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Decline in Vertebrate Biodiversity in Bethlehem, Palestine

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Abstract

Our data showed that in the 1960s/1970s some 31 species of mammals and 78 species of birds were present in the area of the Bethlehem governorate, between Bethlehem and Deir Mar Saba. Comparison with observations done in 2008-2013 showed significant declines in vertebrate biodiversity in this area, which has increasingly become urbanized, with an increase in temperature and a decrease in annual rainfall over the past four decades.

Keywords: Biodiversity, Palestine, Mammals, Birds, Reptiles.

1. Introduction

Research on vertebrate biodiversity in the occupied West Bank is limited compared to that in the nearby areas of Palestine and Jordan; Palestinian research in general still lags behind (Qumsiyeh and Isaac, 2012). More work is needed to study habitat destruction including soil acidification on the fauna of the area (Graveland *et al.,* 1994; Gärdenfors *et al.,* 1995). As early as 1950, scientists warned of an environmental disaster in Palestine (Ives, 1950). The Bethlehem District covers an area of 575 km2 and includes three main towns located on the Judean hills (Bethlehem, Beit Jala, and Beit Sahour). Fertile areas lie to the west of the three towns and to the Green Line (the border between Israel and the occupied Palestinian areas). The eastern part of the area forms slow transitions from a mild Mediterranean zoogeographical region to arid habitats representing Saharo-Arabian floristic and zoo-geographical region (Zohary, 1973; Qumsiyeh, 1996). To the north is occupied Jerusalem, and to the south is the district of Hebron. In addition to the three main towns, there are 71 Palestinian smaller towns and villages, three refugee camps (since the removal of these Palestinians between 1948-1949), and 22 Israeli colonies built since the occupation of 1967 (ARIJ, 1995). The population in the district of Bethlehem tripled from roughly 95,000 in the 1960s to over 285,000 today, consisting of 205,000 Palestinians and 80,000 Jewish settlers (Palestinian Central Bureau of Statistics-PCBS, 2012). The natural increase of the native population is 3% (PCBS) and of the Israeli settler population 5% (more than twice the natural increase because more settlers were imported) (Israel Central Bureau of Statistics, 2012). Additionally, some one million tourists visit the area annually. This created a significant development in the open areas and increased the human pressure in all areas (ARIJ, 1995). However, the impact of these changes on nature was not studied.

To estimate the impact of this human development on nature is difficult. Most studies of fauna and flora of the area South of Jerusalem (Bethlehem Governorate) was done by Western visitors who came on short trips to tour the "Holy Land". One of the first native Palestinians who engaged in faunal studies was Dr. Sana Atallah who did a number of studies from 1962 until his untimely death at the age of 27 in 1970. Since 1970 until 1979, and then since 2008 until the present, the senior author has been collecting data in the area. Notes and a collection of primarily mammals and birds were accumulated in the 1960s and 1970s but only the mammal data was published (Atallah, 1977, 1978; Qumsiyeh, 1996). Because both his work in the 1960s and ours in the 1970s were focused around the Bethlehem area, they provide a baseline when compared to recent work. In sections of two books by one of the authors, the previous sparse studies were summarized, recommending that rigorous studies evaluate environmental impacts of the geopolitical changes of the past 100 years (Qumsiyeh, 1996, 2004). The example from the Hula painted frog, *Discoglossus nigriventer*, that was thought extinct after the draining of the Hula wetlands and was rediscovered recently, show the importance of these kinds of observations (Biton *et al*., 2013). In this paper, we report on vertebrate species collected or observed in this area in the 1960s and 1970s and in the past five years (2008-2013). We focus on mammals and birds but provide some data for reptiles and amphibians.

2. Material and Methods

Dr. Sana Issa Atallah was the first native Palestinian Zoologist. He was born in Beit Sahour on May, 20, 1943 and received his Master's degree from the

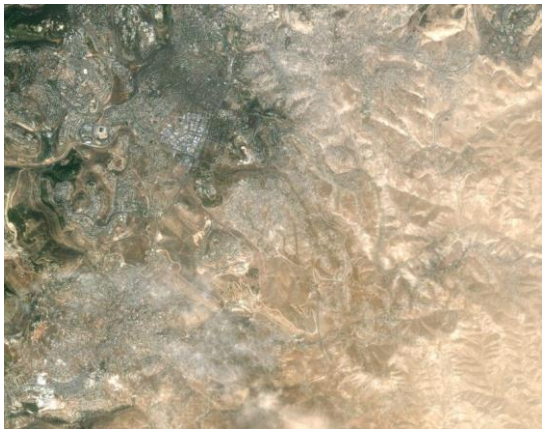
American University of Beirut (on the rodent subfamily Microtinae) and his doctorate degree on mammals of the Eastern Mediterranean region from the University of Connecticut. He died in a car accident in Iran in January, 17, 1970. In the 1960s, he collected animals (primarily mammals but also birds, reptiles, amphibians, and even insects). Because of his frequent trips to his hometown, we had many unpublished observations on the fauna of the Bethlehem region. Only the mammal parts of these observations were included in his doctoral thesis published (with our help) posthumously (Atallah, 1977, 1978). As a teenager, the senior author accompanied him on these field trips and pursued the work after Atallah's death collecting many specimens. Thus, both Atallah and Qumsiyeh accumulated valuable specimens, mostly from Bethlehem, Beit Sahour and the valleys to the north and east. In total, specimens examined from the Bethlehem area included 62 reptiles and amphibians, 210 birds, and 150 mammals. The birds collected in the 1960s and 1970s were acquired from local children who hunted them with slingshots. The rodents were trapped and the bats were collected from caves or mist netted in wadis and agricultural areas. The mammal data was partly included in earlier works (Qumsiyeh, 1996). The data concerning birds were never published till now.

The senior author moved to the US in 1979 and returned permanently to Palestine in 2008. Between 2008-2013, we (with volunteers) studied animals in the Bethlehem area returning frequently to locations visited in the 1960s and 1970s. The present paper examines the observations and the data collected in the 1960s/1970s and comparing them to those seen more recently (2008-2013). In total, over 40 distinct collection/observation trips were made in the 1960s/1970s and 35 in the past five years covering the area. The 1960s and 1970s observations where from the eastern area of Bethlehem (roughly Mar Saba in the East and from South Jerusalem (Deir Mar Elias area) north of Bethlehem to Teqo' in the South of Bethlehem). These earlier observations did not cover the Western slopes of the Bethlehem district (a faunistically rich area). So we focused on the 2008-2013 studies on the same areas studied earlier.

Trips in the 1960s and 1970s involved collecting samples of the animals observed (including birds). We did no bird collecting during 2008-2013, but we relied on photography and observations. All vertebrate specimens collected in the two periods are housed in the Palestine Museum of Natural History (over 200 specimens are on loan to the Environmental Education Center in Beit Jala).

Field work generally followed standard procedures (RSCN, 2005). Species were identified according to Qumsiyeh (1996) for mammals, Porter *et al*. (1996) for birds, Disi *et al*. (2010) for reptiles and amphibians. In the past three years, we also added the use of an ultrasound detector to check the species of bats present in the area.

Figure 1. Area of Bethlehem covered in the present study.



Note encroachment of desertification from the East and dense urbanization in the Western areas.

3. Results

Mammals

96 Species of mammals exist in Palestine (Qumsiyeh, 1996) and we recorded 31 of those in the targeted area (Table 1). But things have been changing very rapidly in this region. Thirteen of the 31 species that we noted in the 1960s and 1970s were not recorded by us in the past five years. This may even be an underestimate of the actual changes in the past century. For example, Tristram (1886) noted that *Plecotus auritus* (*Plecotus christie*) is "very common in all the hill country in Palestine especially the caves and tombs around Bethlehem and Jerusalem, and by the Sea of the Galilee" (p. 27). However, we have not noted this species even after an extensive search by using ultrasound detectors that are supposed to distinguish this species.

Out of the 31 species that were collected previously in the study area, 13 species were not recorded and four became rare during the 2008-2013 study. Only rodents including two species known as pests and associated with urbanization (*Mus musculus* and *Rattus rattus*) are still common or observed several times. In addition, the Palestinian Mole, *Spalax leucodon*, is still common. Bats were severely affected, with the absence of 4 species out of seven used to be either common or recorded several times. Similarly, species of carnivores dropped from eight to three species (Table 1). Populations of the Arabian Hare declined drastically to the level that no individuals were observed during the past five years.

Table 1. Mammal species in two different time zones.

Status: 0=Not recorded, 1=Present but rare, 2=Present (more than one observation), 3=Present and common

Family	Species	Common name	1960's-1970's	2008-2013
Erinaceidae	*Erinaceus europaeus*	European hedgehog	3	2
	Hemiechinus auritus	Long-eared hedgehog	2	0
Soricidae	*Crocidura leucodon*	Bicolored White-toothed Shrew	2	2
	Crocidura suaveolens	Lesser White-toothed Shrew	2	0
Pteropodidae	*Rousettus aegyptiacus*	Egyptian fruit bat	3	2
Rhinolophidae	*Rhinolophus blasii*	Blasius's horseshoe bat	2	0
	Rh. hipposideros	Lesser horseshoe bat	2	2
	Rh. ferrumequinum	Greater horseshoe bat	2	0
	Rh. mehelyi	Mehely's Horseshoe Bat	2	0
Vespertilionidae	*Pipistrellus kuhlii*	Kuhl's pipistrelle	3	2
	Plecotus christiei	Gray long-eared bat	1	0
Canidae	*Canis aureus*	Golden jackal	2	0
	Vulpes vulpes	Red fox	2	2
Herpestidae	*Herpestes ichneumon*	Egyptian mongoose	2	0
Hyaenidae	*Hyaena hyaena*	Striped hyena	2	1
Mustelidae	*Martes foina*	Beech marten	2	2
	Meles meles	European badger	1	0
	Mellivora capensis	Honey badger	1	0
	Vormela peregusna	Marbled polecat	1	0
Procaviidae	*Procavia capensis*	Rock hyrax	3	2
Suidae	*Sus scrofa*	Wild boar	1	2
Bovidae	*Gazella gazella*	Palestine Mountain Gazelle	3	1
Muridae	*Acomys dimidiatus*	The Eastern Spiny Mouse	3	3
	Apodemus mystacinus	Broad-toothed Field Mouse	3	2
	Dipodillus dasyurus	Wagner's Gerbil	3	1
	Meriones tristrami	Tristram's Jird	3	0
	Mus musculus	The House Mouse	3	3
	Rattus rattus	The Black Rat	2	2
Spalacidae	*Spalax ehrenbergi*	The Middle East Blind Mole Rat	3	3
Hystricidae	*Hystrix indica*	Indian Porcupine	3	1
Leporidae	*Lepus capensis*	Arabian Hare	2	0

Birds

Palestine is very rich in avifauna with over 530 species recorded. In the Bethlehem area, covered in this study, our examination of the collection maintained and notes and photographs taken by Qumsiyeh and Sana Atallah showed 78 species in the 1960s and 1970s (Table 2; Figure 2). 34 of the 78 species recorded were residents.

More recent observations over the past five years showed less than half the number of these species in the area. Twenty-nine species that were recorded earlier (1960-1970) were not observed accounting for 36% of the known species in the study area. Furthermore, invasive species such as the Hooded Crow (*Corvus corone*) appeared in the Bethlehem area.

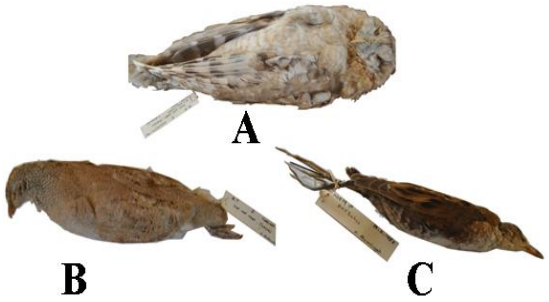


Figure 2. Three specimens of species collected in the Bethlehem area in the 1960s and 1970s. A) Female *Asio flameus*, Deir Mar Saba, 4 Feb. 1965. B) Female *Ammoperdix heyi*, Deir Mar Saba, 4 Feb. 1965; C) Male *Porzana parva*, Beit Sahour, 28 Dec. 1973.

The Yellow vented Bulbul *Pycnonotus xanthopygos* used to be, in the 19th century, more confined to the Jordan valleys or warmer wadies (see Tristram, 1884: p. 57). In the 1970s, we observed this bird, commonly in the uphill country, including the olive groves around Bethlehem in abundant numbers. Now their numbers are much less than before.

Out of the 78 species recorded from the study area, 28 species were not observed during the 2008-2013 study period, including some migrant species such as the Woodlark, Stone Curlew, Red-eyed Dove and the Yellow Hammer.

Table 2. Bird species recorded in Bethlehem district in the 1960s/70s and 2008-2013.

Status: 0=Not recorded, 1=Present, rare, 2=Present (more than one observation), 3=Present Common. M=migrant, M(WV)=migrant/winter visitor, M(PM)=migrant/passage migrant, MB=migrant and breeding, R= Resident.

Family	Species	Common name	Status	1960s-1970s	2008-2013
Accipitridae	*Aquila chrysaetos*	Golden Eagle	R	2	0
	Aquila fasciota	Bonelli´s Eagle	R	1	0
	Buteo rufinus	Long-legged Buzzard	R	2	0
Alaudidae	*Galerida cristata*	Crested lark	R	2	2
	Lullala arborea	Woodlark	M (WV)	2	0
Apodidae	*Apus apus*	Common swift	M	3	3
Burhinidae	*Burhinus oedicnemus*	Stone Curlew	M(PM)	1	0
Ciconiidae	*Ciconia ciconia*	White stork	M(PM)	2	2
Columbidae	*Columba livia*	Rock dove	R	3	3
	Streptopelia decaocto	Collared dove	R	2	2
	Streptopelia roseogrisea	African collared dove	R	2	1
	Streptopelia senegalensis	Palm dove	R	1	0
	Streptopelia semitorquata	Red eyed dove	M	2	0
	Streptopelia turtur	Turtle dove	M(PM)	3	2
Corvidae	*Corvus corax*	Raven	R	1	1
	Corvus corone	Hooded Crow	R	0	3
	Garrulus galandarius	Eurasian Jay	R	3	3
Emberizidae	*Emberiza calandra*	Corn Bunting	M(WV)	2	1
	Emberiza citrinella	Yellow Hammer	M(WV)	2	0
	Emberiza hortulana	Ortolan Bunting	M(PM)	2	1
Fringillidae	*Carduelis cannabina*	Linnet	R	3	1
	Carduelis carduelis	Goldfinch	R	3	0
	Carduelis chloris	Greenfinch	R	3	2
	Fringilla coelebs	Chaffinch	M(WV)	2	1
	Fringilla montifringilla	Brambling	M(WV)	1	1
	Carduelis spinus	Siskin	M(WV)	2	2
	Serinus serinus	Serin	M(WV)	2	0
Falconidae	*Falco tinunculus*	Kestrel	R	3	2
Hirundinidae	*Ptyonoprogne fuligula*	Rock Martin	R	2	1
	Ptyonoprogne rupestris	Pale Crag Martin	M(WV)	2	0
Laniidae	*Lanius excubitor*	Great Grey Shrike	R	2	1
	Lanius minor	Lesser Grey Shrike	M(PM)	2	1
	Lanius nubicus	Masked Shrike	MB	3	2
	Lanius senator	Woodchat shrike	MB	2	1
Motacillidae	*Motacilla alba*	White wagtail	M(WV)	2	2
	Motacilla flava	Yellow Wagtail	M(PM)	2	2

Muscicapidae	*Muscicapa striata*	Spotted Flycatcher	MB	2	1
Nectariniidae	*Nectarinia osea*	Orange-tufted Sunbird	R	3	1
Paridae	*Parus major*	Great Tit	R	3	2
Phasianidae	*Alectoris chukar*	Chukar Partridge	R	3	2
	Ammoperdix heyi	Sand Partridge	R	2	0
	Coturnix coturnix	Common Quail	M(PM)	2	0
Picidae	*Dendrocopos syriacus*	Syrian woodpecker	R	2	0
	Jynx torquilla	Wryneck	M(PM)	2	0
Ploceidae	*Passer domesticus*	House sparrow	R	3	3
Ploceidae	*Petronia petronia*	Rock Sparrow	R	2	0
Prunellidae	*Prunella modularis*	Dunnock	M(WV)	2	0
Pycnonotidae	*Pycnonotus xanthopygos*	Yellow-vented Bulbul	R	3	2
Rallidae	*Porzana parva*	Little crake	M(PM)	1	0
Strigidae	*Asio flammeus*	Short-eared owl	M(PM)	1	0
	Athene noctua	Little owl	R	3	2
	Bubo bubo	Eagle owl	R	1	1
	Otus scops	Scops owl	M(PM)	3	0
Sturnidae	*Sturnus vulgaris*	Common Starling	M(WV)	2	1
Sylviidae	*Cettia cetti*	Cetti´s Warbler	R	2	1
	Hippolais pallida	Olivaceous Warbler	MB	1	0
	Hippolais olivetorum	Olive-tree Warbler	M(PM)	1	0
	Locustella luscinoides	Savi´s Warbler	M(PM)	1	1
	Phylloscopus sibilatrix	Wood Warbler	M(PM)	2	1
	Sylvia atricapilla	Blackcap	M	3	3
	Sylvia curruca	Lesser Whitethroat	M(PM)	3	2
	Sylvia communis	Common Whitethroat	M(PM)	2	2
	Sylvia melanocephala	Sardinian Warbler	R	2	1
Turdidae	*Cercomela melanura*	Blackstart	R	2	1
	Cercotrichus galactotes	Rufous Bushchat	M	2	0
	Erithacus rubecula	Robin	M(PM)	1	0
	Luscinia megarhynchos	Nightingale	M(PM)	2	0
	Oenanthe hispanica	Black-eared Wheatear	M(PM)	3	2
	Oenanthe isabellina	Isabelline Wheatear	MB	2	1
	Oenanthe lugens	Mourning Wheatear	R	2	1
	Oenanthe oenanthe	Eurasian Wheatear	M(PM)	2	2
	Phoenicurus phoenicurus	Common Redstart	M(PM)	5	0
	Phoenicurus ochruros	Black Redstart	M(WV)	2	1
	Saxicola torquata	Common stonechat	M(WV)	2	1
	Turdus philomelas	Song thrush	M(WV	3	0
	Turdus merula	Blackbird	R	3	0
Tytonidae	*Tyto alba*	Barn owl	R	3	1
Upupidae	*Upupa epops*	Hoopoe	MB	3	2

Reptiles and Amphibians

Unlike birds and mammals, we did not perform a complete systematic survey of reptiles and amphibians in the Bethlehem area. We had few observations which are worth mentioning since no previous studies were reported on the herpetofauna of this area. Reptiles we observed and/or collected in the 1960s and 1970s, including *Hemorrhois nummifer* (3 specimens collected on 2.5.1964, and 10.6.1966), *Dolichophis jugularis* (one specimen collected in May 1974), *Stellagama stellio* (dozens of observations and several specimens throughout the year except winter), *Chameleo chameleon*, *Ptyodactylus guttatus* (5 specimens, PMNH R8, on 7.9.1964), *Hemidactylus* sp. (PMNH-R44, on 11.7.1966; PMNH-R57, on 8.10.1976), *Testudo graeca* (common),

Rhynchocalamus melanocephalus (2 specimens, Beit Sahour, in April 1974), *Trachylepis vittata* (4 km NW Beit fajjar 2 specimens PMNH-R34, on 29.3.1966), *Phoenicolacerta laevis* (several observations in the 1970s, one specimen PMNH-R77, on 17.6.1966), *Ophisops elegans*, *Eumeces schneideri* (Beit Sahour, on 6.5.1973), and *Acanthodactylus* sp. (Beit Sahour and Deir Ibn Ubeid, several specimens). We observed all these species in the period 2008-2013. Although these are rather casual observations, they could suggest that reptiles were less vulnerable to the environmental/habitat changes seen here than mammals and birds (see discussion).

However, with amphibians, another story is noted. The Tree Frog, *Hyla savignyi*, was rather common in the areas of Solomons' pools and Artas and declined rapidly over the past few decades. It still occurs in Husan and Battir areas though in small numbers (Salman and Qumsiyeh, In press). In late 2000s, the Islamic Waqf leased the Solomon's pools to developers who established the Bethlehem Convention Center with its various amenities there (opened in 2009). In 2010, the business operators drained and "cleaned" the pools. We have recently reintroduced some tree frogs there (obtained from the nearby area of Wadi Fukeen). The toad *Pseudepidalea viridis* was extremely common in the district in the 1970s. One could observe dozens of these toads everywhere in the fields and even the streets of towns like Beit Sahour and Ubaidya after a good rain. The small winter ponds in the valleys surrounding Jebel Abu Ghnaim teamed with these toads in winter time. That area has ever since been transformed to a large Jewish settlement called Har Homa. Many of the bird species we observed in the 1970s were also observed around Jabal Abu Ghneim.

4. Discussion

Our study is certainly not a comprehensive sampling of the local fauna; but our methods in the 1960s and 1970s are similar to our methods in the many trips during the past 5 years. Thus while perhaps several species could have been missed, the overall picture of the decline we documented is significant especially with regards to mammals, birds and amphibians. Further studies on reptiles are needed. If we treat the data as statistically recorded/not recorded, we find that there was a drop from 31 species to 18 species of mammals, and a drop from 78 species to 50 species of birds (Tables 1 and 2). Amphibians have also declined markedly in the targeted area. The significant decline in vertebrate biodiversity in the Eastern slopes of the Bethlehem district over the past few decades is alarming. Local people lived in harmony with nature for millennia except for a few documented cases of the overuse of the environment; for example in Ain Ghazal in Jordan (Kahler-Rollefson and Rollefson, 1990). The more dramatic changes witnessed in the past 100-150 years are exceptional. The most notable, via looking at statistics and satellite image, is the rampant human population growth and urbanization of the Bethlehem area. As noted, the human population more than tripled between the 1960s and 2008-2013. Land cover changes has also been spectacular. The forested hill of Jabal Abu Ghneim, for example, was transformed to an urban Israeli colony called Har Homa. But other changes are also significant including pronounced impact of global warming (Evans, 2009). The World Bank report in November 2012 on the impact of human induced climate change on the Arab world revealed unsustainable trends. Over the past 20 years, climate monitoring stations across the Arab world have already shown an increase in average annual temperature. Computer models predict that in the next two to three decades annual rainfall will decrease in our area by nearly 25% and average annual temperatures will climb by 4-5 degrees. Climate change makes things far worse because of changes that will impact habitats due to unfamiliar rain patterns (Alpert *et al*., 2002) and the way it will interacts with other issues like urbanization and population shifts (IPCC, 2007; Qumsiyeh, 2013).

Disentangling the causes of declines can be straight forward in some cases and more complicated in others. For example, it is obvious that the Israeli systematic fumigation of caves caused a decline in local bat biodiversity (Makin and Mendelsohn, 1987; Qumsiyeh, 1996; Korine *et al*., 1999). In other cases, it may not be obvious. Yom-Tov (2001) suggested that the decline in the body mass of four species of birds between the 1950s and 1999 is due to global climatic change. Per Bergman's rule, higher temperature can lead to micro-evolutionary changes producing smaller size. But phenotypic plasticity may also play a role in this case (Teplitsky *et al*., 2008) as are other changes in the environment/resource availability. Bilgin *et al*. (2012) used two models and concluded that bat species will be most significantly affected in our area due to climate change. However, caution must be taken in putting out predictive models about the effect of climate change on biodiversity because models cannot take into consideration issues like topography, microclimates, and individual species adaptability (Willis and Bhagwat, 2009). We thus feel that direct studies, like the preliminary study we presented above, are important for monitoring changes in biodiversity.

In the case of the Bethlehem district, we have to consider the geopolitical and population changes. Between 1949-1950, Bethlehem received an influx of refugees removed from their lands to create the Jewish state of Israel. Initially over 50,000 refugees settled in the Bethlehem district but then many moved out. Today, there are over 55,000 of those refugees and their descendants living in the district for a total Palestinian population of the district of 205,000. Since 1967 Israel has also built over 20 settlements in Bethlehem area that now house over 80,000 settlers (ARIJ, 2007).The settlement of Har Homa was built on the previously forested area of Jebel Abu Ghneim between Beit Sahour and Jerusalem which necessitated the destruction of 60,000 trees (ARIJ 2007; see also Qumsiyeh, 2001). The destruction of an environmentally sustainable way of life of the native people forced them to live as semi-urban dwellers in refugee camps or in sprawling suburbs at the edges of large cities (Qumsiyeh, 2004; Qumsiyeh and Issac, 2012). It is these areas that were especially affected by environmental damages and that now include a wall that clearly impacts the environment (Reese, 2003). By

fragmenting habitats, the wall reduces population size and prevents normal movement of wildlife. The wall disrupts the contiguity of natural water flows of streams and springs and this affects vegetation in the area thus effecting fauna.

Similar problems are likely in other areas of historic Palestine and in the nearby areas, like Jordan, where demographic changes have been spectacular in the last few decades. In some other areas, peculiar problems are noted. For example, the draining of the Hula wetlands in the 1950s by the then nascent state of Israel and the diversion of the water from the Jordan River basin created huge environmental problems. 97% of the wetlands in Palestine were drained by Israeli authorities. The idea of large scale manipulation of the Palestinian environment started under the British mandate to fulfill the Zionist ideological desires of transforming the land and the people (Sufian, 2007) but is now compounded by population growth, limited resources and global warming (Qumsiyeh, 2013).

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