

BIODIVERSITY SURVEY IN THE MEDJERDA RIVER AT THE MOUTH OF THE ARTIFICIAL LAKE "SIDI SALEM DAM"



Med'Ex, a project developed and carried out by Exploralis as part of the "PPI-OSCAN: Small scale initiatives for Civil Society Organisations



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Preface	6
I. Summary	8
II . Natural characteristics of the project area	10
1. Presentation of the project area	11
2. Geographical location	11
3. Topography	12
4. Hydrology	13
5. Climatology	13
6. Vegetation	15
III. Avifauna survey	17
1. Introduction	17
2. Material and methods	19
3. Results	19
IV. Mammalian fauna survey	41
1. Introduction	41
2. Material and methods	41
3. Results	44
4. Discussion	48
V. Herpetofauna survey	53
1. Introduction	53
2. Methodology	54
3. Taxonomic structure and the specific nature of the herpetofauna in the studied sector	54
VI. Entomofauna survey	63
1. Introduction	63
2. Methodology	63
3. Results and discussion	64
VII. Habitats survey	72
1. Introduction	72
2. Methodology	72
3. Results	70
Bibliography	80
Synthetic data on the mission	88

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Exploralis is a NGO founded in Tunisia that works in the environmental field. It develops projects of scientific research and works to integrate the produced information in an educational approach of social empowerment.

This work is part of the Med’Ex project, which aims at giving a first report on the state of the ecological and natural wealth of a wetland located around the Medjerda river. This rich and naturally protected ecosystem is located in the governorate of Béja between the villages of Mestouta and Bechouk.

This study was carried out between the months of November 2015 and May 2017 in collaboration with the Faculty of Science of Tunis and the General Directorate of Water attached to the Ministry of Agriculture. About twenty national experts in various scientific sectors contributed to the development of this document. We are happy to have collaborated with them during these two years of study and we are glad to have created a productive synergy between the civil society and the Tunisian university system.

We hope that this publication will draw the attention on the strategic aspect of the good environmental health of the Medjerda river since it supplies with drinking and irrigation water more than two million Tunisians. We thank all those that have collaborated, facilitated and contributed to the various activities of the project, in particular the regional and national official institutions, the universities and the local population. We thank the PPI-OSCAN team for their accompaniment and their support which helped us face certain challenges.

To the beauty of nature.
The Exploralis team.



Exploralis experts team.
(photo M. Boujemâa)

I SUMMARY

This project consists in studying the flora, the avifauna, the herpetofauna, the mammals and the entomofauna of the Medjerda river, at the mouth of the artificial lake of the Sidi Salem dam.

The project area is environmentally important considering the presence of certain marshlands characterized by a complex ecological dynamism.

This inventory of the biodiversity was carried out between November 2015 and February 2017 during the prenuptial and the postnuptial passages, the reproduction period, the wintering of the birds and the activity of the reptiles, the mammals and the insects.

We counted:



187 species of birds: **59** sedentary, **33** nesting, **51** migratory pre and postnuptial and **47** wintering species.



28 species of mammals including a dozen bats.



14 species of reptiles and **6** amphibians.



An undefined number (**+400**) of species of insects (identified and unidentified) estimated at **16** Orders, **53** Families and **82** Genera.



13 types of habitats: **5** types of reed beds, **2** types of forests, **2** types of maquis, **2** types of swamps and **2** types of cliffs.

This work covers neither all of the scientific aspects neither all of the species nor all of the habitats present in the studied area, but it gives a preliminary state based on observations on the ground, operations of capture and of recapture, samplings and on the main features of the project area. This work was achieved over a period of approximately 18 months.

II NATURAL CHARACTERISTICS OF THE PROJECT AREA

2.1 PRESENTATION OF THE PROJECT AREA

The project area is located mainly on the course of the Medjerda river and its surroundings. Mainly, at the mouth of the artificial lake of the "Sidi Salem dam".

The construction of the dam in 1982 created a wetland that, over the years, extended over more than 400 hectares. This contributes greatly to the ecological dynamics of the Medjerda river and constitutes a rich reservoir of the biodiversity.

The zone of study belongs to the public domain; it is under the supervision and the control of the Directorate of dams and water attached to the Ministry of Agriculture.

the area is shown on the map below (fig. 1)



2.2 GEOGRAPHICAL LOCATION

The studied area is located upstream of the Sidi Salem dam, in particular at the south-west of it. It is delimited in the north by the village of Bechouk, in the south by the village of Mastouta, in the east by the village of El Oglia and in the west by the mountain chain of Jbel Errih/Khorchfia.

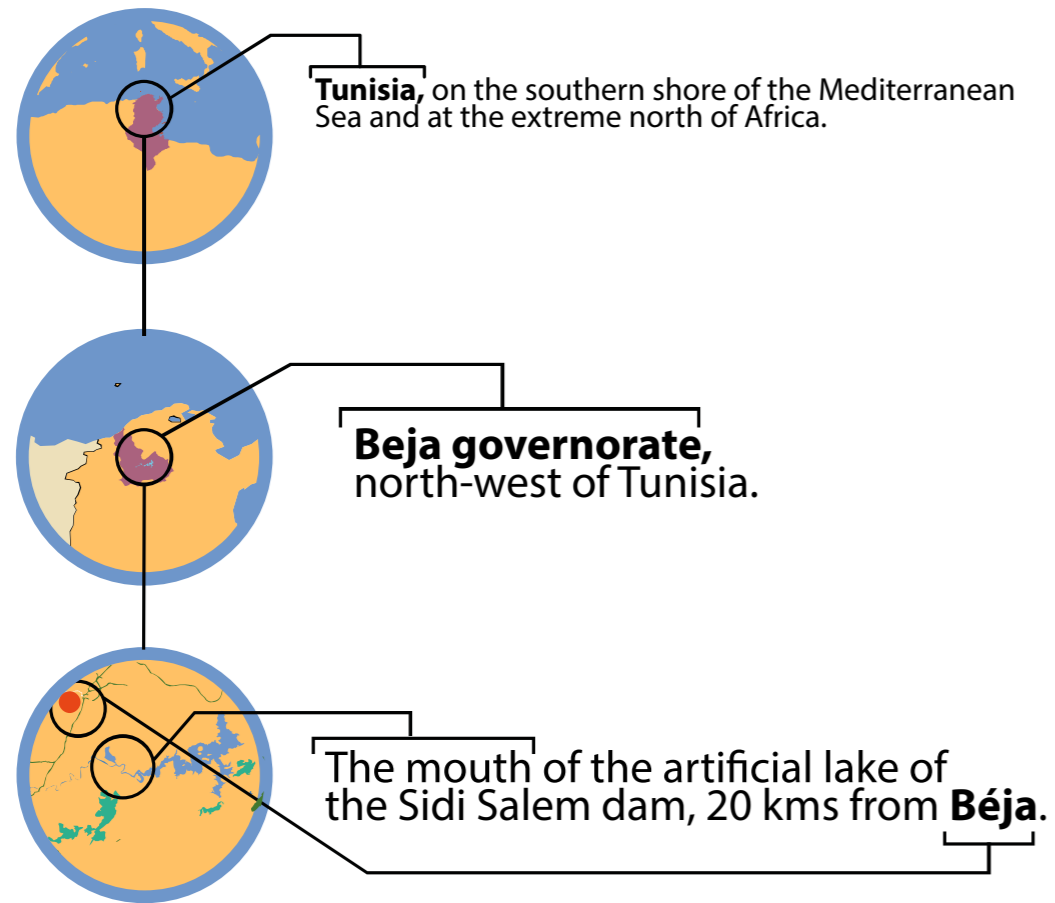
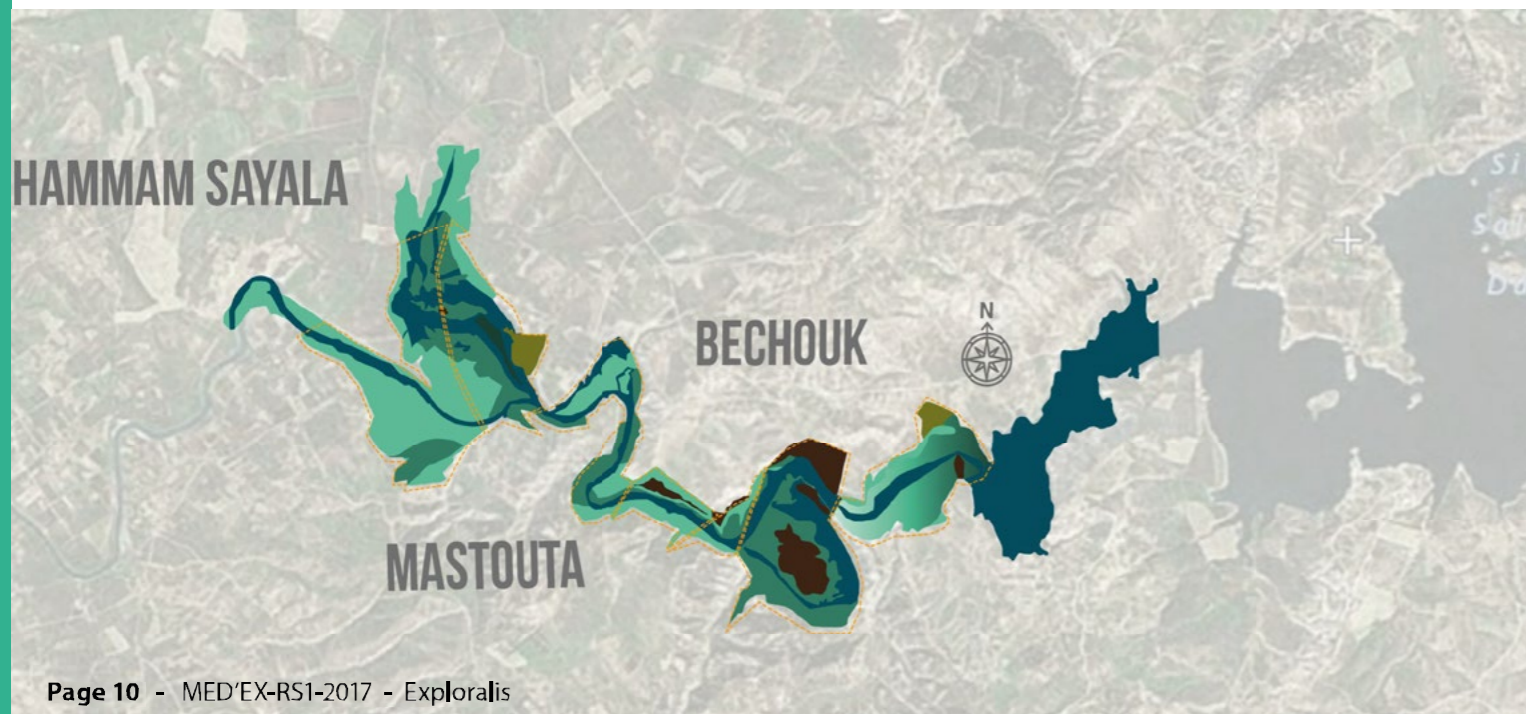


Figure 1: Location map of the studied area.



This sector has been divided into 7 areas (Fig. 2), distributed east to west as follows:

- St. 1 area is located at the east of the studied sector between the Detroit of El Hajama in the north-east and Jbel Guitoune in the south-east. It covers a total of 135 ha. The water depth varies from 0.5m to 5m.
- St. 2 area is also located at the east between El Wtay and Jbel Khorchfia. It covers 165ha. The water depth varies between 0.5m et 2m at the centre of the river. It hosts the biggest island named "Yagouma" that extends on 22.5 ha.
- St.3 and St.4 areas delimited by El Wtay and Baten Lamed in the north and Jbel Khorchfia in the south. They cover respectively 35ha and 56ha. The water depth varies from 0.5m to 2m at the centre of the river.
- St. 5 area covers the hills of Baten Lamed and Demnet Ennahla. It extends on 84ha and the ater depth varies from 0.5m to 2m.
- St. 6 and St. 7 areas are located at the west of the studied sector. They are delimited by Henchir Bechouk (north-east), Dahmania (east) and Jbel Khorchfia (south). They extend on 287ha and the water depth varies from 0.5m to 2m at the centre of the swamp. These two areas host two small islands: The first is covered by a pine and eucalyptus forest and is only 2ha, the second is covered by eucalyptus and is 0.5 ha.

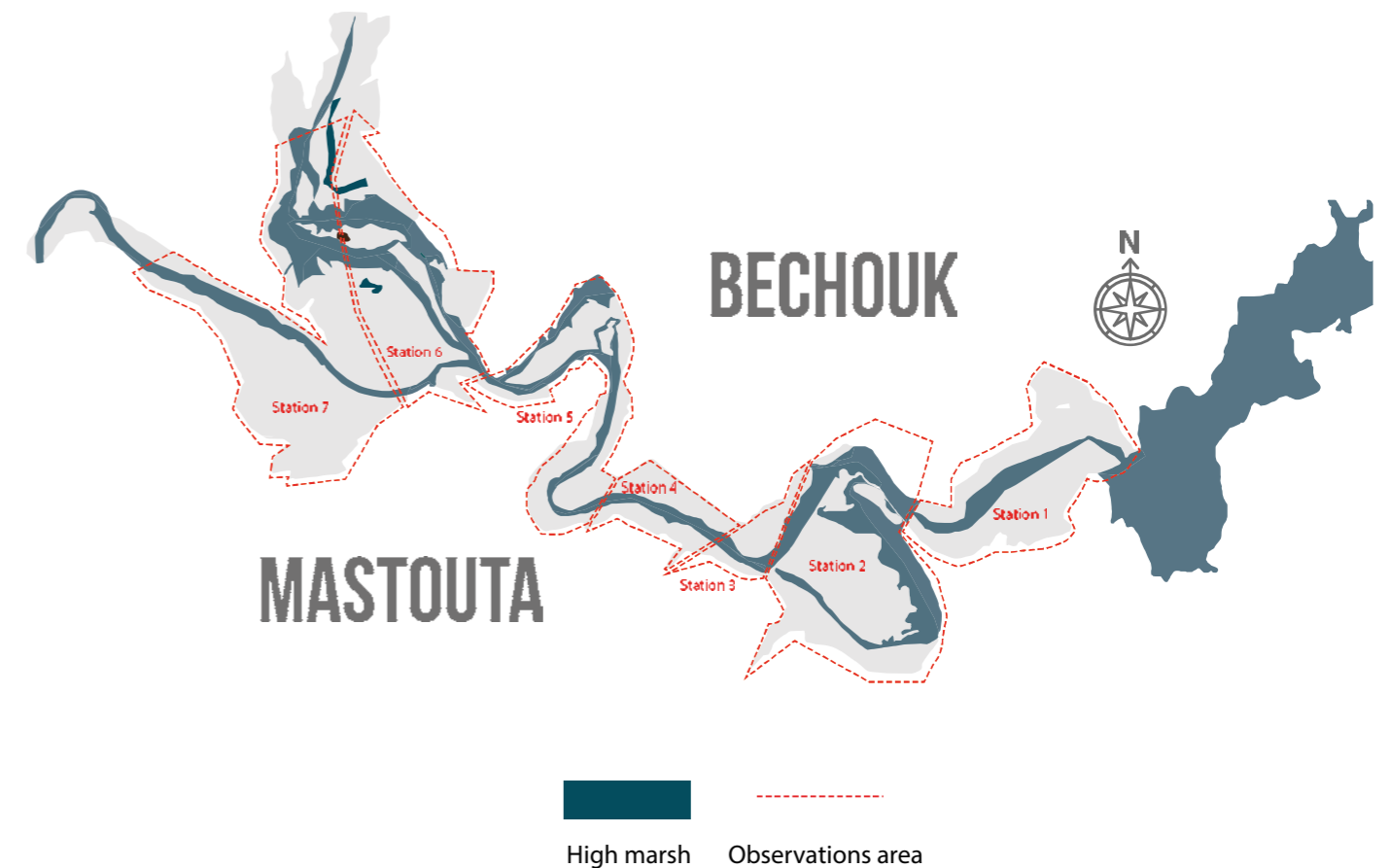


Figure 2: Delimitation of the 7 studied areas (stations 1 to 7) of the project sector (map W. Tlili)

2.3 TOPOGRAPHY

The 2/3 of the studied surface consists in a wetland, bearing on its central axis the Medjerda river and containing several marshy places; the depth varies from 0.5 to 2 meters.

The 1/3 consists of a series of hills and plains with a maximum altitude of 300m and a dozen cliffs with an altitude varying between 50 and 100m. These series of hills include several rivers of which two are permanent (the Béja river located at the west and El Khil river located east of the site). These habitats are home to a considerable ecological wealth.

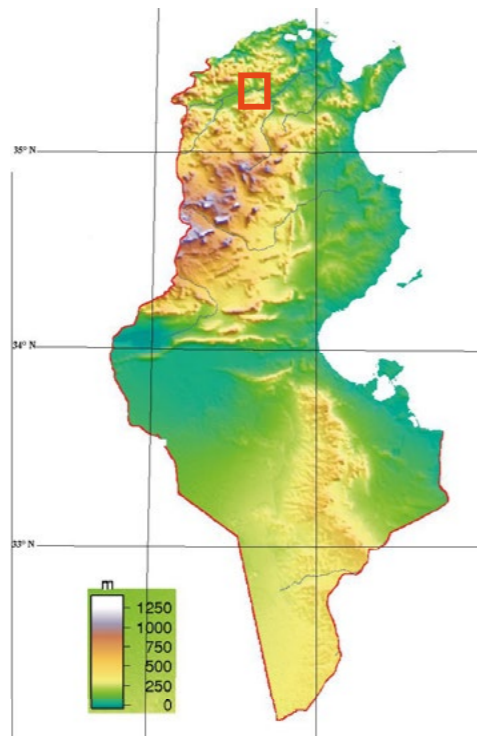
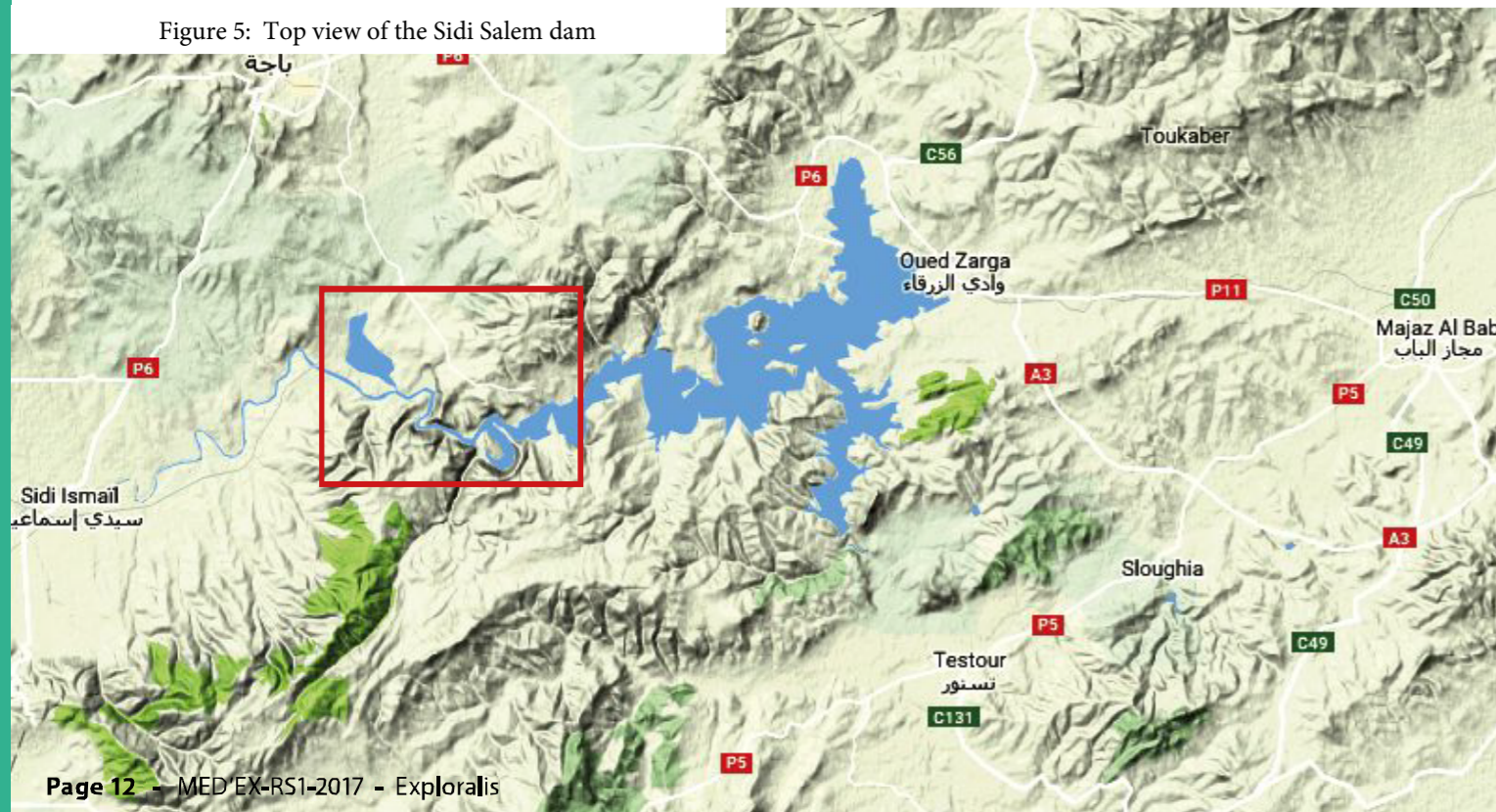


Figure 4: Location of the project project

Figure 5: Top view of the Sidi Salem dam



2.4 HYDROLOGY

The hydrological network is composed of some rivers and some water sources:

Rivers:

- **The Medjerda river** : Supplied by the watersheds of Jendouba and Djebel Souk Ahras in Algeria.
- **Oued Béja** : Supplied by the watersheds of Djebel Fzam, Djebel Sabba and Djebel Bshir.
- **The El Khil river** : Supplied by the watersheds of Djebel Garwawa, Djebel Khorchfia and Djebel Zaldou.

Water sources:

- **El Khil spring well**: The only permanent spring well, located in El Khil river, east of the study area.
- **Sidia Salem dam**: Supplied by many rivers (Kasseb, El Maleh, Raghay, Mliz, Malleg, Tassa, El Hmam, Bou Hartma, Tibar...).

2.5 CLIMATOLOGY

The zone is part of the higher mild winter semi-arid bioclimatic stage, according to the bioclimatic classification of Emberger. It is a climate characterized by a hot summer and a mild winter.

The average annual rainfall oscillates between 400 and 450 mm with an irregular seasonal distribution. An average rainfall of 5.9 mm makes June the driest month. In January, precipitations are the most important of the year with an average of 84.7 mm.

The area is characterized by a mild winter where the average temperature is 10,3°C and a hot summer where the average temperature is 30°C and can reach 47°C in the months of July and August.

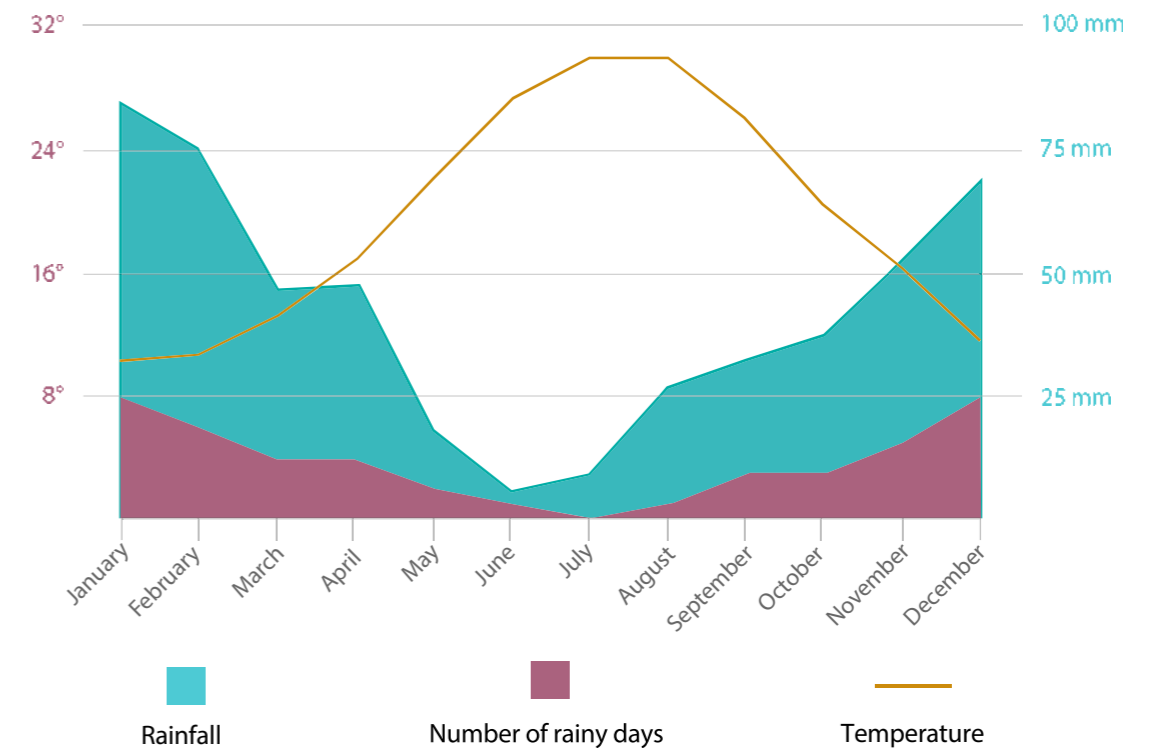
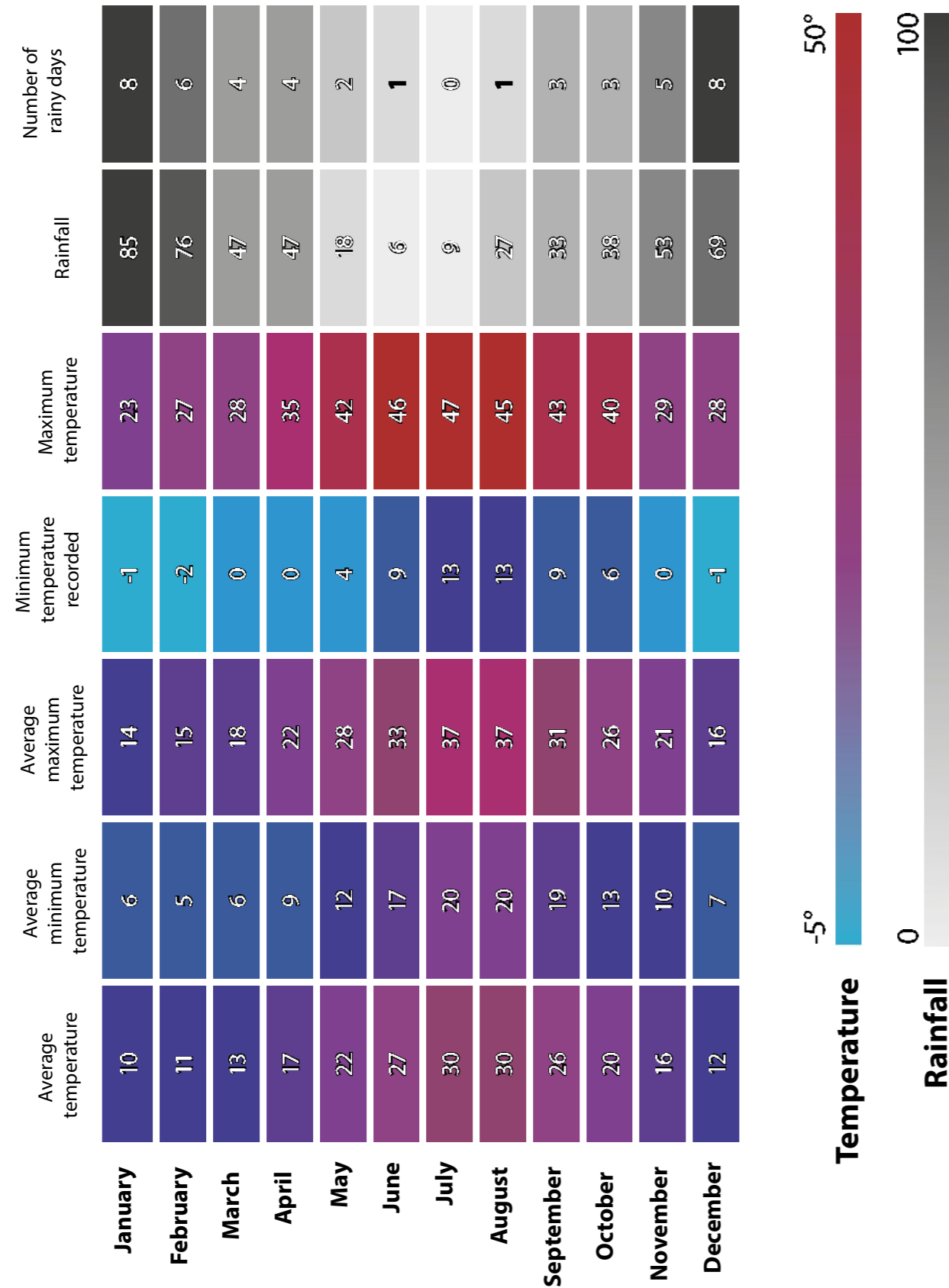


figure 6 : Monthly variations of rainfall, number of rainy days and temperature in the area of study.

The average rainfall, minimum and maximum monthly temperatures are listed in the table below (Weather station Mastouta 2016).



Thanks to a favourable climate and a soil rich to a certain extent, especially on the riverbanks, the area presents a very diversified vegetation cover.

The western riverbank and the gypsiferous hills

Covered by a low shrub layer, dominated by rosemary, thyme, Calicotome spinosa, cistus and grain fields.

The eastern riverbank

Covered by a thick shrub layer, dominated by rosemary, thyme, Calicotome spinosa, cistus, acacia and a thick pines forest without an undergrowth.



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AVIFAUNA SURVEY

1. INTRODUCTION

Tunisia, 164 150 km², is located in the northern end of the African continent, extending on 7 degrees of latitude (from 37°20' to 30°16', 750 km) and 4 degrees of longitude (7°50' to 11°30', 400 km). From a bioclimatic point of view, there are 5 climatic stages from north to south (Gounot, 1995)

- 1) humid
- 2) sub humid
- 3) semi-arid
- 4) semi-arid of steppe type
- 5) Saharan

This bioclimatic diversity generated an important diversity of habitats which are at the origin of a remarkable avifauna wealth.

In total, 46 IBA sites (Important Bird Area) were identified in Tunisia, covering 12,529 km², which accounts for approximately 7.6% of the national territory (Amri & Azafaf, 2001). These sites include the national parks, nature reserves and the hunting preserves. According to the types of habitats, we can distinguish the wetlands, the islands, the steppe sites, the forest sites, the desert sites, the archaeological sites and the migration sites.

The avifauna is an essential zoological group for the safeguarding and conservation of the ecosystemic balance. The birds are sensitive indicators of the biological wealth and the state of the environment.

The Tunisian avifauna consists of 395 species of birds (244 non-Passeriformes and 151 Passeriformes). including 193 nesting species (Isenmann and al., 2005). Among these, 122 are sedentary, which accounts for 63% of the totality of the nesting avifauna; a proportion which amounts remarkably to 73% if we consider only the 89 species of sparrows. These birds are distributed through all the bioclimatic stages of Tunisia from humid to Saharan as well as the various biotopes, particularly the wetlands, the vulnerable insular environments, the orchards, oases, forests and steppe zones.

Compared to Algeria, Tunisia with 164,150 km² has 395 species of which 193 are nesting, whereas Algeria with 2,400,000 km², 15 times larger, has 406 species of which 214 are nesting (Isenmann & Moali, 2000). These numbers show that the Tunisian avifauna is relatively richer. Libya, which is 1,800,000 km², has 351 species of which 100 are nesting (Isenmann et al., 2016). This number of nesting birds is relatively weak compared to Tunisia (193) although Libya is 11 times larger in surface. This is primarily due to the low diversity in habitats since the major part of Libya is located in the arid and Saharan regions.

In addition to the nesting birds, the Tunisian avifauna includes a rather important migrating proportion which follows the migratory system in double displacement pre and postnuptial marking respectively the summer species (nesting and non-nesting) and the wintering species. The two tables below represent the distribution of the Tunisian avifauna according to the ecological statuses and faunal affinity.

Table: Summary of the ecological statuses of the Tunisian avifauna (Isenman et al., 2005).
N: number.

	Non-Passeriformes		Passeriformes		Total	
	N	%	N	%	N	%
Extinct Nesting (ND)	9	2,36	1	0,5	10	1,73
Sedentary nesting (NS)	57	15	65	32,99	122	21,14
Migratory nesting (NM)	32	8,42	24	12,18	56	9,7
Occasional nesting (NO)	15	3,94	0	0	15	2,59
Accidental visitor (VA)	46	12,1	18	9,13	64	11,09
Passing visitor (VP)	111	29,21	47	23,85	158	27,38
Wintering (HI)	105	27,63	39	19,79	144	24,95
Undefined status (SN)	5	1,31	3	1,52	8	1,38
Total	380	100	197	100	577	100

The reproduction cycles of the birds in the south-western bank of the Mediterranean, including Tunisia, are hardly different from those prevailing in Western Europe (Heim De Balzac & Mayaud, 1962). In northern Tunisia, the period of the first egg laying extends from March to May following the awakening of the vegetation after the winter. In the more arid or desert areas, the reproduction is irregular and unforeseeable; its start and its success are conditioned by precipitations.

Tunisia, like Morocco and Algeria, occupies a key position in the migration systems in the Western Palaearctic. On the one hand, these countries constitute an excellent wintering zone for numerous species nesting in Eurasia and on the other hand, they also serve as an ultimate stage of transit before the crossing of the Sahara, for the species which winter in the Sahel, in Ecuador and even in South Africa (Moreau, 1972; Curry-Lindahl, 1981). The geographical position of Tunisia results in a small contrast between summer and winter trophic resources available for the birds. This small contrast allows many species to remain all year in Tunisia.

The richness of the sedentary avifauna does not prevent the addition in winter of the migrating species which come to seek the favourable conditions and the available resources in the southern area of the Mediterranean, in particular the rather abundant trophic resources and the relatively long days of winter (minimum duration: 10h). This wintering avifauna is especially made up of sparrows (35 species) but also of herons, ducks, shorebirds, Laridae and raptors (Isenmann and al., 2005).

The Cap Bon in the North-East of Tunisia is a privileged crossing point for the migratory birds between Africa and Europe. This African peninsula opposing Sicily is particularly used by the migrating soaring birds when crossing towards Europe like the storks and certain raptors, but also by other birds including the sparrows. As in the case of the Gibraltar Strait between Morocco and Spain, the species make profit from the minimal distance which separates the two continents; indeed only 140 km separate there Africa from Europe (Isenmann and al., 2005).

2. MATERIEL AND METHODS

The equipment of observation and sampling used consists of: 2 GPS, a binocular 10x50, a telescope 20x60, sampling tubes and topographic cards of 1/50000.

The exploration of the avifauna of the studied zone was carried out from January 2016 to March 2017. In total, 18 missions on the ground were carried out, with an effort of approximately 164 days of prospections, by two experts in ornithology, on local biotopes marshes, plains and largely open plateaux, attended by processions of northern and sedentary species.

The visits on the ground extended on a complete biological cycle, so as to be able to study the nesting and the wintering birds and the pre and postnuptial migration passages.

During the nesting period from the beginning of May to the end of July four techniques were adapted for the nesting avifauna.

- The absolute method of the squared plans or “quadras”: it consists in determining the number of birds (couples, families, colonies) of any risky species or any species presenting an important issue, nesting on a site of defined surface, studied by repeated and standardized visits. Every observation of every species needs to be noted precisely, so as to obtain a precise image of the territories.
- The relative method “Kilometer abundance index (KAI)”: the totality of the listening points to be able to cover the whole studied surface.
- The transect method: it is intended essentially for the nesting birds’ processions. It consists in carrying out a series of transects within the surface of study. The surveys were carried out in the morning, during the two passages of the beginning of May and mid-June. A special attention was naturally given to the endangered, vulnerable and rare species.
- Direct observation from fixed points: the observations were carried out at each visit, day and night, from the same positions. This enabled us to grasp the behaviour of the diurnal raptors like their nesting status. For the night species, the protocol has been adapted to their activity periods by carrying out night listenings as well as twilight observations.

3. RESULTS

3.1 - DISTRIBUTION OF THE IDENTIFIED BIRDS’ SPECIES

a. The nesting avifauna

• **Sedentary species:** these are the species present all year long on the site of study. We listed 59 species of sedentary birds on a diversity of habitats and biotopes (cliffs, reedbeds, pine forests, Typha, low marsh, high marsh...). We were able to draw up the following list:

- Bonelli’s eagle (*Hieraaëtus fasciatus*): one couple nesting on a cliff west of area 4.
- Harsh harrier (*Circus aeruginosus*): Fifteen couples identified on the reedbeds of the whole area (areas 2, 3, 4, 5, 6 and 7) of which 72% were identified in areas 6 and 7.
- Common kestrel (*Falco tinnunculus*): six breeding couples identified on the cliffs of areas 2, 3, 4, and 5.
- Peregrine falcon (*Falco peregrinus*): Two couples were spotted in the cliffs of areas 3 and 4.
- Lanner falcon (*Falco biarmicus*): One nesting couple on the cliffs of area 4.
- Long-legged Buzzard (*Buteo rufinus*): Three nesting couples on the cliffs of areas 2, 3 and 5.
- Raven (*Corvus corax*): Five nesting couples on the cliffs of areas 2, 3, 4 and 5.
- Barn Owl (*Tyto alba*): Two identified couples; one in the western cliff of area 2 and the other in the

other in the western cliff of area 5.

- Eagle Owl (*Bubo bubo*): One identified couple on the cliff located north of the island in area 2.
- Little Owl (*Athene noctua*): Four couples spotted on the plains of areas 2, 4, 5 and 6.

- The laughing dove (*Streptopelia senegalensis*), the common bulbul (*Pycnonotus barbatus*), the black bird (*Turdus merula*), the chaffinch (*Fringilla coelebs*), the greenfinch (*Carduelis chloris*), the serin (*Serinus serinus*), the linnet (*Carduelis cannabina*), the goldfinch (*Carduelis carduelis*), the Spanish sparrow (*Passer hispaniolensis*), the rock sparrow (*Petronia petronia*), the great grey shrike (*Lanius excubitor*) and the Sardinian warbler (*Sylvia melanocephala*) are all nesting on the trees of areas 2, 6 and 7 and the surrounding areas.



Figure 1: A female common kestrel (*Falco tinnunculus*)
(Photo: M. Boujemâa)



Figure 4: Rock doves (*Columba livia*) colony
(Photo: A. Ben Marzou)



Figure 2 : Long-legged Buzzard (*Buteo runus*)
(Photo: A. Ben Marzou)



Figure 3 : Little owl (*Athene noctua*)
(Photo: R. Ouni)



Figure 5: A: Greenfinch (*Carduelis chloris*) ; B : Chaffinch (*Fringilla coelebs*) ;
C : Great grey shrike (*Lanius excubitorrr*).
(Photos: R. Ouni)

- The crested lark (*Galerida cristata*), the thekla lark (*Galerida theklae*), the calandra lark (*Melanocorypha calandra*), the sky lark (*Alauda arvensis*), the wood lark (*Lulula arborea*), the quail (*Coturnis coturnis*), the barbary partoridge (*Alectoris barbara*) and the corn bunting (*Miliaria calandra*) nest on the ground within the wetland. They are common on the surrounding agricultural fields;

- The black wheateat (*Oenanthe leucura*), the Moussier's redstart (*Phoenicurus moussieri*), the spotless starling (*Sturnus unicolor*), the blue rock thrush (*Monticola solitaries*), the blue tit (*Parus teneriffae*) and the hoopoe (*Upupa epops*) nest on the cliffs of the whole area.;



Figure 6 : A : Crested lark (*Galerida cristata*) ; B : Corn bunting (*Miliaria calandra*)
(Photos: R. Ouni)

- The fan-tailed warbler (*Cisticola jincidis*) and the Cetti's warbler (*Cettia cetti*) nest in the Typha and the reeds;
- The wren (*Troglodytes troglodytes*) was observed in the east side of areas 3, 4 and 5;
- The heron species were represented by the grey heron (*Ardea cinerea*), the cattle egret (*Bubulcus ibis*) and the little egret (*Egretta garzetta*) and were identified in the Typha and reedbeds of areas 6 and 7.;



Figure 7 : A : Moussier's redstart (*Phoenicurus moussieri*) ; B : Fan-tailed warbler (*Parus teneriae*)
(Photos: R. Ouni)



Figure 8: Fan-tailed warbler (*Cisticola jincidis*)
(Photo: R. Ouni)



Figure 9: A: Grey heron (*Ardea cinerea*), B: cattle egret (*Bubulcus ibis*)
(Photos: R. Ouni)

- The little grebe (*Tachybaptus ruicollis*), the coot (*Fulica atra*), the moorhen (*Gallinula chloropus*), the purple gallunile (*Porphyrio porphyrio*), the mallard (*Anas platyrhynchos*) and the black-winged stilt (*Himantopus himantopus*) were identified in the different habitats of the wetland, but with 80% of them in the Oued Béja marsh

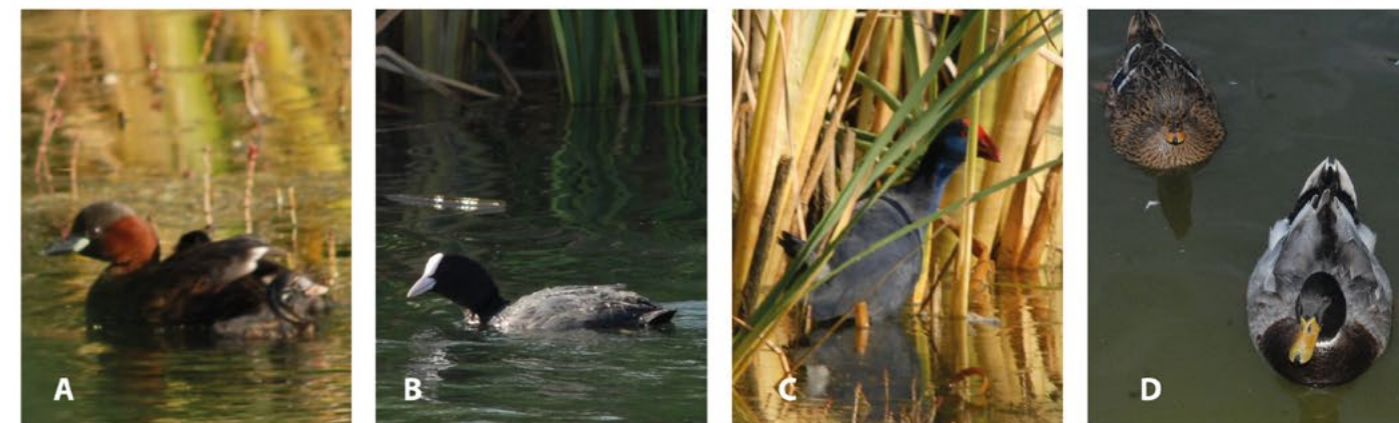


Figure 10: A : Little grebe (*Tachybaptus ruicollis*) ; B : Coot (*Fulica atra*) ; C : Purple gallunile (*Porphyrio porphyrio*) ; D : Mallard (*Anas platyrhynchos*).
(Photos: R. Ouni)

- The black-crowned tchagra (*Tchagra senegala*) is nesting in the pine forest of area 5. Vocalizing males were heard during the mating season;
- The kingfisher (*Alcedo atthis*) is found on the clayey cliffs of areas 4, 5 and 6.

• **Nesting migrating/summering avifauna:** 33 species are present in the studied area only during the breeding season, from April to July.

- The booted eagle (*Hieraaëtus pennatus*): One identified couple, nesting on the cliff east of area 3.
- The lesser kestrel (*Falco naumanni*): Present in all areas. 20 couples were identified.



Figure 11: Lesser kestrel (*Falco naumanni*)

- The black kite (*Milvus migrans*): 6 couples were identified on the cliffs of areas 1, 2, 3, 4 and 5.
- The white stork (*Ciconia ciconia*): A dozen nests were found on the eucalyptuses of areas 5 and 7, but only six were occupied.



Figure 12 : Black kite (*Milvus migrans*)
(Photos: R. Ouni)

- The turtel dove (*Streptopelia turtur*), the spotted flycatcher (*Muscicapa striata*), the woodchat shrike (*Lanius senator*), the subalpine warbler (*Sylvia cantillans*) and the orphean warbler (*Sylvia hortensis*) all nest on the trees following the river and in the little forests surrounding the studied area.



Figure 13 : A : Turtel dove (*Streptopelia turtur*) ; B : Woodchat shrike (*Lanius senator*)
(Photos: R. Ouni)



Figure 14: White stork (*Ciconia ciconia*)
(Photo: R. Ouni)

Figure 15 : Black-eared wheatear (*Oenanthe hispanica*)
(Photo: R. Ouni)

- The black-eared wheatear (*Oenanthe hispanica*) nest on the small cliffs east and west of the studied area.
- The stonechat (*Saxicola torquata*) nest in the plains and the hills with low shrub layers.
- The rufous Bush Robin (*Cercotrichas galactotes*), the olivaceous warbler (*Hippolais pallida*), the Bonelli's warbler (*Phylloscopus bonelli*), the reed warbler (*Acrocephalus scirpaceus*), the nightingale (*Luscinia megarhynchos*) nest within the whole studied area, especially in the Typha and the reedbeds;
- The barn swallow (*Hirundo rustica*) nests under the bridges of area 5.
- The house martin (*Delichon urbica*) nests in the houses and buildings next to the studied area;
- The roller (*Coracias garrulus*): one identified couple on the west cliffs of area 2;



Figure 16 : Reed warbler (*Acrocephalus scirpaceus*)
(Photo: R. Ouni)



Figure 17 : Barn swallow (*Hirundo rustica*),
(Photo: R. Ouni)

- The common swift (*Apus apus*) and the alpine swift (*Apus melba*) nest on the cliffs of areas 2, 3 and 4.
- The European bee-eater (*Merops apiaster*): observed on the clayey and sandy cliffs of areas 1, 2, 5, 6 and 7.

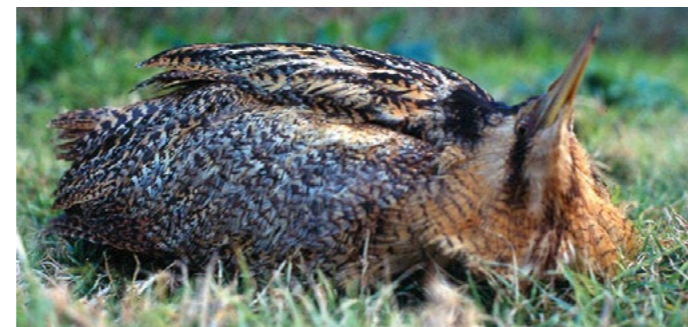


Figure 18 : European bee-eater (*Merops apiaster*)
(Photo: R. Ouni)



Figure 19: Red-necked nightjar (*Caprimulgus ruficollis*).
(Photo: R. Ouni)

- The little tern (*Sterna albifrons*) and the collared pratincole (*Glariola pratincole*) nest in the intertidal zone of area 2, 4, 5 and 6.
- The nightjar (*Caprimulgus europaeus*) and the red-necked nightjar (*Caprimulgus ruficollis*): Some individuals identified in the Oued Béja marsh during the breeding season (June). Probably nesting.
- The short-toed lark (*Calandrella brachydactyla*): nests on the ground in the grain fields around the studied area.
- The heron species: 4 nesting species identified in Oued Béja marsh: The night heron (*Nycticorax nycticorax*) (12 couples), the Indian pond heron (*Ardeola ralloides*) (26 couples), the little bittern (*Ixobrychus minutus*) (10 couples) and the purple heron (*Ardea purpurea*) (3 couples). A fifth species, the common bittern (*Botaurus stellaris*) quite rare in Tunisia in probably nesting in Oued Béja marsh. We identified one dead crushed individual and one living near the bridge of Oued Béja. Its presence is however confirmed in some other wetlands (Ichkeul marsh, Sidi el Barrak dam, Lebna dam, sebkhat Soliman, Ghidma et Douze el Aala)



A **Figure 20:** a : Indian pond heron (*Ardeola ralloides*) ; b : Common bittern (*Botaurus stellaris*)
(Photos: R. Ouni) **B**

b. Wintering avifauna

The inventory of the wintering avifauna was carried out over two distinct periods in order to maximize the chances of meeting the targeted species. The first period was from the beginning of January 2016 to March 2016 and the second from November 2016 to March 2017. The inventory was then continued in the open plains attended by the processions of northern species, in the wetlands and on the dormitories

The direct observations starting from previously selected, strategic points made it possible to identify the existent species and to evaluate the frequentation rates and the use of the studied by these birds.

This sampling effort also enabled us to locate the food, the laybys and to draw up the list of the wintering migrating species, estimated at 47 species:

- The great white egret (*Egretta alba*) and the grey heron (*Ardea cinerea*) are found in the 7 areas, but particularly in areas 6 and 7;
- The robin (*Erithacus rubecula*) is found in all the habitats;
- The stonechat (*Saxicola torquata*) is found in the plains and the low shrub hills;



Figure 21: Stonechat (*Saxicola torquata*)
(Photo: R. Ouni)

- The chiffchaff (*Phylloscopus collybita*), the meadow pipet (*Anthus pratensis*), the water pipet (*Anthus spinoletta*), the red-throated pipet (*Anthus cervinus*), the grey wagtail (*Motacilla cinerea*), the blue-headed wagtail (*Motacilla flava*), the white wagtail (*Motacilla alba*) are found mainly on the shores of the marshlands;
- The song thrush (*Turdus philomelos*), the redwing (*Turdus iliacus*), the mistle thrush (*Turdus viscivorus*) are abundant in the pine forests;
- The back redstart (*Phoenicurus ochropus*) is found in the plains and the low shrub hills.;
- The redshank (*Tringa tetanus*), the marsh sandpiper (*Tringa stagnatilis*), the greenshank (*Tringa nebularia*), the green sandpiper (*Tringa ochropus*), the wood sandpiper (*Tringa glariola*), the common sandpiper (*Actitis hypoleucos*), the little stint (*Calidris minuta*), the dunlin (*Calidris alpina*), the sanderling (*Calidris alba*), the curlew (*Numenius arquata*), the keutish plover (*Charadrius alexandrinus*), the black-tailed godwit (*Limosa limosa*), the common snipe (*Gallinago gallinago*), the lapwing (*Vanellus vanellus*), the black-winged stilt (*Himantopus himantopus*), the avocet (*Recurvirostra avosetta*), the black-headed gull (*Larus ridibundus*), the spoonbill (*Platalea leucorodia*), the cormorant (*Phalacrocorax carbo*), the greater flamingo (*Phoenicopterus ruber*), the shelduck (*Tadorna tadorna*), the wigeon (*Anas Penelope*), the gadwall (*Anas strepera*), the teal (*Anas crecca*), the mallard (*Anas platyrhynchos*), the shoveler (*Anas clypeata*), the pochard (*Aythya farina*) and the spotless starling (*Sturnus unicolor*) are found in the 7 areas.

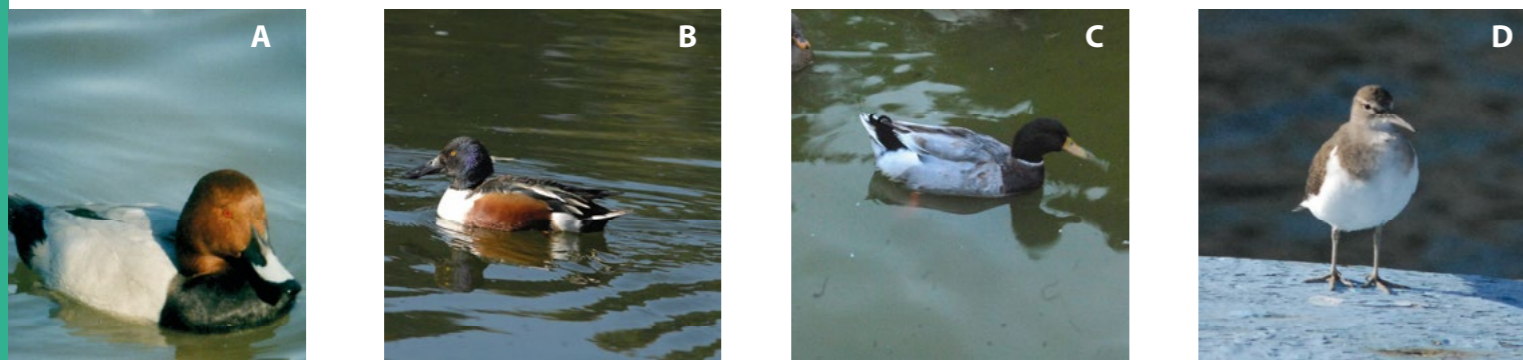


Figure 22 : A :Pochard (*Aythya ferina*); B : Shoveler (*Anas clypeata*); C : Mallard (*Anas platyrhynchos*); D : Common sandpiper (*Actitis hypoleucos*) ; E : Grand cormoran (*Phalacrocorax carbo*) (Photos: R. Ouni)

- The common crane (*Grus grus*): a hundred individuals using areas 1 and 2 as sleeping grounds..



Figure 23: Grue cendrée (*Grus grus*), retour au dortoir (Photo: R. Ouni)

- The firecrest (*Regulus ignicapillus*): identified in the pine forests.
- The spectacled warbler (*Sylvia conspicillata*): identified in the low shrubs of areas 1-5;
- The crag martin (*Ptyonoprogne ruperstris*): identified on the cliffs.;
- The wryneck (*Jynx torquilla*) and the wood cock (*Scolopax rusticola*): identified in the pine forests..

c. Migrating prenoptial and postnoptial avifauna

Twice a year, thousands of birds cross our skies (tens of thousands of raptors, hundreds of thousands water birds and forest birds). From February to June it is the departure towards the sites of reproduction, and from August to October it is the return towards the sites of wintering. Our ground surveys were carried out during these two periods (pre and postnoptial) with an average of two missions per month. The various habitats of the studied area accommodate during these two passages various species of birds (raptors, ducks, sparrows...), either to stopover or to supply. We identified during these two passages 51 species, of which 71% were observed during the prenoptial passage. The observations are distributed as follows:

• Water birds

They are represented by various species distributed on the entire wetland but with variations from one area to another. The data collected show that areas 1, 6 and 7 are used for supply and 2 to 5 are used for resting by the following species: The black stork, the glossy ibis, the ruddy shelduck, the garganey, the marbled duck, the spotted crake, the little crake, Bailon's crake, the corncrake, the dotterel, the ruff, the spatted redshank, the black-tailed godwit, the white-winged black tern, the black tern and the tawany pipit. Other species like the hen harrier, the pallid harrier and Montagu's harrier use the wetland as a place to rest and feed.

• Woodland birds

The whinchat (*Saxicola rubetra*), the Isabelline wheatear (*Oenanthe isabellina*), the Northern wheatear (*Oenanthe oenanthe*), the grasshopper warbler (*Locustella naevia*), Savi's Warbler (*Locustella luscinoïdes*), the redstart (*Phoenicurus phoenicurus*), the moustached warbler (*Acrocephalus melanopogon*), the sedge warbler (*Acrocephalus schoenobaenus*), the reed warbler (*Acrocephalus scirpaceus*), the great reed warbler (*Acrocephalus arundinaceus*), the whitethroat (*Sylvia communis*), the garden warbler (*Sylvia borin*), the wood warbler (*Phylloscopus sibilatrix*), the willow warbler (*Phylloscopus trochilus*), the collared flycatcher (*Muscicapa albicollis*), the pied flycatcher (*Muscicapa hypoleuca*), the brambling (*Fringilla montifringilla*), the siskin (*Carduelis spinus*), the ortolan bunting (*Emberiza hortulana*) and the red-rumped swallow (*Hirundo daurica*): They were identified in all the areas, in the reedbeds, the plains and the high and low density low shrubs.



Figure 24 : Tarier des prés (*Saxicola rubetra*) (Photo: R. Ouni)

• Forest birds

The European honey buzzard (*Pernis apivorus*), the Eurasian golden oriole (*Oriolus oriolus*), the sparrow hawk (*Accipiter nisus*), the red-footed falcon (*Falco vespertinus*), the hobby (*Falco Subbuteo*), the scops owl (*Otus scops*) and the tree pipet (*Anthus trivialis*)

• Cliff birds

The rock thrush (*Monticola saxatilis*), the red kite (*Milvus milvus*), the Alpine swift (*Apus melba*) and the sand martin (*Riparia riparia*).

B - BIO-ECOLOGY OF THE LOCAL AVIFAUNA (AT THE MOUTH OF SIDI SALEM DAM)

a- Species richness and numbers

The result of the carried-out inventory, in particular in the various types of habitats of the study zone (low marsh, high marsh, intertidal zone, cliffs, plains, forests...), confirms that these habitats are very favourable to the stopovers of the various wintering migrating species, either nesting or just passing. Moreover, these habitats shelter a significant number of the sedentary avifauna.

During the year of study, the area hosted 187 species (approximately 47% of the species of the country) distributed in 83 families (Appendix 1). On a specific scale, the sedentary are the best represented. Indeed, their number reached 57 species (30.5%), followed by the migrating species, passing and wintering with 51 and 46 species (27.3% and 24.6%) and finally by the summer nesting species with 33 species (17.6%). On the other hand, if we look at the numbers, the greatest fringe is represented by wintering species, whose number exceeded 3700 individuals thus representing 56.3% of the avifauna. They are followed by the sedentary who account for 25.4% and finally the migrating passing and the summer nesting with 9% each (fig. 26).

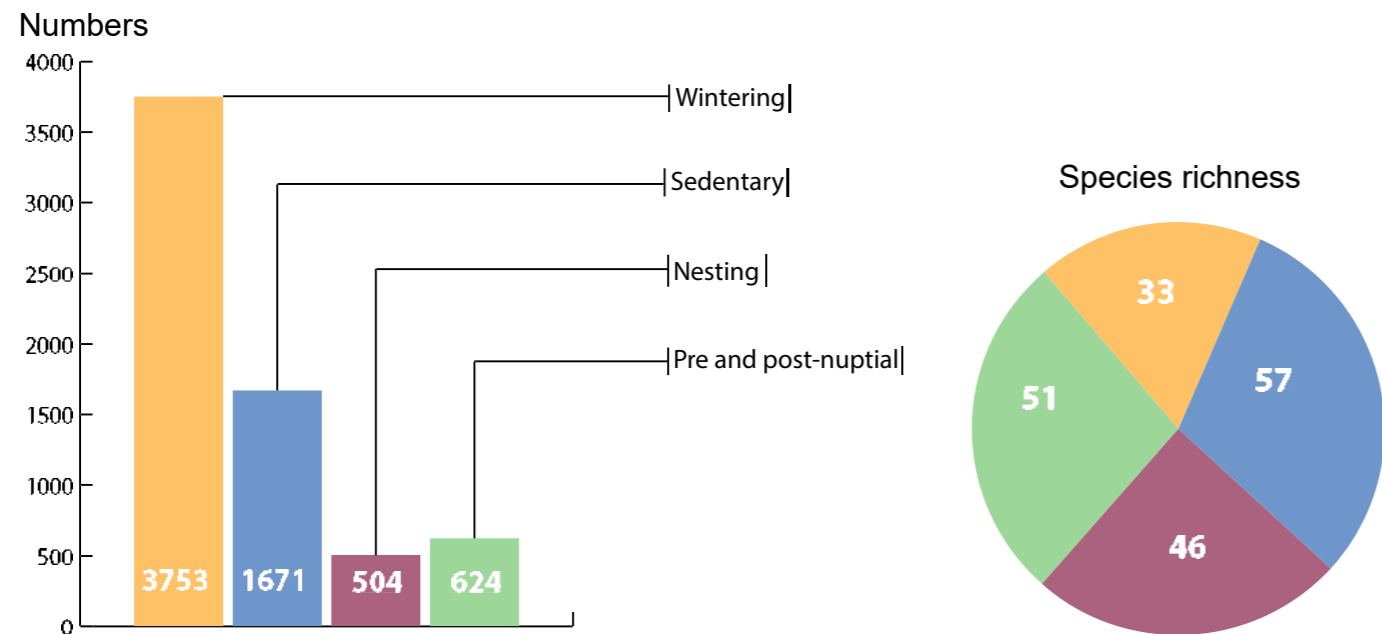


Figure 25: Species richness and numbers of birds in the studied area.

In the wintering period (December-January), the total number of birds in the zone of study exceeds 5000 individuals. This figure starts to drop gradually at the beginning of the migration of the wintering species (February) to reach its annual minimum (1800 individuals) during the beginning of the prenuptial migration, precisely in March (fig. 27). The number of the wintering individuals is estimated at 3700 individuals, that consists mainly of water birds.

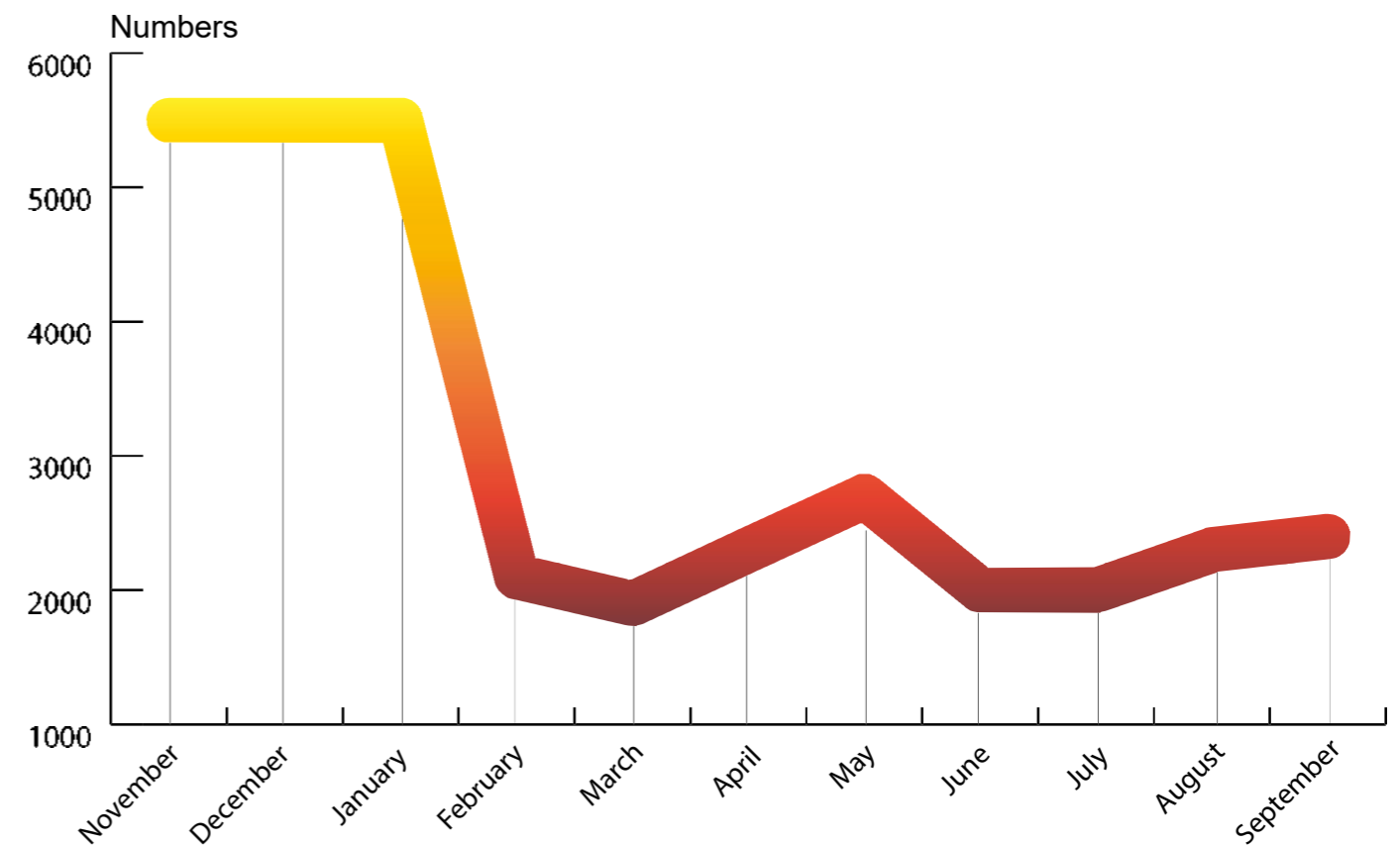


Figure 26: Monthly variations of the birds' numbers in the studied area.

The low marsh of Oued Béja corresponding to station 6 (St6) is the richest sector in species and in numbers throughout the year. It is a multi-specific sector marked by its spatial heterogeneity including more than 5 types of habitats. It is also characterized by the abundance of the trophic resources and the absence of disturbance. It shelters during 4 phenological stages 35.8% of the total avifauna of the zone of study of which the half are wintering species and the other half are passing species. In second position the sectors (St5 and St1) host approximately 36.4% of the total avifauna, of which 81% are wintering species (fig. 28 and 29).

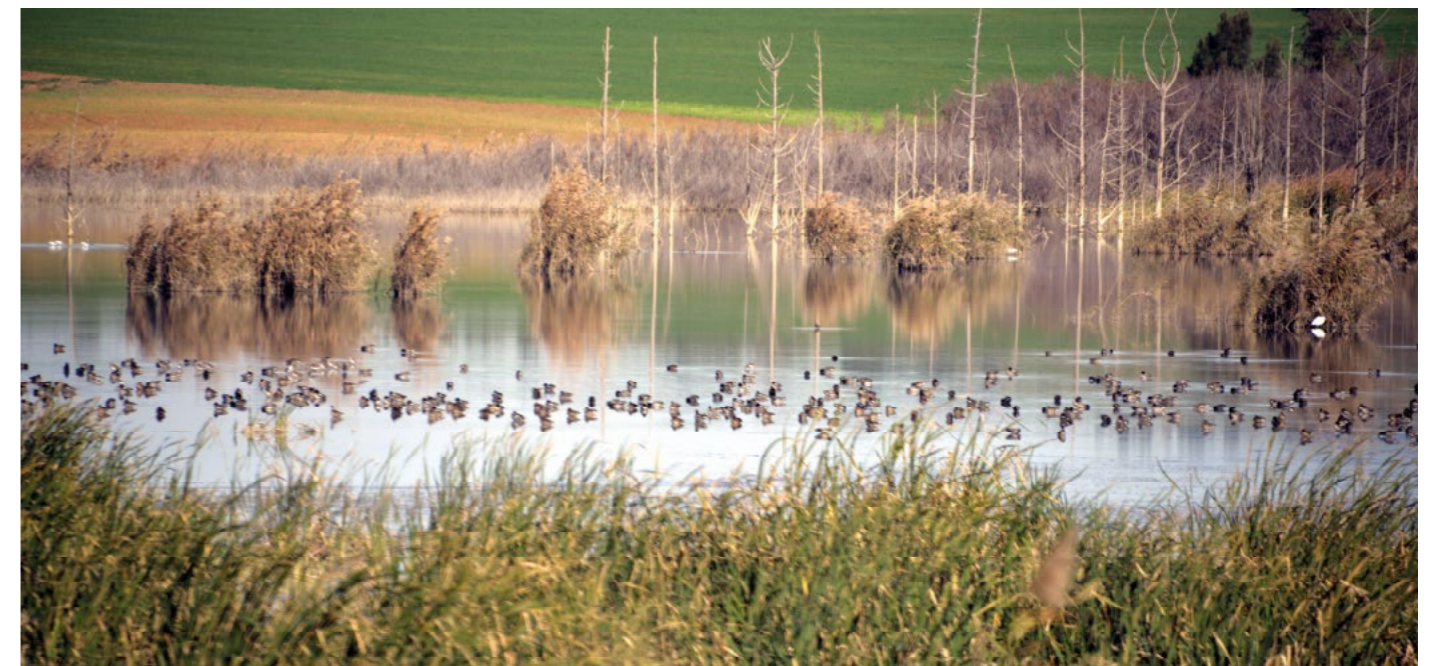


Figure 27 : Wintering wild ducks in St6 (Photo: R. Ouni)

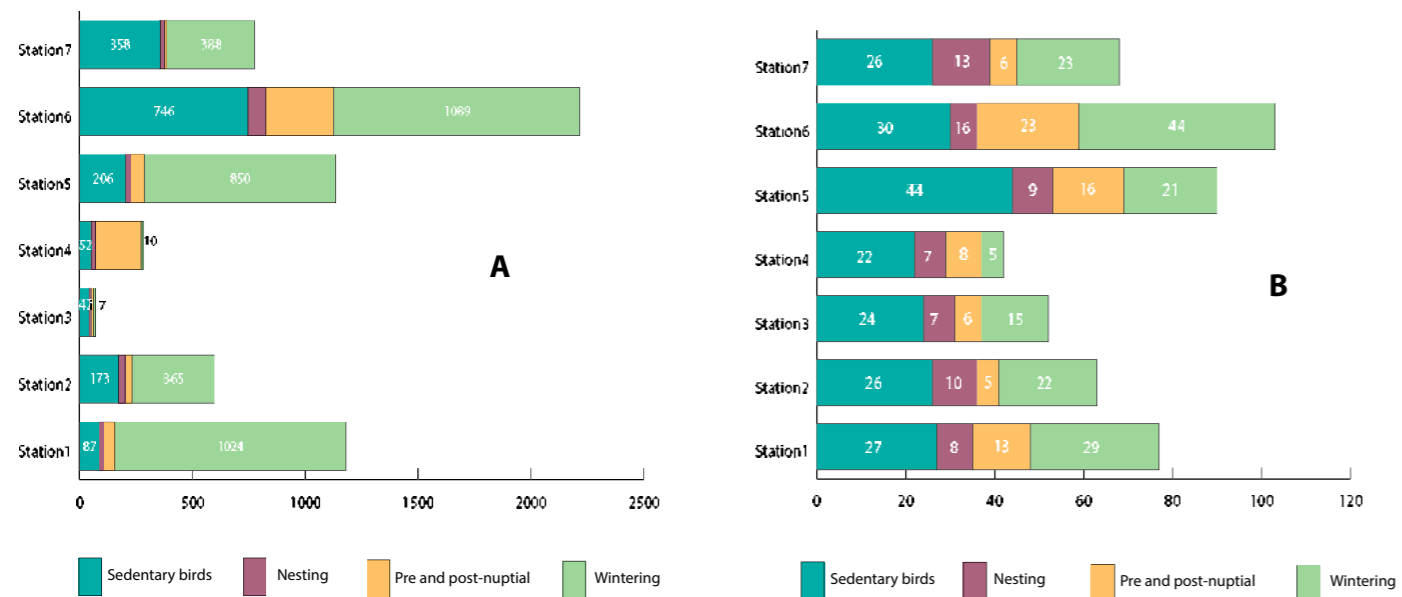


Figure 28 : Numbers (A) and species richness (B) of birds and their phenology classified by stations.

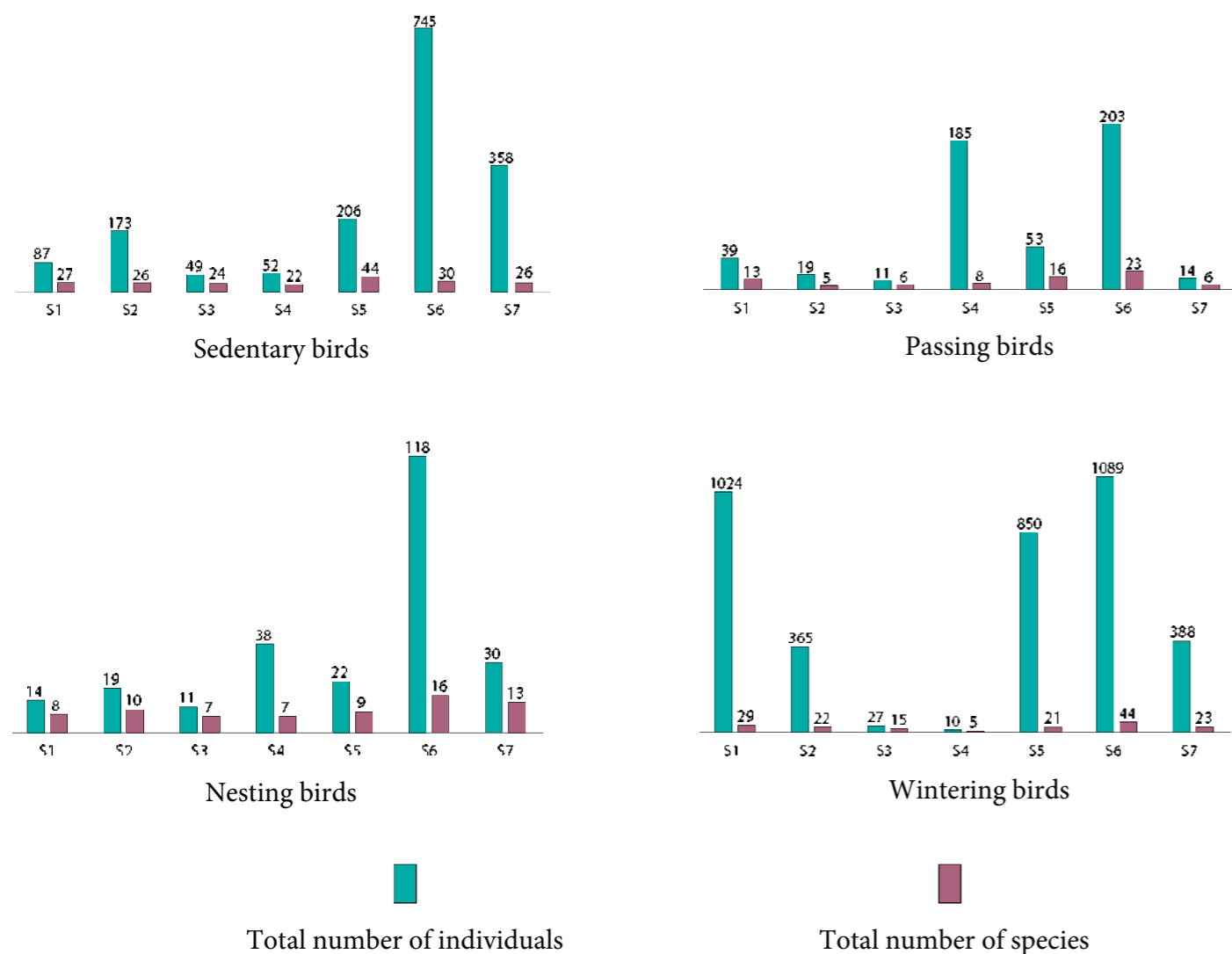


Figure 29 : Spatial variations of the species richness and numbers of birds depending on the phenological stages

b- Nesting raptors diversity in the studied area

The avifauna in the area of study is quite diversified. It regroups a multiplicity of birds including sparrows, shoreline birds, waders and the raptors. The raptors occupy an essential ecological place in the ecosystem that allows its sustainability. Their position at the top of the trophic networks enables them to control the dynamics of the populations of the prey species by exerting pressure on their demographic parameters.

The sampling revealed a total of 98 nesting couples for 16 species of raptors belonging to 5 families and divided on 7 stations. 8 Accipitridae species (black kite, black-shouldered kite, sparrow hawk, short-toed eagle, harsh harrier, long-legged buzzard, booted eagle and Bonelli's eagle), 4 Falconidae species (lesser kestrel, common kestrel, lanner falcon and peregrine falcon), 2 Strigidae species (eagle owl and little owl), 1 Tytonidae (barn owl) and 1 Corvidae (raven).

The lesser kestrel has the most nesting couples (24). He was identified in 5 of the 7 stations. It showed a preference for the mountainous regions and avoided the marshes and the forests (St 6 and 7). Then we have the harsh harrier, the little owl, the common kestrel and the raven with respectively 15, 12,9 and 8 nesting couples distributed on 4 stations. The black-shouldered kite, the short-toed eagle, the sparrow hawk and the booted eagle all had only 1 nesting couple. Bonelli's eagle and the peregrine falcon had 2 nesting couples each and the eagle owl and the lanner falcon had 3 nesting couples each.

Stations 2 and 5 hosted the most nesting couples with respectively 24 and 25 couples. These stations are characterized by a heterogeneity of the biotope including a remarkable diversity in habitats such as the dense cliffs, plains, shrub layers and reedbeds. On the other hand, stations 3, 6 and 7 hosted respectively only 7, 8 and 7 couples. (Fig 31).

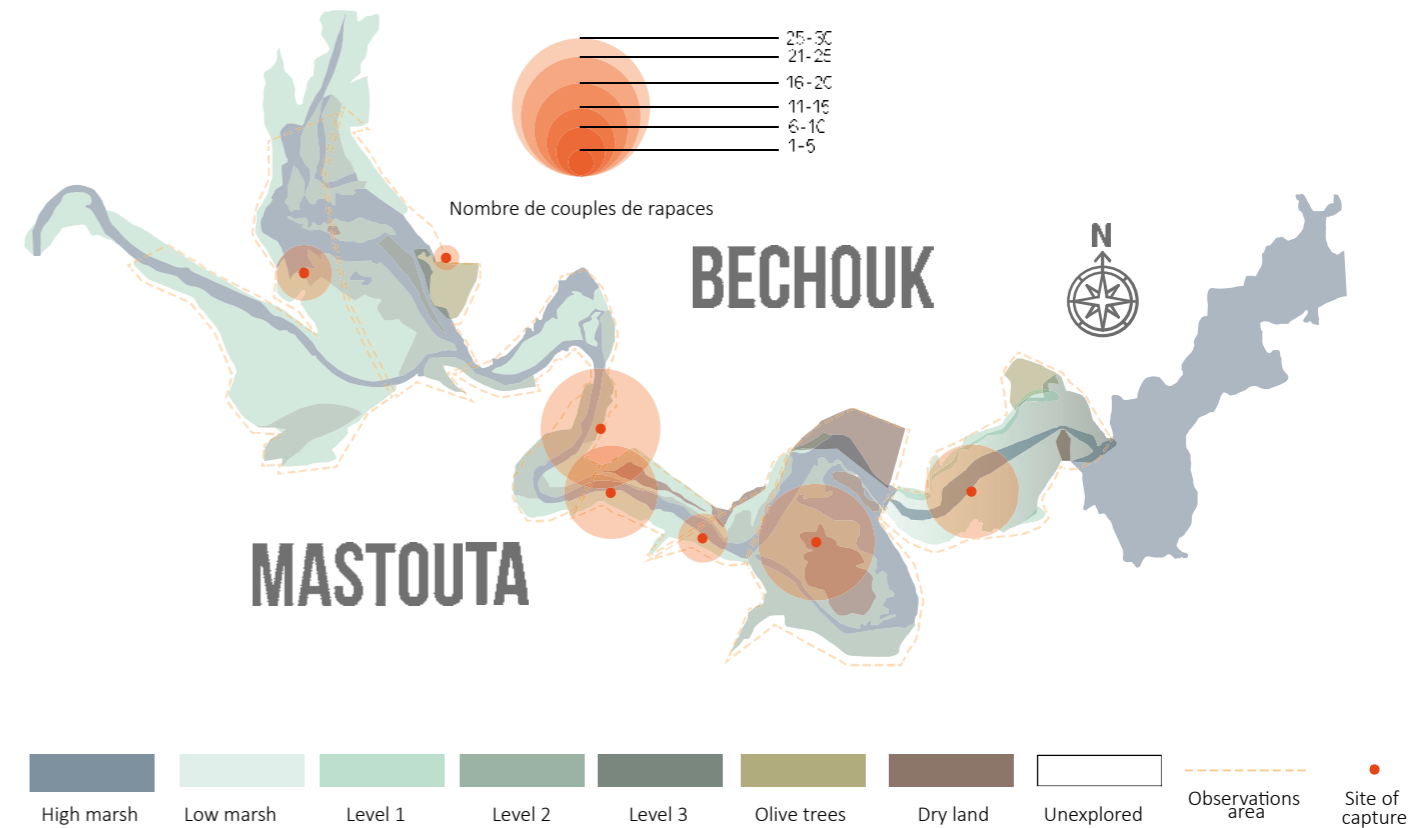


Figure 30: Nesting raptor couples density within the studied area (Map: Wided Tlili)

The international conservation status of the majority of the indexed species is the “Least Concern” (LC). Nevertheless, several diurnal raptors (*Aquila fasciata*, *Falco naumanni*, *Falco biarmicus* and *Falco peregrinus*), and nightly (*Tyto alba* and *Bubo bubo*) are of in a more vulnerable status, reaching the “Critically Endangered” status (Tab.2).

Table 2 : List of the identified nesting raptors and their conservation status.

LC: Least Concern, **Vu:** Vulnerable, **EN:** Endangered, **CR:** Critically Endangered

Family	Common name	Latin name	S1	S2	S3	S4	S5	S6	S7	Total	Conser- vation status in France	Intern- ational conser- vation status
Accipitridae	Black kite	<i>Milvus migrans</i>	1	1	1	1	2	0	0	6	LC	LC
Accipitridae	Black-winged kite	<i>Elanus caeruleus</i>	0	0	0	0	1	1	0	1	EN	LC
Accipitridae	Short-toed snake eagle	<i>Circaetus gallicus</i>	0	0	0	0	1	0	0	1	LC	LC
Accipitridae	Western marsh harrier	<i>Circus aeruginosus</i>	0	3	0	1	0	5	6	15	VU	LC
Accipitridae	Eurasian sparrowhawk	<i>Accipiter nisus</i>	0	0	0	0	1	0	0	1	LC	LC
Accipitridae	Long-legged buzzard	<i>Buteo rufinus</i>	1	1	1	1	2	0	0	6	LC	LC
Accipitridae	Booted eagle	<i>Hieraetus pennatus</i>	0	0	0	0	1	0	0	1	VU	LC
Accipitridae	Bonelli's eagle	<i>Aquila fasciata</i>	0	1	0	0	1	0	0	2	EN	LC
Falconidae	Common kestrel	<i>Falco tinnunculus</i>	2	3	1	1	2	0	0	9	LC	LC
Falconidae	Lesser kestrel	<i>Falco naumanni</i>	5	7	2	3	7	0	0	24	VU	LC
Falconidae	Lanner falcon	<i>Falco biarmicus</i>	0	0	1	1	1	0	0	3	---	LC
Falconidae	Peregrine falcon	<i>Falco peregrinus</i>	0	0	1	0	1	0	0	2	LC	LC
Tytonidae	Barn owl	<i>Tyto alba</i>	1	2	0	0	1	0	0	4	LC	LC
Strigidae	Eurasian eagle-owl	<i>Bubo bubo</i>	0	1	0	1	1	0	0	3	LC	LC
Strigidae	Little owl	<i>Athene noctua</i>	4	2	0	1	2	2	1	12	LC	LC
Corvidae	Common raven	<i>Corvus corax</i>	2	3	0	1	2	0	0	8	LC	LC
Total			16	24	7	11	25	8	7	98		

*The local conservation status was estimated nationwide

Table 3 : Systematic list and ecological status of the inventoried avifauna in the zone of the project
ES: Ecologic status ; **S:** sedentary ; **W:** wintering ; **P:** Passing ; **N:** Nesting ;

Family / French name	English name	Latin name	ES
Podicipedidae			
Grèbe castagneux	Little Grebe	<i>Tachybaptus ruficollis</i>	S
Grèbe huppé	Great Crested Grebe	<i>Podiceps cristatus</i>	N
Phalacrocoracidae			
Grand cormoran	Cormorant	<i>Phalacrocorax carbo</i>	W
Ardeidae			
Butor étoilé	Common Bittern	<i>Botaurus stellaris</i>	N
Blongios nain	Little Bittern	<i>Ixobrychus minutus</i>	N
Héron bihoreau	Night Heron	<i>Nycticorax nycticorax</i>	N
Héron crabier	Indian Pond Heron	<i>Ardeola ralloides</i>	N
Héron gard-boeufs	Cattle Egret	<i>Bubulcus ibis</i>	S
Aigrette garzette	Little Egret	<i>Egretta garzetta</i>	S
Grande aigrette	Great White Egret	<i>Egretta alba</i>	W
Héron cendré	Grey Heron	<i>Ardea cinerea</i>	S W
Héron pourpré	Purple Heron	<i>Ardea purpurea</i>	N
Ciconiidae			
Cigogne noire	Black Stork	<i>Ciconia nigra</i>	P
Cigogne blanche	White Stork	<i>Ciconia ciconia</i>	N
Threskiornithidae			
Ibis falcinelle	Glossy Ibis	<i>Plegadis falcinellus</i>	P
Spatule blanche	Spoonbill	<i>Platalea leucorodia</i>	W
Phoenicopteridae			
Flamant rose	Greater flamingo	<i>Phoenicopterus ruber</i>	W
Anatidae			
Tadorne casarca	Ruddy Shelduk	<i>Tadorna ferruginea</i>	P
Tadorne de Belon	Shelduk	<i>Tadorna tadorna</i>	W
Canard siffleur	Wigeon	<i>Anas penelope</i>	W
Canard chipeau	Gadwall	<i>Anas strepera</i>	W
Sarcelle d'hiver	Teal	<i>Anas crecca</i>	W
Canard colvert	Mallard	<i>Anas platyrhynchos</i>	S
Canard pilet	Pintail	<i>Anas acuta</i>	W
Sarcelle d'été	Garganey	<i>Anas querquedula</i>	P
Canard souchet	Shoveler	<i>Anas clypeata</i>	W
Sarcelle marbrée	Marbled Duck	<i>Marmaronetta angustirostris</i>	P
Fuligule milouin	Pochard	<i>Aythya ferina</i>	W
Accipitridae			
Bondrée apivore	Honey Buzzard	<i>Pernis apivorus</i>	P
Elanion blanc	Black-shouldered Kite	<i>Elanus caeruleus</i>	S
Milan noir	Black Kite	<i>Milvus migrans</i>	N
Milan royal	Red Kite	<i>Milvus milvus</i>	P
Circaète Jean-Le Blanc	Short-toed Eagle	<i>Circaetus gallicus</i>	S

Busard des roseaux	Harsh Harrier	<i>Circus aeruginosus</i>	S
Busard Saint-Martin	Hen Harrier	<i>Circus cyaneus</i>	P
Busard pale	Pallid Harrier	<i>Circus macrourus</i>	P
Busard cendré	Montagu's Harrier	<i>Circus pygargus</i>	P
Epervier d'Europe	Sparrow hawk	<i>Accipiter nisus</i>	P
Buse féroce	Long-legged Buzzard	<i>Buteo rufinus</i>	S
Aigle botté	Booted eagle	<i>Hieraaëtus pennatus</i>	N
Aigle de Bonelli	Bonelli's Eagle	<i>Hieraaëtus fasciatus</i>	S
Falconidae			
Faucon crécerellette	Lesser Kestrel	<i>Falco naumanni</i>	N
Faucon crécerelle	Common Kestrel	<i>Falco tinnunculus</i>	S
Faucon Kobez	Red-foot Falco	<i>Falco verspertinus</i>	P
Faucon hobereau	Hobby	<i>Falco subbuteo</i>	P
Faucon lanier	Lanner Falcon	<i>Falco biarmicus</i>	S
Faucon pèlerin	Peregrine Falcon	<i>Falco peregrinus</i>	S
Phasianidae			
Perdrix gabra	Barbary Partridge	<i>Alectoris barbara</i>	S
Caille des blés	Quail	<i>Coturnis coturnis</i>	S
Rallidae			
Râle d'eau	Water Rail	<i>Rallus aquaticus</i>	W
Marouette ponctuée	Spotted Crake	<i>Porzana porzana</i>	P
Marouette poussin	Little Crake	<i>Porzana parva</i>	P
Marouette de Baillon	Bailon's Crake	<i>Porzana pusilla</i>	P
Râle de genêts	Corncrake	<i>Crex crex</i>	P
Poule d'eau	Moorhen	<i>Gallinula chloropus</i>	S
Talève sultane	Purple Gallinule	<i>Porphyrio porphyrio</i>	S
Foulque macroule	Coot	<i>Fulica atra</i>	S, W
Gruidae			
Grue cendrée	Common Crane	<i>Grus grus</i>	W
Recurvirostridae			
Echasse blanche	Black-winged Stilt	<i>Himantopus himantopus</i>	S
Avocette	Avocet	<i>Recurvirostra avosetta</i>	W
Burhinidae			
Oedicnème criard	Stone Curlew	<i>Burhinus oedicephalus</i>	N
Glariolidae			
Glariolle à collier	Collared Pratincole	<i>Glariola pratincola</i>	N
Charadriidae			
Gravelot à collier interrompu	Keutish Plover	<i>Charadrius alexandrinus</i>	S
Pluvier guignard	Dotterel	<i>Charadrius morinellus</i>	P
Pluvier doré	Golden Plover	<i>Pluvialis apricaria</i>	W
Vanneau huppé	Lapwing	<i>Vanellus vanellus</i>	W
Scolopacidae			
Bécasseau minute	Little Stint	<i>Calidris minuta</i>	W
Bécasseau variable	Dunlin	<i>Calidris alpina</i>	W

Chevalier combattant	Ruff	<i>Philomachus pugnax</i>	P
Bécassine des marais	Common Snipe	<i>Gallinago gallinago</i>	W
Bécasse des bois	Wood Cock	<i>Scolopax rusticola</i>	W
Barge à queue noire	Black-tailed Godwit	<i>Limosa limosa</i>	P
Courlis cendré	Curlew	<i>Numenius arquata</i>	W
Chevalier Arlequin	Sputted Redshank	<i>Tringa erythropus</i>	P
Chevalier gambette	Redshank	<i>Tringa totanus</i>	S
Chevalier stagnatile	Marsh sandpiper	<i>Tringa stagnatilis</i>	W
Chevalier aboyeur	Greenshank	<i>Tringa nebularia</i>	W
Chevalier cul-blanc	Green Sandpiper	<i>Tringa ochropus</i>	W
Chevalier sylvain	Wood sandpiper	<i>Tringa glariola</i>	W
Chevalier guignette	Common Sandpiper	<i>Actitis hypoleucos</i>	W
Laridae			
Mouette rieuse	Black-headed Gull	<i>Larus ridibundus</i>	W
Goéland railleur	Slender-billed Gull	<i>Larus genei</i>	W
Sternidae			
Sterne naine	Little Tern	<i>Sterna albifrons</i>	N
Guifette noire	Black Tern	<i>Chlidonia niger</i>	P
Guifette leucoptère	White-winged Black Tern	<i>Chlidonia leucopterus</i>	P
Colombidae			
Pigeon biset	Rock Dove	<i>Columba livia</i>	S
Pigeon ramier	Woodpigeon	<i>Columba palumbus</i>	S
Tourterelle des bois	Turtel Dove	<i>Streptopelia turtur</i>	N
Tourterelle maillée	Laughing Dove	<i>Streptopelia senegalensis</i>	S
Cuculidae			
Coucou gris	cuckoo	<i>Cuculus canorus</i>	P
Tytonidae			
Chouette effraie	Barn Owl	<i>Tyto alba</i>	S
Strigidae			
Hibou petit-duc	Scops Owl	<i>Otus scops</i>	P
Hibou grand-duc	Eagle Owl	<i>Bubo bubo</i>	S
Chouette chevêche	Little Owl	<i>Athene noctua</i>	S
Caprimulgidae			
Engoulvent d'Europe	Nightjar	<i>Caprimulgus europaeus</i>	N
Engoulvent à collier roux	Red-necked Nightjar	<i>Caprimulgus ufcollis</i>	N
Apodidae			
Martinet noir	Common swift	<i>Apus apus</i>	N
Martinet pale	Pallid Swift	<i>Apus pallidus</i>	N
Martinet alpin	Alpine Swift	<i>Apus melba</i>	P
Alcedinidae			
Martin pêcheur	Kingfisher	<i>Alcedo atthis</i>	S
Meropidae			
Guépier d'Europe	European Bee-eater	<i>Merops apiaster</i>	N
Coraciidae			
Rollier d'Europe	Roller	<i>Coracias garrulus</i>	N

Upupidae			
Huppe fasciée	Hoopoe	<i>Upupa epops</i>	S
Picidae			
Torcol fourmilier	Wryneck	<i>Jynx torquilla</i>	W
Alaudidae			
Alouette calandre	Calandra Lark	<i>Melanocorypha calandra</i>	S
Alouette calandrelle	Short-toed Lark	<i>Calandrella brachydactyla</i>	N
Cochevis huppé	Crested Lark	<i>Galerida cristata</i>	S
Cochevis de Thékla	Thekla Lark	<i>Galerida theklae</i>	S
Alouette lulu	Wood Lark	<i>Lulula arborea</i>	S
Alouette des champs	Sky Lark	<i>Alauda arvensis</i>	S
Hirundinidae			
Hirondelle de rivage	Sand Martin	<i>Riparia riparia</i>	P
Hirondelle de rochers	Crag Martin	<i>Ptyonoprogne ruperstris</i>	W
Hirondelle de cheminée	Barn Swallow	<i>Hirundo rustica</i>	N
Hirondelle rousseline	Red-rumped Swallow	<i>Hirundo daurica</i>	P
Hirondelle de fenêtre	House Martin	<i>Delichon urbica</i>	N
Motacillidae			
Pipit rousseline	Tawany Pipit	<i>Anthus campestris</i>	P
Pipit des arbres	Tree Pipit	<i>Anthus trivialis</i>	P
Pipit farlouse	Meadow Pipit	<i>Anthus pratensis</i>	W
Pipit à gorge rousse	Red-throated Pipit	<i>Anthus cervinus</i>	W
Pipit spioncelle	Water Pipit	<i>Anthus spinoletta</i>	W
Bergeronette printanière	Blue-headed Wagtail	<i>Motacilla flava</i>	W
Bergeronette des ruis-seaux	Grey Wagtail	<i>Motacilla cinerea</i>	W
Bergeronette grise	White Wagtail	<i>Motacilla alba</i>	W
Pycnonotidae			
Bulbul des jardins	Common Bulbul	<i>Pycnonotus barbatus</i>	S
Troglodytidae			
Troglodyte mignon	Wren	<i>Troglodytes troglodytes</i>	S
Turdidae			
Agrobate roux	Rufous Bush Robin	<i>Cercotrichas galactotes</i>	N
Rouge gorge familier	Robin	<i>Erithacus rubecula</i>	W
Rossignol philomèle	Nightingale	<i>Luscinia megarhynchos</i>	N
Rougequeue noir	Black Redstart	<i>Phoenicurus ochropus</i>	W
Rougequeue à front blanc	Redstart	<i>Phoenicurus phoenicurus</i>	P
Rougequeue de Moussier	Moussier's Redstart	<i>Phoenicurus moussieri</i>	S
Tarier des prés	Whinchat	<i>Saxicola rubetra</i>	P
Tarier pâtre	Stonechat	<i>Saxicola torquata</i>	S
Traquet isabelle	Isabelline Wheatear	<i>Oenanthe isabellina</i>	P
Traquet motteux	Northern Wheatear	<i>Oenanthe oenanthe</i>	P
Traquet oreillard	Black-eared Wheatear	<i>Oenanthe hispanica</i>	N
Traquet rieur	Black Wheatear	<i>Oenanthe leucura</i>	S

Monticole de roche	Rock Thrush	<i>Monticola saxatilis</i>	P
Monticole bleu	Blue Rock Thrush	<i>Monticola solitarius</i>	S
Merle noir	Black Bird	<i>Turdus merula</i>	S
Grive musicienne	Song Thrush	<i>Turdus philomelos</i>	W
Grive mauvis	Redwing	<i>Turdus iliacus</i>	W
Grive draine	Mistle Thrush	<i>Turdus viscivorus</i>	W
Sylviidae			
Bouscarle de cetti	Cetti's Warbler	<i>Cettia cetti</i>	S
Cisticole des joncs	Fan-tailed Warbler	<i>Cisticola jincidis</i>	S
Locustelle tachetée	Grasshopper Warbler	<i>Locustella naevia</i>	P
Locustelle lusciniotide	Savi's Warbler	<i>Locustella luscinioides</i>	P
Lusciniole à moustache	Moustached Warbler	<i>Acrocephalus melanopogon</i>	P
Phragmite des joncs	Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	P
Rousserole effarvate	Reed Warbler	<i>Acrocephalus scirpaceus</i>	P
Rousserolle turdoïde	Great Reed Warbler	<i>Acrocephalus arundinaceus</i>	P
Hypolaïs pâle	Olivaceous Warbler	<i>Hippolais pallida</i>	N
Fauvette à lunettes	Spectacled Warbler	<i>Sylvia conspicillata</i>	W
Fauvette passerinette	Subalpine Warbler	<i>Sylvia cantillans</i>	N
Fauvette mélanocéphale	Sardinian Warbler	<i>Sylvia melanocephala</i>	S
Fauvette orphée	Orphean Warbler	<i>Sylvia hortensis</i>	N
Fauvette grisette	Whitethroat	<i>Sylvia communis</i>	P
Fauvette des jardins	Garden Warbler	<i>Sylvia borin</i>	P
Fauvette à tête noir	Blackcap	<i>Sylvia atricapilla</i>	S
Pouillot de Bonelli	Bonelli's Warbler	<i>Phylloscopus bonelli</i>	N
Pouillot siffleur	Wood warbler	<i>Phylloscopus sibilatrix</i>	P
Pouillot véloce	Chiffchaff	<i>Phylloscopus colibita</i>	W
Pouillot fitis	Willow Warbler	<i>Phylloscopus trochilus</i>	P
Roitelet à triple-baudeau	Firecrest	<i>Regulus ignicapillus</i>	W
Muscicapidae			
Gobemouche gris	Spotted Flycatcher	<i>Muscicapa striata</i>	N
Gobemouche à collier	Collared Flycatcher	<i>Muscicapa albicollis</i>	P
Gobemouche noir	Pied Flycatcher	<i>Muscicapa hypoleuca</i>	P
Paridae			
Mésange maghrébine	Blue Tit	<i>Parus teneriffae</i>	S
Oriolidae			
Loriot jaune	Golden Oriole	<i>Oriolus oriolus</i>	P
Lanidae			
Tchagra à tête noire	Black-crowned Tchagara	<i>Tchagra senegala</i>	S
Pie-grièche grise	Great Grey Shrike	<i>Lanius excubitor</i>	S
Pie-grièche à tête rousse	Woodchat Shrike	<i>Lanius senator</i>	N
Corvidae			
Grand corbeau	Raven	<i>Corvus corax</i>	S
Sturnidae			
Etourneau sansonnet	Starling	<i>Sturnus vulgaris</i>	W
Etourneau unicolore	Spotless Starling	<i>Sturnus unicolor</i>	S

Passeridae			
Moineau espagnol	Spanish Sparrow	<i>Passer hispaniolensis</i>	S
Moineau friquet	Tree Sparrow	<i>Passer montanus</i>	S
Moineau soulcie	Rock Sparrow	<i>Petronia petronia</i>	S
Fringillidae			
Pinson des arbres	Chaffinch	<i>Fringilla coelebs</i>	S
Pinson du nord	Brambling	<i>Fringilla montifringilla</i>	P
Serin cini	Serin	<i>Serinus serinus</i>	S
Verdier d'Europe	Greenfinch	<i>Carduelis chloris</i>	S
Chardonneret élégant	Goldfinch	<i>Carduelis carduelis</i>	S
Tarin des aulnes	Siskin	<i>Carduelis spinus</i>	P
Linotte mélodieuse	Linnet	<i>Carduelis cannabina</i>	S
Emberizidae			
Bruant ortolan	Ortolan Bunting	<i>Emberiza hortulana</i>	P
Bruant proyer	Corn Bunting	<i>Miliaria calandra</i>	S



IV MAMMALIAN FAUNA SURVEY

1. INTRODUCTION

Although the first data on the Tunisian mammals go back to the work of Lataste (1887), the fauna of the north Tunisian terrestrial mammals still remains imperfectly known. Among the most important publications, we quote the study of Ghareibeh (1997) which reported only 49 species of mammals in the north of Tunisia based on the analysis of the data collected by Dr. E.L. Cokrum and Dr. R. Baker between 1972-1975, the study of Zava & Masseti (2007) who presented only a list of 27 species in Kroumirie (north-west of Tunisia) including 8 species of bats and the study of Puechmaille and al. (2012) which listed the presence of only 14 species of bats in the north of Tunisia based on a series of expeditions between May 2008 and July 2012.

Since 2011, the natural environment of northern Tunisia has known an important degradation caused by the extensive breeding of sheep and goats, the development of production lands, the deforestation operated by the local populations and by the fires whose surface reached 2000 ha in 2012 (Chriha & Sghari, 2013). These various causes have led to the fragmentation of the natural habitat, and that causes a reduction in the number of species or the number of individuals by species (Pimm and al., 1988; Douglas and al., 2000). Hence the need for inventorying the terrestrial mammals of this area. So, the main aim of our study consists in updating the list of the terrestrial mammals in a typical habitat of northern Tunisia. That will make it possible to take into account the various mammal species, the challenges of their conservation and to integrate them in the next management plans.

2. MATERIAL AND METHODS

The inventory of the terrestrial mammals of the area of Mastouta - Bechouk was carried out in the vicinity of the Medjerda river. It was accomplished between May 2016 and April 2017. That will make it possible to take into account the various mammal species, the challenges of their conservation and to integrate them in the next management plans.

The sampling effort was carried out every season and in particular during the period of reproduction, all the way along linear transects passing through the various habitats. However, the most favorable areas were subject to a more particular research, sometimes by several observers. The daily prospectings (and sometimes nightly) made it possible to count several alive specimens and to reveal several signs of presence (corpses, howls, deposits, droppings, prints, hairs, burrows, meal remains...). The geographical location of the various contacts (signs of presence or visual contact) was calculated via a portable GPS. The observation of certain mammals was carried out on fixed spot using high magnification binoculars.



North African hedgehog (*Atefrix algirus*)
©M. Boujemaa



Figure 1: Mehely's horseshoe bat (*Rhinolophus mehelyi*)
(Photo: M. Boujemâa)

The bats inventory was carried out particularly during three missions: the first at the end of March 2016, the second at the end of August 2016 and the third at the end of February 2017. The signals of echolocation of the bats were detected by using a detecting ultrasound D240x (model D240X; Petterson Electronics AB, Uppsala, Sweden) coupled to an Edirol R09 recorder (Roland Corporation, Shanghai, Clouded). The obtained sequences were analysed using the software Batsound (version 3.10). The signals were identified based on the sound library of Barataud (1999, 2002), the data of Dietz and al. (2009) and the not published data of R. Dalhoumi. Detection took place on fixed spots and the transects in the olive trees fields, cereals fields and the nearby forests.

3. RESULTS

A- Chiroptera

The activity index and the specific wealth of the bats presented important seasonal and spatial variations. In the month of March 2016, the activity of the bats was very weak (4 contacts/hour) in the cereal fields where only two species were detected: Kuhl's pipistrelle (*Pipistrellus kuhlii*) (Kuhl, 1817) and the meridional serotine (*Eptesicus isabellinus*) (Temminck, 1840). In the water supply spots, the activity was more

important. 33 contacts/hour were counted in the artificial water basin (fig. 8) where six species were reported. Kuhl's pipistrelle was the most active species and it was followed by the Felten's myotis (*Myotis punicus*), Felten, 1977. The meridional serotine, the lesser horseshoe bat (*Rhinolophus hipposideros*) (Bechstein, 1800), the long-fingered bat (*Myotis capaccinii*) (Bonaparte, 1837) and the common pipistrelle (*Pipistrellus pipistrellus*) (Schreber, 1774) were seldom detected. The hunting activity exceeded 100 contacts/hour on the Béja river bridge but only four species were detected: Kuhl's pipistrelle, the common pipistrelle, the meridional serotine and *Plecotus teneriffae gaisleri* (Kiefer, Hanák & Veith, 2004).

The prospections carried out at the end of the summer showed that the activity of the bats was limited to the water supply points. No signal was detected in the harvested fields of Hanchir Bechouk. In the artificial water basin, we only detected signals of Kuhl's pipistrelle, the common pipistrelle, the meridional serotine and Schreibers' bat (*Miniopterus schreibersii*) (Kuhl, 1817) and the index of activity was about 150 contacts/hour. On the Béja river bridge we recorded the signals of the meridional serotine, of Kuhl's pipistrelle and of the common pipistrelle with an activity index higher than 200 contacts/hour.

In the abandoned train tunnel (fig. 8), we detected the echoes of the long-fingered bat and Schreibers' bat, of Kuhl's pipistrelle, the meridional serotine, of the European free-tailed bat (*Tadarida teniotis*) (Rafinesque, 1814) during a nightly passage and signals of the long-fingered bat, Schreibers' bat and the greater horseshoe bat (*Rhinolophus ferrumequinum*) (Schreber, 1774) during a diurnal passage. We also indexed a parturition colony of the long-fingered bat and the greater horseshoe bat in the small cracks of the tunnel ceiling.

In February 2017, we captured specimens of Felten's myotis, Schreibers' bat and Mehely's horseshoe bat (*Rhinolophus mehelyi*) (Matschie, 1901) in the tunnel of the water channels (fig. 8). We also detected the signals of the greater horseshoe bat, the lesser horseshoe bat, the long-fingered bat, the common pipistrelle and Kuhl's pipistrelle in the artificial water basin, and the signals the long-fingered bat, the lesser horseshoe bat and Kuhl's pipistrelle in front of the north-western entry of the abandoned train tunnel. We found guanos of bats in a crack located in the Yagoma small island.

B- Erinaceomorpha

The Algeria hedgehog (*Atelerix algirus*) (Lereboullet, 1842) was observed during the nightly observations in the cereal fields. Their droppings are widely distributed in the area of study and they are found particularly in the sparse vegetations. In September 2016, we found a young specimen crushed on the road of Bechouk - El Ma'agoula (CM 127) on the slope on the Béja river.



Figure 2: Algeria hedgehog (*Atelerix algirus*)
(Photo: M. Boujemâa)

C- Soricomorpha

In May 2016, the North African white-toothed shrew (*Crocidura pachyura*) (Kuster, 1835) is observed close to the farms located at El Wtay and Hanchir Bechouk. In March 2017, we found three specimens (♀ + 2♂) of the Etruscan shrew (*Suncus etruscus*) (Savii 1822) in the bed of the Medjerda river (south of Hanchir Bechouk).

D- Carnivora

Howls of the African golden wolf (*Canis anthus*) (Vat, 1820) were heard in the plains of Demnet Ennahala, in Batin Lammad, El Wtay, Hanshir Khrouchfiya, in the hills of Jbal Khrouchfiya and Jbal al Gitoun. Howls of both youngsters and adults were heard in the arborescent shrub layers of Al Morra river during the period of reproduction. Their excrements were found close to the abandoned train

tunnel. Some specimens of the red fox (*Vulpes vulpes*) (Linnaeus, 1758) were observed one hour before the twilight in the cliffs of Batin Lammad in May 2016. A burrow of the fox was localised in the cliff of El Wtay close to the gypseous crack (fig. 4) and their droppings were observed in a low shrub layer close to Béja river in Ad-Dawwas. The Egyptian mongoose (*Herpestes ichneumon*) (Linnaeus, 1758) was only observed in the dense habitats (reedbeds) close to the strait of El Hajama.

However, their deposits are widely distributed: they were found in the cliffs and the reedbeds of El Wtay, in the cliffs of Dahmania and the reedbeds of the Béja river. The common genet (*Genetta genetta*) (Linnaeus, 1758), the striped hyena (*Hyaena hyaena*) (Linnaeus, 1758) and the Eurasian otter (*Lutra lutra*) (Linnaeus, 1758) were not observed. However, two latrines of the common genet with fresh deposits were found: one is located on a small island at the Medjerda riverbank at El Wtay, the other is located close to Béjà river in Ad-Dawwas. We also collected hyena hairs in a burrow located in Demnet ennahla. However, the Eurasian otter was observed by the farmers and the fishermen of the area in the Medjerda river.



Figure 4 : Fox's den
(Photo Ridha Ouni)



Figure 5: A dead red fox (*Vulpes Vulpes*)
(Photos: R.Ouni)



Ridha Ouni

Figure 6: African golden wolf (*Canis anthus*) (Photo: R. Ouni)

E- Artiodactyla

The wild boar (*Sus scrofa*) (Linnaeus, 1758) was widely distributed in the area of study. During the day, it takes refuge in the dense vegetation, in particular the reedbeds. Active during the night, it was observed in the fields and near farms. During the reproduction period, it travels in groups of 4 to 11 individuals.



Figure 7 : Wild boar (*Sus scrofa*)
(Photos: Left: R. Ouni - Right: A. Ben Marzou)

F- Lagomorpha

The Cape hare (*Lepus capensis*) Linnaeus, 1758 was observed several times in the plains of Demnet ennahla. Their latrines with dry granulous deposits were located in the hills of the strait of El Hajama and El Wtay.

G- Rodentia

- Muridae

We only observed two gerbils and four rats. Shaw's jird (*Meriones shawi*) (Duvernoy, 1842) and the North African gerbil (*Dipodillus campestris*) (Loach, 1867) were found in the plains and cereal fields of El Wtay, Demnet Ennahla, Hanchir Bechouk and Ad-Dawwas. The black rat (*Rattus rattus*) (Linnaeus, 1758) is widely distributed in all the area of study. It is frequent in the thorny shrubs and the cereal fields. Its nests were observed in the hedges of Lycium and the acacias on the edges of Medjerda river in El Wtay, Demnet ennahla and Hanchir Bechouk. The brown rat (*Rattus norvegicus*) (Berkenhout, 1769) was observed only in the farms of Hanchir Bechouk. However, the house mouse (*Mus musculus*) (Linnaeus, 1758) is the most widespread rodent in the area of study and it was located in particular in the cereal fields and the farms. The Barbary striped grass mouse (*Lemniscomys barbarus*) (Linnaeus, 1766) was observed in the plains of El Wtay and the plains of Mastouta.

- Hystricidae

The crested porcupine (*Hystrix cristata*) (Linnaeus, 1758) was not observed during the study period but traces were found close to the cliffs and the cracks. Their spines were collected in two natural cracks: one in El Wtay and the other in Dahmania.

4-DISCUSSION

The exploration of the various habitats of the Mastouta-Bechouk area made it possible to inventory 28 terrestrial mammalian species belonging to 7 orders and 16 families, which represents approximately 35% of the Tunisian terrestrial mammals. This list is dominated by the bats which are followed by the rodents and the carnivores.

The bats species of this area represent more than 50% of the total number of the Tunisian bats species, which rose recently to 21 species following the latest discovery by Bendjeddou et al. (2016). With the exception of *Plecotus teneriffae gaisleri*, the other species were reported during the latest decade in the Tunisian North-West by Puechmaille and al. (2012).

Spotted especially in the arid regions of the south and the center of Tunisia (Dalhoumi and al. 2011), *Plecotus teneriffae gaisleri* was captured in June 2009 and July 2012 in the mines of Zaghouan (Puechmaille and al. 2012). With a single mention in the extreme Tunisian north dating back to the year 1930, with the collection of a specimen in Bizerte (Národní Muzeum Praha – NMP),

the long-fingered bat was reported only in five Tunisian sites (Puechmaille and al., 2012) of which three correspond to resting areas, like the abandoned lead mine of Jebel Ressas (Cockrum, 1976; Vaughan and al., 1977), the cave of Tebourba (Museum für Naturkunde Berlin) and the cave of Jbel Ichkeul (Puechmaille and al., 2012). Thus, the abandoned train tunnel constitutes the 4th resting site and the 2nd parturition site known for this species in Tunisia after the cave of Jbel Ichkeul (national park of Ichkeul). Therefore, it is necessary to take all the adequate measures to protect this colony.

This list of bats could be widened by searching for other species emitting signals of low intensity such as the Mediterranean horseshoe bat (*Rhinolophus euryale*) (Blasius, 1853), Blasius's horseshoe bat (*Rhinolophus blasii*) (Peters, 1866) and Geoffroy's bat (*Myotis emarginatus*) (E. Geoffroy, 1806) which were spotted in the northern regions of Tunisia (Dalhoumi and al. 2011). Limited to the Tunisian north, Savi's pipistrelle (*Hypsugo savii*) Bonaparte, 1837 was detected in the dam and the mine of Beni Metir in July 2012 (Puechmaille et al. 2012). It is possible that this species is present in the studied area.



Figure 9: The Etruscan shrew (*Suncus etruscus*)
(Photo: R. Ouni)

The Erinaceidae family is represented in the area of study by only one species: The Algeria hedgehog which is a nocturne species, endemic to the Mediterranean regions. It is common in north Tunisia and its area of distribution extends to the chotts and the coastal areas of south Tunisia (Gharaibeh, 1997). He prefers the open habitats with a shrubby and herbaceous cover such as the fallow fields (García-Rodríguez & Puig-Montserrat, 2014). This species is one of the principal victims of the traffic road in the valley of Soummam (Béjaia, north Algeria) (Mouhoub and al. 2009).

The Soricomorpha order is represented by two species: The North African white-toothed shrew was spotted in north Tunisia (Ain Drahim) and the islands of Ibiza, Sardinia and Pantelleria (Brändli and al., 2005; Turni and al., 2007). It was also spotted in in the Algerian north east by Nicolas and al. (2014), and the Etruscan Shrew is widely distributed in the centre and north of Tunisia (Gharaibeh, 1997).

Among the 14 species of carnivores identified in Tunisia (Hizem, 2007), only six species belonging to five families were listed in the area of study during our prospections. The presence of three other species: The least weasel (*Mustela nivalis*) (Linnaeus, 1766), the caracal (*Caracal caracal*) (Schreber, 1776) and the African wildcat (*Felis lybica*) is probable in the area of study since they were identified before in the north of Tunisia (Gharaibeh, 1997).

The Canidae family is represented by the red fox, a common species in the north and the arid regions of the center and south of Tunisia (Gharaibeh, 1997), and the African golden Wolf which is widely

distributed in the north African countries (Koepfli and al. 2015). The red fox occupies various habitats and in particular the low shrubs areas, the meadows and the pine forests (Cavallini & Lovari, 1991). Omnivorous (Flower 1932; Macdonald 1979; Osborn & Helmy 1980), the fox has an opportunistic dietary habit that includes small mammals (rodents, lagomorphs, ewes), insects, birds (domestic chickens...), scorpions, reptiles, fruits and the leaves of certain plants (Basuony and al. 2005). It digs dens close to each other in small parcels of suitable ground and especially in the cultivated fields, the suburban areas and the meadows (Dell' Arte & Leonardi, 2007). The African golden wolf is observed in the mountainous ecosystems (Yalden and al. 1996). In the Algerian western north, it feeds essentially on the wild mammals (boars_41.51% of the consumed biomass; rabbits_5.81%; crested porcupines_3.24%), on the domestic mammals (sheeps_14.11%; cattle_6.73%) and on seeds and fruits (junipers_8.83%) (Eddine and al. 2017).

The other families (Herpestidae, Viverridae, Hyaenidae and Mustelidae) are represented by only one species each. The striped hyena is a common Hyaenidae found in north Africa (Hofer & Millets, 1998). It generally prefers the open spaces or the sparse thorny shrubs in the arid and semi-arid environments (Leakey and al., 1999; Wagner 2006; Alam et al. 2014). It generally rests in broad caves (Kruuk, 1976; Rieger 1979; Leakey, 1999) and small cracks (R. Ouni, obs. sea-green). It feeds on small mammals, birds, reptiles, arthropods and the remains of domestic animals (ovine, caprine) that died naturally (Albaba, 2015). In Tunisia, the striped hyena is extremely rare and found in all the bioclimatic stages (Gharaibeh, 1997). In a december 2016, a specimen killed by a vehicle was

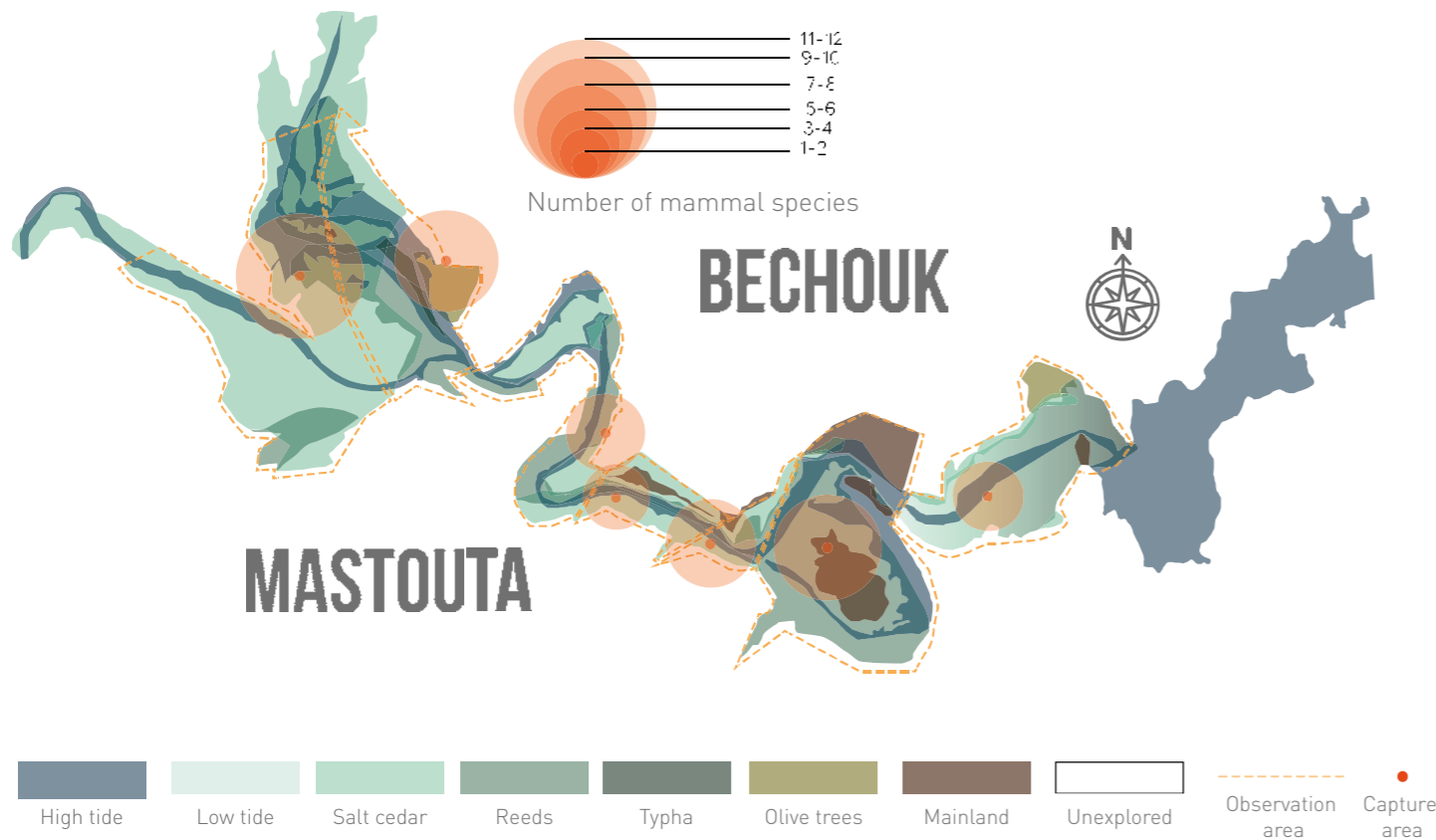


Figure 8 : Distribution area

observed in the vicinity of Sidi Rouin (Ain Drahim, Jendouba) (L. Hamdi, pers. obs. The ecology of the hyena is still badly known in Tunisia hence the necessity of more studies on this species.

The Egyptian mongoose is a small carnivore commonly found in North Africa (Hufnagl, 1972). It prefers the Mediterranean low shrubs (Palomares & Delibes, 1991,1992,1993a) and seems to avoid the desert regions (Aulagnier and Th évenot, 1986), although some populations were observed on the sand dunes littoral east of Libya and in the Egyptian desert (Kasperek, 1993; Aulagnier and al., 2008). Berre, (1991) mentioned that the area of distribution of this species in Tunisia, extends from the north to the south-east of Tataouine. However, Ghraibeh (1997) indicated that this species is limited to the north of Tunisia. The mongoose avoids using open spaces (Palomares & Delibes, 1990) and prefers the dense vegetations like the low shrubs, the undergrowth and the Mediterranean forests (pine forests, ash forests...) (Palomares & Delibes, 1993b). It feeds on rabbits (71% of the consumed biomass), reptiles (9%), birds (5.6%) and on other preys like the Amphibians, insects, eggs, poultry, carrion... (Delibes and al., 1984).

The common genet is a carnivorous species that has a selective food regime based particularly on small mammals (Virgós and al., 1999; Torre and al., 2015) but it can consume birds, small vertebrates, insects and fruits (Delibes & Gaubert, 2013). It generally lives in the Mediterranean mountains (Rivetted-Martínez and al., 1987) and prefers the wooded habitats often associated with rivers and streams (Gaubert and al., 2015). In the North-African countries, it is mainly found north of the Sahara (Gaubert and al., 2015).

The otter is a semi-watery near-threatened Mustelidae that is seldom observed that lives on the riverbanks. Its area of distribution is limited to the North-West of Tunisia (Ghraibeh, 1997). The first observations were made along the Medjerda river (Macdonald & Mason, 1983) but the recent data came from the rivers of the area of Khroumirie-Mogods located about twenty kilometres North-West of the Sidi Salem dam.

R. Ouni observed two specimens: The 1st in The 1st in Sejnane river in the national park of Ichkeul in 2008 and the 2nd passing by the road Béja-Tunis (R.N. 6) in October 2010 close to Oued Zarga. Another specimen was observed on the level of the mouth of Chott Zouarâa (Nefza, Béja) in May 2017 (A. Nefla, pers. obs.). The otter prefers the non-polluted waters,

with a dense vegetation on the banks, a low human disturbance and a strong availability of preys (Baltrūnaitė, 2006; Romanowski and al., 2013). All these ecological needs are available in the area of study which supports the presence of the otter in this region.

The wild boar and the Cape hare are largely spread in the centre and north of Tunisia (Ghraibeh, 1997). The wild boar is an omnivorous Suidae who lives in different habitats (water supply points, fields, conifer forests...) and particularly the agricultural fields when the crops are ripe (Thurfjell, 2009). It feeds mainly on vegetables (90-99%) with a relatively low animals intake (1-10%), depending on the seasonal availability (Pinna and al., 2007). It particularly causes damage close to the forests (Calenge and al., 2004; Thurfjell, 2009). It is the most abundant species and most active in the area. It causes severe damage in the cereal fields and in particular the chickpea fields. Thus, it is necessary to study this species in order to minimize its damage on the farmers of the area. The Cape hare is generally associated with the open habitats in Africa (Boitani and al., 1999). Their droppings are observed particularly in the plains, the meadows and the slopes of the valleys (Novaro and al., 1992).

The order of Rodentia is represented in the area of study by two gerbils, four rats and only one Hystricidae. Shaw's jird is largely spread in the whole Tunisian territory while the North African gerbil is limited to the north of Tunisia (Ghraibeh, 1997). Living in various habitats and particularly in the cultivated fields (Ghawar and al., 2015), Shaw's jird is known as a species responsible for the destruction of cereals and vegetables crops (Stenseth and al., 2003) and their numbers quickly increase after it rains (Granjon, 2016). The North African gerbil lives mainly in the arid and rocky regions but can also be found in the arable lands (Wolf & Sherman, 2007; Granjon, 2016). The house mouse and the black rat are common in the centre and north of Tunisia, the brown rat is found in the north of Tunisia, while the Barbary striped grass mouse is only found in the coastal towns in the extreme south of Tunisia (Ghraibeh, 1997).

The house mouse occupies various habitats including houses, riparian habitats, crop fields and poultry farms (León and al., 2013). The black rat is common in the wooded areas and the forests (Martin and al., 2000). It is the main crop damaging species in Australia (Horskins and al., 1998; Eldridge and al., 2012). The Barbary striped grass mouse lives in the crop

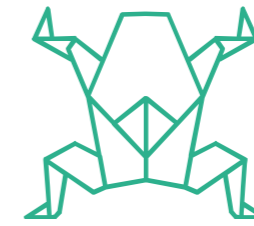
fields, the garrigues and the Mediterranean forests (Carleton & Van der Straeten, 1997; Denys and al., 2015). The crested porcupine is a nightly Hystricidae (Mori and al., 2014a) which uses in particular the closed habitats and seldom the ecotones and open spaces during the night (Sonnino, 1998). It spends the diurnal hours in underground dens located in dry grounds and usually covered with dense vegetations (Corsini and al., 1995; Monetti and al., 2005). It feeds mainly on roots, bulbs, fruits and crop plants such as sunflowers and cereals (Bruno & Riccardi, 1995). In Tunisia, it is widely distributed from the north to the chotts and Jebel Tebaga (Ghraibeh, 1997).

The inventory of the terrestrial mammals of the area of Mastouta-Bechouk made it possible to count two vulnerable species and three near threatened species. All these species should get a special attention and their habitats should be legally protected. In this area, the abandoned train tunnel constitutes a parturition site for the long-fingered bat which was seldom detected in Tunisia during the last decade. Thus, it is necessary to take the adequate measures to protect this site. Lastly, the hyena and the otter, in regression in Tunisia, require to be better studied.

Table1: List of the terrestrial mammals of the Mastouta-Beshouk area.
LC: Least Concern, VU: Vulnerable, NT: Near Threatened, DD: Data Deficient

Odrer	Family	English name	Latin name	IUCN Red List category
Erinaceomorpha	Erinaceidae	North African hedgehog	<i>Atelerix algirus</i>	LC
Soricomorpha	Soricidae	Whitaker's shrew	<i>Crocidura pachyura</i>	LC
		Etruscan shrew	<i>Suncus etruscus</i>	LC
Chiroptera	Rhinolophidae	Lesser horseshoe bat	<i>Rhinolophus hipposideros</i>	LC
		Greater horseshoe bat	<i>Rhinolophus ferrumequinum</i>	LC
		Mehely's horseshoe bat	<i>Rhinolophus mehelyi</i>	VU
	Molossidae	European free-tailed bat	<i>Tadarida teniotis</i>	LC
		Miniopertidae	Schreibers' bat	<i>Miniopterus schreibersii</i>
	Vespertilionidae	Meridional serotine	<i>Eptesicus isabellinus</i>	LC
		Gaisler's long-eared bat	<i>Plecotus gaisleri</i>	-
		Common pipistrelle	<i>Pipistrellus pipistrellus</i>	LC
		Kuhl's pipistrelle	<i>Pipistrellus kuhlii</i>	LC
		Felten's myotis	<i>Myotis punicus</i>	DD
Carnivora	Canidae	Long-fingered bat	<i>Myotis capaccinii</i>	VU
		African golden wolf	<i>Canis anthus</i>	-
	Mustelidae	Red fox	<i>Vulpes vulpes</i>	LC
		Eurasian otter	<i>Lutra lutra</i>	NT
		Viverridae	Common genet	<i>Genetta genetta</i>
Herpestidae	Egyptian mongoose	<i>Herpestes ichneumon</i>	LC	
Hyaenidae	Striped hyena	<i>Hyaena hyaena</i>	NT	
Artiodactyla	Suidae	Wild boar	<i>Sus scrofa</i>	LC
Lagomorpha	Lepoidae	Cape hare	<i>Lepus capensis</i>	LC
Rodentia	Muridae	North African gerbil	<i>Gerbillus campestris</i>	LC
		Shaw's jird	<i>Meriones shawi</i>	LC
		Brown rat	<i>Rattus norvegicus</i>	LC
		Black rat	<i>Rattus rattus</i>	LC
		Barbary striped grass mouse	<i>Lemniscomys barbarus</i>	LC
		House mouse	<i>Mus musculus</i>	LC
	Hystricidae	Crested porcupine	<i>Hystrix cristata</i>	LC

* The IUCN Red list of threatened Species (2017 - 1).



V HERPETOFAUNA SURVEY

1. INTRODUCTION

In Tunisia, the amphibians and the reptiles are represented respectively by 7 and 64 species. Thus, the herpetofauna represents an important component of the Tunisiann fauna biodiversity, by the broad distribution of its species which are met in all ecosystems and the bioclimatic stages of the country, as well as by the role and the place of these species in the trophic chains and networks.

Indeed, many vertebrates and invertebrates depend on these animals; they constitute an essential source of food for several species of birds and small mammals and at the same time they predate on a large number of invertebrates, in particular insects, thus controlling the outbreaks of certain species of which several are harmful for agriculture.

It is also a good indicator of the disturbances of the natural environments and a biological model used to study the impact of the climate changes and trophic activities on the biodiversity.

All that shows the relevance of their survey and study within the framework of this project.

2. METHODOLOGY

The data presented in this report were collected during several missions carried out over two seasons (2016-2017). To inventory and determine the status of taxa present in the 7 areas of the site, the surveys were carried out in an exhaustive way using transects from the edges of the waterway to the marshy zones then to the drier bordering biotopes: wheat fields, olive trees, plains and garrigues and finally the sides and the tops of the mountains. Prospections were also carried out on the small island of Yagouma.

In the winter, we proceeded to look for animals under the stones, the rocks, the barks of trees, in the burrows abandoned by the rodents and in any crevice or seals suitable to shelter a hibernating animal. We calculated for each species, a Frequency F (expressed in %) within the site which consists in dividing the number of areas which shelter the species by the total number of the prospected areas (7 in this site) X 100. The number of individuals observed of each species made it possible to consider an Abundance relative A (in %) by dividing it by the total number of animals observed or captured of all the species of the group (amphibians or reptiles) X 100.

These values remain however approximate considering the weak numbers of detected animals; they however give a rather correct estimate on the relative abundance of taxa and make it possible to distinguish the frequent and common species from the rarer species.

3. TAXONOMIC STRUCTURE AND SPECIFICITY OF THE HERPETOFAUNA IN THE STUDIED AREA

Amphibians:

Out of the 7 Amphibians of Tunisia, five species were met in the prospected sectors; belonging to 5 genera and 4 families (Tab. I). The Sahara frog, two toad species and The Mediterranean painted frog were observed in all areas, while The Mediterranean tree frog (*Hyla meridionalis*) was only detected in area 6, west of the sector, by hearing a male calling. It's worth noting that it is not impossible that this wetland can shelter another rare Amphibian of northern Tunisia, The Algerian ribbed newt (*Pleurodeles nebulosus*) that has been located a few kilometres out of the studied area.

Table I : List of the amphibians of the mouth of Sidi Salem dam

Order	Family	Genus and species	Nom français
Anura	Ranidae	<i>Pelophylax saharicus</i> (Boulenger, 1913)	Sahara frog
	Bufonidae	<i>Bufo boulengeri</i> (Lataste, 1879)	African green toad
		<i>Sclerophrys mauritanica</i> (Schlegel, 1841)	Berber toad
	Alytidae	<i>Discoglossus pictus</i> (Otth, 1837)	Mediterranean painted frog
	Hylidae	<i>Hyla meridionalis</i> Boettger, 1874	Mediterranean tree frog

Among the studied areas (Stations 1 to 7), only area 4 does not shelter amphibians. The two most common species in the studied areas are the Sahara frog (*Pelophylax saharicus*) and the Berber toad (*Sclerophrys mauritanica*). Indeed, these two amphibians were located in 6 out of the 7 areas (a frequency of 85,71%). The number of Sahara frogs (49 specimens) is definitely higher than that of the three other species (varying from 11 to 15 individuals) (Tab. II). Thus, *Pelophylax saharicus* is the most frequent species and most abundant in the mouth of the Sidi Salem dam. The Berber toad is common, like the Sahara frog, but of very low abundance (frequency = 12.5%). The Mediterranean painted frog (*Discoglossus pictus*) and the African green toad (*Bufo boulengeri*) are of the same approximative abundance in the area (respectively 17,05 and 14,77%) except that the first is definitely more frequent (71,43 against only 28,57%). Indeed, the African green toad was located only in 2 stations whereas 5 zones of the prospected sector sheltered the Mediterranean painted frog.

It's worth noting that that on Yagouma we located only 5 specimens of the Berber toad during two visits of this small island, which confirms the frequency of this ubiquitous species, but always of low density. The other small islands do not shelter any amphibians. The minimal vital surface which allows the existence and the survival of a population of toads should be around 2 ha.

Table II : Numbers of spotted amphibians by station and abundance and frequencies of the species
n : number – A : relative abundance – F : Frequency

Species	Station	1	2	3	4	5	6	7	n	A%	F%
<i>Pelophylax saharicus</i>		5	2	2	0	6	20	14	49	55,68	85,71
<i>Sclerophrys mauritanica</i>		2	1	2	0	2	3	1	11	12,50	85,71
<i>Bufo boulengeri</i>		3	0	0	0	0	10	0	13	14,77	28,57
<i>Discoglossus pictus</i>		4	1	0	0	1	6	3	15	17,05	71,43
Specific richness and totals		4	3	2	0	3	4	3	T=88	100	-

In the light of these results, we conclude:

- That the specific richness of amphibians varies from 2 to 4 species per area (except for station 4) according to the ecological characteristics of the biotope, in particular its proximity to the waterway and the moisture degree of the ground.
- That the area of the mouth of the Sidi Salem dam is a wetland very favourable to the amphibians. At least 5 species (and probably a sixth, the Algerian ribbed newt (*Pleurodeles nebulosus*)) out of the seven species found in Tunisia were identified in the area.
- That in terms of abundance and frequency, the composition of this local population reflects that of the whole Tunisian amphibians' population. Indeed, in Tunisia, the most common and abundant species is the Sahara frog (*Pelophylax saharicus*). The Mediterranean painted frog (*Discoglossus pictus*), a species that is considered invasive, and the Berber toad (*Sclerophrys mauritanica*) are very frequent, common, ubiquitous and largely spread, but always in small numbers. The African green toad (*Bufo boulengeri*) is on the other hand more and more rare in Tunisia, in terms of presence as well as in terms of numbers. Lastly, the Mediterranean tree frog (*Hyla meridionalis*) and the Algerian ribbed newt (*Pleurodeles nebulosus*) are very rare species, limited to northern Tunisia.
- That this rich and diversified population deserves to be more studied on the ecological level (dynamic and organization of the populations), in particular in the areas 1 and 6 which shelter 4 sympatric species each.
- Prospecting activities beyond the limits of the area are also necessary to search the rare and more discrete species likely to exist in the region.



Figure 1 : Sahara frog (*Pelophylax saharicus*)
(photo : R. Ouni)

Thirteen species of reptiles belonging to 12 genera and to 9 families live in the various areas delimited in this study: 1 turtle, 1 tortoise, 7 lizards and 3 grass snakes (Tab. III).

Table III : Taxonomic structure and nomenclature of the reptiles' population at the mouth of the Sidi Salem dam.

Order	Suborder	Family	Genus and species	English name
Testudines	Cryptodira	Geoemydidae	<i>Mauremys leprosa</i> (Schweigger, 1812)	Mediterranean pond turtle
		Testudinidae	<i>Testudo graeca</i> Linnaeus, 1758	Common tortoise
Squamata	Sauria	Lacertidae	<i>Psammodromus algirus</i> (Linnaeus, 1758)	Large psammodromus
			<i>Podarcis vaucheri</i> (Boulenger, 1905)	Andalusian wall lizard
			<i>Timon pater</i> (Lataste, 1880)	
		Scincidae	<i>Chalcides chalcides</i> (Linnaeus, 1758)	Three-toed skink
			<i>Chalcides ocellatus</i> (Forskål, 1775)	Ocellated skink
		Gekkota	Phyllodactylidae	<i>Tarentola mauritanica</i> (Linnaeus, 1758)
	Gekkonidae		<i>Hemidactylus turcicus</i> (Linnaeus, 1758)	Mediterranean house gecko
	Serpentes	Natricidae	<i>Natrix maura</i> (Linnaeus, 1758)	Viperine snake
		Colubridae	<i>Hemorrhois hippocrepis</i> (Linnaeus, 1758)	Horseshoe whip snake
			<i>Macroprotodon mauritanicus</i> Guichenot, 1850	False smooth snake
Lamprophiidae		<i>Malpolon insignitus</i> (Geoffroy De St-Hilaire, 1827)	Montpellier snake	

Besides these taxa, three other species are probably present in the studied area, although we did not meet them during our expeditions: the western snake-eyed lizard (*Ophisops occidentalis*) (Boulenger, 1887), the Lebetine viper, (*Macrovipera lebetina*) (Linnaeus, 1758) and the checkerboard worm lizard (*Trogonophis wiegmanni*) (Kaup, 1830). Indeed, their presence is almost certain since:

- The northern limit of the geographical distribution of the western snake-eyed lizard in Tunisia corresponds to the southern limit of the Medjerda valley; moreover, a specimen was captured west of the sector but outside of the limits.
- The Lebetine viper is well-known from the inhabitants, and particularly the shepherds of the area, even if it is seldom observed.
- The checkerboard worm lizard has been signalled south of the studied area, but as it's a very rare species, it is difficult to observe.

Adding these three species, the area shelters the ¼ of the Tunisian herpetofauna. This shows the richness and the importance of the local biodiversity.

In this population, the Mediterranean pond turtle (*Mauremys leprosa*) is a common and even abundant species in some places of this waterway. It was located in the 7 station, in particular in areas 5, 6 and 7 where we counted 78 individuals on a total of 108 turtles observed in the area. This species occupies a paramount place in this wet ecosystem (the waterway and the bordering marshes) by its frequency, its abundance and certainly its impact on the prey populations of invertebrates and small vertebrates especially since it is bigger than the sympatric Amphibians with the same diet.



Figure 2 : Mediterranean pond turtle (*Mauremys leprosa*)
(photo : R. Ouni)

For the terrestrial reptiles, the Mauritania naca gecko (*Tarentola mauritanica*) is by far the most common species and the most abundant one; 32 specimens were located in all the stations. Most other species are frequent (met at least in 4 stations out of 7) and even relatively abundant (numbers varying from 14 to 21 individuals); These species are *Testudo graeca*, *Psammodromus algirus*, *Podarcis hispanicus*, *Chalcides ocellatus*, *Hemidactylus turcicus* and *Natrix maura* (Tabl. IV).

The latter, the viperine snake, is the most common and the most abundant snake of the area since it relies on water, the humid environment and the watery preys (amphibians for example) more than the other grass snakes which are met more in the drier areas and the bordering fields far away from the waterway. The common tortoise population (*Testudo graeca*), although it is not typical of this humid environment is relatively dense and the species is common in the area. This species, more and more rare into in Tunisia, found refuge in this ecosystem.



Figure 3 : Common tortoise (*Testudo graeca*)
(photo : R. Ouni)

Timon pater was localised in 6 stations; it is as common as the large psammmodromus except that its density is very low. Indeed, *Timon pater*, *P. algirus* and *P. vaucheri* are species of palearctic affinity; they are largely distributed and common in northern Tunisia except that the densities of their populations are very different and linked to their respective sizes. The smallest species is *P. veucheri* ; it is also the densest, particularly in altitude. *Timon pater*, on the other hand, is the largest species; its density is always very low. Lastly, the body size of *P. algirus* is intermediate, its density is often close to that of the Andalusian wall lizard.

Our results confirm this rule (relation size/density) which characterizes the Lacertidae and many other zoological groups. The rarest lizard in this area is the three-toed skink (*Chalcides chalcides*) which was detected only twice in stations 4 and 5. This species is also rare and often with low density in northern Tunisia.



Figure 4 : Large psammmodromus (*Psammmodromus algirus*)
(Photo: R. Ouni)

This is also the case with both snakes, *Macroprotodon mauritanicus* and *Malpolon insignitus*, although the first one, which is usually linked to wetlands, should be more frequent in this area. This is also the case with the horseshoe whip snake (*Hemorrhais hippocrepis*), which, like the Montpellier snake (*Malpolon insignitus*), is not typical of this ecosystem; they are both ubiquitous and widely distributed in Tunisia even though *Hemorrhais hippocrepis* is much more anthropophile.

Tableau IV : Reptiles' numbers, abundance and frequency by station
n: numbers A: relative abundance F: frequency

Species	Station	1	2	3	4	5	6	7	n	F%	A%
<i>Testudo graeca</i>		2	1	3	5	6	0	0	17	71,43	11,49
<i>Psammmodromus algirus</i>		1	2	2	4	5	1	0	15	85,71	10,14
<i>Podarcis vaucheri</i>		3	4	2	5	7	0	0	21	71,43	14,19
<i>Timon pater</i>		1	1	1	1	2	1	0	7	85,71	4,73
<i>Chalcides chalcides</i>		0	0	0	1	1	0	0	2	28,57	1,35
<i>Chalcides ocellatus</i>		2	1	2	0	2	4	5	16	85,71	10,81
<i>Tarentola mauritanica</i>		8	3	2	2	9	7	1	32	100,00	21,62
<i>Hemidactylus turcicus</i>		5	2	2	0	2	4	0	15	71,43	10,14
<i>Natrix maura</i>		1	2	1	0	2	3	5	14	85,71	9,46
<i>Hemorrhais hippocrepis</i>		1	0	0	0	1	2	1	5	57,14	3,38
<i>Macroprotodon mauritanicus</i>		0	0	0	0	1	0	1	2	28,57	1,35
<i>Malpolon insignitus</i>		1	0	0	0	0	1	0	2	28,57	1,35
Total		25	16	15	18	38	23	13	148	-	100
Specific richness		10	8	8	6	11	9	5	-	-	-

The specific richness by station, varies from 5 to 11 species of terrestrial reptiles. Areas 5 and 1 are richest in species; they respectively shelter 11 and 10 species out of 12 (if we add the Mediterranean pond turtle). Station 7 is the poorest. Located at the extreme west of the area, it shelters only 5 species: 2 lizards and 3 grass snakes. This area should be better prospected and thoroughly studied to explain the absence of the majority of the common species of lizards.

On the Yagouma small island we counted: 2 *Testudo graeca*, 3 *Psammmodromus algirus*, 2 *Chalcides ocellatus*, 1 *Podarcis vaucheri*, 1 *Tarentola mauritanica* and 2 youth of *Natrix maura*. The "insular" settlement is definitely poorer in species; only the common taxa were able to colonize this reduced space and with limited resources. The 2 other tiny islands located in area 7 do not shelter any reptile; a surface smaller than 2 ha probably does not allow the maintenance and the survival of a population.

In the light of these results, we conclude:

A. That the specific richness of the reptiles' population at the mouth of the Sidi Salem dam is at least of 13 species; 3 others whose presence is not impossible remain to be sought. This number represents approximately the $\frac{1}{4}$ of the biodiversity of the Tunisian terrestrial herpetofauna

B. That such an ecosystem, although wet and not (or less) favourable for the reptiles, constitutes a biotope of predilection for the watery and/or hygrophilous species like the Mediterranean pond turtle and the viperine snake and a refuge for several rare or not very common species in Tunisia like *Chalcides chalcides*, *Podarcis vaucheri* and *Macroprotodon mauritanicus*.

C. That in terms of Abundance and Frequency, and as it was the case for the amphibians, the composition of this local population reflects that of the whole Tunisian herpetofauna.

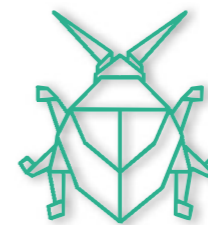
D. By their numbers and the diversity of their preys, these species play a crucial role in the balance of this ecosystem on the level of the waterway as well as in the terrestrial level. The pressure of predation that they exert on the populations of their preys should be important to control their densities and to support the local biodiversity of small invertebrates.

E. As preys for several birds and small carnivorous, these reptiles are essential for the survival of their predators and the maintenance of the biodiversity of the local wildlife.

F. That this population deserves a special protection, and particularly the rarest and most vulnerable species.

G. The follow-up of these populations is essential, in particular on the level of the richest areas to study the dynamics of the biodiversity and to check the processes of colonization – extinction which can happen on the Yagouma small island in the course of time. This last remark is valid for all the fauna listed on this island (birds, ants, coleopters...) in order to better understand these ecological processes and the laws of insular biogeography.





VI ENTOMOFAUNA SURVEY

1. INTRODUCTION

Since Linné and Darwin, the study of the biodiversity rests on the survey of the various species in a given ecosystem. However, besides some vertebrate and invertebrates species which have a direct and notable impact on our economy and our health, the lack of data can be a proof of the big flaw regarding the biodiversity of The Tunisian fauna.

2. METHODOLOGY

During our prospectations, we used the method of hunting at sight,; which is one of the most accessible and effective search methods. In our work, to study the specific diversity of the prospected areas, we focused on the diversity of the prospected habitats (sunny places, rocks, vegetation, dead wood, caves, etc) during the two phases of the day (day and night). Sampling is completed by light traps and Berber traps. The collected samples are placed in 96° alcohol, are labelled (date and station) and are numbered. This method of conservation facilitates the handling of the animals during the study. To further facilitate the visualization of the details of each insect for its identification we edited the labelled collections.



3. RESULTS AND DISCUSSION

The various surveys carried out in the area of study during summer, winter and spring has allowed us to have a general idea about the entomofauna of this area and to establish a preliminary list of species. The review of the collected samples showed us a lot of species belonging to 11 Orders, 57 Families and 114 Genera.

We were already able to identify 52.5% of the species and the rest (47.5%) is under way (Table 2; fig. 4). The Coleoptera Order is the most represented with over 70 species. Among these species, we collected several common species in northern Tunisia including: *Bubas bison*, *Copris hispanus*, *Aphodius fimetarius*, *C. festivities*, *C. spoliatus*, *C. olivieri*, *Percus lineatus*, *Opatroides punctulatus*, *Sclerum armatum*, *caurus atratus* and *Aphodius fimetarius*, but also a few interesting or local species such as: *Zuphium olens olens*, *Polistichus connexus*, *Epomium circumscriptus*, *Platytarus bufo*, *Onthophagus andalusicus* and *Glaphyrus maurus*. Other surveys would allow us to capture several other species like flower beetles with which appear between April and June.

The Dermaptera order is represented by only 3 species (Table 3) in the project area, including the more common species in Tunisia, *Forficula auricu-*

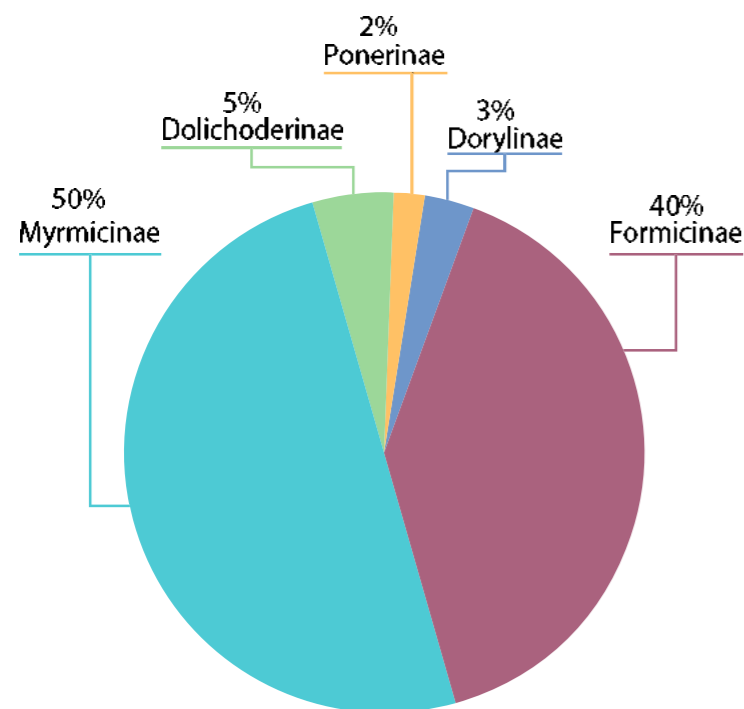


Figure 1: Distribution of the specific richness of the myrmecofauna in the different subfamilies of the studied area.

laria and *Labidura riparia*. The species *Nala lividipes* is considered the most common in the studied area. Other surveys are needed to capture other earwig species using new and more specific sampling techniques.

And finally, the Hymenoptera order, which is mainly marked by the Formicidae Family. Five different subfamilies were collected: Ponerinae, Dorylinae, Dolichoderinae, Formicinae and Myrmicinae. Myrmicinae are the most common with 23 species distributed between 8 genera (fig 1 and table 2). In this subfamily, we reported for the first time *M. foreli* in north Tunisia. The Formicinae subfamily present 18 species of which two genera, *Cataglyphis* and *Lepisiota*, are the most diversified. In this subfamily, we reported new species for northern Tunisia: *Lepisiota frauenfeldi* that is present with three subspecies (*Barbara*, *Pubescens* and *Kantarensis*) as well as *Cataglyphis viatica* that was limited to the Tunisian center according to Rüdiger Wehner (1994). The myrmecofauna of Béchouk has 45 species as a preliminary list (Table 4) but there are still 11 taxa that still need identification.

Table 1: Taxonomic diversity of Béchouk's ants

Subfamily	Genus	Species
Formicinae	4	18
Myrmicinae	8	23
Dolichoderinae	1	2
Ponerinae	1	1
Dorylinae	1	1
Total	15	45

The frequency of occurrence of Formicidae varies from one study area to another (from 12.5% to 100%) (Table 4). *Tapinoma simrothi* is the most common species of Béchouk's myrmecofauna, it abounds in different areas with polydomic colonies. The genus *Tapinoma* gives local resistance against invasive ants (Berville *et al.*, 2014) which we collected at all altitudes in Béchouk (even the highest). Furthermore, in the two islands surveyed *Tapinoma* is present with the highest relative abundance (22.9% and 100%). Calculation of Pielou's evenness index shows values that tend towards 1. This indicates a fair distribution of the abundance of the different species of ants in the various surveyed habitats (Table 5).



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The large island is approximately 32 ha (flat surface) and an altitude of 156 m over the sea and 50 m over Medjerda. About 59% of its land is cultivated, 16% is rugged terrain covered with low shrub in the western part, formed by the Lentisque, Calicotome, Rosemary, and Thyme... and 25% are cliffs varying from 5 to 50 m altitude, gypsious geological formations.

This "island" habitat has a high specific richness with 21 species. More than 148 anthills, of which five species have very important and close relative abundances (*T. simrothi*, *T. nigerrimum*, *L. frauenfeldi kantarensis*, *M. salomonis* and *T. semileave*).

It has been noted in several cases that *T. semileave* and the genus *Tapinoma* abounds in microhabitats which are generally associated with a microfauna of different species of woodlice.

The specific richness of this island represents 50% of all the specific richness of the entire study area. We are talking here about "a hot spot of biodiversity" or "hot spot". On Yagoma, we were able to collect species not detected in the other study areas (*Oxyomyrex saulciyi*, *Tetramorium sp.*, *Lepisiota bipartita*, *Crematogaster laestrygon*, and *Pallescens atlantis*). This hot spot is irreplaceable and the protection of this area is therefore a priority.



Figure 2: *Tapinoma simrothi* anthill (Photo W. Oueslati)



Figure 3: Active *Cataglyphis bicolor* (Photo W. Oueslati)

Table 2: List of identified species

Order	Family	Geus/Species	Abundance
Coleoptera	Carabidae	<i>Chlaenius (Epomis) circumscriptus</i>	XX
		<i>Chlaenius (Chlaeniellus) olivieri</i>	XX
		<i>Chlaenius (Chlaenius) festivus</i>	XXX
		<i>Chlaenius (Chlaenites) spoliatus spoliatus</i>	XX
		<i>Licinus (Licinus) punctulatus punctulatus</i>	X
		<i>Zuphium olens olens</i>	XXX
		<i>Polistichus connexus</i>	XXX
		<i>Siagona europaea europaea</i>	X
		<i>Percus lineatus</i>	X
		<i>Agonum (Agonum) marginatum</i>	XX
		<i>Platyтарus bufo</i>	X
		<i>Distichus (Distichus) planus</i>	X
		<i>Orthomus barbarus</i>	X
		<i>Paranchus albipes</i>	XXX
		<i>Pedius ineptus</i>	XXX
		<i>Brachinus (Brachynidius) sclopeta</i>	X
		<i>Calathus (Bedelinus) circumscriptus</i>	X
		<i>Microlestes corticalis</i>	X
		<i>Poecilus (Ancholeus) gisellae gisellae</i>	XXX
		Scarabaeinae	<i>Onitis belial</i>
	<i>Onitis alexis septentrionalis</i>		X
	<i>Euoniticellus pallens</i>		X
	<i>Copris hispanus</i>		X
	<i>Bubas bison</i>		X
	<i>Onthophagus taurus</i>		X
	<i>Onthophagus andalusicus</i>		X
	Aphodiinae	<i>Aphodius fimetarius</i>	X
	Cetoniidae	<i>Oxythyrea funesta</i>	X
		<i>Tropinota squalida</i>	X
	Glaphyridae	<i>Eulasia bombylius</i>	XX
		<i>Glaphyrus maurus</i>	X
	Tenebrionidae	<i>Scaurus atratus</i>	X
		<i>Pachychila tazmaltensis</i>	X
		<i>Pimelia gibba</i>	X
		<i>Sclerum armatum</i>	X
		<i>Opatrum emarginatum</i>	X
		<i>Belopus elongatus</i>	X
		<i>Opatroides punctulatus</i>	X
	Chrysomelidae	<i>Chrysolina banksii</i>	X
		<i>Chrysolina hyperici</i>	X
	Staphylinidae	<i>Ocypus olens</i>	X

Afterpart of table 2

Lepidoptera	Pieridae	<i>Pieris brassicae</i>	X
		<i>Colias croceus</i>	X
	Papilionidae	<i>Iphiclides podalirius</i>	X
	Nymphalinae	<i>Vanessa cardui</i>	X
<i>Vanessa atalanta</i>		X	
Hymenoptera	Apidae	<i>Apis mellifera</i>	XX
Orthoptera	Acrididae	<i>Acrida ungarica</i>	X
	Gryllotalpidae	<i>Gryllotalpa gryllotalpa</i>	X
Mantoptera	Tarachodidae	<i>Iris oratoria</i>	X
	Mantidae	<i>Mantis religiosa</i>	X
		<i>Amiles spallanzania</i>	X
		<i>Rivetina baetica</i>	X
		<i>Geomantis larvoides</i>	X
Empusidae	<i>Empusa pennata</i>	X	
Hemiptera	Pentatomidae	<i>Carpocoris mediterraneus</i>	X
		<i>Aelia acuminata</i>	X
	Pyrrhocoridae	<i>Pyrrhocoris apterus</i>	X
	Gerridae	<i>Aquarius najas</i>	X
Arachnida	Buthidae	<i>Buthus tunetanus</i>	X
	Scorpionidae	<i>Scorpio maurus</i>	X

Figure 4: Headcount of the identified and in the process of being identified entomofauna samples

	Identified	in the process of being identified
Order	11	0
Family	55	2
Genus	86	28
Species	62	56

Table 3: List of earwigs' samples in the study area

Family	Subfamily	Species	Work
Forficulidae	Forficulinae	<i>Forficula auricularia</i>	Steinmann, 1977
Labiduridae	Labidurinae	<i>Labidura riparia</i>	Steinmann, 1977
	Nalinae	<i>Nala lividipes</i>	VignaTaglianti, 2010 ; 2011



Figure 5 : *Pheidole pallidula*
(Photo W. Oueslati)



Figure 6: *Crematogaster laestrygon* gallery
(Photo W. Oueslati)



Figure 7: *Messor barbarus* gallery
(Photo W. Oueslati)



Figure 8: Light trap for night insects
(using a white light lamp)
(Photo A. Ben Marzou)

Tableau 4 : Diversity and relative frequencies of Béchouk's ants
0 = Absent - 1 = Present

Genus	Species	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Yagoma	Small island	Frequency %
<i>Cataglyphis</i>	<i>bicolor</i>	0	1	1	0	0	0	0	0	25
	<i>viatica</i>	0	0	1	1	0	0	1	0	37,5
	<i>sp</i>	1	0	0	0	0	0	0	0	12,5
<i>Camponotus</i>	<i>micans</i>	1	0	1	1	0	0	0	0	37,5
	<i>sp</i>	1	0	0	1	0	0	1	0	37,5
	<i>schmitzii</i>	1	0	0	0	0	0	1	0	25
<i>Plagiolepis</i>	<i>sp</i>	0	0	0	0	1	0	0	0	12,5
	<i>pallescens atlantis</i>	0	0	0	0	0	0	1	0	12,5
	<i>pallescens maura</i>	0	0	0	1	0	0	1	0	25
	<i>pallescens sordida</i>	0	0	0	1	0	0	0	0	12,5
	<i>pallescens</i>	0	0	0	0	0	0	1	0	12,5
<i>Lepisiota</i>	<i>frauenfeldi barbara</i>	0	0	0	0	1	0	0	0	12,5
	<i>frauenfeldi kantarensis</i>	1	1	1	1	0	1	1	0	75
	<i>frauenfeldi pubescens</i>	0	0	0	1	0	1	0	0	25
	<i>sp1</i>	1	0	0	0	0	0	0	0	12,5
	<i>nigrescens</i>	0	0	0	1	0	1	0	0	25
	<i>sp2</i>	1	0	0	1	0	1	0	0	37,5
<i>Tapinoma</i>	<i>bipartita</i>	0	0	0	0	0	0	1	0	12,5
	<i>simrothi</i>	1	1	1	1	1	1	1	1	100
<i>Monomorium</i>	<i>nigerrimum</i>	1	1	1	1	1	1	1	0	87,5
	<i>Salomonis</i>	1	1	1	1	1	1	1	0	87,5
	<i>salomonis obscuriceps</i>	0	0	0	0	0	0	1	0	12,5
<i>Crematogaster</i>	<i>subopacum</i>	1	1	1	0	0	0	0	0	37,5
	<i>laestrygon</i>	0	0	0	0	0	0	1	0	12,5
<i>Messor</i>	<i>barbarus</i>	1	0	0	1	1	1	1	0	62,5
	<i>lobicornis normandi</i>	1	0	0	0	0	0	0	0	12,5
	<i>meridionalis</i>	0	1	0	0	0	0	1	0	25
	<i>capitatus</i>	1	1	0	1	0	1	1	0	62,5
	<i>sp</i>	0	1	0	0	0	1	1	0	37,5
	<i>wasmanni</i>	1	0	0	0	0	0	0	0	12,5
	<i>foreli</i>	0	0	0	0	1	0	1	0	25
<i>picturatus</i>	1	0	0	0	0	0	0	0	12,5	
<i>Tetramorium</i>	<i>semileave</i>	1	1	1	1	1	1	1	0	87,5
	<i>sp1</i>	0	1	0	0	0	0	0	0	12,5
	<i>schmidti</i>	1	0	0	0	0	0	0	0	12,5
	<i>sp2</i>	0	0	0	0	0	0	1	0	12,5
<i>Cardiocondyla</i>	<i>mauritanica</i>	0	0	0	1	0	1	1	0	37,5
<i>Oxyomyrex</i>	<i>sauciyi</i>	0	0	0	0	0	0	1	0	12,5
<i>Aphaenogaster</i>	<i>pallida</i>	0	0	0	1	0	0	0	0	12,5
	<i>sp</i>	0	0	0	0	0	1	0	0	12,5
<i>Pheidole</i>	<i>pallidula</i>	0	0	1	0	0	0	0	0	12,5
	<i>megacephala</i>	0	0	1	0	0	0	0	0	12,5
	<i>sp</i>	1	0	0	0	0	0	0	0	12,5
<i>Dorylus</i>	<i>fulvus punicus</i>	1	0	0	0	0	0	0	0	12,5
<i>Ponera</i>	<i>sp</i>	1	0	0	0	0	0	0	0	12,5
TOTAL		21	11	11	17	8	14	21	1	



VII HABITATS SURVEY

1. INTRODUCTION

Tunisia's spontaneous natural habitats are still uncounted in the project area (mouth of Sidi Salem Dam).

Thanks to a favourable climate and a rich geological substrate, the project area houses various habitats. A preliminary list has been established for the types of these habitats (forest, scrub, marshes...) in the study area.

2. METHODOLOGY

To identify the natural habitats of the study area we rely on the environmental factors (soil, plant groupings, fauna...) and geomorphological factors (topography, cliffs...)

3. RESULTS

A. Reedbeds:

Reedbeds are plant formations characteristic of wetlands with variable water and salt levels. In total, we identified five types of reedbeds (Figure 1).

Their distributions are mainly conditioned by agricultural practices and their tolerances to flooding and salt content.

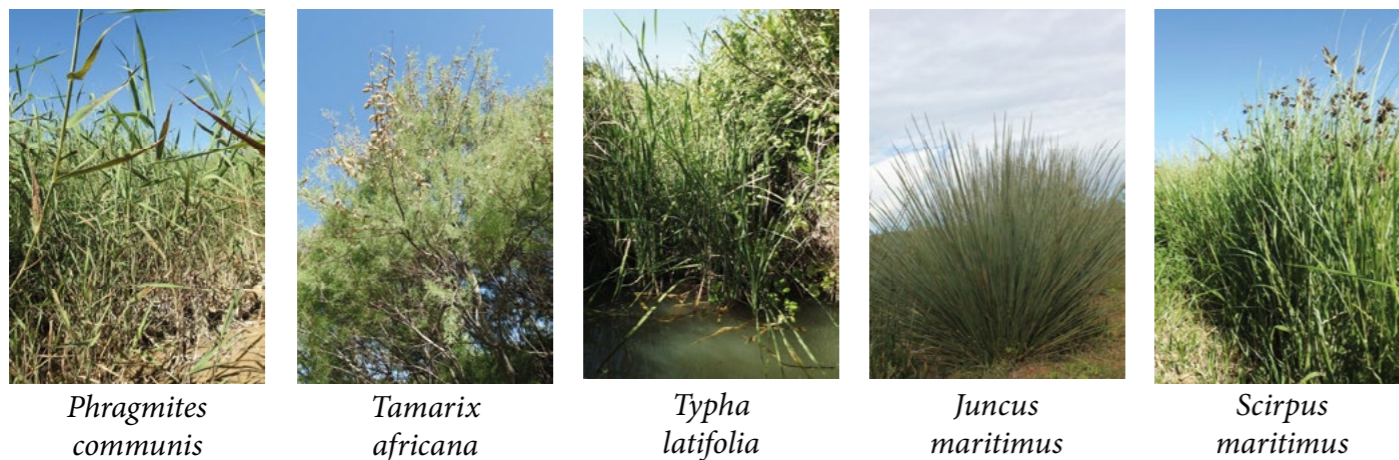


Figure 1: Different types of reedbeds (Photos: R. Ouni)

areas, which are their main source of water supply. The most common and tallest are *Phragmites communis* and *Tamarix africana*, which occupy approximately 163.5ha and 179.5 ha respectively, or 82% of the reedbeds. *Typha latifolia* and *Scirpus maritimus* occupy a surface of about 40 hectares each. *Juncus maritimus* are very scattered and their surface does not exceed five hectares.



Figure 2: A and B: Structure of different reedbeds types in the study area (Photos: R. Ouni)

Table 1: Submergibility of sampled reedbeds

Water level(m)/Reedbed type	warbler	typha	bulrush	rush	tamarix
0					
0,25					
0,5					
0,75					
1					

We've noticed that the specific richness of the reedbeds flora is quite low. This can be explained by the strong colonizing power of the dominant species, advantaged by their long rhizomes.

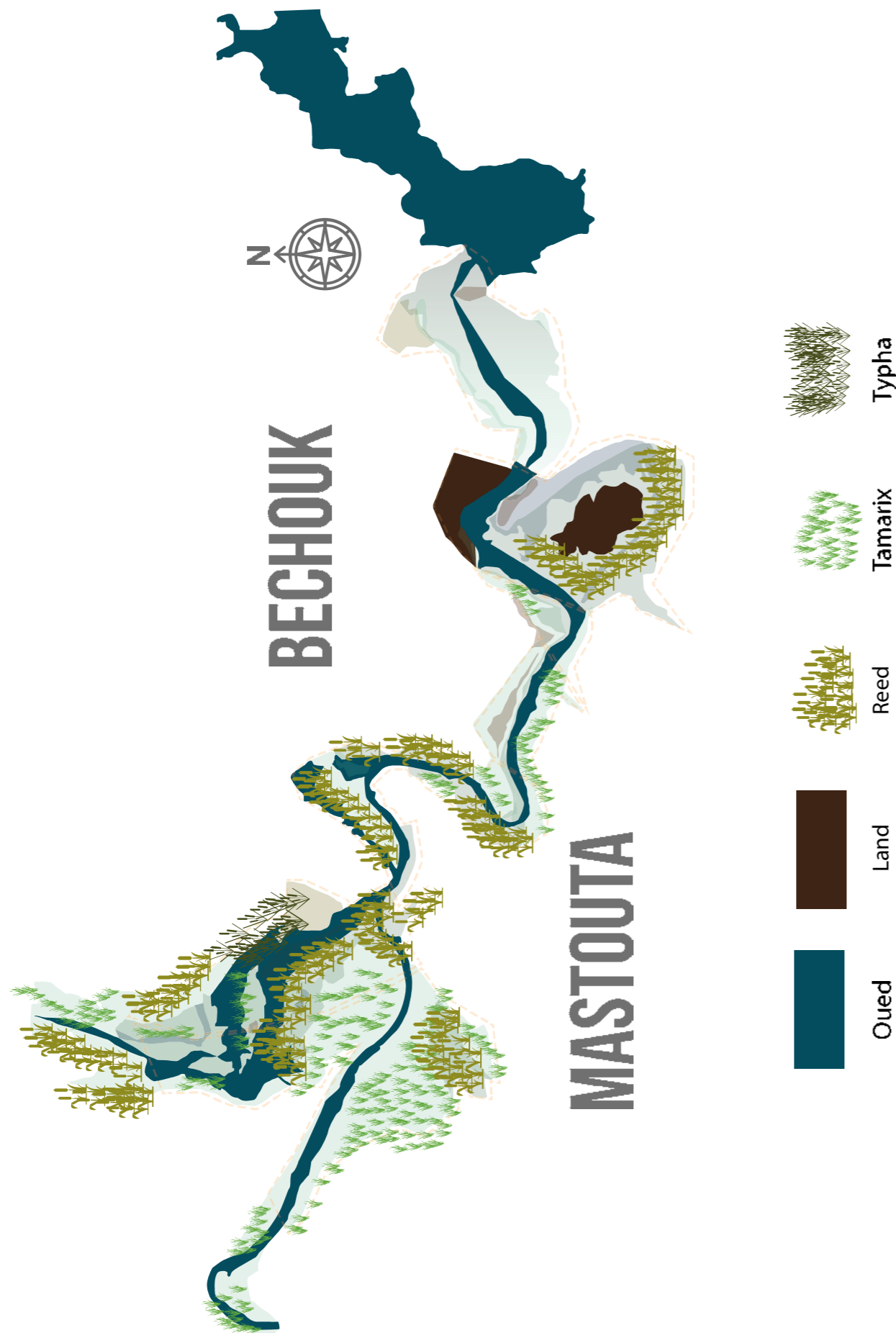


Figure 3: Vegetation map of the study area (Cartography W. Tlili)

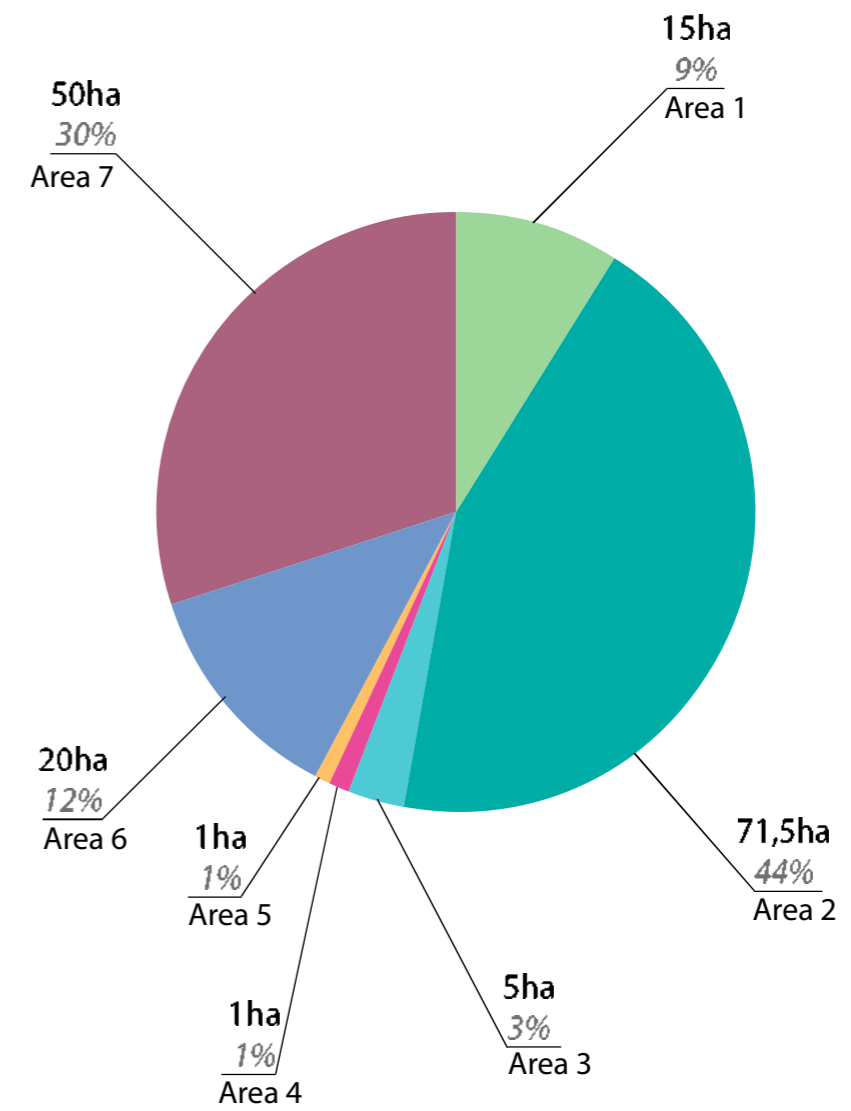


Figure 4: Estimated area of plant cover per station (in hectares) in the wetland of the study area.

Reedbeds play a key role in the natural balance of this wetland. Hence the need to take all appropriate measures to preserve the sustainability of this plant formation, and particularly in a biodiverse ecosystem that is among the main drinking water reservoirs in the northwest of Tunisia.

B. Forests :

They represent an ecosystem where predominant vegetation consists of trees and bushes, spread over a large area.

In this region, three types of forest have been identified:

- The acacias forest, located on the banks of areas 3 and 4. It constitutes a refuge for several boars and a few bird species.
- The pine forest located south of area 5. It represents to a halt zone for most birds and forest raptors during pre- and postnuptial passages.
- The cypress forest.



Figure 5: Pine forest in area 5
(Photo: A. Ben Marzou).

C. The scrublands

Two types of scrublands have been identified:

- A sparsely-stocked low-lying scrub formed by a thyme, rosemary, cistus and calicotome grouping, covering the hills of the west bank of areas 1 to 5.
- A shrub-dense scrub, represented by a group of wild olive trees, cedar, lentisque, calicotome and tree hedges covering the east of areas 2 to 4. It hosts various species of vertebrates.



Figure 6: A shrub-dense scrub of areas 2-4
(Photo: A. Ben Marzou).

D. Cliffs

These are essentially rocky habitats, with an almost vertical surface. Two types of cliffs are observed in the study area:

- Rocky cliffs that are located throughout the main valleys that cut off the trays and mountain ranges, constituting real canyons, sometimes very narrow (the case of the cliffs in areas 2-4).
- Clay and sandy cliffs areas 1 and 6).

The cliffs are home to different species of great raptors and even other small species. like swifts, bluebirds, sparrows, bee-eaters...



Figure 7 (A et B): Cliff types
(Photo: R. Ouni)

E. Wetlands

These are water surfaces of freshwater or brackish water of different depths. The study area is represented by:

- **The lower marsh:** For example, the Béja river watershed upstream of Sidi Salem Dam. It is covered by large stretches of reedbeds and rich in trophic resources and used as dormitories by several species of herons. This habitat is an attractive site particularly for surface water birds. It hosts thousands of birds each year.



- **The high marshes:** area (1) is more or less attractive because of its depth and is only used by diving birds. But it's a good place to rest for winter birds and transient migrants. Each of these different environments plays a different role depending on its ecological importance in the study area.

Note:

The reedbeds contribute to:

- Protection of banks against erosion: Like a natural breakwater, they depreciate the strong currents of tides and floods.
- Sediment sequestration: Rhizomes and leaves retain the finest fractions of the material in suspension. A large amount of sediments is trapped each year, resulting in soil elevation and thus a decrease in the frequency of flooding.

- Cleaning the environment: Reedbeds absorb nutrients (nitrogen, phosphorus...), participate in the oxygenation of the river ("lungs of the wetland"), promote the mixing of fresh and polluted waters and can fix heavy metals.

They are also habitat for a diverse fauna:

- Invertebrates for which they promote reproduction.
- Fish that use them as egg laying areas, maturation and juvenile hiding spot.
- Birds, for which reedbeds represent a feeding site and shelter against predation. They are frequented during all or part of the year by various species during breeding, migration and/or wintering periods.

Forests and scrublands also contribute to:

- Protecting banks against erosion by playing the role of soil fixator and absorbing the strong runoff currents.
 - Sequestration of sediments and leaves by fixing these organic matters.
- They constitute also a habitat for a diverse fauna:
- Invertebrates for which they promote reproduction.
 - Mammals that use them as parturition sites and refuge against weather.
 - Birds that use them as a feeding site and as a refuge against predators. Frequented by various species, during all or part of the year, during breeding, migratory stages or wintering.

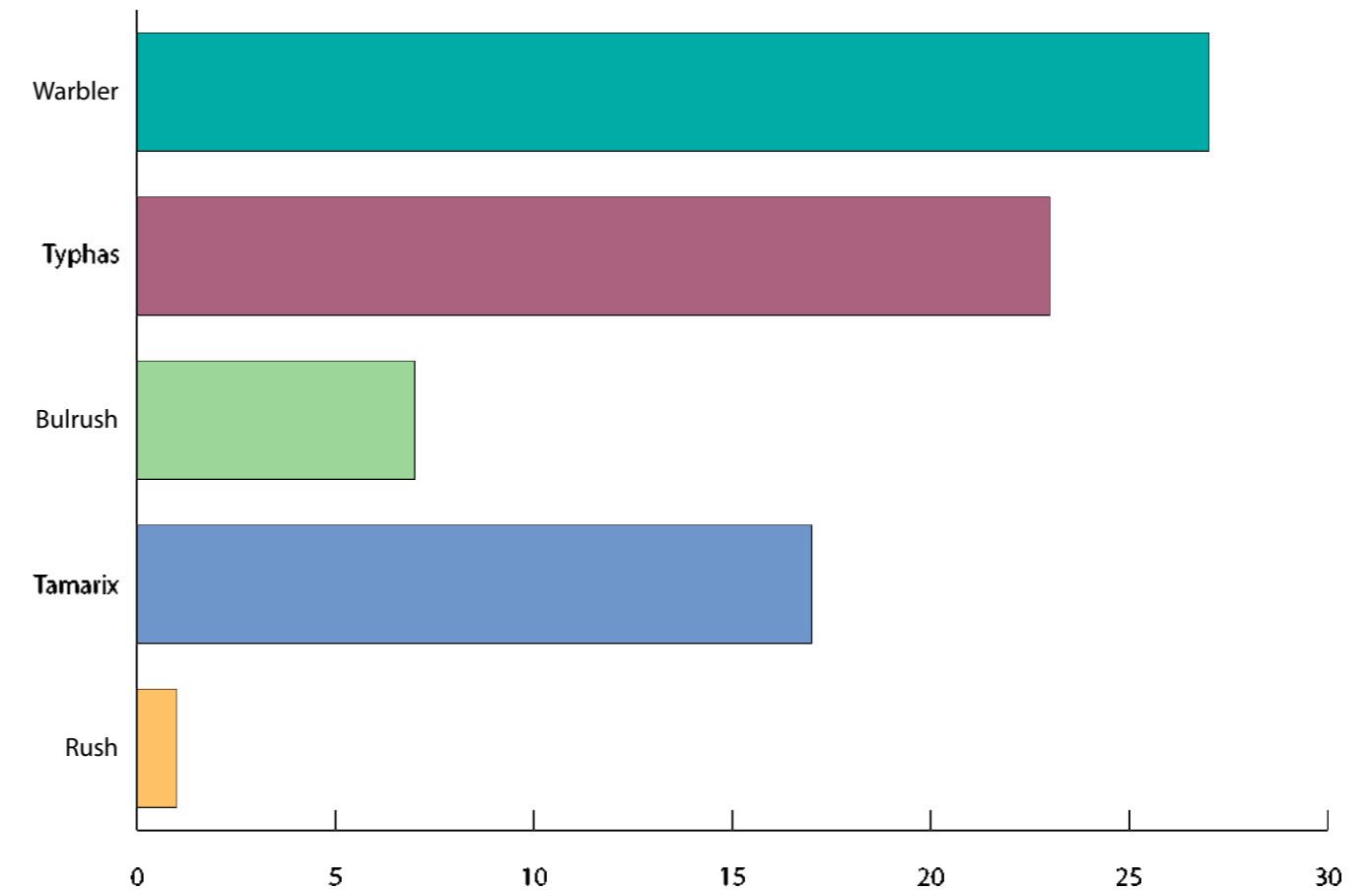


Figure 9: Specific birds' richness within the project's wetland

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SYNTHETIC DATA ON THE MISSION

PLACE: Béja governorate- The mouth of the artificial lake “Sidi Salem dam”

DATE: November 2015 - May 2017

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