# INTEGRATED ECOSYSTEM MANAGEMENT IN THE JORDAN RIFT VALLEY PROJECT (IEM-RV)

## A Technical Report on

## Determination of Grazing Capacity for Yarmouk Protected Area

**Prepared for**

**The Royal Society for the Conservation of Nature**

**Prepared by**

**Dr. Mahfouz Abu-Zanat**

**October 2009**

**Table of Contents**

**List of Tables**

**List of Figures**

**Determination of Grazing Capacity for Yarmouk Nature Reserve**

## 1. Background

### 1.1. Integrated Ecosystem Management in the Jordan Rift Valley Project (JRVT)

The long term goal of the JRVT is to secure the ecological integrity of the Jordan Rift Valley as a globally important ecological corridor and migratory flyway, through a combination of site protection and management, nature-based socio-economic development and land use planning. It is intended to provide a large-scale pilot program for introducing the principles and practice of integrated ecological management throughout a productive landscape and thus a potential global model.

The Jordan Rift Valley is part of the Great Rift Valley, and extends from Yarmouk in the north, to the Gulf of Aqaba in the south, over a length of 370 km. The Jordan Valley in Jordan consists of the Northern Ghor (11,586 ha), Middle Ghor (7,875 ha) and the Southern Jordan Valley (11,500 ha). The Jordan Valley is about 10 km wide in its northern part, narrowing to 4 km in its middle section, and widening again to about 20 km in its southern part. The elevation of the Jordan River drops from 212m below sea level at Lake Tiberias, to more than 400 m below sea level at the Dead Sea, the lowest point on the planet.

South of the Dead Sea, the Jordan Rift Valley is drained by the Wadi Araba, which flows in a northerly direction when in spate. This southern section is about 160 km long, and up to 25 km wide. The valley bottom is bordered by highland (or *jebel*) ranges that run parallel to the Jordan valley proper – in local geomorphological terms; these are known as the *Mountain Ridges and Northern Highlands east of the Rift.* These highlands are more than 50 km wide in the north, but narrow to about 10 km near Aqaba. For the purpose of the Project, the Jordan Rift Valley is considered in its broadest sense, and includes both the valley floor (i.e. the Jordan River Valley, Wadi Araba, and its extension up to Aqaba) and the adjacent highlands (referred to the "escarpment") parallel to the valley bottom.

The JRV proposed several protected areas from north to south of national or international importance and meet agreed national criteria for protected areas designation: (1) the oak-clad valley of the Yarmouk River, (2) the sub-tropical vegetation communities at Fifa, (3) the arid mountain systems of Jabal Masuda; and (4) the mudflats of Qatar. Ecological and socio-economic assessments of the proposed areas are necessary to develop a comprehensive management plan in particular the regulation of grazing to improve the biodiversity in these areas and consequently improving the livelihoods of the targeted communities.

This report focuses only on the Yarmouk Nature Reserve and summarizes the performed activities and outlines the necessary steps to determine the grazing capacity of the Reserve.

### 1.2. Yarmouk Nature Reserve

The Yarmouk Nature Reserve (YNR) is located in the far north at the Jordanian-Syrian Border (Center Coordinates; E 753980, N 3618600), 18 km to the north of Irbid. The size of the YNR is

about 22 sq km (**Fig. 1**). The elevation ranges from 120 m bsl in the north western parts of the Reserve to 380 m asl in the south western parts.

The area represents a set of wadis, surrounded by a number of villages: Shamoos, Al Kursi and Al Mrah from the north, Al Ouleh, Um Al Basees from the eastern side, Balad Al Sheikh, Al Mansoorah, and Om Qais from the south and Mkhaibeh and Mazra'a from the westrn side of the Reserve.

The climate in the area is typical Mediterranean, with hot summer days and cool to cold winter days. The closest meteorological station to the study area is located in Baqura, which is less than 10 km away from the western borders of the study area from its lower part. Rainfall is mainly from November to March with an average annual of 400mm.

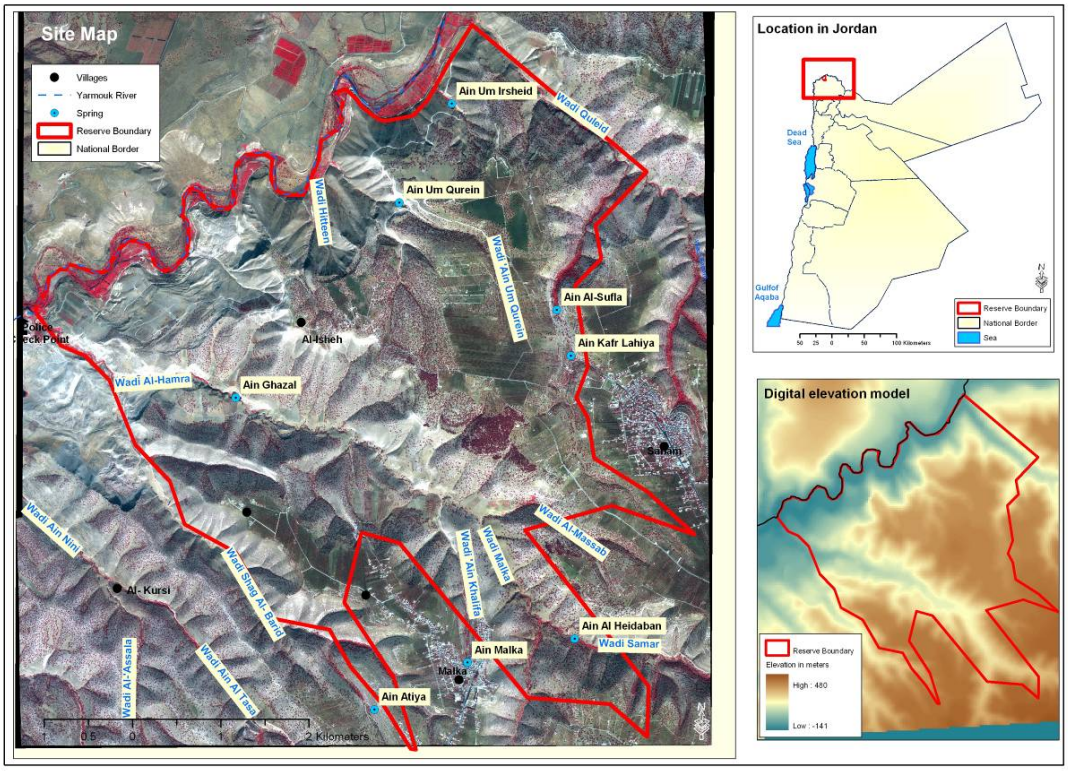


Figure 1. Map of the intended Yarmouk Nature Reserve.

## 2. Introduction

The oak woodlands in the Yarmouk area are under threat because of tree cutting for making coal and/or cleared for small scale farming. The continuous de-branching and de-leafing of the oak trees for feeding sheep and goats weakened the trees and reduced any opportunity for self-

regeneration. Similarly, the herbaceous species are vulnerable because of the open access and destructive grazing that has been practiced for many years.

The capacity of vegetation to support grazing animals can decrease as a result of change in the size, density and growth rate of their food plants. In heavily grazed ecosystems such as the Yarmouk Nature Reserve, the perennial plant species that are palatable to the grazing animals produce fewer seeds and small number of seedlings that can survive from one season to another. The age structure of frequently defoliated forage plant populations becomes skewed to the older age classes because there are not enough seedlings and young plants to replace senescent individuals.

As a consequence, the oak woodlands are amongst the most poorly conserved ecosystems in Jordan. The degradation and loss of biodiversity in oak woodlands will continue unless the present irrational practices are stopped and a sound management plan is developed and applied on the remnants of trees and herbs in the Reserve.

**3. Objectives**

The main objective of this study was to estimate the grazing capacity of Yarmouk Nature Reserve. The specific objectives were:

i. To determine percent cover, frequency, diversity and biomass of the vegetation.
ii. To characterize the grazing animals exploiting the feed and water resources.
iii. To determine the proper stocking rate.
iv. To develop a grazing plan for proper utilization of the vegetation.

**4. Methodology**

**4.1. Sampling vegetation**

**4.1.1. Understory vegetation**

The rugged topography of the YNR governed the selection of sampling sites and the layout of sampling quadrates. Four sites were selected: Kursi (الكرسي), Arqoup Al Qaser (عرقوب القاصر), Um Totah (أم طوطة), and Ersal (إرسال). Additionally, the vegetation of Wadi Ein Al Taseh and Wadi Muntamerah was sampled (Fig. 1).

Several quadrates ($0.5m^2$) were placed randomly at the plateau or top (T), right (R) and left (L) sides or *araqeeb* of each selected site (**Fig. 2**). A total of 30 quadrates were sampled at Kursi, 40 at Arqoup Al Qaser, and 30 at Um Totah sites. The Ersal site was small in area and surrounded by farms, beehives and houses, therefore, a total of 10 quadrates were confined to the top of the site.

The selected sampling sites and locations, similar to the other areas of the YNR, are rocky. At each sampling location, the rock-outcrops areas were estimated before sampling the attributes of vegetation. Estimating the rocky areas versus the vegetated ones is important to avoid over estimation of the grazing capacity.

Figure 2. Layout of sampling quadrates at the locations within the selected sites at Yarmouk Nature Reserve.

#### 4.1.1.1. Plant cover

The vegetation cover encircled inside the sampling quadrates was visually estimated. Percent cover was estimated for total vegetation (TVC), forage species (CFSP), and non-forage species (CNFSP). Spiny (e.g. *Centaurea syriaca*), pubescent (e.g. *Echium judaceum*) and other unpalatable plant species (e.g. *Ruta chalepensis*) were considered as non-forage species based on field experience and information furnished by the shepherds.

#### 4.1.1.2. Plant frequency

All plant species rooted-in the sampling quadrates were identified and recorded. Unknown plant species were photographed by a digital camera and specimens were taken to the RSCN Herbarium for later identification.

#### 4.1.1.3. Plant diversity

The diversity of plant species at the sampling sites was expressed as the average number of plant species per quadrate (total number of recorded plant species at the location or site divided by the number of quadrates).

#### 4.1.1.4. Plant biomass

All the forage plant species encircled inside the sampling quadrates were severed to the ground level by hand shears and the non-forage plant species were left intact. The harvested plant materials were placed in plastic bags to determine fresh weight and then placed in paper bags for dry matter determination using an air-circulating oven at 100 ± 5$^{o}$C for 48 hrs.

The coordinates of the entry routes (entrances) to the Reserve and the locations of the watering points inside the Reserve were recorded using a hand-held GPS.

### 4.1.2. Vegetation of wadies and riparian areas

The vegetation of Wadi Al Ein Taseh and Wadi Muntamerah was viewed as two separate entities: (i) the standing vegetation at the dirt roads and (ii) the vegetation of the riparian or wet areas. The vegetation of the dirt road was sampled using the random quadrate method similar to the understory vegetation. A check list was prepared for all the visible plant species in the riparian areas.

## 4.2. Characterization of grazing animals

### 4.2.1. Survey questionnaire

A structured questionnaire was used to collect specific information on the grazing animals exploiting the resources of YNR (**Appendix A**). The main components of the questionnaire were:

i. Total population, number of flocks, flock size per household, flock structure and composition.
ii. Mobility of flocks from the villages surrounding the Reserve and vice versa.
iii. The start and end of grazing season(s) during the year.
iv. The feeding calendar of the flock.

Three research assistants from RSCN were briefly trained on the collection of the required information. It is worth noting that the RSCN carried out a comprehensive socioeconomic study in the targeted area in 2008.

### 4.2.2. Community meeting

The Rift Valley Project Management Unit arranged a meeting on 19 August 2009 with the local community of YNR in particular the stockowners. The Consultant attended the meeting and discussed the concerns that were raised by the stockowners and farmers using the resources of the Reserve. The main concerns were securing the grazing rights, the effective mechanisms for grazing regulation, and the expected benefits from the collaboration with the RSCN.

### 4.2.3. Collection of secondary data on grazing animals

The Coordinator of the Livestock Identification Project at the Directorate of Animal Production in the Ministry of Agriculture was contacted to obtain a recent record on the population of livestock in the villages surrounding the YNR (**Appendix B**).

## 5. Results and Discussion

### 5.1. Reserve Condition

The following were concluded from the field visits to the Yarmouk Nature Reserve before vegetation sampling in April 2009:

i. The woody component of the Reserve in particular the oak and *Ceratonia* (*carob*) trees were severely damaged because of the irrational practices such as cutting the whole or part of the trees for fuel wood, de-branching and de-leafing of trees to feed sheep and goats and dairy cows in some places. It is worth noting that during these visits no seedlings of the oak or *carob* species were encountered which indicates that the natural regeneration of these species is impeded most likely by both the environmental conditions and irrational practices in particular the destructive grazing.
ii. The intermingling of small strips for planting grain crops (wheat, barley, vetches, lentils), vegetables (radishes, onions, parsley), medicinal plants (thymus, and mint), and orchards (olives, grapes, pomegranates) is expected to create problems in the development and implementation plans aiming for the conservation of the Reserve. The legal status of the planted areas in the Reserve requires a comprehensive investigation to know how these areas are owned by the community, and how to benefit from the existing farming activities to serve the overall goal of the Reserve.
iii. The relatively flat areas of the wadies were cleared from native vegetation and converted to orchards. Continual use of the running water in wadies for the irrigation of orchards might affect the productivity and diversity of riparian vegetation which serves as a refuge for a significant number of reptiles and birds; consequently the integrity of the riparian areas will be deteriorated.
iv. A significant number of beehives were scattered in Ein Al Taseh and Muntamerah wadies for honey production. This activity should be considered as one of the entry points for income generation for the local community.
v. The livestock watering points are full of sediments and mold growth. The improvement of these watering points is essential for the regulation of grazing in the Reserve.
vi. The dirt roads inside the Reserve are damaged and not suitable for driving which impaired accessibility to most locations in the Reserve.

### 5.2. Rockiness and stoniness

The estimated areas of rock outcrops and stones of the sampled sites were 65% for Kursi, 50% for Arqoup Al Qaser, 45 for Um Totah and 40% for Ersal. This indicates that around 50% of the sites are free of the understory vegetation (herbs and dwarf shrubs) which serves as a surface for the run-off of rainfall (**Fig. 3**). In many places, the soils or soil pockets were shallow and fluffy with low water holding capacity, which may explain the fast dryness of herbs in particular the species of *Stipa*, *Phalaris*, and *Plantago* at the sampled sites.

Figure 3. Rocky outcrops in Yarmouk Nature reserve.

### 5.3. Vegetation

#### 5.3.1. Vegetation structure

The vegetation structure of the YNR is typical woodland; the upper layer consisted of dwarf trees (oak and *Carob*) and the understory layer was composed of herbs (grasses and forbs) mixed with few numbers of dwarf shrubs (**Fig. 4**). The woody layer is under threat because of cutting for fuel wood, burning to clear the land for farming, and de-branching and de-leafing to feed animals in particular the goats. There were signs of localized destructive grazing of the herbaceous layer in the Reserve especially at the Ersal site.

Figure 4. Vegetation structure in the Yarmouk Nature reserve.

### 5.3.2. Understory vegetation

#### 5.3.2.1. Plant cover

The raw cover data of the understory vegetation are listed in **Appendix C**. Percent cover of the understory vegetation at the selected sites ranged between 19.5 and 43.0, and averaged 37.6 (**Table 1**). Except for Ersal site, the estimates of the understory coverage at the sites were close indicating the accessibility of the entire Reserve to the grazing animals. The estimated vegetation coverage reflected the "threshold" under **uncontrolled** grazing in a year of normal precipitation. The Ersal site, which is close to the houses that raise livestock, showed the lowest vegetation cover (19.5%) indicating a destructive grazing.

Table 1. Percent cover (mean ± SD) of total understory vegetation (TVC), forage plant species (CFPS), and non-forage plant species (CNFPS) at the selected sites in Yarmouk Nature Reserve.

| | Site | | | | Site Mean |
|---|---|---|---|---|---|
| | Kursi | Arqoup | Um Totah | Ersal | |
| **Percent cover of**: | | | | | |
| Understory vegetation | 40.0 ± 18.6 | 36.4 ± 14.2 | 43.0 ± 15.7 | 19.5 ± 6.4 | 37.6 ± 16.6 |
| Forage species | 34.0 ± 16.6 | 23.8 ± 13.6 | 36.0 ± 13.9 | 15.0 ± 6.2 | 29.1 ± 15.6 |
| Non-forage species | 6.0 ± 11.1 | 12.6 ± 9.7 | 7.0 ± 3.4 | 4.5 ± 2.8 | 8.5 ± 9.0 |
| **Proportion of CFPS/TVC** | 85.0 | 65.3 | 83.7 | 76.9 | **77.3** |

**Figure 5** shows the percent cover of TVC, CFPS and CNFPS at the sampled locations (top, right and left sides) within the selected sites in Yarmouk Nature Reserve. The sampled locations showed a similar trend of vegetation cover except the left side of Arqoup Al Qaser site where the coverage of non-forage species was higher than that of the forage plant species.

Means of forage and non-forage plant species proportions relative to the total coverage of the understory vegetation were 77.3% and 22.7%, respectively (**Fig. 6**). It was surprising to find an abundance of forage plant species under an "open access" strategy of grazing in the YNR. It seems that the heavy grazing pressure that is usually manifested by the uncontrolled grazing was shifted from the understory vegetation to the browse (small twigs and leaves) of the oak trees. During the sampling period in April, the forage plant species were dry and abundant and the shepherds were de-leafing the trees to feed their animals.

The shepherds believed that nourishing their animals on the oak leaves has many advantages: (i) the nutritive value of the green leaves of oak is higher compared to that of the dry herbage material, (ii) animals consume less water when feeding on the green leaves of oak compared with grazing dry herbs, and (iii) less effort is exerted by both the shepherds and animals in searching for forage plants.

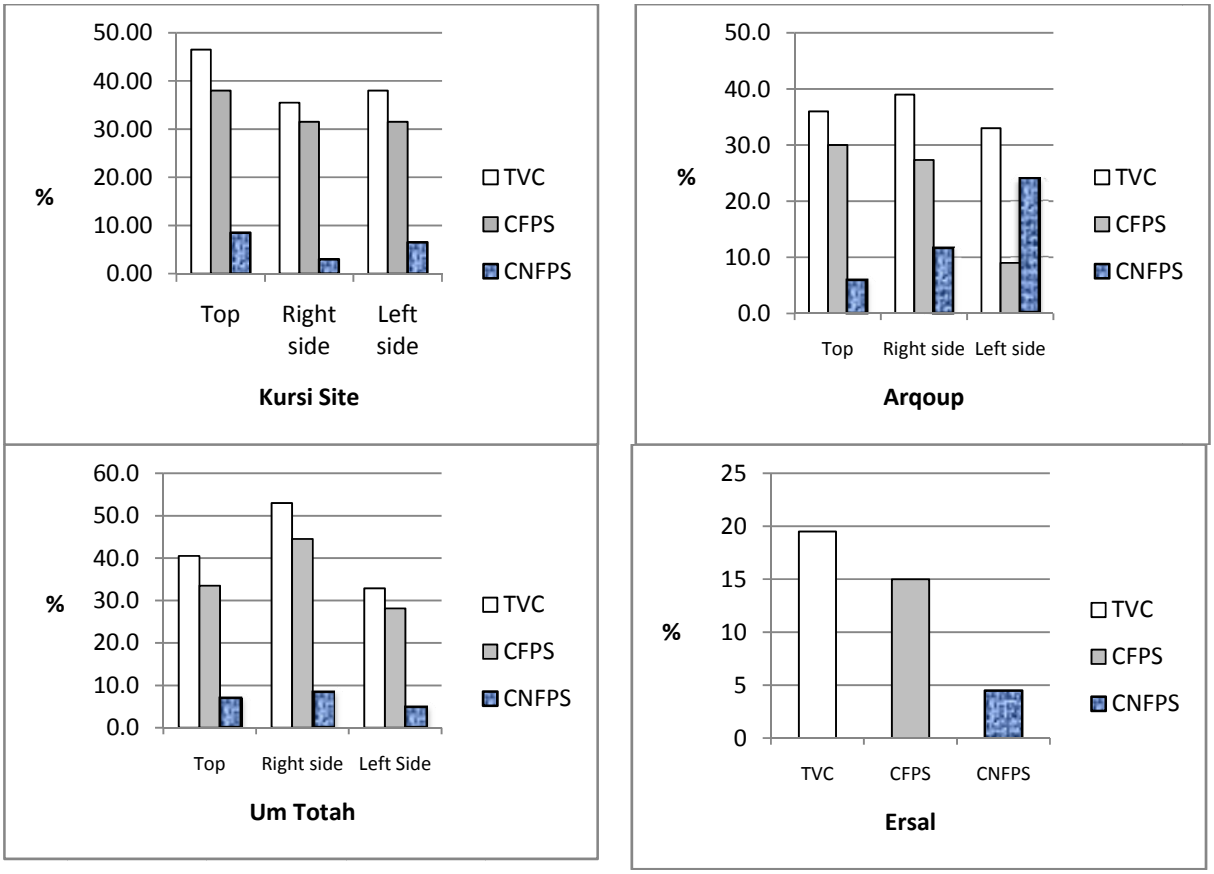


Figure 5. Percent cover of total understory vegetation (TVC), forage plant species (CFPS), and non-forage plant species (CNFPS) at the top, right and left sides within the selected sites in Yarmouk Nature Reserve, 2009.

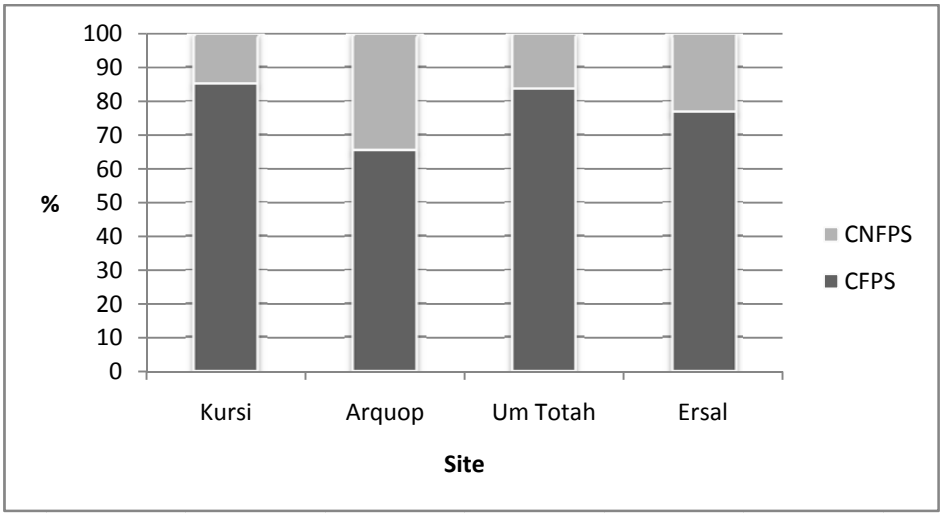


Figure 6. Proportion of forage plant species (CFPS) and non-forage plant species (CNFPS) relative to the coverage of the total understory vegetation.

#### 5.3.2.2. Plant diversity

The plant diversity was viewed from different angles: the total number of species per site, number of plant species per quadrate (species richness), number of plant genera and number of plant families.

**Number of plant species.** The total number of recorded plant species for the understory vegetation was 127. At the site level, the number of recorded plant species was 89 for Kursi, 68 for Arqoup Al Qaser, 68 for Um Totah and 43 for Ersal (**Appendix D**).

**Species richness.** The species richness averaged 10.4, 12.5 and 11.4 plants per quadrate for the top, right and left sides of the selected sites with an overall mean of 11.1 species (**Table 2**). Similarity of recorded numbers of plant species at the different locations reflects the abundance of species at the selected sites.

The recorded values of species richness of YNR under **uncontrolled** grazing were either similar or higher than those reported for other reserves in Jordan under **controlled** grazing. The species richness in the Shaumari Wildlife Reserve which represents a Saharo Arabian ecological zone was 11.4 compared with 4.2 species in Mujib Nature Reserve which represents a mix of Mediterranean, Irano-Turanian and Sudano ecological zones.

**Number of plant genera.** The recorded number of plant genera was 84 with a majority having only one species. There were 8, 6, 4, 3, 3, 3 and 3 species belonging to the genera of *Bromus, Medicago*, *Trifolium*, *Crepis*, *Daucus*, *Hordeum*, *Onobrychis* and *Phalaris*, respectively.

**Number of plant Families.** The plant species were distributed over 29 families (**Fig. 7**). The plant families that showed the highest number of species records were the Gramineae (63), Compositae (40), Leguminosae (35), Caryophyllaceae (22), Liliaceae (13), Umbeliferae (13), Cruciferace (12), and Plantaginaceae (12).

Table 2. Species richness (mean ± SD) at the sampling locations of the selected sites in Yarmouk Nature Reserve, 2009.

| | Site | | | | Location Mean |
|---|---|---|---|---|---|
| | Kursi | Arqoup | Um Totah | Ersal | |
| Location: | | | | | |
| Top | 11.3 | 8.1 | 11.7 | 10.5 | 10.4 |
| Right side | 13.5 | 10.1 | 13.8 | NA | 12.5 |
| Left side | 10.6 | 11.6 | 12.0 | NA | 11.4 |
| Site Mean | 11.8 | 9.9 | 12.5 | 10.5 | |

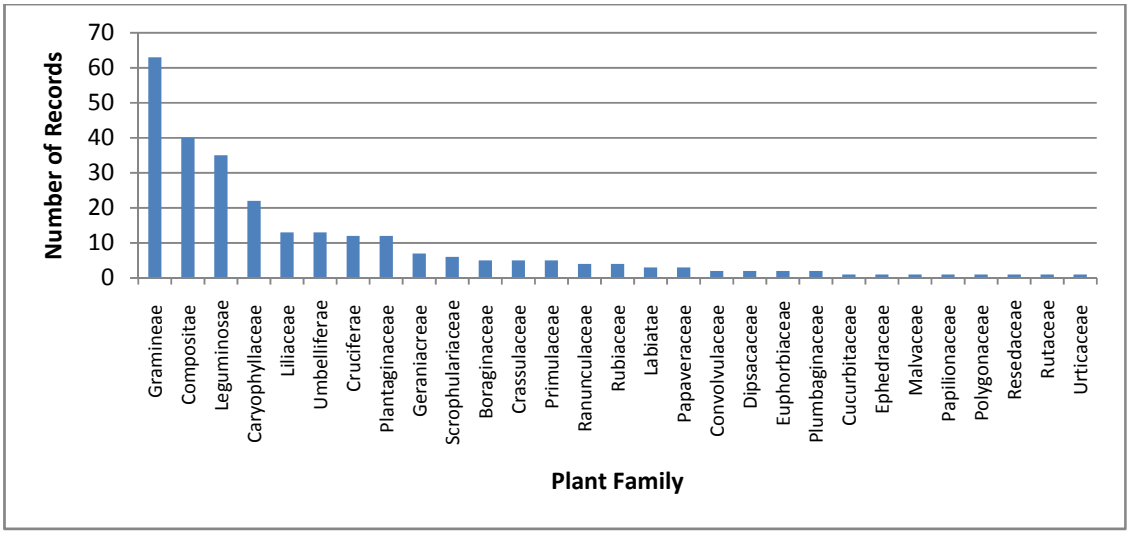


Figure 7. Number of records of the different plant families.

#### 5.3.2.3. Plant frequency

The frequency values of plant species of the understory vegetation are listed in **Appendix E**. The forbs (*Anthemis, Anagalis, Daucus, Rhagadiolus, Trifolium, Plantago, Silene*) were more abundant than grasses (*Phalaris, Stipa, Avena, Hordeum, Bromus, Aegilops, Lolium*) at the sampling sites (Figures 8-11). The forbs are known for their short lifecycle, and in a favorable environment with moderate rainfall such as the Yarmouk area, produce large number of viable seeds to insure self-regeneration.

During the sampling process, substantial amounts of seeds were found in the numerous micro-habitats at the sampled sites in particular the soil pockets and rock fractures which serve as a bank for the replenishment of species.

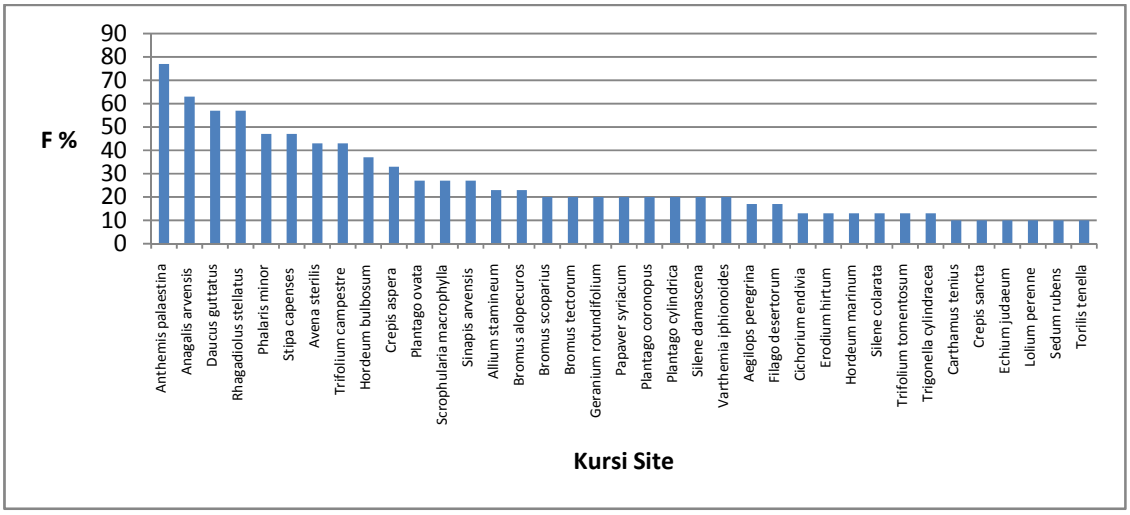


Figure 8. Frequent plant species at Kursi site in Yarmouk Nature Reserve.

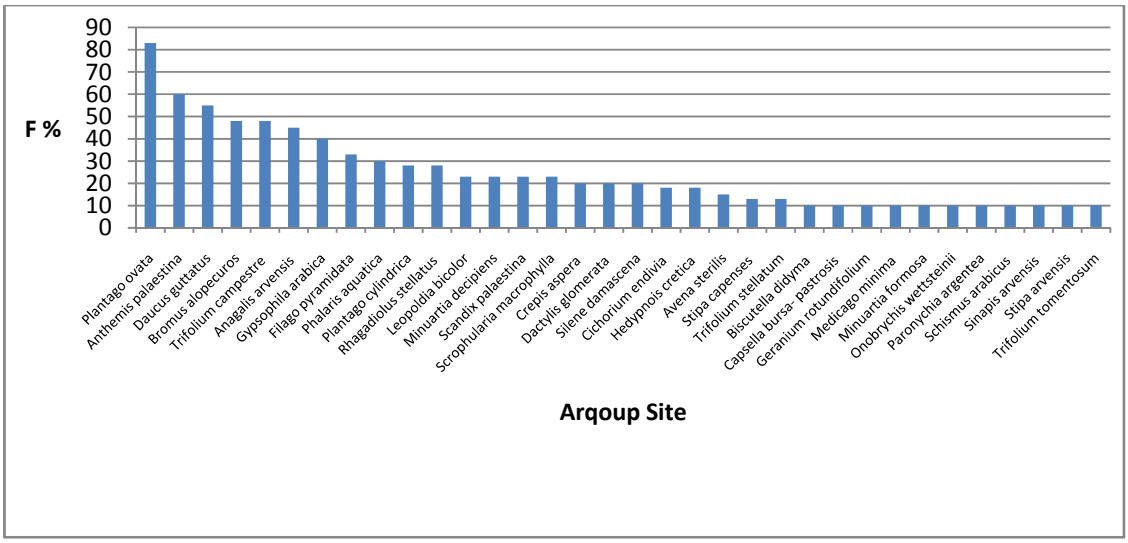


Figure 9. Frequent plant species at Arqoup Al Qaser site in Yarmouk Nature Reserve.

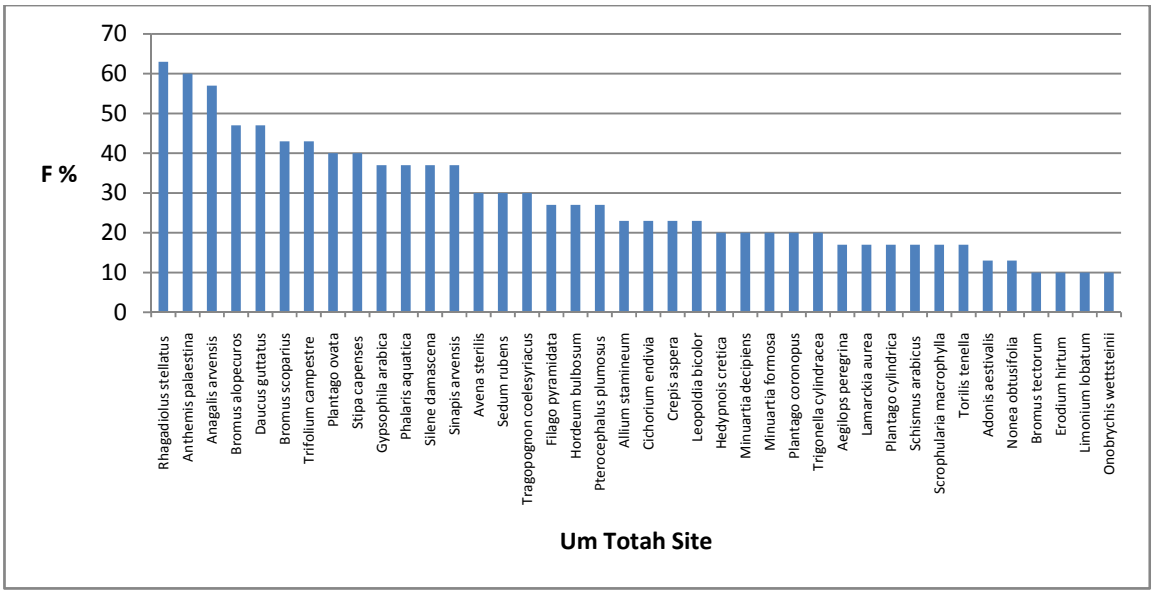


Figure 10. Frequent plant species at Um Totah site in Yarmouk Nature Reserve.

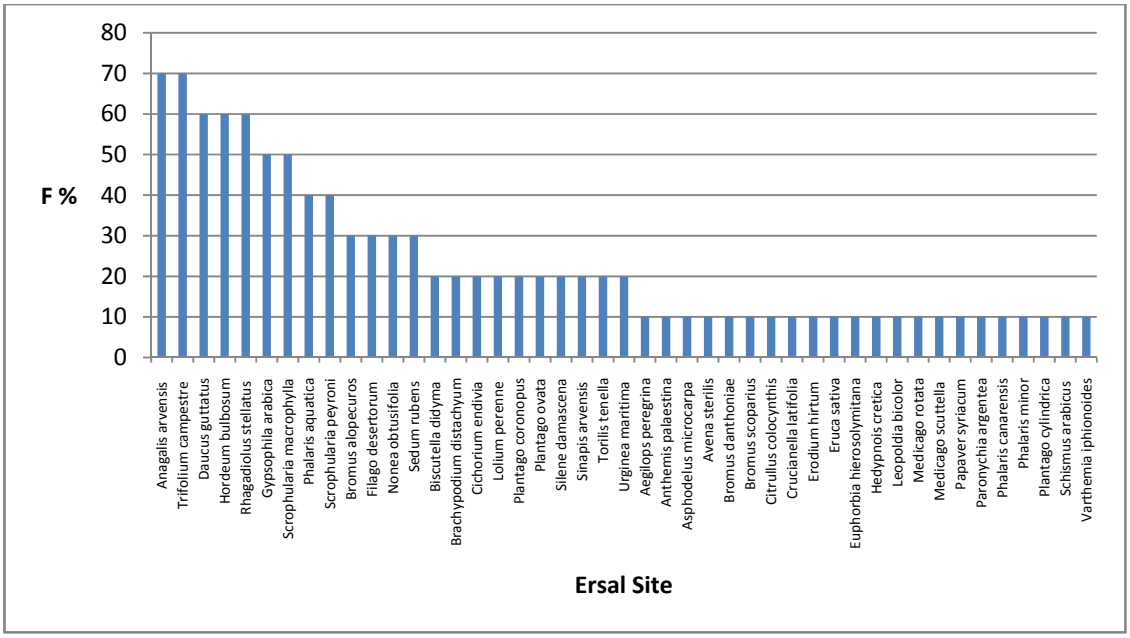


Figure 11. Frequent plant species at Ersal site in Yarmouk Nature Reserve.

Few numbers of the recorded plant species scored frequency values above 40% such as *Plantago ovata* (83%), *Anthemis palaestina* (77%), *Anagalis arvensis* (70%), *Trifolium campestre* (70%), *Rhagadiolus stellatus* (63%), *Daucus guttatus* (60%), *Hordeum bulbosum* (60%), *Gypsophila arabica* (50%), *Scrophularia macrophylla* (50%), *Bromus alopecuros* (48%), and *Avena sterilis* (43%).

The frequency values were organized into successive categories (C1-C10) to give an idea about the number of plant species within each category (**Table 3**). The majority of the recorded plant species occupied the low frequency categories (C1-C3).

Table 3. Distribution of plant frequency at the sampling sites in Yarmouk Nature Reserve, 2009.

| | | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Location | 1-10.0 | 10.1-20 | 20.1-30 | 30.1-40 | 40.1-50 | 50.1-60 | 60.1-70 | 70.1-80 | 80.1-90 | 90.1-100 |
| Kursi | Top | 27 | 6 | 10 | 3 | 2 | 1 | 0 | 2 | 0 | 0 |
| | Right | 26 | 5 | 5 | 5 | 2 | 1 | 1 | 4 | 1 | 0 |
| | Left | 17 | 7 | 5 | 6 | 2 | 2 | 2 | 0 | 0 | 0 |
| Arqoup | Top | 18 | 11 | 5 | 4 | 0 | 0 | 0 | 2 | 0 | 0 |
| | Right | 20 | 19 | 4 | 3 | 2 | 3 | 0 | 1 | 0 | 0 |
| | Left | 21 | 11 | 6 | 2 | 2 | 2 | 0 | 2 | 1 | 0 |
| Totah | Top | 12 | 8 | 15 | 3 | 4 | 2 | 0 | 0 | 0 | 0 |
| | Right | 21 | 6 | 3 | 8 | 5 | 4 | 1 | 1 | 0 | 0 |
| | Left | 15 | 10 | 4 | 2 | 2 | 4 | 2 | 1 | 1 | 0 |
| Ersal | Top | 23 | 10 | 4 | 2 | 2 | 3 | 2 | 0 | 0 | 0 |

### 5.3.2.4. Herbage production of the understory vegetation

**Appendix F** shows the raw data of biomass production of the understory vegetation. Means of dry matter production of forage plant species were 539.1, 675.5 and 628.1 kg per ha for the top, right and left sides of the selected sites, respectively (**Table 4**). At the site level, the biomass production averaged 661.1, 494.0, 763.5 and 336.8 kg DM per ha for Kursi, Arqoup Al Qaser, Um Totah and Ersal, respectively (**Fig. 12**). The overall mean of biomass production of forage species was 598.8 ± 368.9 kg DM per ha.

Percent dry matter ranged averaged 52.5, 72.2, 52.3 and 65.2 for Kursi, Arqoup Al Qaser, Um Totah and Ersal, respectively, with an overall mean of 60.8 ± 17.8.

Table 4. Biomass (kg DM/ha) of forage plant species (mean ± SD) at the sampling locations and sites in Yarmouk Nature Reserve, 2009.

| Location | Site | | | | Location Mean |
|---|---|---|---|---|---|
| | Kursi | Arqoup | Um Totah | Ersal | |
| Top | 575.0 ± 355.6 | 472.7 ± 287.5 | 758.4 ± 735.6 | 336.8 ± 223.9 | 539.1 ± 179.0 |
| Right side | 708.8 ± 298.1 | 526.1 ± 240.7 | 826.0 ± 380.1 | NA | 675.5 ± 169.6 |
| Left side | 699.6 ± 336.5 | 477.6 ± 217.4 | 706.0 ± 257.3 | NA | 628.1 ± 129.4 |
| Site Mean | 661.1 ± 325.3 | 494.0 ± 249.0 | 763.5 ± 485.6 | 336.8 ± 223.9 | |

NA: Not Available

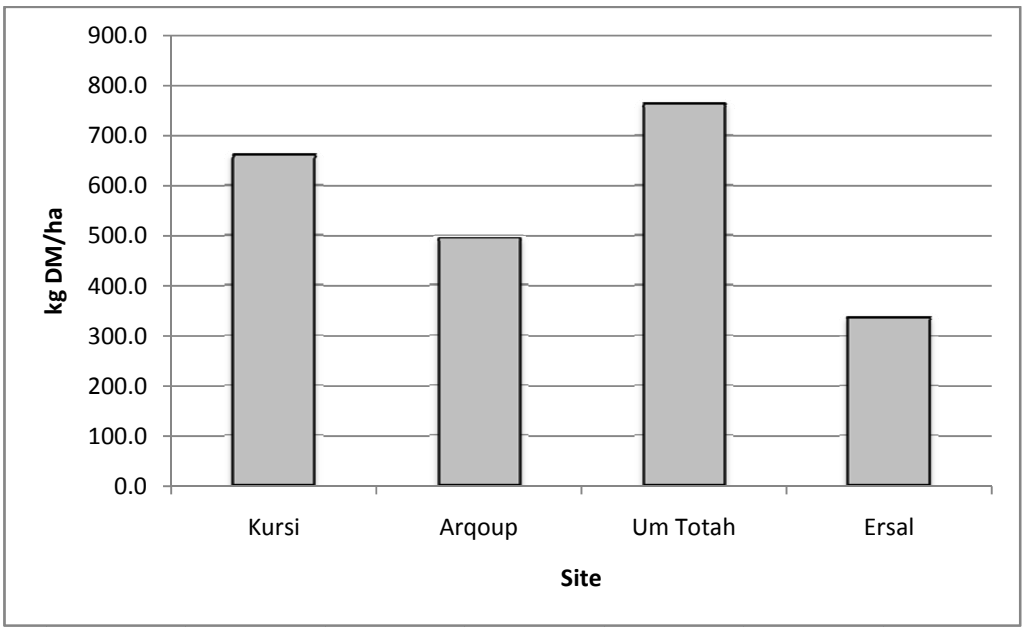


Figure 12. Dry matter production (kg/ha) of forage species at the selected sites in Yarmouk Nature reserve, 2009.

#### 5.3.2.5. Browse production of the wood layer

Estimation of browse production requires data on the density of trees in particular the oak and C*eratonia* in YNR which are lacking. The reserve is not totally populated with trees; significant areas are free of trees due to continuous cutting and de-branching. In the field, the technical team estimated the tree density to be around 100 per ha. The shepherds informed us that a tree of medium size produces around 5 kg of fresh green leaves throughout the growing season which is suffice to feed 5 sheep units per day. The estimated production of fresh browse was 500 kg per ha or 1,100,000 kg in the entire Reserve. Assuming percent dry matter of 40, the Reserve is capable of producing 440,000 kg dry matter of browse.

#### 5.3.2.6. Forage production of Yarmouk Nature Reserve

The term "forage" includes herbage and browse. The total forage of the Reserve was 715, 000 kg DM (275,000 kg of herbage and 440,000 kg of browse). The herbage and browse are available for grazing at different times during the year which expected to complicate the regulation of grazing in the Reserve. Since the ultimate objective of the Rift Valley Project is the conservation of the oak woodlands in the Yarmouk area, only partial production (50%) of the browse component will be considered as a forage resource for grazing animals. The adoption of this strategy will alleviate the pressure on the wood layer in the Reserve.

#### 5.3.2.7. Rain use efficiency

The biomass data are usually used to compute the rain use efficiency (Kg DM per mm of rainfall per ha per year or season) which reflects the site potential productivity. Assuming an average annual rainfall of 400mm at the YNR and an average forage species production of 600 kg DM per ha, average browse production of 200 kg DM per ha, the estimated rain use efficiency was 1.5 and 0.5 for the forage plant species in the understory vegetation and browse production of the wood layer, respectively, which represents the site potential productivity. The compilation of data on precipitation and dry matter production of forage species and browse for several years is necessary to develop a robust empirical model for the prediction of the grazable biomass.

### 5.3.3. Vegetation of wadies and riparian areas

#### 5.3.3.1. Plant cover

Percent cover of vegetation at the dirt road in the wadies averaged 54.0, 42.0 and 12.0 % for TVC, CFPS and CNFPS, respectively (**Table 5, Fig. 13**). The proportion of forage plant species cover relative to the coverage of total vegetation was 78%. Soil moisture conditions in the wadies are more favorable for a robust growth of plants. The plant cover was expected to be much higher than the recorded values which could be attributed to the frequent trampling of plants by animals, farmers and vehicles.

Table 5. Percent cover of wadi vegetation in Yarmouk Nature Reserve, 2009.

| | TVC | CFPS | CNFPS |
|---|---|---|---|
| Wadi Al Taseh | 58.0 ± 16.4 | 42.0 ± 21.4 | 16.0 ± 12.9 |
| Wadi Muntamerah | 50.0 ± 28.1 | 42.0 ± 24.1 | 8.0 ± 5.7 |
| Mean ± SD | 54.0 ± 22.1 | 42.0 ± 21.5 | 12.0 ± 10.3 |

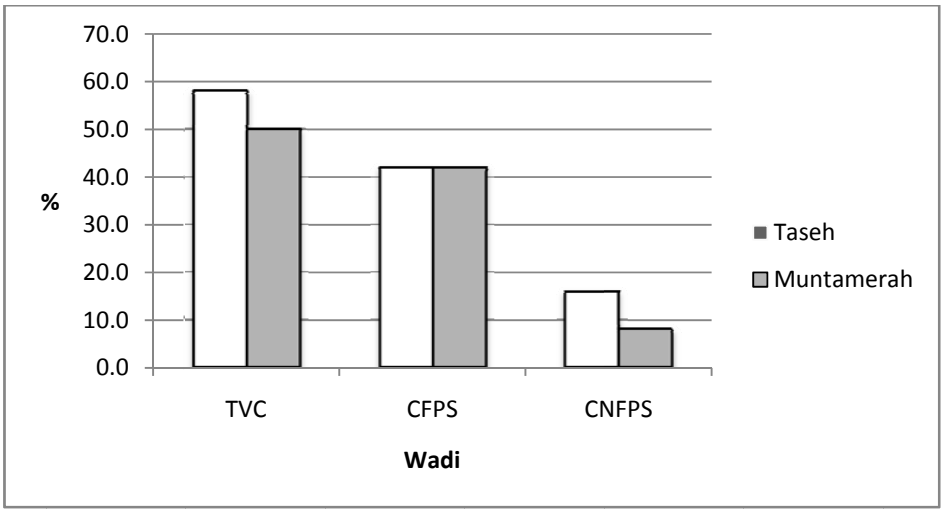


Figure 13. Percent cover of total vegetation (TVC), forage (CFPS) and non-forage plant species (CNFPS) in Wadi Al Taseh and Wadi Muntamerah in Yarmouk Nature Reserve, 2009.

**5.3.3.2. Plant diversity**

The number of recorded species in Wadi Ein Al Taseh and Wadi Muntamerah totaled to 41 out of which seven species (*Malva sylvestris*, *Ononis natrix*, *Heliotropium digynum*, *Cynoden dactylon*, *Lopochloa cristata*, *Capparis parviflora*, and *Phagnalon rupestre*) were not recorded at the other sampling sites.

Species richness averaged 10.0 in Wadi Ein Al Taseh compared to 3.5 for Wadi Muntamerah. The huge floods that struck Wadi Muntamerah last season (2008/2009) resulted in severe erosion of soils and consequently destroyed the standing vegetation at the dirt road.

The number of genera was 34 and the number of families was 12. The Compositae and Gramineae families showed the highest number of records (12 and 8, respectively).

**5.3.3.3. Plant biomass**

Dry matter production of forage plant species averaged 1029.0 kg per ha which is much higher than those of the upland sites (**Table 6**). It seems that the surface runoff from the surrounding *araqeebs* down to the wadies and the continuous supply of animal droppings augmented the

productivity of plant species. The total area of the wadies in the Reserve is small and its contribution to the overall production of grazable material is not substantial. However, the availability of this grazable material during the summer season is very important for animals seeking shade and water in the wadies.

Percent dry matter production averaged 86.5 and was within the range of the dry matter values that were reported at the upland sites. Monitoring the percent dry matter at the upland sites and the wadies for several seasons is expected to improve the predictability of forage production.

Table 6. Biomass production of forage plant species in the wadies of Yarmouk Nature Reserve.

| | Wadi Ein Al Taseh | Wadi Muntamerah | Wadi Mean |
|---|---|---|---|
| Fresh weight (kg DM/ha) | 1456.0 ± 766.7 | 1196.0 ± 548.4 | 1189.0 ± 667.0 |
| Dry weight (kg DM/ha) | 922.0 ± 484.6 | 862.0 ± 452.9 | 1029.0 ± 505.8 |
| DM% | 83.0 ± 12.7 | 93.8 ± 6.9 | 86.5 ± 11.2 |

**5.3.3.4. Species check list of riparian areas**

The ligneous plant species of the riparian areas in the wadies are listed in **Table 7**. The recorded 26 species belong to 21 families. The introduced species included grapes (*Vitis vinifera*), pomegranate (*Punica granatum*), and olives (*Olea europaea*).

The recorded number of the herbaceous species was 33 distributed over 14 families (**Table 8**). The composition of the herbaceous species in the wadies was similar to that of the upland sites. Few numbers of the recorded plant species were only confined to the wadi vegetation such as *Dittrichia viscosa, Kickxia judaica, Verbascum sinaiticum,* and *Lagosia cuminoides.*

Table 7. List of ligneous plant species of the riparian areas in Wadi Ein Taseh and Wadi Muntamerah in the Yarmouk Nature Reserve.

| Plant Species | Family | Plant Species | Family |
|---|---|---|---|
| *Acacia cyanophylla* | Mimosaceae | *Punica granatum* | Punicaceae |
| *Atriplex halimus* | Chenopodiaceae | *Quercus aegilops* | Fagaceae |
| *Ceratonia siliqua* | Caesalpiniaceae | *Quercus ithaburensis* | Fagaceae |
| *Chiliadenus iphionoides* | Compositae | *Retama raetam* | Papilionaceae |
| *Crataegus aronia* | Rosaceae | *Rhamnus palaestinus* | Rhamnaceae |
| *Ephedra aphylla* | Ephedraceae | *Ruta chalepensis* | Rutaceae |
| *Nerium oleander* | Apocynaceae | *Salix alba* | Salixaceae |
| *Noaea mucronata* | Chenopodiaceae | *Salsola vermiculata* | Chenopodiaceae |
| *Olea europaea* | oleaceae | *Sarcopoterium spinosum* | Rosaceae |
| *Phoenix dactylifera* | Arecaceae | *Styrax officinalis* | Styracaceae |
| *Phoenix dactylifera* | Asclepiadaceae | *Tamarix aphylla* | Tamaricaceae |
| *Phragmites australis* | Gramineae | *Vitis vinifera* | Vitaceae |
| *Platanus orientalis* | Platanaceae | *Ziziphus spina-christi* | Rhamnaceae |

Table 8. List of herbaceous plant species of the riparian areas in Wadi Ein Taseh and Wadi Muntamerah in the Yarmouk Nature Reserve.

| Plant Species | Family | Plant Species | Family |
|---|---|---|---|
| *Aegilops kotchys* | Graminaea | *Hordeum spontaneum* | Graminaea |
| *Anagalis arvensis* | Primulaceae | *Kickxia judaica* | Scrophulariaceae |
| *Anthemis palaestina* | *Asteraceae* | *Lagosia cuminoides* | Umbelliferae |
| *Avena sterillis* | Graminaea | *Lolium perrene* | Graminaea |
| *Bromus mollis* | Graminaea | *Malva pariflora* | Malvaceae |
| *Bromus tectorum* | Graminaea | *Notobasis syriaca* | *Asteraceae* |
| *Capparis parviflora* | Capparaceae | *Ononis viscosa* | Papilionaceae |
| *Chiliadenus iphionoides* | *Asteraceae* | *Papaver suriacum* | Papaveraceae |
| *Crepis sancta* | *Asteraceae* | *Phalaris aquatic* | Graminaea |
| Cynoden dactylon | Graminaea | *Phagnalon rupestre* | *Asteraceae* |
| *Dactylus glomerata* | Graminaea | *Rhagdiolus stellatus* | *Asteraceae* |
| *Dittrichia viscosa* | *Asteraceae* | *Ruta challepensis* | Rutaceae |
| *Echium judacecum* | *Boraginaceae* | *Salvia fruticosa* | Labiatae |
| *Erucarica boveana* | Cruciferae | *Sinapis alba* | Cruciferae |
| *Filago constricta* | *Asteraceae* | *Trifolium campestre* | *Leguminosea* |
| *Heliotropium digynum* | *Boraginaceae* | *Verbascum sinaiticum* | Scrophulariaceae |
| *Hordeum murinum* | Graminaea | | |

### 5.4. Grazing animals

Unfortunately, the collaboration of the targeted community with the Project Team was below expectation which was reflected in the low number of the stockowners who accepted to be interviewed and the reluctance of the interviewed ones to furnish detailed information regarding the true number of grazing animals and the flock performance. The reasons behind this lack of collaboration could be:

- The stockowners used to exploit the resources of the Reserve for many years without any regulation. The expansion of urbanization around and inside the Reserve restricted some of the free mobility of grazing animals to and from the Reserve as used before. The stockowners fear that the intended "Reserve" means fencing of the area and forbidding of grazing, which created a feeling of insecurity and threatening of their livelihoods.
- The lack of effective and continuous programs aiming to increase the public awareness of all the stakeholders in the targeted communities about the Yarmouk Nature Reserve. For example, the lack of an office in the targeted area to convey the viewpoints of the RSCN and the Rift Valley Project about the different aspects of the intended Reserve is a real obstacle for effective communication with the targeted community.

Therefore, only the information furnished on the population of animals, feed and water resources, and mobility of flocks will be discussed below.

### 5.4.1. Users of Yarmouk Nature Reserve

The technical team managed to interview 15 stockowners from 5 villages (Malka, Al Mansura, Dar Al Basha, Al Mkhaibeh and Um Qais) around the Reserve (**Table 9**). The interviewed number represented 16.3% of the total animal holdings in the area which is relatively low.

All the respondents have been exploiting the resources of the Yarmouk Nature Reserve for many years and viewed the Reserve as the backbone for their livelihood especially for those who have no other sources of income.

Table 9. Number of interviewed stockowners and livestock population in five villages surrounding the Yarmouk Nature Reserve.

| Villages | Stockowners | | Livestock Population | | | |
|---|---|---|---|---|---|---|
| | Number | % | Goats | Sheep | Total | % |
| Malka | 3 | 18.8 | 126 | 0 | 126 | 6.7 |
| Al Mansura | 3 | 18.8 | 306 | 5 | 311 | 16.6 |
| Dar Al Basha | 4 | 25.0 | 330 | 390 | 720 | 38.4 |
| Al Mkhaibeh | 5 | 31.3 | 467 | 71 | 538 | 28.7 |
| Um Qais | 1 | 6.3 | 30 | 150 | 180 | 9.6 |
| **Total** | **16** | **100** | **1259** | **616** | **1875** | **100** |

**Age of stockowners.** The age of the respondents varied from 18 to 70 years and averaged 49. Only three stockowners out of the interviewed ones were below 45 years old. It seems that the youth refrain from being engaged in the pastoral animal production and if this attitude continues in the future it will be a great loss to the indigenous knowledge. The willing of the youth for education and the riskiness of animal production (because of frequent drought, degradation of grazing resources, and continuous increase of feedstuffs…) could be the main reasons behind the reluctance of the young generation to be engaged in the profession of the pastoral animal production.

### 5.4.2. Population of sheep and goats

According to the interviewed stockowners, the number of sheep and goats totaled to 1875 heads and the proportion of goats averaged 81.2%. The highest population (65%) of sheep and goats was found in Dar Al Basha and Al Mkhaibeh villages. The closeness of these two villages to the YNR which provides cheap forage resource could be the triggering factor for the increased animal population (**Fig. 14**).

The records of the Ministry of Agriculture (MoA) indicated that the numbers of sheep and goats in Mkhaibeh, Al Mansura, Um Qais and Malka villages was around 15254 heads distributed among 92 households (**Table 10**). The discrepancy in the population of sheep and goats of the primary (this survey) and secondary (records of MoA) data in the targeted villages could be attributed to the fact that this study focused on the stockowners using the forage resources of the Reserve while the MoA focused on all the sheep and goat flocks regardless if these animals graze inside the Reserve or not.

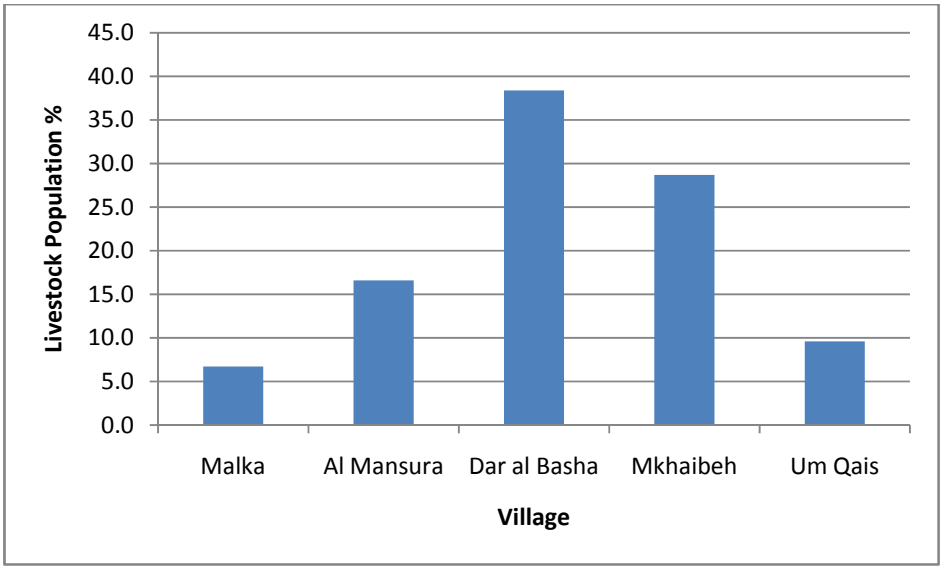


Figure 14. Population of sheep and goats in some villages surrounding Yarmouk Nature reserve.

Table 10. Sheep and goat population and flock composition in some villages surrounding Yarmouk Nature Reserve.

| Village | Sheep | | | | | Goats | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Males | No. of Females | Total | Males (%) | > 1 Year Old (%) | No. of Males | No. of Females | Total | Males (%) | > 1 Year Old (%) |
| Mkhaibeh | 42 | 443 | 485 | 9.5 | 79.0 | 233 | 1709 | 1942 | 13.6 | 75.7 |
| Al Mansura | 216 | 2114 | 2348 | 10.2 | 86.1 | 215 | 1385 | 1580 | 15.5 | 80.1 |
| Um Qais | 506 | 3903 | 4409 | 13.0 | 82.3 | 30 | 454 | 484 | 6.6 | 77.5 |
| Malka | 54 | 629 | 683 | 8.6 | 83.5 | 403 | 2920 | 3323 | 13.8 | 78.6 |

Source: Ministry of Agriculture

### 5.4.3. Feed Calendar

**Table 11** shows the feeding calendar of sheep and goat flocks in the targeted villages around the Yarmouk Nature Reserve. The feed resources were (i) the grazable material (herbs and browse) inside and outside the Reserve and (ii) the traditional feedstuffs (barley grains, wheat bran, shredded wheat straws or *tibin*).

Table 11. Feeding calendar of sheep and goats in the targeted villages surrounding the Yarmouk Nature Reserve.

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| **Grazing:** | | | | | | | | | | | | |
| green herbs | | | | | | | | | | | | |
| *al khasab* | | | | | | | | | | | | |
| leaves & nuts | | | | | | | | | | | | |
| **Traditional feeds** | | | | | | | | | | | | |

All the interviewed stockowners used to graze their flocks inside the Reserve, and 53.3% of them have an access to other grazing resources (waste or rainfed lands owned by the stockowner or belong to others) outside the Reserve. The majority (73.3%) of respondents used to feed their animals on the leaves and nuts of the oak trees for 30-45 days during the year to provide the animals with protein. The shepherds used long wood-sticks to remove the green leaves and nuts from the trees. The branches either bent down to the ground or detached from the trees to enable animals to browse the leaves and small twigs.

The removal of green leaves and nuts from the oak trees commences in mid October and continued to mid or late November. The sheep and goat flocks prefer to graze the green herbaceous plants during the spring season and the dried herbs (*al khasab* الخصاب) during summer and winter seasons.

Nourishing the sheep and goats on the traditional feedstuffs varied from one stockowner to another depending on two main factors: the proportion of sheep in the flock and the proximity of the village to the Reserve. It is well known that the goats are mountainous grazers and more hardy than the sheep in terms of grazing at rough topography. The higher the proportion of goats in the flock the more time spent grazing in the Reserve; consequently the feeding frequency of traditional feedstuffs is reduced. Similarly, the stockowners living in the villages that are close to the Reserve spent more hours grazing in the Reserve compared to those living in remote ones.

### 5.4.4. Mobility of flocks

The collected information on flocks' mobility is expected to yield valuable information on the entry routes to the Reserve and the preferred grazing locations inside the Reserve. **Table 12** shows the entry routes and grazing locations in the Reserve.

The study revealed that there were no definite routes or locations that are commonly used or preferred for grazing animals in the Reserve. One route or more was routinely used by the stockowners to enter or leave the Reserve. The routes that are commonly used for drafting the sheep and goat flocks to and from the Reserve totaled to 16. The relatively high number of recorded entry routes could be attributed to (i) the rough topographic features of the Reserve, the location of village in relation to the Reserve, and (iii) the haphazard mobility of grazing animals.

Regardless of the reason, the identification of routes that are commonly used for entering and leaving the Reserve is important for future plans related to the control and regulation of grazing, and intended interventions such as the construction of stock watering points that could be used as an incentive to ensure sustainable collaboration between the stockowners and the Project Staff.

Table 12. Entry routes and grazing locations in the Yarmouk Nature Reserves.

| | Reserve Entry Routes | Preferred or Accessible Grazing Locations | |
|---|---|---|---|
| | | Inside the Reserve | Outside the Reserve |
| ١ | لفقيرة | الفقيرة | أم تينه |
| ٢ | السهل الجواني | قفا العراق | الدنبة |
| ٣ | المنطمرة | درعاش | سيفين |
| ٤ | عابس | الكرسي | أراضي مملوكة |
| ٥ | خلة الشق | الموبرة | عرقوب الجلدة |
| ٦ | السويدان | أم تينة | المفخوتة |
| ٧ | عرقوب الرومي | عرقوب الجندي | عرقوب رومي |
| ٨ | راس البير | المنطمرة | المنطمرة |
| ٩ | الشاموس | عابس | الماسوم |
| ١٠ | أبو شتول | الدب | المزرعة الشرقية |
| ١١ | باب الطواقي | أم طوطة | وادي عجاج |
| ١٢ | مارطا | المشرع | سهل أم قيس |
| ١٣ | عرقوب القاصر | خلة الشق | حلان كليب |
| ١٤ | أم قيس | السويدان | |
| ١٥ | الحريث | عرقوب الرومي | |
| ١٦ | عرقوب الشريف | العسال | |
| ١٧ | | أم الخشب | |
| ١٨ | | راس البير | |
| ١٩ | | الشاموس | |
| ٢٠ | | الكرشة الفوقا | |
| ٢١ | | عين نيني | |
| ٢٢ | | عرقوب الحلان | |
| ٢٣ | | أبو شتول | |
| ٢٤ | | مصقاع الحلان | |
| ٢٥ | | الغازيات | |
| ٢٦ | | عرقوب الشريف | |
| ٢٧ | | مغر الطرب | |
| ٢٨ | | حلان كليب | |
| ٢٩ | | مارطا | |
| ٣٠ | | الحريث | |
| ٣١ | | عرقوب القاصر | |

**5.5. Grazing capacity**

The determination of the annual grazing capacity was based on five assumptions (i) vegetated areas in the Reserve, (ii) dry matter production of forage plant species, (iii) a proper use factor of 50%, (iv) the average daily intake of mature sheep or goat, and (v) the number of grazing days.

The stocking rate or annual grazing capacity is usually calculated by dividing the allowable forage production by the potential forage demand for a certain animal species. A mature sheep or goat weighing 50 kg with lamb/kid less than 90 days old is considered as one sheep unit. The following data were used in the computation of the annual grazing capacity for the reserve:

Total area of the Reserve: 22 $km^2$ or 2200 ha
Percent of rock outcrops areas in the Reserve: 50%
Percent cover of forage plant species relative to understory vegetation: 75%
Average production of forage plant species: 600 kg DM per ha
Proper use factor: 50%
Average daily intake of one sheep unit: 2.0 kg DM
Number of grazing days in spring season: 90 days (March, April, May)

Based on above assumptions, the calculated number of sheep units that can be grazed at the Reserve without drastic effects on the understory vegetation was 1375 (**Fig. 15**).

The grazing of *al khasab* by sheep and goats in summer and winter is not expected to have any drastic effects on the composition and productivity of the understory vegetation.

The effect of seasonal removal of leaves and nuts from the oak trees requires more investigation to determine if this type of practice has an impact on the vigor, productivity and self regeneration of the trees.

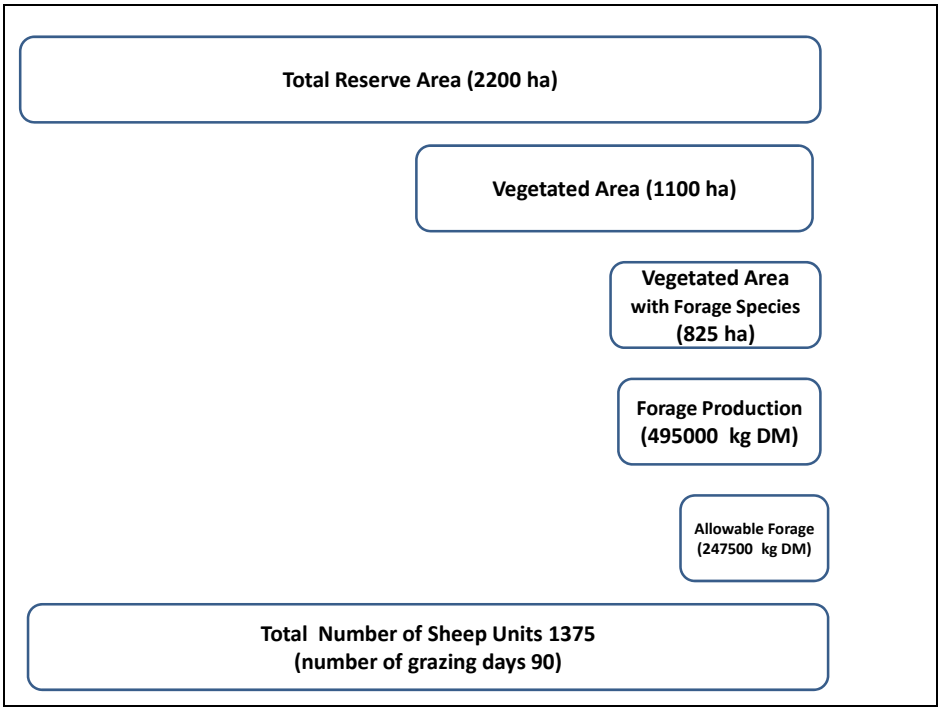


Figure 15. Flowchart for the calculation of the number of sheep units at the Yarmouk Nature Reserve.

### 5.6. Grazing plan

The suggested grazing plan has two dimensions: temporal and spatial. The temporal dimension concerns with the onset and end of grazing while the spatial one focuses on the grazing locations to insure ease of accessibility and sustainability of vegetation composition and sustainability.

#### 5.6.1. Timing of grazing

The suggested onset of grazing at the Reserve is the 1st of March which will be ended on the 30 of May each year for the first three years to give all plant species adequate opportunity to recover from previous grazing. The gradual replenishment of the soil seed bank will increase the density, diversity and productivity of the understory vegetation which represents the main grazing resource for sheep and goats at the Reserve. In subsequent years, the timing of grazing and/or the extension of the grazing season depends on overall conditions of the vegetation in the Reserve.

#### 5.6.2. Grazing locations

The stockowners of each village used to graze their flocks in several locations within the Reserve (**Table 13**). However, competition among the shepherds for certain localities in the Reserve occurs from time to time especially in dry seasons. For example, *Arqoup Al Romi* location is preferred by the majority of the interviewed stockowners. . In some cases, the competition for a certain location was developed into serious conflicts which expanded from the individuals to the entire communities of the villages.

The interviewed stockowners preferred to designate specific locations for each village to secure grazing rights and avoid conflicts. The main criteria that should be considered in the allocation of grazing sites would be the proximity to the village, richness in diverse vegetation with a reasonable level of forage production, presence of watering points and the consideration of population size of animals in the village.

The issue of designating grazing locations for each village is a complex one and requires a transparent and continuous consultation with the targeted community to reach an agreement on all the issues especially the accessibility to watering points during the suggested grazing season (March-May) and in drought years.

As a start, the spatial dimension of the intended grazing plan will be based on the information furnished on the grazing locations commonly used by the village flocks.

Table 13. The grazing locations commonly used by the stockowners of each village.

| Village | Grazing Location | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Malka | الفقيرة | قفا العراق | درعاش | الكرسي | الموبرة | - | - | - | - |
| Al Mansura | أم تينة | عرقوب الجندي | المنطمرة | عابس | الدب | أم طوطة | المشرع | خلة الشق | السويدان |
| Dar Al Basha | عرقوب الرومي | العسال | أم الخشب | راس البير | - | - | - | - | - |
| Al Mkhaibeh | عرقوب الرومي | الشاموس | الكرشة الفوقا | عين نيني | عرقوب الحلان | أبو شتول | مصقاع الحلان | الغازيات | عرقوب الشريف |
| Um Qais | عرقوب الشريف | مغر الطرب | حلان كليب | مارطا | الحريث | عرقوب القاصر | - | - | - |

## 6. Recommendations

- There is an urgent need to organize the stockowners exploiting the resources of the Reserve under the supervision of the RSCN. The initiation of a pastoral entity such as the "Yarmouk Stockowners Cooperative" could be one of the tools to control the number of animals and regulate grazing inside the Reserve.
- A plan should be developed for improving the existing watering points in the Reserve as soon as possible. Improving the structure of the watering points and the water quality reduce the incidence of diseases and the watering costs of animals.
- The presence of farming activities in particular at entrances and the wadies of the Reserve are expected to reduce the chances of successful project interventions. This issue requires effective collaboration with all stakeholders to develop an agreement between the farmers and stockowners to avoid trespassing to the cultivated fields and orchards and at the same permits accessibility to watering points in the Reserve.
- The Agriculture Directorate (DA) of **Bani Kananah** is the authority who grants the permits for grazing in the Reserve. The stockowners claimed that the DA permits outsiders with large flocks to graze in the Reserve which brings animal diseases and destroys vegetation. The RSCN has a vital role to play with the DA to solve this chronic problem. This issue is one of the vehicles for inducing an effective collaboration with the pastoral communities using the grazing resources of the Reserve.
- After the designation of grazing locations for each village, a monitoring plan is expected to be developed to track the changes in the biophysical attributes of these locations in addition to the socioeconomic of the targeted communities.
- From research point of view, it is reasonable to study the impact of removing the leaves and nuts from the oak trees on their vigor, productivity and self regeneration. The establishment of a number of small exclosures (100m X 100m each) at the different topographic features inside the Reserve will be used as reference areas for the evaluation of the intended grazing plans on the integrity of both the understory vegetation and the oak trees.

**7. References**


Abu-Zanat, M. 2009. Field Manual for Sampling Vegetation Attributes of Rangelands. Faculty of Agriculture, The Jordan University, Amman-Jordan.

Barbour, M.G., H.J. Burk and W.D. Pitts. 1980. Terrestrial plant ecology. The Benjamin/Cummings Publishing Company, Inc., California, USA.

Bonham, C.D. 1989. Measurements for Terrestrial Vegetation. John Wiley and Sons, USA.

Cook, C.W. and J. Stubbendieck. 1986. Range research: basic problems and techniques. Society for Range Management, Denver, Colorado, USA.

Elzinga, C.L, Salzer, D.W., Willoughby, J.W and Gibbs, J.P. 2001. Monitoring plant and animal populations. Blackwell Science, Inc., USA.

Green, D., R. Richardson, D. Hart and I. Watson. 2001. Rangeland monitoring, condition assessment and resource inventory activities in New South Wales: a report prepared for the rangeland theme of the National Land and water Resources Audit. Department of Land and Water Conservation, West Australia Department of Agriculture, Australia.

Ingrouille, M. 1992. Diversity and evolution of land plants. Chapman and Hall, New York, USA.

Kent, M. and P. Coker. 1999. Vegetation description and analysis: a practical approach. John Wiley & Sons, New York, USA.

Kirmse, D.R. and Norton, B.E. 1985. Comparison of the reference unit method and dimensional analysis methods for to large shrubby species in the Caatinga woodlands. Journal of Range Management 38:425-428.

Rule, G.B. 1997. Some methods for monitoring rangelands. Cooperative Extension, College of Agriculture, The University of Arizona, Tucson, Arizona.

Tueller, P.T. 1988. Vegetation science applications for rangeland analysis and management. Kluwer Academic Publishers, Maryland, USA.

Vallentine, J.F. 1990. Grazing management. Academic Press, INC., New York, USA.

| Kursi | | Arqoup Al Qaser | | Um Totah | | Ersal | |
|---|---|---|---|---|---|---|---|
| **Species** | **Family** | **Species** | **Family** | **Species** | **Family** | **Species** | **Family** |
| Adonis aestivalis | Ranunculaceae | Adonis aestivalis | Ranunculaceae | Adonis aestivalis | Ranunculaceae | Aegilops peregrina | Gramineae |
| Aegilops peregrina | Gramineae | Aegilops peregrina | Gramineae | Aegilops peregrina | Gramineae | Anagalis arvensis | Primulaceae |
| Allium stamineum | Liliaceae | Allium stamineum | Liliaceae | Allium stamineum | Liliaceae | Anthemis palaestina | Compositae |
| Anagalis arvensis | Primulaceae | Anagalis arvensis | Primulaceae | Anagalis arvensis | Primulaceae | Asphodelus microcarpa | Liliaceae |
| Anchusa italica | Boraginaceae | Anthemis palaestina | Compositae | Anthemis palaestina | Compositae | Avena sterilis | Gramineae |
| Anemone coronaria | Ranunculaceae | Asphodelus aestivus | Liliaceae | Avena sterilis | Gramineae | Biscutella didyma | Cruciferace |
| Anthemis palaestina | Compositae | Avena sterilis | Gramineae | Biscutella didyma | Cruciferace | Brachypodium distachyum | Gramineae |
| Artedia squamata | Umbelliferae | Biscutella didyma | Cruciferace | Bromus alopecuros | Gramineae | Bromus alopecuros | Gramineae |
| Astragalus oocephalus | Leguminosae | Brachypodium distachyum | Gramineae | Bromus rigidus | Gramineae | Bromus danthoniae | Gramineae |
| Avena sterilis | Gramineae | Bromus alopecuros | Gramineae | Bromus rubens | Gramineae | Bromus scoparious | Gramineae |
| Biscutella didyma | Cruciferace | Bromus danthoniae | Gramineae | Bromus scoparious | Gramineae | Cichorium endivia | Compositae |
| Brachypodium distachyum | Gramineae | Bromus mollis | Gramineae | Bromus syriacus | Gramineae | Citrullus colocynthis | Cucurbitaceae |
| Bromus alopecuros | Gramineae | Bromus rubens | Gramineae | Bromus tectorum | Gramineae | Crucianella latifolia | Rubiaceae |
| Bromus scopariuos | Gramineae | Bromus scoparius | Gramineae | Cichorium endivia | Compositae | Daucus guttatus | Ubmelliferae |
| Bromus tectorum | Gramineae | Bromus syriacus | Gramineae | Cirsium arvense | Compositae | Erodium hirtum | Geraniaceae |
| Carlina hispanica | Compositae | Bromus tectorum | Gramineae | Covolvulus dorycnium | Convolvulaceae | Filago pyramidata | Compositae |
| Carthamus tenius | Compositae | Capsella bursa-pastrosis | Cruciferace | Crepis aspera | Compositae | Gypsophila arabica | Caryophyllaceae |
| Centareua hyalolepis | Compositae | Cichorium endivia | Compositae | Crucianella latifolia | Rubiaceae | Hedypnois cretica | Compositae |
| Centaurea iberica | Compositae | Crepis aspera | Compositae | Daucus carotta | Ubmelliferae | Hordeum bulbosum | Gramineae |
| Cichorium endivia | Compositae | Crepis sancta | Compositae | Daucus guttatus | Ubmelliferae | Leopoldia bicolor | Liliaceae |
| Cirsium latum | Compositae | Crucianella latifolia | Rubiaceae | Echium judaeum | Boraginaceae | Lolium perenne | Gramineae |
| Covolvulus arvensis | Convolvulaceae | Dactylis glomerata | Gramineae | Erodium acaule | Geraniacreae | Medicago rotata | Leguminosae |
| Crepis aspera | Compositae | Daucus guttatus | Ubmelliferae | Erodium hirtum | Geraniaceae | Medicago scuttella | Leguminosae |
| Crepis sancta | Compositae | Euphorbia hierosolymitana | Euphorbiacea | Filago pyramidata | Compositae | Nonea obtusifolia | Boraginaceae |
| Crepis sativus | Compositae | Filago pyramidata | Compositae | Gypsophila arabica | Caryophyllaceae | Papaver syriacum | Papaveraceae |
| Crucianella latifolia | Rubiaceae | Geranium rotundifolum | Geraniaceae | Hedypnois cretica | Compositae | Paronychia argentea | Caryophyllaceae |
| Cyclamen persicum | Primulaceae | Gypsophila arabica | Caryophyllaceae | Herniaria hirsuta | Caryophyllaceae | Phalaris aquatica | Gramineae |
| Dactylus glomerata | Gramineae | Hedypnois cretica | Compositae | Hippocrepis unisiliquosa | Leguminaceae | Phalaris canarensis | Gramineae |
| Daucus aureus | Ubmelliferae | Herniaria hirsuta | Caryophyllaceae | Hordeum bulbosum | Gramineae | Phalaris minor | Gramineae |
| Daucus guttatus | Umbelliferae | Hordeum bulbosum | Gramineae | Isatis microcarpa | Cruciferace | Plantago coronopus | Plantaginaceae |
| Echium judaeum | Boraginaceae | Hordeum spontaneum | Gramineae | Lamarckia aurea | Gramineae | Plantago cylindrical | Plantaginaceae |
| Ephedra aphylla | Ephedraceae | Lamarckia aurea | Gramineae | Leopoldia bicolor | Liliaceae | Plantago ovata | Plantaginaceae |
| Erodium acaule | Geraniaceae | Leopoldia bicolor | Liliaceae | Limonium  lobatum | Plumbaginaceae | Rhagadiolus stellatus | Compositae |
| Erodium hirtum | Geraniaceae | Liminium lobatum | Plumbaginaceae | Lolium perenne | Gramineae | Schismus arabicus | Gramineae |
| Eruca sativa | Cruciferae | Lolium perenne | Gramineae | Medicago coronata | Leguminosae | Scrophularia macrophylla | Scrophulariaceae |
| Euphorbia hierosolymitana | Euphorbiaceae | Malva parviflora | Malvaceae | Minuartia decipiens | Caryophyllaceae | Scrophularia peyroni | Scrophulariaceae |
| Filago desertorum | Compositae | Medicago coronata | Leguminosae | Minuartia formosa | Caryophyllaceae | Sedum rubens | Crassulaceae |
| Filago pyramidata | Compositae | Medicago minima | Leguminosae | Nonea obtusifolia | Boraginaceae | Silene damascena | Caryophyllaceae |
| Geranium rotundifolium | Geraniaceae | Medicago orbicularis | Leguminosae | Onobrychis caput-galli | Leguminosae | Sinapis arvensis | Cruciferace |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Gypsophila capillaris | Caryophyllaceae | Medicago scutellata | Papilionaceae | Onobrychis crista-galli | Leguminosae | Torilis tenella | Ubmelliferae |
| Herniaria hirsuta | Caryophyllaceae | Minuartia decipiens | Caryophyllaceae | Onobrychis wettsteinii | Leguminosae | Trifolium campestre | Leguminosae |
| Hippocrepis unisiliqua | Leguminosae | Minuartia formosa | Caryophyllaceae | Paronychia argentea | Caryophyllaceae | Urginea maritima | Liliaceae |
| Hordeum bulbosum | Gramineae | Onobrychis crista-galli | Leguminosae | Phalaris aquatica | Gramineae | Varthemia iphionoides | Compositae |
| Hordeum murinum | Gramineae | Onobrychis wettsteinii | Leguminosae | Phalaris caranensis | Gramineae | | |
| Lamarckia aurea | Gramineae | Ononis viscosa | Leguminosae | Phalaris minor | Gramineae | | |
| Lenus orientalis | Leguminosae | Papaver syriacum | Papaveraceae | Picnomon acarna | Compositae | | |
| Leopoldia bicolor | Liliaceae | Paronychia argentea | Caryophyllaceae | Plantago coronopus | Plantaginaceae | | |
| Lolium perenne | Gramineae | Phalaris aquatica | Gramineae | Plantago cylindrica | Plantaginaceae | | |
| Medicago orbicularis | Leguminosae | Phalaris caranensis | Gramineae | Plantago ovata | Plantaginaceae | | |
| Medicago rotata | Leguminosae | Phalaris minor | Gramineae | Pterocephalus plumosus | Dipsacaceae | | |
| Onobrychis caput-galli | Leguminosae | Plantago coronopus | Plantaginaceae | Rhagadiolus stellatus | Compositae | | |
| Onobrychis crista-galli | Leguminosae | Plantago cylindrica | Plantaginaceae | Scandix palaestina | Ubmelliferae | | |
| Onobrychis wettsteinii | Leguminosae | Plantago ovata | Plantaginaceae | Schismus arabicus | Gramineae | | |
| Ononis viscosa | Leguminosae | Pterocephalus plumosus | Dipsacaceae | Scrophularia macrophylla | Scrophulariaceae | | |
| Onopodron macrocephalum | Compositae | Rhagadiolus stellatus | Compositae | Sedum rubens | Crassulaceae | | |
| Onopordon palaestinum | Compositae | Ruta chalepensis | Rutaceae | Silene damascena | Caryophyllaceae | | |
| Origanum dayi | Labiatae | Scandix palaestina | Ubmelliferae | Sinapis alba | Cruciferace | | |
| Papaver syriacum | Papaveraceae | Schismus arabicus | Gramineae | Sinapis arvensis | Cruciferace | | |
| Paronychia argentea | Caryophyllaceae | Scrophularia macrophylla | Scrophulariaceae | Stipa capensis | Gramineae | | |
| Phalaris minor | Gramineae | Sedum rubens | Crassulaceae | Torilis tenella | Ubmelliferae | | |
| Plantago coronopus | plantaginaceae | Silene damascena | Caryophyllaceae | Tragopognon coelesyriacus | Compositae | | |
| Plantago cylindrica | Plantaginaceae | Sinapis arvensis | Cruciferace | Trifolium campestre | Leguminosae | | |
| Plantago ovata | Plantaginaceae | Stipa arvensis | Gramineae | Trifolium dasyurum | Leguminosae | | |
| Resida lutea | Resedaceae | Stipa capensis | Gramineae | Trifolium stellatum | Leguminosae | | |
| Rhagadiolus stellatus | Compositae | Trifolium campestre | Leguminosae | Trigonella cylindrical | Leguminosae | | |
| Rumex cyprius | Polygonaceae | Trifolium stellaum | Leguminosae | Urginea maritima | Liliaceae | | |
| Salvia dominica | Labiatae | Trifolium tomentosum | Leguminosae | Varthemia iphionoides | Compositae | | |
| Salvia indica | Labiatae | Urginea maritima | Liliaceae | Veronica syriaca | Scrophulariaceae | | |
| Scandix stellata | Ubmelliferae | | | | | | |
| Schismus arabicus | Gramineae | | | | | | |
| Scrophularia macrophylla | Scrophulariaceae | | | | | | |
| Sedum rubens | Crassulaceae | | | | | | |
| Silene aegyptiaca | Caryophyllaceae | | | | | | |
| Silene colarata | Caryophyllaceae | | | | | | |
| Silene damascena | Caryophyllaceae | | | | | | |
| Sinapis arvensis | Cruciferae | | | | | | |
| Stipa capenses | Gramineae | | | | | | |
| Torilis tenella | Ubmelliferae | | | | | | |
| Tragopognon coelesyriacus | Compositae | | | | | | |
| Trifolium campestre | Leguminosae | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Trifolium purpurum | Leguminosae | | | | | | |
| Trifolium tomentosum | Leguminosae | | | | | | |
| Trigonella cylindracea | Leguminosae | | | | | | |
| Umbilicus intermedius | Crassulaceae | | | | | | |
| Urginea maritima | Liliaceae | | | | | | |
| Urtica pilulifera | Urticaceae | | | | | | |
| Varthemia iphionoides | Compositae | | | | | | |
| Velezia rigida | Caryophyllaceae | | | | | | |
| Vicia monantha | Leguminosae | | | | | | |