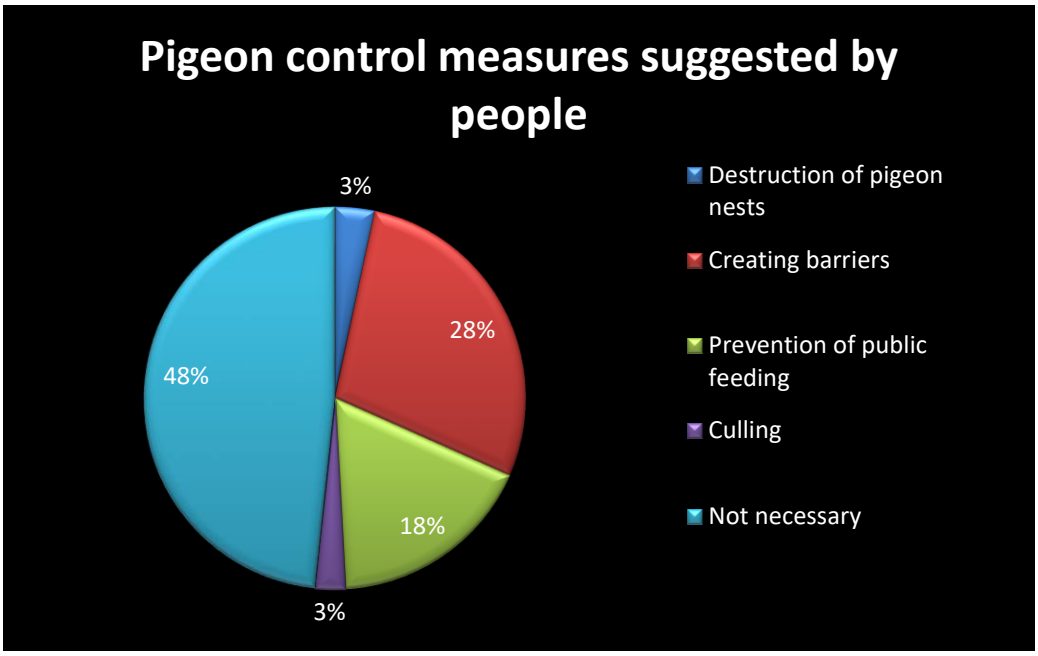

Figure 26: Pigeon control methods suggested by people (out of 120 people)

The study revealed that almost half of the respondents' were not ready to impose any control methods for pigeons. While regulation methods which were supported were of creating barriers at pigeon roosting and nesting sites, followed by prevention of public feeding. More lethal methods like culling and destruction of pigeon nests were least supported (Fig. 26). Even those who are affected due to pigeons do not agree to reduce pigeon by any lethal method (Jones & Thomas, 1998).

Attitude towards pigeon was mostly positive as found out in the study. People's attitudes towards pigeons were best explained by whether or not they fed birds and how often they interact with wildlife. People who fed birds generally were less likely to have a negative opinion of pigeons this is because interacting with wildlife through anyway can lead to greater appreciation of the animals (Ryan, 2011).

V. CONCLUSION…

While many species have been unable to adapt to urban areas, pigeons have been able to exploit the abundant food resources found in the urban environment. The species has synurbanized itself, and rely on humans for food. As seen in the present study pigeon feeding as well as the importance of regular food resources from humans play an important role in determining the population distribution. Pigeons selected for areas closer to pigeon feeder sites where people regularly feed pigeons in bulk amounts. They also select public places where food is provided in the form of casual feeders, who feed pigeons smaller amounts on an irregular basis. Further, the model also explains the distribution of pigeons is related to higher human density, as it was observed that higher numbers of pigeons are recorded in urban areas than in rural areas, corresponding to the availability of supplementary food provided in the cities. Additionally, site loyalty was a characteristic feature at all nine spots and morning visits were preferred due to increased food resources locally available. The human attitude towards pigeon in the city was mostly influenced by whether they feed pigeons or not. Most of the people showed a positive attitude towards the bird owing to the fact that bird feeding like any other form of wildlife interaction can cause a positive attitude and appreciation towards wildlife. In spite of knowing the large population of the pigeons around the city, almost half of the respondents were against any control measures and the ones which suggested any control measures, supported non-lethal technique. This shows peoples considerable tolerance and empathy towards wildlife in the city. This has created a dilemma that the pigeon population has increased due to pigeon feeding, which causes human-wildlife conflict, yet these people are against any control measures for the bird.

Through this issue of pigeon it has to be understood that the concept of nuisance species relies on complex dynamics which definitely includes ecological and behavioral characteristics of the animal (here, their abundance and foraging behavior), but also involves their interaction with socio-political processes. So the species needs to be understood more diligently as it has turned into a multidimensional nuisance. Further, long-term studies are needed for a greater degree of correlation between increasing pigeon population, its threat to other bird species and human health.

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WEB SOURCE:

Image source: www.pigeoncontrolresourcecentre.org

VII. APPENDIX…

Survey on relationship of people with feral pigeons

Questionnaire:

1. How large is the group of feral pigeons you see near your property?

A. "Between 10 to 20"

B. "Between 20 to 40"

C. "Between 40 to 60"

D. Larger than 60

Out of 120 people 58 gave the answer B (48.33%), 44 gave the answer A (36.66%), 12 gave the answer C (10%) and 6 gave the answer D (5%).

2. What is your age?

A. 10 to 20

B. 20 to 40

C. 40 to 60

D. More than 60

Out of 120 people 17 belongs to options A (14.16%), 31 belongs to option B (25.83%), 47 belongs to Option C (39.16%), while 25 belongs to option D (20.83%).

3. In your opinion, in your surroundings there are?

A. There are too many feral pigeons

B. About the right amount

C. Not enough feral pigeons

Out of 120 people 59 people gave the answer A (49.16%), while 38 gave the answer B (31.66%), while 23 gave the answer C (19.16%).

4. Do you provide food or water to the pigeons?

A. NO

B. YES

Out of 120 people 82 said YES (68.33%), while 38 said NO (31.66%)

5. Do you provide them food daily, often or rarely?

Out of 82 people 31 people provided them food daily (37.80%), while 22 people provided them food often (26.82%), and 29 people provide them food rarely (35.36%).

6. What do you provide them in food?

A. Wheat

B. Wheat and Millet

C. Rice

D. Green gram

E. Corn

F. Artificial food or any other

Out of the 82 feeders 31 people feed them with only wheat (37.80%), 9 with millet and wheat (10.97%), 11 feed them only with rice (13.41%), 8 people with green gram (9.75%), 4 people with corn (4.87%) and 19 people with artificial food or any other (23.17%).

7. Why do you provide them with food?

Out of the 82 feeders 59 people, in some way or another, tried to convince me that it was an act of helping and saving birds, as well it will provide them with god's blessing through wildlife appreciation (71.955%).

12 people felt that the bird was helpless and so it should be provided with food (14.63%).

7 people did it for self-satisfaction (8.53%).

4 people did not have any relevant answer (4.87%).

8. What measures you would suggest to control the number of feral pigeons?

A. Shooting pigeons.

B. Creating barriers near their roosting or nesting sites near public or private property.

C. Prevention of public feeding.

D. Destruction of pigeon nests on private or public property.

E. Not necessary.

Out of 120 people 58 people gave the answer E (48.33%), 34 gave the answer B (28.33%), 21 gave the answer C (17.5%), 4 people gave the answer D (3.33%), while 3 gave the answer A (2.5%).