Executive summary- Long term mountain gazelle driven surveys 2003-2015

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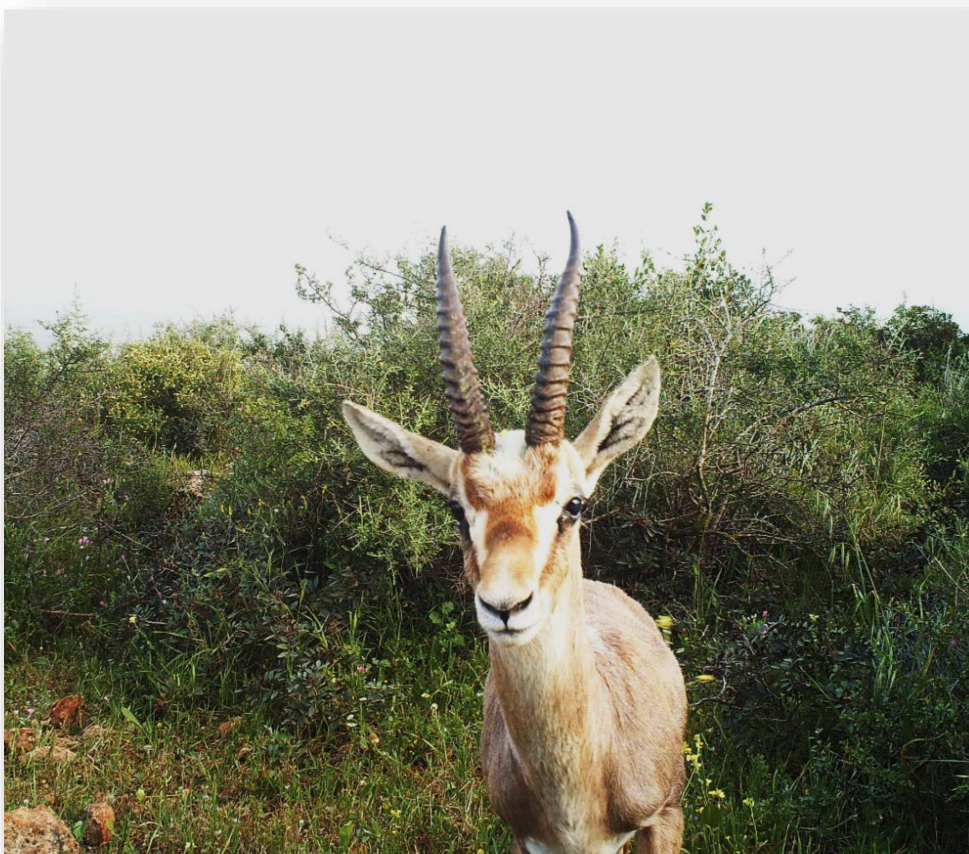


INTRODUCTION

Up until recently, mountain gazelles (*Gazella gazella*) were categorized in the vertebrates red list as vulnerable (Dolev and Perevolotsky 2002). However, recent decrease in gazelle numbers have alerted authorities to recognize mountain gazelles as endangered and raised the importance to better understand how human driven changes effect gazelle population viability and distribution (Hadas et al. 2015). Mountain gazelles are sensitive to environmental changes and their sensitivity can be measured by their population reproductive success rates, therefore, they can be used as bio-indicator for ecosystem health. Also, gazelles are considered charismatic and can play a role as a flag species for conservation purposes.

Ramat Hanadiv has set a goal to monitor and study the park's mountain gazelle population responses to different management and anthropogenic changes within the landscape.

During the past two decades Ramat Hanadiv has funded a few studies prior to the mountain gazelle driven surveys. The first study took place during 1987-89 (Getraida and Perevolotsky 1989) within the nature park and the surroundings. The maximum density reported within an area of 2 km^2 was 35 individuals estimated from **driven surveys**. The average density reported was 20 individuals per 2 km^2 (n=15, sampling unit-day). It should be noted that significant fluctuation was recorded between seasons.

Population size estimates which took into account **fecal transacts** and the **driven counts** was 95 individuals within a 3.02 km^2 during 1988-89 and 44 within 3.03 km^2 during 1997-98 (Rosenfeld and Getraida 2001). Juvenile female ratio was 1:1.4 respectively during both studies.

A study on ecological and physiological aspects of mountain gazelle population in Ramat Hanadiv was carried out during 1992-93 (Gefen 1996). This was the first study to monitor females by individual recognition. Gefen found that females belong to fixed groups. Home-range overlap between groups was recorded, but groups were not active in the same area simultaneity, indicating on temporal partitioning behavior.

All of the mentioned above were short term studies with different methodologies, therefore, it is difficult to compare between them. In 2003 a long term ecological research (LTER) station was established in Ramat Hanadiv, part of an international LTER network which aims to monitor environmental changes in different ecosystems around the world and create a platform for research collaborations. As part of the LTER station responsibilities, a long term mountain gazelle and chukar partridge (*lectoris chukar*) survey began.

This report contains analyzed mountain gazelle survey data from 2003-2015.

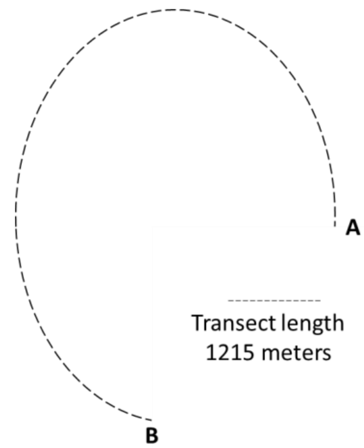
The survey goals are to monitor changes within the population, demographic changes, reproduction, and recruitment rates.

METHODS

A 12150 meter transect was chosen for the long term survey. The survey can be divided into to two separate time periods: 1) 2003-2011 a horse back ridden survey conducted by Bill Woodley,

2) 2012-2015 a driven survey conducted by Amir Arnon.

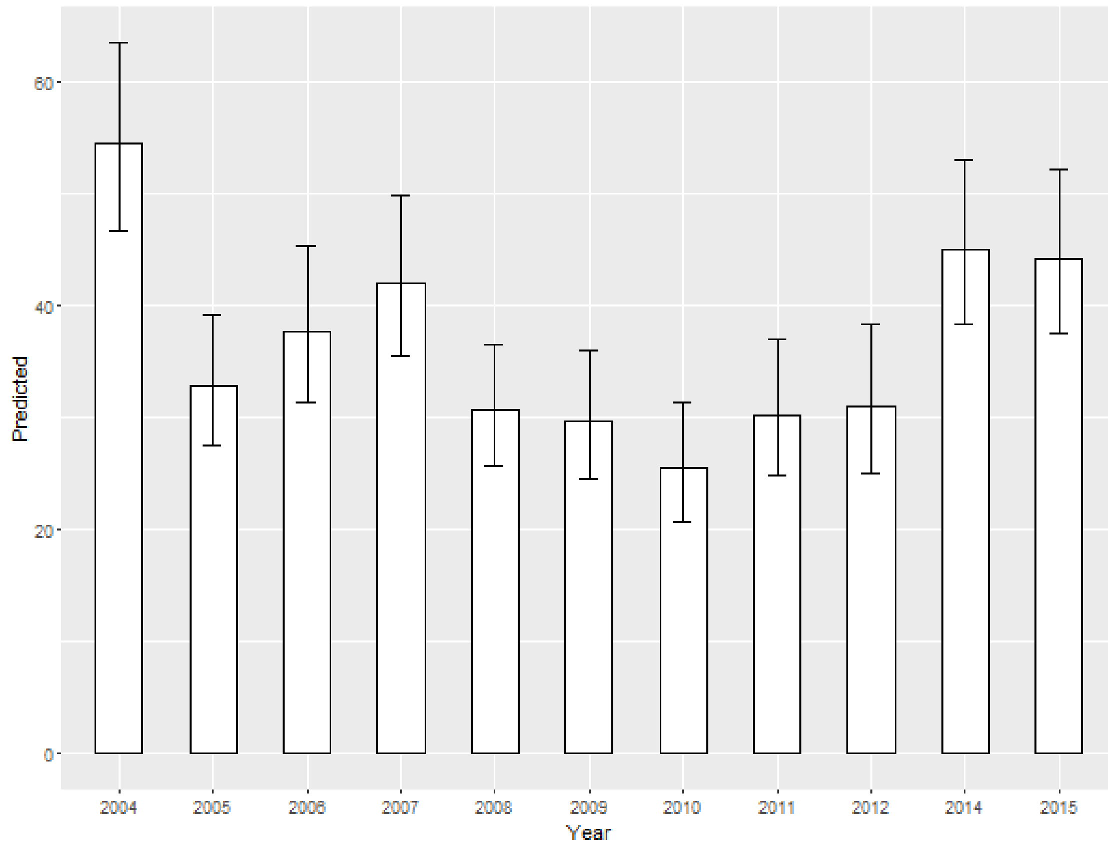
The survey is carried out four time a month. Twice starting at sunrise and twice at sunset. The beginning point is rotated, twice begging at the northern point (A), and twice in the southern point (B) (See illustration). The chosen transect represents different factors that may influence population distribution. Every sighting is recorded in ArcGIS online application. The surveyor fills out the coordinates, date, time, weather condition, sex, state.



SHORT RESULTS

Distance sampling population size estimates indicate that between 2004 -2012 there was a decrease in population size (Fig.1). Gazelle sightings fluctuated seasonally, therefore, month was considered in the model. Maximum estimates were calculated during December and January probably due to landscape cover state, short green vegetation, which help sight gazelles and gazelle prefer grassy areas during winter. During February the estimates drop. This might be due to two reasons: 1) Seasonal vegetation growth makes it difficult to spot gazelles, 2) Cattle enters the nature park and may influence gazelle activity. Low population size estimates continue till September, and then climb up again. When the vegetation is dry it also difficult to sight individuals. Presented in the figures are the high estimates (January) so it will be easier to compare trends between years.

Fig.1: Distance sampling population size estimates for 2004 -2015. Presented are the highest estimates within confidence intervals (whiskers).



The yearly decrease between 2004 -2012 is not uniform demographically. Males appear to be more stable and the female fluctuated between years (Fig. 2, 3). Higher estimates were calculated during 2014 and 2015. High female counts are suspicious and I think this is not real population growth since juvenile counts remained low (Fig. 4). High counts might be due to a good rainy season during the winter of 2014-2015. This means more grass, and more gazelle sighting at open areas. Juvenile counts continue to plummet and this is very alarming.

Fig.2: Female - distance sampling predicted number of female individuals estimates for 2004 - 2015. Presented are the highest estimates within confidence intervals (whiskers).

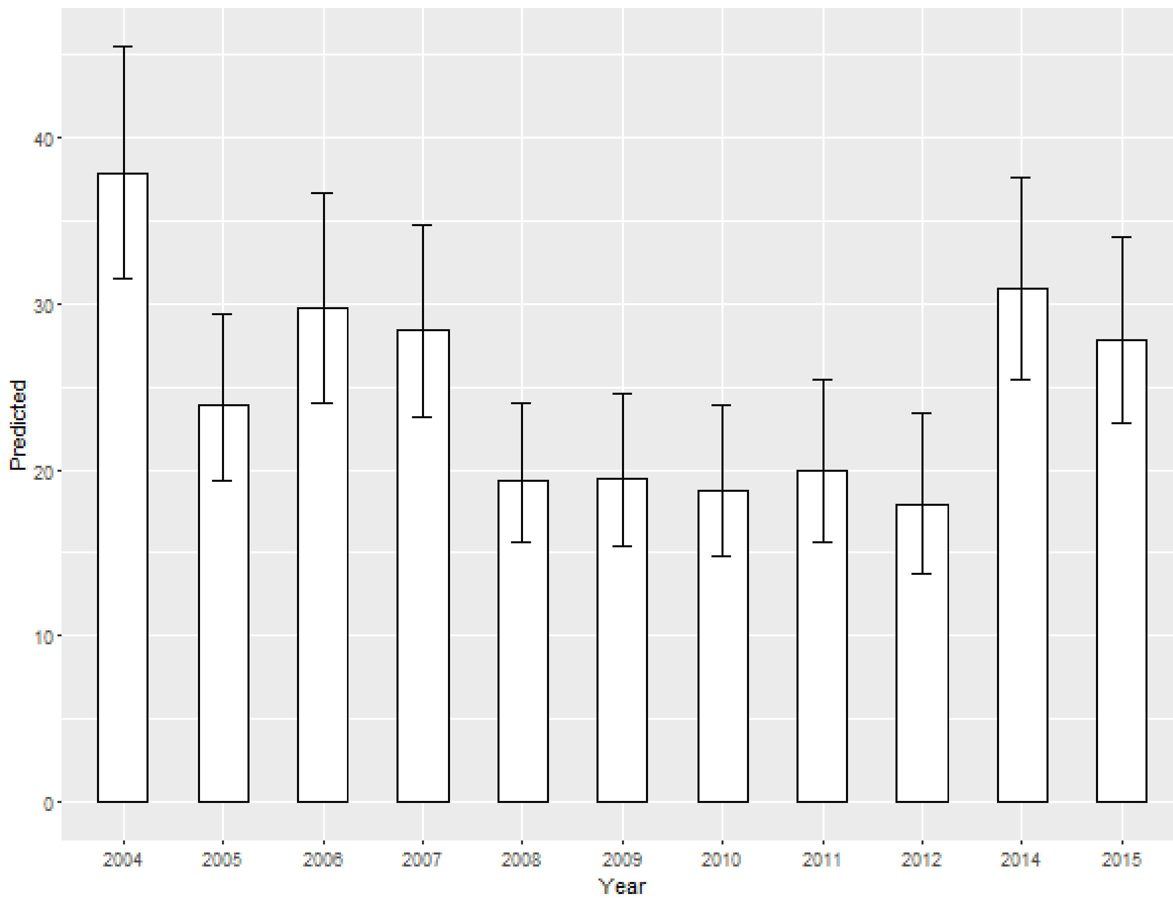


Fig.3: Male - distance sampling number of individuals estimates for 2004 -2015. Presented are the highest estimates within confidence intervals (whiskers).

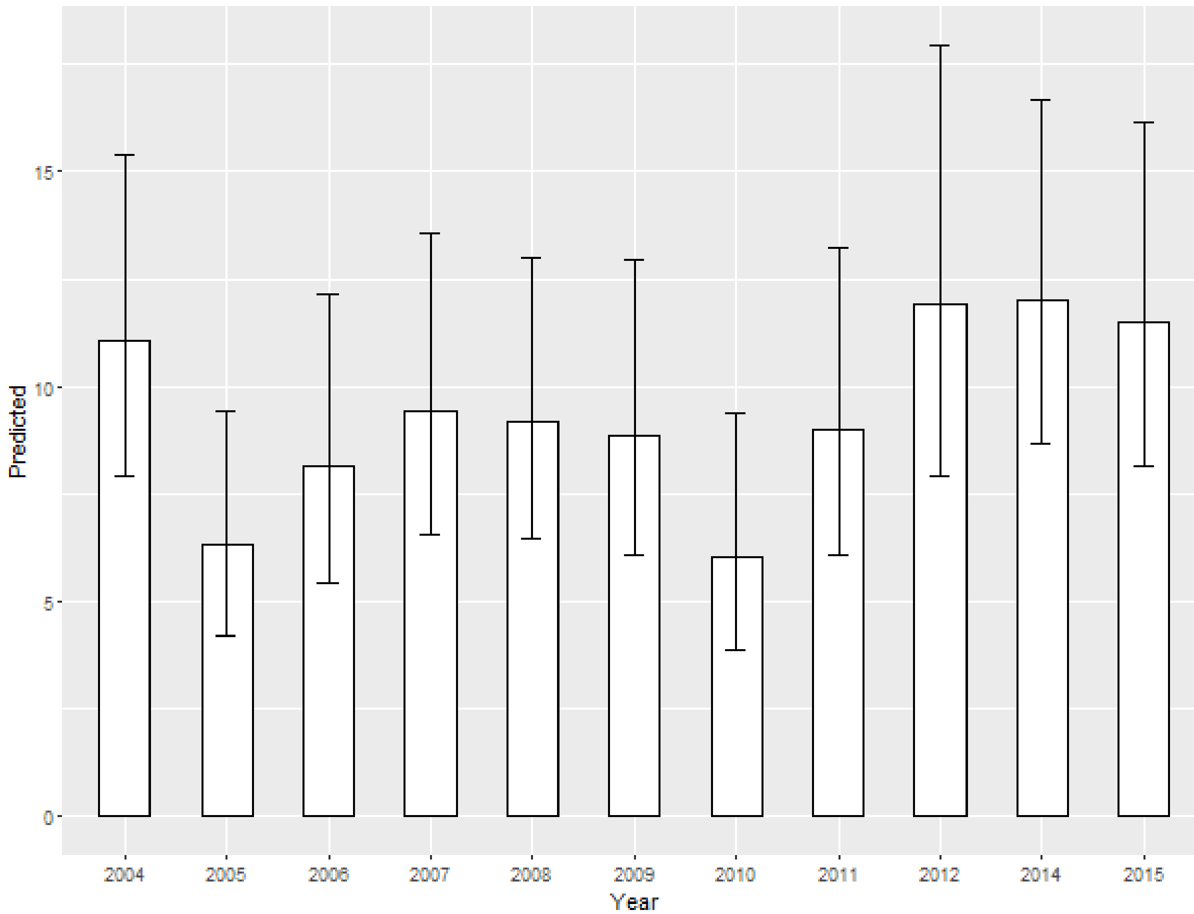
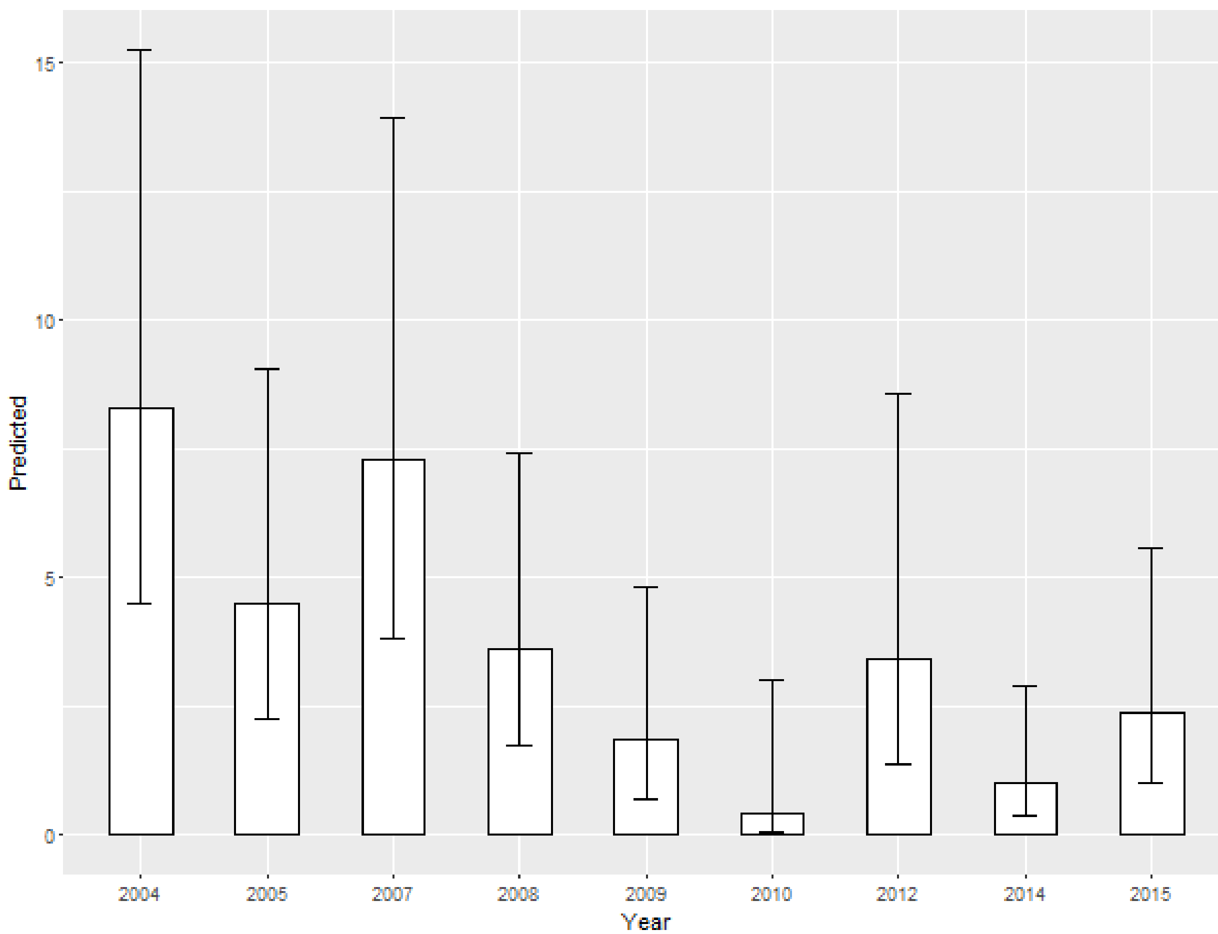


Fig.4: Juvenile - distance sampling number of individuals estimates for 2004 -2015. Presented are the highest estimates within confidence intervals (whiskers).



RECOMMENDATION

The main concern that raises from the analysis is low fawn and juvenile densities. This means that Ramat Hanadiv population might be a sink population which is dependent on viable connectivity to a source population (Alona Hills). Other factors that can be the cause for low juvenile destines 1) high predator densities, 2) competition on fawn hides during grazing season, 3) a genetic deformation within small populations. Therefore, I think that the first question that needs to be answered is why are fawns not successful?

Ramat Hanadiv area is small enough too able the parks personals to monitors all individuals within the population. The driven survey takes up about 144 hours spent each year, 12 hours each month. That is a major effort that can be more productive.

Long term monitoring alternatives:

1. **Monitor with camera traps**: place a constant camera trap grid twice a year. Two seasons: winter- record individuals that enter winter, and summer- record individuals that survived winter and new recruitments. Estimate population size using SECR (Spatially explicit capture recapture) (Efford and Fewster 2013) for individual recognition, or use N-mixure models to estimate unmarked individuals (Royle et al. 2004).
2. Continue the **driven survey only change the sampling effort**. Survey twice a year, again, winter and summer. During each season to survey 16 consequent times. Record all individuals that enter winter, and in the summer record the survivals and new recruitments.

3. **Direct sightings** as done by Gefen (1995). We pretty much have a good idea where all the herds (groups) are located within the park. It is possible monitor the herds by direct sighting surveys that will give good insights about population fitness.

***** Whatever is decided, I think data should be analyzed and revisited annually for the first couple of years so you know the method chosen is appropriate.**

If it is decided to continue the driven surveys than I suggest a number of modifications:

1. **Survey form**: I think that date, time, and meteorological variables should be automatically be inserted to every record. This will diminish the missing values problems.
2. **Distance of sightings**. It has come to my attention that the real distance for the sighting was not always appropriately recorded as written in the protocol. For instance if a group of individuals was sighted but not all in the same area than the mean distance was recorded. This is a huge problem for the detection function in the distance model. The right way to record sightings should be very clear in the protocol.
3. For accurate distance records I suggest purchasing a **laser distance meter**.

Further points to think about:

1. Ramat Hanadiv gazelle population is dependent on its connection to the Alona population, therefore, it is imperative to maintain a safe and suitable passage between these areas.
2. It is important to understanding the challenges and dynamics of the outside population by **expanding the monitoring program to Alona Hills.** This will benefit the park's management decisions.

3. Monitoring the gazelle population alone will not explain the drivers behind its seasonal and yearly fluctuations. I think it is very important to monitor potential predators and other threats alongside gazelles. Camera traps can provide this information and much more. It's moving forward from a single species to a **multiple species monitoring approach**.

Academic studies:

1. Gazelle estimate drop every year as soon as cattle grazing starts. Female gazelle detectability estimated from camera trap encounters was also found to be negatively influenced by cattle presents (Shamoon PhD 2016). I suggest to GPS tag 10-20 individuals from the cattle herd and at the same time place a camera trap grid to study how **cattle effects gazelle activity.**
2. Evaluate **stress hormone levels** in fecal droppings to assess recreation (e.g. visitors, dogs, bikers) and land management (e.g. grazing) effects on gazelles. Compare Ramat Hanadiv population and Alona population.