IDENTIFICATION OF DEMOGRAPHIC STRUCTURE AND POPULATION VIABILITY ANALYSIS OF *Gazella subgutturosa* IN ŞANLIURFA

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ABSTRACT

IDENTIFICATION OF DEMOGRAPHIC STRUCTURE AND POPULATION VIABILITY ANALYSIS OF *Gazella subgutturosa* IN ŞANLIURFA

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Goitered gazelle (*Gazella subgutturosa*) is an Asian antelope species and it is classified as Vulnerable by IUCN. They have an economic, esthetic and cultural value; therefore, they had been hunted and domesticated for a long time. Additional human disturbance over years nearly led goitered gazelle populations in Turkey to extinction. Today in Turkey, only natural population of goitered gazelle lives in Şanlurfa.

In this theses, demographic structure and population parameters of natural population goitered gazelle in Şanlıurfa is studied. Line transect and regular surveys are performed to collect data about demographic structure of the population such as sex ratio and group composition. Line transect sampling, which is a distance sampling technique, is used to estimate population size and density of the population. GPS collared goitered gazelles are monitored for fecundity and survival rate.

Data is collected for 18 from July 2008 to December 2009 during 32 field surveys. Four main transect samplings have been performed and including transect samplings that are done during regular surveys, 90 line transects are walked.

Population sizes and densities were estimated to be (average ± standard error) 242 ± 184 and 2.302 ± 1.590 individual per km^2 for July 2008; 365 ± 179 and 3.476 ± 1.707 individual per km^2 for January 2009; 319 ± 111 and 3.039 ± 1.059 individual per km^2 for June 2009 and lastly, 317 ± 243 and 3.019 ± 2.315 for November 2009. Survival rate is estimated to be 0.276, 0.540 and 0.585 for calves, 1 year old and 2+ years olds respectivelty, and fecundity is estimated to be 0.4.

This preliminary study shows that according to Population Viability Analysis results, natural goitered gazelle population in Turkey will be extinct in next 10 years if more effective conservation is not performed.

Keywords: Goitered Gazelle, *Gazella subgutturosa*, population demography, line transect sampling, population viability analysis.

ÖZ

ŞANLIURFA'DAKİ *Gazella subgutturosa*'NIN DEMOGRAFİK YAPISININ VE TOPLUM YAŞAYABİLİRLİK DEĞERLERİNİN BELİRLENMESİ

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Ceylanlar Asyalı (*Gazella subgutturosa*) bir antilop türüdür ve IUCN tarafından Hassas (Vulnerable) olarak sınıflandırılmıştır. Ekonomik, estetik ve kültürel değerinden ötürü uzun süredir avlanmakta ve evcilleştirilmektedir. Yıllar boyunca artan insan etkisi, Türkiye'deki ceylan populasyonunu neredeyse yok olmaya sürüklemiştir. Günümüzde Türkiye'de, tek doğal ceylan Şanlıurfa'da yaşamaktadır.

Bu tezde, Şanlıurfa'daki doğal ceylan populasyonunun demografik yapısı ve değişkenleri çalışılmıştır. Yapılan çizgi transekt ve devamlı arazi çalışmalarıyla populasyon yapısı hakkında cinsiyet oranı ve grup içerik bilgileri toplanmıştır. Bir uzaktan örnekleme yöntemi olan çizgi transekt yöntemi, populasyon büyüklüğü ve yoğunluğunu hesaplamada kullanılmıştır. Küresel yer belirleme sistemli tasma takılmış ceylanlar yavrulama ve yaşama oranları için izlenmiştir.

Veriler Temmuz 2008 ile Aralık 2009 arasında toplam 32 arazi çalışması sırasında toplanmıştır. Çalışmada dört ana transekt örneklemesi ve devamlı arazi çalışmalarında yapılan transekt örneklemeleri dahil 90 çizgi transekt yürünmüştür. Sırasıyla populasyon büyüklüğü ve yoğunluğu Temmuz 2008 için (ortalama ± standard hata) 242 ± 184 ve kilometre karede 2.302 ± 1.590 birey; Ocak 2009 için 365 ± 179 ve kilometre karede 3.476 ± 1,707 birey; Haziran 2009 için 319 ± 243 ve kilometre karede 3,039 ± 1,059 birey; Kasım 2009 için 317 ± 243 ve kilometre karede 3.019 ± 2.315 birey olarak hesaplanmıştır. Hayatta kalma oranı yavrular, 1 yaşındakiler ve 2 ve daha fazla yaştaki bireyler için sırasıyla 0.276, 0.540 ve 0.585; doğurganlık ise 0.4 olarak hesaplanmıştır.

Bu başlangıç çalışması gösteriyor ki toplum yaşayabilirlik analiz sonuçlarına göre, doğal ceylan populasyonunun önümüzdeki 10 yıl içinde daha verimli bir koruma çalışması yapılmazsa yok olacağı tahmin edilmiştir.

Anahtar Kelimeler: Ceylan, *Gazella subgutturosa*, toplum demografisi, çizgi transekt örneklemesi, toplum yaşayabilirlik analizi.

To my dearest friend Sinan

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TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER 1

INTRODUCTION

1.1. *Gazella subgutturosa*

Gazella subgutturosa, commonly known as "Ceylan" and also known as "Kursaklı Ceylan", "Ceren", "Ahu", "Acem Güzeli", "Kara Kuyruk", "Meral" and "Gazal" in Turkish; and, "Goitered Gazelle", "Black-Tailed Gazelle", "Persian Gazelle" and "Sand Gazelle" in English, is an antelope species. *Gazella subgutturosa* is called goitered gazelle because of larynx enlargement in rutting season which resembles goiter (Clark et al, 2006). This enlargement is more conspicuous in males but is seen in both sexes (Roberts, 1977 cited in Kingswood & Blank, 1996).

1.1.1. Taxonomy

Gazella subgutturosa has 4 defined subspecies so far, which are: *Gazella subgutturosa hillieriana* (Heude 1894), *Gazella subgutturosa marica* (Thomas 1897), nominate form *Gazella subgutturosa subgutturosa* (Güldenstaedt 1780) and, *Gazella subgutturosa yarkandensis* (Blanford 1875). These subspecies closely resemble each other. Even species in genus *Gazella* are so related that Harrison & Bates (1988 cited in Kingswood & Blank, 1996) expresses, a simple key to identification of *Gazella* species according to color, horn and cranial characteristics is very hard. On the other hand, Kingswood & Blank (1996) suggests that if all characteristics are considered, a solid identification can usually be done. *Gazella subgutturosa* taxonomy can be seen in Table 1.

The synonyms of these 4 subspecies are (in alphabetic order):

Gazella subgutturosa hillieriana (Heude 1894): *Gazella. hilleriana, Gazella mongolica, Gazella reginae and Gazella sairensis.*

Gazella subgutturosa marica (Thomas 1897): None

Gazella subgutturosa subgutturosa (Güldenstaedt 1780): *Antelope dorcas* var. *persica, Antelope gutturosa, Gazella gracilicornis, Gazella persica, Gazella seistanica and Gazella subgutturosa typica.*

Gazella subgutturosa yarkandensis (Blanford 1875): None

Figure 1. An adult male and a two month old calf of *G. s. subgutturosa*.

Table 1. Taxonomy of *Gazella subgutturosa*

Domain - Eukaryota (Whittaker & Margulis, 1978)
Kingdom - Animalia (Linnaeus, 1758)
Subkingdom - Bilateria (Hatschek, 1888)
Infrakingdom - Chordonia (Haeckel, 1874)
Phylum - Chordata (Bateson, 1885)
Subphylum -Vertebrata (Cuvier, 1812)
Superclass - Tetrapoda (Goodrich, 1930)
Class - Mammalia (Linnaeus, 1758)
Subclass - Theria (Parker & Haswell, 1897)
Infraclass - Holotheria (Wible et al., 1995)
Superlegion - Trechnotheria (Mckenna, 1975)
Legion - Cladotheria (Mckenna, 1975)
Sublegion - Zatheria (Mckenna, 1975)
Infralegion - Tribosphenida (Mckenna, 1975)
Supercohort - Theria (Parker & Haswell, 1897)
Cohort - Placentalia (Owen, 1837)
Superorder - Preptotheria (Mckenna, 1975)
Grandorder - Ungulata (C. Linnaeus, 1766)
Order - Artiodactyla (Owen, 1848)
Suborder - Ruminantia (Scopoli, 1777)
Infraorder - Pecora (Flower, 1883)
Superfamily - Bovoidea (Gray, 1821)
Family - Bovidae (Gray, 1821)
Subfamily - Antilopinae (Gray, 1821)
Genus - *Gazella* (Blainville, 1816)
Subgenus - *Trachelocele* (Ellerman & Morrison-Scott, 1951)
Species - *Gazella subgutturosa* (Güldenstaedt, 1780)
Subspecies - *G. subgutturosa hillieriana* (Heude, 1894)
Subspecies - *G. subgutturosa marica* (Thomas, 1897)
Subspecies - *G. subgutturosa subgutturosa* (Güldenstaedt, 1780)
Subspecies - *G. subgutturosa yarkandensis* (Blanford, 1875)

1.1.2. General Characteristics

Goitered gazelles have medium size and light build however they are mostly larger and heavier compared to other Asian Gazella species (Kingswood & Blank, 1996). Adult males have length between 94-126 cm (Zhevnerov & Bekenov, 1983 cited in Baskin & Danell, 2003); and, weight between 20-43 kg respectively (Heptner et al., 1988 cited in Kingswood & Blank, 1996). Adult females have length and weight between 94-120 cm (Zhevnerov & Bekenov, 1983 cited in Baskin & Danell, 2003); and, 18-33 kg respectively (Heptner et al., 1988 cited in Kingswood & Blank, 1996). Adult males and females have height at shoulder between 580-790 mm and 560-765 mm respectively (Kingswood & Blank, 1996).

Adult male horn length is between 203-340 mm and shape of horn is usually lyrate. Horns are closer at the base (Kingswood & Blank, 1996). Females of *G. s. hillieriana* and *G. s. yarkandensis* are hornless; on the other hand, *G. s. subgutturosa* females are either hornless or have horns mostly less than 70 mm is mentioned in literature. On the contrary, *G. s. marica* females have horns between 71-226 mm (Allen, 1940; Groves, 1969; Groves & Harrison, 1967; Heptner et al., 1988; Lobachev & Smirin, 1970; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996; Turan, 1984). External measurements show that, generally all *Gazella subgutturosa marica* are smaller in size with an average length between 940-993 mm, male horn length between 203-312 mm horn, and average body mass of 20.2 (Groves & Harrison, 1967; Harrison & Bates, 1991 all cited in Kingswood & Blank, 1996). One month old males have horns between 10-15 mm and 6 month old males have horns about 90 mm (Heptner et al., 1988; Mowlavi, 1978; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). Zhevnerov (1984 cited in Kingswood & Blank, 1996) states that “most horn development occurs at 3-6 months and 1-1.5 years of age. In this study, it is observed that one female goitered gazelle had vestigial horns but measurement is not performed (Fig.2).

Figure 2. An adult female with vestigial horns, and her two months old calf.

Goitered gazelle horns are black in color and gnarled (Turan, 1984); and, also they are long and curved upward and backward (Kingswood & Blank, 1996).

It must be noted that measurements mentioned in Kingswood & Blank (1996) usually have fairly low sample sizes and more extensive studies can come up with different measurements.

Pelage colors vary from tile brown to dark cream (Turan, 1984). The dorsal and flanks of the body vary in coloration from rich brown to pale fawn (Nowak, 1991; Kingswood & Blank, 1996). Dorsal pelage is mainly light brown and this colors gains variety with shades of colors of gray, white, red and yellow (Baskin & Danell, 2003). Pelage color in under the neck, chest, underside, ventral pelage, inside of legs and the body part that is from hind leg to tail is white. Their forehead and back of eyes have light colors (Turan, 1984).

Geographical variation in pelage color also exists. *G. s. marica* has color from nearly white to light sandy-yellow; *G. s. subgutturosa*'s dorsal pelage is light brown with variety by colors of gray, red and yellow as mentioned above; *G. s. hillieriana* and *G. s. yarkandensis* have light sandy-yellow with less gray or red colors (Lydekker & Blaine, 1914; Sokolov, 1959; Zhevnerov & Bekenov, 1983 all cited in Kingswood & Blank, 1996; Groves, 1985).

Their tails are covered with quite long, hard and black hair (Turan, 1984). Furthermore, as Baskin & Danell (2003) indicates that tail is short and two-third of its length is tufted dorso-distally with black and dark brown hair.

Figure 3. An adult female and her two 2 months old calves.

Facial coloration and markings changes geographically and have a propensity to whiten and fade with age (Lydekker & Blaine, 1914; Sokolov, 1959; Zhevnerov & Bekenov, 1983 all cited in Kingswood & Blank, 1996; Groves, 1985). *G. s. yarkandensis* and young of *G. s. subgutturosa* have fairly distinct facial stripes; *G. s. marica*'s face is white and has less markings. Goitered gazelle's eyes are placed antero-laterally; and, they are large and black (Kingswood & Blank, 1996). Their hooves are pointed anteriorly, narrow and black in color (Kingswood & Blank, 1996).

Goitered gazelle’s pelage gets longer, dense and pale in winters compared to summers (Allen, 1940; Lydekker, 1900; Roberts, 1977 all cited in Kingswood & Blank, 1996). Summer hair is shorter and sparser, and hair is longer on belly and shorter on head (Zhevnerov & Bekenov, 1983 cited in Kingswood & Blank, 1996).

Molt occurs during spring and fall; however, molt period depends on geography, age and nutritional state. Molted areas are neck, back and flanks in fall. During spring, firstly neck and withers molt; then head, back, flanks and hindquarters; and lastly underside molt. New wool grows during the fall (Zhevnerov, 1984 cited in Kingswood & Blank, 1996).

“Goitered gazelles have 2n = 30-33 chromosomes; 20-28 metacentric and 0-5 acrocentric, with a submetacentric X and an acrocentric Y” (Effron et al., 1976; Hsu & Benirschke, 1977; Kingswood & Kumamoto, 1988; Vassart et al., 1993 all cited in Kingswood & Blank, 1996).

1.1.3. Habitat

Goitered gazelle’s habitats can be classified as Tropical Steppe, Subtropical Steppe, Tropical Desert, Subtropical Desert, and Temperate Desert (Baskin & Danell, 2003). In a detailed perspective, goitered gazelle’s habitat varies from areas having sandy and clayed soils, that these soils sustain grasses, forbs and shrubs, to basalt deserts, shale slopes and salt flats that do not support vegetation (Lay, 1967; L’vov, 1979; Sokolov, 1959; Thouless et al., 1991 all cited in Kingswood & Blank, 1996). In addition to that, Clark et al. (2006) defines goitered gazelle’s habitat as “mountain slopes and valleys in semi-desert and desert habitats” which conforms with Baskin & Danell (2003) in which it is also shown that goitered gazelles can live in mountain valleys, flat planes, and low mountains; and, furthermore they can go upwards against slope.

Turan (1984) stated that, they also do not like valley plains and riversides; however, on the contrary to this statement, it is demonstrated that they can live in seashores, shoreline of fresh water, flood plains in deserts, flat areas, sand hills, valleys and mountain foothills, also slopes, ravines, and finally plateau (Gorelov, 1972; Ishadov, 1972; Sludsky, 1977; Rustamov et al., 1986; Annenkov, 1992; Sokolov & Tembotov, 1993 all cited in Baskin & Danell, 2003). Goitered gazelles also shown to prefer areas that have gullies and ravines but avoid thick and woody vegetation and cultivation or livestock grazing areas (Neronov & Bobrov, 1991; Roberts, 1977 all cited in Kingswood & Blank, 1996). They are also adapted to live almost in every type of desert and semiarid terrain in their range (Kostin, 1955; Heptner, 1956; Reimov, 1981; Zhevnerov & Bekenov, 1983 all cited in Baskin & Danell, 2003, Heptner et al., 1988 cited in Kingswood & Blank, 1996). Goitered gazelles prefer to live in areas that are sandy and with slight roughness, low hills, and sparse trees (Turan, 1984), gullies, ravines and on hard ground with gravel and clay, and deserts consolidated with plants (Baskin & Danell, 2003). They graze at the frame of cultivated land as long as it is within their range (Blank, 1990; Lay, 1967; Misonne, 1957; Vereshchagin, 1939 all cited in Kingswood & Blank, 1996)

Goitered gazelle’s northern distribution, where snow depths reach 10-15 cm, is restricted by the difficulty of foraging; thus it is stated that their habitat is limited by snow depth that is greater than 10 cm (Baskin & Danell, 2003). Furthermore, their pelage is not adequate for protection against wind and bitter cold in northern areas (Sludsky, 1963; Zhevnerov 1975, 1984 all cited in Kingswood & Blank, 1996). In winter, they live in windy but snow-free areas if they are able to find a shelter from wind in deep wadis, valley of low mountains, or thickets (Blank, 1990 cited in Kingswood & Blank, 1996).

All these definitions are partially valid for the study area. The region is dotted with farms and animal husbandry is a common practice. Consequently gazelles can not fully avoid these areas, which mean almost everywhere, but it is observed that they avoid mountainous regions. They were also observed to prefer ravines and gullies however it should be noted that there is only one watercourse in the area which is a waste disposal stream. Thus, stream beds in the area are all dried up. After rain, few tiny ponds appear for a few hours to a few days and they seem to visit these places. Moreover, there is virtually no tree in the area and apart from handful exceptions, only trees that are found are either in settlements or in perimeters of farms; as a result, no preference or avoidance of trees observed so far.

1.1.4 Dispersal and Migration

Goitered gazelles migrate seasonally to find pasture and water (Clark et al, 2006). They are mostly nomadic and they settle in a given areas only in winter (Baskin & Danell, 2003). In summer, availability of water determines the distribution pattern (Baskin & Danell, 2003). Earlier migrations were found to be about 450-700 km. However, this distance has shortened and decreased to 50-60 km when the population size decreased (Zhevnerov & Bekenov, 1983; Blank, 1990 all cited in Baskin & Danell, 2003). Furthermore, Sludsky (1963 cited in Kingswood & Blank, 1996) states that their movements are more localized compared to early years, the movements are about in 50-60 km range now, this localization is a result of habitat changes that forces populations out of their former range. In Central Asia, goitered gazelles have been migrating between deserts in the south and northern steppes that have deep snow cover historically. This migration used to take place during autumn and spring. In summer dry period, they migrate to find water (Antipin, 1941; Heptner et al., 1988; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). However, in the study area no migration or dispersal action or pattern is observed as the area is only about 105 km^2 and surrounded by settlements, roads and very rough terrain. On the other hand, it is suspected that there may be other populations nearby, especially in westward and southward direction of the area and study period is too short to make an appropriate observation. Thus, statement of "no migration or dispersal" considering the surrounding areas may not be definitive.

1.1.5 Diet

"Goitered gazelles mostly feed on grasses, halophytes, composites, legumes, caltrops, ephedras, gourds, leadworts and tamarisks" (Blank, 1990; Harrison & Bates, 1991; Heptner et al., 1988; Mohamed et al., 1991; Mowlavi, 1978; Sludsky, 1977; Thouless et al., 1991; Zhevnerov, 1975; Zhevnerov & Bekenov, 1983 all cited in Kingswood & Blank, 1996). They eat fruits or shoots of barley, chick peas, cotton, dates, maize, melons, onions, sugar cane, and wheat in agricultural areas (Afanasyev et al., 1953; Blank, 1990; Dementyev, 1935; Heptner et al., 1988; Pitman, 1922; Vereshchagin, 1939 all cited in Kingswood & Blank, 1996). They prefer to eat plants that are rich in protein and water. There is no common diet habit, so that plants eaten in some area may not be preferred in another one (Gorelov, 1972; Heptner et al., 1988; Mohamed et al., 1991 all cited in Kingswood & Blank, 1996). They consume leaves and twigs of shrubs and prefer to eat ephemeral plants after the rains (Zhevnerov & Bekenov, 1983; Prisyazhyuk & Soldatova, 1984; Sokov, 1993 all cited in Baskin & Danell, 2003). They also consume large amount of toxic plants (Baskin & Danell, 2003).

Diet of goitered gazelles in the study region is not recorded. However it is known that they feed in agricultural area according to our observations and local people's complaints. In captivity station in the study area, they are fed with clover and grains.

An individual goitered gazelle eats about as much as 30% of its body weight per day, which amounts to almost 6.0 kg forage in a day. "Stomach contents weigh about 2.5 - 4 kg" (Heptner et al., 1988; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). A four month old female calf eats 362 g dry weight per day of forage (Mowlavi, 1978 cited in Kingswood & Blank, 1996). Goitered gazelles consume up to 30-37% of the vegetation mass in an area at a density of 24 animals per km^2 (Mardonov, 1997 cited in Kingswood & Blank, 1996). Available crop mass in an usual gazelle feeding ground is about 30-40 ton/km on the average (Kurochkina et al., 1986 cited in Baskin & Danell, 2003).

Goitered gazelle's water requirement is 3-4 liter/day (Zhevnerov & Bekenov, 1983 cited in Baskin & Danell, 2003). They live within 10-15 km of water in summer because of water need, and when water freezes they require snow. In spring, they benefit from fresh plants to meet their water requirement. Goitered gazelles drink water generally in the morning, evening and night (Prisyazhyuk, 1986 cited in Baskin & Danell, 2003). In addition, Kingswood & Blank (1996) mentioned that goitered gazelles meet their water requirement from green plants and snow for much of the year; however, they may drink surface water when available which is confirmed by Dunham (1998). Especially during spring and summer, they seek surface water. Daily water intake is nearly 2-4 liters mainly for lactating females (Heptner et al., 1988; Mowlavi, 1978; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). They are capable of using salt water up to 20 gram/liter concentration and, if the salt content is greater than this, mortality occurs among the animals, especially among the young ones (Gorelov, 1972; Sludsky, 1977 all cited in Baskin & Danell, 2003). In the study area, water sources are very limited throughout the year so they are gathered around a few artificial water sources (Durmuş, 2010). Also as it is mentioned above goitered gazelles stay around green farmlands if possible because of water need although they are adapted to arid conditions and resistant to dehydration (Kingswood & Blank, 1996; Baskin and Danell, 2003).

1.1.6. Reproduction

Goitered gazelles have two rutting seasons in spring and autumn; but mating occurs only in autumn (Tsaplyuk, 1972 cited in Baskin & Danell, 2003). Before rut, male gazelles dig in the ground and defecate there during 2-3 days, forming "rutting latrines". After that, harems including 1 male and 2-5 females are established.

However, in the study area, encountered harems had 2-17 females with an average of 5 females (n=58). The harem is kept together by dominant male. Furthermore, one or more males, females and yearlings may form mixed groups. In these mixed groups, sexual activity does not take place. Females takes apart from the group before calving, they prefer to take shelter in semi closed habitats, like shrubs and ravines, where protect females against wind. Lactation lasts for 3 months. A female gazelle produce milk about 400 g, 4% of which is fat. "Lambs can stand up after 17-25 min, suck after 45-60 min and follow the mother after 4-5 days". During the first 2 weeks, lambs hide and twins always lie 40-100 m apart. Lactation by mother occurs three times in 24 hour period (Baskin & Danell, 2003). "After 5-10 days lambs eat grass and after 3-3.5 months they eat only vegetation and can live alone" (Zhevnerov & Bekenov, 1983; Pereladova & Pereladov, 1986 all cited in Baskin & Danell, 2003**)**. In the study area, rutting season of goitered gazelles takes place in mid-October to mid-January in autumn. Moreover, calves are born in May in the area.

Sexual maturity is gained by 1 year of age for goitered gazelles. First estrus mostly emerges at 6-18 months of age; however conceiving occurs for a few precocious females at about 5 months of age (Blank, 1985; Carter, 1991; Habibi et al., 1993; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). As yearlings, males generally display sperm in the epididymis; they also can sire offspring as early as age of 10.5 months (Carter, 1991; Tsaplyuk, 1972 all cited in Kingswood & Blank, 1996). There is a direct relationship between sexual maturity in males and testicular size, the size does not definitely depend on age (Bland, 1985 cited in Kingswood & Blank, 1996). Yearlings generally do not mate with females before the age of 1.5-2.5 years; however actually they might successfully sire offspring if older males are absent (Heptner et al., 1988; Tsaplyuk, 1972 all cited in Kingswood & Blank, 1996). Goitered gazelles can stay reproductively active for almost 10 years. A calf can be sired at about 10 years and 9 months by a male, and a female can give a birth at 13 years, 10 months (Carter, 1991 cited in Kingswood & Blank, 1996).

Gestation period was recorded as 148-149 days (Frazier & Hunt, 1994; Roberts, 1977; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). “Judging from periods of mass rut and parturition, gestation lasts 5-6 months”(Heptner et al., 1988; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996).

Goitered gazelles mostly have two or three calves; it is rare to litter of three or four (Carter, 1991; Grzimek, 1972; Heptner et al., 1988 all cited in Kingswood & Blank, 1996). While young females at 3-7 years of age generally give birth to twins, older females generally produce single calves. The females that produce twins forms a overall proportion varying from 2.6% to 75% (Bannikov, 1954; Carter, 1991; Habibi et al., 1993; Heptner et al., 1988; Pitman, 1922; Rietkerk et al., 1992; Roberts, 1977; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). In the study area, no female gazelle is seen more than 2 calves after calving period. Goitered gazelle calves’ growth takes place intensively during their first month, and 50% of their growth occurs during their first 10 days (Zhevnerov, 1984 cited in Kingswood & Blank, 1996). The increase of body mass corresponding to ages is as follows:

- 5-8 kg for 4-5 weeks age
- 7-13.5 kg for 10-13 weeks age
- 16.5-20 kg for 6-8 months
- 23 kg for 12 months

Approximate adult weight is attained at 18-19 months by young (Heptner et al., 1988; Lindsay & Wood, 1992; Mowlavi, 1978; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996).“Neonates are precocious, standing and nursing at 10-15 minutes” (Blank, 1985 cited in Kingswood & Blank, 1996). Calves generally lie down for the first 4-6 days moving with their mothers and at 2 month of age with other adults (Blank, 1985; Habibi et al., 1993 all cited in Kingswood & Blank, 1996). Young gazelles imitate their mothers by sniffing at plants at 2-3 days and they start to nibble grass and leaves at 5-10 days (Blank, 1985; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). At 4-6 months, they gain ability to graze like adults and to drink water. Nursing of calves by females lasts for minimum 3-6 months (Blank, 1985; Heptner et al., 1988; Lindsay & Wood, 1992; Roberts, 1977 all cited in Kingswood & Blank, 1996). Hand-reared goitered gazelles consume milk by 300-420 ml/day at the age of 0-10 weeks, but they can be able to live on solid food at 3 weeks (Lindsay & Wood, 1992 cited in Kingswood & Blank, 1996).

1.1.7. Behavior

Goitered gazelles are gregarious animals and they generally live in small groups. However the herds they form may reach hundreds or thousands in number (Allen, 1940; Mendelssohn, 1974 all cited in Kingswood & Blank, 1996). During spring and summer, they form groups that generally contain 2 to 9 individuals or they may be solitary (Blank, 1990; Heptner et al., 1988; L'vov, 1979 all cited in Kingswood & Blank, 1996). Structure of the groups significantly changes during fall at the beginning of rut. Herds of up to 10-30 individuals are formed by females and young. Single adult males generally prefer to be solitary during rut, while sometime they may join herds; sub- adult males frequently form bachelor groups. Adult males may keep staying solitary after rut, but more frequently they join bachelor groups or herds formed by females and young, these herds may have greater than 50 individuals (Blank, 1990; Habibi et al., 1993 all cited in Kingswood & Blank, 1996). During spring, large herds tend to be divided into small male groups and also before parturition, pregnant females prefer to be solitary (Blank, 1992 cited in Kingswood & Blank, 1996).

They are polygamous. Male gazelles court females throughout year, but most intensely during rut period (Blank, 1985 cited in Kingswood & Blank, 1996). During courtship, males' necks swell and their preorbital glands are dilated and show a tarry secretion (Allen, 1940; Habibi et al., 1993 all cited in Kingswood & Blank, 1996). "Courtship displays of males include: neck stretch, nose-up posture, flehmen, foreleg kick, and erect posture" (Habibi, 1992; Walther et al., 1983 all cited in Kingswood & Blank, 1996). Courtship occurs when females are in males' territory and males may herd and chase females in order to keep females in their territory (Blank, 1985; Habibi, 1992 all cited in Kingswood & Blank, 1996). Courtship occurs if females stay in male's territory overnight, and mating occurs during the peak period -around 7-10 days- of rut. Number of females that male mate with changes from 2 to 12; number of females in a harem may reach to 30 as mentioned above. However some territorial males do not mate at all (Blank, 1985; Jamsheed, 1976 all cited in Kingswood & Blank, 1996).

"When mounting, a male stands on his hind legs; forelegs spread apart, and moves close to a female, touching her on with his pelvis. Of 185 mounts during 25 minutes, eight resulted in intromission". Male gazelles have been observed while they are orally masturbating (Blank, 1992 cited in Kingswood & Blank, 1996).

Prior to calving, females change their places from low-lying or deserts' open areas to foothills or to regions having high ground or vegetative cover (Blank, 1992; Pitman, 1922 all cited in Kingswood & Blank, 1996). After parturition, graze distance of females from their calves is between 50 - 500 m and this distance decrease as the calves gets older. Females may separate from calves by 4 – 5 km when they go to watering holes. "Dams lead their infants to new hiding places after each nursing; twins are bedded 50 – 1000 m apart during the first 4 - 6 days" (Blank, 1992 cited in Kingswood & Blank, 1996). Females carefully get closer to their young's hiding places in order to minimize the risk of detection by predators (Kingswood & Blank, 1996). While it may be observed that dams occasionally nurse young of twins together, twins generally are nursed and moved in turn (Blank, 1992 cited in Kingswood & Blank, 1996). "Until they are about 6 weeks old, calves are nursed two to four times/day at intervals of 2-6 h". Trials to nurse from other females do not become successful (Kingswood & Blank, 1996). When they are about at 2 – 2.5 month age, young begin following their mothers (Blank, 1992 cited in Kingswood & Blank, 1996). "In captivity, hand-reared females have proven to be capable mothers"(Lindsay & Wood, 1992 cited in Kingswood & Blank, 1996).

Goitered gazelles are active in feeding during late afternoon and early morning; however, they become partially nocturnal if they are intensely hunted (Launay & Launay, 1992; Roberts, 1977 all cited in Kingswood & Blank, 1996). During the morning and return in evening, at a 10 – 15 km distance, gazelles change their places from nighttime pastures to watering regions to rest regions (Blank, 1990 cited in Kingswood & Blank, 1996). They change their places leisurely, they graze continually and their resting period is once or twice in a 20- 60 minute intervals. They may prefer to stay at rest areas in case of harsh weather throughout the day (Kingswood & Blank, 1996). In order to increase foraging effectiveness, they alter pastures even if water is plentiful (Blank, 1990 cited in Kingswood & Blank, 1996). During winter, they graze during all day and relax for a short time about midday. During summer, their peaks of feeding activity are morning and evening (Heptner et al., 1988; Sludsky, 1977; Zhevnerov, 1984 all cited in Kingswood & Blank, 1996). Because of the increased time to spend their territory, territorial males' grazing time is about 50 % of their yearly average (Blank, 1990 cited in Kingswood & Blank, 1996). Time spent for foraging and rest is affected by captive animals' age, sex and social status (Launay & Launay, 1992 cited in Kingswood & Blank, 1996).

The vocalizations of goitered gazelles have been variously described as:

- Guttural grunts made by adults and young (Pitman, 1922 cited in Kingswood & Blank, 1996);
- A nasal hiss made as an alarm before taking flight (Roberts, 1977 cited in Kingswood & Blank, 1996);
- Hoarse, low-pitched calls made by females as vocal signals for their young; and low-pitched "moos" made by young (Blank, 1992 cited in Kingswood & Blank, 1996).
- A low, gurgling wheeze grunted by males constantly can be heard from 100 – 150 m during rut and courtship (Blank, 1992; Habibi, 1992 all cited in Kingswood & Blank, 1996).

Goitered gazelles can keep going at speed of almost 100 and 50 km/h, respectively for 0.8 and 16 km (Allen, 1940; Jamsheed, 1976 all cited in Kingswood & Blank, 1996). Their flight distance changes from 2 km to less than 200 m (Allen, 1940; Habibi et al., 1993; Jamsheed, 1976; Thouless et al, 1991 all cited in Kingswood & Blank, 1996). "Goitered gazelles seek shade under rock ledges and bushes on dune slopes"(Gallagher & Harrison, 1975; Stewart, 1963 all cited in Kingswood & Blank, 1996). Nevertheless, captive individuals do not show any attempt in order to find shade if they are resting during day's hottest part (Habibi, 1992; Roberts, 1977 all cited in Kingswood & Blank, 1996). While goitered gazelles prefer rest in depressions to avoid detection in open areas, resting areas are usually determined as foothills, dunes, or thickets (Blank, 1990; Jamsheed, 1976 all cited in Kingswood & Blank, 1996). Rest periods are times that grouping is more pronounced (Launay & Launay, 1992). In order to protect their territories, males mark along borders in autumn (Sludsky, 1959; Krisvossheev et al., 1969; Mambetzhumaev, 1970 all cited in Kingswood & Blank, 1996).

Goitered gazelles are very vigilant animals. They are able to recognize danger at 2 km by sight and from 300 - 400 m by hearing. They can keep their position "fixed" for 5 – 8 min. They get closer to watering places very slowly, and they sometimes shy without any obvious reason. In order to drink water they prefer open banks and frequently look around. The reactions of disturbed animals include sneezing and striking the ground with a hoof and making some kind of "signal jumps" females try to attract attention away from their newborns (Gorelov, 1972; Zhevnerov & Bekenov, 1983 all cited in Baskin & Danell, 2003).

It is mentioned in Turan (1984) that "they always move around as a herd" however depending our observations this was not the case for the study area. In the study area, where males were mostly independent of any group and except rutting periods they were mostly alone. We observed that, sometimes big herds are formed, especially in rutting periods as it is mentioned in Turan (1984).

They are diurnal and mostly active earlier in mornings and around evenings. While they are active, they graze and move around. While they are inactive they sit, groom themselves and rest. During daytime while they are not active, they try to find a shade to sit under. In the study area, nearly only available shades are rocks and hills, as trees are very rare. In summer they are less active than winter times probably because of heat (Kingswood & Blank, 1996; Baskin and Danell, 2003).

In literature, goitered gazelle life span is a bit ambiguous. Turan (1984) states that they live about 15-18 years; on the other hand, Zhevnerov & Bekenov (1983 cited in Baskin & Danell, 2003) states that lifespan is 5-6 years for males and 8-12 years for females.

1.1.8. Distribution in the World

Total number of individuals in the World is about 120.000 to 140.000. Although goitered gazelles are quite widespread in Asia, their numbers are reportedly decreasing and they may even be extinct in Afghanistan, Kyrgyzstan, Pakistan and Yemen. They are already extinct in Armenia, Georgia and Kuwait. Four subspecies can be found in Figure 4 (alphabetic order). *Gazella subgutturosa* is found in most parts of Asia (Fig. 5).

Possible subspecies found in study area are *Gazella subgutturosa marica* and *Gazella subgutturosa subgutturosa* or maybe even a hybrid as seen in some countries. Although genetic analysis of goitered gazelles regarding identification is not performed in Turkey yet, between these two subspecies and hybrid, *G. s. subgutturosa* seems more likely (as it is shown in Fig. 4); because of, generally hornless females and average body measurements which are larger than *G. s. marica*'s. This deduction is supported by distribution information in Turan (1984) and Groves (1985).

a) *Gazella subgutturosa hillieriana* (Heude 1894): China and Mongolia.

b) *Gazella subgutturosa marica* (Thomas 1897): Bahrain, Iraq, Jordan, Oman, Saudi Arabia, United Arab Emirates and Yemen.

c) *Gazella subgutturosa subgutturosa* (Güldenstaedt 1780): Afghanistan, Azerbaijan, China, Iran, Iraq, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Syria, Tajikistan, Turkey, Turkmenistan and Uzbekistan.

d) *Gazella subgutturosa yarkandensis* (Blanford 1875): China.

Figure 4. Distribution of *Gazella subgutturosa* in the World (Groves, 1985; Kingswood & Blank, 1996; Abdusalyamov, 2001; Al-Hamar and Almutai, 2001; Al-Robaae and Kingswood, 2001; Bekenov et al., 2001; Dunham et al., 2001; Gorelov, 2001; Habibi, 2001; Hemami and Groves, 2001; Insall, 2001; Jiang and Sung, 2001; Kingswood et al., 2001a; Kingswood et al., 2001b; Kiwan et al, 2001; Lhagvasuren et al., 2001; Mallon and Al-Safadi, 2001; Mallon & Kingswood, 2001; Marmazinskaya and Mardanov, 2001; Mohamed and Al Dosari, 2001; Ölçer, 2001; Samour, 2001; Shavgulidze, 2001; Shchadilov and Hadjiev, 2001; Toktosunov and Mallon, 2001; EPAA, 2003; Clark et al., 2006; Czudek, 2006)

1.1.9. Conservation of Goitered Gazelle

Throughout the World, goitered gazelles are under threat and have a general tendency of decrease in population sizes (Mallon, 2008).

1.1.9.1.Status

In IUCN, only *Gazella subgutturosa* as a species and *Gazella subgutturosa marica* as a subspecies is assessed (Mallon, 2008). In literature situation of neither *Gazella subgutturosa hillieriana* nor *Gazella subgutturosa yarkandensis* is mentioned

(Kingswood & Blank, 1996). According to IUCN Red list both *Gazella subgutturosa* and *Gazella subgutturosa marica* are classified as Vulnerable which means that species is under threat of extinction (Mallon, 2008).

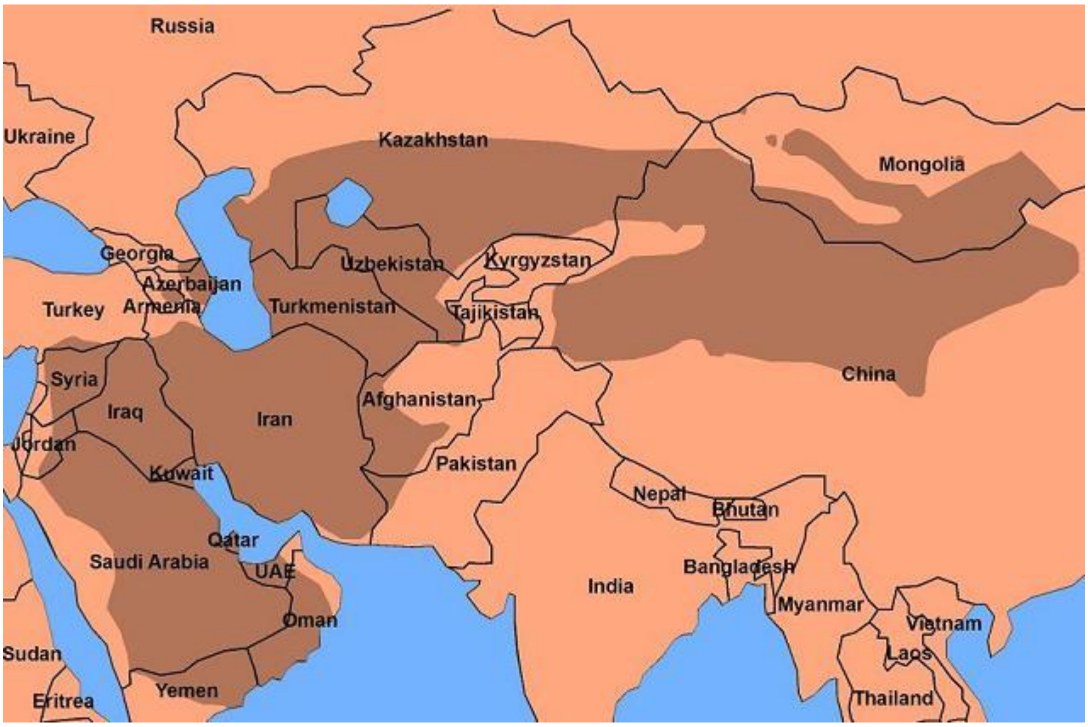

Figure 5. Distribution of *Gazella subgutturosa* in Asia.

In a more detailed fashion, *Gazella subgutturosa* is classified as A2ad which means:

- A: Reduction in population size (in this case, based on the following)
    - A2: “An observed, estimated, inferred or suspected population size reduction of $\geq 30\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible.” (in this case, based on following)
        - A2a: Direct observation
        - A2d: “Actual or potential levels of exploitation”

Again in a more detailed fashion, *Gazella subgutturosa marica* is classified as C2a(i) which means:

- C: “Population size estimated to number fewer than 10,000 mature individuals” (and in this case, based on the following)
    - C2: A continuing decline, observed, projected, or inferred, in numbers of mature individuals (and in this case, based on the following)
        - C2a(i): “no subpopulation estimated to contain more than 1000 mature individuals”

It should be noted that *Gazella subgutturosa* was assessed as Lower Risk/Near Threatened in 1996, Near Threatened in 2003 and Vulnerable in 2006 (Mallon, 2008). The trend is clear and if conservation actions are not taken, their condition will be worse.

Reasons of this decrease around the World are (Mallon & Kingswood, 2001; Clark et al, 2006)

1. Hunting [(a)]
2. Habitat loss / fragmentation [(a)]
3. Metapopulation fragmentation [(b)]
4. Inadequate protected area coverage [(a)]
5. Inefficient administration / enforcement of legislation [(a)]
6. Competition with livestock [(a)]

a: Relevant for study area

b: Deficient data for study area

Another reason may be hybridization which is encountered in many countries including United Arab Emirates, Bahrain, Iraq, Kuwait, Syria, etc. (Mallon & Kingswood, 2001). For the study area live catching is also an important factor. Once found, newborns are easy to catch and some local people look after these gazelles as pets. Another reason is pesticide usage which was used in 1950s (Turan, 1984); however, today’s situation for this issue is unknown. Furthermore, domestic dogs which are used as guards for houses and livestock herds are a serious problem for gazelles.

1.1.9.2.Conservation and Status in Turkey

The historical range of goitered gazelles in Turkey had been extended from Gaziantep to Şırnak; in addition to this region there was an isolated population in Iğdır in 1900s (Fig. 6).

Figure 6. *G. s. subgutturosa* distribution in Turkey at the beginning of 20th century (bright orange area) (Turan, 1984; Ölçer, 2001)

Figure 7. *G. s. subgutturosa* distribution in Turkey between the years 1940 - 1950 (bright orange area) (Turan, 1984; Ölçer, 2001)

Population size decreased significantly after 1950 as a result of the human based disturbances; namely, illegal hunting, habitat loss and fragmentation because of expanding agricultural activities and pesticide use, and live catching of calves in order to sell as pets which were mentioned above (Fig. 7).

Therefore, the range of gazelles was decreased to an area which extends from Şanlıurfa to Şırnak. The decrease has continued until today, and the remnant population is living only in Şanlıurfa region (Turan, 1984; Ölçer, 2001). Hunting goitered gazelles is banned since 1957; however despite all efforts of General Directorate of National Parks and Game-Wildlife of Ministry of Forestry, illegal hunting still goes on although probably in a smaller degree since population size is quite smaller than its historical values (Turan, 1984; Mallon and Kingswood, 2001; Mallon, 2008). In 1968 General Directorate of Natural Parks and Game estimated the population size about 3000 individuals. In 1977, Ceylanpınar Agriculture Enterprise is founded in Şanlıurfa due to decreased population size to 300 individuals. In 1978, 3 female, 1 male and 1 calf goitered gazelle were captured and breeding of gazelles continue ever since (Turan, 1984). In 2006, total number of goitered gazelles in the facility is reported as 1219 in which 501 individuals are female and 718 individuals are male and in 2009 it is reported that for a total of 1530 individuals reside in the facility. In 2005, reintroduction of 86 goitered gazelles to Kızılkuyu Wildlife Development Area is performed (Ölçer, 2001; TİGEM, 2009).

1.2. Distance Sampling

“Conservation biology is the biology of population decline and scarcity and is a central focus of much public concern” (Krebs, 2008). In order to understand organisms and conserve them efficiently, we must study their ecology. This study focuses on demographic structure of goitered gazelle’s population in terms of size and other certain characteristics, which are mentioned in material and methods chapter.

Counting all individuals of a particular animal group in an area is not feasible. Distance sampling is a method used to estimate density and population size (Buckland et al., 2001). Most of the studies related to populations require population parameters such as population size and density (Buckland et al., 2001). Many studies of biological populations require the estimates of population density and size. Distance sampling is utilized for estimating the abundance or density of a population. In distance sampling, observers record distances from their locations to an object of interest that is studied while traversing a line or at a stationary point (Buckland et al., 2001). In other words, distance sampling is a method for estimating the density and/or abundance of biological populations, and this method is a widely-used group of closely related methods (Thomas et al., 2002).

It is necessary to make sure that objects in the surveyed strip are uniformly distributed with respect to distance from the line. To guarantee this, the line or point should be placed randomly with respect to the local distribution of objects (Thomas et al., 2002).

1.3. Population Viability Analysis

Population viability analysis (PVA) is the frequently used method in conservation biology that estimates survival and extinction probability of a population in a given years (Beissinger, S. R., 2002). There are two approaches, deterministic and stochastic. Everything is exact in deterministic models; there is no uncertainty or variability. On the other hand, stochastic approach evaluates uncertainty and variation. Types of stochasticity used in PVA models are demographic stochasticity, genetic stochasticity, spatial and temporal stochasticity. Many scenarios can be run in PVA by changing population parameters such as survival rate and fecundity, and future of a specific species can be predicted. The input data necessary for a PVA are the stage or age structure of the population, survival and fecundity rate of age or stage classes. Leslie matrix is obtained from these data, and in order to evaluate stochasticity, standard deviation matrix is needed to be formed. The other parameters are required for modeling initial abundance and density dependence type (Akçakaya et al., 1999). Consequently, population viability analysis is very important for conservation studies, especially in re-introduction studies conservation management as it shapes action plans and forewarns the possible population crashes.

1.4. Objective of the Study

Objective of this study is to understand the demographic structure such as sex ratio, group size, group composition, and estimate population size, and population viability parameters of goitered gazelles such as fecundity, survival and growth rate in Şanlıurfa. In the future, these data can be used for more effective conservation programs and studies regarding this endangered species.

CHAPTER 2

MATERIAL AND METHODS

2.1. The Study Area

The study area, Kızılkuyu Wildlife Development Area, is located in Şanlıurfa, Southeastern Anatolia Region of Turkey. Protected area can be accessed by Gaziantep-Şanlurfa highway, approximately 15 km away from Şanlıurfa city center. Even though study base is located in protected area; study area extends its boundaries.

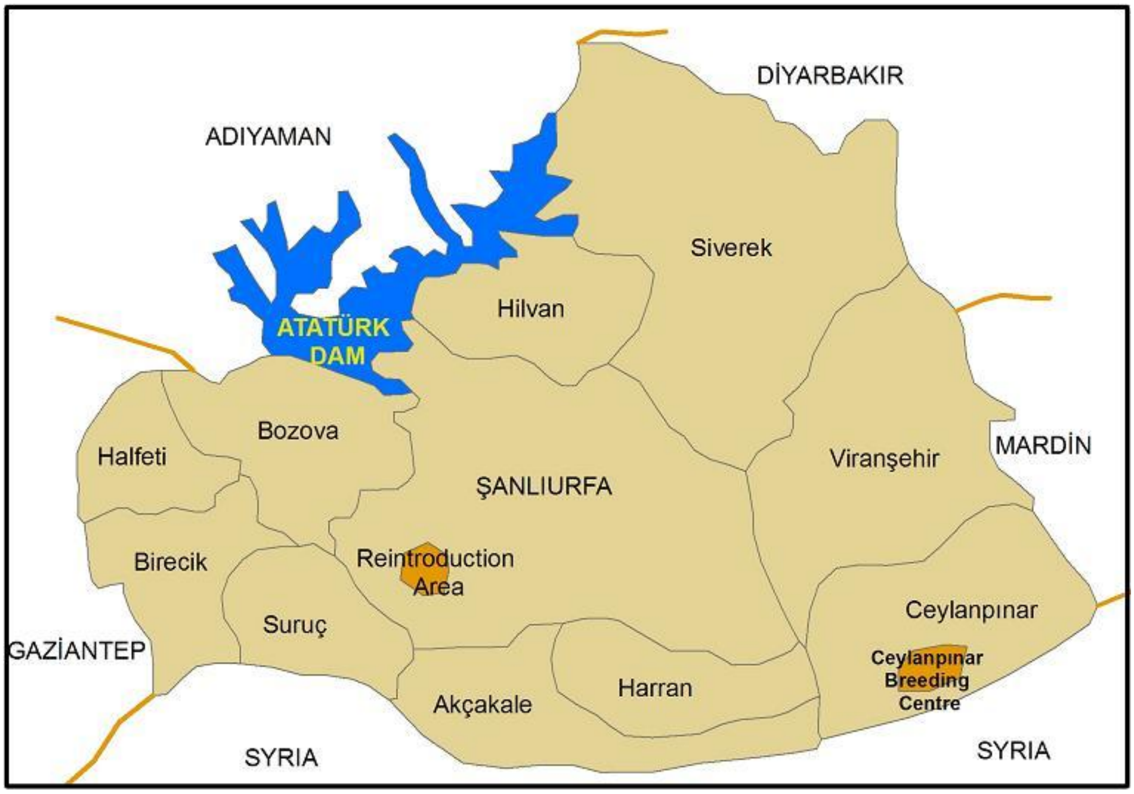

Figure 8. Location of Protected Area and Ceylanpınar Breeding Center

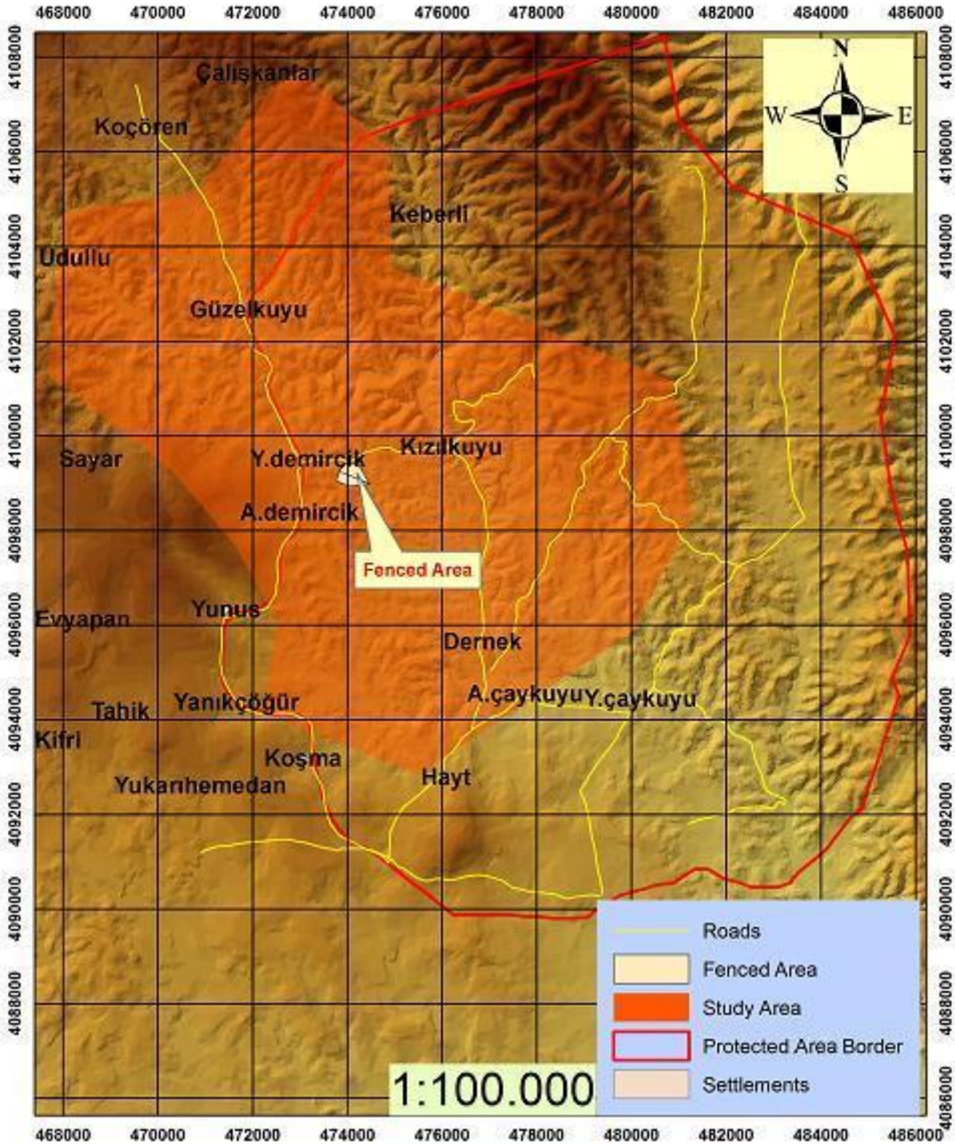

Figure 9. Digitized map of study area and protected area

The protected area has an area approximately 285 km^2 and study area is 105 km^2 (Fig. 9). The study area is different from main protected area because protected area does not cover all the habitat of goitered gazelles in the region. Moreover, protected area covers lots of unrelated area for this species. Protected area covers unsuitable high mountain ranges and farmlands. It must be noted that field surveys are done not only in study area but also in whole protected area. After intensive surveys, study area is defined according to locations of goitered gazelles. Rarely or never used areas are omitted. The study area can be called stony grassland with virtually no trees. Kızılkuyu Wildlife Development Area is stationed towards western central of the protected area and consists of a two story building and two adjacent fenced areas. First built and bigger one is 0.13 km^2 and harbors about 70 goitered gazelles at the time of November 2009. Reintroduced animals were captured from this site and its purpose is acclimatization of goitered gazelles to the environment. Second built (in July 2009) and smaller fenced area is about 0.1 km^2 and previously had an artificial water source which was used by both gazelles and livestock. After fencing, this source became no longer accessible. These two fenced areas are planned to be used for periodic grazing. At roughly same days of secondary fence building, 7 additional artificial water sources are constructed. Two of these are located outside of the protected area but only 1 of them is outside of the study area (Fig. 10).

Table 2. Means of Climate Data for Şanlıurfa from 1975 to 2008 (DMİGM, 2008)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mean[1]	5.8	6.8	10.8	16.2	22.2	28.1	31.9	31.1	26.8	20.1	12.5	7.4
Max[2]	10.1	11.8	16.5	22.3	28.6	34.5	38.7	38.2	33.9	26.8	18.2	11.7
Min[3]	2.5	2.9	6.1	10.7	15.7	20.9	24.5	23.9	20.2	14.8	8.3	4.1
Prec[4]	12.3	11.2	10.9	9.7	7.1	2.2	1.3	1.2	1.7	5.4	8.6	11.6
Prec[5]	74.9	76.1	63.6	43.1	27.5	3.7	0.8	1.0	3.3	27.4	49.5	74.2

[1] Mean Temperature (^oC)

[2] Mean of Maximum Temperature (^oC)

[3] Mean of Minimum Temperature (^oC)

[4] Mean Number of Day with Precipitation

[5] Mean Precipitation (kg/m^2)

There are also settlements and farmlands in the area. Although human population is low, every village has several herds and animal husbandry is a common practice. All habitat resources, even artificial water ponds that are build by General Directorate of Nature Conservation and National Parks, are shared by domestic animals and resource competition is high. Local people do not complain about goitered gazelles that drink water from water sources in villages; however, they are complaining about gazelles that enter agricultural lands and orchards.

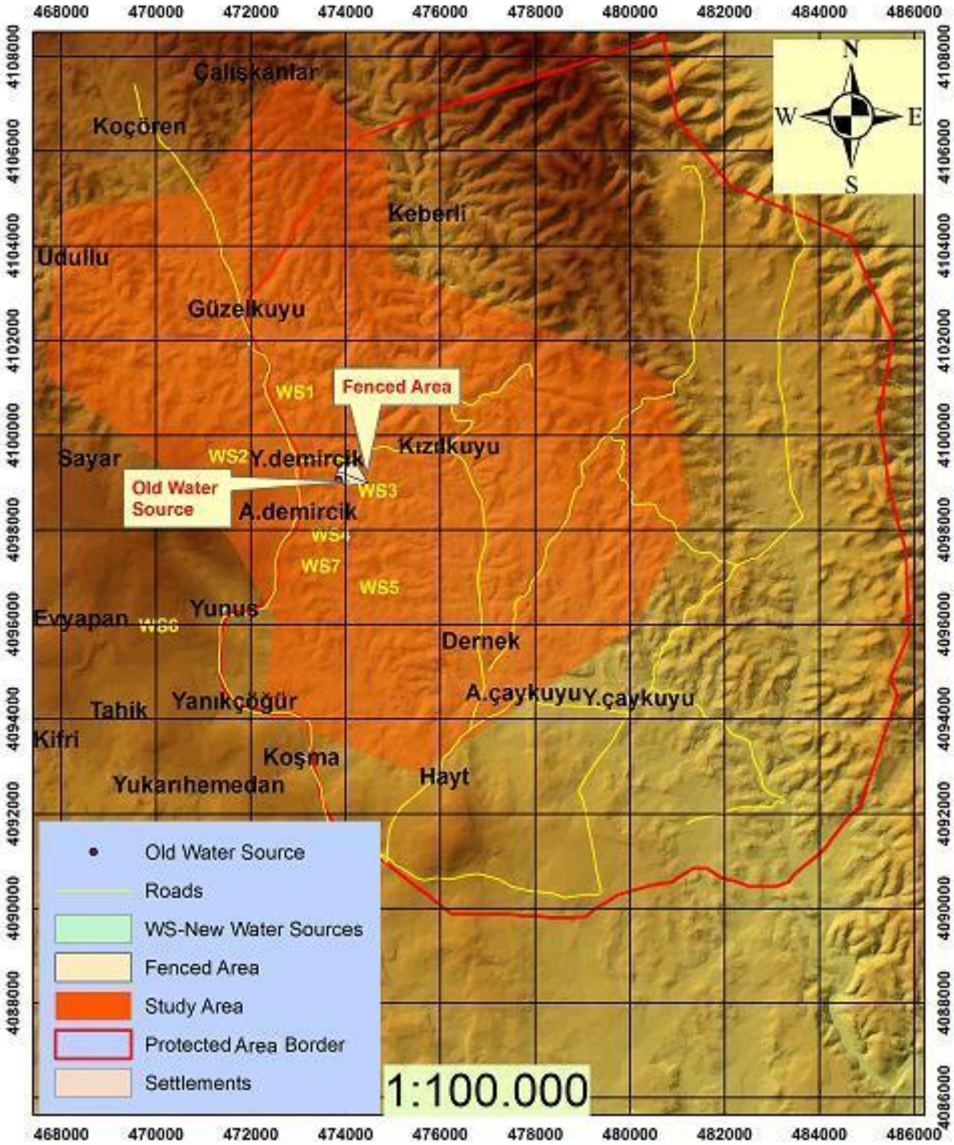

Figure 10. Digitized map of study area and protected area with recently built water sources

Apart from goitered gazelles, livestock and farm animals, red fox (*Vulpes vulpes*) and European hare (*Lepus europaeus*) is observed in the area as mammals. Some villagers and national park workers claim that there is gray wolf (*Canis lupus*) around Kızılkuyu village however no direct observation is done by observers. As birds, pin-tailed sandgrouse (*Pterocles alchata*), see-see partridge (*Ammoperdix griseogularis*), cream-colored courser (*Cursorius cursor*), rock pigeon (*Columba livia*), long-legged buzzard (*Buteo rufinus*), black kite (*Milvus migrans*), great bustard (*Otis tarda*), lesser grey shrike (*Lanius minor*), northern lapwing (*Vanellus vanellus*), Finsch's wheatear (*Oenanthe finschii*) and skylark (*Alauda arvensis*) are directly observed and in some cases photographed. As reptiles horned viper (*Vipera ammodytes*) and desert cobra (*Walterinnesia aegyptia*) are observed so far.

2.1.1. Geographical Properties

The study area has an elevation range between 479 meters to 726 meters above sea level and protected area has an elevation range between 390 meters to 805 meters above sea level (Durmuş, 2010).

Figure 11. A view from the study area

The study area consists of villages, farmlands, plains, hills and empty stream beds. Earth is thin and most of the area is rocky and sometimes bare rock. In addition to these, protected area consists of high mountain ranges and more farmlands. Southern and eastern parts of the protected area is mostly covered by farmlands and villages; whereas, northern part consists of high mountains. Field studies showed that these parts have no or a few goitered gazelles; as a result these parts are omitted from study area. On the other hand field studies showed that north-western and western region outside of the protected area border harbors goitered gazelles, so this area is included in study region.

2.1. Study Period

Table 3. Timeline of Regular Surveys

January	February	March	April	May	June
03.01.2009	05.02.2009	05.03.2009	02.04.2009	10.05.2009	18.06.2009
04.01.2009	21.02.2009	19.03.2009	16.04.2009	11.05.2009	
15.01.2009	05.03.2009	26.03.2009	23.04.2009	16.05.2009	
22.01.2009	19.03.2009			17.05.2009	
	26.03.2009				

July	August	September	October	November	December
23.07.2009	01.08.2009	17.09.2009	01.10.2009	28.11.2009	04.12.2008
	02.08.2009	18.09.2009	02.10.2009		11.12.2008
	16.08.2009		03.10.2009		12.12.2008
			04.10.2009		12.12.2008
			08.10.2009		18.12.2008
			15.10.2009		
			17.10.2009		
			18.10.2009		
			22.10.2009		

Table 4. Timeline of Transect Surveys

Summer 2008	Winter 2009	Summer 2009	Autumn 2009
23.07.2008	17.01.2009	19.06.2009	19.11.2009*
24.07.2008	18.01.2009	20.06.2009	20.11.2009
25.07.2008	23.01.2009*	21.06.2009	21.11.2009
	24.01.2009*		22.11.2009*

*These transect surveys are not taken into account in calculations

Transect surveys are done in 2 post-lambing (Summer 2008-2009), 1 pre-breeding (Autumn 2009) and post-breeding (Winter 2009) periods. In these surveys out of 20 observers whom participated, 3 observers were permanent and 2 other observers were semi-permanent. Most of the study is performed by those 5 people. In order to minimize observer differences, inexperienced observers either walked with experienced observers or trained beforehand.

2.3. Surveys

Goitered gazelles mostly occur in clusters; as a result each individual observation is represented as a group in data files and cluster in distance sampling analysis.

2.3.1. Demography

In this study, both male and female goitered gazelles are divided into 2 age categories which are:

a) Calf (0 - 1 years old)
b) Adult (1 - 1+ years old)

Reason for this simplistic approach is the difficulties of age identification.

In female case, age categories are determined by body size. Newborn females of the year have nearly same size of adult females in autumn. Therefore, these yearlings are identified by comparison of their size and other females around. It is very difficult to identify age of alone yearling female after autumn. It is observed that in

May when new calves are born, previous year's females cannot be told apart from other females; on the other hand in April they can be identified. As a result females are differentiated as female calf and adult female.

In male case, male calves grow horns in July at the latest as far as observed and become easily differentiable from yearling females in August. However, even though males in different ages have different length and shape of horns, in the field it is very difficult to understand the subtle differences. It is observed that, previous year's male is still differentiable from other males in December of second year. However in order to make this identification observer must be very experienced with animals. In addition to that, observer should have enough time to observe in a longer period. Consequently males are only differentiated into two categories, which are male calf and adult male.

Transects are done through Summer 2008 to Winter 2009, but from August to November 2008 no transect or regular survey is done. Instead GPS collars are acquired, trapping of animals for collaring and marking were done.

2.3.2. Data

During field surveys, following data and notes are taken:

1. Observer
2. Date and Time
3. GPS coordinate of the observer
4. Distance between group and observer
5. Angle of group in geographic coordinate system
6. Group number
7. Number of individuals in the group
8. Presence and absence of collar and/or marking (if present, description of it)
9. Frequency of collar
10. Signal intensity
11. Signal type

12. Sex, age, behavior and health condition of individuals
13. Habitat
14. Notable geographic structure
15. Other notes
16. Start and end points of transect (if survey is a transect survey)

For 8th data, there was 7 GPS collared, 7 identification collared individuals. There were a total of 15 ear-marked individuals.

By using 3rd, 4th and 5th data, Coordinates of the Group is calculated by using analytic geometry.

1) Angle of group according to magnetic North pole is corrected to geographic north. This is called "magnetic declination" and calculated according to NGDC website calculator (NGDC, 2008).

2) Corrected angle in geographic coordinate system is converted into trigonometric angle.

$O_x + D.\cos\alpha = G_x$ and $O_y + D.\sin\alpha = G_y$

O_{xy}=Observer X/Y G_{xy}=Group X/Y α=converted corrected angle

D=Distance between observer and group

3) In transect surveys (which is the main source of this theses), perpendicular distance of group to the transect line is needed. This is achieved by basic analytic geometry. First transect function is defined with virtual transect line's starting and finishing coordinates and its slope. First and last coordinates are shown as T_{x1} T_{y1} T_{x2} T_{y2}.

Then transect's slope (tangent) is calculated with $(T_{y2} - T_{y1}) / (T_{x2} - T_{x1}) = m$

Then again in analytic geometry formula of a line on a plain is ax+by+c=0

-a/b=m so if b=-1 a=m

c is calculated from the equation.
Last part is the distance formula which is = $|((ax)+(by)+c)| / \sqrt{(a^2+b^2)}$
If we put the values: $D_p = |((m*G_x)+(-1.G_y)+c)| / \sqrt{(a^2+1)}$
(Karakaş, 1994)

This perpendicular distance is used in distance sampling. It should be underlined that no matter where the observer makes his/her observation, it does not affect the perpendicular distance data related to transect line. Also by the help of this formula, observers can move more freely around the transect line in case of terrain difficulties.

Buckland et al. (2001) suggests using $x = r.\sin\theta$ ($x = D_p$, $r = D_{og}$, $\theta = \alpha$). However, as 4th assumption is "In accuracy in distance measurements" and the formula used is more accurate than this simplified one, complex formula which incorporates GPS data is used as it is also suggested in Buckland et al. (2004).

When opportunity arose, actual positions of animals had been taken. Data gathered from these give the most accurate perpendicular distance data. In addition, observer's accuracy had been tested by comparing actual position and estimated position data. The difference between actual position and estimated position data is found to be less than 10%. Therefore observations are seemed to be quite accurate.
For the population parameter following data are used.

1. Date and Time
2. Number of individuals in the group
3. Sex, age, behavior and health condition of individuals

2.3.3. Transect Surveys

Between July 2008 and December 2009, total number of walked transects is 90 and total length of walked transect is 579.75 km.

In transect surveys, transect lines are systematic randomly set. In these surveys, distance between transect lines were 500 to 1000 meters and transects were parallel to each other because of logistic difficulties and safety reasons. Moreover, for the sake of efficiency of these surveys, direction of the transects in transect surveys were most of the time either north-south direction with 180° with respect to "true north" or south-north direction with 0° respect to "true north". Reasons for this arrangement are, firstly less experienced observers can walk easier on these paths by the help of GPS as X coordinate is fixed and only Y coordinate is changing. Secondly, observers are less affected by Sun while walking if Sun rays do not reach the observer from front or back.

Systematic random transect starting points are decided by using random number generator of Microsoft® Excel 2002. For the sake of user friendliness and simplicity, starting x coordinate is selected with zero in last two digits. By using 1 km^2 UTM grids, study area is divided into squares. For systematic random transects, these grids are divided into 20 equal parts north to south wise and by using random number generator one of these 20 is selected. After that, transect is fitted on that abstract line and other transect lines are selected with a fixed distance between them. If possible, both starting, ending and/or meeting points are selected according to their logistic locations. In order to reach the starting and/or meeting points, most of the time observers had to walk more, sometimes up to 3 km or more. It is observed that average speed of observers is 1.5 km/h so on average the walked distance is known. Therefore transect lengths are arranged according to the total walking hours with respect to daylight duration. Animal observation during dawn and dusk is not feasible, thus maximum walking hours are calculated as "Daylight duration - 1 hour". It should be noted that the first systematic transect sampling (Summer 2008) was not optimized according to these rules, consequently this sampling was pretty harsh and made a good example for what can and cannot be done in this study area.

In regular surveys, animals with GPS collars are found with radiotelemetry. They are observed carefully for a longer period of time in order to take more detailed notes and detect subtle changes in behavior and health condition. Their calves are observed in the same fashion. When all GPS collared animals are found and made sure that their condition is recorded accordingly, observers randomly wander around or purposely walk. In Autumn 2009, in some cases small transects are performed. Start and end points of these transect (and naturally direction) is randomly set. Purpose of this was limiting the random wandering and/or observation in the excess time and again to test the observers. Moreover, these transects analyzed to see how much difference will be seen in results compared to systematic random transects. Note that only experienced observers performed these regular and minor transect surveys.

In these surveys both GPS, compass and binocular with a compass is used to walk on a straight path. Radiotelemetry equipments, namely antenna, antenna cable, radio receiver is used in regular surveys in order to find GPS collared gazelles. For communication handheld transceivers and cell phones are used when conditions are met. A notebook is used to record data that are mentioned above. A digitized map of area is used to find route and exact locations.

2.3.3.1.Line Transect

During line transect surveys, observers move along an abstract line by walking, aircraft, boat, land vehicle, etc. and record the detected objects of interest which can be animals, plants, feces and so on. According to assumptions, which are mentioned below, all objects on or near this abstract transect line should be seen but the method also allows missing of some proportion of objects of interest (Buckland et. al., 2001).

The success of distance sampling depends on the accuracy of distance. Thus, it is very important to make measurements unbiased and to minimize a potential error.

In other words, it is unrealistic to expect distance measurement to be exact (Buckland et. al., 2001).

Since visual estimation of distances is most likely subject to bias and large errors, it is the least favorable method. Thus, this method should only be used when none of other methods is practical. If this is the case, so that visual estimation of distances methods is the only available option, it is very important that observers should be trained and tested (Buckland et al., 2001).

However in this study all distance data are gathered by visual detection as no other alternative was available. As it is mentioned below, all observers who recorded distances were trained and other observers acted as helpers.

Staying on the line is not very strict rule for the observer. If moving off the line is necessary to gather more accurate data, then field methods do not put a restriction on this and moving off the line is allowed for the observer (Buckland et al., 2001).

In some cases animals cannot be recorded effectively on the first encounter. Therefore, we strayed away from the line and recorded group data with more details. Note that distance and angle data of groups are recorded when the group is first encountered.

“Generally, the detection function decreases with increasing distance” (Buckland et al., 2001). Decrease in detection rate of individuals as a function of distance from the line results in the main departure from ideal. Modeling this decay has largely been concerned by distance sampling methods, and it is termed a detection function (Buckland et al., 2001). “A useful rule of thumb at the analysis stage is to truncate around 5% of the data from the right hand tail of the detection function” (Buckland et al., 2001). Buckland explains the alternative way that is to fit a reasonable preliminary model to the data. In this alternative way, firstly detection function is computed and writing g(x) = 0.15, the value of x is found. Then, this value of x is used as the truncation point for further analysis (Buckland et al., 2001).

In this study detections are selected as strictly monotonically decreasing and truncation is performed after point x which has a detection function of g(x) <0.15. Note that every time detection model is changed, truncation points are changed accordingly.

There are four assumptions for line transect.

1 – Independence:

The distribution of animals is random and animals are distributed independently. Even if they are not distributed independently, detection of them is assumed to be independent. Also, departure from this assumption is not very problematic (Buckland et al., 2001).

If there is dependence between detection, this may create bias in estimation of animal density. Suppose density varies substantially. Compared to detected objects in areas of low density, detected objects in area of high density will be likely to have more near-neighbors. If the detection of one object will lead to detection of nearby objects to be more likely, then additional detections will have a tendency to be triggered. Therefore, the effective width of the strip in higher density areas is increased (Buckland et al. 2001).

It is assumed that a population is composed of objects that are distributed in the area. These objects of interest are sampled according to some stochastic process with rate parameter D. D is defined as expected number per unit area. Even though several places in literature mistakenly write that objects have a Poisson distribution, actually it is not necessary. More importantly, it is significant that the lines or points should be placed randomly with respect to the distribution of objects (Buckland et al., 2001). If random line placement holds, objects are safely assumed to be uniformly distributed with respect to perpendicular distance from the line. However, the study area may not be large compared to typical detection distances, or it may be very fragmented. If this is the case, there is a possibility that most of the strips that have half-width w will fall outside the study area. The proportion of strips that fall outside the study area will be likely to increase as distance from the line increases. As a result, uniform distribution of objects within the study area with respect to distance from the line will not be valid any more. In such a situation, if allowance is not made for the effect, estimation may be significantly biased. Luckily, it is possible to neglect the bias from this source for the large proportion of studies (Buckland et al., 2001). In order to reach reliable estimates of density from line transect sampling, three assumptions are critical. Buckland et al. explains the effects of partial failure of these assumptions and corresponding theoretical extensions in detail (Buckland et al., 2001).

2 – Detection on the line:

All of the animals on the line will be detected. Design of surveys should guarantee that g(0)=1. g(0) is detection on the line and if it is realized that g(0) is less than 1, some methods are used to increase it. These methods can be summarized as:

- Use more observers to cover the line
- Travel more slowly along the line
- Use only experienced observers
- Improve the training of observers and upgrade optical aids (Buckland et. al., 2001).

3 – Movement prior to detection:

Random movement of objects before detection causes positive bias in estimates of object density. If object movement is slow compared to movement of observer, this bias becomes small. Slower means less than one half of the observer speed.

Movement in response to observer is problematic. From a practical perspective, field procedures that guarantee the occurrence of most detections to be at distances, that responsive movement is unlikely to have occurred in these distances, should be developed. In another saying, before the object moves far from its initial position in response to the observer's presence, the observer should try hard to detect that object.

4 – In accuracy in distance measurements:

Bias in distance estimation should be avoided. In the case of distances are overestimated, in response to this overestimation, densities are underestimated, or visa versa. Even if it is provided that distance estimation is unbiased on average, measurement errors causes downward bias in D that does not decrease with the increase in sample size.

If survey is well designed, sample size is set adequately, and main assumptions are valid in the data collected, then data analysis becomes relatively easy. To set sample size adequately, special software is strictly necessary. In this study, Distance 5.0 and 6.0 were used. Although there are other differences between these two versions, multiple key functions testing (up to 5) and using according to AIC or other selection methods was the main reason of using 6.0 over 5.0. Since lots of tests were run on the software, this mini addition had saved great time. Moreover, test runs were done in order to see which parameters affect the results in which way. In June 2008 and January 2009 transects, survey were designed in Distance by looking at the coverage area but it should be noted that all transects were line transect, not strip transect; therefore, observers can miss animals during the sampling. This coverage based design allowed us to explore the area more systematically without missing any important geographical feature. In Distance program runs, among hundreds of combination, relatively few were selected according to Distance manual and Introduction to Distance Sampling book. All data that were used in Distance had been prepared in Microsoft® Excel.

2.3.3.2.Summer 2008

The survey was performed from 23.07.2008 to 25.07.2008. On each day, observers were at their starting points before sunrise about 4 a.m. Since conditions was harsher than expected, in the afternoon all observers had a break for 2 to 4 hours. On the first day 4 transects were walked with a total of 6 observers. Second part of the first day transects lasted until 9 p.m after sunset. On the second day 3 transects were walked with a total of 6 observers. Second part of the transects lasted until 7-8 p.m before sunset. On the third day 4 transects were walked with a total of 4 observers because of health problems of other 2. Second part of transects lasted until 7-8 p.m before sunset. 4 out of 6 observers were experienced.

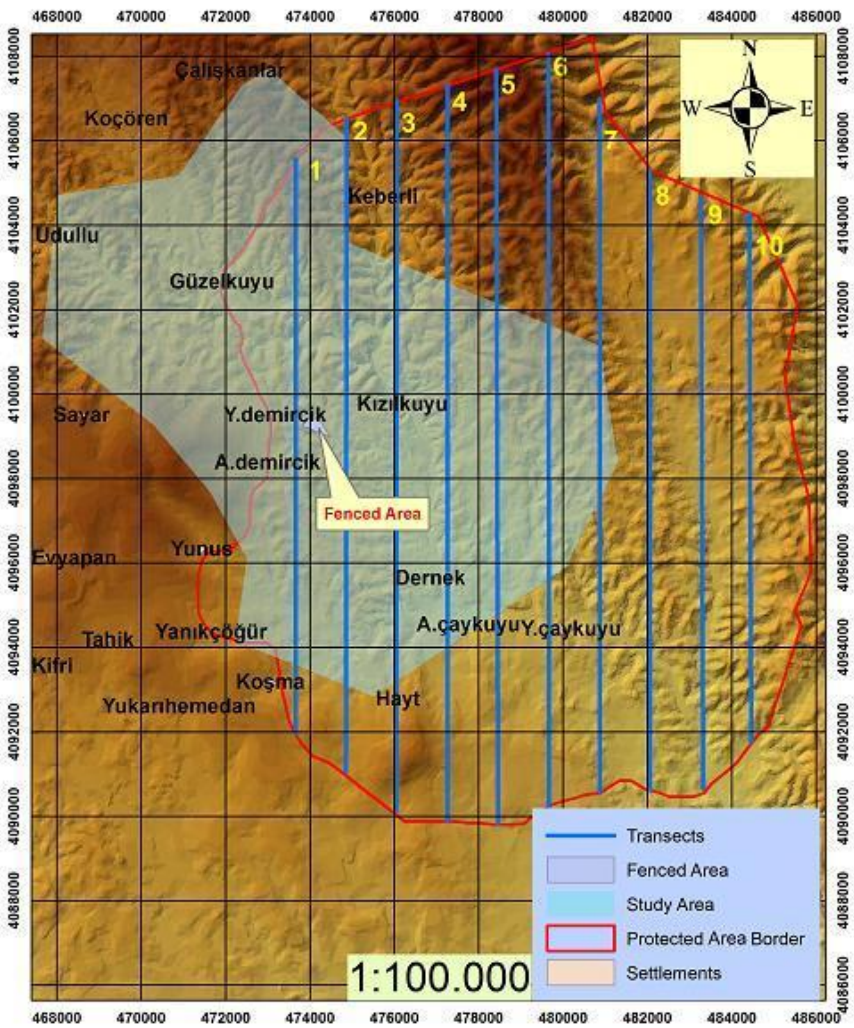

Figure 12. Transect Surveys of Summer 2008

2.3.3.3.Winter 2009

The survey was performed from 17.01.2009 to 18.01.2009 and 23.01.2009 and 24.01.2009. Last two days are not taken into account in calculations. On each day, observers were at their starting points after sunrise (approximately 6:30 a.m) and finished before sunset (approximately 16:30 p.m). On the first day 5 transects were walked with a total of 9 observers, 2 of them was experienced. On the second day 5 transects were walked with a total of 7 observers 2 of them was experienced. On the third day 2 transects were walked with 2 experienced observers. Again on the forth day 2 transects were walked with 2 experienced observers.

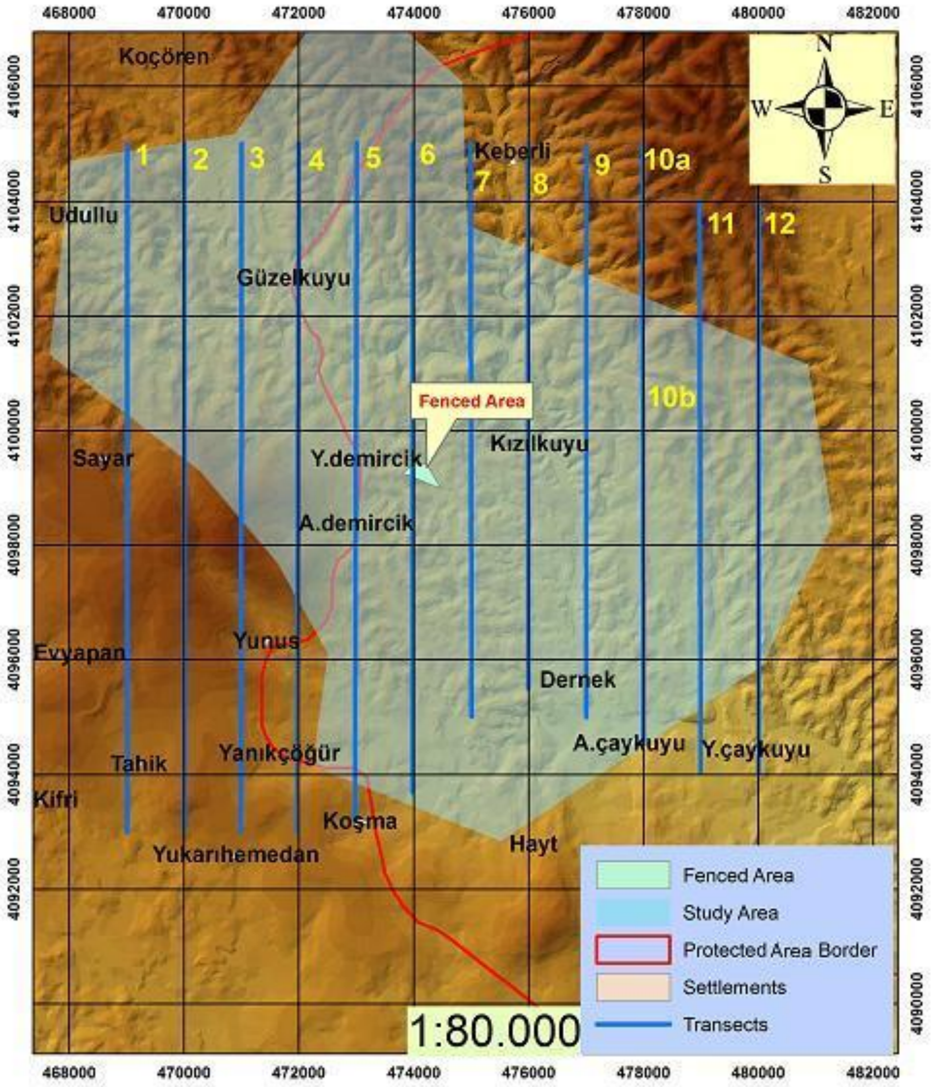

Figure 13. Transect Surveys of Winter 2009

2.3.3.4.Summer 2009

The survey was performed from 19.06.2009 to 21.06.2009. On each day, observers were at their starting points after sunrise (approximately 6:00 a.m) and finished before sunset (approximately 18:00 p.m) except third day when transects are finished before late afternoon (3:00 pm). On the first day 5 transects were walked with a total of 9 observers, 5 of them was experienced. On the second day 5 transects were walked with 5 experienced observers. On the third day 4 transects were walked with 4 experienced observers.

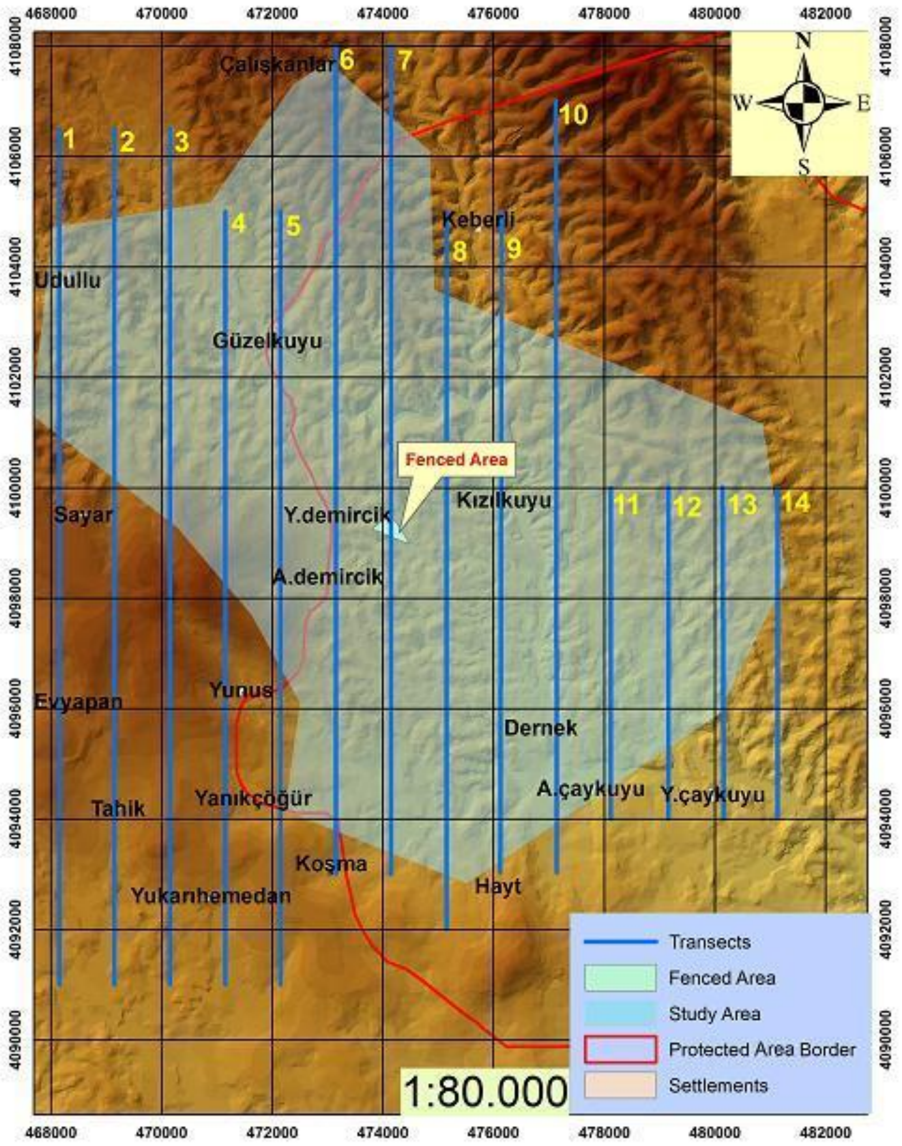

Figure 14. Transect Surveys of Summer 2009

2.3.3.5.Autumn 2009

The survey was performed from 19.11.2009 to 22.11.2009 but first and last days are not used in calculations and shown in the map. On second and third day, observers were at their starting points in the late morning (approximately 9:00 a.m) because of fog and in the morning day (approximately 7 a.m) respectively. Each day transects are finished in late afternoon (approximately 4:00 pm). On the second day 6 transects were walked by 6 observers, 3 of them was experienced. On the third day 6 transects were walked with 7 experienced observers, 3 of them was experienced. On the first and forth day transects were walked with 2 experienced observers.

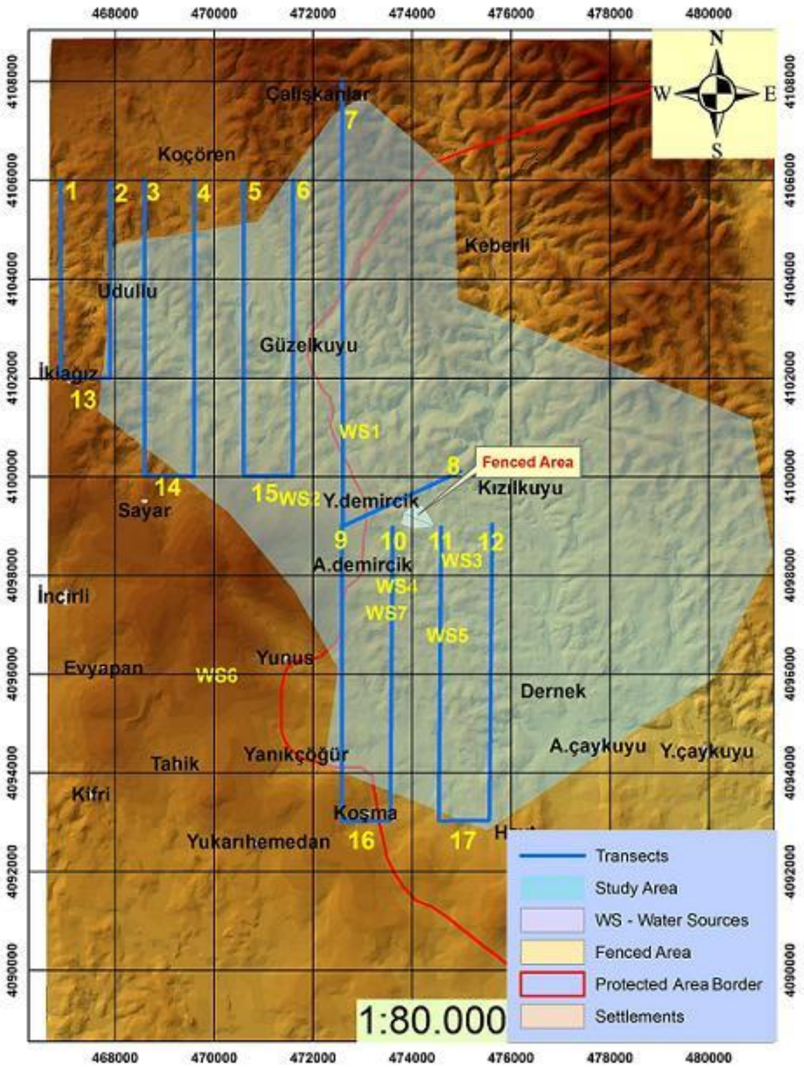

Figure 15. Transect Surveys of Autumn 2009

2.4. Population Viability Analysis

Data needed for population viability analysis of this population are initial abundance, survival, fecundity, age structure and density dependence type. Initial abundance is taken from distance analysis; survival and fecundity is taken from GPS collared animals; age structure and density dependence are based on observations. Age structure that is used is pretty simple, calves and adults for both sexes. Density dependence is selected as exponential as current density is way below density of other goitered gazelle populations and model is short termed. Moreover, carrying capacity is not calculated so scramble competition model is could not be used. For initial abundance, survival rate and fecundity only female adults and calves are taken into account. Environmental stochasticity is taken into account.

Survival rate is estimated by Mayfield method. In this method following formulas are used:

$$\overline{Sd} = \sum_{i=1}^{n} (x_i - y_i) \,/\, \sum_{i=1}^{n} x_i$$

Sd: Mean daily survival rate   i: Day

x_i: # of animals that began the i^{th} day y_i: # of animals that died on the i^{th} day

Instead of the formula above, this simplified formula can be used:

$$\overline{Sd} = (x-y) \,/\, x \qquad x = \sum_{i=1}^{n} x_i \qquad y = \sum_{i=1}^{n} y_i$$

After that mean survival rate over a period of time is calculated which can be showed as:

$Sn = (Sd)^n$ Sn: Survival over n days   n: Period of time in days

$Sn = (Sd)^n$ Sn: Survival over n days n: Period of time in days

In this study, survival rate is calculated for one year, therefore n will be 365 (Trent & Rongstad, 1974). In this survival calculation it is assumed that, survival is constant and does not change throughout the year (Heisey and Fuller, 1985; van der Toom, 1997).

Fecundity, by definition, "is the average number of offspring per individual of age x alive at a given time step censused at the next step" (Akçakaya et al., 1999). In this study, fecundity is calculated as number of live female calves per adult females after one year. However GPS collared animals have not been observed for 1 year after calving, the GPS collared animals are observed after they give birth, which is roughly 6 months. Thus fecundity value for one year is estimated according to the number of live calves the study period. It is assumed that no calf died after that point. Also this value is divided by 2 as sex ratio in birth is assumed to be same.

2.4.1. Models

Three scenarios are used to predict the possible future of goitered species in Şanlıurfa. Numbers are given arbitrarily. Note that in 2008, 9 female adult and 1 calf female is supplemented into to the wild along with 5 males.

Model 1: Close to current situation.
- No management
- Hunting: 2 females killed / year
- Live catching of calves: 2 female calves caught / year

From personal communication with national parks and local people, we know that illegal hunting and live catching still goes on since law enforcement is not effective enough and "local tradition" of live catching is very payable business. Hunting and live-catching values may not even show the minimum but at least they are not exaggeration.

Model 2: Better than current situation.

- No management
- No hunting / No live catching of calves

In this scenario National Parks prevent hunting and live-catching but does not supplement the population. Animals are relatively under less stress. This is surely better than current situation but in current conditions, this will not seem to be achieved.

Model 3: Mild Conservation Efforts

- Supplementation of population: 5 adult females / year
- No hunting / No live catching of calves

In this scenario, National Parks supplements the population with 5 adult females every year. Even the fenced acclimatization area can support that much supplementation.

Model 4: Moderate Conservation Efforts

- Supplementation of population: 10 adult females / year
- No hunting / No live catching of calves

Probably, this is one of the most realistic scenarios of current situation. National Parks supplements the population with 10 adult females every year. Ceylanpınar Breeding Center can surely support that much supplementation.

CHAPTER 3

RESULTS

3.1 Demography

All demography data are gathered in the field observations. Observational difficulties led low resolution age class differentiation and late sex differentiation. All data are recorded in small notebooks that are designed to make recording data in following section easier. All observations are done during the day and by experienced observers. Every transect survey more individual is seen and observed regardless of walked distance and number of observers. Estimated population numbers do not show clear pattern. Population seems to consist of more female individuals.

Figure 16. Mixed goitered gazelles in June.

3.1.1 Statistical analysis

Distance 6.0 is used in analysis of line transects (Laake et al., 1996; Buckland et al., 2001). As goitered gazelles occur in clusters, in order to improve stability, regressions of the cluster size on detection probability were used to evaluate the cluster size at zero distance. The key functions in Distance 6.0 are uniform, half-normal, hazard-rate, and negative exponential. By default half-normal is selected. All these functions have the same 3 series expansions which are cosine, simple polynomial and hermite polynomial. By default cosine is selected. In this study, half-normal and hazard-rate can be used as key functions and all 3 series expansions can be used. In order to select between these 6 choices (3 for half-normal, 3 for hazard-rate), The Aikake Information Criterion (AIC) was used as suggested by Buckland (2002) in order to select the most appropriate key function and other variables. Additional statistical analyses are done with Microsoft® Excel 2002 and Minitab 15.1.30.0 (2007).

3.1.2 Group Structure and Composition

Groups are classified as follows:

- Female-only: Composed of adult females and with any combination of calves.
- Male-only: Composed of adult males and with any combination of calves. However adult males with female calves have not been observed yet.
- Harem: Composed of 1 adult male and females equal or more than 2 with any combination of calves.
- Calf: Only calves with any combination (A rare sight indeed).
- Mixed: Composed of any combination of ages and sexes except the ones above.

As mentioned in 2.3.1 Data section, number of individuals in the group; sex, age, behavior and health condition of individuals are recorded. For total sex ratio, sex identified calves and adults are summed. After first calves are born, all yearlings are counted as adults. This time is considered as 15^{th} May since we are sure that calves are already started to born at this time. Consequently in summer, no calf is identified for sex since. Since sex determination is done only after male calves are clearly identified as males, which corresponds to October. In calculation of survival only females are used.

Table 5. Numbers of individuals observed in transect surveys and estimated population size and density

Transect Surveys	Summer 2008	Winter 2009	Summer 2009	Autumn 2009
# of Adult Males	20	54	52	75
# of Adult Females	12	78	78	200
# of Fawns	11	10 M / 12 F	56	11 M / 28 F
Total Observed	43	154	186	314
Estimated Population Size and Standard Error	242 ± 184	365 ± 179	319 ± 111	317 ± 243
Density (animal / km^2)	2.302 ± 1.590	3.476 ± 1.707	3.039 ± 1.059	3.019 ± 2.315

The data of "Estimated Population Size" and "Density" are obtained from line transect surveys by using DISTANCE 6.0 (Thomas et. al., 2009).

Excluding the Summer 2008 data, general trend is rather stable (Table 5, Fig. 17). In Summer 2009 minimum standard error is achieved. As Distance program uses total area or area covered for density, densities follow the same pattern as estimated population sizes Summer 2009 and Autumn 2009 transect surveys resulted in nearly same population size and density estimation. However, number and composition of goitered gazelles observed are quite different.

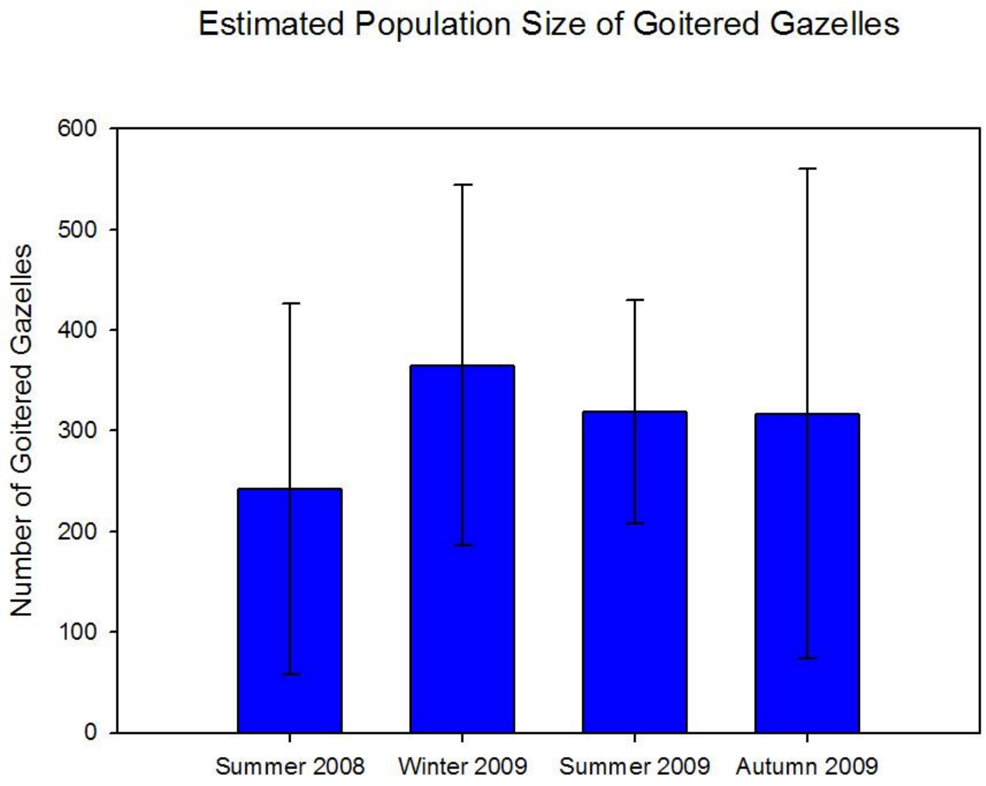

Figure 17. Estimated population size change over 1.5 years period.

Table 6. Group Structure of goitered gazelles in all surveys.

All Surveys	**Summer 2008**	**Winter 2008 - 09**	**Spring 2009**	**Summer 2009**	**Autumn 2009**	**Winter 2009**
Number of Groups Observed	18	80	35	118	177	12
Female–only Groups	22.22%	30,00%	34,29%	54,24%	35,59%	25,00%
Male-only Groups	50.00%	35,00%	20,00%	28,81%	29,94%	8,33%
Mixed Groups	11.11%	16,25%	5,71%	9,32%	16,95%	33,33%
Harem Groups	11.11%	17,50%	25,71%	5,93%	16,38%	33,33%
Calf Groups	5.56%	1,25%	14,29%	1,70%	1,13%	0,00%

Table 7. Group Structure of Goitered Gazelles in Transect Surveys.

Transect Surveys	Summer 2008	Winter 2009	Summer 2009	Autumn 2009
Number of Groups Observed	18	34	64	46
Female–only Groups	22,22%	20,59%	50,00%	19,57%
Male-only Groups	50,00%	38,24%	31,25%	21,74%
Mixed Groups	11,11%	20,59%	9,38%	30,44%
Harem Groups	11.11%	17,65%	7,81%	26,09%
Calf Groups	5.56%	2,94%	1,56%	2,17%

Group structures of goitered gazelles in all surveys and in transect surveys are showed in Table 6 and Table 7 respectively. Note that in Summer 2008, all surveys were transects surveys and its values are inserted in tables for the sake of completeness. Number of groups seen in Summer 2008 and Winter 2009 is low because observation period was pretty small since climatic conditions made surveying unsuitable. Also in Spring 2009, comparatively a low number of groups were observed. Total number of individuals observed is not significantly different from other seasons since large groups are observed. In Winter 2008 – 09 all and transect surveys show similar results. Since there are no transect surveys in Spring 2009 and Winter 2009, we cannot make a comparison. In Summer 2009 both results of all and transect surveys are consistent. On the other hand, for Autumn 2009 all and transect results, proportion of all group compositions except calf are different.

Table 8. Sex and Age Ratios of Goitered Gazelles Throughout the Study

All Surveys	Summer 2008	Winter 2008 - 09	Spring 2009	Summer 2009	Autumn 2009	Winter 2009
Total Female / Total Male	0.600	1,459	2,151	1,563	2,319	2,947
Adult Female / Adult Male	0.600	1,510	1,911	1,563	2,051	3,429
Female Calf / Male Calf	-	1,167	3,500	-	4,125	1,600
Total Calf / Adult Female	0.917	0,248	0,488	0,700	0,400	0,271
Male Calf / Adult Female	-	0,115	0,093	-	0,072	0,104
Female Calf / Adult Female	-	0,134	0,326	-	0,298	0,167

Table 9. Sex and Age Ratios of Goitered Gazelles According to Transect Surveys

Transect Surveys	Summer 2008	Winter 2009	Summer 2009	Autumn 2009
Total Female / Total Male	0.600	1,406	1,500	2,651
Adult Female / Adult Male	0.600	1,444	1,500	2,667
Female Calf / Male Calf	-	1,200	-	2,545
Total Calf / Adult Female	0.917	0,282	0,718	0,196
Male Calf / Adult Female	-	0,128	-	0,055
Female Calf / Adult Female	-	0,154	-	0,140

Sex and age ratios of goitered gazelles based on all and transect surveys are shown in Table 8 and Table 9. Ratios are pretty consistent in Winter 2008 – 2009 and Summer 2009. In Autumn 2009, female and male calf ratio changes between two tables. Excluding Summer 2008, it seems that females constitute the majority of the population both in calf, adult, and total categories.

Table 10. Female-only Group Size in All Surveys

	Summer 2008		Winter 2008 - 09		Spring 2009		Summer 2009		Autumn 2009		Winter 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	4	4	24	24	12	12	64	64	63	63	3	3
Mean	2	1	1,917	1,667	2,917	2,083	2,719	1,547	3,127	1,905	4	3
Min	1	1	1	1	1	1	1	1	1	1	1	1
Max	3	1	5	3	6	4	11	4	8	8	6	6
Std	0,816	0,000	1,018	0,816	1,856	1,202	1,821	0,853	1,519	1,353	2	2,646
SE	0,408	0,000	0,212	0,167	0,536	0,347	0,228	0,107	0,191	0,170	1,155	1,528

p = 0,065 (Female-only with (w/) calves group size between seasons) R-Sq (adj) = 2,51%

p = 0,154 (Female-only without (w/out) calves group size between seasons) R-Sq (adj) = 1,36%

Table 11. Female-only Group Size in Transect Surveys

	Summer 2008		Winter 2009		Summer 2009		Autumn 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	4	4	7	7	32	32	9	9
Mean	2	1	1,857	1,286	2,818	1,438	3,444	3,111
Min	1	1	1	1	1	1	2	1
Max	3	1	5	3	11	4	8	8
Std	0,816	0	1,464	0,756	0,833	0,759	1,810	2,028
SE	0,408	0	0,553	0,286	0,147	0,134	0,603	0,676

p = 0,327 (Female-only with (w/) calves group size between seasons) R-Sq (adj) = 1,05%

p = 0,001 (Female-only without (w/out) calves group size between seasons) R-Sq (adj) = 25,65%

Table 12. Male-only Group Size in All Surveys

	Summer 2008		Winter 2008 - 09		Spring 2009		Summer 2009		Autumn 2009		Winter 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	9	9	28	28	7	7	34	34	53	53	1	1
Mean	1,667	1,667	2,071	1,893	4,714	4,429	1,765	1,765	1,736	1,717	1	1
Min	1	1	1	1	1	1	1	1	1	1	1	1
Max	3	2	7	5	19	17	4	4	6	6	1	1
Std	0,866	0,866	1,412	1,133	6,448	5,711	0,987	0,987	1,195	1,199	-	-
SE	0,289	0,289	0,282	0,214	2,437	2,159	0,169	0,169	0,164	0,165	-	-

p = 0,001 (Male-only with (w/) calves group size between seasons) R-Sq (adj) = 10,14%

p = 0,001 (Male-only without (w/out) calves group size between seasons) R-Sq (adj) = 10,10%

Table 13. Male-only Group Size in Transect Surveys

	Summer 2008		Winter 2009		Summer 2009		Autumn 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	9	9	13	13	20	20	10	10
Mean	1,667	1,667	2,308	2,077	1,8	1,800	1,4	1,3
Min	1	1	1	1	1	1	1	1
Max	3	3	7	5	4	4	2	2
Std	0,866	0,866	1,601	1,188	1,056	1,056	0,516	0,483
SE	0,289	0,289	0,444	0,329	0,236	0,236	0,163	0,153

p = 0,271 (Male-only with (w/) calves group size between seasons) R-Sq (adj) = 1,99%

p = 0,312 (Male-only without (w/out) calves group size between seasons) R-Sq (adj) = 1,28%

Table 14. Mixed Group Size in All Surveys

	Summer 2008		Winter 2008 - 09		Spring 2009		Summer 2009		Autumn 2009		Winter 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/ou t calf	w/ calf	w/out calf
N	2	2	13	13	2	2	11	11	30	30	4	4
Mean	3,5	3	7,692	6,923	7,5	6	6,182	4,545	10,1	8,133	8,75	6,250
Min	3	2	2	2	7	5	2	2	2	2	3	2
Max	4	4	21	21	8	7	15	11	53	36	20	14
Std	0,707	1,414	4,516	4,609	0,707	1,414	4,834	3,532	11,124	8,649	7,676	5,315
SE	0,5	1	1,253	1,278	0,5	1	1,457	1,065	2,031	1,579	3,838	2,658

p = 0,487 (Mixed with (w/) calves group size between seasons) R-Sq (adj) = 0,00%

p = 0,405 (Mixed without (w/out) calves group size between seasons) R-Sq (adj) = 0,00%

Table 15. Mixed Group Size in Transect Surveys

	Summer 2008		Winter 2009		Summer 2009		Autumn 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	2	2	7	7	6	6	14	14
Mean	3,5	3	8	7,286	5,167	3,667	11,714	10,143
Min	3	2	2	2	2	2	2	2
Max	4	4	21	21	11	6	53	36
Std	0,707	1,414	6,055	6,264	3,189	1,862	14,046	10,582
SE	0,5	1	2,289	2,368	1,302	0,760	3,754	2,828

p = 0,527 (Mixed with (w/) calves group size between seasons) R-Sq (adj) = 0,00%

p = 0,367 (Mixed without (w/out) calves group size between seasons) R-Sq (adj) = 1,09%

Table 16. Harem Group Size in All Surveys

	Summer 2008		Winter 2008 - 09		Spring 2009		Summer 2009		Autumn 2009		Winter 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	2	2	14	14	9	9	7	7	29	29	4	4
Mean	5,5	3,5	6,643	5,571	9,222	7	6,714	5	7,069	5,655	6,750	6,750
Min	4	3	3	3	3	3	4	3	3	3	3	3
Max	7	4	16	12	27	18	9	9	15	15	11	11
Std	2,121	0,707	3,815	2,766	7,379	4,899	2,059	2,098	3,206	3,330	3,500	3,500
SE	1,5	0,5	1,020	0,739	2,460	1,633	0,778	0,793	0,595	0,618	1,750	1,750

p = 0,406 (Harem with (w/) calves group size between seasons) R-Sq (adj) = 0,00%

p = 0,483 (Harem without (w/out) calves group size between seasons) R-Sq (adj) = 0,00%

Table 17. Harem Group Size in Transect Surveys

	Summer 2008		Winter 2009		Summer 2009		Autumn 2009	
	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf	w/ calf	w/out calf
N	2	2	6	6	5	5	12	12
Mean	5,5	3,5	8,667	7,500	7,2	5,200	8,5	7,583
Min	4	3	4	4	5	3	4	4
Max	7	4	16	12	9	9	15	15
Std	2,121	0,707	4,457	2,950	2,049	2,280	3,729	4,209
SE	1,5	0,5	1,820	1,204	0,917	1,020	1,077	1,215

p = 0,657 (Harem with (w/) calves group size between seasons) R-Sq (adj) = 0,00%

p = 0,331 (Harem without (w/out) calves group size between seasons) R-Sq (adj) = 2,54%

Table 18. Calf Group Size in All Surveys

	Summer 2008	Winter 2008 - 09	Spring 2009	Summer 2009	Autumn 2009	Winter 2009
N	1	1	5	2	2	0
Mean	2	3	1,4	1	1,5	-
Min	2	3	1	1	1	-
Max	2	3	3	1	2	-
Std	-	-	0,894	0	0,707	-
SE	-	-	0,4	0	0,408	-

p = 0,997 (Calf group size between seasons) R-Sq (adj) = 0,00%

Table 19. Calf Group Size in Transect Surveys

	Summer 2008	Winter 2009	Summer 2009	Autumn 2009
N	1	1	1	1
Mean	2	3	0	2
Min	2	3	0	2
Max	2	3	0	2
Std	-	-	-	-
SE	-	-	-	-

p= No value (Calf group size between seasons) R-Sq (adj) = No value

Note that, in all surveys tables (Tables 10-12-14-16-18) statistical analyses are performed according to seasons regardless of the year.

Female-only, male-only, mixed, harem and calf group sizes in all surveys and transect surveys with number of groups, mean, minimum and maximum values in addition to standard deviation and standard error are shown in Tables 10 to 19.

In Table 10, it is shown that in all surveys, female groups' sizes do not differ significantly if calves excluded. Maximum values greatly change in Summer 2009 and do not change much in Autumn 2009 and Winter 2009. ANOVA results show that female-only groups' sizes do not change significantly between seasons (p=0,065 and p = 0,154).

In Table 11, it is shown that in transect surveys, female groups' sizes differ significantly if calves are excluded. Maximum values greatly change in Summer 2009 and do not change in Autumn 2009. Opposite to Table 10, ANOVA results show that female-only groups' sizes do not change significantly between seasons (p = 0,327); whereas, female-only groups' sizes excluding calves change significantly between seasons (p = 0,001).

In Table 12, it is shown that in all surveys, male groups' sizes do not differ significantly if calves are excluded. ANOVA results show that male-only groups' sizes with or without calves change significantly between seasons (p = 0,001 and p = 0,001 respectively).

In Table 13, it is shown that in transect surveys; male groups' sizes do not differ significantly if calves are excluded. ANOVA results show that male-only groups' sizes with or without calves does not change significantly between seasons (p = 0,271 and p = 0,312 respectively).

In Table 14 and 15, it is shown that in all and transect surveys, mixed groups' sizes differ significantly if calves are excluded. Maximum values greatly change in Autumn 2009 and do not change in Summer 2008 and Winter 2009. ANOVA results show that mixed groups' sizes with or without calves does not change significantly between seasons (for all surveys p = 0,487 and p = 0,405 respectively; for transect surveys p = 0,521 and p = 0,367 respectively).

In Table 16 and 17, it is shown that in all and transect surveys, harem groups' sizes differ significantly if calves are excluded except Winter 2009. Maximum values greatly change in Spring 2009 and do not change in Summer 2009, Autumn 2009 both for all and transect surveys and Winter 2009. ANOVA results show that harem groups' sizes with or without calves does not change significantly between seasons (for all surveys p = 0,406 and p = 0,483 respectively; for transect surveys p = 0,657 and p = 0,331 respectively).

Sample sizes of Calf groups are so small as can be seen in Tables 18 and 19, they are small, few and do not change in response to seasons (p = 0,997). In Table 19, sample size is so little that (3 in total) ANOVA could not be performed.

Seasonal differences do not explain changes in groups sizes of mixed, harem and calf groups (R-Sq (adj) = 0,00%). Exceptions are mixed groups without calves in transects surveys (R-Sq (adj) = 1,09%) and harem groups without calves in trasect surveys (R-Sq (adj) = 2,54%), but these values still does not explain changes greatly. Seasonal differences explain changes in groups sizes of female-only without calves in transect surveys (R-Sq (adj) = 25,65%) and male-only with and without calves (10,14% and 10,10% respectively). Other female-only, male only values and remaining harem group's R^2 adjusted values do not explain seasonal differences as much as previous three situations.

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3.2 Population Viability Analysis

7 goitered are released with GPS collars in 27th November 2008. By using body measurements of gazelles, 3 of them were identified as 2+ years old and 4 of them identified as 1-2 years old. During the study period, 3 of them died, a 1-2 years old in 19th February 2009, a 2+ years old in 13th May 2009, and a 2+ years old in 13th September 2009. By looking at stored data in GPS collars, one can understand exactly when the animal died. Remaining collars are gathered in 10th December 2009 after release mechanism was activated in the same day (Durmuş, 2010). This is used in survival estimation that is done according to Mayfield method which is mentioned in materials and methods chapter. 1-2 and 2+ age classes' survival rates are calculated separately. For 1-2 age class survival rate, animals is considered 2 years old in 15th May 2009 and same process is performed for the same period. 2 survival rates are found; survival rate of 1-2 and 2+ ages in 2008. After that, the previously one year old individuals' survival is calculated with the remaining 2+ age classed individual. All calculations are done via Microsoft® Excel 2002.

Daily survival for 1-2 years old in 2008 is calculated as 0,998310811 so survival rate for one year is $(0{,}998310811)^{365} = 0{,}5399520024$.

Daily survival for 2+ years old in 2008 is calculated as 0,998023715 so survival rate for one year is $(0{,}998023715)^{365} = 0{,}485751742$.

Daily survival for 2+ years old in 2009 is calculated as 0,998960499 so survival rate for one year is $(0{,}998960499)^{365} = 0{,}684124597$.

A mean survival rate for 2+ years old is calculated as
(0,485751742+0,684124597) / 2 = 0,5849381695

Remaining 5 GPS collared individuals were all pregnant before calving. However no individual, either GPS collared or not, was seen with her calf/calves until mid-June, which is roughly 4 weeks after calving. Thus, in calculation of survival rate of calves only included calves which their mothers are known. Therefore, we omitted unintentionally survival of first month. We know that, 2 of GPS collared animals had twins, which means a total of 4 calves. Again in estimation Mayfield is used. 2 of the calves had lived until the end of study period. 2 of them are considered dead in the midpoint of last surveys in which were seen and the first survey they were not seen. Thus, daily survival for 0-1 year old in 2009 is calculated as:
0,996478873 so survival rate for one year is $(0,996478873)^{365}$ = 0,275965536.

For fecundity, it is assumed that, the remaining 2 calves and 4 adults will not die until 15th May 2010. Also it is assumed that, birth ratios of males and females are same, thus 50%. As a result, fecundity is calculated as follows:

$$\frac{\text{2 live calves at the end of year (15}^{\text{th}}\text{ May 2010)}}{\text{5 adults those were alive when calves are born}} = 0{,}400$$

0,400 x 0,500 (birth sex ratio) = 0,200 (fecundity)

Fecundity value is used for all groups of adults.

Table 20. Leslie Matrix of Goitered Gazelle in Şanlıurfa

Leslie Matrix	0-1 years old	1-2 years old	2+ years old
0-1 years old	0	0,400	0,400
1-2 years old	0,276	0	0
2+ years old	0	0,540	0,585

3.2.1 Models

PVA is a useful tool for forecasting future of the endangered species and it gives invaluable insight and information for the researchers, managers and administrators. The fate of a species can be forecasted for a particular time interval. In this part of thesis, some parameters are changed for evaluating the suitability of current and possible conservation scenarios that are presented below.

All models are calculated by using the Leslie Matrix in Table 20. Density dependence is selected as exponential since carrying capacity is not known but the density of gazelles is quite low for competition. Furthermore, in Ramas ® help file (Akçakaya, 1998) it is written as, "Exponential: No density dependence. All parameters related to density dependence are ignored, only the stage matrix is used in calculations". Initial population size is based on observations in Autumn 2009 transect survey. Numbers are shown below:

0-1 years old	1-2 years old	2+ years old
28	30	170

All models are run for 25 years duration for 1000 replications.

Model 1: Close to current situation.

- No management
- Hunting: 2 females killed / year
- Live catching of calves: 2 female calves caught / year

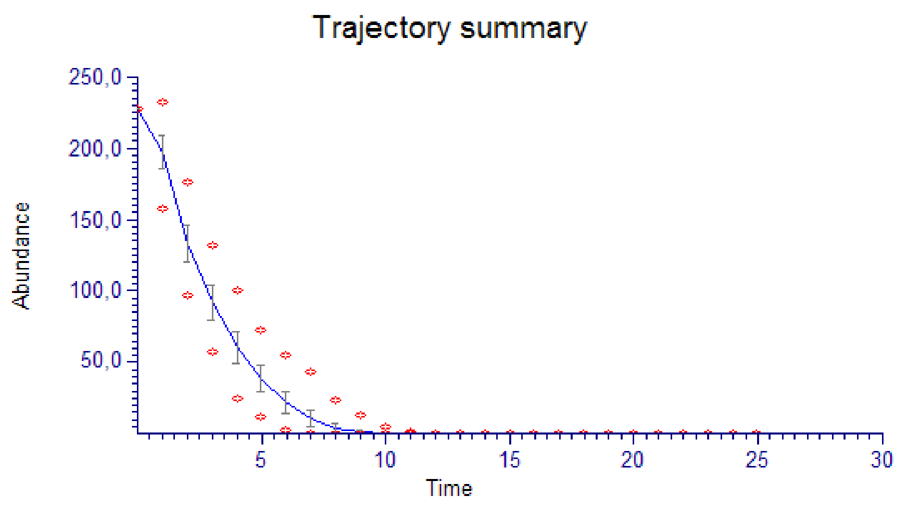
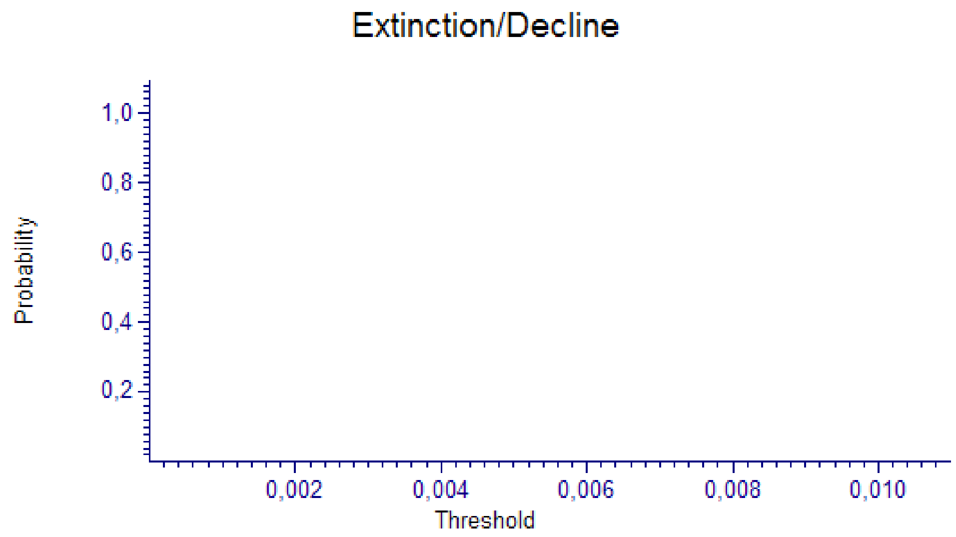


Figure 18. The trajectory summary of Model 1. Blue line represents mean value, dashes represent standard deviations and red dots represent minimum and maximum values. Abundance is number of individual gazelles. Time shows years. (created by Ramas ®)



Threshold	Probability	95% confidence interval	
0	1,0000	0,9720	1,0000

Figure 19. The extinction/decline curve of Model 1. The empty graph indicates that extinction risk is 1.0 and threshold value is zero which is correct for this result as shown above (Akçakaya, 1998). (created by Ramas ®)

Figures 18 indicates that population will crash before 10 years and Figure 19 confirms it with 100% probability of extinction.

Model 2: Better than current situation.

- No management
- No hunting / No live catching of calves

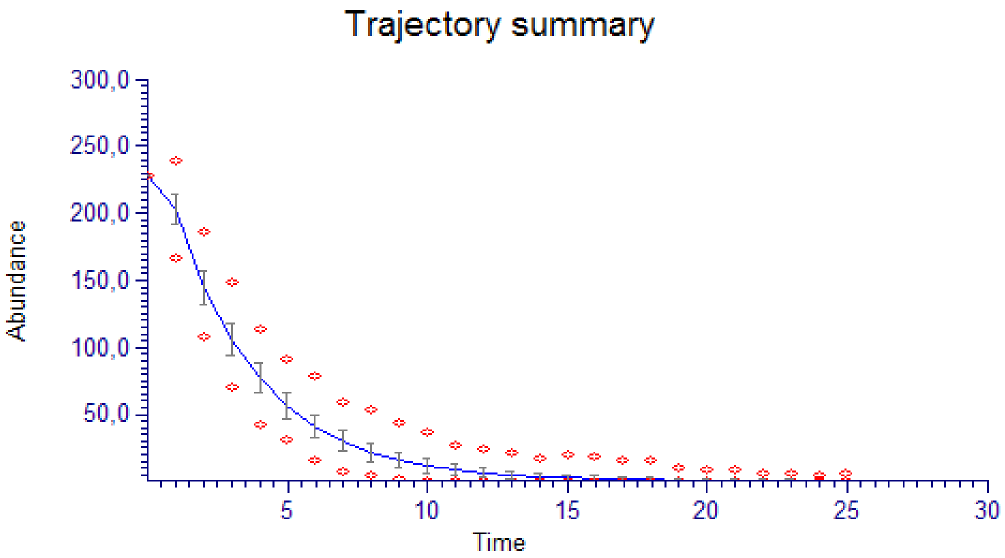
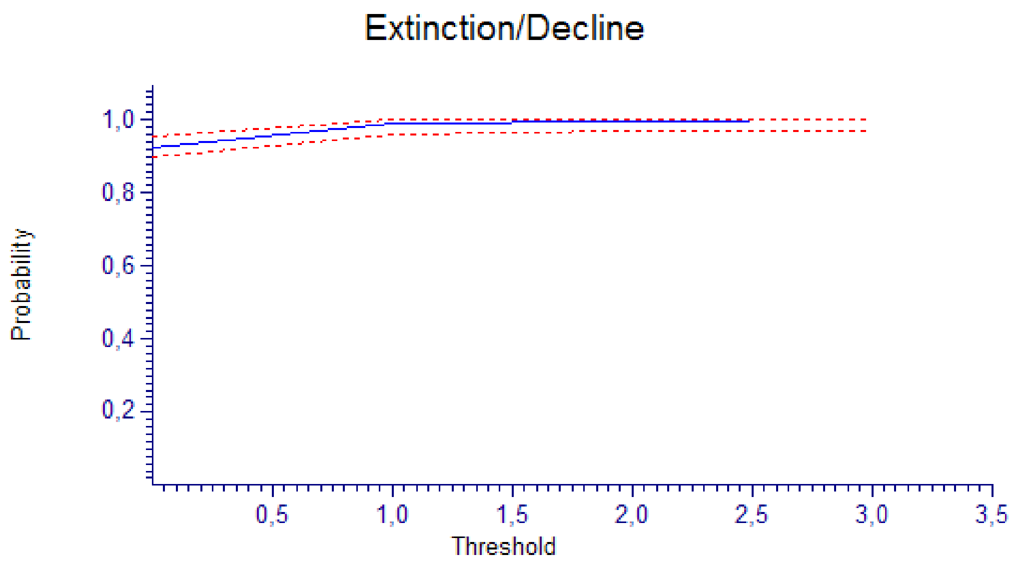


Figure 20. The trajectory summary of Model 2. Blue line represents mean value, dashes represent standard deviations and red dots represent minimum and maximum values. Abundance is number of individual gazelles. Time shows years. (created by Ramas ®)



Threshold	Probability	95% confidence interval	
0	0,9270	0,8990	0,9550
1	0,9900	0,9620	1,0000
2	0,9990	0,9710	1,0000
3	1,0000	0,9720	1,0000

Figure 21. The extinction/decline curve of Model 2. Blue line represents mean threshold value which shows the probability that the population abundance drops below the represented value at least one throught the duration and line with red dots represent risk curves which are the 95% confidence intervals based on Kolmogorov-Smirnov test statistic (Sokal and Rohlf, 1995). (created by Ramas ®)

Figures 20 indicates that population will crash before 20 years and Figure 21 confirms it with 100% probability of population decline to 3 individuals.

Model 3: Mild Conservation Efforts

- Supplementation of population: 5 adult females / year
- No hunting / No live catching of calves

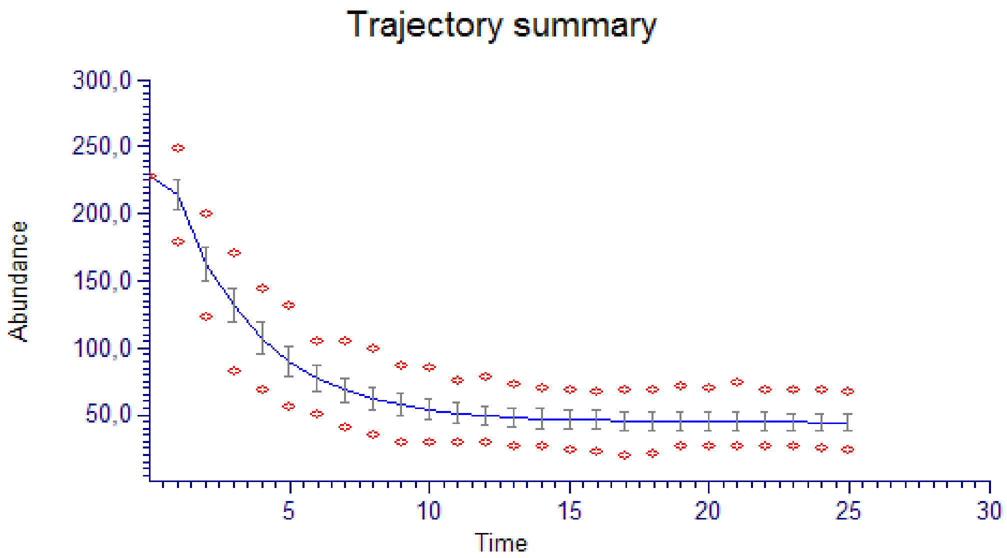
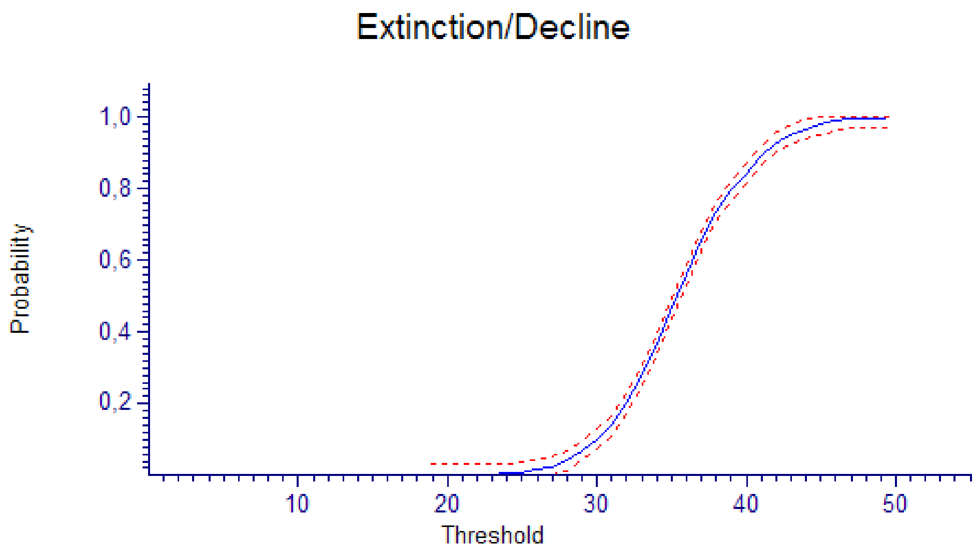


Figure 22. The trajectory summary of Model 3. Blue line represents mean value, dashes represent standard deviations and red dots represent minimum and maximum values. Abundance is number of individual gazelles. Time shows years. (created by Ramas ®)



Threshold	Probability	95% confidence interval	
20	0,0010	0,0000	0,0290
25	0,0060	0,0000	0,0340
30	0,1000	0,0720	0,1280
35	0,4550	0,4270	0,4830
40	0,8390	0,8110	0,8670
45	0,9810	0,9530	1,0000
50	1,0000	0,9720	1,0000

Figure 23. The extinction/decline curve of Model 2. Blue line represents mean threshold value which shows the probability that the population abundance drops below the represented value at least one throught the duration and line with red dots represent risk curves which are the 95% confidence intervals based on Kolmogorov-Smirnov test statistic (Sokal and Rohlf, 1995). (created by Ramas ®)

Figures 22 indicates that population will not crash in 25 years but Figure 23 shows that there is a 100% probability of population decline to 50 individuals.

Model 4: Moderate Conservation Efforts

- Supplementation of population: 10 adult females / year

- No hunting / No live catching of calves

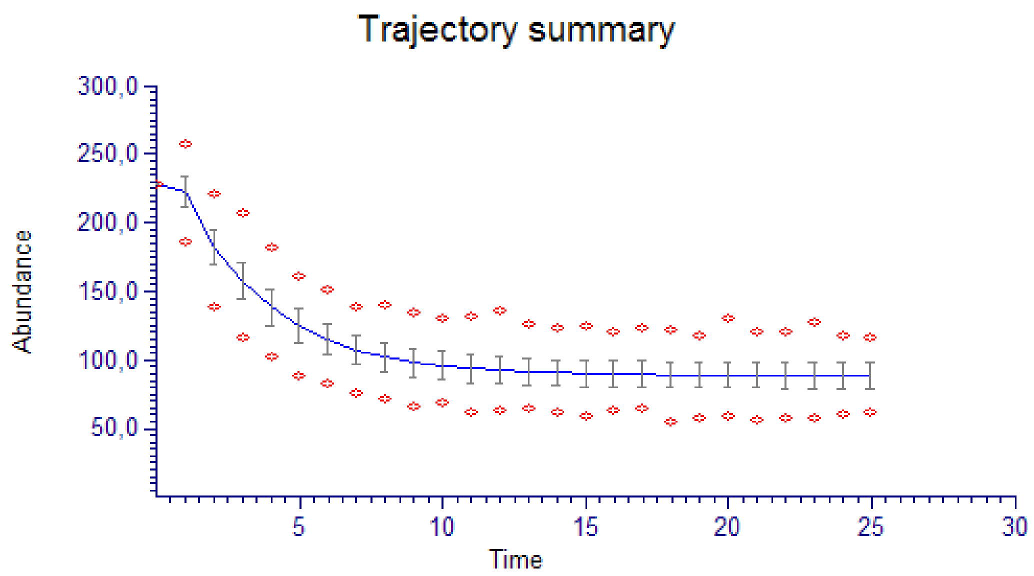
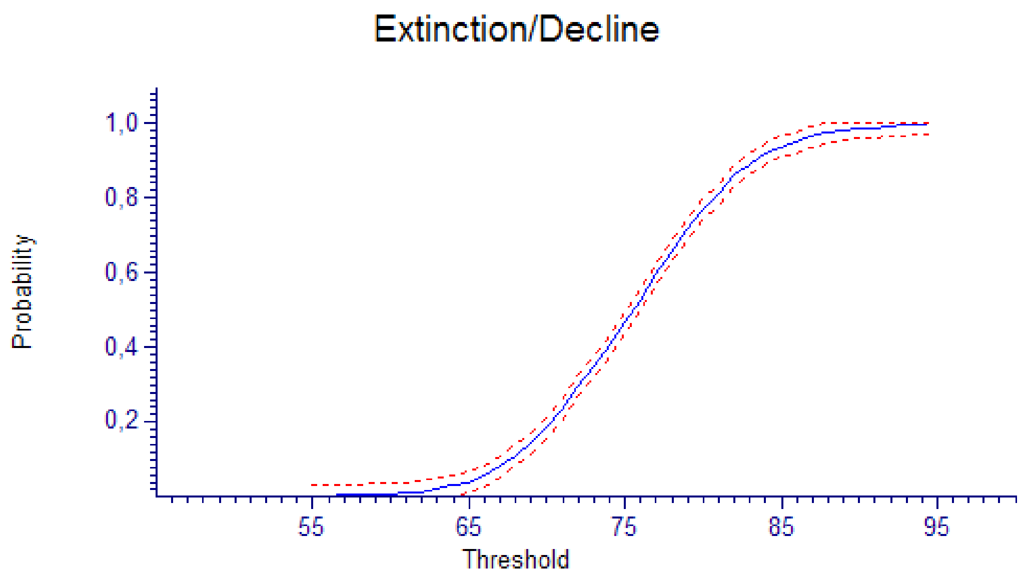


Figure 24. The trajectory summary of Model 4. Blue line represents mean value, dashes represent standard deviations and red dots represent minimum and maximum values. Abundance is number of individual gazelles. Time shows years. (created by Ramas ®)



Threshold	Probability	95% confidence interval	
55	0,0010	0,0000	0,0290
60	0,0070	0,0000	0,0350
65	0,0380	0,0100	0,0660
70	0,1830	0,1550	0,2110
75	0,4670	0,4390	0,4950
80	0,7670	0,7390	0,7950
85	0,9360	0,9080	0,9640
90	0,9890	0,9610	1,0000
95	1,0000	0,9720	1,0000

Figure 25. The extinction/decline curve of Model 2. Blue line represents mean threshold value which shows the probability that the population abundance drops below the represented value at least one throught the duration and line with red dots represent risk curves which are the 95% confidence intervals based on Kolmogorov-Smirnov test statistic (Sokal and Rohlf, 1995). (created by Ramas ®)

Figures 24 indicates that population will not crash in 25 years but Figure 25 shows that there is a 100% probability of population decline to 95 individuals.

CHAPTER 4

DISCUSSION

In November 2008, 3 adult males, 2 male calves, 9 adult females and 1 female calf are reintroduced to wild in Kızılkuyu Wildlife Development Area. Seven of adult females were GPS collared and except 1 male calf all remaining individuals were identification collared. Furthermore, all 15 individuals were ear marked. During supplementation studies, we measured that adult males and females weigh on average 19 kg (n=2, 18-20 kg) and 16.25 kg (n=4, 15-17 kg) respectively and 5.5-6 month old male and female calves weigh on average 10.67 kg (n=3, 10-13 kg) and 12.33 kg (n=6, 9-13 kg) respectively. However, sample size is small and captive-bred animals were somewhat starved and under stress as a result of catching attempts; so these conditions can very well result in lower body mass. In addition to that, in our field studies, newborns calves aged from approximately 1 to 5 days old have been measured to weight on average 1.93 kg (n=11, 1.43-2.62 kg). This conforms to Zhevnerov & Bekenov (1983 cited in Baskin & Danell, 2003).

All transects were done by walking and neither dogs nor mounts like horse or donkey were used. In this study, only 1 out of 3 transects were done by multiple observers due to lack of personnel. On average, transects were walked with a speed of 1.5 km/h. It is quite slow compared to normal walking speed even with that rough terrain and harsh weather conditions. In addition, transect lengths and total duration was fitted according to this speed. This speed enabled the observers to look around more and upon encounter animals are observed more.

On the other hand, the first transect survey on July 2008 was designed for a speed of 5 km per/hour. In the end, cumulative stress of high temperature, rough terrain and low detection probability of goitered gazelles resulted in carelessness and low efficiency. Furthermore, that survey was designed that observers would walk nearly all day long about 14 hours including rests. Again this was proved to be a bad decision. Also, this was the first field survey for more than half of the observers and lack of experience showed its flaws. Only 18 groups were observed for 3 days. Consequently, estimated number 242 seems to be an underestimation and it may be better to use a higher number within confidence interval. Moreover, it should be noted that, this was the only transect survey in which detected male ratio is higher than females. First possible explanation to this is easier detection of males because of their long, contrasted colored horns. Second explanation is that, adult males are less shy than female ones and probably out of curiosity before they escape they tend to watch you for longer periods. During the whole study period (July 2008-December 2009), some males even approached towards the observer. Maximum detection distance was about 550 meters by an experienced observer. Less experienced observers had not recorded any animals more than 300 meters away.

The second transect survey on January 2009 had been done in far better climatic conditions than the previous one. Total duration was shorter than the previous transect survey. On the other hand, this time number of observers previously experienced in line transect sampling was half the previous one. In addition, this is the only transect sampling in which inexperienced observers walked in pairs or alone without proper guidance of experienced walkers. These conditions led to inaccurate and rounded angle and distance measurements. People tend to exaggerate the distance for an unknown reason and this sampling shows it beautifully. Inexperienced observers have noted such great distances that, even one year later, some experienced observes would find it difficult to detect gazelles at that distance. As a result, lots of data are truncated, discarded or modified accordingly, like based on habitat and geographic information. Truncation is done according to detection probability suggestions of Buckland et al. (2001) which is discarding data below 15% probability, like all other transect data gathered in the study period. Some observers' all distances are divided in two for the sake of an orderly modification and avoid exaggerated distance usage. Since last two days of the transect survey was done about 1 week later than the first two days, the data collected in these two days are not taken into account of population size estimation. The detection of 34 groups in 2 days with only 2 experienced observers can be explained by climatic conditions and despite objections mentioned above by devotion of inexperienced walkers. Group and sex ratios are more reasonable than the previous one's. As expected, harem and mixed group sizes are high because of rutting season. Male-only groups have the majority in group ratios. They are small and consist of male calves, bachelors and/or opportunists. Estimated population size and density is reasonable. Maximum detection distance was about 1 km in the survey by an experienced observer which means that higher the experience, higher the detection will be.

The third transect survey on June 2009 was the first transect sampling that was planned properly and in a more detailed fashion. Observers were more experienced with terrain and animals. Helper attended to survey but since they were ill-prepared, this situation was proved to be more impediment than assistance. Observers were not exposed to extreme summer temperatures of the region because not only equipments were well selected, but also enough time was given to observers to rest more if needed. Only flaw of the survey was transecting path that crossed farmlands and villages which are source of study area that result in decreased efficiency and waste of time & effort. Experienced observers showed their merits for 3 days by both detecting 64 groups and carrying equipment of their helpers in addition to theirs. Mixed and harem group ratios are low, because before calving these groups were observed to scattered and did not reform until autumn. In addition, females have observed to prefer to be alone before and after calving. Therefore all of these resulted in high ratios and low sizes of female and male groups. Estimated population size and density is close to anticipated values, and have the lowest standard error. Moreover, study area coverage was very successful. Maximum detection distance was about 650 meters in the survey. Decrease in detection distance can be explained by shimmering effect due to higher temperature.

The forth and last transect survey on November 2009 was the most efficient of all. Unlike June 2009 transect sampling, no transect passed through farmlands. The first and last day transects were passing through transects of second and third day. Moreover, first and forth days was not well planned. Consequently, they were not used in calculations since that would result in recount and overestimation. Climatic conditions were very suitable for walking except early morning fog. Helpers were better this time, but they still did not or could not improve the overall efficiency. Nevertheless, for an emergency situation they were ready. Again, equipments were well selected and resting time was more than enough. Sampling time overlapped with mating season. All individuals were concentrated in a relatively small area. This resulted in higher detection of gazelles as activity was high and groups were bigger. Gazelles were relatively indifferent towards us so detection was done in all distances. Maximum detection distance was 2 km. For a total of 46 groups were detected. Number of observed individuals was 314 and estimated population size in that sampling and June 2009 317 and 319 respectively. We can interpret that, nearly all individuals in the population was detected in the survey. The information we gathered from the local people and absence of gazelles in other regions supports the explanation. If so, then the current (Autumn 2009) group structure of goitered gazelles in the area is pretty much showed in Tables 10 to 17. Under that assumption it can be said that female/male ratios are underestimated in other transect surveys. In order to avoid overestimation, study area size was adjusted for just this transect sampling according to the new gathering area for Distance analysis. Another flaw of this transect sampling was lack of experienced observers. This resulted in low number of transects, thus high error rate.

In field surveys, distances were recorded as accurately as possible. Sometimes actual position of animals was taken. During surveys, distances were taken with angle from the observers point. After surveys, these distances were converted to perpendicular distances to the imaginary transect line.

All four assumptions of distance sampling are obeyed. For the “independence” assumption, no animal is flushed or particularly disturbed. For the “detection on the line” assumption, we used every experienced observer available. Since resources were limited, not all observers were equipped with telescopes and mostly helpers could not even be equipped with binoculars. Thus, available equipment is shared. However, as the detections were most of the time done by experienced observers, they carry the observation equipment most of the time. This shows that, if we had enough resources, it was possible that helpers may be more effective. Travel speed was set as slow as possible as mentioned above. For the “movement prior to detection” assumption, observers walked as silently as possible especially when approaching new areas. After reaching a strategic location, slowly and silently observers stopped and scanned the field of view. For the “in accuracy in distance measurements” assumption, whenever possible distances are taken by experienced observers and as in January 2009 other distance values are adjusted or not used altogether.

Surveys are designed to cover the whole area and no transect is altered to pass through known high density region. We can say that core area of the goitered gazelles in the study area is around fenced acclimation site. In every transect survey, we placed transects to cover unexplored or known areas in order to detect borders of gazelle distribution in the area. As this core area is “core”, it cannot be helped but pass through that area in systematic random sampling as lines are placed next to each other with a systematic fashion to cover the maximum possible area.

Group compositions clearly show that, harem formation increases in spring and autumn / winter as expected when rutting takes place. Decreased percentage of male-only and increased percentage of mixed groups again suggest the gathering of gazelles from both sexes. Lone males were observed stalking and stealing females from large harems. Therefore it would not be definitive if male only groups in rutting periods are labeled as groups composed of unsuccessful males. The average group sizes of mixed groups were much higher in all seasons especially in autumn than the single-sex groups because of mating season. Average number of mixed groups observed per season was lowest in summer. In autumn, it increased as expected due to the mix of sexes in rut. Apparently, females constitute a greater portion in population than males. This can be because of longer life span of females. Sex ratio 2.661 for total female per total male which is calculated from Autumn

2009 transect survey results, is substantially higher than value of 1.17 found by Pereladova et al. (1998). It is mentioned this favor towards females can be resulted in counting of sub-adult males as females, but even adult females per adult males was found to be 2.651 in Autumn 2009 and 1.500 in Summer 2009 transect surveys. Hence, bias towards females cannot be explained by wrong counting.

In our results, it can be interpreted that male and female group sizes are the most effected groups from seasonal differences. Probably main group size differences can be explained with rutting and calving seasons. Other possible reasons can be food availability difference in different seasons, unpredicted movement and disturbance of local nomadic people and their livestock, and movement and grazing level differences in domestic livestock that belong to people in settlements.

Density of gazelles is estimated between 2.320 ± 1.590 and 3.476 ± 1.707 animals per km^2 throughout the study period. These values are substantially lower than values 25 and 41 gazelles in km^2 in *Gazella gazella* study of Kaplan (2002). This result supports the decision of selecting exponential growth in PVA.

The trend of the population size during study period is found to be rather stable, but study period is too small to say anything for longer periods. At least 2 more year is needed in order to discuss any trend. Average group sizes of females were larger than males in all seasons, most probably due to the associated juveniles and yearlings. Group sizes differences between with and without calf values also support this. Furthermore as there is a significant change in female-only groups' sizes between seasons and transect surveys with calves but without calves, again association with calves is supported.

Survival rate and fecundity estimations can be underestimation because of the following reasons:

- Both are calculated from captive bred animals which were probably not very adapted to the environment. On the other hand, adaptation to captivity may lead to decreased vigilance, survival skill and avoidance of predators.

- Only feasible water source other than sources in villages became inaccessible to animals which were getting accustomed to this source and suddenly lose it. Even though National Parks built new water sources in July, almost for one month period in August water was not properly replenished thus leaded to even more catastrophic effect.
- Young, particularly primiparous, mammals are often less fecund than older ones and are more susceptible to environmental stress which could further decrease fecundity (Bronson, 1989).

In survival estimation it was assumed that survival was constant and did not change throughout the year. Depending our observations and deductions, this is most probably wrong. Survival should be lower in summer in which precipitation is virtually non-existent; water sources in the area were either isolated by fences (artificial), polluted or empty (artificial). It is even suggested that one of the GPS collared animal died because of dehydration (Durmuş, 2010). On the other hand, this was the most appropriate method for this study. Mayfield method is also used in another ungulate species with similar study conditions (Özüt, 2009). It would be better, if the study period was longer, more age structure could be recognized in the field and more animals were collared, so a more complete survival rate would be calculated. It should be noted that truly natural mortality of goitered gazelles is most probably a minor fraction of actual mortality because of human related disturbance as it is in many present day large vertebrates (Eberhardt, 1987).

For fecundity, again if the study period was longer detection of calves would be higher and a more complete number of live individuals at the end of 1 year could be used. Moreover, again if more age structure could be recognized, fecundity could be estimated specifically to these age categories. Furthermore, if more animals were to be collared, sample size would be higher and estimated value would be more reliable.

It is extremely difficult to encounter a newborn goitered gazelle in the field that is up to 2 weeks old. Therefore, in calf survival estimation, calves died in that period are not taken into account. From field observations we know that, remaining 5 GPS collared individuals were all pregnant. However, none of them is seen with a calf during the first parts of calving. After about 2-3 weeks, 2 of them are seen with calves so fecundity was based on these individuals.

Population viability analysis models showed if no additional or effective conservation action is not taken, goitered gazelles in Şanlıurfa will be no more approximately in 10 years. Even if current conservation (towards illegal hunting and live catching) is done 100% effectively, this population will be extinct in Turkey in 25 years. On the other hand, if population is supplemented with just 5 adult females, the population size will decrease but at last will be stable at a very small size in 25 years. Same result is achieved in model 4 where 10 adult females are released. These results indicate that for an effective conservation certain steps should be taken in order to increase calf and adult survival rates. However, it should be noted that, the survival and fecundity rates are possibly underestimated as mentioned above. Moreover, based on our observations and information from both National Parks and local people, the population is not observed to decline sharply in recent years. Most probably, population is in decline but we are not sure of severity.

CHAPTER 5

CONCLUSION

Goitered gazelles are worthy of strong effort in research and conservation for it is an endangered species, one of the large herbivores living in of Southeastern Anatolia. As the only natural population in Turkey is found in Şanlıurfa and general population trend in the world is decreasing, strong conservation efforts must be performed.

This thesis can be considered as a preliminary study for goitered gazelle demographic studies. As mentioned in discussion chapter, the longer the duration of study, the better one will get. Moreover, for the sake of efficiency, transects surveys should be planned according to the capabilities and limits of observers. It is clearly observed that, fatigued observers miss detections more often, take notes shorter and faster and most importantly may forget to take important data. Health problems are another issue and as a result it is observed that after three days of transect sampling efficiency decreases drastically.

A massive road construction was observed near the study area (out of the protected area) during Autumn 2009 transect sampling. Although gazelles were observed in that area before, this area was omitted from the study area region. If National Parks had drawn the borders of the protected area more carefully, this area would still harbor gazelles. Furthermore, protected area borders not only cover large mountainous unsuitable habitats for goitered gazelles (and farming practices) but also busy roads that probably disturb gazelles. Moreover, the borders are clearly fitted on roads. If protected area has covered the gazelle region, these clear cut borders may have served as buffer zones. Instead these areas only constitute a nominal bulk of protected area. It is thought provoking that even National Parks knows the protected area was not defined well. This is proved when National Parks built new artificial water sources. 5 out of 7 water sources are in protected area where as 6 out of 7 water sources are in the study area. A possible solution in order to increase survival values is building more water sources and filling them properly. Another one is restricting animal husbandry in some areas.

For the future studies, the population trend should be monitored using appropriate methods. In the future, if decision makers work together with experts in conservation studies from the very start, there would be more hope for goitered gazelles or any endangered species for that matter.

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