

ACTIONS FOR ENVIRONMENTAL SUSTAINABILITY IN WADI AI-ZARQA AL-ULWI



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This project was funded by the Global Environment Facility/Small Grants Programme (UNDP/GEF/SGP) and performed by the Palestine Institute for Biodiversity and Sustainability (PIBS) and the Palestine Museum of Natural History (PMNH) at Bethlehem University (BU) and with collaboration and consultation with the Environmental Quality Authority (EQA) and Ministry of Agriculture.

The information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the UNDP-GEF/SGP.

Table of Contents

Preface	5
1. Introduction	7
2. Literature review	10
2.1 General	10
2.2 Flora	10
2.3 Fauna.....	10
2.3.1. Reptiles and Amphibians	10
2.3.2. Birds.....	11
2.3.3. Mammals.....	11
2.3.4. Invertebrates.....	13
3. Materials and Methods	14
3.1 Vertebrate	14
3.2. Invertebrate.....	16
3.3 Flora and Other	16
4. Results	17
4.1. Area Study.....	17
4.2. Reptiles and Amphibians.....	22
4.3. Birds.....	25
4.4. Mammals	32
4.5. Land Snails	36
4.6. Arachnida	38
4.7. Microfauna.....	38
4.8 Insecta	39
4.9. Others Invertebrates.....	44
4.10. Flora	45
4.11. Threats.....	55
5. Environmental Education and Awareness (EEA)	64
6. Sustainable Economic Development	68
6.1 Tourism	68
6.2 Permaculture.....	68
7. Discussion	70
7.1 SWOT analysis.....	70
7.2 Recommendations and management plan.....	70
7.3 Concluding remarks	72
8. References	75

Preface

This project was performed with funding and supervision from the Global Environment Facility/Small Grants Programme (UNDP/GEF/SGP) by the Palestine Institute for Biodiversity and Sustainability (PIBS) and the Palestine Museum of Natural History (PMNH) at Bethlehem University (BU) and with collaboration and consultation with the Environmental Quality Authority (EQA) and key stakeholders (Ministry of Education, local authorities, farmers, environmentalists and more, see below). The project (PAL/SGP/OP6/Y2/CORE/16/01- Bethlehem University) focused on actions for environmental sustainability through conducting a biodiversity study and developing and implementing strategies to protect the area of Wadi Al-Zarqa Al-Ulwi (henceforth WZU). The project aims included: 1) surveying the fauna and flora of the area to identify the species at risk, 2) Performing a SWOT analysis (strengths, weaknesses, opportunities, and threats) of the area and providing practical recommendations for action that maximize benefit while minimizing use of resources, 3) Reaching out to the community via tested permaculture models and environmental education programs (women, school children, and farmers) to enhance community buy-in and increase community benefits from environmental conservation and 4) Increasing local community and students' public awareness through a series of 10 workshops. The total beneficiaries were 493, including 200 students (more than 50% female) and 293 adults. The two objectives accomplished via education were: a) increased environmental awareness and behavioral change to conserve ecosystems in WZU, and b) introduced methods that improve people's lives and the economy via things like permaculture, recycling, upcycling, and composting (many started implementing these practices).

Many people contributed to the success of this project. From the team of PIBS/PMNH (Figure 1), we thank Zuhair Amr, Elias Handal, Khawla Abualia, Reena Saeed, Mohammad Najajreh, Mubarak Zawahra, Mohammad Abusarhan, Jessie Chang, Anton Khalilieh, Banan Alshaikh, and Taleb Alharethi. Administrative people at BU were very cooperative, especially Luda Mustafa, Diala Awad, George Al-Ali, and Eli Sammour. We thank Nadia Elkhodary GEF/SGP National Coordinator for her time working with us on every stage of this project. We thank the officials of the Environmental Quality Authority who cooperated with us in this project. We thank members and heads of the village councils of Deir Ballot, Kufr Al-Deek, Bruqin, and Bani Zeid villages as well as the mayor and municipal council of Salfit. The Directorate of Education in Salfit Governorate and school officials were particularly helpful in organizing the student workshops. We are also thankful to many local people who facilitated our work, especially Bassem Moussa and his family from Deir Ballout.



1. Introduction

Biodiversity is variably defined as the diversity of living organisms (flora, fauna, and microorganisms) produced via evolutionary diversification and now considered integral to continuing life on earth as we now know it (Wilson and Peter, 1988). In the late 20th century the conservation of biological diversity became recognized as an urgent issue for humanity. This is largely due to scientific observation of significant decline in biodiversity accompanying the industrialization that spread widely in the 19th and 20th centuries. Two key texts emerged from a number of preparatory meetings that rang the danger bell at the global level: Publication of the Global Biodiversity Strategy and the adoption of the Convention on Biological Diversity (CBD) signed at the Earth Summit in Rio de Janeiro (both in 1992). The UN 2030 sustainable development goals added additional mileposts to these calls to action. Palestine was represented at the Seventh Special Session of the Governing Council/Global Ministerial Environment Forum in Cartagena, Colombia, 13-15 February 2002. At that convention, a resolution was adopted concerning the condition of the environment in the Occupied Palestinian Territories (OPT). The Governing Council requested that the United Nations Environment Program (UNEP) carry out a desk study as a first step in the implementation of the decision to support and advance environmental conservation in the OPT. The study identified major areas of environmental threat and lacked detail, but was seminal in the field. (UNEP, 2003), Later, the Environmental Quality Authority performed an expanded desk study in compliance with the Convention on Biological Diversity (EQA, 2015). That report estimated over 50,000 species living in Palestine. The world's protected areas provide a critical safeguard against habitat loss and other human activities that decrease biodiversity (Chape et al. 2008). In this chapter we will review the rich biodiversity areas, including Important Plant Areas (IPAs), Important Bird Areas (IBAs), Wetland, and natural forests and go into the issue of protected areas in OPT. Ghattas et al. (2006) reported on the natural forests and Garstecki et al. (2010) on the status of the protected areas. Both commented on need for additional information.

48 natural reserves were declared in the West Bank per Israeli authorities after 1967 These reserves have a total area of 69,939 hectares and constitute 12.35% of the total area of the West Bank. However, the National Spatial Plan indicates that the total area of natural reserves in the West Bank is only 51,157 hectares, or 9% of the total area of the Palestinian Territories. (Isaac and Hilal, 2011). More recent detailed studies from ARIJ show a total of 576,491 dunums of Israeli designated protected areas forming 10.2% of the West Bank region. (ARIJ 2015). Only 13 reserves are within the Area B and under Palestinian control, accounting for 1.3% of the total reserve area (5th National Report to CBD; EQA, 2015). The Palestinian Authority has expressed concern that some of these protected areas have been established mainly for Israeli security, military objectives, and settlements, rather than conservation goals (UNEP, 2003). Most of the protected areas designated by the ministerial committee in 2015 fall in the Northern West Bank. Wadi Ain Al-Zarqa Al-Ulwi محمية وادي عين الزرقا العلوي (Figure 2) is an important reserve in this area, designated by GEF/SGP as a critical area for funding pilot and protection projects. We selected Wadi Al-Zarq Al-Ulwi for our project, because it is little studied in comparison to Wadi Quff which is the first protected area for which a management plan was generated as a result of a scientific study.

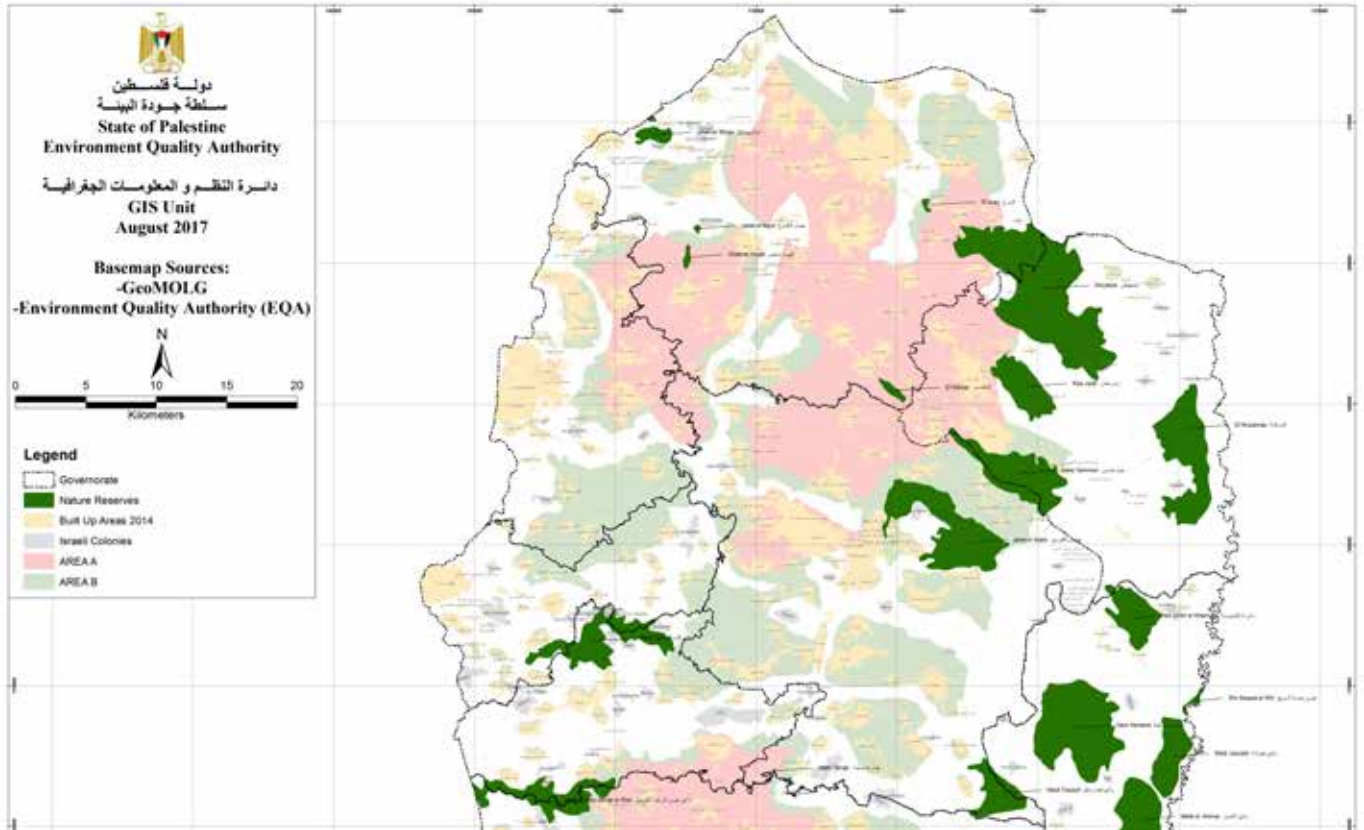


Figure 1. Protected areas in northern West Bank including WZU PA..



Figure 2. Protected areas approved by the State of Palestine in the Ramallah district and this include WZU PA which is shared with Salfit governorate.

Palestine was represented at the Seventh Special Session of the Governing Council. At that time, a resolution was adopted concerning the situation of the environment in the Occupied Palestinian Territories (OPT). The Governing Council of the Global Ministerial Environment Forum in Cartagena, Colombia requested that the United Nations Environment Program (UNEP) carry out a desk study as a first step in implementing the decision to support and advance environmental conservation in the OPT

(UNEP, 2003). Since then much has happened, especially in the last three years, including the first detailed study by Palestinians of a particular protected area (Wadi Al-Quff, see Qumsiyeh et al., 2016) and a detailed report on the status of the Palestinian Environment (ARIJ, 2015). The Environmental Quality Authority of the Palestinian Authority issued the most detailed report (the fifth report) in compliance with the Convention on Biological Diversity (EQA, 2015), which emphasized the importance of undergoing objective studies of the fauna and flora in the rich biodiversity areas in Palestine. Additionally, we just completed a most detailed survey of status of environmental conservation and protected areas in Palestine (Qumsiyeh and Amr, 2016a).

Upon reexamination of available data and needs in Palestine, the Global Environment Facility (GEF of UNDP) issued a call for proposals (small grants program 6th operational phase) that focus on environmental protection and include account biodiversity and socio-economic and educational aspects in four areas in the Occupied Palestinian Territories: Gaza, Wadi Al-Quff, Al-Jalaboun, and Wadi Ain Al-Zarqa Al-Ulwi (Wadi Suraidah). We have extensively studied Wadi Al-Quff and helped draft a management plan via our studies on fauna. Gaza is off limits to us from the West Bank. The two other areas need significant studies of fauna and flora and a plan of management that takes into account local socioeconomic factors. We choose to focus on WZU because we have some preliminary data of the presence of endangered species (e.g. *Pipistrellus pipistrellus*) and because of the significant threats to the biodiversity of the area.

Project objectives

- Conduct faunal and floral biodiversity studies in the study area.
- Determine the most threatened and endangered species according to the IUCN Red Data Book
- Identify threats to the existing ecosystems
- Environmental awareness and education in the area to achieve sustainability

2. Literature Review

2.1. General

Palestine connects Africa with Eurasia and is in the western part of the Fertile Crescent where the first humans migrated out of Africa and agriculture first developed. The geologic activities over the past 100 million years, especially the formation of the Great Rift Valley, ensured varied and rich topography. This resulted in a burst of speciation, producing many endemic species of plants and animals inhabiting five ecozones and four biogeographical regions (Por, 1975; Qumsiyeh, 1985, 1996).

Studies of biodiversity in the Occupied Palestine Territories (OPT) have been limited in contrast to the nearby areas of Palestine and Jordan. Research in general still lags behind in the OPT (Qumsiyeh and Isaac, 2012). The area has been sporadically studied before by visitors to the "Holy land" from Tristram (1866, 1884) to Morton (1924) to David Harrison in the 1960s (Harrison and Bates, 1991). In the 1950s and 1960s there were some studies of fauna and flora conducted by Israelis. The most notable of these was the series "Fauna Palaestina" issued by the Israel Academy of Sciences (e.g. Levy and Amitai, 1980; Tchernov and Yom-Tov, 1988; Zohary, 1966, 1972). Israeli academics publish mostly in areas within the Green line and the Palestine Museum of Natural History, founded in the West Bank, publishes in the area of the West Bank (e.g. see list of published work posted at <https://www.palestinenature.org/research/>). The area of the Gaza Strip has been ignored and isolated by research.

Palestine has a rich fauna and flora in spite of its small area due to its geographical position as a meeting point between Asia and Africa, and Europe where four biogeographical regions found: the Mediterranean, Irano-Turanian, Saharo-Arabian and Sudano-Ethiopian (Qumsiyeh, 1996). The Palestinian environment as experienced declines in biodiversity due to a combination of factors that destroy habitats (Amr et al. 2016; Hammad and Qumsiyeh, 2013; Khlaif and Qumsiyeh, 2016; Qumsiyeh

2.2. Flora

Most studies on the flora of the West Bank were conducted inside the Green Line (Zohary 1966, 1972, 1973; Feinbrun-Dothan, 1978 and 1986; Danin 1992; Al-Shaikh et al., 2000). Previous studies, when consolidated, would suggest roughly 2000 species of plants in the WB & Gaza Strip which is about 75% of species found in Mandatory Palestine (Boulos 1997, Danin 2004; and Görlach et al., (2011). Yet, much more work is needed in this area and hardly any work was done previously (and if it was done it is un-published) in WZU protected area or its vicinity

2.3. Fauna

2.3.1. Reptiles and Amphibians

Salman et al. (2014) reported four species of frogs and toads in the vicinity of WZU (Table. 1). *Pelobates syriacus* is currently extinct from Jordan and threatened in the West Bank Palestine, where it found only in Jinsafut near Wadi Qana and may occur in the temporary rainwater ponds that accumulate near Wadi Ain Al-Zarqa Al-Ulwi PA.

Family	Common Name	Scientific Name	IUCN Status
Bufo nidae	Variable Green Toad	<i>Bufo</i> tes variabilis	LC
Pelob atidae	Syrian Spadefoot	<i>Pelobates syriacus</i>	LC
Ran idae	Levant Green Frog	<i>Pelophylax bedriagae</i>	LC
Hyl idae	Tree Frog	<i>Hyla savigni</i>	LC

Table 1. Amphibians reported WZU and surrounding areas.

Palestine has nearly 100 species of reptiles, which are fairly well studied except in the West Bank and Gaza strip (see Werner 2016 and copious references therein). Handal et al. (2016) made the first study specifically focused on the West Bank with records from WZU and surrounding areas (Table 2).

Family	Common Name	Scientific Name	IUCN Status
Chamaeleonidae	The European chameleon	<i>Chamaeleo chamaeleon</i>	LC
Gekkonidae	Fan-fingered Gecko	<i>Ptyodactylus guttatus</i>	LC
Gekkonidae	Mediterranean Thin-Toed Gecko	<i>Mediodactylus kotschy</i>	LC
Lacertidae	Snake-eyed Lizard	<i>Ophisops elegans</i>	LC
Lacertidae	Lebanon Lizard	<i>Phoenicolacerta laevis</i>	LC
Scincidae	Ocellated Skink	<i>Chalcides ocellatus</i>	LC
Scincidae	Rueppel's Snake-eyed skink	<i>Ablepharus rueppellii</i>	LC
Colubridae	Large Whip Snake	<i>Dolichophis jugularis</i>	LC
Colubridae	The Coin Snake	<i>Hemorrhois nummifer</i>	LC

Table 2. The reptiles known to occur in WZU area according to Handal et al. (2016).

2.3.2. Birds

Birds are the most visible of the Palestinian fauna and much earlier scientific work was done on them. Unlike the studies of other groups, there were also "layman" books and booklets published about birds (Kharoob, 1992, Awad, 2009). Brett (1988) reported on the birds of prey in Palestine. The birds of Gaza Strip were studied on several occasions. Abu Shammalah and Baha El-Din (1999) gave an account of the birds of Gaza. Rabou et al., (2015) recorded 118 bird species. Al-Safadi (1997) presented a comprehensive study on the breeding cycle of the Spur-winged Plover, *Hoplopterus spinosus*, in the sewage lagoon of Beit Lahia, Gaza Strip. So far, 373 bird species belonging to 23 Orders, 69 families, 21 Subfamilies, and 172 genera have been recorded from Palestinian areas (Awad et al., 2016).

2.3.3. Mammals

The most comprehensive study on mammals of the West Bank dates to the 1960s and 70's (see Atallah 1977, 1978 and references there in) and included both the West Bank and surrounding countries. Later, Qumsiyeh (1996) included many records on the mammals of Palestine and Jordan. Mendelssohn and Yom-Tov (1999) published data on Palestine, where they listed more than 90 species of mammals. Based on these and other reference studies we note WZU could have the species listed in Table 3. This present study and others showed that there is much unknown about the mammalian fauna in the West Bank.

Order	Scientific Name	Common Name	
Eulipotyphla	<i>Erinaceus concolor</i>	Southern White-breasted Hedgehog	
	<i>Hemiechinus auritus</i>	Long-eared Hedgehog	
	<i>Crocidura leucodon</i>	Bicoloured White-toothed Shrew	
	<i>Crocidura suaveolens</i>	Lesser Shrew	
	<i>Suncus etruscus</i>	Pygmy White-toothed Shrew	
Chiroptera	<i>Eptesicus serotinus</i>	Serotine	
	<i>Myotis nattereri</i>	Natterer's /bat	
	<i>Pipistrellus kuhlii</i>	Kuhl's Pipistrelle	
	<i>Rhinolophus blasii</i>	Peter's Horseshoe Bat	
	<i>Rhinolophus ferrumequinum</i>	Larger Horseshoe Bat	
	<i>Rhinolophus hipposideros</i>	Lesser Horseshoe Bat	
	<i>Rhinolophus mehelyi</i>	Mehely's Horseshoe Bat	
	<i>Rosettus aegyptiacus</i>	Fruit Bat	
	<i>Tadarida teniotis</i>	European Free-Tailed Bat	
	Carnivora	<i>Canis aureus</i>	Golden Jackal
<i>Canis lupus</i>		Wolf	
<i>Caracal caracal</i>		Caracal	
<i>Felis chaus</i>		Jungle Cat	
<i>Felis silvestris</i>		Wild Cat	
<i>Herpestes ichneumon</i>		Egyptian Mongoose	
<i>Hyaena hyaena</i>		The Striped Hyena	
<i>Martes foina</i>		Stone Marten	
<i>Meles meles</i>		The common Badger	
<i>Vormela peregusna</i>		Marbled Polecat	
<i>Vulpus vulpus</i>		Red Fox	
Artiodactyla		<i>Gazella gazelle</i>	Mountain Gazelle
		<i>Sus scrofa</i>	The Wild Boar
Rodentia	<i>Acomys cahirinus</i>	Porcupine Mouse	
	<i>Apodemus flavicollis</i>	Wood Mouse	
	<i>Apodemus mystacinus</i>	Broad Toothed Field Mouse	
	<i>Cricetulus migratourius</i>	The Gray Hamster	
	<i>Gerbillus dasyurus</i>	Wagner's Gerbil	
	<i>Hystrix indica</i>	Indian Crested Porcupine	
	<i>Meriones tristrami</i>	Tristram's Jird	
	<i>Mesocricetus auratus</i>	Golden Hamster	
	<i>Mesocricetus socialis</i>	?	
	<i>Microtus guentheri</i>	Mediterranean Vole	
	<i>Mus musculus</i>	House Mouse	
	<i>Sciurus anomalus</i>	Syrian Squirrel	
	<i>Spalax leucodon</i>	The Mole Rat	
Leporidae	<i>Lepus capensis</i>	Cape Hare	

Table 3. Mammals predicted to occur around WZU and surrounding areas based on biogeographical indicators.

2.3.4. Invertebrates

Very limited information is available on the invertebrates of the West Bank. Previous studies on the freshwater snails of Palestine include Tristram (1884) and Germain and de Kerville (1922). Azim and Gis-mann (1956) included data on freshwater snails collected from the West Bank during a study on the snail intermediate host for schistosomiasis in south-western Asia. Recent studies on the snails of the genus *Melanopsis* including records from the West Bank were published by Heller et al. (2005). Recently Bdir and Adwan (2011, 2012) investigated the presence of larval stages of trematodes among freshwa-ter snails collected from the Palestinian Territories. A recent study by Handal et al. (2016) reported on the taxonomy and distribution of the freshwater snail fauna in the Palestinian territories. A total of 10 spe-cies of freshwater snails belonging to four families (*Neritidae*, *Melanopsidae*, *Pulmonata* and *Thiari-dae*) in seven genera (*Galba*, *Haitia*, *Lymnaea*, *Melanoides*, *Melanopsis*, *Pseudoplotia*, and *Theodoxus*) were collected.

Palestine's scorpions were studied by Levy and Amitai (1980). Qumsiyeh et al. (2013) reported on a col-lection of scorpions from the occupied Palestinian territories, including the first karyotypes of spe-cies from the Eastern Mediterranean region. We later published a paper on a species of scorpion from the protected area of Wadi Al-Quff (Qumsiyeh et al., 2014b).

The Palestine Museum of Natural History (PMNH) started to collect invertebrates since 2013 for sci-en-tific studies. This resulted in a number of scientific publications on butterflies, freshwater snails, grass-hoppers, scorpions and dragonflies (Qumsiyeh et al., 2013; Handal et al., 2015; Abusarhan et al., 2016; Qumsiyeh et al., 2014; Adawi et al., 2017; Abusarhan et al., 2017). These studies show high biodi-versity and ongoing habitat destruction.

3. Materials And Methods

3.1 Vertebrates

The assessment included comprehensive multi database review of literature, rapid diagnosis field visits in addition to surveying species diversity, small mammals trapping, and line transects to study reptilian diversity.

The following methods were used to document the mammals and reptiles of the study area:

- **Field observations:** in this method, the site was examined carefully for the presence of active animals, animal signs and tracks, active burrows, remains or any other vital signs that indicate the activity of animals. Bat echolocation was recorded to determine species
- **Trapping:** Sherman traps were used (Figure 3) to trap small mammals and camera traps for large mammals.
- **Line transects:** many transects of over 100 m long each were undertaken to study the presence of reptiles. Observed species were recorded and photographed as possible.
- **Literature and previous records:** This is based on personal field data obtained through extensive studies on the fauna of Jordan, as well as on previous records available in published scientific papers. All available data known in the study area and adjacent regions were tabulated.
- **Species status:** Global species conservation status was assigned according to the IUCN Red Data Book (2016). For the regional status we relied on Dolev & Perevolotsky (2004).

Field work for birds covered the breeding season and the spring and the winter migration seasons. Three different methods were used to study the birds of the site; for the bird baseline and breeding bird survey we used point counts and line transects where 54 points were chosen (Bibby et al. 2000) For the survey and monitoring of soaring birds a vantage point count was used. The 54 point counts cover the whole area of WZU and its surrounding areas that have a high potential of finding important breeding bird species.

All habitats of WZU PA and its vicinity were covered. During the survey, researchers were equipped with binoculars, telescope, digital camera with telephoto lens, mp3 player and speakers, bird calls, bird field guide, GPS, notebook and data sheet. The researcher recorded the common name of the species, its location, the bird's status, and when possible a picture of the recorded birds. Additionally, any observation of roosting birds (soaring birds) and their location during this survey was recorded. All birds heard (singing or calling) and/or seen, were recorded. Line transects were created between these point counts and the researcher moved from one-point count to the other using these lines, whenever is possible.

In addition, any casual or opportunistic observation of birds obtained while walking/driving to the point counts, during walks carried out within the protected and its vicinity were recorded and added.

The breeding bird survey was combined with the baseline survey during the spring season and extended to the third week of May. The field activities for all vertebrates were followed by data verification, normalization and analysis to establish proper description of the ecological character of the study area (Figure 4).



Figure 3. Sherman traps that used to trap small mammals



Figure 4. Collecting specimens and ecological data sometimes by hand. Amphibian eggs.

3.2. Invertebrates

Butterflies and other flying insects were captured with a butterfly net. To collect moths, a fluorescent light was placed at night in promising locations near wooded areas and with a white cloth under it. This attracts moths, which then can be picked up into containers directly or transferred to containers via aspirator. Other arthropods were simply picked up from substrates and plants they feed on. Insects were killed in killing jars or by freezing and all other preparations done by standard zoological methods (Millar et al. 2000). Scorpions were collected via turning over rocks and other objects they use to hide under during daytime or by sweeping the area using a UV light at nighttime (usually 10 PM to midnight). Spiders were collected from under rocks, among plants. Snails were simply picked up where they occur (usually under rocks, in crevices, around trees or shrubs). In winter, slugs and active snails were noted and photographed. A hand held lens was used for smaller snails. Other methodologies for mollusks (collecting, cleaning, preservation, storage) followed standard protocols (Millar et al., 2000; Sturm et al., 2006; Geiger et al., 2007).

Species were identified using standard keys and works (e.g. Vachon 1966, 1974; Levy 1985, 1988; Levy and Amitai 1980; Amr and Abu Baker 2004; Heller 2009; Sama et al., 2010). For many specimens, processing was done at Palestine Museum of Natural History (PMNH), including our nascent Palestine Bio-diversity Research Center (PBRC) and the Bethlehem University laboratories for genetic studies. Some voucher specimens were kept or photographs stored for future work/publication at PMNH and PBRC. For more on other field and laboratory methodologies see RSCN (2005).

3.3 Flora and Other

The site was surveyed for geological, geographic and botanic attributes focusing on biodiversity surveys by the methods of Hill (2005). Plant species occurrence and biodiversity monitoring was done mostly in spring 2017 using techniques such as those explained in Ansari (2017). Data collected include number of species occurring along these transects, coverage interception per species, and maximum height, which was then analyzed using such keys and descriptions as found in Zohary (1966, 1972). We also observed several species of fungi (including mushrooms).

4. Results

4.1. Area Study

We will describe the topography, geography, geology (Figure 8-10), and fauna and flora from information gathered during the 21 trips we took to the area. We will also describe threats to biodiversity. The studied area falls within Salfit district, located to the north west of Ramallah and surrounded by seven villages; Deir Ballout, Kufr al-Deek, Brukin, Deir Ghasana, Beit Rima, Abud, and Rantis (Figure. 5 and 7). The total area is 9,740 dunums. The handed over area is about 2700 dunums, which includes hills with *Quercus calliprinus* woodland on limestone baserock and disturbed areas with significant agricultural intrusions.

According to Garstecki et al. (2010), the area is classified as Category IV (Managed Reserve), which means that it is managed by land owners in collaboration with the Ministry of Agriculture. Core areas (along the slopes) within this Managed Reserve could be designated as IUCN Category I (Strict Nature Reserve). Most of the land ownership is private.

The protected area is roughly 2700 dunams of the valley, with several villages and the city of Salfit located at the periphery of the protected area. We worked with five local municipalities (Deir Ballout, Bruqin, Kufr Deik, Deir Ghassaneh, Salfit), the Ministry of education, the Environmental Quality Authority, and the Governorate of Salfit to prepare the educational workshops and to gather the needed data. We also referenced data available in the literature, like the Applied Research Institute-Jerusalem published village profiles.

Table 4 illustrates percentage of people working in agriculture in the different areas according to these studies

	Area (dunum)	Population	Work in Agriculture
Salfit	26,123	8,905	30%
Kufr Al Deek	15,529	4,494	3%
Bruqeen	12,285	3,194	38%
Deir Ballut	11,898	3,154	35%
Bani Zaid (Deir Ghassaneh and Beit Rima)	21,978	5,184	10%

Table 4. Human population size and % working in agriculture in the area.

Poverty levels are high (15.1%) and the area suffers from the presence of an industrial settlement (Barqan Industrial Zone) housing pollutant producing industries like leather and plastics. A study from our laboratory at Bethlehem University showed that these pollutants produce chromosome breaks and DNA damage in high levels compared to a control site (Hammad and Qumsiyeh, 2014). Further, there is also significant runoff of sewage mixing with spring water, which affects sensitive animals like amphibians (data from our work see Salman et al., 2014).

The confiscation of Ras Imweis and six adjacent areas of the WZU watershed is an example of taking land designated as "nature reserve" for the sake of Israeli settlements. Nahal Shilo has a total land area of 15134 dunums, (15.1 km²). According to the Oslo II interim agreement of 1995, the land on which Nahal Shilo nature reserve stands is classified into areas A, B and C, where 340 dunums (2.2% of the total nature reserve area) is classified as area A and 2862 dunums (16% of the total nature reserve area) is classified as area B. The remaining area of the Nature reserve, which amounts to 11932 dunums (78.8% of the total nature reserve area) is classified as area C. Despite such classification, Israel administers and manages the entire nature reserve and Palestinian administration (Nahal Shilo) is totally prevented" (POICA, 2013)



Figure 5. Location of Wadi Al-Zarqa.

In surveying the localities near the protected area, the most significant biodiversity rich area we found is in the eastern edge of Deir Ballout where we noted a rainwater fed temporary (winter) pond (Figure 6) that harbors the unique crustaceans *Lepidurus apus* and *Triops cancriformis*, a food source for local amphibians and migrating birds. We think this area as a transitional buffer zone should be included in the management plan/protection recommendations of this area (see discussion and SWOT and recommendations below).



Figure 6: Urbanization and agricultural expansion close to natural breeding sites in Deir Ballout.

Wadi Al-Zarqa is about 20 Km long and lies within rugged mountains (400-270m asl) and a deep Valley (120-250 m asl), which exposes a broad range of geologic strata. The area covers diverse habitats including urban areas, natural forests, cultivated fields, and rocky outcrops.

Wadi Al-Zarqa is within in the Mediterranean zone. This zone represents most of the Palestinian Territory, extending from Hebron across Jerusalem and north to Jenin. Soil type is dominated by terra rossa and pale rendzinas with patches of grumusols, brown and pale rendzinas, and solonchalks. Annual rainfall ranges from 400-700 mm, with occasional snowfall. Average minimum temperature ranges from 8-12o C during winter and average maximum temperature ranges from 22-28o C in summer. Forests with-

in this area include *Ceratonia siliqua*, *Pinus halepensis*, *Pistaci alentiscus*, *Pistacia palaestina*, *Quercus caliprinos*, *Rhamnus palaestinus*, with shrubs including *Sarcopoterium spinosum* and *Retama raetam* (Zohary, 1947; Ghattas et al., 2006).

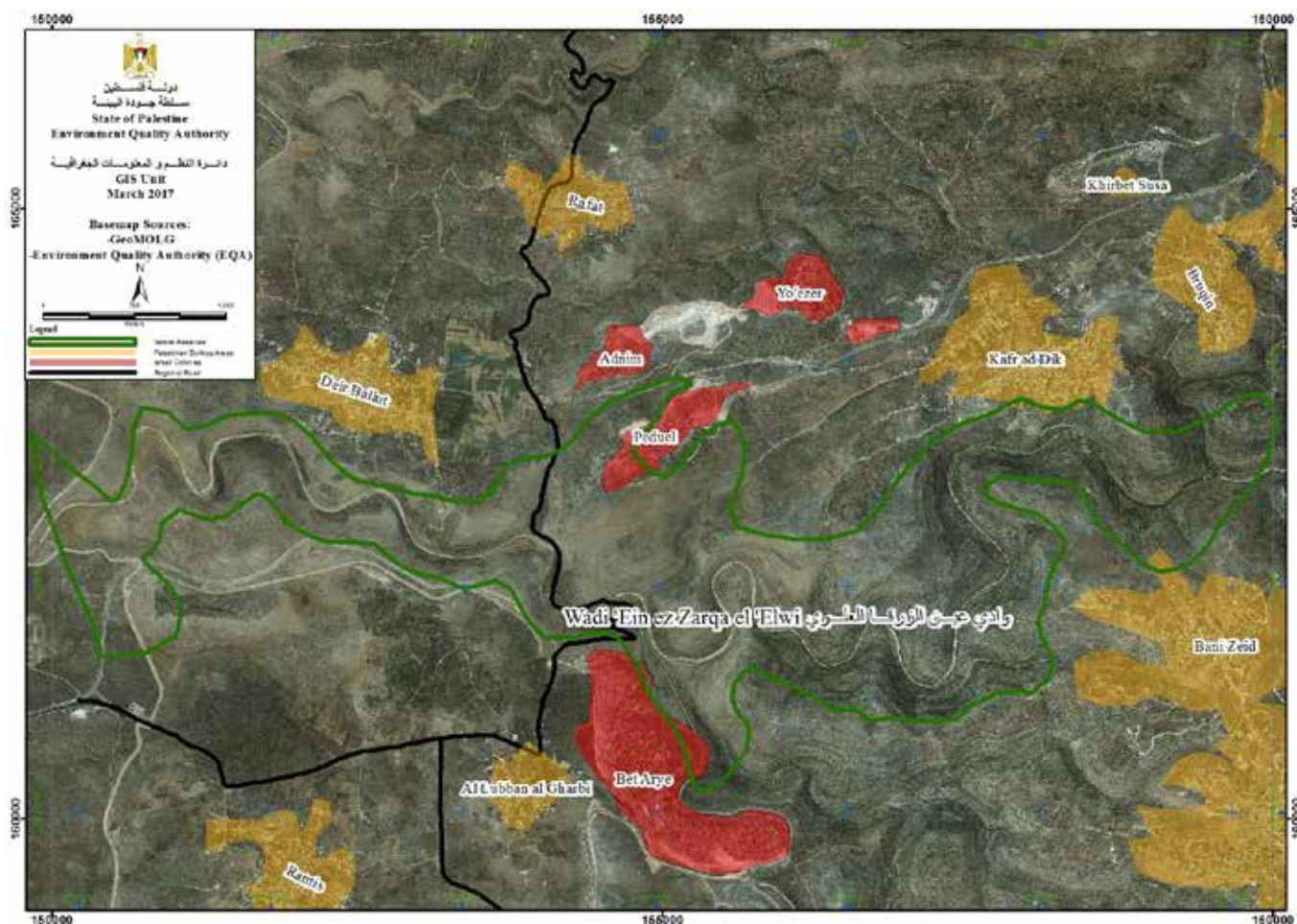


Figure 7: Map to Wadi Al Zarqa area showing adjacent villages.

The core of the Mediterranean area is primarily composed of maquis and forests of *Ceratonia siliqua* and *Pistaci alentiscus*. Semi-steppe garigue and steppe vegetation also surrounds the eastern borders of the arid regions in the Mediterranean zone (Danin, 1992). Several types of habitats can be observed within the Wadi including a karst formation in Bruqin (Figure 8), lime stones and habitat fragmentation in Dayr Balout (Figure 9,10), and areas with olive trees and sparse oak trees in Kufir Al Deek.



Figure 8. Karstic formation at Bruqin.



Figure 9. Lime stone formation at Dayr Balout.



Figure 10. Deir Ballout Valley from the main karstic cave.

The wadi system can be divided into two sections; the western part that extends along the boundaries of Deir Ballout to the extreme west reaching the Separation Wall. This area is arid with very few or no trees. In general, the northern edges of the wadi are more rocky than the southern edge, with very scattered and dead bushes of *Rhamnus palaetisna* in most of the wadi. To the most western side, close to the separation wall, *R. palaetisna* becomes denser and healthier. The separation wall surrounds the wadi system from the west and the south. The wadi bed is about 12-30 meters wide, covered with

rounded rocks. Olive trees are planted in open areas around the wadi bed, but become less to the west. In the entire western side, we were not able to find trees except *R. palaetisna* and a few *Amygdalus communis* (Figure 11).

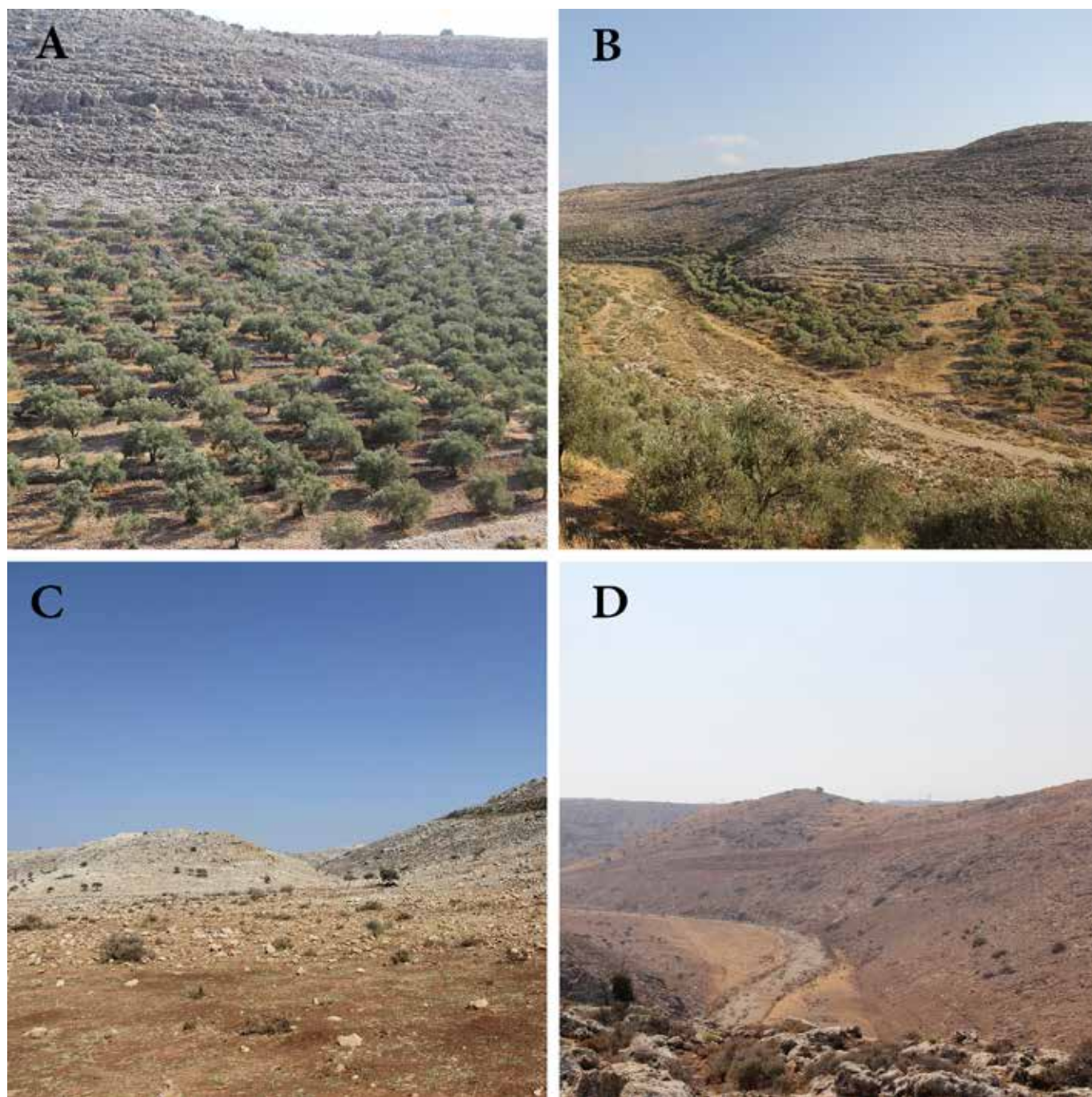


Figure 11. Habitats in eastern section of WZU.

The eastern part of the wadi is more densely vegetated by a secondary growth of evergreen oak, *Quercus calliprinos*, and mixed *Pistacia lentiscus* and *Pistacia palaestina*, few stands of Carob, *Ceratonia siliqua*, and relatively obvious but scattered *Crataegus aronia* and *Rhamnus palaetisna*. The plains and slopes of the wadi and are cultivated with olive trees. The middle part of this section supports dense vegetation around its natural drainage due to formation of pools filled with sewage water (Figure 12).

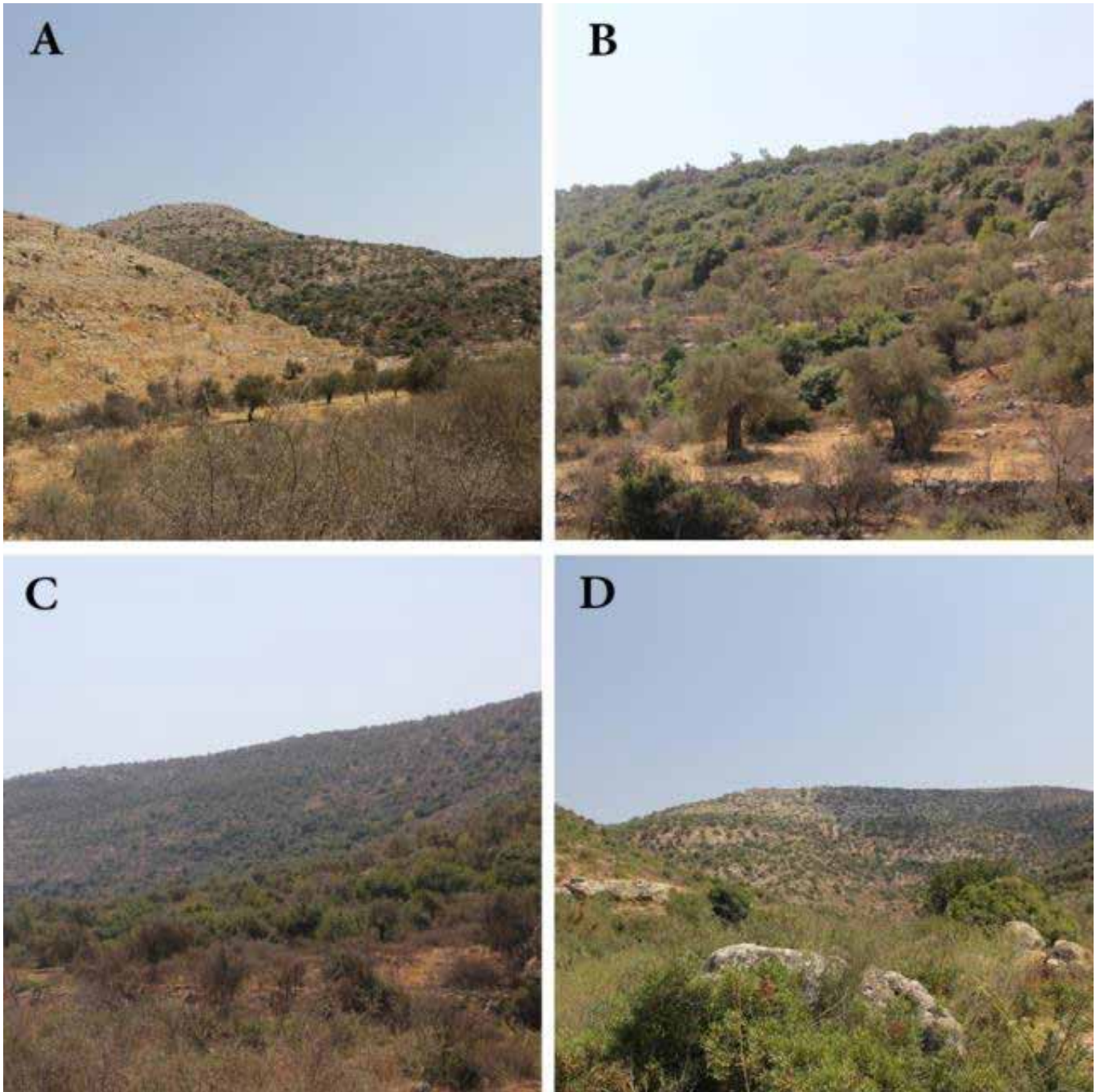


Figure 12. Habitats in eastern section of WZU.

4.2. Reptiles and Amphibians

Eleven species of amphibian and reptiles were identified in the study area (Table 5, Figure 13). Of the amphibians, the Syrian Spadefoot Toad is of conservation value and is considered critically endangered in this regional, since its population is declining in the West Bank largely due to water management issues and agricultural practices (Gafny and Gasith, 1986/1987) and was extirpated from Jordan (Disi 2002). The Spur-thighed Tortoise is another species of concern, as it is captured and traded as a and as a result is listed globally and regionally as vulnerable. Regionally, both the European Chameleon and Rueppels Snake-eyed Skink are also listed as vulnerable (Table 6).

Family	Scientific Name	Common name	الاسم العربي	Location
Bufo idae	<i>Bufo variabilis</i>	Green Toad	علجوم اخضر	Kufr Al Deek
Agam idae	<i>Agamstellio stellio</i>	Starred Agama	حردون	All the Valley
Testudin idae	<i>Testudo graeca terrestris</i>	The Spur-thighed Tortoise	سلحفاة مهمازية الورك	Dayr Ballout/Kufr Al Deek
Gekkon idae	<i>Mediodactylus kotschy</i>	Kotschy's Gecko	برصعة كوتشياي	Kufr Al Deek
Phyllodactyl idae	<i>Ptyodactylus guttatus</i>	Sinai Fan-fingered Gecko	برصعة مروحية القدمين	Dayr Ballout/Kufr Al Deek
Scinc idae	<i>Ablepharus rueppellii</i>	Rueppels Snake-eyed Skink	سحلية روبيلي ثعبانية العين	Dayr Ballout/Kufr Al Deek
Lacert idae	<i>Phoenicolacerta laevis</i>	Lebanon Lizard	سحلية لبنان	Dayr Ballout/Kufr Al Deek
	<i>Ophisops elegans</i>	Snake-eyed Lizard	السحلية الأنيقة	Dayr Ballout/Kufr Al Deek
Chamaeleon idae	<i>Chamaeleo chamaeleon</i>	European Chameleon	حرباء	Kufr Al Deek
Colubr idae	<i>Eirenis decemlineata</i>	Narrow-striped Dwarf Snake	حية السلام المخططة	Dayr Ballout
	<i>Eirenis rothi</i>	Roth's Dwarf Racer	حية السلام مخططة الرأس	Dayr Ballout

Table 5. List of Reptile and Amphibians that found in the area.

Scientific Name	Common Name	IUCN Status	
		Global	Regional
<i>Bufo variabilis</i>	Green Toad	DD	NE
<i>Pelobates syriacus</i>	Syrian Spadefoot Toad	LC	CR
<i>Agamstellio stellio</i>	Starred Agama	LC	LC
<i>Testudo graeca terrestris</i>	The Spur-thighed Tortoise	VU	VU
<i>Mediodactylus kotschy</i>	Kotschy's Gecko	LC	LC
<i>Ptyodactylus guttatus</i>	Sinai Fan-fingered Gecko	LC	LC
<i>Ablepharus rueppellii</i>	Rueppels Snake-eyed Skink	LC	VU
<i>Phoenicolacerta laevis</i>	Lebanon Lizard	LC	LC
<i>Ophisops elegans</i>	Snake-eyed Lizard	LC	LC
<i>Chamaeleo chamaeleon</i>	European Chameleon	LC	VU
<i>Eirenis decemlineata</i>	Narrow-striped Dwarf Snake	LC	LC
<i>Eirenis rothi</i>	Roth's Dwarf Racer	LC	

Table 6: Conservation status of reptiles and amphibians collected from WZU.

Interviews with the locals revealed and confirmed the presence of the European Glass Lizard, *Pseudopus apodus* and the Palestine Viper, *Daboia palaestinae*. Photos for the Bridled Skink, *Trachylepis vittata*, taken from WZU were presented to us. Yet, with further investigation, more reptiles are expected to be found in WZU, including snakes and other geckos.

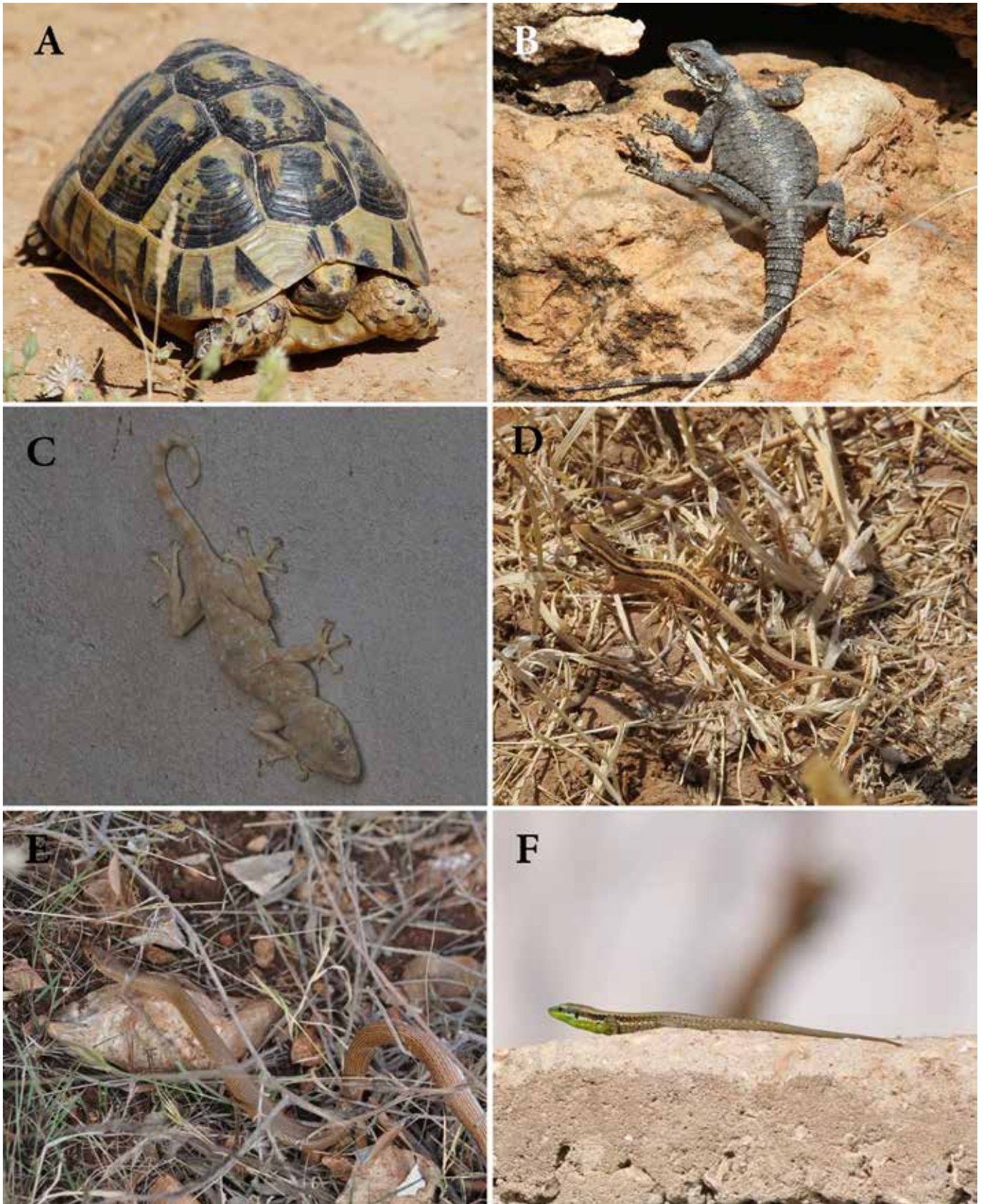


Figure 13. Some reptiles from WZU. A. The Spur-thighed Tortoise. B. Starred Agama. C. Sinai Fan-fingered Gecko. D. Snake-eyed Lizard. E. Narrow-striped Dwarf Snake. F. Lebanon Lizard.

4.3. Birds

A total of 88 species of birds were observed and identified along Wadi Al Zaraq (Table 7) Figure 16,17,18). Species of family Passeriformes were the most dominant and comprised 66% of observations, followed by species of family Falconiformes (7%). Families Cuculiformes, Galliformes, Gruiformes Strigiformes, and Pelecaniformes were the least common species, and were represented by a single species for each family (Figure 14).

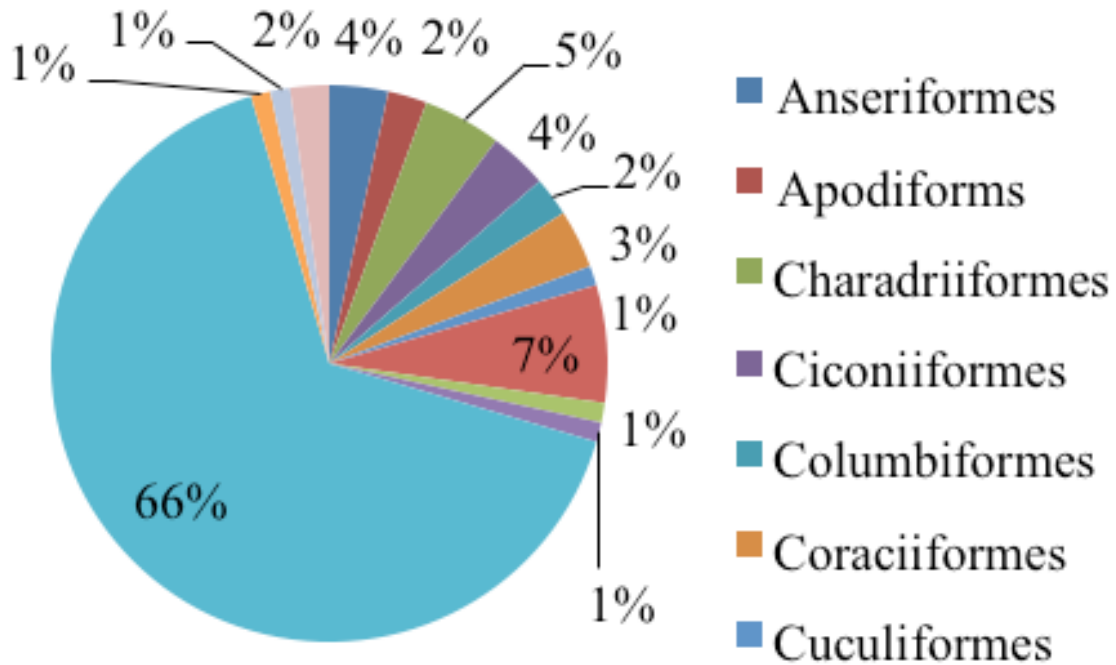


Figure 14. Species representation by families in WZU.

By status, the majority of birds recorded from the study site are passage migrant (42%), while 24% are considered as resident breeders (Figure 15). The invasive species, the common Myna, *Acridotheres tristis*, was found mostly in the surrounding villages.

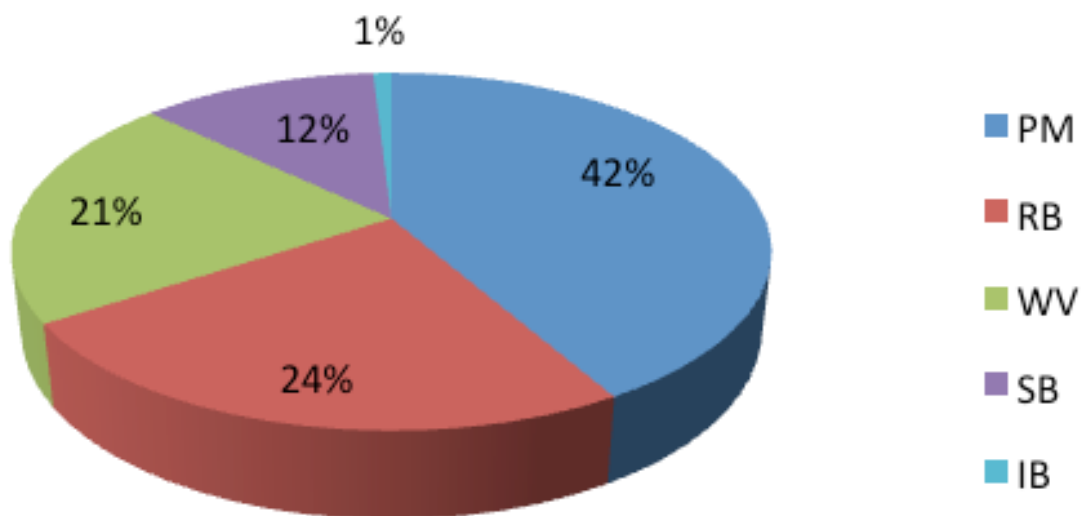


Figure 15. Status of birds recorded from WZU. IB: Invasive breeder, RB: Resident breeder, PM: Passage migrant, SB: summer visitor breeder, WV: Winter visitor and breeder.

Species of conservation status according to the global IUCN assessment include the European Turtle Dove (VU), and four near threatened species (Northern Lapwing, Cinereous Bunting, Meadow Pipit and the Western Cinereous Bunting). The regional assessment regarded the European Bee-eater and the Little Swift as (VU), while the Yellow Wagtail as Critically Endangered.

Order	English Name	الاسم العربي	Scientific Name	Status	IUCN
Anseriformes	Common Teal	حذف شتوي	<i>Anas crecca</i>	WV	LC
	Garganey	حذفة صيفية	<i>Anas querquedula</i>	WV	LC
	Mallard	الخضاري	<i>Anas platyrhynchos</i>	WV SB	LC

Apodiformes	Common Swift	سمامة شائعة	<i>Apus apus</i>	PM	LC
	Little Swift	سمامة صغيرة	<i>Apus affinis</i>	PM	LC

Charadriiformes	European Golden Plover	زقراق مذهب أوراسي	<i>Pluvialis apricaria</i>	WV, PM	LC
	Northern Lapwing	قطقاط شمالي	<i>Vanellus vanellus</i>	WV	NT
	Green Sandpiper	طيوطى خضراء	<i>Tringa ochropus</i>	WV	LC
	Stone-curlew	كروان	<i>Burhinus oedicephalus</i>	?RB, SB	LC

Ciconiiformes	Cattle Egret	بط المزابل/ أبو قردان	<i>Bubulcus ibis</i>	RB	LC
	Common Little Bittern	الواق الصغير	<i>Ixobrychus minutus</i>	PM	LC
	Glossy Ibis	أبو منجل	<i>Plegadis falcinellus</i>	PM	LC

Columbiformes	Eurasian Collared Dove	يمام مطوق	<i>Streptopelia decaocto</i>	RB	LC
	European Turtle Dove	يمام قمري	<i>Streptopelia turtur</i>	?PM, SB	VU

Coraciiformes	Eurasian Hoopoe	هدهد	<i>Upupa epops</i>	RB, WV, PM	LC
	European Bee-eater	وروار أوروبي	<i>Merops apiaster</i>	PM	LC
	White-throated Kingfisher	صياد السمك أبيض الصدر	<i>Halcyon smyrnensis</i>	RB	LC

Cuculiformes	Great Spotted Cuckoo	وقواق مرقط كبير	<i>Clamator glandarius</i>	PM, SB	LC
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Falconiformes	Common Kestrel	عوسق	<i>Falco tinnunculus</i>	RB	LC
	Black Kite	الحدأة السوداء	<i>Milvus migrans</i>	PM	LC
	Lesser Spotted Eagle	عقاب رقطاء صغيرة	<i>Aquila pomarina</i>	PM	LC
	Long-legged Buzzard	حوام طويل الساق	<i>Buteo rufinus</i>	RB	LC
	Short-toed Eagle	عقاب الثعابين	<i>Circaetus gallicus</i>	SB, PM	LC
	Steppe Buzzard	حوام السهول	<i>Buteo buteo vulpinus</i>	PM	LC

Galliformes	Chukar	الحجل	<i>Alectoris chukar</i>	RB	LC
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Gruiformes	Common Moorhen	دجاجة الماء	<i>Gallinula chloropus</i>	SB	LC
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Passeriformes	Common Blackbird	الشحرور	<i>Turdus merula</i>	RB	LC
	Common Chaffinch	عصفور ظالم	<i>Fringilla coelebs</i>	WV, PM	LC
	Common Nightingale	هزار شائع	<i>Luscinia megarhynchos</i>	PM	LC
	Common Redstart	الحميراء	<i>Phoenicurus phoenicurus</i>	PM	LC
	Common Stonechat	قلبي مطوق	<i>rubicola Saxicola torquatus</i>	WV	LC
	Eurasian Jay	القيق	<i>Garrulus glandarius</i>	RB	LC
	Eurasian Siskin	حسون الشوك	<i>Carduelis spinus</i>	WV, PM	LC
	European Greenfinch	حسون اخضر	<i>Carduelis chloris</i>	RB	LC
	European Serin	نعار أوروبي	<i>Serinus serinus</i>	WV	LC
	Western Jackdaw	غراب الزرع	<i>Corvus monedula</i>	SB	LC
	Barn Swallow	سنونو	<i>Hirundo rustica</i>	PM, rb	LC
	Barred Warbler	هازجة كحلاء	<i>Sylvia nisoria</i>	PM	LC
	Black Redstart	حميراء سوداء	<i>Phoenicurus ochruros</i>	WV	LC
	Blackcap	أبو قلنسوة (التيني)	<i>Sylvia atricapilla</i>	PM	LC
	Black-eared Wheatear	أبلق أعشى شرقي	<i>Oenanthe hispanica</i>	SB	LC
	Blue Rock Thrush	سمنة الصخور الزرقاء	<i>Monticola solitarius</i>	RB, WV	LC
	Bluethroat	زرقاء الزور	<i>Luscinia svecica</i>	WV	LC
	Brambling	شرشور جبلي	<i>Fringilla montifringilla</i>	WV	LC
	Chiffchaff	نقشارة (فسفس)	<i>Phylloscopus collybita</i>	WV	LC
	Cinereous Bunting	درسة ذقناء غربية	<i>Emberiza cineracea</i>	PM	NT
	Common Chiffchaff		<i>Phylloscopus collybita</i>	PM	LC
	Common Linnet	حسون نقاحي	<i>Linaria cannabina</i>	RB	LC
	Common Myna	المنيا الشائعة	<i>Acridotheres tristis</i>	IB	LC
	Crested Lark	قبرة متوجة	<i>Galerida cristata</i>	RB	LC
	Cretzschmar's Bunting	درسة زرقاء	<i>Emberiza caesia</i>	SB	LC
	Easter Bonelli's Warbler	دخلة بونيلية شرقية	<i>Phylloscopus orientalis</i>	PM	LC
	Finsch's Wheatear	أبلق فينشي	<i>Oenanthe finschii</i>	WV	LC
	Garden Warbler	هازجة حدائقية	<i>Sylvia borin</i>	PM	LC
	Graceful Prinia	نمنمة ذنوب	<i>Prinia gracilis</i>	RB	LC
	Great Tit	القرقف الكبير	<i>Parus major</i>	RB	LC
	Hooded Crow	غراب ابقع	<i>Corvus corone cornix</i>	RB	LC
	House Sparrow	عصفور دوري	<i>Passer domesticus</i>	RB	LC
	Masked Shrike	صرد مقنع	<i>Lanius nubicus</i>	SB, PM	LC
	Meadow Pipit	جشنة مروجية	<i>Anthus pratensis</i>	WV, PM	NT
	Northern Wheatear	أبلق شمالي	<i>Oenanthe oenanthe</i>	PM	LC
	Olivaceous Warbler	دخناء زيتون شرقية	<i>Hippolais Iduna pallida</i>	PM, SB	LC
	Olive-tree Warbler	دخناء شجر الزيتون	<i>Hippolais olivetorum</i>	PM	LC
	Orphean Warbler		<i>Sylvia hortensis</i>	PM	LC
	Ortolan Bunting	درسة الشعير	<i>Emberiza hortulana</i>	PM	LC
	Palestine Sunbird	عصفور الشمس الفلسطيني	<i>Cinnyris osea</i>	RB	LC

	Red-rumped Swallow	سنونو احمر العجز	<i>Ceropsis daurica</i>	PM, RB	LC
	Red-throated Pipit	جشنة حمراء الزور	<i>Anthus cervinus</i>	WV, PM	LC
	Reed Warbler	دخناء أوراسية	<i>Acrocephalus scirpaceus</i>	PM	LC
	Rufous-tailed Scrub Robin	شواله	<i>Cercotrichas galactotes</i>	SB	LC
	Sardinian Warbler	هازجة سردينية	<i>Sylvia melanocephala</i>	RB, WV	LC
	Sedge Warbler	دخناء سعديية	<i>Acrocephalus schoenobaenus</i>	PM	LC
	Song Thrush	سمنة مغردة	<i>Turdus philomelos</i>	WV, PM	LC
	Spectacled Bulbul	الببل اصفر العجز	<i>Pycnonotus xanthopygos</i>	RB	LC
	Spotted Flycatcher	خطاف الذباب الأرقط	<i>Muscicapa striata</i>	PM, SB	LC
	Thrush Nightingale	عدليب	<i>Luscinia luscinia</i>	PM	LC
	Tree Pipit	شجنة شجرية	<i>Anthus trivialis</i>	PM	LC
	Western Cinereous Bunting	درسة ذقناء غربية	<i>Emberiza cineracea</i>	PM	NT
	Whinchat	برقش احمر	<i>Saxicola rubetra</i>	WV	LC
	White Wagtail	ذعرة بيضاء	<i>Motacilla alba</i>	WV	LC
	Willow Warbler	نقشارة الصفصاف	<i>Phylloscopus trochilus</i>	PM	LC
	Wood Warbler	دخلة غابية	<i>Phylloscopus sibilatrix</i>	PM	LC
	Woodchat Shrike	صرد محمر القنة	<i>Lanius senator</i>	PM, SB	LC
	Yellow Wagtail	ذعرة صفراء	<i>Motacilla flava</i>	PM	LC

Pelecaniformes	White Pelican	بجعة بيضاء	<i>Pelecanus onocrotalus</i>	PM	LC
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Piciformes	Eurasian Wryneck	اللواء	<i>Jynx torquilla</i>	PM	LC
	Syrian Woodpecker	نقار الخشب السوري	<i>Dendrocopos syriacus</i>	RB	LC

Strigiformes	Little Owl	البومة الصغيرة	<i>Athene noctua</i>	RB	LC
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Table 7. Birds recorded at WZU.

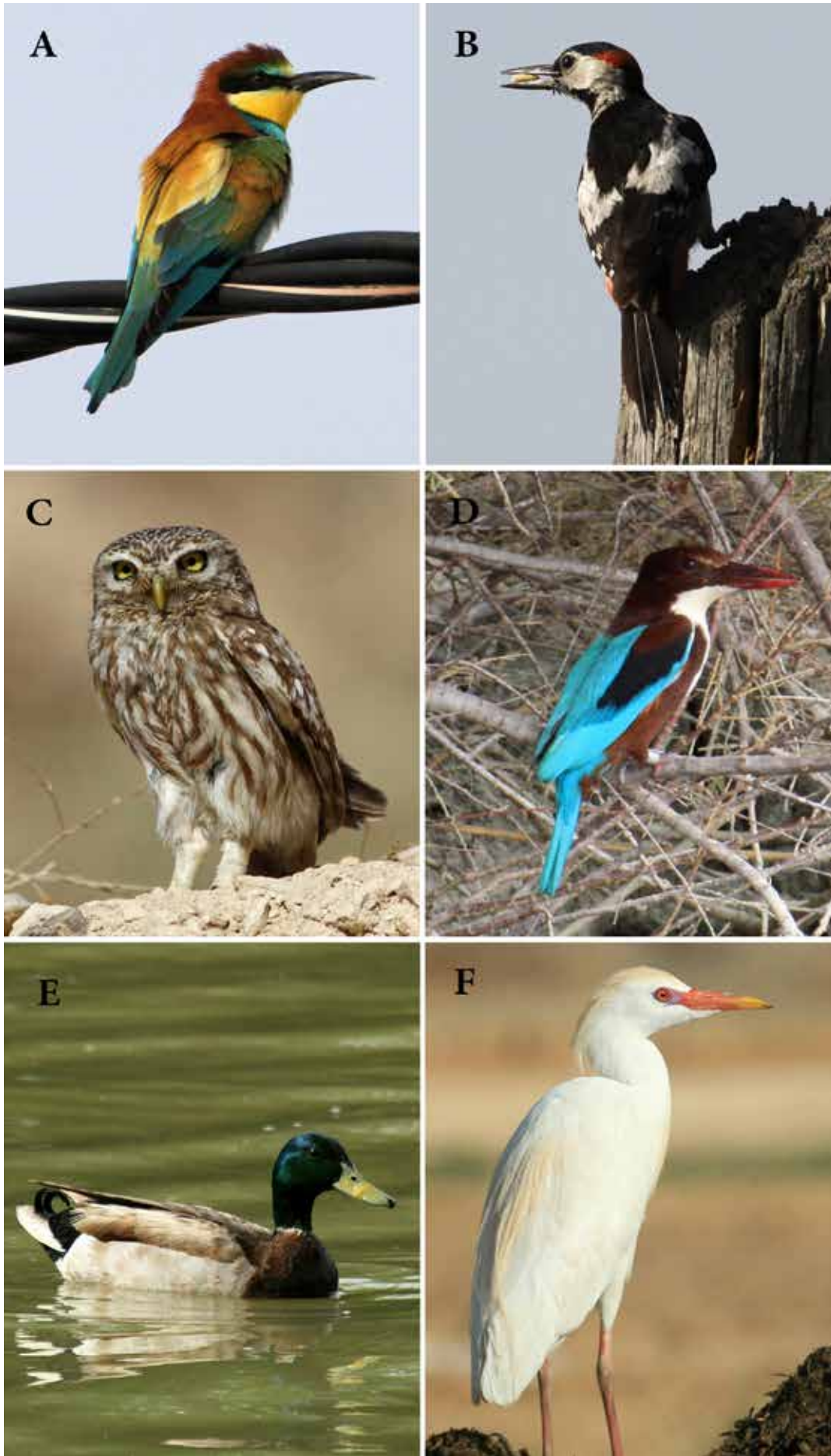


Figure 16. Some birds recorded from the study site. A. European Bee-eater. B. Syrian Woodpecker. C. Little Owl. D. White-throated Kingfisher. E. Mallard. F. Cattle Egret.



Figure 17. Some birds recorded from the study site. A. Kestrel, B. Steppe Buzzard, C. Long-legged Buzzard, D. Eurasian Hoopoe. E. Black Bird, F. European Turtle Dove.

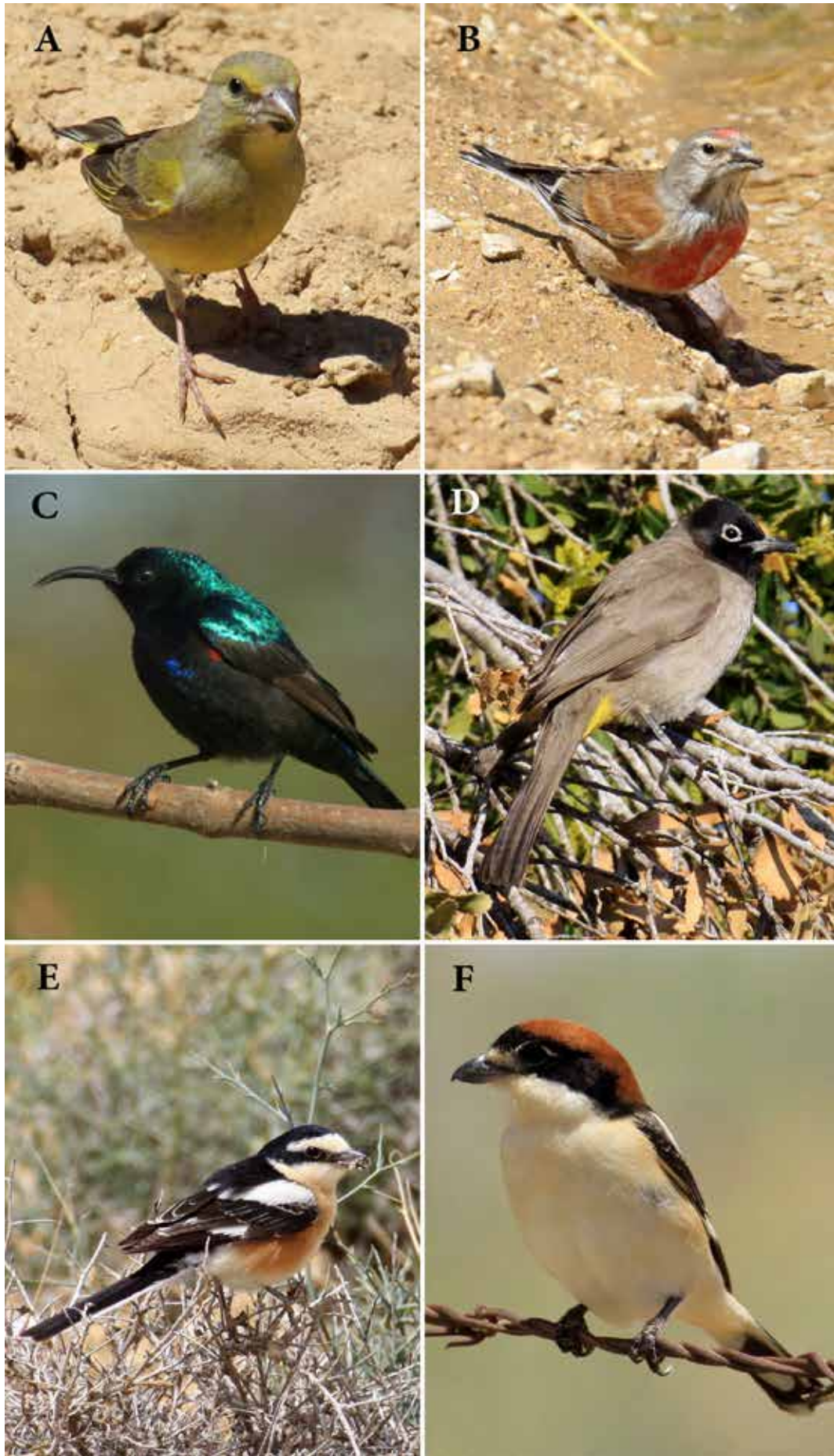


Figure 18. Some birds recorded from the study site. A. European Greenfinch, B. Common Linnet, C. Palestine Sunbird, D. Spectacled Bulbul, E. Masked Shrike, F. Woodchat Shrike.

4.4. Mammals

Thirteen species of mammals were observed in the study area (Tables 8 & 9). Six species were found to be common and distributed along the entire area; *Vulpes vulpes*, *Acomys dimidiatus*, *Hystrix indica* (Figure 19), *Procavia capensis* (Figure 20), *Sus scrofa* (Figure 21), and *Spalax ehrenbergi*. During daytime, we observed two red foxes in the western section, and at night spotlight survey, two others were observed along the eastern section. Local claims that the red fox is common and can be seen in towns around garbage dumpsters.

The Wild Boar is very common was observed in herds reaching up to 10 individuals in the eastern section near Kufr Al Deek. Others were seen individually or dead along the wadi bed. The boar attacks trees and is considered as a pest.



Figure 19. Porcupine from WZU.



Figure 20. Family of Hyrax *Procavia capensis*.



Figure 21. Wild Boars are common and hated by the farmers.

A large colony of the Egyptian Fruit Bat, *Rousettus aegyptiacus*, of at least 400-500 individuals was noted in a cavern at the beginning of the western section. At dusk, hundreds of fruit bats were observed leaving the cave and heading to the west/coastal regions (Figure 24). In another cave close to the fruit bats colony, we found a relatively large colony of about 200 individuals of the Naked Bellied Tomb Bat, *Taphozous nudiventris* (Figure 22).



Figure 22. Cavern with Naked Bellied Tomb Bat, *Taphozous nudiventris*.

We also were able to do some mistnetting and caught *Pipistrellus pipistrellus*, which is a rare, small, and threatened bat (Figure 23).



Figure 23. Mistnetting in the area yielded *Pipistrellus pipistrellus* and *Pipistrellus kuhli*.



Figure 24. Egyptian fruit bats leaving its cave at dusk heading west.

The Rock Hyrax was the most dominant medium-sized mammal observed in the wadi, seen in various parts of the wadi system. It takes refuge around rocky areas, especially with small caves or crevices. Number of individuals observed ranged from 1-6 in some locations. Figure 25 shows locations where the hyrax was spotted.



Figure 25. Locations at which the rock hyrax was observed along WZU.

Family	Scientific Name	English Name	الاسم العربي	Location
Pteropodidae	<i>Rousettus aegyptiacus</i>	Egyptian Fruit Bat	خفاش الفاكهة المصري	Dayr Ballout
Emballonuridae	<i>Taphozous nudiventris</i>	Naked Bellied Tomb Bat	خفاش أبو بوز	Dayr Ballout
Vespertilionidae	<i>Pipistrellus kuhli</i>	Kuhl's pipistrelle	خفاش كوهلي	Valley below near water source
Vespertilionidae	<i>Pipistrellus pipistrelle</i>	Small pipistrelle	خفاش	Valley below near water source
Rhinopomatidae	<i>Rhinopoma hardwicki</i>	Free tailed bat	خفاش أبو ذئب	Dayr Ballout
Muridae	<i>Apodemus mystacinus</i>	Field mouse	فأر الغابة	Eastern oak forest
Muridae	<i>Acomys dimidiatus</i>	Eastern Spiny Mouse	الفأر الشوكي	Dayr Ballout
Hystricidae	<i>Hystrix indica</i>	Indian Crested Porcupine	النيص	Kufr Al Deek
Spalacidae	<i>Spalax ehrenbergi</i>	Blind Mole Rat	خلند	All the Valley
Canidae	<i>Vulpes vulpes</i>	Red Fox	الثعلب الاحمر	Kufr Al deek / Dayr Ballout
Procaviidae	<i>Procavia capensis</i>	Rock Hyrax	الوير الصخري	All the Valley
Suidae	<i>Sus scrofa</i>	Wild Boar	الخنزير البري	All the Valley
Bovidae	<i>Gazella gazella</i>	Mountain Gazelle	الغزال الجبلي	Dayr Ballout

Table 8. Mammals observed at WZU.

Scientific Name	Common name	IUCN Status	
		Global	Regional
<i>Rousettus aegyptiacus</i>	Egyptian Fruit Bat	LC	LC
<i>Taphozous nudiventris</i>	Naked Bellied Tomb Bat	LC	Threatened
<i>Rhinopoma hardwicki</i>	Free tailed bat	?	Threatened
<i>Pipistrellus kuhli</i>	Kuhl's pipistrelle	LC	LC
<i>Pipistrellus pipistrelle</i>	Small pipistrelle	?	Threatened
<i>Acomys dimidiatus</i>	Eastern Spiny Mouse	LC	LC
<i>Apodemus mystacinus</i>	Field mouse	LC	LC
<i>Hystrix indica</i>	Indian Crested Porcupine	LC	LC
<i>Spalax ehrenbergi</i>	Blind Mole Rat	LC	LC
<i>Vulpes vulpes</i>	Red Fox	LC	LC
<i>Procavia capensis</i>	Rock Hyrax	LC	LC
<i>Sus scrofa</i>	Wild Boar	LC	LC
<i>Gazella gazella</i>	Mountain Gazelle	VU	VU

Table 9. Conservation status of mammals collected and/or observed from WZU.

Interviews were conducted with the locals to identify mammals they have encountered along the wadi. We have positive confirmation from several persons on the presence of the badger, *Meles meles*, the Stone Martin, *Martes foina*, the Hyena, *Hyaena hyaena*, the Caracal, *Caracal caracal*, and the Marbled Polecat, *Vormela peregusna*. While the above represent the main species noted, clearly this is not an intensive mammalogical survey of the area and investigation is ongoing.

4.5. Land Snails

Nineteen species of land snails belonging to nine families were collected from WZU basin and its vicinity (Table 10, Figure 26). This is one of the richest sites we encountered during our study on the land snails of the West Bank (Amr et al., 2018 and manuscript on systematics). Fifteen species are restricted to the Mediterranean zone, with only *C. haasi*, *M. berytensis*, *P. glaucum*, and *R. rhodia* confined to areas with annual rainfall of 700 mm.

The family Enidae is represented by five species. *Buliminus labrosus* was the most common enid, found in habitats with calcareous rocks. *Paramastus episomus* distribution reached as far as the 500 mm is height, and usually in rocky areas of forested regions. It could be also found around decaying oak leaves. *Pene bulimoides* was found to be associated with calcareous rocky outcrops of various sizes. The genus *Euchondrus* includes two species, whereas *E. septemdentatus* was the most widely spread species in-habiting rocky cliffs. Families Clausiliidae, Pomatiidae, Oxychilidae and Vertiginidae are represented by a single species for each family.

The Family Hygromiidae is represented by four species in WZU. *M. syriaca*, *M. berytensis*, *Sphinterochila cariosa* and *Xeropicta krynickii* were found in various habitats including hard rocky boulders and calcareous rocks and open rocky slaps. *Helix engaddensis* and *L. caesareana* are all lithophiles inhabiting many rocky areas. *Levantina caesareana* can also be found in semi-arid regions of the Mediterranean. As for family Ferussaciidae, *C. hierosolymarum* and *C. acicula* were associated with soft soil under large boulders. All these land snails have no current conservation status.

Family	Scientific Name	Location
Pomatiidae	<i>Pomatias glaucum</i>	Kufr Al Deek/Dayr Ballout
Chondrinidae	<i>Granopupa granum</i>	Kufr Al Deek/Dayr Ballout
	<i>Rupestrella rhodia</i>	Kufr Al Deek/Dayr Ballout

Enidae	<i>Euchondrus chondriformis</i>	Kufr Al Deek/Dayr Ballout
	<i>Euchondrus septemdentatus</i>	Kufr Al Deek/Dayr Ballout
	<i>Paramastus eposomus</i>	Kufr Al Deek/Dayr Ballout
	<i>Buliminus labrosus</i>	Kufr Al Deek/Dayr Ballout
	<i>Pene bulimoides</i>	Kufr Al Deek
Clausiliidae	<i>Cristataria haasi</i>	Dayr Ballout
Hygromiidae	<i>Xeropicta krynickii</i>	Kufr Al Deek/Dayr Ballout
	<i>Monacha syriaca</i>	Kufr Al Deek/Dayr Ballout
	<i>Sphinterochila cariosa</i>	Kufr Al Deek/Dayr Ballout
	<i>Metafruticicola fourousi</i>	Kufr Al Deek
Vertiginidae	<i>Truncatellina haasi</i>	Kufr Al Deek
Ferussaciidae	<i>Calaxis hirosolyमारुम</i>	Kufr Al Deek/Dayr Ballout
	<i>Cecilioides acicula</i>	Kufr Al Deek
Oxychilidae	<i>Eopolita protensa</i>	Dayr Ballout
Helicidae	<i>Levantina caesareana</i>	Kufr Al Deek/Dayr Ballout
	<i>Helix engaddensis</i>	Kufr Al Deek

Table 10. Land snails collected from the study site.

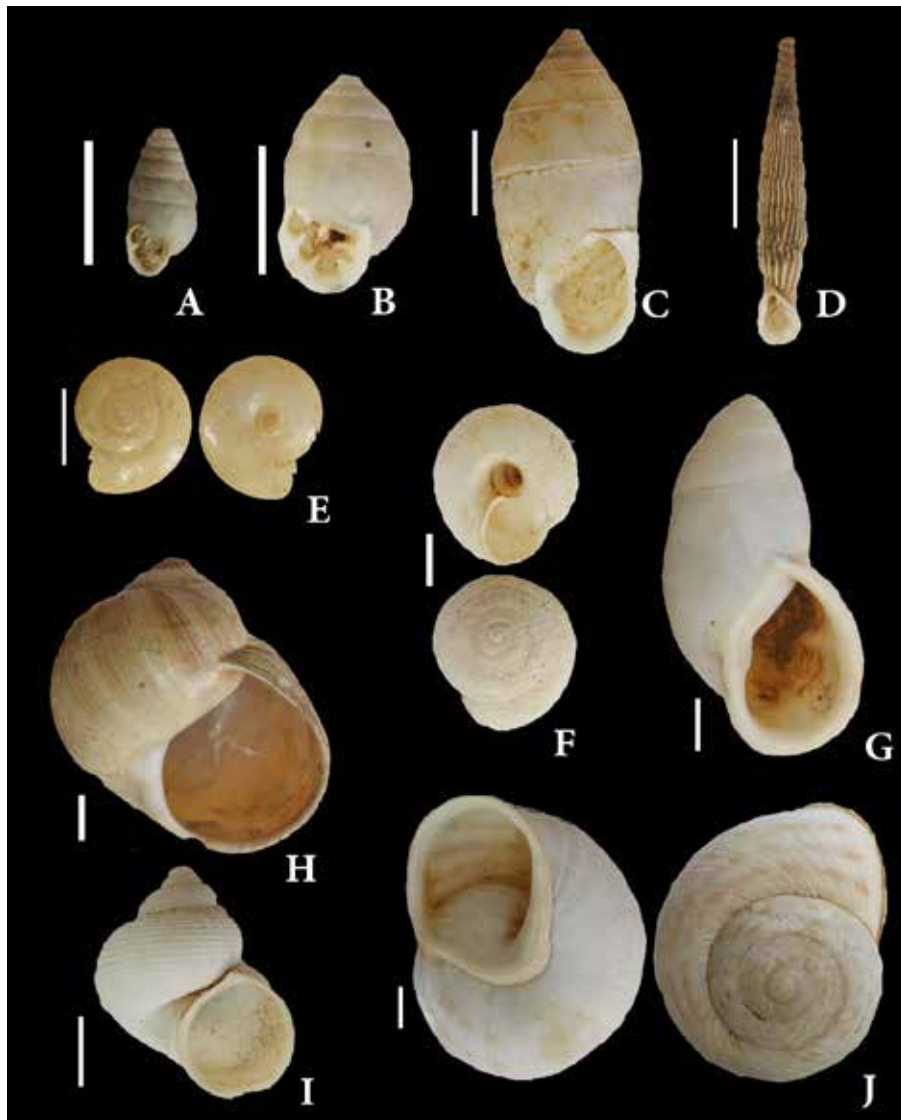


Figure 26. Land snails recorded from WZU. A. *Euchondrus chondriformis*. B. *Euchondrus septemdentatus*. C. *Paramastus eposomus*. D. *Cristataria haasi*. E. *Eopolita protensa*. F. *Sphinterochila cariosa*. G. *Buliminus labrosus*. H. *Helix engaddensis*. I. *Pomatias glaucum*. J. *Levantina caesareana*. Scale bar=10mm.

4.7. Arachnida

Three species of scorpions belonging to two families were recorded (Table 11). All these species are common in the Mediterranean zone. They are not considered very dangerous species, since their venom is not fatal to human in low doses. Over 23 species of spiders were collected many remain to be identified.

Family	Scientific Name	Location
Scorpionidae	<i>Scorpio maurus</i>	Dayr Ballout
Buthidae	<i>Compsobuthus weneri</i>	Kufr Al Deek
	<i>Hottentotta judaicus</i>	Kufr Al Deek

Table 11: Species of scorpions found in WZU.

4.7. MicroFauna from Leafletter

We collected leafletter from beneath deciduous trees, including oaks, and used a funnel with sieve and light above to drive fauna down. The initial examination showed high biodiversity of microfauna (pseudoscorpions, collembola, mites, spiders, tiny ants, beetles and others). This rich biodiversity includes many new species that we will describe in the scientific literature (Figure 27). Two rare species of pseudoscorpions belonging to two families were recovered from WZU; *Neobisium* cf. *validum* (Family Neobisiidae) and *Chthonius jonicus* (Family Chthoniidae).



Figure 27. Microfauna found in leafletter collected from WZU. Clockwise from upper left: spider, coleopteran beetle, ant, centipede, crickets, collembola. Animals shown range in length from 1 mm (ant) to 4 mm (centipede).

4.8. Insecta

Order Lepidoptera

Butterflies were the most common species identified in the study area. 30 species belonging to four families were identified (Table 12, Figure 28). Family Pieridae has the highest number of species followed by family Nymphalidae. The most common butterflies observed and collected were the Small White, *Pieris rapae*, the Bath White, *Pontia daplidice*, and the Common Blue, *Polyommatus icarus*. Possible threatened species, based on our preliminary studies are: *Archon apollinus*, *Zegris eupheme*, *Gonepteryx cleopatra taurica*, and *Hipparchia fatua sichaea*. According to the IUCN assessment of the Mediterranean butterflies (Numa et al., 2016), all species in the West Bank are listed as being of least concern. Abusarhan et al. (2016) recorded 54 species of butterflies, representing 5 families in a very small part of Palestine (West Bank).

Family	Subfamily	Scientific Name	Common Name	IUCN status	
Papilionidae	Papilioninae	<i>Papilio machaon</i>	Swallowtail butterfly	LC	
	Parnassiinae	<i>Archon apollinus</i>	False Apollo	LC	
Pieridae	Pierinae	<i>Anthocharis cardamines</i>	Orange Tip	LC	
		<i>Aporia crataegi</i>	The Black-veined White	LC	
		<i>Belenois aurota</i>	Brown-veined White	LC	
		<i>Colotis fausta</i>	Large Salmon Arab	LC	
		<i>Euchloe belemia</i>	The Green-striped White	LC	
		<i>Pieris breassicae</i>	Large cabbage white	LC	
		<i>Pieris rapae</i>	The Small White	LC	
		<i>Pontia daplidice</i>	Bath White	LC	
		<i>Pontia glauconome</i>	Desert White	LC	
		Coliadinae	<i>Colias croceus</i>	Clouded Yellow	LC
			<i>Gonepteryx cleopatra</i>	The Cleopatra	LC
			<i>Lasiommata maera</i>	The Large Wall Brown	LC
			<i>Maniola telmessia</i>	The Eastern Meadow Brown	LC
			<i>Melanargia titea</i>	The Levantine Marbled White	LC
			<i>Ypthima asterope</i>	The African Ringlet	LC
Nymphalidae	Nymphalinae	<i>Melitaea trivia</i>	The Mullein Fritillary	LC	
		<i>Vanessa cardui</i>	Painted Lady	LC	
	Lycaeninae	<i>Lycaena thersamon</i>	Lesser Fiery Copper	LC	
	Polyommatainae	<i>Aricia agestis</i>	The Brown Argus	LC	
		<i>Polyommatus icarus</i>	Common Blue	LC	
		<i>Zizeeria karsandra</i>	The Asian Grass Blue	LC	
		<i>Leptotes pirthous</i>	Lang's Short-Tail Blue	LC	
		<i>Freyeria trochylus</i>	Grass Jewel	LC	
		Limenitidinae	<i>Limenitis reducta</i>	The Southern White Admiral	LC
	Charaxinae	<i>Charaxes jasius</i>	Two-tailed Pasha butterfly	LC	
Hesperiidae	Pyrginae	<i>Carcharodus alceae</i>	The Hollyhock Skipper	LC	
		<i>Spialia orbifer</i>	The Orbiferous Skipper	LC	
	Hesperiinae	<i>Thymelicus sylvestris</i>	Small Skipper	LC	

Table 12. List of Butterflies species from Wadi Al Zarqa.

Two species of moths were identified: *Ocnogyna loewii* and *Utetheisa pulchella*. Both species are common in the Mediterranean zone. However, we did collect many more species which are in the process of being identified and data published.

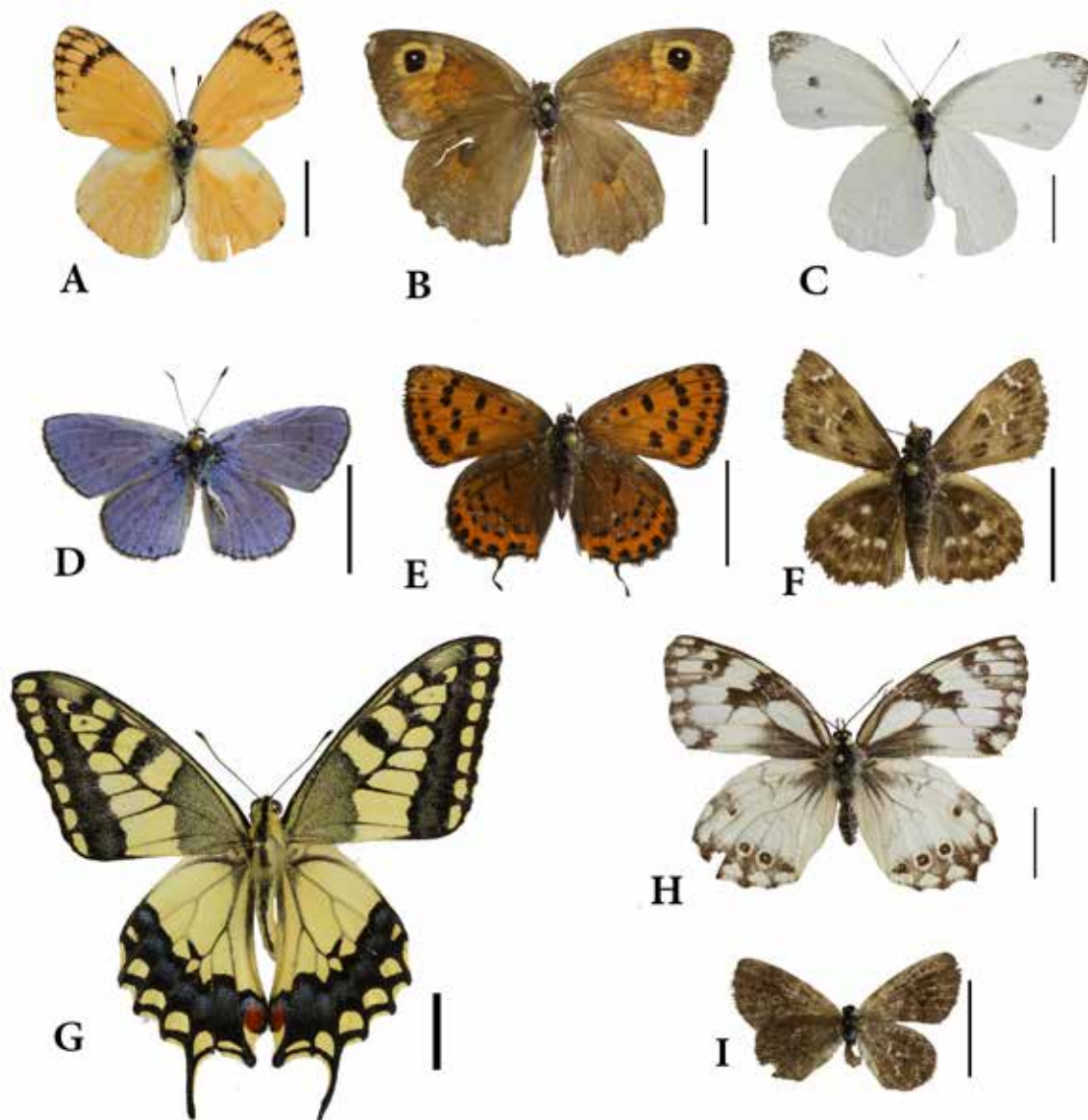


Figure 28. Some butterflies collected from WZU. A. *Colotis fausta*. B. *Maniola telmessia*. C. *Pieris rapae*. D. *Polyommatus icarus*, E. *Lycaena thersamon*. F. *Carcharodus alceae* G. *Papilio machaon*. H. *Belenois aurota*. I. *Zizeeria karsandra*. Bar=10mm.

Order Mantodea

Four species belonging to two families were identified (Table 13). All collected species are Mediterranean and considered common. Species of this order are carnivorous insects with a wide range of prey.

Family	Species
Empusidae	<i>Empusa fasciata</i>
	<i>Blepharopsis mendica</i>
Mantidae	<i>Ameles kurvillei</i>
	<i>Riventina byblica</i>

Table 13: List of Mantodea in Wadi Al Zarqa

Order Coleoptera

This order is one of the most diverse insect groups (Table 14). It is estimated that over 1000 species of beetles are known in Palestine. In Wasdi Zarqa, this order is represented by 11 families (Scarabaeidae, Glaphyridae, Buprestidae, Carabidae, Meloidae, Tenebrionidae, Cerambycidae, Coccinellidae, Curculionidae, Cleridae, and Dermestidae).

Other orders of insects identified from the area belong to the orders Hymenoptera, Diptera, Orthoptera, Odonata, Heteroptera, Homoptera, Blattodea and Neuroptera (Figure 29-31) (Table 14).

Order	Scientific Name
Coleoptera	<i>Protaetia cuprea ignicollis</i>
	<i>Tropinota hirta suturalis</i>
	<i>Oxythyrea noemi</i>
	<i>Aplidia joanis</i>
	<i>Onthophagus truchmenus</i>
	<i>Eulasia (Eulasia) nitidicollis</i>
	<i>Eulasia rittneri</i>
	<i>Pygopleurus israelitus</i>
	<i>Pygopleurus syriacus</i>
	<i>Capnodis carbonaria</i>
	<i>Meloe sp.</i>
	<i>Nemognatha quinquemaculata</i>
	<i>Certallum ebulinum</i>
	<i>Agapanthia lais</i>
	<i>Agapanthia pustulifera</i>
	<i>Coccinella septempunctata</i>
	<i>Hippodamia variegata variegata</i>
	<i>Lixus (Dilixellus) punctiventris</i>
	<i>Oedemera (Oncomera) natolica</i>
	<i>Chrysanthia flavipes</i>
<i>Xanthochroina auberti</i>	
<i>Chrysolina sp.</i>	
<i>Trichodes syriacus</i>	
<i>Trichodes affinis</i>	
<i>Trichodes quadriguttatus</i>	
<i>Melyris oblonga</i>	
Hymenoptera	<i>Aipis melaferra</i>
	<i>Polistes dominula</i>
	<i>Vespa orientalis</i>
	<i>Bombus sp.</i>
	<i>Sceliphron spirifex</i>
	<i>Camponotus sanctus</i>
<i>Cataglyphis niger</i>	
Odonata	<i>Crocothemis erythraea</i>
	<i>Sympetrum fonscolombii</i>
	<i>Sympetrum meridionale</i>
	<i>Trithemis annulata</i>

	<i>Trithemis arteriosa</i>
	<i>Anax pathenope</i>
Heteroptera	<i>Rhynocoris iracundus</i>
	<i>Rhynocoris punctiventris</i>
	<i>Tuponia sp</i>
	<i>Spilostethus pandurus</i>
	<i>Scantius aegyptius</i>
	<i>Enoplops scapha</i>
	<i>Eurydema ornatum</i>
Diptera	<i>Blaesoxipha delilah</i>
	<i>Psychoda sp.</i>
	<i>Asilidae sp. At least 3 species</i>
	<i>Culiseta sp.</i>
	<i>Unknown 5 species</i>
Neuroptera	<i>Acanthaclisis occitanica</i>
	<i>Palpares geniculatus</i>
Blattodea	<i>Hemelytrobatta marismortui</i>
Orthoptera	<i>Gryllodes hebraeus</i>
	<i>Acrometopa syriaca</i>
	<i>Isophya savignyi</i>
	<i>Tmethis pulchripennis</i>
	<i>Prionosthenus galericulatus</i>
Homoptera	<i>Dorysarthrus sp.</i>
	<i>Cicadetta (Melampsalta) musiva</i>
	<i>Cercopis intermedia</i>
	<i>Flatidae sp.</i>
	<i>Icerya aegyptiaca</i>

Table 14. List of insects from Wadi Al Zarqa.

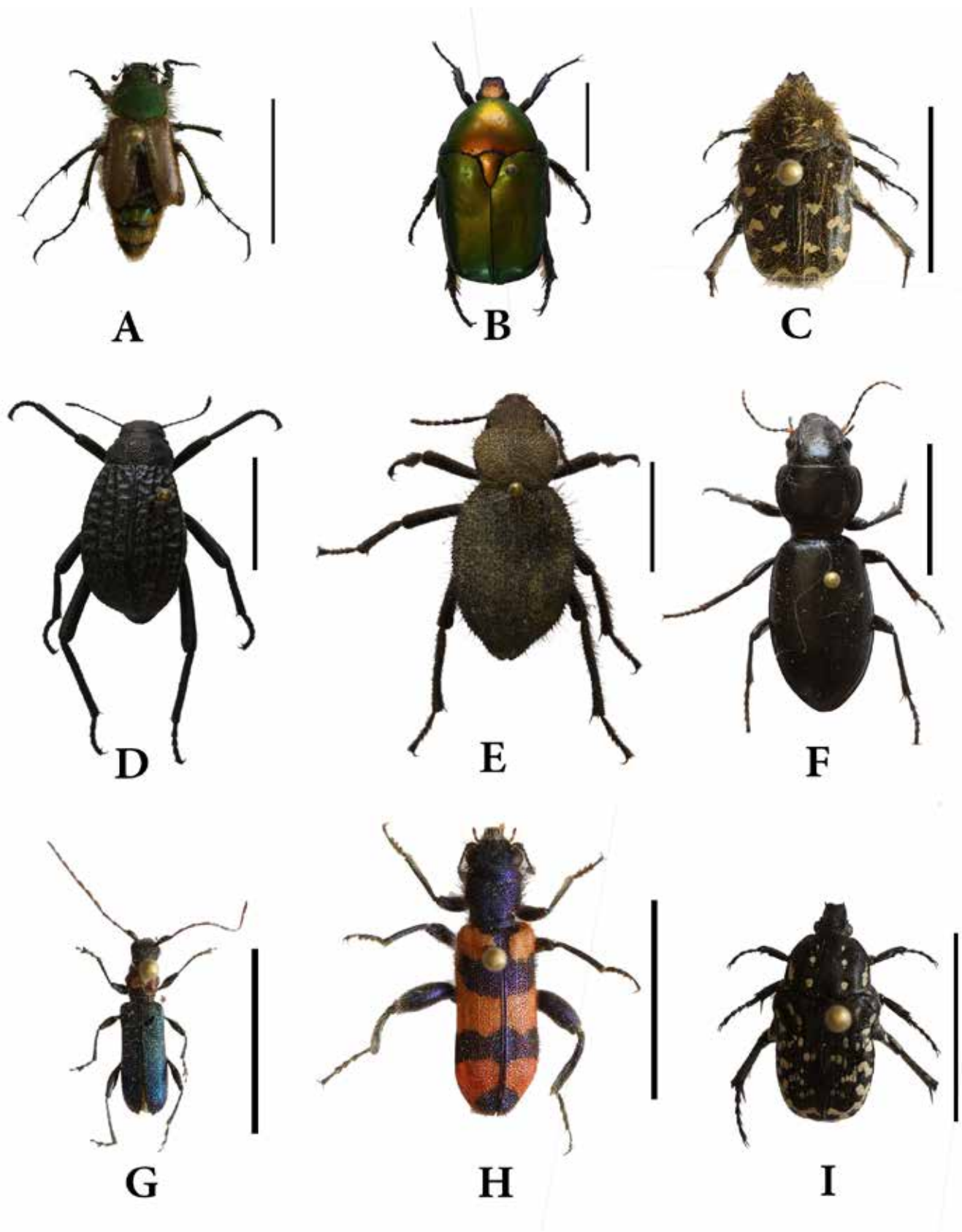


Figure 29. *Eulasia* sp., *B. Protactia (Potosia) cuprea ignicollis*, *C. Tropinota (Epicomentis) hirta suturalis*, *D. Adsmia* sp., *E. Pachyscelis* sp., *F. Tentyria* sp., *G. Certallum ebulinum*, *H. Trichodes affinis*, *I. Oxythyrea noemi*. Bar=10mm.



A



B



C



D



E



F



G



H

Figure 30. Various insects A. *Cicadetta (Melampsalta) musiva*, B. *Zygaena (Mesembrynus) graslini*, C. *Pyrrhocoris apterus*. D. *Eurydema ornatum*, E. *Stenozygum coloratum*, F. *Hemelytrobatta marismortui*, G. *Cercopis intermedia*. H. *Spilostethus pandurus*. Bar=10mm.

4.9. Others Invertebrates

Other species of invertebrates were also found in the area (Table 15).

Order	Scientific Name	Location
Spirostreptidae	<i>Archispirostreptus syriacus</i>	Dayr Ballout/Kufr Al Deek
Isopoda	<i>.Armadillidium sp</i>	Dayr Ballouot
Ixodidae	<i>Hyalomma aegyptium</i>	Dayr Ballout on tortes
Solifugae	<i>.Paragaleodes sp</i>	Kufr Al Deek
Araneae	<i>Argiope lobata</i>	Kufr Al Deek
	<i>Misumena vatia</i>	Kufr Al Deek

Table 15. List of other ivertebrates.

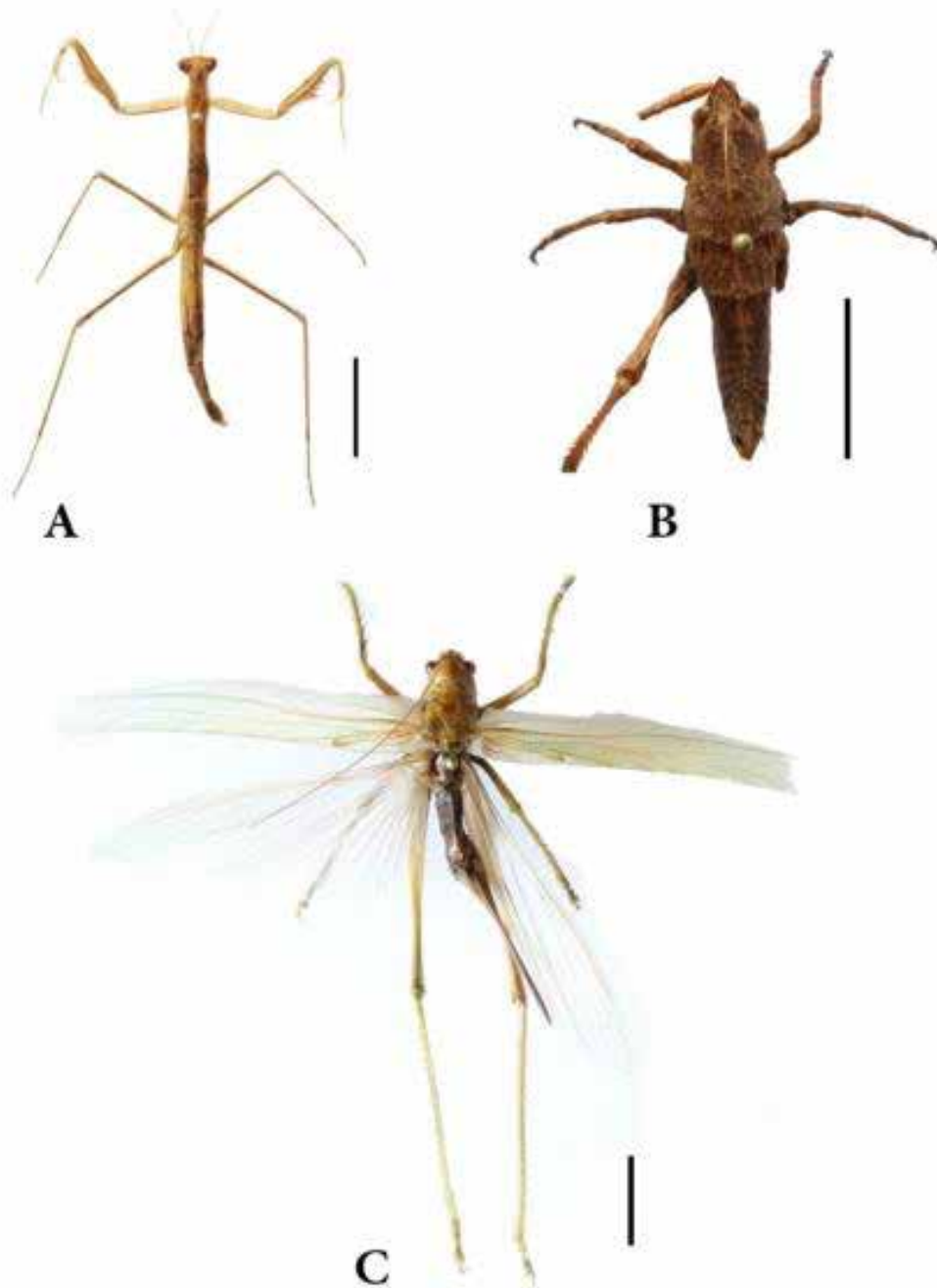


Figure 31: A. Riventina byblica, B. Prionosthenus galericulatus, C. Acrometopa syriaca. Bar=10mm.

4.10. Flora

Plant communities in the area include maquis, phrygana and garrigue. Maquis areas are usually dominated by oak, however, dense stand of *Arbutus andrachne* are also very common. This is a unique patch of *Arbutus*, and is protected because it is located in a very steep mountain. The phrygana area has olive groves, while the garrigue area is subjected to heavy grazing especially in the south western part of WZU. Species of families Asteraceae and Leguminosae were the most dominant while 23 families were represented by only a single species (Figure 32). Woody plants include several species; *Amygdalus communis*, *Arbutus andrachne*, *Ceratonia siliqua*, *Crataegus aronia*, *Olea europea*, *Pinus halapensis*, *Pistacia lentiscus*, *Pistacia palaestina*, *Pyrus syriaca*, *Qercus calliprinos*, *Rhamnus palaetisna*, and *Rhus tripartite* (Table 16) (Figure 33, 34). The area is inhabited by typical Mediterranean flora (Figure 35, 36). A total of 195 plant species belonging to 53 families were recorded (Table 17).

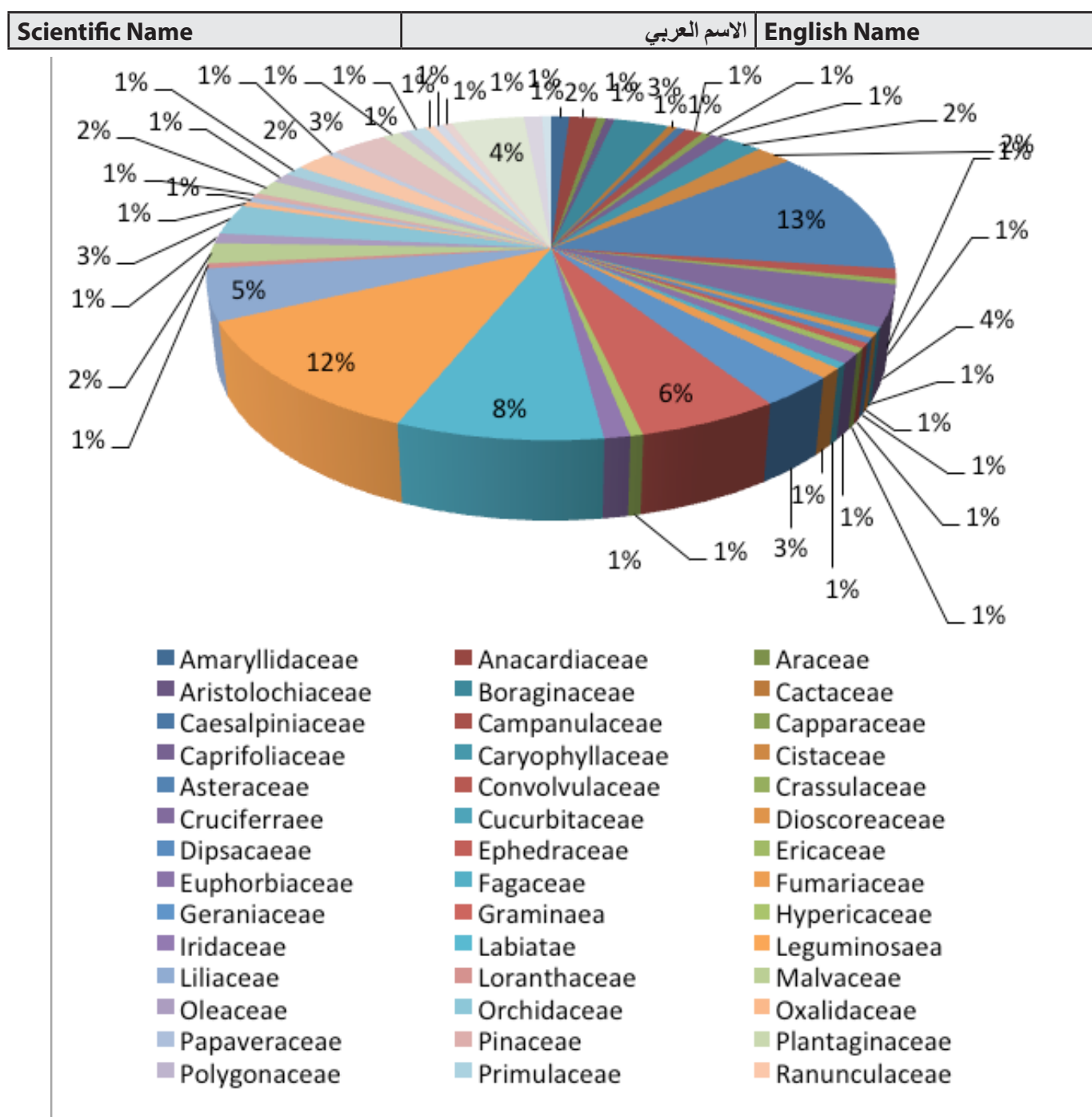


Figure 32. Percentage of plant species by families recorded from WZU.

<i>Amygdalus communis</i>	اللوز البري	Almond
<i>Arbutus andrachne</i>	القيقب	Strawberry tree
<i>Ceratonia siliqua</i>	الخروب	Carob
<i>Crataegus aronia</i>	الزعرور	Spiny Hawthorn
<i>Olea europea</i>	الزيتون البري	European Olive
<i>Pinus halapensis</i>	الصنوبر الحلبي	Aleppo Pine
<i>Pistacia lentiscus</i>	البطم العدسي	Mastic tree
<i>Pistacia palaestina</i>	البطم الفلسطيني	Terebinth
<i>Pyrus syriaca</i>	الإجاص البري	Syrian pear
<i>Qercus calliprinos</i>	بلوط، سنديان دائم الخضرة	Palestine oak
<i>Rhamnus palaetisna</i>	السويد الفلسطيني	
<i>Rhus tripartite</i>	السماق	Sumac
<i>Styrax officinalis</i>	عبر	Snowdrop bush

Table 16. Woody plants recorded from the study site.

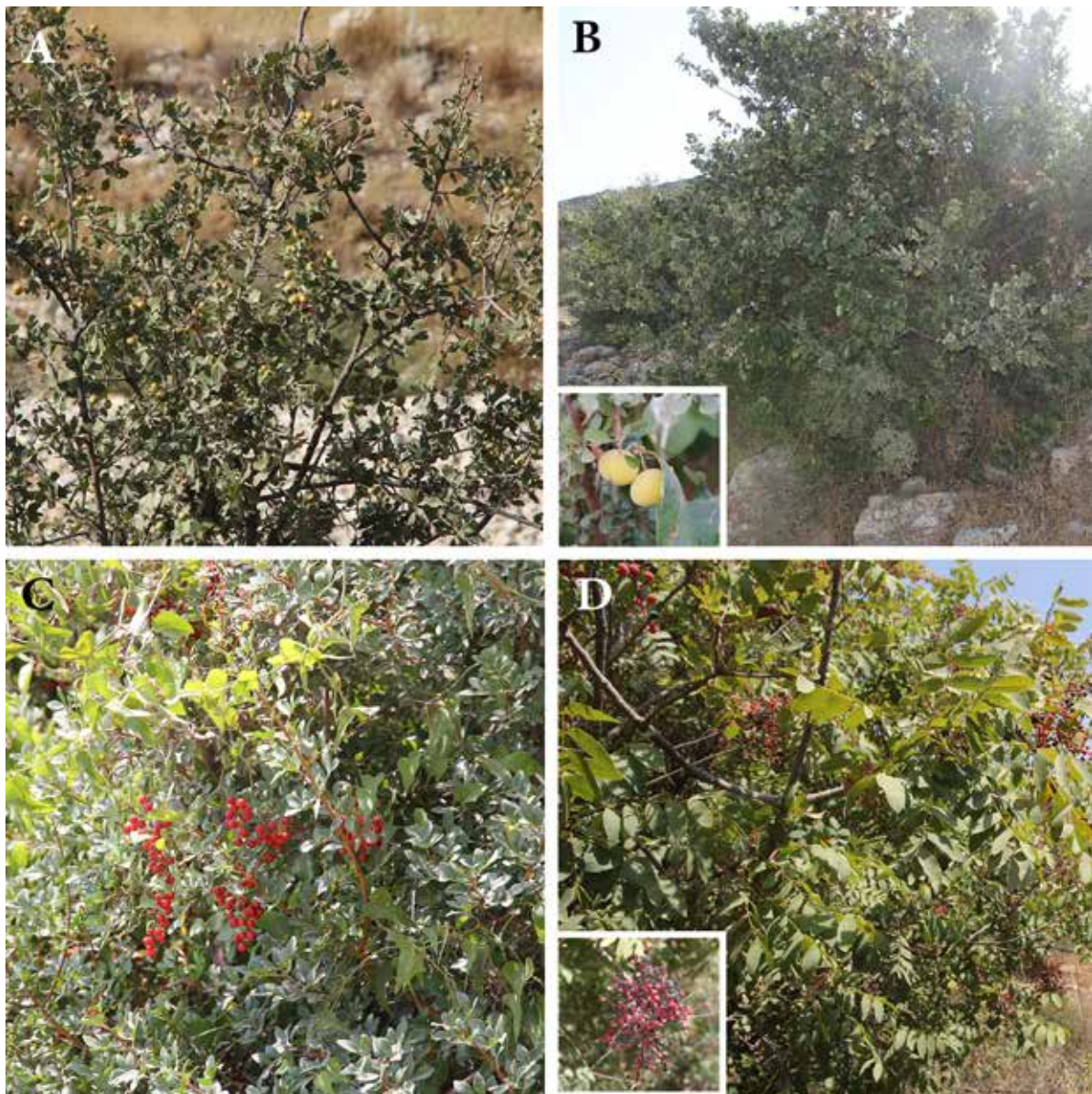


Figure 33. Woody trees recorded from WZU. A. *Crataegus aronia*. B. *Styrax officinalis*. C. *Pistacia lentiscus*. D. *Pistacia palaestina*.

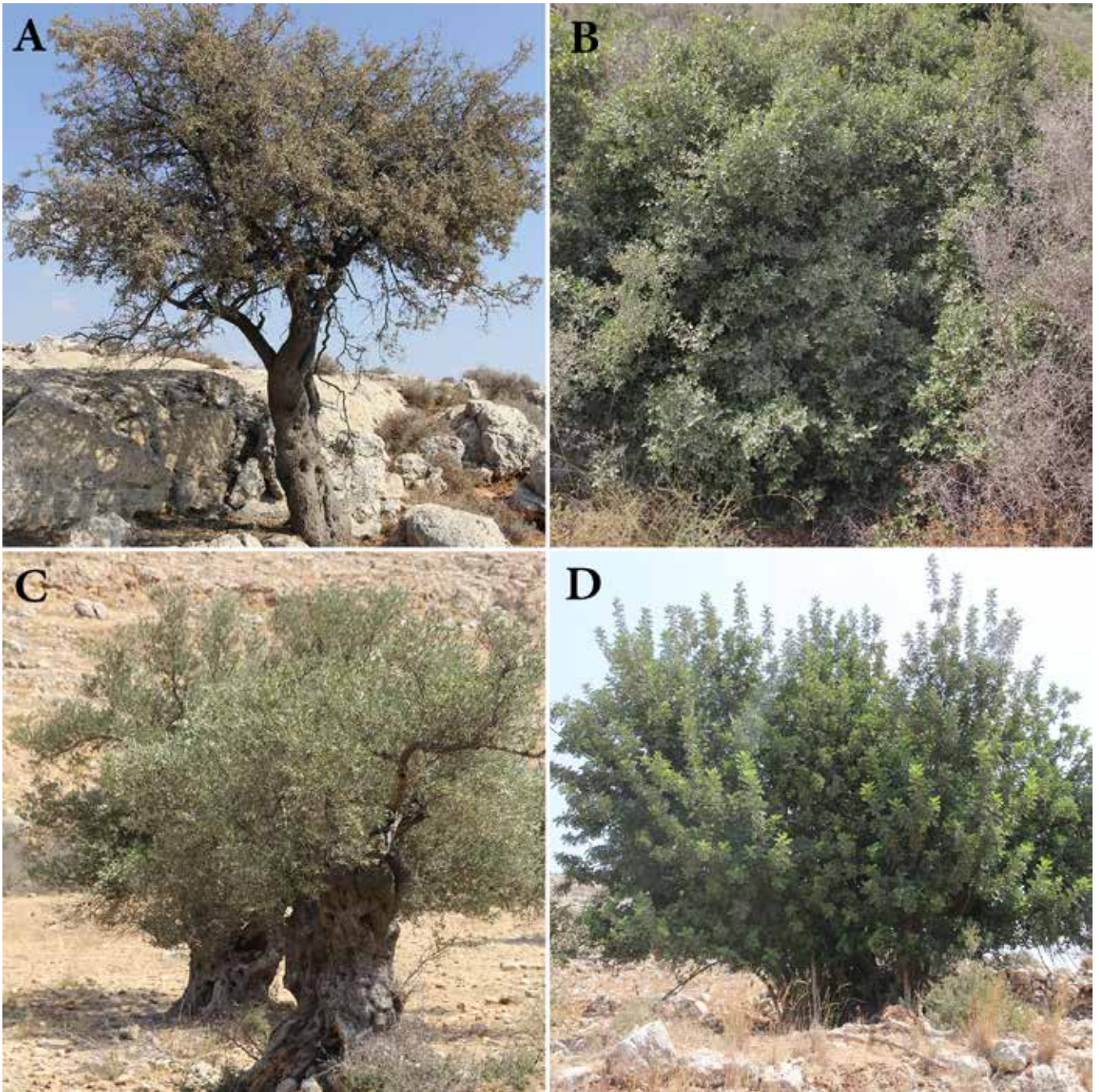


Figure 34. Commonly encountered trees. A. *Rhamnus palaetisna* .B. *Quercus calliprinos* . C. *Olea europea* . D. *Ceratonia silique*.



Figure 35. A. *Satuja thymbra*. B. *Arbutus andrachne*. C. *Vitex agnus-castus*. D. *Thymbra spicata*. E. *Salvia fruticose*. F. *Ophrys transhyrcana*. G. *Scilla hyacinthoides*. H. *Serapias vomeracea*.

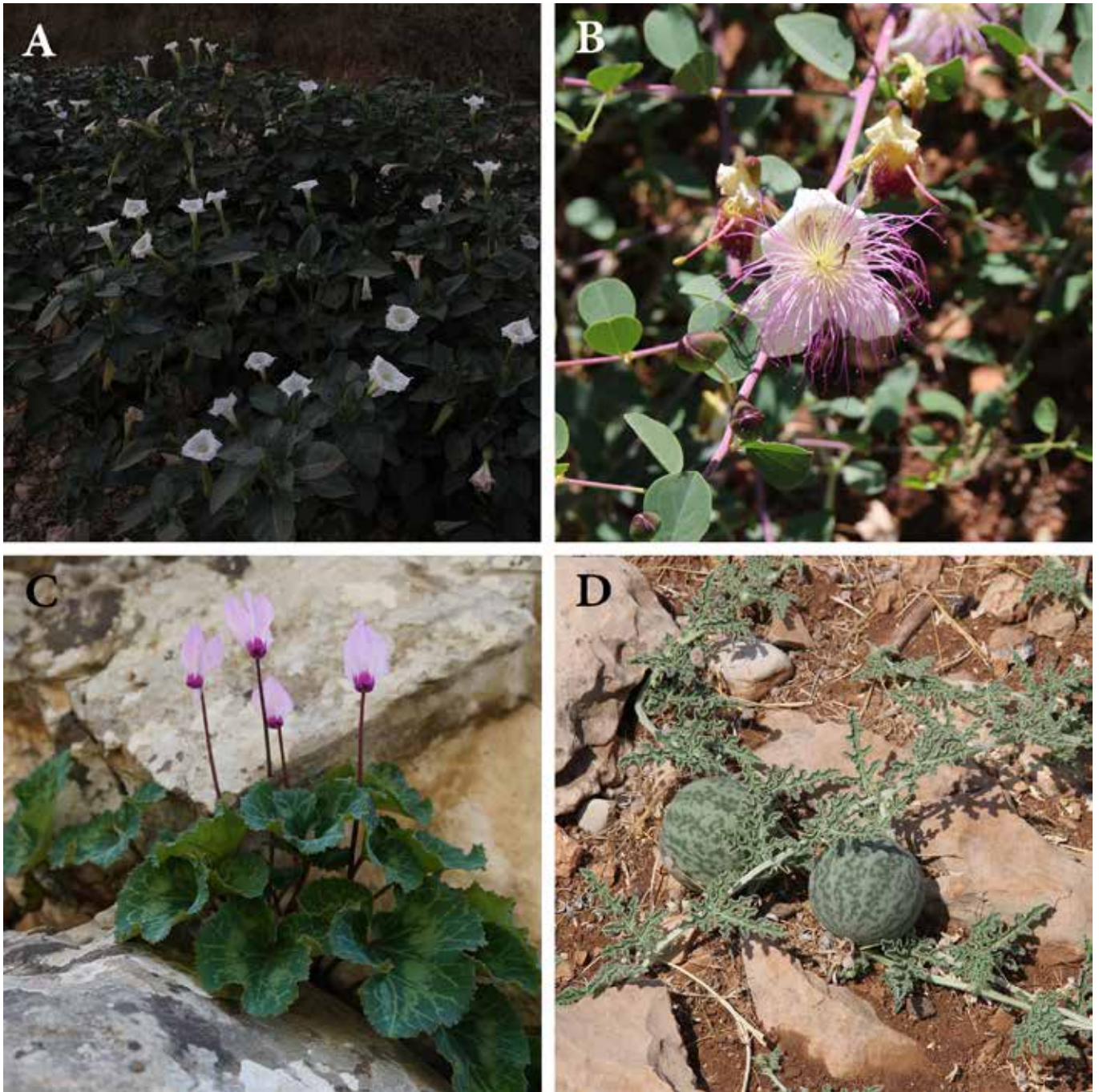


Figure 36. Some plant species from WZU. A. *Datura stramonium*. B. *Capparis spinosa*. C. *Cyclamen persicum*. D. *Citrullus colocynthis*.

Family	Species	Abundance
Amaryllidaceae	<i>Narcissus tazetta</i>	C
	<i>Pancratium parviflora</i>	R
Anacardiaceae	<i>Pistacia lentiscus</i>	CC
	<i>Pistacia palaestina</i>	C
	<i>Rhus tripartita</i>	F
Araceae	<i>Arisarum vulgare</i>	C
Aristolochiaceae	<i>Aristolochia parviflora</i>	R
Asteraceae	<i>Anthemis pseudocotula</i>	CC
	<i>Anthemis tinctoria</i>	F
	<i>Asteriscus spinosa</i>	C
	<i>Atractylis comosa</i>	C
	<i>Calendula arvensis</i>	CC
	<i>Carlina hispanica</i>	CC
	<i>Carthamus tenuis</i>	CC
	<i>Centaurea cyanoides</i>	C
	<i>Centaurea iberica</i>	CC
	<i>Chiliadenus iphionoides</i>	CC
	<i>Chrysanthemum segetum</i>	RR
	<i>Cichorium pumilum</i>	CC
	<i>Crepis sancta</i>	CC
	<i>Echinops adenocaulos</i>	CC
	<i>Filago contracta</i>	C
	<i>Helichrysum sanguineum</i>	C
	<i>Inula viscosa</i>	CC
	<i>Notobasis syriaca</i>	CC
	<i>Phagnalon rupestre</i>	CC
	<i>Rhagadiolus stellata</i>	CC
	<i>Senecio vernalis</i>	CC
	<i>Smilax aspera</i>	CC
	<i>Thrinicia tuberosa</i>	C
	<i>Tolpis varigata</i>	CC
	<i>Urospermum picroides</i>	CC
Boraginaceae	<i>Anchusa aegyptiaca</i>	CC
	<i>Anchusa strigosa</i>	CC
	<i>Echium angustefolium</i>	CC
	<i>Echium glomeratum</i>	R
	<i>Heliotropium routindifolium</i>	CC
	<i>Onosma orientalis</i>	CC
Cactaceae	<i>Opuntia ficus-indica</i>	CC
Caesalpinaceae	<i>Ceratonia siliqua</i>	C
Campanulaceae	<i>Campanula heirosolymitana</i>	C
	<i>Campanula strigosa</i>	C
Capparaceae	<i>Capparis spinosa</i>	CC

Caprifoliaceae	<i>Lonicera etrusca</i>	C
	<i>Scabiosa prolifera</i>	CC
Caryophyllaceae	<i>Paronychia argentea</i>	CC
	<i>Silene aegyptiaca</i>	CC
	<i>Silene colorata</i>	CC
	<i>Silene vulgaris</i>	F
Cistaceae	<i>Cistus cretica</i>	CC
	<i>Cistus salviiflorus</i>	CC
	<i>Fumana arabica</i>	C
	<i>Helianthemum syriaca</i>	R
Convolvulaceae	<i>Convolvulus althoides</i>	F
	<i>Convolvulus coelesyriacus</i>	O
Crassulaceae	<i>Sedum sediforme</i>	F
Cruciferaeae	<i>Biscutella didyma</i>	CC
	<i>Capsella bursa-pastoris</i>	CC
	<i>Cardaria draba</i>	CC
	<i>Eruca sativa</i>	C
	<i>Hirschfeldia incana</i>	CC
	<i>Isatis lucitanica</i>	CC
	<i>Ochtodium aegyptiacum</i>	CC
	<i>Sinapis alba</i>	CC
Cucurbitaceae	<i>Bryonia cretica</i>	C
Dioscoreaceae	<i>Tamus communis</i>	C
Dipsacaeae	<i>Cephalaria joppensis</i>	CC
Ephedraceae	<i>Ephedra aphylla</i>	CC
Ericaceae	<i>Arbutus andrachne</i>	C
Euphorbiaceae	<i>Euphorbia peplus</i>	CC
	<i>Mercurialis annua</i>	CC
Fagaceae	<i>Qercus calliprinos</i>	CC
Fumariaceae	<i>Fumaria capreolata</i>	F
	<i>Fumaria densiflora</i>	C
Geraniaceae	<i>Erodium cicutaurum</i>	CC
	<i>Erodium gruinum</i>	CC
	<i>Erodium malacoides</i>	CC
	<i>Geranium dissectum</i>	F
	<i>Geranium molle</i>	CC
	<i>Geranium routindifolium</i>	C
	<i>Avena sterilis</i>	CC
	<i>Brachypodium distacyon</i>	CC
	<i>Bromus scoparius</i>	C
	<i>Cynodon dactylon</i>	CC
	<i>Hordeum bulbosum</i>	CC
	<i>Hyparrhenia hirta</i>	CC
	<i>Lamarkia aurea</i>	C

	<i>Lolium rigidum</i>	CC
	<i>Pennisetum divisum</i>	R
	<i>Peptatherum meliacum</i>	CC
	<i>Stipa capensis</i>	CC
Hypericaceae	<i>Hypericum triquetrifolium</i>	CC
Iridaceae	<i>Gladiolus italicus</i>	C
	<i>Gynandiris sisyrinchium</i>	CC
Labiatae	<i>Ajuga chia</i>	CC
	<i>Coridothymus capitatus</i>	C
	<i>Lamium moschatum</i>	CC
	<i>Micrimeria nervosa</i>	CC
	<i>Phlomis viscosa</i>	C
	<i>Prasium majus</i>	F
	<i>Salvia fruticosa</i>	C
	<i>Salvia verbenaca</i>	F
	<i>Salvia viridis</i>	C
	<i>Saturja thymbra</i>	CC
	<i>Sonchus oleraceus</i>	CC
	<i>Stachys neurocalycina</i>	F
	<i>Teucreum creticum</i>	C
	<i>Teucrium divaricatum</i>	C
	<i>Teucrium polium</i>	CC
	<i>Thymbra spicata</i>	F
Leguminosaea	<i>Astragalus hamosus</i>	F
	<i>Calycotome villosa</i>	CC
	<i>Coronella scorpioides</i>	F
	<i>Hippocrepis unisiliqua</i>	CC
	<i>Hymenocarpus circinatus</i>	C
	<i>Lathyrus aphaca</i>	C
	<i>Lathyrus blepharicarpus</i>	CC
	<i>Lotus peregrinus</i>	CC
	<i>Lupinus palaestina</i>	RR
	<i>Medicago polymorpha</i>	CC
	<i>Medicago truncatula</i>	F
	<i>Onobrychis squarrosa</i>	CC
	<i>Ononis natrix</i>	C
	<i>Ononis spinosa</i>	CC
	<i>Pisum fulvum</i>	C
	<i>Scorpiurus muricatus</i>	F
	<i>Trifolium campestre</i>	CC
	<i>Trifolium clypeatum</i>	C
	<i>Trifolium purpureum</i>	CC
	<i>Trifolium rusipenatum</i>	CC
	<i>Trifolium scabrum</i>	C

	<i>Trigonella bertheya</i>	F
	<i>Vicia palaestina</i>	C
Liliaceae	<i>Allium neopolitanum</i>	C
	<i>Asparagus aphylla</i>	CC
	<i>Asphodelus aestivus</i>	CC
	<i>Bellevalia flexuos</i>	CC
	<i>Leopoldia comosa</i>	R
	<i>Muscari pulchellum</i>	R
	<i>Ornithogalum narbonance</i>	CC
	<i>Scilla hyacinthoides</i>	R
	<i>Urginea maritima</i>	CC
	<i>Linum pubscence</i>	C
Loranthaceae	<i>Viscum cruciatum</i>	F
Malvaceae	<i>Alcea setosa</i>	CC
	<i>Lavatera cretica</i>	CC
	<i>Lavatera trimestris</i>	RR
	<i>Malva nicaeensis</i>	CC
Oleaceae	<i>Jasminum fruticans</i>	R
	<i>Olea europea</i>	CC
Orchidaceae	<i>Ophrys carmeli</i>	C
	<i>Ophrys lutea</i>	F
	<i>Ophrys transhyrcana</i>	R
	<i>Orchis caspia</i>	CC
	<i>Serapias vomeracea</i>	R
Oxalidaceae	<i>Oxalis pescaprae</i>	R
Papaveraceae	<i>Papaver subperiforme</i>	CC
Pinaceae	<i>Pinus halapensis</i>	CC
Plantaginaceae	<i>Plantago afra</i>	CC
	<i>Plantago cretica</i>	CC
	<i>Plantago lanceolata</i>	CC
Polygonaceae	<i>Rumex cyprius</i>	F
	<i>Rumex pulcher</i>	F
Primulaceae	<i>Anagallis arvensis</i>	CC
	<i>Cyclamen persicum</i>	CC
Ranunculaceae	<i>Adonis cupiana</i>	CC
	<i>Anemone coronaria</i>	CC
	<i>Clematis flammula</i>	RR
	<i>Ranunculus asiaticus</i>	CC
Rhamnaceae	<i>Rhamnus palaetisna</i>	CC
Rosaceae	<i>Amygdalus communis</i>	CC
	<i>Crataegus aronia</i>	F
	<i>Pyrus syriaca</i>	F
	<i>Rubus sanctus</i>	C
	<i>Sanguisorba minor</i>	F

	<i>Sarcopodium spinosa</i>	CC
Rubiaceae	<i>Galium judaicum</i>	CC
	<i>Rubia tenuifolia</i>	C
Rutaceae	<i>Ruta chalapensis</i>	F
Scrophulariaceae	<i>Verbascum sinautum</i>	CC
	<i>Verinoca cymbalaria</i>	CC
Solanacea	<i>Datura stramonium</i>	F
Styracaceae	<i>Styrax officinalis</i>	F
Theligonaceae	<i>Theligonum cynocrambe</i>	CC
Umbelliferae	<i>Ainsworthia trachycarpa</i>	CC
	<i>Conium maculatum</i>	F
	<i>Daucus carota</i>	CC
	<i>Eryngium glomeratum</i>	C
	<i>Eryngium Creticum</i>	CC
	<i>Foeniculum vulgare</i>	CC
	<i>Scadix pecten -veneris</i>	C
	<i>Torilis tenella</i>	CC
Urticaceae	<i>Urtica pilulefera</i>	F
Urticaceae	<i>Urtica urens</i>	CC
Verbenaceae	<i>Vitex agnus-castus</i>	C

Table 17. List of flora recorded from WZU. C= common, CC= very common, F= frequent, O: critically endangered, R= rare, RR= very rare.

Most species are common, while 13 species are considered rare or very rare (Table 18). One species, *Convolvulus coelesyriacus*, is on the verge of extinction. According to Garstecki et al. (2010), four plant species of high conservation value including *Verbascum galilaeum*, *Turgenia latifolia*, *Rosa phoenicia*, and *Linaria triphylla* are present in Wadi Al-Zarqa.

Species	Status		
<i>Aristolochia parviflora</i>	R	<i>Leopoldia comosa</i>	R
<i>Chrysanthemum segetum</i>	RR	<i>Lupinus palaestina</i>	RR
<i>Clematis flammula</i>	RR	<i>Muscari pulchellum</i>	R
<i>Convolvulus coelesyriacus</i>	CR	<i>Ophrys transhyrcana</i>	R
<i>Echium glomeratum</i>	R	<i>Oxalis pescaprae</i>	R
<i>Helianthemum syriaca</i>	R	<i>Pancratium parviflora</i>	R
<i>Jasminum fruticans</i>	R	<i>Pennisetum divisum</i>	R
<i>Lavatera trimestris</i>	RR	<i>Scilla hyacinthoides</i>	R
		<i>Serapias vomeracea</i>	R

Table 18. Some rare plant species found in WZU. Abbreviations R=rare, RR=very rare, CR=critically endangered.

Deir Ghassaneh and Kufer Al Deek areas are rich in medicinal plants such as *Salvia fruticosa*, *Salvia hiero-solymitana*, *Thymbra spicata* and *Saturja thymbra*. They are most often found in very steep areas, where it is very difficult for people to go for harvesting these species. Generally speaking, the area constitutes a reservoir of medicinal plants and spices for Ramallah.

4.11. Threats Affecting Wadi Al-Zarqa

We were able to identify a number of threats that affects the integrity of WZU protected area. Most of these threats due to irresponsible practices. The direct and indirect effects of these threats should be evaluated in order to better understand the role of these threats on the overall biodiversity of the study area.

Urbanization

Originally, the study area was surrounded by several small villages where natural caves were used to keep animals. Now, these villages are expanding horizontally and animal sheds have been constructed on ledges around the wadi area, reaching the periphery of the core area of WZU. This certainly will affect bats that take refuge in the caves (Figure 37-39).



Figure 37. Animal sheds and use of natural caves for animal keeping.

Houses and side roads are encroaching on the natural boundaries of the wadi system (Figure). The boundaries should be outlined and a buffer zone should be delineated.



Figure 38. Deir Ballout urban spreading.



Figure 39. Kufir Al-Deek urban sprawl.

Side and dirt roads are constructed randomly for access across the wadi system (Figure 40) with no regard to the existing flora or fauna. These roads may cause destruction of trees and removal of nesting sites for ground nesting birds and other animals.



Figure 40. Dirt roads within WZU PA fragmenting habitats.

Overgrazing

We observed many herds of sheep and goats grazing within the lowlands of the study site. Goats can climb and feed on trees and shrubs (Figure 41), while sheep feed on annual plants and grasses (Figure 42). Grazing period occurs from March to November, with animals switching from green to dry plant material in May. Thus, this will affect seed formation if grazing is not organized.



Figure 41. Overgrazing goats in Wadi Al-Zarqa.



Figure 42. Overgrazing sheep in Wadi Al-Zarqa.

Solid and Liquid waste

Littering and sewage dumping is one of the major threats encountered during this study. Piles of do-mestic garbage are dumped in the wadi with no regard to the aesthetic value of the site. Household wastewater is dumped directly into the wadi on daily basis (Figure 43), creating a permanent flow of un-treated sewage (Figure 44). Wastewater from Salfeet and surrounding colonies is also dumped di-rectly in the wadi.



Figure 43. Septic truck dumping household sewage in Kufr Al-Deek.



Figure 44. Flow of untreated sewage in WZU PA. Picture also shows olive trees planted in the valley while small remaining natural areas on the steeper hills.

Household garbage that consists mostly of plastic (plastic bags and bottles), metal cans, and food re-mains is also dumped in several areas of the wadi (Figure 45-46). These materials are sometimes burned on site, forming fumes and fire in the wooded areas.



Figure 45. Household garbage consisting mostly of plastic materials dumped in WZU



Figure 46. Burned household garbage in WZU PA.

Other Habitat Destruction by Locals

Wood Cutting: It seems that wood cutting is a major threat that affected the vegetation cover in the western section. This is mainly due to the traditional limestone manufacturing process for building houses and painting. Locally, the burning site is called "Al Kabarah". Large numbers of trees were cut to fuel piles of stones. This area harbor ruins whereas inhabitants practiced manufacturing lime stone. Besides, wood cutting was practiced on large scale as fuel for heating and other house holds activities by the surrounding counties. On the other hand, the western side has still dense vegetation and wood cutting is not a major problem, since regeneration and secondary succession replaced old trees. Also, cutting wild trees for cultivating olive trees and wheat has took its toll on lands close to the wadi bed and some hills in both the western and eastern sides of WZU. Locals cut trees for domestic use (heating and cooking) in many villages around the area, perhaps due to the high price of fuel.

Hunting: Hunting is practiced on large scale by the locals. The porcupine, rock hyrax and the mountain gazelle are the main targeted species. Porcupines are hunted using dogs and their meat is consumed on the belief that it can cure asthma and other respiratory illnesses. The lack of public awareness among hunters towards the natural heritage of the study area caused severe decline in large mammal's pop-ulations in the upper reaches of WZU. The lack of implementations of Palestinians laws regarding the protection of wildlife plays an important role in the loss of large mammals and other birds. Birds such as chucker, black birds and blackcap are hunted for their meat, while the European Serin and the siskin are trapped for cage keeping.

Other Human Activities

WZU is located in close proximity to Ben Gorion airport, with various airplanes descending or taking off at low altitude casing noise pollution. Air traffic is active all day and night (Figure 47).



Figure 47. Planes over Wadi Al Zarqa.

Israel constructed the segregation wall during 2002. Dayr Ballout is one of the most negatively impacted Palestinian towns both by the direct loss of land behind the wall or by loss of agricultural wealth, water resources and impact on the environment (Figure 48). 8000 donums of agricultural and grazing lands were confiscated behind the wall. In addition, the locals are not allowed to cultivate their lands that are adjacent to the wall. Since all confiscated land behind the wall were previously used as grazing areas and for cultivating winter crops, this forced many livestock owners to seek other parts of the wadi causing overgrazing and decline in the natural vegetation cover.

The Israeli Authorities established the segregation wall close to a garbage dumping site and buried parts of this site and cut the road on the remaining part forcing Dayr Ballout Municipality to rent another garbage dumping site close to the town.

The segregation wall also segregated animal populations on both sides of the wall. The Mountain Gazelle was observed in the western side, however, it cannot move freely across the natural flow of the wadi system. Other large and medium sized animal such as the badger is also denied free movement across the WZU system. The Israeli Authorities changed the name of the valley and claims it as an Israeli protected area (Figure 49).



Figure 48. Segregation wall on the western part of WZU limiting free movement of large animals on both sides.



קמ"ט שמירת הטבע והפארקים - המינהל האזרחי ליהודה ושומרון
 صابو أركان الحفاظ على الطبيعة والشهزات - الإدارة المدنية في يهوذا والسامرة
 Nature and Parks Protection Authority - Civil Administration in Judea and Samaria



**UPPER SHILOH STREAM
 NATURE RESERVE**

Welcome!
 The Shiloh Stream is one of the larger tributaries of the Yarkon River. The reserve includes 12 kilometers of the streambed, along which it is broad and deep. There are a few impressive bends in the stream, the most beautiful of which is located south of the Bint Bar Ruins. The reserve features water sources (springs and wells) and antiquities sites, among them a fortified Crusader-era farm (the Deir Kal'a Ruins), remains of a Byzantine church (e-Dawelr Ruins) and burial places (Sheikh e-Raf'i and Rujei Is'afa). Olive groves and patches of natural woodlands are also part of the reserve, as well as rocky areas where an extensive grassy batha and a prickly burnet batha grow.

Enjoy your visit!

- Please follow these rules:
- Do not harm flora, fauna or inanimate objects.
 - Trails are for fit hikers only. Trip leaders must have recent 1:50,000 trail maps.
 - Use only marked trails and roads.
 - Keep away from the cliff edge. Be careful of falling and rolling stones.
 - No passage at night.
 - Rappelling and cliff-climbing are prohibited except in authorized areas.
 - Carry 5 liters of water per person per day. Do not rely on natural water sources for drinking. Wear walking shoes and a hat.
 - Flooding is a danger in winter, spring and fall. Follow weather reports and do not walk in streambeds or cross them in cloudy weather.
 - Do not enter the water except where authorized by posted signage.
 - Keep the area clean. Do not bury or burn trash; take it with you.
 - We recommend leaving written notice on your vehicle of your route, schedule and the number of people in your group.
 - Do not enter military firing zones without proper authorization from the army.
 - Visit at your own risk.

**المحمية الطبيعية
 وادي شيلو العلوي**

أهلاً وسهلاً!
 وادي شيلو هو أحد الروافد الكبيرة لنهر البركون العوجا. تشمل المحمية 12 كم في فناء الوادي، وهو فيها واسع وعميق. توجد في الفناء بعض الانواءات المنيرة. أجملها يقع جنوب خربة باتا بر. تشمل منطقة المحمية مصادر مياه (بنايع وآبار) وعدد من المواقع الأثرية. من بينها مزرعة صليبية محمية (خربة دير قلعة)، بقايا كنيسة بيزنطية (خربة الذوير) ومواقع دفن (صريح نتج الرقاصي). توجد في المحمية بنايات رتيون، محميات حجري طبيعي ومناطق من الأشواك تنمو فيها أرض بور من الأعشاب وسنة اللان.

نزهة ممتعة!

- الرجاء الالتزام بالعلامات التالية:
- ممنوع إلحاق الضرر بالنباتات الحية والحيات والحمام.
 - مسارات الرحلة مخصصة للذين يتعدون المنسى. يجب على مرشدي الرحلة النزود بحارطة محليلة لتحديد للمسارات بمقياس 1:50,000.
 - مسموح التحرك في الطرق والسبل الموضحة فقط.
 - ممنوع الاقتراب من حافة المنحدر الصخري. احذروا سقوط وندرج الحجاره.
 - ممنوع التحرك في الليل.
 - ممنوع تسلق المنحدرات الصخرية او التحرق عليها ما عدا المناطق المصرح بها لذلك فقط.
 - يجب النزود بحمسية لترات من الماء للشخص الواحد يوماً، وعدم الاعتماد على مصادر المياه الطبيعية للشرب. احضروا على انفسكم اذية علامته للمسي وارتداء قفصه.
 - يوجد خطر من الغصبات في فصل الشتاء والمواسم الانتعاشيه. يجب متابعة الارصاد الجوية. يحظر المنسى في قنوات الاودية او قطعها عندما يكون الطقس عائم.
 - ممنوع الدخول الى الماء ما عدا الأماكن المسموح بها ووفقا لعلامات اللافتات في المكان.
 - الرجاء المحافظة على النظافه. يجب عدم دفن او حرق النفايات وايضا احذها معكم.
 - من المصحذ ترك رساله خطفه على باقه السيارة تشمل تفاصيل مسار الرحله. الحدوك الرصدي وعدد المشاركين.
 - ممنوع التبره في مناطق اطلاق البار بدون تصريح لائمه من حسي الدفاع الاسرائيلي.
 - الرحله على مسؤوليه المرشدي فقط.

**שמורת טבע
 נחל שילה עילי**

ברוכים הבאים!
 נחל שילה הוא אחד מיובליו הגדולים של הירקון. תחום השמורה כולל 12 ק"מ באפיק הנחל, ובהם הוא רחב ועמוק. באפיק כמה נפתולים מרשימים, שהיפה שבהם ממוקם דרומית למחבת בת-בר. בתחום השמורה נכללים מקורות מים (מעיינות ובארות) וכמה אתרי עתיקות, בהם חווה צלבנית מבוזרת (ח' דיר קלעה), שרידי כנסייה ביזנטית (ח' א-דויר) ואתרי קבורה (שייח' א-רפעי ונח'ל עזופה). בשמורה מטעי זיתים, כתמי חורש טבעי ואזורי טרשים שבהם גדלה בתה עשבונית וכן בתה טירה קוענית.

טיול נעים!

- אנא הקפידו על הכללים האלה:
- אין לפגוע בחי, בצומח ובדומם.
 - מסלולי הטיול מיועדים למיטיבי לכת. על מובילי הטיול להצטייד במפת סימון שבילים מעודכנת בקו"מ 1:50,000.
 - התנועה מותרת בדרכים ובשבילים המסומנים בלבד.
 - אין להתקרב לשפת המצוק. היהירו מנפילה ומדרור אבנים.
 - התנועה בלילה אסורה.
 - גלישה וטיפוס מצוקים אסורים אלא במקומות שאושרו לכך.
 - יש להצטייד ב-5 ליטר מים לאדם ליום. אין להסתמך על מקורות מים טבעיים לשתיה. הקפידו לנעול נעלי הליכה ולחבוש כובע.
 - בחורף ובקונות המעבר קיימת סכנת שיטפונות. יש לעקוב אחר תחזית מזג האוויר. במזג אוויר מעונן אין ללכת באפיקי נחלים או לחצונות.
 - הכניסה למים אסורה, אלא במקומות שאושרו לכך ועל פי הוראות השילוט המוצב במקום.
 - שמרו על הניקיון. אין לקבור או לשרוף אשפה. קחו אותה עמכם.
 - מומלץ להשאיר הודעה בכתב על חלון הרכב, ובה פרטי המסלול, לוח הזמנים ומספר הששתתפים.
 - אין לטייל בשטחי אש ללא אישור מתאים מצה"ל.
 - הטיול באחריות המטיילים בלבד.



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Figure 49. Israeli Sign found in Wadi Al-Zarqa.

The water bed of WZU is fed by several springs across the wadi system. Now, most of these springs dried or closed. At the same time, Israel started to construct artesian wells that drained the water bed and caused drying out of most of the natural springs, causing the absence of flowing water in the wadi system all year long as it used to be. With increasing demand on freshwater, both by the surrounding villages and Israeli colonies, water is abstracted from these wells and sold to the Palestinian villages (Figure 50). Also this water is transported to the 1948 occupied regions. This certainly affected the natural flow of water, affecting decline or mass extinction of the freshwater fauna and flora.



Figure 50. Water Station in Wadi Al Zarqa near Deir Ballout.

5. Environmental Education and Awareness (EEA)

Programs in EEA in and around population around any protected areas need to be developed with a cohesive strategy that also helps creativity, innovation, and sustainability strategies (Franzen and Meyer, 2010; Kassas, 2002). This includes comprehensive public engagement with the parks service resources to ensure communities benefit from protection of their natural resources. System wide participation addressing leaders and developing leaders who are able to take on tasks on protected area programs and strategies at a local regional and global scale. Increased awareness can be done through marketing, education and cooperative associations which lead to increased interest, research, and protection.

The first student workshop was held on Sunday 24 September 2017 Spanish Basic Girls School and the Boys Salfit School (Figures 51, 52) (Governmental Schools) and another 1/10/2017 with two other schools. We held the workshop at the Salfit Directorate (Figure 53) of Education training center with attendance from high level officials of the Ministry and school teachers and 40 students (50% of them female). The school's environmental health official was also present emphasized importance of clean/green environment. The main body of the workshop was conducted by Mr. Elias Handal (with a Power Point presentation but interactive that included photos of local habitats, fauna, and flora). A total of 10 workshops were held (Table 19). We prepared a workshop evaluation form and distributed to participants at the end of each workshop. Completed evaluation forms were collected and our team engaged in self-evaluation and review of performance based on all collected data. The questions asked and average response of 207 who filled out these questionnaires is shown in Table 20.





Figure 51. Workshop in Salfit School.

# Workshop	Date	Village	location	Focus group
1	24.9.2017	Salfit	Training Center/ Spanish School	School Students
2	1.10.2017	Kufr Al Deek	Kufr AL Deek High School for Girls	School Students
3	8.10.2017	Bruqeen	Broqeen High School for Boys	School Students
4	15.10.2017	Dayr Ballout	Dayr Ballout Secondary School for Girls	School Students
5	22.10.2017	Dayr Ghassana	Club Union Bani Zaid Sports	School Students
6	5.11.2017	Kufr Al Deek	Kufr Al Deek Municipality Hall	Stakeholders and locals
7	16.11.2017	Bruqeen	Bruqeen Municipality Hall	Stakeholders and locals
8	20.11.2017	Dayr Ballout	Dayr Ballout Municipality Hall	Stakeholders and locals
9	22.11.2017	Dayr Ghassana	Bani Zaid Municipality Hall	Stakeholders and locals
10	27.11.2017	Salfit	Salfit Municipality Hall	Stakeholders and locals

Table 19. The ten workshops held in the communities. There was also an opening workshop and a closing ceremony.

Feedback from students was received both during the workshop and also via an evaluation form (see annex). The summary of the data from 207 people who filled the evaluation forms and the nature of the questions asked. There were two sets of questions. The first set related to the place of holding the workshop (amenities). The attendees were asked to rate from 1 (very bad) to 10 (excellent) on that set of questions. As can be seen from Table 19, the range of answers for three questions were 8.72 to 9.04 so we did well in choosing the place and the hospitality. The second set of questions related to the content of the workshop and respondents were asked to evaluate these in terms of 1 (weak) to 5 (excellent). Most responses were between good (3) and very good (4) and the averages fell there. We are satisfied with these results. The lower scores (averages between 2 -3) was for questions like interactions between students and we indeed had limited interactions between students than that between students the facilitator. The last question if the workshop achieved the expectations (a yes or no question), the vast majority answered yes (88% of students).

		Min	Max
The following questions relate to the venue of the workshop:	Average	1	10
What is your opinion about the Workshop place?	8.874396		
What do you think of the facilities of the place	8.724638		
How you see the hospitality provided during the workshop	9.294686		
Was the place suitable in terms of space and provide the appropriate environment for education	9.048309		
How you can evaluate the quality of the following points in the workshop:	Average	0	4
Audio Education	3.207729		
Means of reading instruction	3.458937		
Group discussion with the lecturer	3.115942		
The presentation time for the workshop	3.362319		
Presenting during the workshop	3.483092		
Respond to questions	3.227053		
During the workshop how much was ...	Average	0	4
Interaction with other students	2.850242		
Help other students and their interaction in the workshop	2.618357		
Asking questions and comments on the subject of the workshop	3.077295		
Communicate with the lecturer	3.246377		

Was the offer motivated to complete the workshop	3.478261		
Have you been prompted to learn more about the Upper Zarqa Valley Reserve	3.483092		
Was the level of the workshop difficult	1.531401		
How satisfied are you with the following points:	Average	0	4
I learned a lot from the workshop	3.405797		
I can apply what I have learned in my life	3.256039		
The information you received was new	3.323671		
This workshop deserved my time	3.198068		
I have the ability to convey what I have learned to others	3.149758		
I would like to attend more workshops with the lecturer	3.497585		
Did the workshop achieve your expectations?	0.879227	0	1

Table 20. Responses to questionnaires from workshop participants. The average of 207 respondents.

Finally the questionnaire shown in Annex 1 included open ended questions asking feedback on many areas including what they knew before or after. One question that asked what specific part you learned and benefitted from in the workshop. Many students talked about that they learned that we have very interesting rich biodiversity area. Others commented about how they learned that they should reduce, recycle, and reuse solid waste. Others talked about the threats they and nature faced. Many explained that they would like to learn more and do more.

In short, there were 493 beneficiaries including 200 students (more than 50% female) and 293 adults. The feedback as noted above was very positive and we believe there will be a ripple effect for the environmental education/awareness done via this project. As a side benefit, the modules and experiences developed will be used by our team and offered to others for future similar projects in other regions.



Figure 52. Workshop in Kufir Al Deek for the locals.

6. Sustainable Economic Development

Our study of the area and those of others cited before shows that most people living near the PA depend on service and agricultural jobs. It is thus incumbent upon us to think of strategies that profit the local people while also protecting the environment. We identified two such areas: tourism and permaculture.

6.1 Tourism

The global tourism industry is huge and growing with all attendant positives and negatives. The Middle East accounts for only 2% of that tourism economy (Neto, 2003) but if political situation stabilizes and tourists feel safe this could increase to 10-15%. The environmental impact of that needs to be evaluated. For the OPT, there is very limited tourism (again largely due to political issues) and this is essentially a trickle down economy from the tourist industry now largely Israeli (Isaac et al., 2016). Tourism indirectly contributes to 14% of Palestinian GDP but only 4% from direct tourism and only 2% of employment directly (PCBS, 2014). There is a lack of resources, financial and human, to manage, develop and promote Palestinian destinations whether in ecotourism or in agricultural tourism which are relevant to our area of interest. There still a narrow vision of tourism, without connections to the different key attractions and with other sectors such as agriculture and nature. Agricultural tourism for example (Jolly and Reynolds, 2005) can be promoted because Palestine is rich in agricultural traditions and history being part of the Fertile Crescent where humans first developed domestication of plants and animals. Palestinians do not seem to have adequate awareness of the advantages found in the cultural and natural heritage and what it can offer to local development plans and the local economy.

The concept of ecotourism (nature tourism with social and environmental conservation benefit) was developed in the 1980s as alternative to mass tourism (Orams, 1995). The philosophy of ecotourism is contrary to the notions of human development as practiced in the ideas of "using nature" (i.e. all that is natural is "undeveloped" and could/should be developed to serve human needs). Ecotourism by contrast presupposes the values and philosophy of environmentalism in the modern sense (Stephen and Neil, 1999, Honey, 2008). Ecotourism is a tiny segment of a "tourism industry" that is valued at trillions of dollars worldwide (roughly 10% of world GDP). But ecotourism, if done properly and with well-designed programs, may play a significant role in reversing negative trends of world development and contribute significantly to the world Millennium Development Goals (Bricker et al., 2012).

A conference on development of eco-tourism in Palestine was held 8 November 2007 by The Centre for Cultural Heritage Preservation (CCHP) in partnership with Bethlehem University. This alternative tourism sometimes led people in nature walks to enjoy the rich biodiversity and landscape beauty. However, for good or bad and without good data, Palestinians have already started doing ecotourism. Palestine generally has unique and promising rich landscape and wildlife habitats and ecosystems including WZU and the nearby Wadi Qana which could be developed as an integrated area of tourism (two protected areas) perhaps in conjunction with agricultural tourism. In our discussion with women cooperative (جمعية الإبداع التعاونية) in Deir Ballot for example, we discussed ideas of having products both from farms and from recycled material sold to tourist.

6.2. Permaculture

Permaculture has the potential to improve soil fertility, biodiversity and sustainability of agricultural production; to conserve natural resources; to improve agronomic and economic performance; to make yields more stable, especially in risk-prone tropical ecosystems; to achieve better food quality and food security (Kilcher, 2007; Wezel et al., 2014). Permaculture in developing countries is being studied as a potential tool to address challenges of sustainable human food security while protecting biodiversity and ecosystems in developing countries (Akhtar et al., 2016; Pingali, 2012; Pant, 2016). While promising, tran-

sition to permaculture as an agroecological strategy involves significant complexities in implementation and transition periods even under ideal situations (Ferguson and Lovell, 2014). The challenges are exacerbated in many developing countries such as Palestine (Abdelnour et al., 2012; Qumsiyeh, 2016).

Before 1967, the largest economic sector for Palestinians in the West Bank and Gaza was agriculture. Agriculture now contributes to less than one fifth of the local economy but remains of great economic and social significance to the Palestinian people. Israel controls most of the land and 91% of the water in the West Bank and this caused a detrimental effect on the ability of Palestinian farmers to survive and thus most Palestinians became dependent on humanitarian aid rather than focusing on self-sufficiency (Hever, 2010).

Historically cultivation in Palestine depended on rainfall (called Baal agriculture in the local customs) not on irrigation. The first domestication of plants and animals happened in this Fertile Crescent during the Natufian period roughly 10,000-11,000 BC. This innovation of agriculture allowed for growth of population and for development of civilizations like the great Ugaritic and Canaanitic civilizations of the Levant (Eshed et al. 2004). These civilizations flourished around fields planted with products like wheat, barley, lentils, chickpeas and later almonds, figs, and olives. Agriculture remained the key economic activity for Palestinians during the first half of the 20th century. Before the foundation of the state of Israel, more than 70% of the population depended on agriculture (Swedenburg 1990). Self-sufficiency existed and increased throughout the periods of knowledge development in the 19th and early 20th century with exports of agricultural products to Europe with very few imports such as rice.

Today the idea of permaculture as an alternative to modern "industrialized" agriculture (largely monoculture with heavy use of herbicides and insecticides) has become an international movement with over 400,000 projects and more than a million participants. The idea spread to several locations in the Palestinian territories such as in Marda Village. From his farm, the family gets all its need of vegetables, eggs, white meat, honey, and oil and selling surplus to the neighbors and at the village market. This motivation can be used (opportunity) to advance such systems among the population which accomplish both food security and environmental conservation.

7. Discussion

7.1 Swot Analysis

Strength	<ul style="list-style-type: none"> • There is still high biodiversity and resilient ecosystem • There are endemic and interesting species (e.g. land snails) • There are key transition zones around the PA tha include for example the rainwater fed pool near Deir Ballot • Strong local (students, farmers, village councils, city officials), regional (governorate), and national (EQA, MOA) interest • There are key individuals with environmental interest in the area • Local law and International treaties that obligate action
Weakness	<ul style="list-style-type: none"> • Lack of environmental law enforcement • Unanswered threats from human activities (local and occupiers) • Political turmoil • Human Poverty • Population growth (currently 4.5% annually) and concomitant habitat destruction (environmental threats like climate change and desertification) • Knowledge – Practice gap
Opportunities	<ul style="list-style-type: none"> • Development of local, regional, national, and global environmental interest in the area. • Potential for combination of efforts/cooperation between governmental, academic, and non-governmental institutions and individuals • Potentiality of developing both ecotourism and agricultural tourism • Potentiality of developing permaculture to increase food security and protect nature
Threats	<ul style="list-style-type: none"> • Continued lack of sovereignty limits human potential and potential to use resources in this area which is mostly area C • Continued habitat destruction and other environmental threats discussed above • Some potentiality of nature-human selfishness conflict continuing. For example, short term financial gain from hunting versus long term communal/collective benefit. Also inability to protect nature on some lands for being private lands being developed. • Poverty and economic deprivation

Table 21. Overall SWOT analysis for WZU PA

7.2 Recommendations & Proposed Management Plan

We tried to synthesize threats to protected areas in Palestine in general in a report issued to Hanns Seider Foundation based on these and other indicators (see HSS, 2017). Strategies to protect environmentally sensitive areas must be focused on involvement of populations around these areas (Adams et al, 2004; Alhirsh et al 2016). A key aspect of this is environmental education and awareness focused on coaching (not “teaching”) and creating environments where by the community can see by examples how to improve their own economy and well-being by conserving natural resources (Qumsiyeh et al., 2017).

Very limited information is available on the fauna of the West Bank and most of it is from older literature that needs updating or from nearby parts of Palestine beyond the Green Line (not the occupied territories of the West Bank). The nascent Palestine Museum of Natural History (PMNH) started to change this resulting in a number of scientific publications (see <https://www.palestinature.org/research/>).

But much more is needed. We started to do some work to explore rich areas of biodiversity in protected areas (from Garstecki et al., 2010 and EQA 2015) and in other areas including transition and buffer zones which are critical for biodiversity protection (see Ewel et al. 2001). Our work has identified three areas with very rich biodiversity and some threatened and endangered species: Wadi Quff, Wadi Al-Zarqa Al-Ulwi, and Wadi Qana. Our team studied the first (Wadi Quff) with support from IUCN and the second is this study supported by UNDP/GEF. Data was valorized for Wadi Quff and a management plan is being implemented (collaboration of EQA, Ministry of Agriculture, and Municipality of Hebron). Valorizing Wadi Al-Zarqa data started in late 2017 with workshops and is expected to continue.

This work we did in WZU PA is thus critical in expanding the knowledge base not only of what is currently there and the threats facing fauna, flora, and human sustainability in the area but also in using these data to create a scientifically sound management strategy with appropriate rational recommendations.

Proposed management plan for Wadi Ain Al-Zarqa Al-Ulwi should take into account these aspects which we summarize here based on the SWOT analysis above (Table 19).

- 1- **Reduce and recycle liquid waste:** We need to solve the liquid waste water that is found extensively in the protected area especially near Bruqin and Kufir Al-Deek. Programs to reduce and reuse (after treatment) liquid waste should be implemented. A liquid waste treatment facility can be built upstream and near the agricultural areas and the treated water used for fruit trees.
- 2- **Reduce, Reuse, & Recycle solid waste:** Solve the solid waste issues: Village and municipal councils must enforce existing laws of collection but can also develop new projects such as separating organic waste (currently over 50% of waste) and compost it to produce organic natural fertilizers for the farmers.
- 3- **Reducing and eventually eliminating harmful human activities:** Overgrazing in the area need to be controlled by designating and regulating grazing in specific areas and seasons. Hunting and cutting trees in the PA should be strictly prohibited and laws enforced (training and empowering rangers from MOA). The same for solid and liquid waste disposal in the valley.
- 4- **Develop sustainable local economies linked to environmental conservation:** Eco-Tourism can be developed which will benefit the locals and help protect the area. However, this needs to be well structured and paths designated and marked by experts. The work we did can provide baseline data. Another area of local economic development is to expand on training locals in areas like recycling, composting, up-cycling and using permaculture methods in agriculture. This increases food security while protecting and valuing the ecosystem.
- 5- **Environmental education and awareness:** More workshops need to be done so that the locals, students, stakeholders stay informed and ACT for environmental protection. Environmental clubs at schools need to be nurtured and supported. Awareness campaigns can also include media campaigns (social and mainstream), posters and brochures (like the brochure we did as part of this project).
- 6- **Strict laws and their enforcement:** The EQA is in the process of formulating new laws for the parliament to approve to supplement the Palestinian Environmental Law (1999). But these laws need to be strictly enforced to prevent destruction of habitats and prevent poaching that decrease the fauna in area especially for the hyrax, gazal, porcupine and others. The same can be said for collecting wild plants (herbs and medicinal plants).
- 7- **Environmental justice:** This is now considered essential aspect to include in areas of conflict zones. There must be accountability for Israel's placing of a highly polluting

industrial zone (Brukeen) that dumps toxic waste both on people and the environment (Hammad and Qumsiyeh, 2013). The same for the destructive control of water resources discussed above and the segregation and annexation wall built on the land of this protected area. There is also now the concept of integrating environment in peace building efforts. A good example of this is <http://environmentalpeacebuilding.org/> as a positive approach instead of the negative one of normalization. Normalization activities (also in environment) involve cooperation between the occupiers and occupied with assumptions of normalcy of the situation. Little or no demand is made on the colonizer to end the oppressive reality but actually it relieves the pressure because the colonizers can ease their conscience by claiming “working together in peace.” Real peacebuilding requires facing hard realities and for the occupiers who wish to work with the oppressed to challenge the system and genuinely join in the struggle of the oppressed including on environmental justice issues.

- 8- **Manage and protect endangered species and habitats:** There are certain critically endangered species that can be saved with better study and management. Examples include orchids (genus *Orchis*), bats (especially *Pipistrellus pipistrellus* and *Rhinopoma hardwicki*), and tree frogs (*Hyla savignyi* group), among others (see results). Monitoring these species and ensuing strict protection of the ecosystem that harbors them is critical. Designating these key species and for special attention going forward could be important for their survival.
- 9- **Better rural and urban design:** There needs to be master plans for the villages around the protected area and for the municipality of Salfit that take into account environmental issues including not encroaching on the protected areas (which is happening now). There needs to be enforcement of these issues such as preventing random opening of agricultural and other roads that fragment habitats and impact the valley.
- 10- **Study and protect transitional key areas:** This project was focused on the protected area itself but we did preliminary studies of transition zones at the margins of the protected area which are critical also in management (Ewel et al., 2001). Many areas surrounding the borders of Wadi Al Zarqa need to be protected and include it under the reserve especially the Balou' (temporary rain pool) in Dayr Ballout.

7.3. Concluding remarks

The ten key recommendations listed above if followed going forward could save the valley (WZU PA) from continuing deterioration. Continued deterioration will effect not only the local fauna and flora but also the lives and livelihoods of the people living near WZU PA. The key vision that drives or should drive environmental conservation in Palestine as elsewhere should be a vision of a sustainable human population in a sustainable diverse natural environment. Since the industrial revolution, sustainability of ecosystems around the world has eroded due to human activity that causes habitat loss and environmental degradation. In the last few decades and especially with the growing realization of global human induced climate change, there has been increased awareness and efforts focused on environmental conservation and at least trying to halt destruction and mitigate effects with even some efforts going towards reversal of human induced habitat changes . Most efforts are focused on in situ conservation of natural resources (Adams et al. 2004; Alhirsh et al., 2016).

Two key factors that enter into success of environmental conservation in any country are economic and social factors. As noted above the level of GDP is directly correlated with environmental concern (Mills and Waite, 2009). The 12 million Palestinians in the world are now dispersed in many countries with 7 million being refugees or displaced people. The GDP of Palestinians is low (Hever 2010).

This has impact on environment and R&D (Qumsiyeh and Isaac 2012). For example, according to UNEP (2003), the GDP of the OPT which grew at 6% in 1999 shrunk by 6.5% in 2000 due to Israeli measures in response to the 2000 uprising. Further, there was a decline in GDP growth in the past few years as population grew while the economy did not expand (MOPAD, 2014). There was some evidence that poorer communities and countries do worse in protecting their own environments but this has been challenged but richer countries may be fueling their own prosperity via exploitation of natural resources in poor countries (Mills and Waite, 2009).

According to Qumsiyeh and Amr (in press), based on the IUCN criteria (Dudley, 2008), this protected area can be designated as Managed Reserve (Category IV, Managed by land owners, in collaboration with MOA. Core areas could be designated under category I (Strict Nature Reserve). Such managed re-serves as discussed above should be “managed” in ways that help bring out ecosystem services in benefit of the local communities. This is a main part of our project. We came to realize how much the support of the local people (served communities) is key to success of any project. We did note that locals were more cooperative than we expected. They were generous with their time and local resources (e.g. a place to sleep) but more importantly wanted to learn what is surrounding them and how to manage these rich natural resources that they learned about via the workshops.

Modern conservation philosophy argues that the local buy-in is critical for success of conservation efforts. We in Palestine certainly need to think strategically about how people around protected areas are to benefit from protection. There are models in nearby areas for example the way the Royal Society for Conservation of Nature worked with local communities to ensure active buy-in via direct benefit from things like ecotourism and environmentally sensitive agriculture.

This project showed that with minimal resources much can be done to study, disseminate information (environmental education and awareness) and produce significant impact if done in a methodical structured way. As with any project, there is a learning curve to learn by trial and error what works and what does not to achieve the stated objectives. Having flexibility is key to dealing with unexpected events. Selecting the right staff and contractors who are efficient and effective is important. But here are some issues that developed during the course of this project.

- One of our contractors delayed the study and reporting
- One piece of our field equipment (camera trap) was stolen and after some work based on our good contacts with local authorities was retrieved
- Our university car is high and could help us reach most areas (we got stuck once and had to be pulled out by tractor).
- Israel sometimes closed roads or limited access to certain areas.
- Sewage water in valleys of the area cut off the way and makes it hard to travel according the plan.
- Staff spent more than expected amount of time on paperwork relating to this grant (especially to reconcile both university and funder grant requirements)

All the above was resolved and addressed in adequate way to continue the work by flexibility of our team and with local and funder cooperation.

The long term benefits we think we achieved in this project are:

1. **Scientific knowledge:** This project increases scientific knowledge on an area little studied previously. Publications will help build the body of scientific literature on areas like taxonomy (systematics), ecology, environmental management (including threats and mitigation strategies), ecosystem services, local sociological issues relating to environmental protection, and more.

2. **Local engagement and sustainable development:** This project generates environmental awareness especially among key adult stakeholders and children. This would have long term impact on environmental protection/sustainability not only of the protected area but also of the communities in the areas surrounding the protected area (Salfit, Deir Ballout, Bruqeen, Kufr AdDik, Deir Ghassaneh, Bit Rima).
3. Our data collection for the SWOT analysis generated a set of plans and recommendations for management which will be used by scientists, stakeholders, government officials, local farmers and all the local people to ensure sustainability.

Looking forward, the material and data collected during the course of this project and the results are good but certainly do not end with this report. Many of the specimens collected from various groups of animals will be worked on (together with other collections from other areas) in a comparative way for years to come. We expect that several research papers will be published as a result of this work in peer-reviewed journals. We already know we have some interesting new species (e.g. we are sending one of our students to University of Siena in Italy this spring to work with an expert to identify the many species of Colembola we collected from the forest leaf litter, see Fig. 27). The data from the questionnaires that we collected in the workshops was used to improve later workshops and will also be used for our future environmental awareness and education campaigns for years to come. The relationships we built with the local community is also continuing and already we are helping farmers with ideas and we continue to work with students, locals, and officials to ensure that this area of Wadi Ain Al Zarqa and its nearby buffer/transition zones are protected as a national and local heritage for generations to come.

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Annex 1. Questionnaire used for workshop evaluation



استمارة تقييم ورشة عمل التنوع الحيوي في محمية وادي الزرقا العلوي

التاريخ:	المؤسسة:
الجنس:	العمر:
مكان عقد ورشة العمل:	موضوع ورشة العمل:

ما الذي تعرفه عن متحف فلسطين للتاريخ الطبيعي؟

- ما مدى تفاعلك مع الصفحات الالكترونية للمتحف (فيسبوك، تويتر)؟
- اعرف بانها موجودة واتابعها
 - اعرف بانها موجودة ولا اتابعها
 - لا اعرف بوجودها

الاسئلة التالية تتعلق بمكان عقد ورشة العمل:-

ما هو رايك بمكان عقد الورشة على مقياس 1-10 (1 سيء جدا / 10 ممتاز)؟

ما رايك بالمرافق الخاصة بالمكان على مقياس 1-10 (1 سيء جدا / 10 ممتاز)؟

كيف ترى الضيافة المقدمة خلال ورشة العمل على مقياس 1-10 (1 سيء جدا / 10 ممتاز)؟

هل كان المكان مناسب من حيث المساحة وتوفير البيئة المناسبة للتعليم على مقياس 1-10 (1 سيء جدا / 10 ممتاز)؟

كيف يمكنك تقييم جودة النقاط التالية في ورشة العمل:

جانب التقييم	ممتاز	جيد جدا	جيد	مقبول	ضعيف
وسائل التعليم المسموع (التسجيلات الصوتية الفيديو)					
وسائل التعليم المقروء (الكتب، الصفحات الالكترونية، المراجع العلمية)					
النقاش الجماعي مع المحاضر					
وقت العرض للورشة					
التقديم خلال ورشة العمل					
الاستجابة للاسئلة					

خلال ورشة العمل كم كان ...

جانب التقييم	دائما	معظم الوقت	احيانا	نادرا	ابدا
التفاعل مع الطلاب الاخرين					
مساعدة الطلاب الاخرين وتفاعلهم في الورشة					
طرح الاسئلة والتعليقات حول موضوع الورشة					
التواصل مع المحاضر					
هل كان العرض دافع لاكمال الورشة					
هل دفعك الموضوع للتعلم اكثر عن محمية وادي الزرقا العلوي					
هل كان مستوى ورشة العمل صعبا					

ما مدى موافقتك للنقاط التالية:

جانب التقييم	اوافق بشدة	اوافق	محايد	لا اوافق	لا اوافق بشدة
تعلمت الكثير من ورشة العمل					
يمكنني تطبيق ما تعلمته في حياتي العملية					
كانت المعلومات التي تلقيتها جديدة					
استحقت هذه الورشة وقتي					
لدي القدرة على نقل ما تعلمته للآخرين					
ارغب في حضور المزيد من ورش العمل مع المحاضر					

الاسئلة التالية تتعلق بالمادة العلمية في ورشة العمل:-
هل حققت ورشة العمل توقعاتك؟

ما هو اكثر جزء استفدت منه في الورشة؟

ما هي نقاط القوة ونقاط الضعف في الورشة؟

نقاط القوة	نقاط الضعف

ما هو الجزء الذي ترغب في تحسينه في الورشة؟

بعد مشاركتك في الورشة ما الذي ترغب في تعلمه او فعله لاحقاً؟

ما هو اكثر شيء قيم تعلمته في الورشة؟

اذا كان لديك اقتراحات او تعليقات للقائمين على المشروع يمكنك مشاركتنا بها

شكرا لك لملأ هذا التقييم

سيتم استخدام هذا التقييم من اجل تحسين ما سنقدمه في المستقبل من حيث محتويات الورشة وطريقة عرض المعلومات والمحاضرين في الورشة، شكرا لك مجددا على وقتك ونامل بان تكون قد استمتعت واستفدت من خلال وجودك مع طاقم متحف فلسطين للتاريخ الطبيعي/ جامعة بيت لحم.

