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**BIOLOGICAL DIVERSITY AND TROPICAL FORESTS
IN TUNISIA**

Prepared by :
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January, 1988

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for

The Washington D.C. and Tunis Offices of the
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Preface

This document was prepared for the Agency for International Development (AID) in response to FAA Amendments 118 and 119, which concern the conservation and enhancement of biological diversity and tropical forests. The status, trends and influences on the flora, fauna and ecosystems are addressed in order to provide an information base for use by AID/Tunis in reporting to AID/Washington D.C., formulating action plans and preparing Environmental Assessments of proposed projects. The document has been cross-referenced by ecosystems and gouvernorats to facilitate Environmental Assessment preparation. This document is also intended for use by non-governmental organizations, donor organizations and the Government of Tunisia.

Following the precedent of the FAA amendments, there are separate discussions of biological diversity and tropical forests in this survey. However, forests are a major component of biological diversity, so the bulk of ecological information has been concentrated in Part I. In literature describing the ecosystems of Tunisia, certain arabic terms are so common (such as 'djebel' for mountain) that they are used in the text. An inherent problem with local terms (including names of cities) that the reader should be aware of is that differences in phoenetic spellings are found in other documents (ex. djebel, jebel, djebbel are all used in the literature). A short glossary has been provided to define some of the unfamiliar terms.

This survey was funded by AID/Washington through AID/Tunis. The support given by Peace Corps/Tunisia, including use of a word processing computer, information gathering assistance and moral support, is sincerely appreciated. Information from the Direction des Forets in the form of published reports and discussions comprises a large part of this survey. Special thanks go to Mr. Selmi Khemaies, who greatly facilitated my work in Tunisia, and to each of the ingenieurs and gardes-chasse that accompanied me in the field. Mr. Michael Smart of the International Waterfowl Research Bureau was an invaluable source of information on wetlands and environmental concerns in Tunisia, and guided me to the most important locations in the field. I am also grateful to Thorstor Weilbel of the GTZ for vegetation information and a home base in Tunis.

BIOLOGICAL DIVERSITY AND TROPICAL FORESTS IN TUNISIA

EXECUTIVE SUMMARY

Tunisia is the smallest of the Maghreb nations with a total surface area of 16 million hectares and a population of 7,259,000. Although its small size, low mountains (maximum elevation 1544 m compared to 4167 m in Morocco) and dense population leave Tunisia with fewer endemic species of fauna and flora than are found in the rest of the Maghreb, the species diversity is fairly rich and is distributed through a variety of ecosystems.

Flora

There are 2200 species of plants in Tunisia. Of the 870 species of plants that are rare, threatened or endemic in North Africa (IUCN 1980), 151 occur in Tunisia, but the local conservation status is unknown for all of them. At the national level there are 307 rare and 99 very rare plants. Of those 406 plants, 335 are distinct species (not subspecies or forms), which is 15 % of the total flora. Tunisia's rare flora include 6 species endemic to the country and 81 species endemic to North Africa and the northern Sahara. Individual species in need of protection are discussed.

Many of the plants are valuable as a genetic resource. Important forage plants (Medicago, Hedysarum), medicinal plants (Myrtus communis, Urginea maritima, Daphne genkium), fiber plants (Stipa tenacissima) and plants of food value occur (Olea, Capparis) occur. Conservation and research of the rare plants and genetic resources is done by the Agronomy Institutes (INAT, INRAT), Genetic Resources Center (INRST), Nature Protection Association (ATPNE) and the national MAB committee.

Fauna

Tunisia has suffered a drastic decline in fauna in the past century. About 75 species of mammals, 400 species of birds, and more than 500 species of herps and fish can still be found. However, all of the large mammals are threatened, with the exception of the wild boar Sus scrofa barbarus. Monk seals (Monachus monachus) have almost been extirpated. Several mammal species (mostly rodents) are endemic to North Africa. Rare and endangered mammals in the IUCN Red Data Book (in: Grant 1980) include:

Barbary hyena	<u>Hyaena hyaena barbara</u>
Barbary deer	<u>Cervus elaphus barbarus</u>
Dorcas gazelle	<u>Gazella dorcas massaesyla</u>
Cuvier's gazelle	<u>G. cuvieri</u>
Slender-horned gazelle	<u>G. leptoceros</u>

Rare and endangered birds listed in the Red Data Book (IUCN 1985) that occur in Tunisia include:

White stork	Peregrine
Marbled teal	Audouin's gull
White-headed duck	Red-necked nightjar
Red kite	Houbara bustard
White-tailed sea eagle	Little bustard
Bearded vulture	Slender-billed curlew

To conserve the rare and endangered fauna, 32 mammal species and many bird species were submitted for inclusion under the regulations set by the Convention on International Trade of Endangered Species (CITES). The Forestry Directorate, Directorate of the Environment, ATPNE and National Ornithological Association (AAO) are involved in conservation activities.

Ecosystems

There are 7 major ecosystems in Tunisia: coastal, island, wetland, mountain, steppe, desert and oasis.

Tunisia's 1200 km of coast give it one of the highest coast:surface area ratios in Africa. The north coast is deep and has important formations of red coral reefs. Southern coastal areas are shallower and provide internationally important feeding areas for migrating shorebirds. The entire coastline has a rich diversity of marine fauna. Eight major island archipelagos and several small islands are distributed along the coast. Islands are an interesting special habitat and some rare and endemic species found on the islands include monk seals, rabbits, Audouin's gulls and Eleonora's falcons.

Of the more than 100 permanent and temporary wetlands, many are of international importance. Each year more than 75,000 flamingos, 400,000 anatids (ducks) and 250,000 coots and moorhens use the wetland and coastal areas. The wetlands include 7 large marine lakes and more than 30 salt lakes (sebkhetts and chotts). Several freshwater wetlands exist, including at least 1 permanent and many seasonal lakes. Dar Fatma, a peat bog in the northwest, has many rare and geographically isolated plant species.

Five major mountain systems contain most of the forests and endemic plants of Tunisia. In the northwest the Khroumirie/Mogod mountain chains are the wettest part of the country and barbary deer live in forests of cork oak Quercus suber, zen oak Q. canariensis and the rare Q. afares. The High Tell and Tunisian Dorsal mountain ranges shelter endangered Cuvier's gazelles and hyena in Pinus halipensis/Quercus ilex forests. A few stands of the rare maple tree Acer monspessulanus occur in the Tunisian Dorsal and thuya Callitris articulata, a species with tropical affinities, is dominant in the forests of Bou Kornine National Park. Mountains in the High Steppes of central Tunisia and the Douirat mountains of southern Tunisia are dominated by Juniperus and other species characteristic of degraded forests, in which aoudad (barbary mountain sheep) Ammotragus lervia occur.

Vast areas are dominated by steppe vegetation. The High Steppes near Kasserine contain the densest esparto grass Stipa terracissima of the country and a processing plant has been constructed to make paper from esparto fibers. Wild boar and hyena are commonly found in the High Steppes. Low Steppes, east of Sidi Bou Zid and in the Kairouan area are dominated by sage Artemesia and Zizyphus lotus and the halophile vegetation of the many salt lakes distributed in the region. Threatened houbara bustards nest in the low steppes. The last remaining remnants of the sub-Sahara type savanna dominated by Acacia raddiana trees are found in the Subdesertic Littoral Steppe at Bou Hedma. Addax, oryx and ostrich - extirpated in the past century - have been re-introduced at Bou Hedma, and dorcas gazelles exist there and in the region of Hamada. In the Subdesertic Continental Steppe, sage plains grade to Rhantherium and Arthrophytum plains - the former range of several species of ungulates.

The Sahara desert or Eastern Grand Erg are dominated by pseudo-forests of Calligonum comosum and the Grand Erg endemics C. azel and C. arich. There are more than 2,500,000 ha of Sahara type desert in Tunisia; if desertic steppes are included the area is c.4,000,000 ha. Vegetation removal and wind erosion are increasing the desert area by 18,000 ha each year. Endangered slender-horned gazelles, the North African endemic gundi and a wide variety of birds and herpes are found in the desert.

Dispersed in the steppes and desert edges are more than 75,000 ha of oases. Intense cultivation restricts the natural vegetation, but some rare plants do occur. Few mammals tolerate the high rate of human activity in the oases, but the lush vegetation provides important feeding and resting sites for many sedentary passerine and migratory birds. Biological diversity data summaries are given for each gouvernorat.

Major Environmental Influences

Although the Tunisian coast is one of the cleaner parts of the Mediterranean sea, untreated sewage and chemically contaminated wastewater are discharged and garbage is dumped into the sea and several salt lakes. Intensive fishing activity and coral harvesting also disrupts many coastal ecosystems.

Some of the most serious environmental impacts are results of dam projects upstream from important wetlands. Two of the most important wetlands in Tunisia, which are also very important on an international level have been drastically affected by dams. A decrease in freshwater inflow has put Lake Ichkeul in danger of a major change in salinity, which would severely reduce its value to waterfowl. Sebket Kelbia now holds water for much shorter periods of time than before the Nebhana dam was built, thus reducing the time period for birds to hatch and fledge.

Forest degradation is occurring at an alarming rate on the mountains, and in many areas esparto grass is being harvested for the paper plant faster than it can regenerate. Overgrazing and fuelwood and fodder collection also reduces the ground cover and accelerates erosion and desertification. With over 18,000 ha lost annually to desertification, this must be considered the prime ecological concern of Tunisia.

Manipulation of water resources for irrigation and domestic use is resulting in the dessication of some oases and dune formation is threatening others. Large areas of steppe have been cultivated, often using equipment such as disc plows in inappropriate areas, which leads to wind erosion and dune formation.

Habitat loss and poaching are seriously threatening much of the national fauna. Chances for recuperation of the monk seal Monachus monachus population are slim, but recent protection efforts have shown encouraging results for gazelles, aoudad, barbary deer and hyena.

Protection

Forestry code law No. 66-60 provides the legal basis for establishing protected reserves and national parks. There are currently 5 national parks, 2 proposed national parks and 9 reserves protecting some of the most important ecosystems of Tunisia. There are also recommendations for the establishment of 19 additional protected areas (IUCN 1987). A goal of the program is to have a national park representing each of the major ecosystems of Tunisia. So far island (Zembra), wetland (Ichkeul), thuya mountain forest (Bou Kornine), aleppo pine mountain forest (Chambi), and arid mountain/pseudo-savanna (Bou Hedma) ecosystems are represented and the next 2 areas under consideration represent oak forest (El Feidja) and desert (Sidi Toui - Hamada) ecosystems.

Most national parks already have management plans with itemized budgets and only need additional staff and finances to implement the plans. Unfortunately, budget problems have reduced national park management to a minimum of protection and little public use is allowed. Designation of a protected area can also be overruled by other interests, as in the case of the Lake Tunis Protected Wetland, which is currently being filled for development.

There are a number of wetlands and mountains protected from hunting, and special zones where grazing is prohibited or only allowed in years of extreme forage shortages. Tunisia is signatory to the World Heritage convention (1975), Ramsar convention (1976) and the Barcelona convention (1977).

Biological Diversity Protection Needs

Additional protection is needed to stem the degradation of biological diversity in Tunisia. To establish a base for flora protection, it would be advisable to inventory the national flora, establish a National herbarium and create a botanic garden. The fauna are in need of protection through the improvement of law enforcement capabilities and control of illegal commerce in wildlife products.

While the intent of the protected area system is well founded and is of great importance for the preservation and enhancement of biological diversity, there is a desperate need for additional funding, trained staff and equipment. The national parks are also in need of improved public access.

Effective pollution control legislation should be passed, enforcement strengthened and the technology and means to comply with the legislation should be made available to the major pollution sources (chemical industries, public sewage and trash systems). Marine ecosystems are in need of increased protection; especially for the coral reefs, monk seals and internationally important Gulf of Gabes intertidal zones.

Ichkeul National Park is in immediate danger of drastic changes in its ecosystems, to the detriment of many species of endangered or vulnerable birds and rare plants. Amelioration projects have been proposed, but funds for implementation are lacking. Sebket Kelbia is also in need of action (water releases from upstream reservoirs) and it would enhance biological diversity to increase protection for the Dar Fatma bog and Oued Essed pools

Increased protection of El Feidja, Djebel Zaghouan and Djebel Ichkeul would be desirable. Tropical forest and mountain habitat could be enhanced by assisting with Bou Korrine National Park.

Anti-desertification projects, such as dune stabilization and reforestation should be increased according to the National Anti-desertification Strategy and in a manner compatible with the natural ecosystems (proper species selection).

PART I

BIOLOGICAL DIVERSITY

1. INTRODUCTION

Tunisia 'the green' was once the breadbasket of the Roman Empire. An amazing diversity of ecosystems and animals existed, including lions, barbary apes, and elephants and savannas similar to those in sub-Saharan Africa. The environment has changed drastically since the Roman era, but there is still a wide range of ecosystems containing diverse fauna and flora.

In this survey, the flora and fauna are be discussed, followed by descriptions of the seven primary ecosystems (coastal zones, islands, wetlands, mountains, steppes, desert and oases) and their biological components, as well as the influences on them. Summary sheets for each gouvernorat are cross-referenced to the sections on ecosystems. The section on biological diversity protection includes agencies invloved, legislation, sites and needs.

The biological diversity of Tunisia evokes mixed responses. It is fascinating when viewed in its entirety, somewhat disheartening when compared to what it once was and encouraging when viewed in light of the results of some recent protection efforts. Unfortunately, for every site protected, many more are threatened, so continued efforts must be made to preserve the precious natural heritage of Tunisia.

2. BACKGROUND INFORMATION ON TUNISIA

2.1. THE COUNTRY

Between Algeria and Libya is Tunisia, the country with the northernmost extension in Africa. The smallest of the Maghreb nations (16 million hectares), Tunisia has a rich cultural and social heritage, as well as a diversity of natural ecosystems. Many empires have played a role in the history of Tunisia, ranging from Phoenicians through the Romans, Byzantines, Arabs and Ottoman Turks, to the French. Unlike the other Maghreb nations, the Arab invasions in Tunisia were so thorough that the original Berber population now only represents 1 % of the total; confined mainly to the mountains in the northwest and the dry southern parts of the country. The total national population in mid-1985 was 7,259,000.

About 35% of Tunisia's labor force is involved in agriculture; growing wheat, barley, olives and citrus fruit (70% of arable land) or raising sheep, goats, cattle and camels. Thus, 25% of Tunisia is cultivated and grazing occurs on most uncultivated and undeveloped land.

2.2. CLIMATE

Due to the varied topography, extensive coastline, long N-S axis and the presence of the Sahara desert, the climatic conditions of Tunisia vary greatly throughout the country. Yearly rainfalls vary from a few millimeters in the south to over 1500 mm in the northern mountains. Rainfall is most abundant in spring and autumn, with the lowest percentage in the summer. Snow falls on many of the higher mountain peaks, but usually melts in a matter of days.

Temperatures vary from below 0° C during winter in the mountains to over 50° in the summer south of Gafsa. However, in most of the country the temperatures are moderated by the Mediterranean Sea. Temperature and precipitation data for locations in each gouvernorat (administrative district) are given in Table 1.

Winds are also affected by the Mediterranean, and daily land breezes and sea breezes occur along most of the coast, as well as frequent stronger winds. An important wind-related climate factor is the occurrence of Sirocco winds, which are hot, dry winds from the Sahara that dessicate vegetation and soils in the summer.

A system of classifying temperature and precipitation data, used widely in the literature on North African biological diversity is that of bioclimates. Bioclimates are based on temperature and precipitation data using Emberger's Quotient, obtained by the following formula:

$$Q = \frac{2000p}{M^2 - m^2}$$

where p = Mean annual precipitation
M = Mean maximum temperature of the hottest month
m = Mean minimum temperature of the coldest month
(temperatures in degrees Kelvin)

Emberger's Quotient is used to assign bioclimate categories in the following manner:

<u>If Q is:</u>	<u>then the bioclimate is:</u>
> 110	Humid (H)
70-100	Subhumid (SH)
45-70	Semi-arid Superior (SAS)
35-45	Semi-arid Inferior (SAI)
25-35	Arid Superior (AS)
12-24	Arid Inferior (AI)
5-11	Saharan Superior (SS)
< 5	Saharan Inferior (SI)

Variants of the above bioclimates are separated according to the average minimum temperatures of the coldest month (in degrees Celsius), as below:

<u>If m is:</u>	<u>then the winter variant is:</u>
> 7	hot
5.5 - 7	mild
3 - 5.5	temperate
0 - 3	cool

Table 1.
Climate and Bioclimate Data for Several Locations in Tunisia

Location	P	T	m	M	B
Beja	626	17	7.3	35.6	SH,t
Jendouba	700-1000	17	3-5	--	SAS,t
Ain Draham	1534	14.9	3.9	31.3	H,t
El Feidja	1110	16	2.6	29.2	H - SH,t
Tabarka	1029	18	7.2	31.4	H,m
Galite	525	--	10.3	28.6	SH - SA
Le Kef	524	16.3	3.3	34	SAS,c
Siliana	410	16.7	3.6	35.1	SAS,t
Maktar	500	14.6	1.7	32.2	SA,c
Bizerte	600-700	18	5-7	--	SH,m
Ichkeul	690	18.4	11.3	25.2	SH,h
Nabeul	400-500	18	> 7	--	SAS,h
Zembra	550-600	18	5	28	SH,t-m
Tunis	450	18	7.3	31.7	SAS,m
Zaghouar	700-1000	15	5	--	SAS-SH,t
Kairouan	290	19	5	36	AS,t
Kasserine	300	16.4	1.9	35	AS,c
Chambi	400	--	2	< 35	AS-SH,c
Sidi Bou Zid	250	19	5	35-40	AS,t
Bou Hedma	200	19.2	4	38	A,c
Mahdia	300	18-19	7	35	SAI,h
Monastir	300	18-19	7	35	SAI,h
Kuriate	300-400	--	7	35	SAI,m
Sousse	300-400	18-19	6	< 35	SAI,m
Enfidaville	371	--	6	32	SAI,m
Sfax	200	19	6.8	30.8	AS,m
Kerkennah	200-300	--	> 7	< 35	SA,h
Gabes	175	19.7	10.9	26.7	AI,h
Matmata	175-200	19.3	5-6	< 35	AI,m
Gafsa	150	19	3.9	38.1	AI,c
Kebili	90	21	3.1	42.2	SS,c
Medenine	100-200	20	6	35	AI,m
Jerba	150-300	19	8.3	30	A,h-m
Douirat	200-300	19	5	35-37	A,t
Bahiret el Bibane	150-200	19	6	35	AS,m
Tataouine	100-150	20	5.5	35-40	AI,t
Remada	50-100	20	5	38	SS,t
Grand Eastern Erg	20-50	21-22	< 3	> 40	SI,c
Tozeur	100	21	< 3	> 40	SS,c

P = Mean annual precipitation (mm)
T = Mean annual Temperature (°C)
m = Mean min. temp. of coldest month (°C)
M = Mean max. temp. of hottest month (°C)
B = Bioclimate
H = Humid
SH = Subhumid
SAS = Semi-arid Superior

SAI = Semi-arid Inferior
AS = Arid Superior
AI = Arid Inferior
SS = Saharan Superior
SI = Saharan Inferior
h = hot winter variant
m = mild winter var.
t = temperate winter var.
c = cool winter var.

2.3. FLORA

The vascular plants of Tunisia represent 115 families, 742 genera and approximately 2200 species. Of the 115 families, 4 are represented by more than 100 species (Nabli 1987):

Asteraceae (254 species)	Graminae (197)
Papilionaceae (216)	Cruciferae (108)

A national total of 2200 species is fairly high compared to the adjacent countries of Algeria (3150 species) and Libya (1800 species), both of which are several times larger in area than Tunisia.

The lack of high mountains in Tunisia has limited the evolution of endemic plants to a total of 34, of which 14 are distinct species (figure 1) and 20 are infraspecific (Nabli 1987). There are several other plants that may be endemic to Tunisia, but insufficient information is known of their range to be certain. The total number of true endemics is not likely to be much over 50, which is considerably less than the number in Algeria and Libya (approximately 250 and 134 endemics, respectively - Heywood 1987).

Of 870 species of plants that are rare, threatened or endemic in North Africa (IUCN 1980), 151 occur in Tunisia. The current local conservation status is unknown for most of them and all have been insufficiently documented for final status designation. At the national level, there are 307 rare and 99 very rare plants (Annex 1). Of those 406 plants, 335 are distinct species (not subspecies or forms), which is 15% of the flora. In Algeria, rare plants constitute 33% of the total. Tunisia's rare flora include 7 species endemic to the country (figure 1) and 81 species endemic to North Africa and the northern Sahara. About 68% of Tunisia's rare plants occur in the north and 32% occur in the center and south.

Figure 1
Plant Species Endemic to Tunisia

v <i>Teucrium radicans</i>	v <i>Linaria paradoxa</i>
r <i>Pancratum foetidum</i>	r <i>L. cossoni</i>
r <i>Sporobolus tourneuxii</i>	r <i>Crepis tunetana</i>
<i>Marrubium aschersonii</i>	<i>Scabiosa farinosa</i>
<i>Plantago tunetana</i>	<i>Silene barrattei</i> (IUCN 1980)
r <i>Lathyrus brachyodus</i>	<i>Rumex tunetanus</i> "
<i>Anarrhinum brevifolium</i>	<i>Paronychia chabloziana</i> "

r = Rare
v = Very Rare

Important factors influencing the rare plants (Nabli 1987) include:

- wetland draining and dam construction, which dessicate or flood important plant habitats;
- herbicides, especially aerial applications; and
- urban expansion.

Although there is a fairly good data base, information on the flora is in need of completion, correction and updating. The two main floras of Tunisia (Cuenod 1954, Pottier-Alapetite 1979) are both incomplete. A complete national inventory is needed to provide comparative information for international cooperation in conservation strategies. At the very least, a complete checklist of the national flora should be prepared (Heywood 1987). The Conservation Monitoring Centre (CMC) of the International Union for the Conservation of Nature (IUCN) can give advice on inventories and the preparation of checklists and they maintain worldwide computerized plant databases, which is helpful in determining endemism, rarity and conservation priorities.

In the process of a national inventory, it would also be desirable to collect specimens and establish a complete national herbarium for proper documentation and to serve as a reference for other research. Herbariums already exist at the agronomy institutes, but they are not complete or easily accessed. Assessments should also be made of the species actual or potential economic value, both for traditional and modern uses. Scattered references on plant uses are available (ex. Le floc'h 1983, Buroillet 1927), but they should be consolidated to provide complete information for determining genetic resource conservation priorities.

2.3.1. Genetic Resources

The term 'genetic resources' is used here to denote plants of actual or potential economic value. This includes, but is not limited to, native crop species, crop relatives, forestry species, forage plants, oil or fiber plants, aromatics and medicinal plants. Forestry species are described in Part II (Tropical Forests). The wide array of traditional uses of many plants is too much to be discussed in total here, so only partial lists are given. Le floc'h (1983) and Buroillet (1927) give more complete lists of current and traditional plant uses.

A. Crop Species and Relatives

Wild olive Olea europaea oleaster is a native tree that is cultivated for its olives or used as root stock, to which better producing varieties are grafted. The wild olive is hardier than domestic varieties and can withstand harsher climatic conditions. It is widespread in northern Tunisia and occurs on many mountains in central Tunisia. In addition to its crop value, wild olives are also grazed by livestock.

Carob Ceratonia siliqua is a tree that has become naturalized in Tunisia. The seed pods can be used to produce a chocolate substitute,

industrial alcohol or wine, and tragasol (locust bean gum). Traditional uses include survival food for the poor, livestock fodder, and tannin production. Tunisia is one of the world's top 8 producers of carob (Merwin 1981). Wild carob is distributed throughout most of non-desert Tunisia, usually scattered in associations of wild olive and Pistacia lentiscus (Olea-lentiscus formations). Carob is also one of the few trees in Tunisia with tropical affinities (see Part II, Tropical Forests).

Wild blackberry Rubus ulmifolius is often grown in gardens for its fruit. It produces well in favorable conditions and wild bushes are sometimes harvested. Wild blackberries are most common along streams and watersheds and can be found in brush fields and hedges in, and north of, the Tunisian Dorsal mountain range.

Wild grape Vitis vinifera ssp. silvestris and subsontaneous domestic grapes Vitis vinifera ssp. sativa occur along streams and in humid ravines in the Kroumirie/Mogod mountains and Cap Bon, or in abandoned gardens. The fruits of the wild grapes are eaten and could be valuable for hybrid crossings.

There are other plants in Tunisia that are not actual crop species, but have edible parts that are collected for consumption by people or livestock. Those species include:

Quercus suber (cork oak): acorns for forage

Q. ilex (holm oak): acorns for forage and human consumption

Arbutus unedo: edible fruits - commercial sales

Crataegus sp. (hawthorn): edible fruits

Pinus halepensis (aleppo pine): edible seeds - commercial sales

B. Aromatic and Medicinal Plants

Many types of plants, or parts of them, are harvested for their aroma, flavor or medicinal properties. Traditional uses cover a wide spectrum and the presence of herbalists at most local markets shows that wild plants are still commonly used.

Some plants, such as jasmine Jasminum fruticans have fragrant flowers that are collected to produce perfumes, or oils that are distilled and sold (Erica sp.). Other plants, including rosemary Rosmarinus officinalis, thyme Thymus sp., oregano Origan sp. and capers Capparis spinosa are used as spices in cooking. In 1984, approximately 58,000 ha of rosemary and 4,500 ha of capers were harvested.

Medicinal uses of plant parts is a well established practice. While modern medicines have replaced many of the traditional remedies, people without the means to buy, or access to, commercial medicines still rely on, and some prefer, medicinal plants. A wide variety of plants are used (figure 2) to cure ailments ranging from headaches, stomach aches and diarrhea to curing infections and easing childbirth. Pharmacists throughout the world have studied the chemical nature of medicinal plants in order to discover new drugs or improve others. In Tunisia, studies

have been made of medicinal plants (Nabli 1987) such as:

Ajuga iva	Urginea maritima
Zygophyllum album	Nerium oleander
Daphne gnidium	

Export of medicinal plants is also a source of foreign exchange. Oil from Myrtus communis is highly valued in some European countries. Each year, branches are cut from thousands of ha (9,000 in 1984) of Myrtus for extraction of oil reputed to help treat rheumatism and other ailments.

C. Fiber Plants

Vegetable fiber is obtained from dwarf palm Chamaerops humilis. In 1975 over 350 metric tons of dwarf palm leaves were harvested at a value of 30,000 Tunisian Dinars. Valuable leaves and somewhat slow regeneration make dwarf palm sensitive to overharvesting. It is a species warranting special attention to ensure its continued abundance.

Esparto grass Stipa tenacissima (also called alfa grass) is a fibrous plant, used traditionally for weaving. A modern use of large quantities of esparto fiber is the production of high quality paper. Paper mills in Kasserine use such great quantities of esparto grass that more than half of the esparto grasslands of Tunisia are exploited. Esparto regenerates fairly well, but overharvesting followed by grazing or cultivation has led to serious degradation of the grasslands in many areas.

D. Forage Plants

Many of Tunisia's grazing lands are degraded and occupied by poor quality forage plants. Some plants, such as Saccharum ravennae and Andropogon sp. are becoming rare due to overgrazing (Nabli 1987). In desertic areas, important sand-fixing species are being decreased with serious consequences to the ecosystem. Pasture improvement and rational grazing strategies are needed throughout Tunisia. Pastures can be improved by improving the water regime and nutrients of an area, and by increasing high quality forage species.

The development of high quality forage plants is a concern of several international organizations and seed companies. Attention has been focused on producing hybrids of several types of highly palatable and nutritional plants. To determine favorable forage plants for cultivation and produce optimum hybrids, a large number of species are being tested and efforts are being made to inventory the geographic distribution and availability of some of the more desirable genera. The International Bureau for the Protection of Genetic Resources is currently conducting such a study on the genus Medicago. Tunisia's flora includes many species of plants in genera of interest, including 24 species of Medicago, 34 species of Trifolium, 6 species of Hedysarum (two of which are of high interest for local propagation) and many subspecies of these and other forage plants (Festuca, Dactylis, etc.).

Many species in Tunisia are of high forage value without hybridization and need only be increased in suitable ecosystems (ex. Hedysarum carnosum). Nabli (1987) suggested the propagation of several species of

Figure 2

Examples of Medicinal Plant Species
(in part from Burrolet 1927, Nabli 1987)

Anthemis sp.	Artemisia sp.
Asphodelis sp.	Ajuga iva
Bryonia dioica	Centaurium sp.
Callitris articulata	Cuppressus sempervirens
Capparis spinosa	Cynomorium coccineum
Daphne gnidium	Echinops bovei
Eruca sativa	E. spinosus
Erica sp.	Euphorbia sp.
Ficus carica	Fumaria sp.
Globularia alypum	Habiscus esculentus
Hyoscyamus albus	Lawsonia alba
Lavandula multifida	Myrtus communis
Nerium oleander	Opuntia ficus-indica
Peganum harmala	Phoenix dactylifera
Pistacia lentiscus	Plantago sp.
Portulaca oleracea	Punica granatum
Reseda alba	Retama raetam
Rosmarinus officinalis	Ruta graveolens
Solanum sodomaeum	Thapsia garganica
Tamarix sp.	Urtica sp.
Urginea maritima	Verbascum sinuatum
Zizyphus vulgaris	Zygophyllum album

forage plants that have become uncommon in Tunisia, such as:

Graminees:	<i>Themeda triandra</i>
	<i>Festuca drymeja</i>
Papilionaceaes:	<i>Bonjeania recta</i>
	<i>Onobrychis argentea africana</i>
	<i>Anthyllis barba-jovis</i>
Cruciferae:	<i>Brassica cretica</i> ssp. <i>atlantica</i>
Ulmaceae:	<i>Celtis australis</i>

2.3.2. Species in Need of Protection

Of the 406 rare and very rare plants in Tunisia, some have been diminished to the point that they merit special protection measures to prevent their disappearance from the country. The preservation of a species in a country requires more than just saving some specimens in gardens or artificial reserves; the characteristic ecosystem and associated plants must also be preserved in an area large enough to ensure genetic viability.

Tree species are somewhat difficult to preserve or expand in Tunisia, due to the great demand for fuelwood and fodder. However, certain species have been reduced to scattered groves and their continued presence in Tunisia is uncertain unless assistance is given.

Acacia raddiana is a highly palatable tree species. During the Roman era the entire south of Tunisia was covered by acacias in the plains, giving it an appearance similar to Sudan or sub-Saharan Africa (P. Boudy in: ORSTOM 1962). By 1889 only 35,000 ha of the acacia pseudo-savanna were left; by 1921 it was reduced to 25,000 ha and only 5,000 ha remained in 1938. Today there are only about 10 ha of truly representative *Acacia raddiana* pseudo-savanna left (Dir. For. 1980), with some scattered trees elsewhere in the region. The trees are now protected on more than 60,000 ha for the slow process of allowing them to become re-established in the region around Bou Hedma called 'Bled Talha'.

Acer monspessulanum is a rare maple tree that grows at the summits of Djebel Zaghouan, Dj. Bargou and Dj. Serdj in the Tunisian Dorsal mountain range. Groves at all 3 sites are relatively small. If cutting were to occur, regeneration would be made difficult by the fact that the young trees are palatable forage. Although probably never widespread in Tunisia, the species merits special protection in its present range.

Cupressus sempervirens numidica, or Maktar cypress, only exists naturally in three small stands in the Kessera massif near Maktar (see Part II, Tropical Forests). Although it is planted widely as a windbreak tree, the three natural stands should be protected.

Quercus afares is a rare oak that once probably grew as a vast forest in Tunisia and Algeria. Of the three remaining groves in Tunisia, the one at El Feidja may be protected as part of a national park (see Section 3.4.1.1, and 5.4), but the grove at Ain Zana is still in need of serious protection.

Two other trees of the Kroumirie mountains that are in need of protection are Juglans regia and Prunus avium (Nabli 1987). Both species are scattered and not easily protected by the creation of special reserves. Therefore, restrictions on cutting and clearing must be strongly enforced.

Nabli (1987) recommended that protection be given to the following:

- Calligonum azel: a Saharan 'tree' in need of protection from grazing and charcoal making;
- Cyclamen persicum: a very rare plant in need of protection from being transplanted into pots;
- Euphorbia dendroides: in need of protection at Djebel Zaghouan;
- Phyllitis dendroides and P. scolopendrium: rare ferns in need of protection from being collected for potting.

2.3.3. Protection Agencies

Conservation of plant resources is the responsibility of the Forestry Directorate and the Directorate of the Environment. The Nature Protection Association and the national Man and Biosphere (MAB) committee also make recommendations for needed actions. Research on plants of genetic value is done and herbariums have been started by the agronomy institutes (INAT, INRAT) and the Genetic Resources Center of the Institute of Scientific Research (INRST). A seed bank at Ariana (Tunis) with a field station at Kairouan is currently maintained for the production and storage of forest and range plant seeds.

Additional protection could be given to rare plants and plants of genetic value by increasing and improving the seed bank and creating a national botanical garden. Improvement of the seed bank is included as part of the National Anti-desertification Strategy (Min. Agr. 1985). Botanical gardens serve as a gene bank, research site and station for introducing plants to cultivation (Heywood 1987). These roles are especially valuable for crop relatives and medicinal plants. The IUCN has a Botanic Gardens Conservation Secretariat based at its CMC at Kew, England. The Secretariat would be helpful and supportive of plans for a botanical garden in Tunisia.

2.4 FAUNA

Currently, about 75 species of mammals (Annex 2), 350 species of birds (Annex 3) and more than 500 species of herpes and fish occur in Tunisia (Dir. For. 1976). Exact figures are difficult to determine, since new species continue to be discovered, others are extirpated or reintroduced, and taxonomic classifications change. A number of species have been lost from the mammalian fauna of Tunisia and several others are in danger.

2.4.1. Mammals

Over 7,000 years ago, a change in the climate of Tunisia resulted in the loss of many species of animals, including rhinoceroes. Since that time almost all extirpations of mammal species have been due to hunting and habitat changes caused by man. Elephants Loxodonta africana still existed during the Roman era and were recorded in the 1st century A.D. (IUCN 1987) at Bled Talah, near Bou Hedma. More recently, in the 1800's, there were still a wide variety of ungulates and large cats. Barbary lions Panthera leo leo lived in the Tunisian Dorsal mountain range in the 1850s (Monchicourt 1906), but the last one was shot at Babouch in 1891 (Dir. For. 1931). Only 34 years later, the last barbary leopard Panthera pardus was killed (IUCN 1987) and by 1931 cheetahs Acinorix jubatus were reduced to a few in the extreme south, which have since been eliminated.

During the French occupation of Tunisia, ungulate populations were decimated by hunters. Although hartebeasts Alcelaphus buselaphus were still abundant in the south in 1870, no verified reports of their presence were recorded after 1931. Scimitar-horned oryx Oryx dammah and addax Addax nasomaculatus were uncommon, but still hunted in the Sahara in 1931. Soon after, both species were decreased to a few animals, then extirpated.

The barbary deer Cervus elaphus barbarus is the only native species of deer in africa. Large numbers of barbary deer were hunted and killed (many by American soldiers during WWII), but their secretive nature and mountain habitat protected small populations until the 1950s. After the deer became protected, they dispersed back into Tunisia from Algeria (where they were still hunted) in the 1960s. There are three barbary deer reserves in Tunisia - El Feidja, Ain Baccouch and Mhibes (see Section 5.4). The total deer population of Tunisia is now somewhere around 1,500.

Tunisia's three species of gazelles were decimated by hunting, poaching and habitat degradation, but were never completely extirpated. Cuvier's gazelles Gazella cuvieri were reduced to a small number at the southwest end of the Tunisian Dorsal mountain range, but once they were protected, additional animals immigrated from Algeria and reinhabited some of their former range. There is a reserve at Kechem el Kelb for Cuvier's gazelles and many others find refuge in Chambi N.P. (Section 3.4.3.1). Dorcas gazelles Gazella dorcas once inhabited the plains of Kairouan, but they are now restricted to the southern plains, where hunting pressure is compounded by habitat loss to desertification. Slender-horned gazelles Gazella leptoceros are able to survive the harsh climatic conditions of

the Sahara and desertic steppes. Although probably never numerous, slender-horned gazelles became quite rare in the recent past. Currently, scattered populations have been increasing in number.

Whether or not buffalo Bubalis bubalis are truly native to Tunisia is uncertain, but doubtful. However, it is believed that there were buffalo at Ichkeul in Carthaginian times and there were about 1,000 in 1882 (El-Ghezal 1982). After uncontrolled hunting, only 3 buffalo remained in 1961. Protection measures were taken and a reproduction program was started at Dar Chichou to increase the herd.

Aoudad Ammotragus lervia (also known as barbary mountain sheep) were once found on almost all of the mountains of south-central Tunisia; especially Djebels Chambi, Selloum, Semmama, Bou Hedma, Berda, Oum Ali and Tebaga (Lavauder 1924). Hunting eliminated the aoudad from many of the mountains, but small groups survived near Chambi, Bou Hedma, Tebaga, etc. and once protection was given, the slow process of reproduction and dispersion began. The recolonization of former range is hampered by hunting and habitat degradation.

If barbary hyena Hyaena hyaena barbara were not completely eliminated from Tunisia in the past, their numbers were reduced to very few animals. Dispersion from hyena populations in Algeria started the population of hyenas in Tunisia increasing. Today, hyenas are spreading north and eastward along the Tunisian Dorsal, High Tell and High Steppe relatively rapidly. The animals are becoming locally numerous, especially in the Kasserine region.

Monk seals Monachus monachus were once found on Tunisia's north coast, Zembra island and Cap Bon (Gaulthier 1978). Today, the only location in Tunisia where that endangered mammal is found is the Galite archipelago (Section 3.2.1). An English expedition in 1978 found only 5 adults and one juvenile at the archipelago (Rosser 1978). Although the secretive nature of the seals may have resulted in an underestimation of the number, it is not likely that there were more than 10 seals at that time. The low number caused concern that there would be an ultimate breeding collapse due to lack of genetic diversity. A decrease in sightings in recent years has added to the concern for the seals. Only one monk seal was observed at Galite in 1986 (IUCN 1987) and it is not likely that the population will recover on its own.

European rabbits Oryctolagus cuniculus originated in North Africa and then spread into West Europe. A North African subspecies O. c. algirus lives on three of Tunisia's archipelagos (Galite, Zembra, Kuriate). It is possible that the rabbits may have been brought to the islands by Phoenicians (Gaulthier 1978) as a food reserve, or they may have crossed land bridges from the mainland when the seas were lower during glacial periods. There are no rabbits on the mainland today, so this North African endemic subspecies is of special interest as a genetic resource.

Other animals of interest include rare otters Lutra lutra, which occur in the lakes and rivers of northern Tunisia; wild boar Sus scrofa barbarus, which are numerous north of the High Steppe and sparse in the southern mountains; and a shrew Suncus etruscus that is said to be the smallest mammal in the world.

All of the large mammals of Tunisia are threatened, with the exception of the wild boar. The boar is a hardy animal that is unwittingly protected by the Islamic prohibition on eating pork. Rare and endangered mammals listed for Tunisia in the IUCN Red Data Book (in: Grant 1980) include the barbary hyena, barbary deer, dorcas gazelle, Cuvier's gazelle and slender-horned gazelle.

Several mammal subspecies are endemic to North Africa; these include rabbits and the larger mammals, such as barbary deer, barbary hyena and (according to some) the Ichkeul buffalo. Full species of mammals endemic to North Africa are all rodents and are noted in Annex 2.

2.4.2. Birds

Tunisia's avian fauna includes North African endemic (Moussier's redstart) and sub-Saharan (black-headed bush shrike) species as well as many that are threatened throughout their range. Rare and endangered birds listed in the Red Data Book (IUCN 1985) that occur in Tunisia include:

White stork	Peregrine
Marbled teal	Audouin's gull
White-headed duck	Red-necked nightjar
Red kite	Houbara bustard
White-tailed sea eagle	Little bustard
Bearded vulture	Slender-billed curlew

Little bustards are listed because they once occurred in northern Tunisia, and still may, but their status is uncertain. Ostriches were extirpated from Tunisia earlier this century, but they have been reintroduced at Bou Hedma National Park (Section 5.4.4). Griffon vultures, bearded vultures and white-tailed sea eagles were hunted in the beginning of the century and are now very rarely seen in Tunisia.

One of the most important sites for migrating raptors and passerine birds is the Cap Bon peninsula. Cap Bon is an internationally important bottleneck area for migratory birds in the Mediterranean region (Grimmet 1987). About 40,000 raptors of over 20 species rest at Cap Bon before crossing the Mediterranean sea to Sicily in the spring. The most common species reported are honey buzzard, black kite, buzzard, marsh harrier, lesser kestrel and kestrel. Many passerines also rest at Cap Bon before making the 150 km flight. Large numbers of sparrowhawks were formerly captured for use in quail hunting, but this practice has been restricted to a very small number today.

Tunisia also has sites of very high international importance for waterfowl and waders. The most important sites are Lake Ichkeul, the Gulf of Gabes and Sebket Kelbia, described in Sections 3.3.1.1, 3.1.4 and 3.3.2.4, respectively.

2.4.3. Hunting

The Hunting Department (Service de la Chasse) of the Forestry Directorate is responsible for the organization of hunting in Tunisia. This involves determining species to be hunted, dates of opening and closing of seasons, locations where hunting is to be allowed and acceptable hunting methods and equipment. The Forestry Directorate is also responsible for the enforcement of hunting regulations. Hunting clubs are organized in each gouvernorat, and many play an important role in promoting wildlife conservation.

In 1983, 11,076 hunting licenses were sold and 590 metric tons of game meat were produced in addition to trophies. This amounted to 1.2 million Tunisian Dinars, or 10% of the total value of forestry related products harvested. The amount has doubled in the following years.

Wild boars are especially popular game with foreign hunters. Other hunted game includes:

Brown hare	Greylag goose	Tufted duck
Algerian hedgehog	Pintail	Moorhen
Barbary partridge	Shoveler	Coot
Quail	Mallard	Woodcock
Sandgrouse	Wigeon	Plovers
Turtle dove	Teal	Lapwing
Stock dove	Garganey	Larks
Wood Pigeon	Pochard	Rock dove

2.4.4. Fauna Protection

Hunting rare and non-game species is prohibited. To conserve the rare and endangered fauna, 32 mammal species and many bird species were submitted for inclusion under the regulations set by the Convention on International Trade of Endangered Species (CITES). There are also many national parks and reserves (Section 5.4) and approximately one-third of the country is closed to hunting each year.

The Forestry Directorate, Directorate of the Environment, Tunisian Nature Protection Association (ATPNE) and the national ornithological association (AAO) are all involved in conservation activities (see Section 5.4). The AAO was especially instrumental in gaining protection for migrating raptors on Cap Bon.

A game warden (garde-chasse) and one or two assistants is assigned to each gouvernorat, but with territories of up to 3,600,000 ha their effectiveness is limited. Additional staff, communication and observation equipment and training are needed.

3. PRIMARY ECOSYSTEMS OF TUNISIA

3.1. COASTAL ZONES

With 1200 km of coastline and a surface area of 164,000 km², Tunisia has one of the highest coastline:surface area ratios in Africa. A marine zone to a depth of 200 meters covers an area of 77,300 km² (Andren 1978). The extensive length of coastline (figure 3) adds significantly to the biological diversity since there is a change in the characteristic flora and fauna of the coastal and marine ecosystems as one progresses from the humid rocky coasts in the north to the shallow sandy coastal areas under the influence of the Sahara in the south.

Coastal waters are influenced by the East and West Mediterranean basins (Ben-Othman 1973). Water in the West Mediterranean basin, which affects the north coast, is often mixed with nutrient rich water from the Atlantic ocean, especially in the winter. The south coast is more affected by the East Mediterranean basin, which has slightly warmer water with a higher salt content.

The East and West basins are actually the deep offshore waters. Shallower waters closer to shore are part of the Sicululo-Tunisian basin or Street of Sicily (Var Dijk 1986), which stretches from Tunisia to Sicily and on to Italy, dividing the East and West Mediterranean basins.

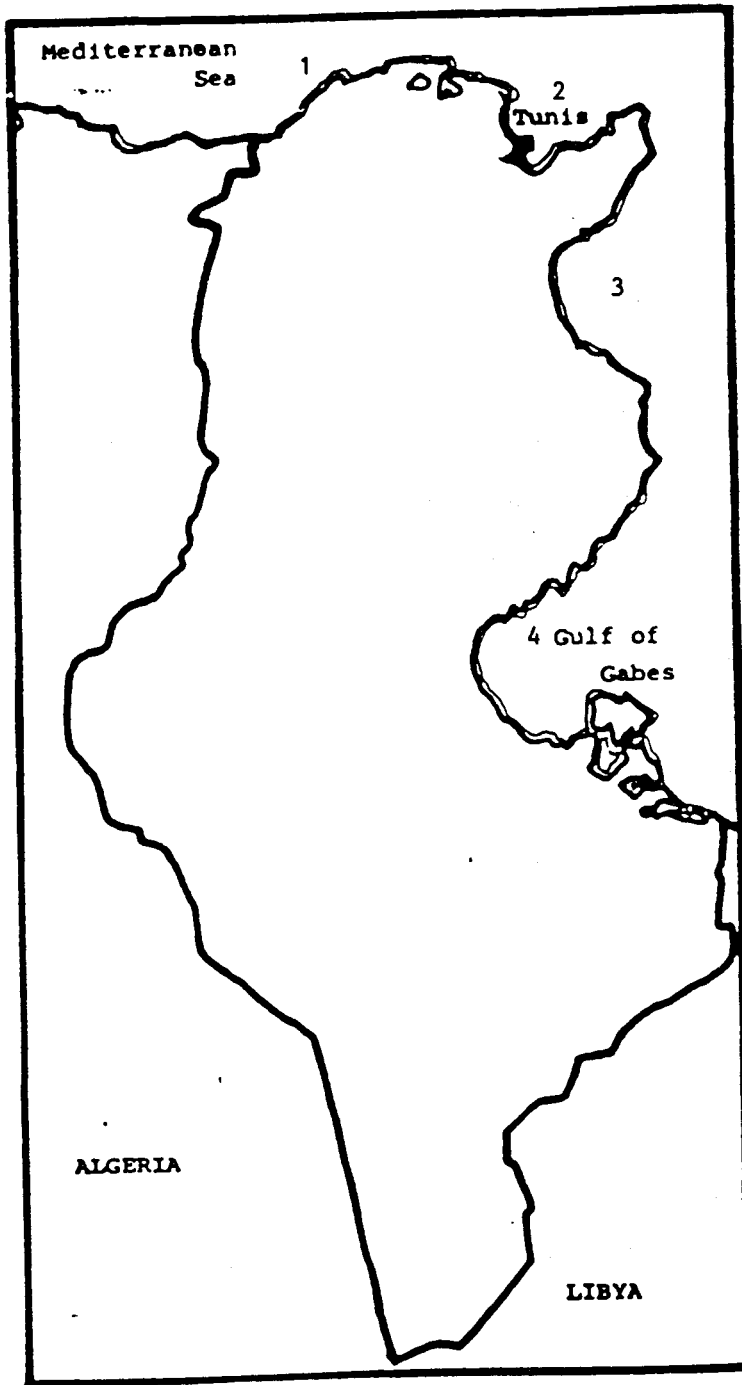
Although Atlantic tides do not penetrate far into the deep waters of the Mediterranean, the weak tides of the current that flows through the Street of Sicily are amplified by the rising seafloor of the Pelagean sea and the Gulf of Gabes (Var Dijk 1986). Therefore, although the steeply sloping sea bottom of the north coast results in negligible tides, the shallow Gulf of Gabes has tidal amplitudes of up to 2 meters.

The Tunisian coast is cleaner than many other parts of the Mediterranean; nevertheless, pollution is a serious problem affecting the marine fauna and flora. Most of Tunisia's industry is located on the coast and anti-pollution regulations are not enforced strongly enough to prevent discharge of chemical wastes into the sea.

In the 1970s, off-shore drilling resulted in an average average of 300,000 tons of oil released into the sea (Andren and Salem 1978). Production has decreased since then, but pollution still occurs. Phosphate plants at Sfax and Gabes release contaminated water in the sea. Some treatment of wastewater is done, but it is inadequate for the amounts produced.

Olive oil and soap processing plants, canneries, cement factories, tanneries, paper plants and chemical industries all release waste products into the sea. Other industries release lubrication oil, solvents, detergents, metallic powders, heavy metals, acid compounds, etc. with their wastewater. Although some industries are improving pollution control practices, industrial expansion along the coast is resulting in increasing total amounts of pollutants. Darmoul et. al. (1980) reported that chemical industrial wastes at Gabes have caused diverse damage to the marine environment.

Figure 3
Coastal Zones
of Tunisia



1. Coral Coast
2. Gulf of Tunis
3. Gulf of Hammamet
4. Gulf of Gabes

Urban wastes (sewage) also alter coastal ecosystems. Virtually all of the major cities discharge at least some untreated sewage into the sea, as well as large quantities of partially treated wastewater. Runoff from agricultural lands carries chemical compounds such as nitrogen fertilizers and over 35 types of pesticides, including: Malathion, Dieldrine, Lindane and 2,4-D (Andren and Salem 1978). Chemical compounds affect the marine flora and fauna and some can be passed on to the birds, wild mammals and people that eat seafood.

In addition to chemical pollution, coastal areas are sensitive to:

Shoreline development

Shoreline degradation:

- Erosion due to grazing, vegetation removal, soil disruption

Human activity in nesting areas

Overharvesting fauna and flora:

- Fishing
- Coral harvesting

3.1.1. Coral Coast

The north coast from Tabarka to Bizerte is also known as the "Coral Coast". The Kroumirie/Mogod mountain ranges give the coastline its characteristic steep slopes, low cliffs and rocky shores, interspersed with sandy beaches and coastal plains. Even where the mountain edges are under the sea, the slopes remain fairly steep. The depth is greater than 100 m within 10 km of the shore along almost the entire coast. The continental shelf is narrow, often with a rough steep slope and cut with deep channels (Azouz 1975).

The Mediterranean sea moderates the ambient temperatures of the coast. Near Tabarka the average annual temperature is at the 16° C isotherm. Progressing east, the average annual temperature increases to the 17° C isotherm near Cap Negro, and at Bizerte the 18° C isotherm is reached. Dominant winds are from the W-NW, bringing moist air in from the sea. Annual precipitation decreases from a rate of > 900 mm annually to 600 mm annually as one progresses eastward along the Coral Coast. Precipitation patterns appear to be related more to the presence of the mountain ranges than to coastal influences.

A. Vegetation

Coastal vegetation types reflect those of the inland forests, but trees are often stunted, resulting in vast coastal maquis. Salt intolerant species, such as aleppo pine Pinus halepensis, are replaced by more tolerant species; however, there is a sizable aleppo pine forest at Ras el Koran, about 15 km west of Bizerte.

Maquis. From Tabarka to Cap Serrat the coastal ridges are often covered with Olea europaea - Pistacia lentiscus (referred to as Olea-lentiscus) dominated maquis with varying densities of holm oak Quercus ilex. Cork oak Q. suber grows better in dryer and warmer conditions, but it is often a component of the maquis, as is zen oak Q. canariensis, which grows in cool ravines down to the sea. Other common woody plants of the coastal maquis are:

<u>Quercus coccifera</u>	<u>Lavandula stoechas</u>
<u>Cistus monspeliensis</u>	<u>Rosmarinus officinalis</u>
<u>Myrtus communis</u>	<u>Calycotome villosa</u>
<u>Erica multiflora</u>	<u>Rhamnus sp.</u>
<u>Arbutus unedo</u>	<u>Juniperus phoenicea</u>
<u>Phillyrea angustifolia media</u>	<u>J. oxycedrus</u>

Dunes. Vast expanses of moving sand dunes have formed along the north coast. Dune formation is a dynamic process whereby large areas are covered with sand, then revegetate and are often covered again over a period of many years. At the mouth of Oued Melah, more than 1000 ha were covered by dunes. The Forestry Directorate stabilized 360 ha, leaving about 800 ha. Vegetated dunes were planted to eucalyptus, acacia, maritime pine Pinus pinaster and other tree species. The undergrowth that invaded naturally is very similar to the maquis vegetation described above, but not quite as dense. Also occurring are:

<u>Retama monosperma</u>	<u>Scrofularia sambucifolia</u>
<u>Ammophila arenaria</u>	<u>Crucianella maritima</u>

On the stabilized dunes of Saouania, west of Ouchtata, the vegetation is characterized by a complete sequence going from A. arenaria to kermes oak Quercus coccifera, with some zones dominated by Lotus creticus, Retama monosperma, Juniperus oxycedrus and J. phoenicea. The site has the largest stands of kermes oak in Tunisia (Radford and Peterken 1969).

Watersheds. Along the ravines and streambeds there are associations characterized by Juncus sp. and oleander Nerium oleander. Where there is running water, cattails Typha angustifolia are often present.

Marshes. At Cap Serrat there are freshwater coastal marshes surrounded by a maquis of Lavandula stoechas, Arbutus unedo and kermes oak. The marsh vegetation includes:

<u>Cladium mariscus</u>	<u>Themeda triandra</u>
<u>Teucrium scopioides</u>	<u>Alnus glutinosa</u>
<u>Carex pseudocyperus</u>	<u>Osmunda regalis</u>
<u>Campanula alata</u>	

and many rare (Radford and Peterken 1969) and North African endemic species, such as Themeda triandra and Gerista ulcina.

Marine Flora. Vegetation on the narrow, uneven continental shelf is influenced by Atlantic surface waters in the winter and Mediterranean waters in the summer (Azouz 1975b). The heterogeneous bottom and the

combination of surface waters produce a very high species diversity along the north coast. Along the coast, and especially in the Galite channel, the flora include Arundo donax and Ricinus communis (IUCN 1987). Red algae species, such as Chondrius crispus are common, as well as a number of green seaweeds (ex. Udotea petiolatas) and Leptometra phalangium is present. Progressing seaward, there are Cridaris funiculina prairies on the high bottoms, which are replaced by Isidella in the middle depths where there are light-soiled bathysal bottoms (Azouz 1975b).

B. Fauna

Mammals. Many of the mammals of the upland forests also range into the coastal maquis and plains. Of special significance is the presence of otter Lutra lutra sign along many of the rivers that drain into the sea. Common mammals include: wild boar Sus Scrofa, jackal Canis aureus, red fox Vulpes vulpes, Egyptian mongoose Herpestes ichneumon and brown hare Lepus capensis. A variety of rodents also live along the coast.

Birds. Although the diversity of shorebirds and waterfowl is not nearly as great as it is in the intertidal flats of the southern coast, the diversity of upland coastal habitats results in a fair species richness for the birds of the Coral Coast. A sample of the bird species includes those listed for the Galite archipelago (Section 3.2.1), and:

Buzzard	Sardinian warbler
Long-legged buzzard	Dartford warbler
Marsh harrier	Nightingale
Barbary partridge	Blackbird
Palm dove	Black-eared wheatear
Bee-eater	Spotted flycatcher
Bulbul	Chaffinch
Great tit	

Marine Fauna. Rich biological diversity is characteristic of the north coastal waters, especially around the Galite archipelago. Red coral Corallium rubrum forms many reefs and there are a variety of molluscs, fish and even spiny lobster Palinurus elaphas. Fish species reported by Gauthier (1978) include:

Pagellus pagellus	Morone labrax
Boops salpa	Labrus bimaculatus
Cornina nigra	Diplodus sargus
Serranus scriba	Mullus surmuletus
Maraena helena	

C. Influences

Grazing is fairly heavy along most of the coast. The effects of the grazing are a shift in species composition to less palatable species, decreased vegetation cover and increased erosion. Grazing animals may also disturb birds during the resting season and limit the effective range of some species of mammals.

In the maquis, Myrtus communis and rosemary Rosmarinus officinalis branches are harvested for the distillation of oils and fragrances. Large quantities of the plants are cut, which alters the species composition and decreases vegetation cover.

Species composition was also altered by reforestation work done by the Forestry Directorate. Large areas have been planted to pine, eucalyptus and acacia. Eucalyptus plantations have an especially significant influence on species composition since allelopathic compounds produced by the trees restrict the growth of other species and often virtually eliminate the lower vegetation strata.

Small agricultural plots are developed along part of the coast - notably at Cap Serrat and Sidi Mechreg. There are also several villages along the coast.

3.1.2. Gulf of Tunis: Bizerte to El Haouaria (Cap Bon)

The coast from Bizerte to Raf Raf (Porto Farina) is a transition from the rocky shores and steep sloping bottoms of the Coral Coast to the shallower waters and higher percentage of sandy beaches in the Gulf of Tunis. From Raf Raf to Solimar the coastline is fairly low and flat with many coastal plains and an estuary at the mouth of Oued Medjerda. At Korbous and again at El Haouaria the shores are steep and rocky due to the extension of the Tunisian Dorsal mountain range through Cap Bon.

Inside a line from Bizerte to El Haouaria the area of the sea deeper than 100 m is relatively small. Salinity in the Gulf of Tunis averages 37 ppt and water temperatures average 17° C (Ber-Othmar 1973). Shallow water and the sheltering effects of the bay formed by the Cap Bon peninsula, greatly affect the physical and biological components of the coast.

Mean annual temperatures from Bizerte to Tunis are slightly higher than 18° C. From Tunis to El Haouaria the mountains of Cap Bon result in a slight drop in average temperatures, but they are still near 18° C. The average annual precipitation rate drops from 600 mm at Bizerte to 500 mm at Raf Raf, then to 400 - 500 mm from Tunis to Korbous. Between Korbous and El Haouaria the annual precipitation is increased by the mountain influence to 500 - 700 mm.

Only one out of five days is calm in Tunis. Dominant winds are from the W-NW, but east winds are also very common and land-sea breezes are regular. The bioclimate is Subhumid, hot winter variant. Only 15 km inland the bioclimate changes to Semi-arid Superior.

A. Vegetation

Much of the upland from Bizerte to Raf Raf is cultivated. There is a large plantation (c.3,000 ha) of mixed tree species bordering over 10 km of coastline between Bizerte and Cap Zebib. At Cap Zebib the mountains meet sea, resulting in areas of rocky, eroded sandstone coastline interspersed among the sandy beaches. Tidal pools with a variety of fauna and flora are common in the rocky areas.

Raf Raf is highly cultivated, except the tip of the point and the higher ridges. On uncultivated land there is a degraded forest of carob Ceratonia siliqua and wild olive Olea europaea oleaster and a spontaneous (unplanted) forest of aleppo pine Pinus halepensis. This is also the only location in Tunisia where the rare Pinus microphylla grows (Radford and Peterken 1979).

South of Ghar el Melh and extending to Cap Gammarth is the Medjerda delta; the only extensive littoral plain in northern Tunisia (Ben-Othman 1973). The littoral plain extends about 10 km inland and reaches almost 20 km inland near Oued Medjerda. Much of the higher land of the Oued Medjerda floodplain has been cultivated. Uncultivated land is vegetated to plants characteristic of halophile associations (see Section 3.3.2), including:

Suaeda sp.	Halocnemum sp.	Arthrocnemum sp.
Cynodon dactylon	Limonium sp.	Atriplex sp.

From Gammarth to Soliman much of the coast is low with sandy shores or there is a sandy fringe where the hills reach the sea. Upland areas were originally vegetated to Olea-lentiscus formations, but now most of the land is cultivated or developed.

Near Soliman, 30 km east of Tunis, is a shallow coastal marsh. About 40 ha of wet marsh are separated from some dry marsh land by a raised dirt road (Morgan 1982). Runoff and ground water supply the marsh with slightly salty water (4-5 g/l). The marsh varies in size from year to year and dries out in exceptionally dry years. Morgan (1982) reported a 40% vegetation cover of Scirpus maritimus and a carpet of Characeae on 90% of the bottom. Other plants include:

Polygonum amphibium	Ranunculus sp.
Phragmites communis	Eleocharis sp.

North of Soliman, at Korbous, the coast is steep and mountainous. Sandstone slopes south of Korbous are covered by open maquis with several species characteristic of hotter southern locations. Dominant and rare species include:

Quercus coccifera	Chamaerops humilis
Olea europaea	Retama monosperma
Pistacia lentiscus	Juniperus phoenecia
Calycotome villosa	Epedra alata
Rosmarinus officinalis	Linaria cossoni (Tunisia endemic)

Along the coast of Cap Bon the climax vegetation species is kermes oak, which usually grows in bush form in various associations depending on the climate and soil (ORSTOM 1962). On the coastal dunes Ammophila arenaria and Imperata cylindrica are associated with:

Cakile maritima	Mathiola tricuspidata
Crucianella maritima	Eryngium maritimum
Pancratum maritimum	

which succeed to:

Lotus creticus	Juniperus oxycedrus
Cutandia divaricata	J. phoenicea

Dunes with calcareous crusts formed by seashell debris are vegetated to:

Thymus capitatus	Helianthemum racemosum
Hypparhenia hirta	Elychrysum stoechas
Asteriscus maritimus	Ebenus pinata
Fumana thymifolia	

Where juniper has stabilized the dunes and enriched the soil with humus, characteristic species are:

Pistacia lentiscus	Smilax aspera
Asparagus acutifolius	Arum italicum
Geranium robertianum ssp purpureum	Prasium majus

Between the dunes, where the water table is closest to the surface, Myrtus communis and hygrophile plants are favored, such as:

Carex divisa	Lotus corniculatus
Galium aparine	Plantago crassifolia

On the windiest parts of the coast grow associations of:

Quercus coccifera	Silene gallica
Halimium halimifolium	Linaria heterophylla
Lavandula stoechas	Brachypodium distachyum
Juniperus phoenicea	Filago gallica
J. oxycedrus	Rosmarinus officinalis
Cistus salviifolius	Thymus capitatus

The coast from Ras el Fartass to El Haouaria is a mosaic of kermes oak or juniper maquis with the previously mentioned associations. Near Sidi Daoud a mixed plantation dominated by aleppo pine stretches from the sea to the other side of the peninsula by Dar Chichou. Olea-lentiscus associations are dominant at the point of Rass el Ahmar and over much of Cap Bon.

Marine Flora. The flora of the infralittoral zone on rocky substratum of the Gulf of Tunis is composed mainly of 3 types of algae (Sname 1977):

Phaeophyceae (brown algae)

Cystoseira stricta	Dictyota dichotoma
C. abrotanifolis	Dilophus fasciola
C. opuntoides	Polysiphona subulifera
Padina pavona	

Chlorophyceae (green algae)

Acetabularia mediterranea	Dasycladus clavaeformis
Anadyomene osellata	Halimeda tuna
Codium bursa	

Rhodophyceae (red algae)

Laurencia obtusa
Peyssonnelia squarimis
P. polymorpha
P. rubia

Phyllophora nervosa
Aglaothamnium tripinnatum
Vidalia volubilis
Crodedia expansa

B. Fauna

Mammals that use the coastal areas in and around the Gulf of Tunis are jackal, fox, kaffir cat Felis sylvestris libyca, Egyptian mongoose and several species of rodents. Birds along the coast are much more varied than the mammals. Waterfowl and waders include:

Grey heron	Avocet	Black-tailed godwit
tr. Marbled teal	Spotted redshank	Herring gull
Mallard	Redshank	Slender-billed gull
n. Coot	Greenshank	Mediterranean gull
n. Moorhen	Kentish plover	Black tern
Glossy ibis	Curlew sandpiper	Little tern
Little egret		

Marine Fauna. Marine fauna that occur around the Zembra archipelago (Srnac 1977) include:

Molluscs:

Aplysia fasciata	Dentalium vulgare	Nassa mutabilis
Arca barbata	D. inaequicostatum	N. limita
Avicula hirundo	Fissurella graeca	N. costulata
Bulla stricta	Fusus syracusanus	N. reticulata
Cardium sp.	F. rostratus	Octopus vulgaris
Cerithium vulgatum	Gibbula cineraria	Ostrea edulis
Chlamys flexuosa	Murex brandiaris	Oxynos olivacea
C. opercularis	M. trunculus	Pecten jacobaeus
Cardita calycula	Natica josephira	Pisaris maculosa
Chlamys vavia	N. millipunctata	Sepia officinalis
Clanculus jusieni	Nucula nucleus	Venerupis aureus

Crustaceans:

Carcinus maeras	Maia verrucosa	Pagurus calidus
Dorippe lanata	Palaemon serviatus	Paguristes oculatus
Idotea hectica	P. squilla	Stichopus regalis
Ilia nucleus		

Echinoderms:

Astropecter johnstoni	Echinaster sepiotus	Ophiura texturata
A. bispinosis	Holothuris sp.	Stylocidaris affinis
Artedon mediterraneum	Hacelia attenuata	

Cnidaria:

Alcyonium acaule	Parcamuricea elavata	Pteroides griseum
A. palmetum	Pennatula phosphorea	Veretillum cynomorium
A. coralloides		

Sponges:

Axinella demicornis
A. verrucosa

Fish:

Boops boops	Hippocampus guttulatus	Scorpaena porcus
Boops salpa	Cristocapo argentatus	S. scrofa
Blennium sp	Labrus sp.	Serranus scriba
Conger conger	Myliobatis aquila	S. cabrilla
Crenilebrus pavo	Murena halena	Sparus aurata
Diplodus annularis	Mullus swimelutus	Solea solea
Dasyatis pastiraca	Mugil sp.	Syngnatus sp.
Dentex dentex	Penaeus kerathurus	Raia sp.
Julius sp.	Pagellus morymus	Torpedo oculata
	Siphonostoma rondelati	Uranoscopus scaber

C. Influences

Most of the coast from Bizerte to El Haouaria has been developed. Residential development near Bizerte and Tunis and tourism development (hotels, restaurants, managed beaches) near the major cities has permanently changed much of the coastal habitat. In addition to continued and increasing construction along the coast, large numbers of residents and tourists produce great quantities of sewage and other waste that often ends up in the sea and on the shore.

Fishing has affected many species in the Gulf of Tunis. Srane (1977) described 3 distinct biotopes in the marine zone of the Zembra archipelago. Each zone contains an abundance of fauna and flora, including some species that have become rare in the rest of the Gulf of Tunis. This rich marine diversity is important in an overfished region and the site is of international importance.

3.1.3. Gulf of Hammamet: El Haouaria to Chebba (Rass Kaboudia)

Although the coastline is fairly rocky and hilly near El Haouaria and Monastir, most of the Gulf of Hammamet is characterized by sandy beaches and flat coastal plains. Dunes frequently form in the littoral cordon, but vast expanses of inland migrating dunes, such as those along the north coast, are not evident.

The littoral cordon of dunes often forms a barrier that slows runoff water from flowing directly into the sea. Backed-up water forms long bands of brackish sebkhet (salt lakes) along the coast. Sebkhet Sidi Khalifa and Sebkhet Halk el Merzel stretch for 37 km, from Bou Ficha to Sidi Bou Ali, along the inland side of the littoral dunes.

South of El Haouaria, the coastline is perpendicular to the predominant westerly and easterly winds. The West Mediterranean influence in the Sicululo-Tunisian basin decreases in the Gulf of Hammamet and influences of the Sicilian High Basin and the East Mediterranean increase (Ben-Othman 1973). Proceeding south from Cap Bon, the water becomes warmer and shallower. At the mid-point of the Gulf of Hammamet coast, near Enfida, the water is less than 100 m deep for over 65 km from shore.

Mean annual temperatures along this section of coast are slightly higher than 18° C. Mean annual precipitation north of Menzel Temime, on Cap Bon, is about 500 mm. From Menzel Temime to Enfida annual rainfall averages 400 - 500 mm; between Enfida and Mahdia the rate decreases to 300 - 400 mm and south of Mahdia it is less than 300 mm. The bioclimate is Semi-arid Superior from Kelibia to Nabeul, with winter variants of hot to mild. At Hammamet the bioclimate is Semi-arid, hot winter variant, and south of enfida the bioclimate is Semi-arid Inferior, mild winter variant.

A. Vegetation

Vegetation associations south of El Haouaria are not as diverse as those to the north. From El Haouaria to Dar Chichou the climax vegetation type is kermes oak (see Section 3.1.2). South of the oak maquis the climax vegetation is *Olea-lentiscus* formations until Hammamet, then thuya *Callitris articulata* until Enfida, followed by the Low Steppes. Most of the vegetation is not at the climax stage and many of the associations currently found on this section of the coast are characterized by:

Artemisia herba alba
Asarum vulgare
Stipa parviflora (sub-association)
Solanum sodomaeum (variant)

with many types of mosaics indicated by:

Zizyphus lotus

and	<i>Helianthemum lippii</i> <i>H. racemosum</i> <i>Lygeum spartum</i> <i>Phlomis floccosa</i>	<i>Echiochilon fruticosum</i> <i>Atractylis serratuloides</i> <i>Lavandula multifida</i>
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or	<i>Cynodon</i>	<i>Artemisia campestris</i>
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Another association is indicated by:

<i>Corynephorus articulatus</i>	<i>Lupinus hirsutus</i>
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and there is a vegetation group indicated by:

<i>Spergula diandra</i> <i>Scolymus hispanicus</i>	<i>Solanum sodomaeum</i>
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A common association along the Gulf of Hammamet and the Gulf of Gabes is the littoral sand group indicated by:

<i>Ammophila arenaria</i> <i>Agropyrum junceum</i>	<i>Cakile maritima</i> <i>Medicago marina</i>
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Two important associations that occur along the entire coast and in the steppes are found on saline soils, especially around sebkhetts. The first association consists of slightly to moderately halophile plants, including several species each of

<i>Suaeda</i> <i>Salsola</i>	<i>Frankenia</i> <i>Limonium</i>	<i>Atriplex</i>
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and the second association is composed of moderately to strongly halophile species, including

Salicornia (several sp)	Halocnemum strobilaceum
Arthrocnemum indicum	Halopeplis amplexicaulis

Marine Flora. The marine flora of the Gulf of Hammamet is characterized by some of the same algae species as are found in the Gulf of Tunis (Section 3.1.2), but the overall species composition is closer to that of the Gulf of Gabes (Section 3.1.4).

B. Fauna

Mammals. Jackals, red fox and Egyptian mongoose prey on brown hare Algerian hedgehogs Erinaceus algirus and small rodents, such as jerboa Jaculus orientalis and the North African endemics Shaw's jird Meriones shawi and gerbil Gerbillus campestris (Bernard 1969). At Cap Bon wild boars occasionally venture from the hills into coastal areas, but it is not their primary habitat.

Birds. During migration periods thousands of shorebirds rest on the shores and in the sebkhet along the Gulf of Hammamet. Most of the species that visit the rest of the Tunisian coast also stop between El Haouaria and Rass Kaboudia. During the summer, the number of birds and species is greatly reduced; however, in July of 1987 the following species were common or were beginning to arrive in the area:

Gannet	Temminck's stint	Mediterranean gull
Grey heron	Little ringed plover	Caspian tern
Little egret	Common sandpiper	Little tern
Flamingo	Curlew sandpiper	Black tern
Shelduck	Spotted redshank	Palm dove
Oystercatcher	Redshank	Hoopoe
Avocet	Greenshank	Collared pratincole
Black-winged stilt	Black-tailed godwit	Swallow
Ringed plover	Slender-billed gull	Great grey shrike
Kentish plover	Little gull	Fan-tailed warbler
Little stint	Herring gull	

C. Influences

Thousands of people go to the beaches daily during the summer; especially near Nabeul, Hammamet and Sousse. Large areas of coastline have been developed for tourism (hotels, managed beaches) and other areas have been degraded by heavy pedestrian and vehicle traffic. Hunting and poaching occurs in the coastal sebkhet and cultivation has broken up many of the halophile zones. The Gulf of Hammamet is fished by individual and commercial operators. Overfishing and pollution are affecting the size, quantity and quality of the catch.

3.1.4. Gulf of Gabes: Rass Kaboudia to the Libyan border

The majority of the coastline south of Rass Kaboudia forms the Gulf of Gabes. The coastline of the gulf consists of narrow, shallow, muddy intertidal flats or sandy beaches. From Ras Kaboudia to approximately 5 km south, near Amra (Kriba), the shoreline is steep enough to prevent large areas from being exposed during low tides. The shoreline soon levels out and most of the rest of the coastline to Jerba (except 25 km near Gabes, parts of Garaet bou Grara, El Kantra to Zarzis and Rass Adjir) is typified by intertidal flats. Large expanses occupy more than 25,000 ha, of which c.14,600 ha is situated at Kneiss (Van Dijk 1986).

Dunes cover much of the shore inland of the intertidal flats and beaches, except at the gypsous cliffs of Tar-el-Jorf and Bou Grara and the calcareous cliffs of Ras Maamour to Zarzis (Ben-Othman 1973). Inside the littoral dunes, long narrow sebkhet often form, such as sebkhet Dreiaa, south of Skhira.

Flat coastal plains subside very gradually into the sea. At some points the water is less than 50 m deep for more than 100 km from shore, and at no point is the water over 100 m deep within 100 km from shore. The flat shelf is so extensive that the -200 m isobathe is 250 km from shore (Ben-Othman 1973). The shallow water amplifies the weak tidal influences of the Atlantic ocean and results in tidal amplitudes of up to 2 m in the Gulf of Gabes (Van Dijk 1986). Surface currents consist of water with a constant temperature (14 - 15° C) and relatively low salinity (37.3 - 37.9 ppm) throughout the year (Van Dijk 1986). Near the shore, the shallower waters are usually warmer (c.19.5° C) and saltier (38 ppm).

The subtropical Saharan influence is much stronger at the Gulf of Gabes than along the coast to the north. Temperatures remain mostly between 20 - 30° C from May to August and the average yearly precipitation is less than 200 mm, most of which falls between September and March. Sirocco winds occur about 35 days per summer, and rapidly dessicates the vegetation. Bioclimates range from Semi-arid Inferior by Rass Kaboudia, to Arid Superior by Sfax and Arid Inferior south of Sfax. Due to the sea, bioclimates are all of the mild winter variant.

A. Vegetation

Lowland halophile vegetation and vegetation found on littoral sands are similar to that of corresponding areas north of Rass Kaboudia (see Section 3.1.3B). However, the vegetation found on higher, less saline ground differs significantly from that on the coast to the north. There are essentially no forest or maquis associations along this section of coast, but there are some oasis (see Section 3.7). Climax vegetation types are those characteristic of secondary steppes of low plains and Subdesertic Littoral Steppes. The actual associations present are those typical of degraded lands (Le Houerou and Froment 1969).

North of Sfax the vegetation associations are usually dominated by halophile groups and:

Artemisia herba alba	Zizyphus lotus (sub/assn.)
Asparagus albus	Atractylis serratuloides "

or a group of

Trigonella anguina	Solanum sodomaeum (variant)
Lygeum spartum	

South of Sfax the halophile groups are interspersed with associations of:

Pituranthos tortuosa	Erodium glaucophyllum (s/a)
Halophyllum vermicularire	

and

Rhantherium suaveolens	Lygeum spartum (s/a)
Artemisia campestris	Atractylis serratuloides "

South of Kneiss the vegetation is joined by an association of:

Zygophyllum album	Anarrhinum brevifolium
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and a gypso-halophilo association of:

Nitraria retusa
Suaeda vermiculata
Salsola sieberi var. vesceritensis

On the Zarzis peninsula is an association of

Artemisia herba alba	Gymnocarpos decander (sub.)
Arthrophytum scoparium	

Intertidal mudflats are often covered by dense Zostera nolti (Van Dijk 1986), and near Mahares sea lettuce Ulva sp. grows on the sea bottom. Close to the shore at Kneiss, Spartina sp. and Halocnemum strobilaceum grow. Where inundation is less frequent and of shorter duration Halimone portulacoides, Limonium cf. duriaei, Limoniastrum monopetalum and Suaeda sp. appear. On the shore and small dunes Arthrocnemum cf. fruticosum, A. perene, Zygophyllum album, Thymelaea hirsuta and Haloxylon articulatum replace the more salt tolerant species.

Marine Flora. Near Kerkennah island at the north end of the Gulf of Gabes, Posidonea oceanica comprises 95% of the marine fauna at depths less than 30 m. Between 30 - 45 m depth, Canlerpa sp. and Vidalia volubilis (green algae) dominate. At depths greater than 50 m, the red calcareous algae Lithophyllum racemus is found (Najai and Zaarah 1981).

B. Fauna

Mammals. Although there is a diversity of vegetation types along the coast, the most common associations are of halophile species. Halophile associations provide adequate cover for small to mid-sized mammals, such as jerboa Jaculus orientalis, gerbil Gerbillus campestris, sand rat Psammomys obesus, Shaw's jird, brown hare, Algerian hedgehog and the Egyptian mongoose, red fox and jackals that prey on them. Upland areas also harbor many of the above mammals, but cultivation, overgrazing and other forms of disturbance limit the habitat value.

Birds. Van Dijk (1986) reported that "it would appear that the Gulf of Gabes is the major area in the Mediterranean for wintering waders and some waterfowl species". This conclusion was based on counts made of wintering waterfowl and waders over 380 km of shoreline (76% of the Gulf of Gabes total) in January - March 1984.

The Gulf of Gabes is the most important wintering area in the Mediterranean for cormorants and spoonbills. At least 3 threatened species also occur there. Nineteen wader and waterfowl species were determined to winter in the Gulf of Gabes in numbers greater than 1% of their total flyway or biogeographical populations. Those species are noted in the list of Gulf of Gabes bird species (figure 4).

Marine Fauna. The monotony of sediments, the homogeneity, and the absence of rocky substrates in the gulf results in a vast extension and low diversity of marine fauna (Azouz 1975). Dominant species of the southeast coast are:

Geodea sp.	Pinctada albida (not found to the north)
Spatangus purpureus	Hacelia attenuata (sub-tropical)
	Centrostephanus longispinus "

Although species diversity is low, production is very high. Almost all of the sponges, 75% of the shrimp and 60% of the benthic fish harvested in Tunisia come from the Gulf of Gabes (Ben-Othman 1973). Extensive lists of harvested fish species are given by Ben-Othman (1973) and Najai and Zaarah (1981).

A total of 500 mollusc species have been reported for the Gulf of Gabes (Rosso 1979, Seurat 1924 and 1929, as cited in Van Dijk 1986); however, only a few species are important in terms of biomass and density. Average dry weight per square meter of macrobenthos fauna from the intertidal flats near Kneiss island is 26.0 grams (Van Dijk 1986). The taxonomic groups represented in that weight are: Gastropodia (49%), Bivalvia (30%), Polychaeta (10%), Crustacea (10%) and other groups only comprised 1% of

the total. The most common species found are:

Lepidochitona cinerea	Solen marginatus
Bittium sp.	Marphysa sanguinea
Gourmya vulgata	Drilonereis filum
Trunculariopsis trunculus	Perinereis cultrifera
Nassariidae	Natantia
Pinctada radiata	Maldanidae
Loripes lacteus	Callianassa sp.
Cerastoderma edule	Brachyura
Venerupis decussa	Isopoda
V. aurea	Amphipoda
Scrobicularia cottarde	Ophiuroidea
Gastrana fragilis	Dasybrachus sp.
Penaeus keranturus	Holothuroidea

C. Influences

As with the coastline to the north, much of the Gulf of Gabes coastline is cultivated, grazed or developed. Hunting and poaching occur and the gulf is the primary source of fish, shrimp and sponges harvested in Tunisia. The most sensitive locations are the intertidal flats, which are internationally important for migrating waterfowl and waders. The soft bottom protects many of the intertidal flats from frequent disturbance and development.

Figure 4

Birds of the Gulf of Gabes

Little grebe	• Curlew sandpiper	Kingfisher
Great crested grebe	• Dunlin	Hoopoe
Black-necked grebe	Ruff	Short-toed lark
Cory's shearwater	Broad-billed sandpiper	Lesser s-toed lark
Gannet	Black-tailed godwit	Skylark
• Cormorant	Bar-tailed godwit	Crested lark
Squacco heron	Whimbrel	Swallow
n* Little egret	t Slender-billed curlew	House martin
Great white egret	• Curlew	Meadow pipit
Grey heron	Spotted redshank	Red-throated pipit
Glossy ibis	n* Redshank	Water pipit
t* White stork	• Greenshank	White wagtail
Spoonbill	Marsh sandpiper	Grey wagtail
• Greater flamingo	Wood sandpiper	Robin
n* Shelduck	Common sandpiper	Black redstart
• Wigeon	• Turnstone	Moussier's redstart
Pintail	Red-necked phalarope	Stonechat
Garganey	Pomarine skua	Isabelline wheatear
Shoveler	Arctic skua	Wheatear
Marsh harrier	Great skua	Red-rumped wheatear
Hen harrier	• Mediterranean gull	Mourning wheatear
Buzzard	Little gull	Blackbird
Long-legged buzzard	Black-headed gull	Song thrush
Golden eagle	n* Slender-billed gull	Rufous bushchat
Osprey	Common gull	Reed warbler
Kestrel	Lesser black back	Fan-tailed warbler
Merlin	Herring gull	Marmora's warbler
Lanner falcon	Great black backed gull	Spectacled warbler
t Peregrine	Kittiwake	Sardinian warbler
Barbary partridge	Gull-billed tern	Chiffchaff
Coot	• Caspian tern	Fulvous babbler
• Crane	Lesser-crested tern	Great grey shrike
Oystercatcher	Sandwich tern	Corn bunting
Black-winged stilt	n Common tern	Reed bunting
n* Avocet	n Little tern	Trumpeter finch
Stone curlew	n Black tern	Linnet
Little ringed plover	White-winged black tern	Goldfinch
Ringed plover	Whiskered tern	Greenfinch
• Little stint	Green sandpiper	Raven
• Kentish plover	Rock dove	Serin
Dotterel	Palm dove	Chaffinch
Golden plover	Little owl	Starling
* Grey plover	Short-eared owl	Spotless starling
Knot	Swift or pallid swift	Spanish sparrow
Sanderling	White-rumped swift	

n = nesting birds

t = threatened species

• = > 1% of population of flyway or biogeographical region

3.2. ISLANDS

Eight major island archipelagos are distributed along the coast of Tunisia (figure 5). There are also many smaller islands, some of which are mere rocks jutting from the water and some large enough to support a bit of vegetation, but not large enough to be considered important in terms of national biological diversity. The two largest islands, Kerkennah and Jerba, are both in the south. The islands are separated by distances of 26 to 135 km, but none are more than 50 km from the mainland.

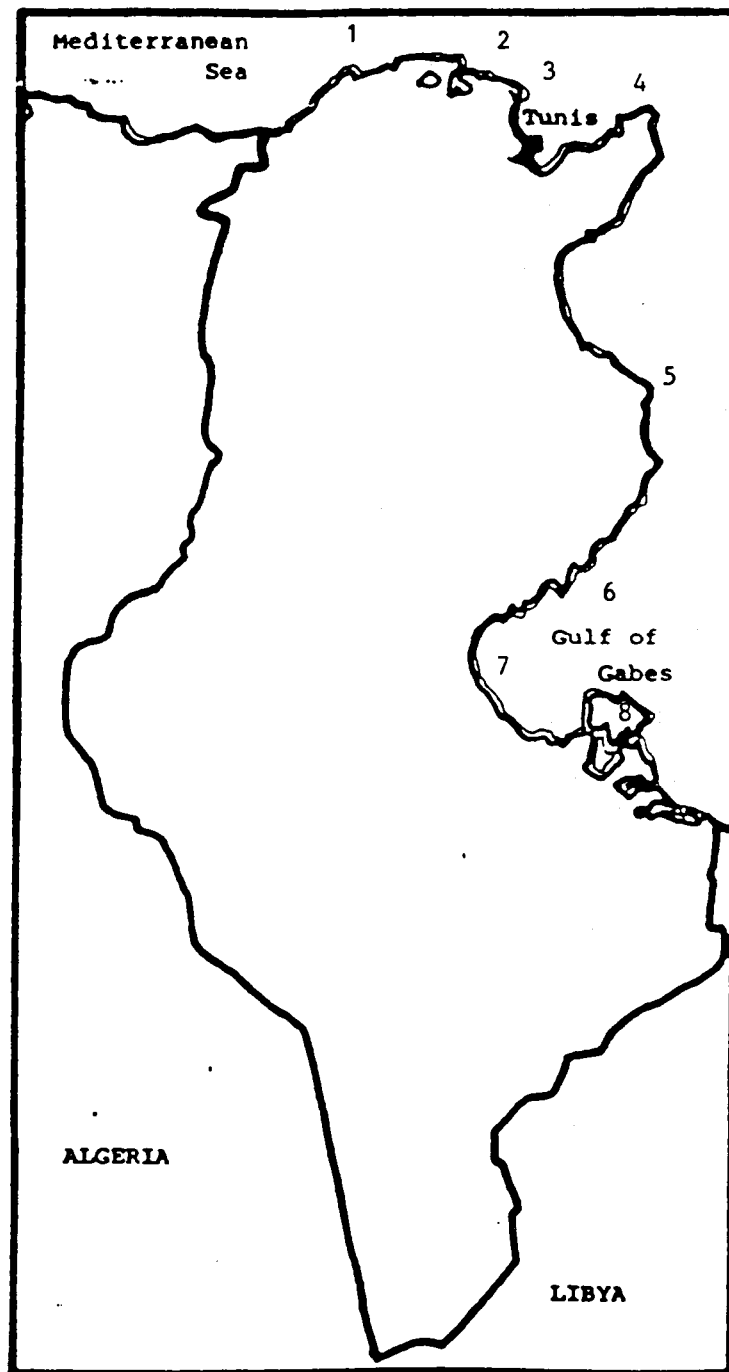
Species composition in vegetation associations on islands are affected by a factor known as insularity. Gene pools are restricted primarily to plants present on the islands with a minimum of invasion by wind borne and floating seeds. Without the frequent dispersion of seeds between areas, as is common on the mainland, species are more easily eliminated from an island. Therefore, there are usually fewer total species on islands and rare species merit special attention.

The combination of the insularity factor, thin soils and on southern islands the relatively low annual precipitation makes island flora and fauna quite sensitive to influences on the ecosystem. Grazing is already so intense on most islands that it is undoubtedly drastically affecting species composition. An increase in livestock numbers, cultivated land or urban areas could result in fewer native species of flora able to occupy the limited space.

Development projects often upset the soil stability of islands, resulting in sand dune formation or the loss of land by erosion. Pollution is also a serious concern that should be assessed in regard to development plans for the islands. The water around Kuriate, Kerkennah and Jerba are already affected by the large amounts of industrial and urban pollution issuing from coastal cities (Section 3.1). Increased pollution in the shallow waters would not only be detrimental to marine fauna and flora and shorebirds, but the local harvest of fish and other seafood would have higher levels of contaminants, thus affecting human health and welfare.

Population growth and increasing tourism will also increase demands on the islands' resources. Fresh water is an especially valuable resource, and as use increases the groundwater may be overexploited. If groundwater use is not properly regulated it may be pumped faster than it is replenished by freshwater, thus lowering the water table and allowing seawater to infiltrate, causing an irreversible increase in salinity (and in pollutants from the sea). A lowered water table would also affect vegetation communities that exist in areas where the groundwater is currently near the surface.

Figure 5
Locations of Islands
of Tunisia



1. Galite
2. Cani
3. Plane
4. Zembra
5. Kuriate
6. Kerkennah
7. Kneiss
8. Jerba

To summarize, the general factors to which the island ecosystems are sensitive include:

Erosion causing activities:

Vegetation removal - especially on steep slopes
Disturbance of surface soil
Shoreline degradation - especially on the smaller islands

Activities that reduce flora and fauna species and numbers:

Water pollution
Water exploitation (i.e. over-exploitation)
Human activity - especially during the nesting season
Egg collection or destruction
Erosion above nesting ledges - destroys nests and birds
Animal species over-population - can damage vegetation
Under-population - gene pools below critical levels
Poaching
Coral collecting (Galite)

3.2.1. Galite

The Galite archipelago is 40 km from the north coast of Tunisia, 45 km northwest of Cap Serrat and 64 km northeast of Tabarka. The archipelago is dominated by the "T" shaped main island of Galite, which is 5.4 km long and c.950 m across at the narrowest point and 2.5 km at the widest part of the "T". The planimetric surface area of the island is 650 ha, which is in reality increased by the sloping topography, culminating at 391 m ASL.

About 2.5 km to the southwest of Galite is the islet of la Fauchelle, 14 ha in area and fairly low in altitude. The islet of Galiton is only 50 meters to the west of la Fauchelle, has an area of 27 ha and is topped by a lighthouse. A trio of small islets, the Isles de Chiens ("Dog Islands") lie 1.6 km north of Galite, the largest of which is less than 9 ha, but has an altitude of 119 m (Gauthier 1978). Thus the total planimetric land area of the archipelago is about 700 ha.

The Galite archipelago is the only granitic formation in Tunisia (IUCN 1987). Soils are thin, of granitic origin, and some of the smaller islets and parts of the larger ones are scoured by the wind and waves to the point that there is little soil or vegetation cover. On the main island there are some valleys and plateaus with deep soils, and in many locations the soil is thick enough to have been cultivated to vineyards and gardens.

Caves with above water or underwater entrances have been carved into many places by the action of the sea (Rosser 1978). Relatively shallow water (compared to the rest of the "Coral Coast") with a rocky bottom surrounds the islands. Around the archipelago the water depth is scarcely over 100 m (Gauthier 1978) and it is much less between the islets.

A. Vegetation

Much of Galite is covered by "diss" Ampelodesma tenax, a low grass that is sometimes very dense on hills. Some valleys on the northwest side support shrubs so dense that they are impenetrable (Gauthier 1978). Those maquis are of the Olea-lentiscus type, with some Tamarix and Laurus mixed in.

The gentler slopes of the islets of Galiton and la Fauchelle also support short and scrubby Olea-lentiscus formations, but the main vegetation is diss. Two of the three Isles de Chiens are very weather beaten and produce very little vegetation, but that which does occur is mainly grasses and annual herbs.

Dominant species of the archipelago include:

<u>Ampelodesma tenax</u>	<u>Cistus</u> sp.
<u>Pistacia lentiscus</u>	<u>Rosmarinus officinalis</u>
<u>Olea europaea</u>	<u>Scilla maritima</u>
<u>Tamarix africana</u>	<u>Cynara scolymus</u>
<u>Laurus nobilis</u>	

B. Fauna

Mammals. In 1986 only one monk seal Monachus monachus was observed at Galite (IUCN 1987), which seems to indicate a decrease in numbers as well as a stronger tendency to rest inside caves with underwater entrances instead of on beaches. Reasons for the change in behavior are probably related to increased human activity in the area (especially recreational activity) and it is essential to the conservation of the monk seal population that disturbance be reduced to the minimum level possible (Rosser 1978).

The North African subspecies of the European rabbit (Oryctolagus cuniculus) is found on Galite, Galiton and la Fauchelle (Sname 1977). The rabbits originated in North Africa and may have crossed to Galite when the archipelago was connected to the mainland by a land bridge during the Riss-glacial sea regression (IUCN 1987) or they may have been introduced during the Punic epoch as a food reserve (Gauthier 1978). Current residents make use of that food reserve, and although rabbits are usually abundant on Galiton and la Fauchelle, fishermen have hunted so frequently on Galite that they have almost eliminated the rabbits in the past. Bats Pipistrellis sp. are common on the islands and common dolphins Delphinus delphis are frequently seen offshore.

Birds. A breeding colony of 60 - 70 pairs of endangered Eleonora's falcons Falco eleonora nests on one of the islets (Gauthier 1978). The world population of Eleonora's falcon is less than 4000, so the 3% found on the Galite archipelago are of high international importance.

Audouin's gulls Larus audouinii are the rarest breeding gull of the Europe and North Africa region (Heinzel et.al. 1979). They only breed on rocky islands in the Mediterranean sea and there are reports of a small breeding colony at Galite (Gauthier 1978). This species is in serious danger of extinction and any breeding colony is of international significance.

Nesting birds at the Galite archipelago include:

Shag	Blue rock thrush
Cory's shearwater	Spanish sparrow
Storm petrel	Rock dove
t Eleonora's falcon	Woodchat shrike
t Peregrine	Sardinian warbler melan.
Kestrel	Dartford warbler
Herring gull	Marmora's warbler
t Audouin's gull	Goldfinch

t = Threatened Species

Non-nesting birds include:

Grey heron	Hoopoe
Booted eagle	Wood pipit
Common sandpiper	Grey wagtail
Turtle dove	Icterine warbler
Barn owl	Whitethroat
Swift	Wood warbler
	Wheatear

Herpetofauna. The rich herpetofauna is Atlanto-mediterranean in origin (IUCN 1987), and the most abundant are lacertids and Scincids:

Scincus sp.
 Terentola sp.
 Testudo graeca
 Caretta caretta

C. Influences

There is a small village of fishermen on Galite. About 10 families (approximately 35 people) were permanent residents on the island in 1978, and in prime lobster season the population was augmented by an additional 18 families, raising the population to c.158 people. In addition to the houses of the villagers, a primary school and a military base (with about 40 people) have been established on Galite. Galite is occupied by a lighthouse and its attendants.

The activities of the fishermen are having a profound influence on some of the rare fauna of the area. To protect the fish populations, some fishermen seek to eliminate natural predators, including the rare marine tortoise Thalassochelys corticata, which sometimes become entangled in fish nets. Monk seals are killed because they eat fish and sometimes damage nets.

During the nesting season it is common for fishermen to collect eggs from colonies of Cory's shearwaters and herring gulls to supplement their diets. This activity has had a profound effect on the Cory's shearwater population. In the past, eggs and chicks were gathered from Eleonora's falcon nests to supply falconers. Garbage dumping, sewage outflows and village expansion are other human influences on the island ecosystems.

Recreational activity also influences the fauna of the archipelago. For 5-6 months of the year, yachts anchor in the waters of Galite and passengers engage in SCUBA diving and spear fishing. Not only does this activity affect the fish and coral formations, it also disturbs monk seals and nesting birds. Prolonged visits to the shore during the nesting season can result in serious losses of eggs due to insolation.

Feral goats, sheep and cows are affecting the vegetation composition and successional stages of Galite. Other introduced mammals are affecting the fauna of the islands. Rats Rattus norvegicus are found on all of the islets and commonly raid the nests of Cory's shearwaters and gulls. Rats are abundant, or overabundant, even though they are preyed upon by cats on Galite and raptors throughout the archipelago. Feral cats also prey on nesting birds and their young.

Rabbits are so overabundant in some locations that they have taken over all of the secluded niches where Cory's shearwaters traditionally nested (Gauthier 1978). When the birds are forced to use less favorable locations for nesting they become much more vulnerable to cats and rats. Rabbits dig burrows in many of the more favorable locations of the islands. Those diggings are sometimes detrimental to the vegetation, which is aggravated by the feeding activity of the abundant animals.

Galiton islet was designated a strict nature reserve on 4 July 1980. The reserve includes the islet and a 0.5 sea mile radius as an integral nature reserve; therefore, it also includes la Fauchelle islet. Galite is of international importance because of the endangered Mediterranean monk seals and the nesting colonies of Audouin's gulls, Eleonora's falcons and Cory's shearwaters. In spite of the terrestrial and marine fauna and island habitat, which is at least of national importance, there is little active management at the present time (IUCN 1987).

3.2.2. Zembra and Zembretta Islands

The Zembra archipelago is located in the Gulf of Tunis near the northern tip of Cap Bon. At the closest point, the islands are 11 km northwest of the mainland. Zembra, the largest island of the archipelago, has an area of 370 ha. On the southeast side of Zembra is Zembretta, a much smaller island of 5 ha. There are also two tiny islets - the Cathedral and Lantouche, which are not much more than rock formations jutting out of the sea, 60 m and 400 m from Zembra, respectively.

Zembra is a prismatic shaped mountainous island (Snare 1977), with a maximum altitude of 435 m. There are steep cliffs around the island, rising up to 200 m high on the north side, making access difficult. At the base of the cliffs and along the rest of the 12 km shoreline there are

many caves and coves. Zembretta is also prismatic in shape and difficult to access. The 1.2 km of shoreline rises to cliffs on the northwest side and there is a lighthouse at the highest point of the island (53 m).

There are 4 seasonal rivers on Zembra - Oued of the Harbor, Oued Zitoun, Oued Callefroda and Oued el Kebir - that drain watersheds of 25 to 100 ha. The only permanent spring is Ain Kabbar. Thin, soils originate from substrates that are a continuation of strata found on Cap Bon: alternating layers of sandy limestone and clays from the oligocene and miocene eras (IUCN 1987). There are also eocene deposits rich in marine fossils.

Violent winter winds affect the island vegetation by blowing salty spray onto the land. Water salinity at the surface is 37 ppt. In June the surface water temperature averages 15°C (IUCN 1987). The islands have a Sub-humid bioclimate with a warm winter variant in the lowlands and a mild winter variant in the highlands.

A. Vegetation

Species diversity is poorer on Zembra than it is at mainland sites with similar climate and soil conditions (Sname 1977); probably due to the insularity factor. In 1953 there were 230 plant species recorded on Zembra. Many of the species found in the alluvial plain at the south end of the island have disappeared since that time.

One of the species that disappeared from Zembra at some time is holm oak Quercus ilex. The absence of holm oak is of significant interest since it should be the climax forest species of the island (Sname 1977). Although there are no oaks on Zembra, associated plants characteristic of the Q. ilex climax stage are well represented as well as the pioneer seral stages. Bare land is colonized by a Helianthemum sward; accompanied by:

Mentha pulegium	Filago gallica
Trifolium arvense	Plantago coronopus
T. tomentosum	Radiola linoides
Vicia tetrasperma	

Helianthemum swards succeed to Cistaceae scrub (Cistus monspeliensis and C. salviifolius), which occupy about 50 ha, then low Erica multiflora with:

Pistacia lentiscus	Clematis cirrhosa
Periploca laevigata	Parietaria lusitanica
Phillyrea angustifolia ssp media	Aristolochia longa
Myrtus communis	Sonchus oleraceus
Daphne gnidium	Bryonia dioica
Lonicera implexa	Arisarum vulgare

which has been replaced on 50 ha by the high Erica arborea and Arbutus unedo shrub complex - the stage preceding a Q. ilex climax. Additional

species appearing at this stage include:

Echium plantagineum	Campanula dichotoma
Paronychia echinata	Calycotome villosa
Silene gallica	Rubia peregrina
Cichorium intybus	Polypodium vulgare
Allium roseum	Trilax apula
A. pallens	Ammi majus

Frequent disruptions to the ecosystems set back the successional stages and insularity and other influences prevent establishment of the Quercus ilex climax forest. More xerothermic locations are occupied by Olea europaea - Pistacia lentiscus (or Olea-lentiscus) formations. Olea europaea has survived only in the most xerothermic sites (c.30 ha), so most stands are dominated only by Pistacia lentiscus (more than 140 ha). Olea-lentiscus formations occupy a belt 50 - 350 m wide between the lowest limit of the Quercus ilex type formations and the halophile zone along the sea. Species associated with the formation include:

Galactilis tomentosa	Euphorbia peplis
Hyoseris radiata	Juniperus Phoenicia
T Brassica cretica atlantica	Ruta chalepensis
Avia tenorii	Rapistrum rugosum
Carex divisa	Brisa maxima
Capparis spinosa	Dactylis glomerata
Prasium majus	Medicago hispida

Along the shore of Zembra and over most of Zembretta is a littoral zone subjected to sea water spray, which favors halophile vegetation. This zone is 50 - 100 m wide on Zembra and extends up to 50 m in altitude, covering a total of 80 ha. The halophile vegetation is typified by:

Crithmum maritimum	Statice virgata
Inula crithmoides	S. echioides
Senecio crassifolius	Lotus allionii

and accompanied by

r Senecio cineraria typicus	Fumaria capreolata
Urginea maritima	Mesembryanthemum cristallinum
r Erodium maritimum	Atriplex patula
Cakile aegyptia	T Scabiosa farinosa
Polygonum maritimum	rT Dianthus rupicole hermaensis
Polypogon maritimus	Brassica cretica atlantica
Iberis semperflorus	Erodium chium

The remainder of Zembretta, around the lighthouse is occupied by

Pistacia lentiscus	Phillyrea angustifolia
Olea europaea	Chamaerops humilis

r = Rare
T = Tunisia Endemic

Vegetation Characteristics of Special Importance

The Zembra archipelago is the only island location of the *Olea-lentiscus* association in Tunisia. Insularity has resulted in the halophile vegetation formation being different from that same type elsewhere. The littoral zone has been left undamaged by man for many years and the halophile vegetation is therefore a prime example of its type in Tunisia. Some species on Zembra are also common in Italy, but have not extended their range into mainland Africa. These include:

Senecio cinerea	Iberis semperflorens
Echium maritimum	Poterium spinosum
	(Sanguisorba spinosum)

The only Tunisian location of *Calendula suffruticosa* is Zembra. Rare and endemic species include (Gauthier 1978, IUCN 1987, Radford and Peterken 1969):

T Scabiosa farinosa (Cap Bon only)	r Avena longiglumis
rT Dianthus rupicola hermaensis (Cap Bon only)	r Melilotus elegans
T Melica minuta ssp euminuta	r Silene neglecta
NA Ferula tingitana (Cap Bon and Oran, Algeria)	r Erodium hymenoides
v Sisymbrium polyceratum	r E. maritimum
v Brassica cretica atlantica	r Lavatera punctata
TA Sedum tuberosum	

v = Very Rare

r = Rare

NA = North African Endemic

TA = Tunisia/Algeria Endemic

T = Tunisia Endemic

B. Fauna

Mammals. Aside from small rodents and bats, the only mammal on the island that is probably native is the Maghreb subspecies of the European rabbit. In areas where rabbits congregate, they can virtually eliminate *Brassica cretica* and *Daucus carotta* by grazing. Myomatosis drastically reduced the rabbit population in the past, but in 1977 Snane still estimated 10 rabbits per hectare near Cappel Croso and 3 per ha around Calla Freda and Air Kabar.

Introduced species include abundant black rats *Rattus rattus alexandrus*, which are preyed upon by feral cats. Some European mouflon *Ovis musimon* were introduced to the island, as well as feral goats and sheep, which are now causing overgrazing and soil compaction problems - especially the goats.

Endangered monk seals were observed on the Zembra coast in the past (IUCN 1987), but there have been no reports in recent years. Common dolphins are often observed near the coast.

Birds. Of the 140 bird species recorded for the Zembra archipelago, most are migratory. Some species stop at the islands for only a few days while others remain most of the year. The lack of a dense herb layer under the shrub formations results in a lack of nesting cover and a low production of insects for insectivores to prey on (Snane 1977). Both

factors increase predation on upland ground nesting birds; therefore, not many resident nesting upland bird species have been recorded for Zembra.

Some rather large populations of sea birds nest on the islands. A colony of c.20,000 - 25,000 Cory's shearwaters nests there (IUCN 1987). This is one of the largest known Cory's shearwater colonies in their entire range (Sname 1977), and the only other known nesting location in Tunisia is the Galite archipelago. There are also nesting colonies of herring gulls and endangered Audouin's gulls and peregrine falcons, giving the site international importance. The main resident nesting birds are:

Cory's shearwater	Shag
Herring gull (900 pairs)	t Peregrine (11-13 pairs)
t Audouin's gull (10 pairs)	Rock dove

t = Threatened Species

Migratory birds, many of which are likely to nest on the islands, include:

Kestrel	Fan-tailed warbler
Long-legged buzzard	Corn bunting
Blue rock thrush	House sparrow
Long-tailed tit (uncommon)	Goldfinch
Coal tit	Raven

Non-nesting migrants include:

Gannet	Marsh harrier	Red-backed shrike
Grey heron	Hen harrier	Yellow wagtail
Little egret	Eleonora's falcon	Grey wagtail
White stork	Common sandpiper	Tree pipit
Black stork	Cuckoo	Water pipit
Crane	Quail	Swallow
Black kite	Wren	House martin
Short-toed eagle	Blackcap	Black redstart
Sparrowhawk	Whitethroat	Redstart
Buzzard	Bonnelli's warbler	Stonechat
Honey buzzard	Chiffchaff	Robin
Booted eagle	Goldcrest	Blackbird
Egyptian vulture	Spotted flycatcher	Dunnock

Herpetofauna. The reptiles and amphibians of Zembra have not been well studied, but Sname (1977) made a partial list, including:

Psammodromus algirus (common)	Challoides ocellatus (common)
Hermidactylus turcicus turcicus	Coluber hipporrepis - (snake)
Phyllodactylus europaeus (probable)	Malpolon monspressulanus "
Caretta caretta caretta- marine turtle	Cornella girondica "

C. Influences

During the successive periods of control by various nations through history, several vegetation degradation and regeneration cycles have occurred on Zembra. Degradation of the climax vegetation types by cultivation, grazing, burning and woodcutting encouraged invasion by more xeric species and eliminated some less xeric species (Sname 1977). The prolonged human activity resulted in the evolution of the present shrub communities and the absence of oaks, which would otherwise be the climax forest type of the island.

After 1900 agriculture and population pressure decreased, but occasional fires continued. After 1963 tourism began to increase. By 1977 tourist use had only reached the lowest part of the alluvial plain, but the effects were great enough to decrease species diversity. On steep slopes where the vegetation cover is inadequate, the erosion rate equals the soil formation rate. Human interference accelerates the soil loss.

To protect this unique and internationally important natural area the entire archipelago and a 1.5 mile marine zone were designated as Tunisia's first national park and biosphere reserve in 1977. Plans for tourism and protection and enhancement of the fauna and flora were made, but very little has been implemented, largely due to the fact that the island was later placed under military control.

3.2.3. Kuriate

The Kuriate islands are two relatively small emergences E-NE of Monastir and E-SE of Sfax. The main island is about 2.5 km long by 2 km wide, with an area of about 350 ha. It lies 16 km from the mainland (Monastir) and 2 km from the smaller island. The small island is only about 100 ha in size - much of which is intertidal flats and lowland.

Like the mainland at Sousse, to which the islands were once connected, Kuriate is formed of a limestone substrate overlain by calcareous and sandstone crusts topped by a thin layer of sand deposited by the sea. The islands are low and flat - always less than 10 m ASL and usually only a few meters above sea level. The sea bottom slopes very gradually away from the islands and does not reach 50 m depth until more than 10 km out to sea.

A. Vegetation

Approximately one-third of the main island is a low sebkhet-like depression with an outlet to the sea. The center of the depression is a few hectares of bare sand surrounded by a halophile association of Arthrocnemum and Halocnemum. On higher ground, dominant plants include:

NAS <i>Limoriastrum guyonianum</i>	<i>Euphorbia paralias</i>
<i>Pistacia lentiscus</i>	<i>Frankenia</i> sp
<i>Crataegus azarolus</i>	<i>Tamarix</i> sp.

B. Fauna

Kuriate is one of the three Tunisian locations (along with Galite and Zembra) where the Maghreb subspecies of the European rabbit is found. The rabbit population is unknown, but several rabbit burrows were noted on an inspection of the main island in October, 1987. Rodents also occur on the island, but species lists or other records were not found by the author. Birds include sedentary Sardinian warblers, migratory passerines, such as Brambling, and most of the birds recorded for the Gulf of Hammamet (Section 3.1.3).

C. Influences

There is a lighthouse complex and a marabout on the island, which occupy some of the scarce habitat space, but the main human caused influence on the ecosystem appears to be overgrazing by the lighthouse keeper's sheep and goats. All of the Crataegus and many Pistacia bushes are severely browsed and stunted. Some vegetation cutting and capture of birds and rabbits by the residents also seems likely. Erosion is resulting in shoreline degradation that may lead to significant decreases in surface area of the main island.

3.2.5. Kerkennah

The Kerkennah archipelago lies 22 km east of Sfax, at the northern end of the Gulf of Gabes. Two main islands, Isle Rharbi ("West Island") and Isle Chergui ("East Island") form a 22 km long strip oriented NE-SW, parallel to the coast. Isle Rharbi is the closest to the mainland with a minimum distance of 21 km to Rass Sfax.

Isle Chergui is the largest island, approximately 6400 ha including the low marshy areas. Isle Rharbi is 5400 ha in size. Within two km of Isle Chergui are 3 small islands: Isle Sefnou (80 ha) to the NW, Isle Roumedia (200 ha) to the north and Isle Khermedi (250 ha) to the east. The archipelago is on a shallow platform (Van Dijk 1986) and at low tide c.3600 ha of tidal flats are exposed.

A large plain once extended from Sfax to beyond Kerkennah. The rising sea level flooded the lower areas around Kerkennah and left a low flat archipelago. Neither island rises more than 50 m above sea level. Steep banks occur in some places, but most of the shoreline recedes gently into the sea. The sea bottom is less than 10 m deep for several kilometers and does not reach 50 m depth until a minimum of 32 km from the islands. Shallow waters less than 50 m deep extend as far as 140 km from the coast (Najai and Zaarah 1981).

A limestone bedrock substrate is topped by silty soil, boulders and caliche, or by sand and sandy clay (Van Dijk 1986). Intertidal areas have sandy substrates, often covered by or mixed with silt or clay.

A. Vegetation

Most of the high ground is dominated by uncultivated palm trees Phoenix dactylifera. Olives were cultivated on the islands as early as the fifth century (Burolet 1927). Lygeum spartum grows beneath the palms in gypsous areas and there are scattered locations of Rhus tripartitum, Juncus, Pituranthos tortuosa, and several species of grasses and other annuals - all of which are heavily grazed by goats and sheep. Many of the species of annual plants found on the island of Jerba (Section 3.2.6) could also be expected to occur on Kerkennah. Depressions have a moderately dense ground cover of:

NAS <u>Limoniastrum guyonianum</u>	<u>Frankenia</u> sp
<u>Zygophyllum album</u>	<u>Lyceum europaeum</u>
<u>Limonium</u> sp.	

NAS = North African Sahara Endemic

Shorelines and sebkhets that are frequently inundated by seawater often support halophile associations characterized by Halocnemum and Arthrocnemum (Van Dijk 1986). Intertidal areas are often covered by Cymodocea meadows.

B. Fauna

Mammals. The mammalian fauna of Kerkennah is relatively poor. Many species have been eliminated by hunting pressure and loss of habitat to cultivation and overgrazing. Algerian hedgehogs, brown hares, bats and a variety of rodents are still common on the islands, but other species are scarce.

Birds. A variety of sedentary and migratory birds have been recorded on Kerkennah. The lack of high cliffs and dense forest cover restricts nesting birds to some extent, but the long stretches of sandy beaches invite a number of shorebirds. Most shorebirds listed for the Gulf of Gabes (Section 3.1.4) also occur on Kerkennah. Other species include:

Crane	Great grey shrike	Blackbird
Stone curlew	Meadow pipit	Skylark
Barbary partridge	White wagtail	Wood lark
Palm dove	Stonechat	Crested lark
Hoopoe	Moussier's redstart	Starling
Swallow	Robin	Spotless starling
		Spanish sparrow

C. Influences

Vegetation under the palm trees is so overgrazed that by autumn only scattered unpalatable plants remain. This leaves the ground quite barren with little cover for fauna. Cultivation influences the fauna and flora near the cities. Vegetables are grown where the salinity level of the soil is low and there are many orchards and olive groves. Residents further affect the flora by collecting vegetation for fuel and fodder.

Fishermen construct long barricades made of wooden poles on the intertidal flats to direct fish into traps and many people walk on the intertidal flats to collect mussels and other seafood. These activities affect more than the species collected; vegetation is also trampled.

Large amounts of land are occupied by seven cities, roads and garbage dumps. Several cemeteries exist, which have a positive influence on the native vegetation by providing areas relatively free from disturbance.

Several tourist hotels have been constructed and a large section of beach is heavily used in the summer by tourists. The intensive concentration in one area could accelerate ecosystem degeneration in the tourism zone if proper management practices are not followed. However, concentrating tourist use in one area does lessen impacts on the rest of the island.

3.2.6. Kneiss

A former coastline and estuary were washed away by the post-glacial rise in sea level, leaving the Kneiss islands and intertidal flats (Van Dijk 1986). The Kneiss islands are 57 km straight line distance from both Sfax and Gabes. The main island is about 1.5 km from the mainland proper, but due to the shallow water, low tides expose much of the area between the island and the coast. Kneiss is part of the large intertidal complex of the Gulf of Gabes (Section 3.1.4).

Kneiss is composed of a main island (Dzirat el Bessila) of 650 ha and a row of four smaller islets to the south. The small islets, named Dzirat el Hajar, Dzirat el Laboua and El Jazirat el Rharbia (2 islets) each have an area of 1 to 2 ha. All five islets are flat and low. A limestone base is often bordered by sandy beaches with rocks and pebbles mixed in or on top. Adjacent intertidal areas may have several layers of sand and sediments.

A. Vegetation

Tides have a great effect on the vegetation of Kneiss. Even on the higher ground, where tidal waters seldom reach, sea spray keeps the environment saline enough to encourage a predominance of halophile vegetation. Halocnemum strobilaceum and Halimone portulacoides with some Spartina sp. dominates high ground vegetation. Inland on the main island, Arthrocnemum, Suaeda and some species of herbaceous plants similar to those found in halophile associations on the mainland, are likely to occur. On the intertidal flats, Zostera noltii forms extensive meadows.

B. Fauna

Mammals. The small size and halophile vegetation of Kneiss severely restricts the species of mammals that can inhabit the islands. Sand rats have been recorded (Van Dijk 1986) and some other rodents probably occur, but permanently residing large mammals are absent.

Birds. Kneiss is such an important part of the Gulf of Gabes coastal complex that virtually all of the waders and waterfowl recorded in section 3.1.4 are found on or around the Kneiss islands. Passerines, nesting and threatened species include:

n Little egret	Marsh harrier
n Redshank	Lesser short-toed lark
n Slender-billed gull	Skylark
n Common tern	Meadow pipit
n Little tern	Water pipit
t White stork	White wagtail
t Slender-billed curlew	Fan-tailed warbler
t Peregrine	Spectacled warbler

t = Threatened Species
n = Nesting Birds

C. Influences

Human influences on Kneiss date back to the Roman empire, as evidenced by ruins and artifacts on each of the islands. Currently the main island is inhabited by temporary residents who fish and collect carpet shells Venerupis decussata and V. aurea. Residents from villages on the mainland also fish and collect bivalves in the area. In the spring of 1984 there were 80 - 100 people collecting bivalves in the area (Van Dijk 1986). The exploitation affects the food source of many species of fauna (especially oystercatchers), disrupts the vegetation cover and may disturb birds during the nesting season.

3.2.6. Jerba

At the south end of the Gulf of Gabes lies Jerba, Tunisia's largest island. Jerba and the circumjerbian islands are the closest archipelago to the mainland. At the closest point Jerba is only 2 km from Rass el Djerf and at the southeast point a 7 km bridge connects Jerba to the mainland. Jerba is 58 km E-SE of Gabes and 23 km N-NW of Zarzis.

Roughly 30 km long by 20 km wide, Jerba covers 50,000 ha with an additional 3000 ha of coastal marsh and intertidal zones. The 3 largest of the circumjerbian islands, Djillidj, Adjim and Djorf, are on the south side, between Jerba and the coast. Although the largest of the circumjerbian islands have only a few hundred hectares of high ground each, there are many smaller islands and low marshy areas which total 3500 to 4000 ha (Olney 1965).

There are cliffs 2 - 10 m high of friable sandstone and limestone around Jerba (Van Berghen 1977). Inland, above sandstone and limestone crusts are sandy, often silty soils with many gypsous locations. The land gently undulates at about 10 m above sea level and drops to coastal lagoons, sebkhetts and dune areas along the coast. Dunes are generally unstable and form littoral bands 30 - 100 m wide. Behind those dunes is a complex of stable, or 'fixed', dunes that were vegetated long ago.

A. Vegetation

Most of Jerba has been cultivated to date palms, olives, various fruit trees and vegetables. The rest is so overgrazed that only a poor representation of the native vegetation remains. Inland, on the higher ground, a group of nitrophilic species is found. Those species include Malva parviflora, Aizoon hispanicum and Peganum harmala. Around the areas of nitrophilic species are warmer locations with 5460 ha characterized by a Pituranthos tortuosa and Haplophyllum vermiculata association (Euphorbia serrata variant), 1440 ha with an Artemesia herba-alba and Arthrophytum scoparium association (Gymnocarpus decander sub association, Asphodelis microcarpos variant) and 34,000 ha characterized by an A. microcarpus variant of the Zarzis peninsula association (Le Houerou and Froment 1969).

Van Berghen (1977) noted two major associations on the dunes between Bordj Kastil and Bordj Djellidj composed of 32 species: one on the low dunes characterized by Agropyron farctum and the other on the high dunes, characterized by Ammophila arenaria. Annuals compose 56% of the vegetation.

On the west and north sides of Jerba there are coastal dunes vegetated by species groups characterized by A. arenaria and Agropyrum junceum or Cakile maritima and Medicago marina (Le Houerou and Froment 1969). Where the dune sands are more saline, such as in the northwest corner and on the east side of Jerba, a gypso-halophile association of Nitraria retusa, Suaeda vermiculata and Salsola sieberi var vesceritensis is found. In the depressions between the dunes there are 6 major plant associations composed of 83 species (Van Berghen 1979):

1. A single species aquatic association (water 1-4 m deep) of Ruppia cirrhosa var drepanis.
2. A pioneer community on wet sands with Riella notarissi and some Chara vulgaris.
3. Very open cover with Limonium tunetanum and Aeluropus lagopoides.
4. Along depression edges, Juncus maritimus var arabius occurs.
5. A Schoenus nigrans association on water-holding substrates.
6. A pioneer community with Frankenia pulverulenta.

Along the coast are found:

<u>Halocnemum strobilaceum</u>	<u>Juncus maritimus</u>
<u>Limoniastrum guyonianum</u>	<u>Atriplex halimus</u>
<u>Zygophyllum album</u>	<u>Limonium</u> sp.
<u>Tamarix africana</u> (sparse)	

Rare plants include Peganum harmala var. garamanteum.

B. Fauna

Mammals. Many fox have been released on Jerba by departing tourists who purchased fox kits and found that they were unable to take them out of the country. The introduced fox are now so numerous that they have virtually eliminated barbary partridge from the island (A. Abed, pers. comm). Brown hares were similarly introduced by tourists, but have been

overhunted and almost eliminated. Other reported species include:

Fennec fox	<u>Fennecus zerda</u>
Lerot	<u>Eliomys quercynus</u>
Shaw's jird	<u>Meriones shawi</u>
Gerbil	<u>Gerbillus campestris</u>

Birds. A large proportion of the waders and waterfowl listed for the Gulf of Gabes (Section 3.1.4) can be seen at the intertidal flats of Jerba. Turtle doves and cranes are also reported to use the island. Some of the upland birds observed in November 1987 include:

Marsh harrier	Sardinian warbler
Rock dove	Stonechat
Hoopoe	Raven
Great grey shrike	

C. Influences

Almost all of the upland area of Jerba is cultivated or developed, leaving little land for natural vegetation associations or animal habitat. Intense cultivation has also resulted in wind erosion and some dune formation. Hotel construction destroyed fragile vegetation cover and resulted in wind erosion in several locations (Van Berghen 1977).

3.3. WETLANDS

In this document the term 'wetland' refers to permanent and temporary fresh or brackish water bodies and their adjacent floodplain or zone of influence. This includes all inland rivers and water bodies, coastal salt lakes and marine lakes, (figure 6) but excludes the Mediterranean coast, which is described in Section 3.1. Tunisia has more than 100 permanent and temporary wetlands, many of which are of international importance. Most of the wetlands are in the northern half of the country, especially near the coast, and there is a fair interspersion almost everywhere but in the Sahara.

Wetlands permit a variety of plant species to grow in ecosystems that are otherwise often somewhat homogenous - especially in the steppes. Numerous invertebrates, reptiles, amphibians, birds and mammals take advantage of the cover and nutritional productivity of wetlands. Each year more than 75,000 flamingos, 400,000 anatids of many species, and 250,000 coots and moorhens use Tunisia's wetlands for nesting, migration rest stops or wintering locations (Dir. Env. 1977). Many species of rare and endemic plants and animals are also found at wetlands.

Unfortunately, many of Tunisia's wetlands are being detrimentally influenced by industrial complexes, urban expansion, agricultural development projects (dams, drainage), pesticide use, hunting pressure, pollution and dessication (Dir. Env. 1977). The Tunisian government has taken steps to protect some of the principal sites by creating permanent reserves and national parks (Section 5.4). However, the mere designation of protected areas is often insufficient in the face of heavy population and economic pressures, as evidenced by the filling of Lake Tunis (see 3.3.1.3).

The factors that wetlands are most sensitive to include:

Activities affecting water levels

- Upstream dams
- Draining of marshland for cultivation

Changes in water quality

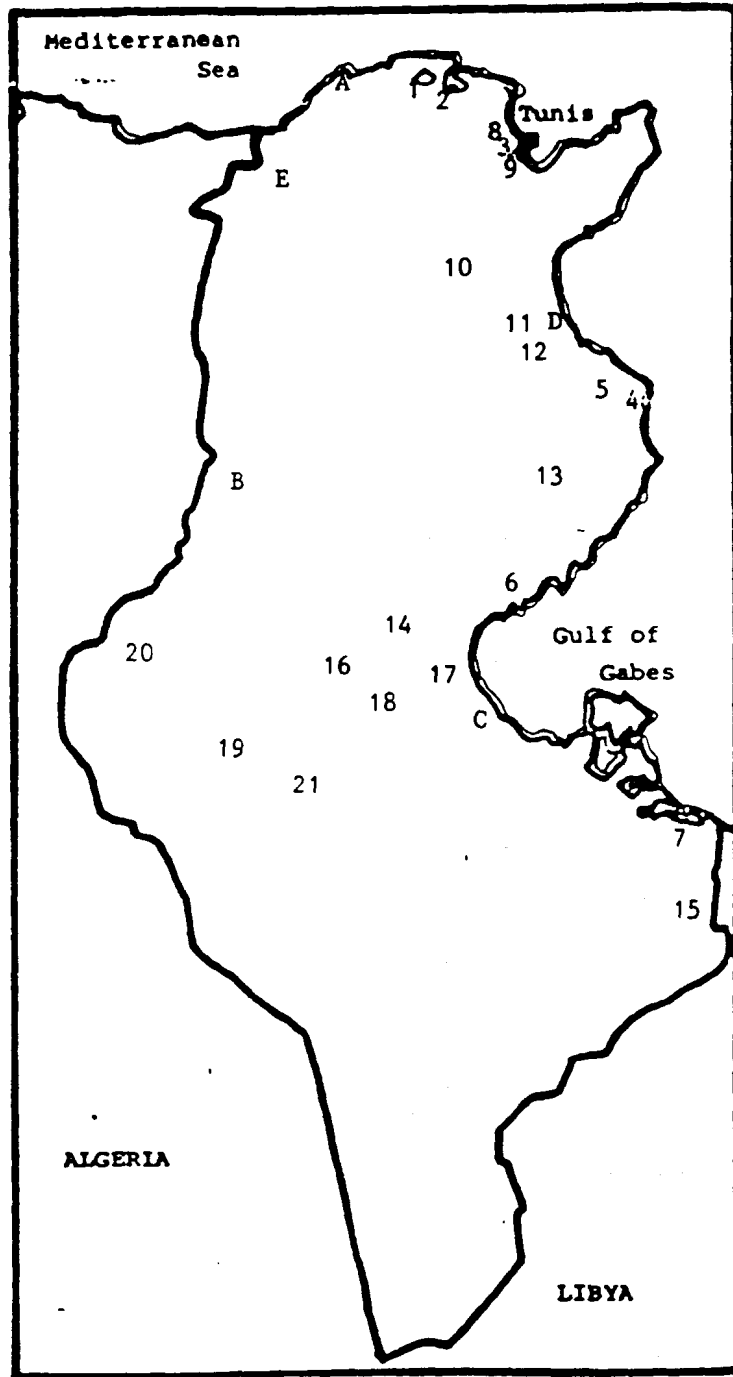
- Abnormal inputs of seawater or saline runoff
- Chemical pollutants - herbicides, sewage, chemical waste

Actions reducing wetland areas

- Cultivation of edge zones
- Adjacent urban development
- Filling and construction

Figure 6

Wetlands of Tunisia



1. Lake Ichkeul
2. Lake Bizerte
3. Lake Tunis
4. Lake Monastir
5. Monastir Salines
6. Thyna Salt Ponds
7. Bahiret el Bibane
8. Sebkhet Ariana
9. Skt. Sedjoui
10. Skt. Kourzia
11. Skt. Kelbia
12. Skt. Sidi el Han:
13. Skt. el Djem
14. Skts. Sidi Manso and En Noual
15. Jeffara Complex
16. Skt. el Guettar
17. Skt. el Hamma
18. Chott Fejjij
19. Chott Jerid
20. Chott El Gharsa
21. Kebili Lakes
- A. Lake Chitane
- B. Lake el Fiel
- C. Lake Zerkine
- D. Oued Essed Pools
- E. Dar Fatma Bog

3.3.1. Marine Lakes and Lagoons

3.3.1.1. Lake Ichkeul

37°10' N 9°40' E

Ichkeul is a permanent, brackish lake in the plain of Mateur at the north end of Tunisia. The lake is 20 km southwest of Bizerte and 60 km N-NW of Tunis. During summer, when the water level is low, Lake Ichkeul has an area of about 8500 ha and is surrounded by 2737 ha of marshes (El-Ghezal 1982). After winter rains raise the water level, the surface area is about 10,000 ha.

At its highest winter level, the maximum lake depth is only 3.7 m. Summertime depth is usually around 1.5 m. The shallow depth and low sloping sides result in the drastic seasonal changes in surface area. On the south side of the lake is Djebel Ichkeul (see Section 3.4.1.6), which rises to 508 m altitude. Five permanent rivers and several temporary streams, draining a basin of 2089 km² feed 335 million m³ of water annually into Lake Ichkeul (El-Ghezal 1982). The proportion of input, by river, is Sejnane 30%, Joumine 48%, Melah 12%, Ghezala 3% and Doumis 3%.

Along with fresh water, the rivers also carry an average of one million cubic meters of sediments from erosion into the lake. About 75% of the sediments are evacuated by Oued Tinja, leaving 250,000 m³ of sediments to settle on the lake bottom. The effects of this high rate of sedimentation are illustrated by the fact that during Carthaginian times the lake had an area of 30,000 ha and completely surrounded Djebel Ichkeul. Today only one third of that area remains as open water, all to the north of Dj. Ichkeul (El-Ghezal 1982).

Oued Tinja connects Lake Ichkeul to Lake Bizerte, which is connected to the sea. In the summer, when the water level drops due to evaporation and decreased input, salt water flows into Lake Ichkeul via Oued Tinja.

A. Vegetation

The vegetation of Lake Ichkeul and the surrounding marshes is interspersed and varied, but there is a general pattern of vegetation types radiating out from the center of the lake. In the open water Potamogeton pectinatus dominates the submergent vegetation, especially in the west end where it is an important food source for waterfowl. Another submergent common in winter is Zannichellia palustris. Enteromorpha intestinalis, Chara sp., Ruppia maritima and Callitriche palustris are common summer species (Morgan 1982; Zouali 1975).

At the edge of the lake, bands of reeds Phragmites communis separate the lake from the marshes and shoreline. Beyond the reeds, Scirpus maritimus, S. lacustris and Juncus subulatus dominate the marshes. Typha angustifolia grows along channels through the marshes, whose higher banks are fringed by Tamarix africana. In saltier locations Salicornia arabica and Suaeda maritima dominate halophile associations. On higher ground, Hordeum maritimum, Lolium multiflorum, Daucus carota, Nerium oleander and Zizyphus lotus appear. More complete vegetation information is given in UCL 1977, Morgan 1982 and IUCN 1987.

Rare Species. The marshes of Lake Ichkeul are one of the few sites in Tunisia where the rare Ranunculus ophioglossum and Sparganium erectum have been recorded.

B. Fauna

Mammals. Many of the mammals that inhabit Djebel Ichkeul descend into the marshes to feed. Algerian hedgehog, four species of bat (Rhinolophus ferrum-equinum, R. euryale, Myotis myotis, Minopterus schreibersii), Egyptian mongoose, jackal, red fox, brown hare, rodents (Jaculus orientalis and others) and wild boar are among the mammals recorded at lake Ichkeul (UCL 1977). Otters Lutra lutra are a rare species in Tunisia that also use the Lake Ichkeul marshes. A small, semi-wild herd of buffalo Bubalis bubalis has become established after re-introduction in the 1970s (see Section 2.4, Fauna).

Birds. Lake Ichkeul is the most important single wetland for birds in North Africa (Carp 1980) and one of the most important sites in the entire Mediterranean region (IUCN 1987). Approximately 4% of the known world population of the rare white-headed duck were observed at Ichkeul in May, 1977 (UCL 1977) and they have been known to breed there in the past (Carp 1980). The lake is also a traditional nesting site for the threatened marbled teal and many other birds (see figure 7).

Migrating birds use the lake extensively since it is one of the last remaining freshwater (salinity is < 5 g/l in winter) lakes in North Africa. At the peak of the winter migration 150,000 to 200,000 ducks and coots and 5,000 to 7,000 greylag geese are present (Carp 1980) along with thousands of waders. The high numbers of wintering wigeon (39,000) shoveler (6,500) and pochard (120,000) are of international importance based on the Heiligenhafen criteria (Morgan 1982). Greylag goose and pochard numbers are the highest for wintering populations in the Maghreb (IUCN 1987). More than 200 bird species have been recorded for Djebel and Lake Ichkeul. The most comprehensive bird list (Skinner 1986) includes birds found both on the mountain and at the lake, and since many of the mountain species descend to the marsh edges to feed and drink, the entire list is reproduced in figure 7.

Invertebrates. The salinity level limits the invertebrate fauna of the lake to salt tolerant species and restricts the less tolerant species to the marshes. Although the number of recorded invertebrate species is only around 26 (UCL 1977), the dominant species are present in large numbers. In the open waters of the infralittoral zone, zooplankton such as Copepoda and dense Mysidacea (Crustacea) are found, along with invertebrates such as

Annelida:	<u>Nereis diversicolor</u>	<u>Mercierella enigmatica</u>
Crustacea:	<u>Sphaeroma hookeri</u> <u>Gammarus aequicauda</u>	<u>Idothea balthica</u> , <u>Corophium volutator</u> <u>C. acherusicum</u>
Mollusca:	<u>Hydrobia ventrosa</u> <u>Abra tenuis</u>	<u>Cerastoderma glaucum</u>

the number of species (Zouali 1975) is highest at the east end (20) and lowest at the west end (5). The mediolittoral zone contains dense Potamogeton beds that have abundant invertebrate populations and are important feeding areas for fish and waterfowl. Dominant species include:

Hydrobia ventrosa	Nereis diversicolor
Sphaeroma hookeri	Idothea viridis

In the waters of the infralittoral zone (marsh edge), fluctuations in water level, temperature and salinity are unfavorable for invertebrate populations (Zouali 1975). However, the Djoumine marsh has freshwater channels that contain the richest and most diverse aquatic fauna in the area (UCL 1977). Characteristic species include dragonflies, alderflies Sialis sp., Corixid water bugs, water scorpions Nepa sp., Dytiscid water beetles, crustaceans (Assellus), freshwater molluscs Limnea sp., flatworms Turbellaria sp. and other freshwater species not found in the lake or anywhere else in the area in such abundance.

Fish. Several species of fish are exploited by commercial fishermen at Oued Tinja (Zouali 1975); these include:

Anguilla anguilla	Mugil cephalus
Dicentrarchus labrax	M. ramada
Barbus barbus	Solea solea
Alosa fallax	Aphanius fasciatus
Syngnathus abaster	Engraulis encrasicolus

Herpetofauna. The distribution of reptiles and amphibians is influenced by the water level and salinity in the lakes and marshes. Dominant species and their habitat types are:

5 Rana ridibunda	1 Malpolon monspessalanus
1,2 Bufo viridis	1,3,4 Natrix maura
4 B. bufo	2,4 Discoglossus pictus
2,4 B. mauritanicus	2,3,4 Clemmys leprosa
1 Lacerta ocellata	4 Emys orbicularis

1 = upper marsh	3 = brackish water	5 = All 4 habitats
2 = lower marsh	4 = fresh water	

C. Influences

Although Lake Ichkeul is included in Ichkeul National Park, human influences are still affecting the the environment. The marshes are overgrazed by cattle to the point that the buffalo become malnourished (IUCN 1987); fishing is still done at Oued Tinja and sometimes in the lake; and occasional poaching occurs. Non-marsh areas around the lake are cultivated and runoff water from the fields contain sediments and possibly chemical pollutants.

A canal was dug through the Djoumine marsh by the Rural Works department. The Rural works department does not consider the canal necessary, but so far no action has been taken to fill the canal. As water drains from the marsh into the canal, the vegetation composition changes and the habitat value for waterfowl decreases.

Figure 7

Birds of Ichkeul
(from Skinner 1986)

n Little grebe	n Black-winged stilt	Tawny pipit
n Great crested grebe	Avocet	Tree pipit
Black-necked grebe	Stone curlew	Meadow pipit
Cormorant	n Pratincole	Red-throated pipit
Bittern	Little ringed plover	Water pipit
n Least bittern	Ringed plover	n Yellow wagtail
n Night heron	n Kentish plover	Grey wagtail
Squacco heron	Dotterel	White wagtail
Cattle egret	Golden plover	Bulbul
Little egret	Grey plover	Wren
Great white heron	Lapwing	Dunnock
n Grey heron	Little stint	Alpine accentor
n Purple heron	Temminck's stint	n Rufous bushchat
Black stork	Sanderling	Robin
t White stork	Curlew sandpiper	n Nightingale
Glossy ibis	Dunlin	Bluethroat
Spoonbill	Ruff	Black redstart
Greater flamingo	Jack snipe	Redstart
Swan spp.	Snipe	Moussier's redstart
Bear goose	Great snipe	Whinchat
White-fronted goose	Bar-tailed godwit	Stonechat
Greylag goose	Black-tailed godwit	Isabelline wheatear
Bar-headed goose	Curlew	Common wheatear
Snow goose	Whimbrel	Black-eared wheatear
Barnacle goose	Spotted redshank	Black wheatear
Ruddy shelduck	Redshank	Blue rockthrush
Shelduck	Greenshank	Ring ouzel
Wigeon	Marsh sandpiper	Blackbird
Teal	Green sandpiper	Song thrush
Mallard	Wood sandpiper	Redwing
Pintail	Common sandpiper	Mistle thrush
Garganey	Mediterranean gull	Cetti's warbler
Shoveler	Little gull	n Fan-tailed warbler
t Marbled teal	Black-headed gull	n Savi's warbler
Red-crested pochard	Slender-billed gull	n Moustached warbler
Pochard	Lesser black back	Sedge warbler
n Ferruginous duck	Herring gull	n Reed warbler
Tufted duck	Gull-billed tern	n Great reed warbler
tn White-headed duck	Caspian tern	n Olivaceous warbler

Figure 7 (Continued)

Honey buzzard	Sandwich tern	Icterine warbler
Black kite	n Little tern	Melodeous warbler
Egyptian vulture	Whiskered tern	Marmora's warbler
Griffon vulture	Black tern	Dartford warbler
Short-toed eagle	White-winged b. tern	Spectacled warbler
n Marsh harrier	B.-bellied sandgrouse	Subalpine warbler
Hen harrier	Rock dove	Sardinian warbler
Pallid harrier	Stock dove	Orphean warbler
Montagu's harrier	Turtle dove	Whitethroat
Sparrowhawk	Palm dove	Blackcap
Buzzard	Cuckoo	Garden warbler
Long-legged buzzard	Scops owl	Bonelli's warbler
Golden eagle	Barn owl	Wood warbler
Tawny eagle	Eagle owl	Chiffchaff
Booted eagle	Little owl	Willow warbler
Bonelli's eagle	Short-eared owl	Goldcrest
Osprey	Nightjar	Firecrest
Kestrel	Swift	Spotted flycatcher
Red-footed falcon	Pallid swift	Collared flycatcher
Merlin	Alpine swift	Pied flycatcher
Hobby	Kingfisher	Blue tit
Eleonora's falcon	n Bee eater	Golden oriole
Lanner falcon	Roller	Bush shrike
Saker falcon	Hoopoe	Great grey shrike
t Peregrine	Wryneck	Woodchat shrike
n Barbary partridge	Calandra lark	n Corn bunting
n Quail	n Lesser short-toed lark	Reed bunting
Water rail	n Short-toed lark	Hawfinch
n Spotted crake	Thekla lark	Linnet
Baillon's crake	n Crested lark	Goldfinch
Corncrake	Skylark	Greenfinch
n Moorhen	n Sand martin	Serin
n Purple gallinule	Crag martin	Chaffinch
n Coot	Swallow	Rock sparrow
Andalusian hemipode	House martin	Spanish sparrow
Crane	Raven	Starling
		Spotless starling

n = Nesting Birds

t = Threatened Species

By far the most serious problem threatening Lake Ichkeul is a series of 6 dams being constructed on all 5 of the main rivers flowing into the lake. The dams will severely reduce the freshwater input to the lake, resulting in lower summer water levels and increased influxes of seawater. Significant increases in salinity will kill off much of the Potamogeton and Scirpus that currently attract waterfowl. If no mitigation actions are taken, the habitat value will drop sharply, with serious ramifications for many species of birds and the natural integrity of the national park.

Hollis (1986) recommended five possible schemes for ameliorating the effects of the dams. None of the actions has been due to indecision by responsible agents and a lack of finances for the projects. The recommended actions include filling the Djoumine marsh; installing a weir or sluice at Oued Tinja to control water flow; building dykes to reduce the area of the lake, thus reducing salinity; and reservoir releases when the lake is below 10 cm ASL.

3.3.1.2. Lake Bizerte

Lake Bizerte is connected to, and lies northeast of, Lake Ichkeul. The lake area is about 13,000 ha and fluctuates slightly with the tides. Water in Lake Bizerte is saline, but during winter and spring, water entering from Lake Ichkeul through Oued Tinja lowers the salinity to slightly less than that of seawater (35 g/l). At its deepest point the lake is 12 m deep and most of the lake is deeper than 2 m. The adjacent terrain is gently undulating with a low marsh on the east side.

A. Vegetation

Most of the shoreline has been cultivated or developed. In the marsh at the east side the parts that have not been cultivated or developed support halophile vegetation. Marine flora totals 145 species (Zaouli 1980). The number of species decreases close to Oued Tinja due to the lower salinity, but marine Phanerogames such as Zostera marina and Ruppia maritima can be found. Other marine Phanerogames growing in the lake include Zostera noltii between 0.5 m and 1 m deep (especially on the north side) and Cymodocea nodosa at depths between 1 and 2 m. Algae found in the shallow waters include:

Chlorophyceae:

Ulva lactuca
Enteromorpha compressa
Chaetomorpha linum (rare)
Cladophora prolifera (rare)
C. laetevirens
Caulerpa prolifera

Pheophyceae:

Cystoseira abrotanifolia
Dictyota abrotanifolia
Dictyopteris polupodioides
Padina pavonia (rare)

Rhodophyceae:

Lithothamnium fruticulosum
L. lenormandi
Jania rubens (rare)
Corralina officinalis
Laurencia papillosa (rare)
Gracilaria confervoides (rare)
Posidonia oceanica
Acetabularia mediterranea
Halimeda tuna

B. Fauna

Mammals. Red fox, jackal, brown hare, Algerian hedgehog, and Egyptian mongoose are likely to be found in the area. Bernard (1969) reported the presence of several rodents such as Shaw's jird, gerbil Gerbillus campestris and field mouse Apodemus sylvaticus in the area.

Birds. The lake is too deep for extensive bird use, such as that which occurs at Lake Ichkeul. Many of the species of waders, terns and gulls that use Ichkeul also occur in smaller numbers at Lake Bizerte. Species noted on the east side of the lake in August 1987 include herring gull, white-winged black tern, little egret and swallow.

Marine Fauna. The marine fauna, as reported by Zaouli (1980), consists of:

Sponges:

Suberites domunicula
Clathria coralloides
Leuconia aspera

Cnidaires:

Anemonia sulcata
Bunodactis verrucosa

Polychetes:

Nereis diversicolor
Perenereis cultrifera
Hermione hystrix
Amphytechne auricoma
Sabella pavonia
Ficopomatus enigmaticus
Hydroides elegans
H. dirampha
Vermiliopsis striaticeps
Pileolaria millitaris
Jania pseudocorrugata

C. Influences

Extensive cultivation and development around Lake Bizerte has reduced the available habitat. Fishing and boating activity disturb avifauna and commercial fishing skews the fish population structure.

3.3.1.3. Lake Tunis

36°50' N 10°16' E

Between the capitol city of Tunis and the sea lies Lake Tunis. The lake is actually a large (4500 ha) shallow lagoon that formed when an accreting sandy barrier spit separated an open bay from the Mediterranean sea in the 16th century (Saubade and Rosso 1983). Lake Tunis is composed of three distinct ecosystems: North Lake, South Lake, and Navigation canal (Belkhir and Salem 1983). The North and South parts are always less than 2 m deep and the majority is less than 1 m deep. The navigation canal is c.5 m deep. Lake Tunis is connected to the sea by the Khereddine canal in the north and the Rades canal in the south. There is one small island, Chikli, on which there are the remains of an old fortress.

A. Vegetation

Lake Tunis is a highly eutrophic, brackish lake, so there is not a high diversity of vegetation. The outlet to the sea is often choked by sea lettuce Ulva sp. and calcified tubes of Mercurella enigmatica (Carp 1980). Algae mats form on the stagnant water during the summer.

B. Fauna

Mammals. Due to the high degree of development, only occasional jackals, fox or hares would be expected to occur at the lake. Bernard (1969) listed Shaw's jird, gerbil Gerbillus campestris and jerboa Jaculus orientalis for the area. Some species of bats also occur.

Birds. Chikli island is one of only two or three little egret nesting areas in Tunisia. Cormorants, herring gulls and kestrels also nest on the island. Mallards and marbled teal nested at the lake in the past (Carp 1980). Lake Tunis is very important for wintering great crested grebe and little grebe (825 in 1975), cormorant (1,000 - 1,500), flamingo (8,000 - 10,000 in 1984), pintail (1300 in 1972), shoveler (6,000 in 1973), cattle egret, spoonbill and black-winged stilt (IUCN 1987; Carp 1980; Hollis 1986).

Rare species include peregrine falcon and significant numbers of the rare white-headed duck have been seen on the lake (44 in 1975 and 666 in 1973). Other birds found at Lake Tunis are:

Black-necked grebe	Kentish plover	Swallow
Grey heron	Ringed plover	Meadow pipit
Greylag goose	Little ringed plover	Water pipit
Shelduck	Wood sandpiper	Grey wagtail
Teal	Black-tailed godwit	Blue-headed wagtail
Tufted duck	Ruff	White wagtail
Osprey	Snipe	Great grey shrike
Marsh harrier	Stone curlew	Skylark
Barbary partridge	Slender-billed gull	Fan-tailed warbler
Lapwing	Black-headed gull	Chiffchaff
Little stint	Mediterranean gull	Reed bunting
Common sandpiper	Little tern	Robin
Curlew sandpiper	Sandwich tern	Linnet
Redshank	Gull-billed tern	Chaffinch
Greenshank	Kingfisher	Starling
Dunlin	Hoopoe	Spanish starling

C. Influences

Although municipal law prohibits the discharge of pollutants into Lake Tunis (see Section 5.3), some dumping still occurs. Strong industrial pollution in certain zones has decreased, if not eliminated some of the marine fauna (Saubade and Rosso 1983). Waste water was discharged into the lake before 1981, but is now treated and not returned to the lake (IUCN 1987). The choked outlet from the sea is also being cleared. Pollutants and disturbance from boats in the navigation canal affect the

center and the lake edge is highly developed. There is a salt processing area near Tunis where a sizable area has been sectioned off, but it is still used by waders and waterfowl.

The most serious influence on the lake is a development project that has already filled 900 ha and is projected to fill at least 1,500 ha for a new section of the city of Tunis. The project will reduce the area available to waterfowl and increase disturbance in the unfilled portion of the lake. This development is occurring in spite of the fact that Lake Tunis was designated a Protected Wetland in 1980 (see Section 5.4).

3.3.1.4. Lake Monastir

On the coast just south of Monastir and 160 km south of Tunis is Lake Monastir. More properly called a coastal lagoon, Lake Monastir is the site of the former Monastir salt ponds; abandoned in 1952 (Mortier 1977). The lagoon is formed by a sandy barrier spit that extends for 2.5 km along the coast and a final 0.5 km artificial rock bank that has been constructed at the south end to complete the barrier and close off a 175 ha water body. Canals at the north and south ends provide communication with the sea. Most of the lagoon is less than 2 m deep, but the Office National des Peches (National Fisheries Office) has dragged channels 2.5 - 3.5 m deep to improve fish production. The channels allow water to circulate between the 2 canals to the sea, and in good weather a current provides partial water replacement every 6 hours.

A. Vegetation

Mortier (1977) described 5 zones in the lagoon:

1. Cymodocea zone. Dense Cymodocea nodosa dominates the shallow non-stagnant waters.
2. Caulerpa zone. In the deeper, more turbid and less frequently renewed waters and in parts of the canals the more tolerant Caulerpa prolifera grows.
3. Green filamentous algae zone. Some parts attain extreme levels of temperature and salinity during periods, restricting growth of Cymodocea and resulting in the formation of algae mats.
4. Shallow muddy-sand zone. Unvegetated.
5. Deep stagnant zone. Turbid and unvegetated canals.

B. Fauna

Little information is published regarding the vertebrate fauna of the lagoon, but it is probably similar to the rest of the coastline of the Gulf of Hammamet. Terns, grebes and other fish eating birds are attracted by the fish being raised in the lagoon.

Marine Fauna. The marine fauna (Mortier 1977) is composed of:

Nereis sp. (Polychete)	Crustaceans
Cerithium vulgatum (Gasteropod)	Isopods
Clibanarius misanthropus "	Amphipods
Lucinia lactea (Pelecypod)	Maldanid Polychetes

C. Influences

Since Lake Monastir is managed for fish production, there are several water control structures and fish traps. Guardians keep out other sources of disturbance, so the site is a safe haven for many birds.

3.3.1.5. Monastir Salt Ponds (Salines)

West of Monastir is the lagoon that replaced Lake Monastir as a salt collection site. The site is over 1000 ha, much of which has been sectioned off into evaporation ponds. The salines are further inland than Lake Monastir and the banks prevent free circulation of the water.

A. Vegetation

Halocnemum strobilaceum, Arthrocnemum indicum, Salicornia sp. and Halopeplis amplexicaulis dominate the vegetation on the shores of the salines. Poor water circulation and high salinity prevent vegetation growth in many of the sections. In the large, less salty sections green filamentous algae mats form.

B. Fauna

Mammals. Brown hares inhabit the halophile vegetation around the salt ponds and it is possible that red fox and Egyptian mongoose occasionally occur there. The range of Shaw's jird and Gerbillus campestris (gerbil) extends to this area and the habitat between the saltponds and the Monastir airport is favorable for those species.

Birds. Many species of waterfowl and waders feed in the salt ponds and there are several nesting species such as shelduck and little tern. Most of the species found along the coast of the Gulf of Hammamet and the Gulf of Gabes probably also stop at the Monastir salt ponds and Lake Monastir. Species present in August, 1987 included:

Little grebe	Oystercatcher	Black-tailed godwit
Grey heron	Kentish plover	Slender-billed gull
Little egret	Curlew sandpiper	Mediterranean gull
Flamingo (1400)	Spotted redshank	Herring gull
Spoonbill	Redshank	Little tern
Shelduck	Greenshank	Collared pratincole
Black-winged stilt	Marsh sandpiper	Spectacled warbler
Avocet (1000+)	Wood sandpiper	Lesser short-toed lark

C. Influences

Water level manipulation and equipment operation for salt production affect the vegetation and nesting birds. The adjacent airport causes some disturbance to the birds. Water quality is fairly good since it must be kept clear for acceptable salt production. Fish are seined in the larger ponds, but hunting is usually not allowed.

3.3.1.6. Thyna Salt Ponds

Just south of Sfax, and 270 km south of Tunis, are the Thyna salt ponds. The salt ponds are part of the ecological unit of the Gulf of Gabes coast, but are described separately here because they also qualify as a marine lagoon. The east side of the lagoon borders the sea and the two are only separated by an embankment. Before the embankment was constructed, the area was an intertidal zone. The salt ponds are continuously being extended toward the south. In 1984 there were 860 ha sectioned off from the sea, although not all of it was in operation for salt production (Van Dijk 1986). The salt ponds are shallow (most less than 1 m deep, all less than 3 m) with sandy and muddy bottom substrates.

A. Vegetation

Sparse halophile vegetation (Halocnemum, Arthrocnemum) occurs at the edges of the salt ponds, but there is almost no submergent vegetation in the ponds. In the less saline sections there is abundant phytoplankton and algae.

B. Fauna

Mammals. Red fox and sand rat have been observed (Van Dijk 1986), but they are not likely to occur in large numbers.

Birds. The close proximity to the sea makes Thyna a good high tide resting place for many species of waterfowl and waders and several species also nest there. Most of the birds listed for the Gulf of Gabes (figure 4) can also be observed at Thyna. The following species were observed in August, 1987:

Black-necked grebe	Turnstone	Black-headed gull
Little egret	Redshank	Mediterranean gull
Spoonbill	Greenshank	Lesser black back
Flamingo	Marsh sandpiper	Herring gull
n Shelduck	Curlew sandpiper	n Slender-billed gull
Oystercatcher	Black-tailed godwit	Gull-billed tern
Avocet	Bar-tailed godwit	n Common tern
Kentish plover	Curlew	Black tern
Little stint	Black-winged stilt	n Little tern
Dunlin	Ruff	Sandwich tern
White-winged black tern		

n = Nesting Birds

C. Influences

The ponds were created for commercial salt production, so there is frequent manipulation of water levels and equipment operation. Nests can be flooded or crushed by this activity, but the salt company's guardians protect adult birds from poaching and harassment. An adjacent phosphate plant and an olive oil refinery discharge effluents into the sea.

3.3.1.7. Bahiret el Bibane (Bibane Lagoon)

Bahiret el Bibane is on the southeast coast of Tunisia, only 15 km from the Libyan border. The lagoon is approximately 35 km long and has an area of c.30,000 ha. Large sand bars separate the lagoon from the sea, but there is a sizable outlet allowing free interchange of water. The lagoon is shallow with a sandy bottom over a limestone substrate.

A. Vegetation

Upland areas around the lagoon are vegetated by associations typical of the southern Subdesertic Littoral Steppe (Section 3.5.3). The edge vegetation is composed of halophile associations dominated by:

	Halocnemum sp.	Atriplex sp
	Zygophyllum album	Juncus sp
NAS	Limoniastrum guyonianum	Lygeum spartum

NAS = North African Sahara Endemic

B. Fauna

The islands at the entrance to the lagoon are rich in nesting birds (Olney 1965), notably several species of Laridae such as slender-billed gull, caspian tern and gull-billed tern (Carp 1980). Large numbers of migrating birds (see figure 4) pass through or winter at the lagoon, including the threatened white stork.

C. Influences

Bahiret el Bibane is encircled by roads, some of which run along the water's edge. Fishing and hunting is common at the lake, but not at excessively high levels.

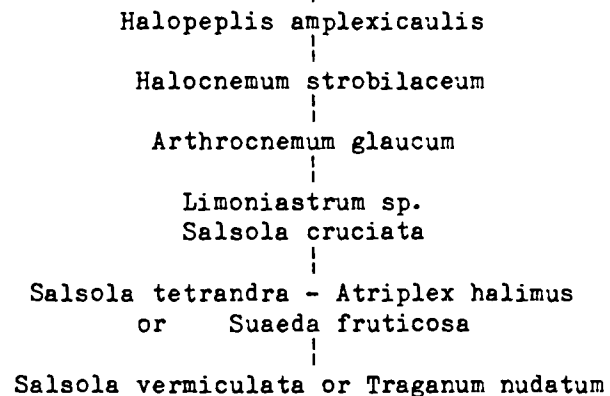
3.3.2. Sebkhets and Chotts

Sebkhets are temporary wetlands, generally on salty soils, fed by slightly to moderately saline runoff water. Most sebkhets are dry by late summer, but some retain part of their water throughout the year. Chotts are vast dry depressions that were lakes in the pleistocene age (Morgan 1982). They are too large to be completely filled with runoff water, but portions contain water in most years. The fauna and flora of chotts and sebkhets are similar, although the chotts have a higher percentage of bare, dry ground.

Sebkhets and chotts occupy a significant area in Tunisia (almost 2 million ha) and they play an important role in moderating floodwaters, trapping sediments and providing habitat for a variety of fauna. The greatest concentration of sebkhets is in the Low Steppe region of eastern Tunisia and near the southeast coastal region. Large chotts form a line across south-central Tunisia from Gabes to the Algerian border.

Saline soils in the sebkhets and chotts restrict the vegetation associations to salt tolerant species. Dominant species do not vary greatly among the chotts and sebkhets, although some secondary components vary with soil, water and climatic conditions. A vegetation transect from the center to the edge of a typical sebket or chott in summer would show the following basic characteristic zonation (ORSTOM 1962):

Unvegetated center with very salty soils - often with salt crust



A low diversity of dominant vegetation species, most of which are halophiles, does not favor diverse or abundant sedentary animal populations in the chotts and sebkhets. The temporary nature of most sebkhets restricts their use as wetland habitat during the seasons when they are dry. However, during the seasons when there is water, great numbers of migrating and wintering waders and waterfowl feed and rest in the chotts and sebkhets. Waterfowl feed on plants such as Potamogeton pectinatus and filamentous algae in the larger, less saline sebkhets and on invertebrates, typically Moina rectirostris, Eurytemorpha velox, Ephydra sp., Chironomus sp. and Cyprinid larvae (Morgan 1982).

While saline soils do not favor a diversity of plant species, they also limit cultivation. Often sebkhet are the only untilled land in an area, thus increasing their value as habitat for fauna. Heavy grazing by livestock occurs at most chotts and sebkhet, and the disturbance and competition for palatable plants restricts the numbers of native animals.

Mammals that could be expected in the vegetated edge zones include jackal, red fox, fennec fox, kaffir cat, common genet, egyptian mongoose, brown hare, and many species of rodents, notably North African endemics such as Shaw's jird and the gerbil Gerbillus campestris.

There are more than 30 chotts and large sebkhet and numerous smaller sebkhet in Tunisia. Since most of the chotts and sebkhet are similar from a biological diversity standpoint, the following descriptions include only the larger and more important (to biological diversity) sites.

3.3.2.1. Sebkhet Ariana

36°54' N 10°15' E

This 2500 ha salt lake is located about 10 km northeast of Tunis, near Gammarth. It is separated from the sea by less than 500 m of dunes and has water for most of the year, but usually dries out for a period in the summer. The sebkhet is a large flat pan with a sandy bottom and salty water, surrounded by rolling cultivated hills, eucalyptus plantations and developed areas.

A. Fauna

Sebkhet Ariana, in association with Lake Tunis and Sebkhet Sedjoumi, form a wetland complex that is very important for migrating and wintering waterfowl (Carp 1980). Typical species include:

Shelduck	Dunlin	Black-headed gull
Flamingo (hundreds)	Sanderling	Herring gull
Cranes	Sanderling	Kentish plover
Avocet	Redshank	

B. Influences

The main human influences are tourism development between the sebkhet and the sea, sewage discharge, grazing and some shooting. Although the sewage adds nutrients to the water, if chemical wastes were discharged it could have severely detrimental effects on the flora and fauna.

3.3.2.2. Sebkhet Sedjoumi

36°48' N 10°12' E

On the southwest edge of Tunis, this 2700 ha sebkhet is only 2 km from Lake Tunis. Sedjoumi dries up in August and September of some years; during the other months it has water averaging less than 1 m deep. The shallow water creates ideal conditions for plants such as Potamogeton pectinatus, Althenia filiformis, filamentous algae and Enteromorpha (Morgan 1982, Pottier-Alapetite 1979).

A. Fauna

In the south and west parts of the lake there are about 40 islands varying in size from several square meters to several hectares. The islands are used for nesting sites by thousands of avocets and hundreds of black-winged stilts, making the sebkhet of national importance (Morgan 1982). Sedjoui is of international importance for its overwintering waterfowl (regularly supports more than 10,000) based on the Heiligenhafen criteria (Annex 4). Shelduck (4,000), pintail (16,000) and shoveler (5,700) occur in large numbers in winter. Flamingos occasionally nest on the islands and up to 50,000 have been observed in the lake (Morgan 1982). The importance of the site to flamingos is significantly increased when the sebkhet and chotts to the south dry up. Other birds recorded (Morgan 1982, Carp 1980, Van Dijk 1986) include:

Black-necked grebe	Ruff	Robin
Cattle egret	Snipe	Blackbird
Lapwing	Quail	Song thrush
Grey plover	Little owl	Fan-tailed warbler
Dunlin	Crag martin	Chiffchaff
Little stint	Skylark	Greenfinch
Redshank	Water pipit	Goldfinch
Curlew sandpiper	Meadow pipit	Chaffinch
Marsh sandpiper	Grey wagtail	Corn bunting
Wood sandpiper		

B. Influences

Human influences include hunting, sewage discharge, encroachment by construction projects and a large rubbish dump, grazing, and disturbance caused by traffic on the adjacent roads. Encroachment is an especially detrimental influence, since it reduces the effective habitat area of the sebkhet.

3.3.2.3. Sebkhet Kourzia

36°26' N 09°46' E

Located 10 km northwest of le Fahs and 55 km southwest of Tunis, Kourzia has an area of over 1000 ha. The surrounding terrain is low, cultivated hills that drain into Kourzia. Water remains for most of the year, but dries in the summer, leaving a salt crust. There is an eroded edge bank about 2 m high, and the bottom is clayey sand.

A. Fauna

A variety of ducks and waders feed on the the invertebrate Artemia sp. (Morgan 1982). The site is used by enough waterfowl to meet Heiligenhafen criteria for international importance. In some years great numbers of flamingos (up to 22,000) have been recorded. Other species include:

Shelduck	Ruff	Eagle owl	Crested lark
Pintail	Woodcock	Kestrel	Great grey shrike
Avocet	Quail	Merlin	

B. Influences

Human influences include hunting and cultivation to within 5 m of the waterline, which leaves only a narrow band of vegetation. The ecosystem would be sensitive to heavy concentrations of fertilizers or pesticides in the runoff water from farmlands if large scale chemical use was initiated.

3.3.2.4. Sebket Kelbia

35°50' N 10°17' E

Kelbia is located at the edge of the Low Steppes, 20 km northeast of Kairouan and 30 km west of Sousse. It has an area of 13,000 ha and a maximum depth of 2.5 m. Three intermittent rivers drain the adjacent watershed (15,000 km²) into Kelbia - the Nebhana, Merguellil and Zeroud. Before the rivers were dammed, they flooded after heavy rains, causing erosion and resulting in a delta of silt deposited at the south end of the lake (Morgan 1982). During the summer the lake occasionally dries, leaving a light salt crust on the bottom. Water salinity varies from 1 g/l in the spring to saturation as the lake dries (Zaouali 1976).

A. Vegetation

Along with the halophile vegetation typical of sebkhas, there are bands of tamarisk along the edge and emergents such as cattails Typha angustifolia, reed Phragmites communis and Scirpus lacustris covering about 10% of the edge. When there is water in Kelbia, a dense prairie of Zanichella palustris covers about 90% of the bottom and dominates over Potamogeton pectinatus and Tolypella (Zaouali 1976, Morgan 1982). A floating mass of Spyrogyra often forms during the spring.

B. Fauna

Zaouali (1976) and Morgan (1982) reported several species of fauna:

Zooplankton:

Arctodiaptomus wierzejskii
Daphnia atkinsi

Daphnia magna
Diacyclops crassicaudis

Invertebrates:

Cymatia borsdorffi
Micronecta sp.
Ilyocoris sp.
Sigara sp.
S. dorsalis

Plea sp.
Berosus sp.
Palaemonetes varians (Crustacean)
Gyrinus sp.

Palaemonetes and the insects are adapted in such a manner that after dry periods they can recolonize Kelbia from nearby water bodies. The zooplankton has resistant eggs.

In former times, before the construction of the dams, up to 82 metric tons of fish have been taken from Kelbia by commercial fishermen. Fish species include:

Fundulus hispanicus
Barbus barbus
Mugil cephalus
M. ramada

Gambusia affinis
Cyprinus carpio
Anguilla anguilla

Birds. Two rare species of duck have nested at Kelbia in the past, marbled teal and white-headed duck (Morgan 1982). Kelbia meets Heiligenhafen criteria (Annex 4) for international importance based on the high number of wintering waterfowl (Carp 1980). Some of the many bird species recorded for Kelbia (Olney 1965, Morgan 1982, Carp 1980) are:

n Squacco heron	Purple gallinule	Crane
Flamingo (7,000)	Coot	Little owl
n Shelduck (up to 1800)	Great grey shrike	Hoopoe
Wigeon (30,000)	Black-winged stilt	Crested lark
Pintail (14,000)	Black-eared wheatear	Kentish plover
Shoveler (10,600)	Cream colored courser	Desert wheatear
Moorhen	Black-bellied sandgrouse	Bee-eater

n = Nesting Birds

C. Influences

Kelbia has been described as "unique in the Maghreb and probably in the whole of North Africa" and of outstanding international importance (Morgan 1982). After Lake Ichkeul and the Gulf of Gabes, it is probably the third most important wetland in Tunisia. It is one of the least saline large water bodies in Tunisia and supports a variety of fauna and flora. Before the 3 rivers were dammed (construction began on the Oued Zeroud dam in 1978) the lake almost never, or rarely dried out (Olney 1965, Radford and Peterken 1969). Since the damming of the rivers, dessication is much more frequent and the effects on the flora and fauna have been detrimental.

The ecosystem is sensitive to long or frequent periods of dessication and a program for regulated water release from the dams would be beneficial. Hunting and egg collection are two other influences on the Kelbia ecosystem that should be controlled.

3.3.2.5. Sebket Sidi el Hani

35°31' N 10°27' E

Figure-8 shaped Sidi el Hani is one of the largest (36,000 ha) salt lakes to be called a sebket instead of a chott and the third largest salt lake in Tunisia. The lake is located 25 km southwest of Sousse and 20 km E-SE of Kairouan. It is often dry in summer, but occasionally retains water for more than a year. Salinity is very high and salt crystals sometimes remain on the substrate even when there is water in the lake (Morgan 1982).

A. Vegetation

The high salinity restricts vegetation growth in and around the lake, resulting in large mudflats at the south end. On some of the fresher edges, the rare plant Potentilla supina grows.

B. Fauna

There are several islands that provide nesting habitat, especially for flamingos. In 1972, c. 10,000 flamingos were recorded breeding at Sidi el Hani (Carp 1980). Lesser numbers breed there fairly regularly, making the site of international importance. The frequency of nesting may have decreased in recent years.

Excessive salt also restricts the invertebrate fauna and therefore bird use is lower than that of other sebkhet, such as Kelbia. A variety of waders pass through on migration and permanent residents of the adjacent area include palm dove, great grey shrike, fulvous babbler, lesser short-toed lark and crested lark.

C. Influences

Human influences include cultivation close to the edge of the lake and some egg collecting by local villagers (Carp 1980). The ecosystem would be sensitive to alterations in the watershed feeding the lake.

3.3.2.6. Sebket El Djem

Twelve kilometers south of the city of El Djem, 50 km north of Sfax, and 20 km west of the sea, is the 3,000 ha Sebket El Djem. Water depths reach 3 - 4 m when the lake is full, but it is frequently dry in summer. The surrounding region is rolling hills, cultivated to cereals and olives.

A. Vegetation

The south shore is fairly steep and there is only a narrow band of halophile vegetation. On the north side the halophiles extend for 100 - 300 m over the gently sloping terrain.

B. Fauna

There are several small islands and 2 larger islands that provide nesting cover for black-winged stilts, flamingos and avocets, which nested there in the early 1970s, but may no longer breed there regularly (M. Smart, pers. comm.). Other birds reported for Sebket El Djem (Carp 1980, Morgan 1982, Van Dijk 1986) include:

Pochard (over 10,000)	Little stint	Great grey shrike
Coot (33,000)	Kentish plover	Blackbird
tn White-headed duck (349)	Hoopoe	Song thrush
n Collared pratincole	Swallow	Fulvous babbler
Cream colored courser	Crane	Short-toed lark
n Slender-billed gull	Rock dove	Chaffinch
n Gull-billed tern	Palm dove	Starling
Lesser short-toed lark		

n = Nesting Birds
t = Threatened Species

The high numbers of pochard and coot make the site internationally important and it is a quality example of a representative sebkhet (Morgan 1982).

C. Influences

Human influences on the ecosystem include cultivation of the adjacent area and encroachment into the edge vegetation. Egg collection has occurred in past years (Carp 1980).

3.3.2.7. Sebkhets Sidi Mansour and En Noual 34°15'-25' N 9°39'-58' E

En Noual is 20 km west of the coast, 60 km northwest of Gabes and 11,000 ha in size. Sidi Mansour is 50 km west of the coast, 70 km northwest of Gabes and 3,000 ha in size. Both are shallow (maximum depth 1.5 m) with low salinity levels.

A. Vegetation

Large densely vegetated areas surround the sebkhets, which frequently dry out in summer. Interspersed in the typical sebkhet type halophile vegetation are Tamarix sp. and species common to the surrounding steppes, such as Rhantherium suaveolens and Artemisia campestris

B. Fauna

The dense vegetation provides excellent cover for gerbils, Shaw's jird, brown hare, red fox, and dorcas gazelles. Great numbers of waders visit the sebkhets. An exceptional 75,000 flamingos were recorded in 1971 (Carp 1980) and they occasionally attempt to nest at Sidi Mansour (Olney 1965). Other birds include:

Black-necked grebe	Crane	Scrub warbler
Teal	Little stint	Desert wheatear
Shoveler	Avocet	Mourning wheatear
Pochard	Pratincole	Red-rumped wheatear
t White-headed duck	Long-legged buzzard	White wagtail
Mallard	Swallow	Hoopoe lark
t Marbled teal	Crested lark	

t = Threatened Species

C. Influences

Human influences are widespread at these sebkhets. The dry eastern ends are sometimes cultivated to cereals, vegetation is cut and gathered for fuel and fodder, grazing is excessive, and egg collection has ruined at least one nesting attempt by flamingos (Carp 1980). Hunting and poaching (birds and mammals) are also very common.

3.3.2.8. Minor Sebkhets of the Low Steppes

Due to the flat topography and the runoff from the adjacent mountains, the Low Steppes are spotted with sebkhets. In addition to those already described (Kelbia, Sidi el Hani, El Djem, Sidi Mansour, En Noual) there are several other less important sebkhets worth mentioning. Sebkheth Moknine is about 35 km southeast of Sousse and is less than 5 km from the coast. Usually dry in the summer and not very full in the winter, Moknine offers a safe haven for birds migrating down the coast. Sebkheth Menzel Dar Bel Ouar is 20 km S-SW of Enfida. It is a relatively salty lake, dry in summer, but used by migrating birds in winter.

Sebkhets Ech Cherita, El Gherra, Mecheguig El Bahira and Menzel Chaker are all similar temporary salt lakes southwest of Sousse, northwest of Sfax and east of Sbeitla. These and many other small sebkhets enhance the biological diversity of the region by increasing the interspersion of habitat types and providing cover in heavily cultivated areas.

South of Chebba and a few hundred meters in from the coast is Sebkheth Baradaa. The main standing water body is about 40 ha and the surrounding halophile vegetated floodplain is c.500 ha. Close proximity to the sea makes the wetland attractive to waterfowl and waders migrating along the coast. Some birds, such as black terns, also nest there.

About 20 km north of Kairouan and just south of the town of Metbasta is a vast vegetated floodplain. Relatively low salinity makes this wetland more of a temporary freshwater lake than a sebkheth and therefore the local population calls it Lake Metbasta. Although it only holds water for a short period during and after the winter rains, the vast extension of the floodplain makes it a valuable site for migrating waterfowl and waders, nesting sedentary birds (including the threatened houbara bustard) and mammals.

3.3.2.9. Jeffara Complex

At the Libyan border is a complex of salt lakes and saline river beds covering over 160,000 ha on the Tunisian side. The complex includes Sebkheth el Melah and Bou Djemel - large coastal salt lakes by Bahiret el Bibane; Sebkheth Tader, which extends inland 70 km along the border; Sebkheth Oum el Krialate; Garaet Djedid; Sebkheth Areg el Makriene; and Garaet ez Zets. Although the complex is dry for most of the year it provides important diversity in the habitats of animals such as dorcas gazelles, brown hares and houbara bustards. It is also a potentially valuable rest stop for migrating birds. Relatively little research has been done on the complex and further study is needed.

3.3.2.10. Sebkheth El Guettar

Sebkheth El Guettar, also called Chott El Guettar, is 15 km southeast of Gafsa and 120 km northwest of Gabes. Since the lake is in an arid region, it dries early in the summer and sometimes remains dry throughout the year. The salt lake covers 7,400 ha, with an additional 5,000 ha of halophile vegetation. There are 2 other smaller sebkhets 10 and 25 km northwest of Gabes covering about 4,000 ha each.

A. Fauna

When there is water, the sebkhet receives heavy seasonal use by migrating waterfowl, waders and other birds. Slender-billed gulls and black-winged stilts have been recorded breeding (Morgan 1982) and the threatened houbara bustard is occasionally observed in the halophile vegetation. There is also a resident population of reptiles, rodents (gerbils, jirds), brown hare, red fox and jackal.

B. Influences

Grazing and vegetation gathering occur throughout the area, but the edge zone is so large that adequate cover usually remains for fauna. Hunting and poaching are probably the most detrimental human influences.

3.3.2.11. Sebkhet El Hamma 33°58' N 9°57' E

The system of chotts that form a belt through the center of Tunisia begins near the Mediterranean coast with Sebkhet El Hamma, 25 km W-NW of Gabes. Separated from Chott Fejij to the west by a slight ridge, Sebkhet El Hamma is c.5,000 ha in area. It is often dry for many years, except at the site of a hot (70° C) spring at the southern end (Morgan 1982).

A. Fauna

The hot spring is the only known habitat of a small blind crustacean Thermosbaena mirabilis (Carp 1980). When there is water in the rest of the sebkhet, thousands of flamingos and pochards and hundreds of wigeons, shovelers and other waterfowl and waders use the lake.

B. Influences

Grazing, vegetation gathering, poaching and cultivation of the adjacent area are having an unquantified impact on the sebkhet.

3.3.2.12. Chott Fejij 33°55' N 9°10' E

Extending west from Sebkhet El Hamma is the 570,000 ha Chott Fejij. Often dry for over a year, when there is water it is brackish to fresh (Carp 1980). Water remains longest in four depressions along the chott and usually covers less than 10% of the total area (Morgan 1982).

A. Vegetation

Along with the typical halophile vegetation, the margins support Tamarix sp. and sedges Carex sp.

B. Fauna

Invertebrates include low densities of Artemia sp. (typical of chotts), Daphnia carinata, Dytiscidae and Corixidae. Flamingos nest occasionally (8,000 pairs in 1974) and large numbers of ducks (pochard, shoveler, shelduck) sporadically winter at the chott.

C. Influences

Influences include grazing, cultivation and development.

3.3.2.13. Chott Jerid

33°42' N 8°26' E

West of, and connected to, Chott Fejij is the largest chott of the Maghreb, Chott Jerid, which covers c.700,000 ha. The huge area is never completely inundated, even in wet years only 5% of the chott is covered by water. Standing water occurs sporadically in the chott, depending on where the rains fall, and movement due to the winds is common. The most frequently inundated site is located just to the west of center (Morgan 1982). Water in the chott is brackish to salty and leaves salt deposits after evaporation.

A. Fauna

Sparse invertebrates include Artemia sp., a Dytiscidae and a Corixidae (Morgan 1982). Nesting flamingos (3,000 pairs) were recorded in 1959 (Carp 1980) and some waders may rest at Djerid during migration (Olney 1965), but it is not a site of prime importance for birds. Threatened houbara bustards nest in the area.

B. Influences

Grazing, vegetation collection, cultivation and manipulation of underground water reserves for irrigation all affect the chott.

3.3.2.14. Chott El Gharsa

Ten kilometers to the northwest of Chott Jerid and distinctly separated from it, Chott El Gharsa is connected to the belt of chotts extending westward into Algeria. Covering c.60,000 ha, the chott has a center altitude of 7 m below sea level. El Gharsa is similar to the other chotts in terms of water regime, flora, fauna and influences.

3.3.2.15. Artificial Lakes Near Kebili

33°37' N 8°53' E

Near the southeast edge of Chott Jerid, 15 km southwest of Kebili, is a series of small brackish lakes averaging a few hundred hectares in size. Lakes Nouiel, Graad, Taffaya, Menchia and Fatnassa are fed by excess irrigation water from the adjacent oases and therefore are less saline than most sebkhetts and are almost never completely dry.

A. Fauna

The lakes are attractive to migrating waterfowl and waders, especially since they are some of the last wetlands before the birds cross the Sahara, and the first ones they reach when they return. Many birds also

winter there. Waterfowl observed in January 1986 (Smeti, pers. comm.) include:

Flamingo	Teal	Shoveler	Gadwall
Moorhen	Pintail	Wigeon	Mallard

B. Influences

Waterfowl are hunted at the lakes each year, but not at excessive levels (about 10 hunters annually). The edge vegetation is heavily grazed by livestock.

3.3.3. Rivers and Reservoirs

Permanent rivers only exist in the north, but there are intermittent rivers and streams scattered throughout Tunisia. All major rivers and many of the smaller, intermittent rivers have at least one dam, constructed to conserve water for irrigation or domestic use and to reduce flood damage. A catastrophic flood in 1969 eroded 260 million tons of soil from a watershed of 8,577 km² where normally 5 million tons are lost annually (Grant 1980). The flood also changed the watercourses of several streams and destroyed many bridges, roads and buildings. That destructive flood spurred the Tunisian government into increasing its dam construction program.

Due to the dams and the long dry season, a large proportion of the surface water evaporates before it is used for irrigation or reaches the sea. The high annual evaporation rate - 1400 mm in the north to 3000 mm in the south (Grant 1980) - results in the dessication of many rivers and some of the smaller reservoirs.

Typical vegetation along rivers and reservoirs of the north includes planted acacia and eucalyptus and:

Tamarix sp	Juncus	Phragmites communis
Carex sp	Nephron oleander	Rubus ulmifolius

In southern watersheds the saline soil results in moderately halophile vegetation. Submergent vegetation is uncommon due to the turbidity and seasonality of waterflow in the rivers and the depth of the reservoirs.

Tunisian rivers are poor in fish species diversity (Kraiem 1983). There are only 12 species, of which 8 are native and 4 are introduced. Fish of the northern and central rivers and reservoirs are in the genera: Aphianus, Gambusia, Barbus and Pseudophoxinus.

Rivers provide important habitat for local populations of birds and mammals. Although the depth and resulting lack of submergent vegetation makes most reservoirs poor habitat, several species of waterfowl and waders use the large freshwater bodies as migration rest stops. The threatened white-headed duck uses the Besbesia dam reservoir between Tunis and Bizerte, and great crested grebes and some ducks breed at the Gdir el Ghoul ponds just outside of Tunis.

The biological diversity of Tunisia's rivers has received scant attention in the past and additional studies are needed. The two major permanent rivers are the Medjerda and the Miliane, described below.

3.3.3.1. Oued Medjerda

Oued Medjerda is the largest river in Tunisia. It originates in Algeria, enters Tunisia near Ghardimaou and flows into the Mediterranean sea south of Porto Farina. The river is 460 km long and has a watershed of 23,000 km², of which 15,000 km² is in Tunisia (Andren and Salem 1978). The mean rate of flow is 30 - 1500 m³/second, which fluctuates greatly since 30 - 85% of its discharge is in floodwaters (Grant 1980).

Oued Medjerda has been altered substantially by water control projects and 80% of its water is now retained. The watercourse has been channelized in several locations, a large cement lined canal has been created to bring water to Cap Bon, and several dams have been constructed along the river and its tributaries.

The largest reservoir in North Africa has been created by the Sidi Salem dam near Beja. At maximum water levels c.4,600 ha are inundated by the reservoir. Soils in the area are very erodible; massive landslides have dumped large quantities of earth into the reservoir and upstream erosion has resulted in a fast sedimentation rate. The dam is relatively new, so the surrounding vegetation has not succeeded to riparian associations. Grazing and cultivation to the edge of the reservoir in some locations is also slowing the succession process and increasing erosion. Although the reservoir is filling in fast, it is too deep to provide optimum wildlife habitat. Birds of interest noted in September of 1987 include great crested grebe, kentish plover and marsh harrier.

There are also many dams on the 12 tributaries to Oued Medjerda. North of Le Kef is the Oued Mellegue dam, constructed in 1948-54. The maximum area of the reservoir is 1000 ha, which is important in a region with few natural wetlands. The reservoir has many coves and a very irregular coastline. Drastic water fluctuations have resulted in little submergent or edge vegetation. Migrating teal, wigeon, mallards and waders use the reservoir as a rest stop. A variety of game birds, passerines and mammals occur on the adjacent land.

3.3.3.2. Oued Miliane

Oued Miliane discharges into The Gulf of Tunis just south of the city of Tunis. A watershed of 2,000 km² drains into the river, which carries an annual volume of 6 million m³ of usable water (Andren and Salem 1978). Two dams, El Kebir and Bir M'Chergua have been constructed on the Miliane.

3.3.4. Other Freshwater Wetlands

Truly freshwater wetlands are scarce in Tunisia. Most of the wetlands are somewhat saline due to salt in the watershed soil or influxes of seawater into the wetland. The freshest wetlands existing in Tunisia are those fed directly by rainwater or groundwater. The following five

wetlands have been selected as representative of the various small wetlands that exist in Tunisia or because they exhibit special characteristics of interest in regard to biological diversity.

3.3.4.1. Djebel Chitane Lake

37°11' N 9°10' E

Inland of Cap Serrat, 45 km northeast of Tabarka on the north coast, is the mountain lake of Djebel Chitane. The lake is not very large and the water is fresh.

A. Vegetation

Lake Chitane is surrounded by cork oak Quercus suber forest. The fresh water creates conditions favorable for the growth of aquatic and edge vegetation species that are found in only a few other locations in Tunisia. Species include (Radford and Peterker 1969, Pottier-Alapetite 1979):

r	<u>Nymphaea alba</u>		<u>Isoetes velata</u>
r	<u>Sparganium erectum</u>	r	<u>Echinodorus ranunculoides</u>
	<u>Ranunculus ophioglossifolius</u>		<u>Asplenium adiantum nigrum</u>
	<u>R. aquatilis ssp baudotii</u>		

r = Rare

B. Influences

There have been no recent reports on factors influencing the lake, but it would be very sensitive to activities increasing sedimentation, salinity, or pollution.

3.3.4.2. Lake El Fiel

Between Djebel Kechem el Kelb and Djebel Touila, 22 km southwest of Kasserine, is a small depression (100 ha) at an altitude of 650 m. The wetland is fed by runoff water and it dries out each summer for about 2 months. Salinity is about 2 g/l (Morgan 1982). Clay substrates help retain water and the basin can fill rapidly after heavy rains.

A. Vegetation

The land around the lake is Artemisia herba alba steppe, much of which has been cultivated to wheat. Scirpus maritimus covers 10% of the wetland and when there is water an algae mat forms on the surface.

B. Fauna

Invertebrates reported by Morgan (1982) are Sigaria concinna (a brackish water form), thaumalid larvae and a calanoid. Coot, little stint, curlew sandpiper and other waders and birds feed and rest at the wetland during migration.

C. Influences

Scirpus would probably cover more of the wetland if it was not grazed intensively by livestock.

3.3.4.3. Lake Zerkine

33°15' N 10°17' E

Twenty-five kilometers southeast of Gabes is a small (c.50 ha) wetland fed by groundwater and runoff. The shallow lake has a maximum depth of 1 meter and the salinity in May of 1976 was 3.2 g/l (Morgan 1982). Lake Zerkine is therefore not one of the freshest water bodies of Tunisia, but it is one of the freshest in the region.

A. Vegetation

Scirpus maritimus forms a marsh on 40% of the bottom and Characeae is dispersed over 80% of the pond (Morgan 1982). This is probably the only southern location of Butomis umbellatus, which is rare throughout Tunisia. Dasmonium alisma is another aquatic plant found in the marsh.

B. Fauna

Pond fauna includes:

Benthic:	Notonecta sp.	Lebellulidae	Baetidae
	Corixa panzeri	Chironomidae	Coenagrionidae
	Sigara concinna		
Insect:	Daphnia sp.	Daphnia atkinsoni	
Amphibian:	Rana sp.	Bufo viridis	

Birds. During migration, many of the waterfowl and waders listed for the Gulf of Gabes (Section 3.1.4) could be expected to feed in the pond. Morgan (1982) recorded summertime use by grey heron, little egret, squacco heron, night heron, glossy ibis, coots, black tern and garganey.

C. Influences

The fresh water and vegetation of the marsh attract herders with their livestock to the site. Grazing is a primary source of disruption to the ecosystem. Although it may not be possible to completely eliminate grazing, the implementation of some sort of sensible use strategy could greatly enhance the habitat value of Lake Zerkine.

3.3.4.4. Oued Essed Pools

35°55' N 10°28' E

When Sebkheth Kelbia (Section 3.3.2.4) overflows, it drains into the sea via Oued Essed. Since Kelbia only occasionally overflows (Zaouali 1976), usually most of Oued Essed is dry except for some pools near Sidi Bou Ali, between the railroad tracks and GP1. The pools are fed by springs and only extend a few hundred meters along the riverbed.

A. Vegetation

Along the pools, the fresh, flowing water supports a lush growth of cattails Typha angustifolia, Phragmites communis, Juncus sp., Tamarix sp. and a few halophile species.

B. Fauna

Abundant invertebrates occupy the water area that does not dry up during the summer; therefore an unusual variety of birds are attracted. In August of 1987, the following birds were recorded:

Little egret	tn Marbled teal	Wood sandpiper
n Night heron	n Black-winged stilt	Marsh sandpiper
Moorhen	Little ringed plover	Greenshank
Coot	Kentish plover	Hoopoe
Water rail	Little stint	Fan-tailed warbler
Shelduck	Temminck's stint	Olivaceous warbler
Mallard	Cream colored courser	

t = Threatened Species

n = Nesting Birds

C. Influences

The riverflow has been altered by bridges, road construction and upstream gravel excavation, but the pools appear to be relatively undisturbed. This is a valuable wetland site that would be very sensitive to vegetation removal or disruption of the water flow.

3.3.4.5. Dar Fatma Bog

36°48' N 8°45' E

The only known peat bog in the country is 25 km south of Tabarka in the Kroumirie mountains of northwest Tunisia. Mountain streams flow into a basin (770 m altitude) creating a small wetland about 3 ha in size, and subterranean groundwater seepage has created a true Sphagnum bog in a small part of the basin.

A. Vegetation

Radford and Peterken (1969) reported that 150 - 200 plant species grow in the basin, many of which do not occur elsewhere in Tunisia. The bog, which is only a few square meters in size, is dominated by several species of Sphagnum moss, primarily S. subsecundum. Other species in and at the edge of the bog include:

Eleocharis multicaulis	Montia fontana
Hypericum afrum	Angallis crassipes
Holcus lanatus	Potentilla repens
Bellis repens	Hylocomium sp.
Juncus sp.	

Surrounding the bog are soligenous mire communities of

<i>Erica scoparia</i>	<i>Phragmites communis</i>
<i>Asphodelis microcarpus</i>	<i>Isoetes hystrix</i>

The forest ecosystem around the basin is dominated by

<i>Quercus canariensis</i>	<i>Erica arborea</i>
<i>Q. suber</i>	<i>Calycotome villosa</i>
<i>Crataegus monogyna</i>	

B. Influences

The bog was fenced at one time to protect it from grazing and trampling, but it is doubtful that the fence has been maintained. The small ecosystem would be very sensitive to trampling or any other form of vegetation disruption or removal. Since the bog is only a few square meters in size, rare species of plants could be eliminated by a single days grazing. The site is known to be important for its unique vegetation, but little study has been made of the fauna.

3.4. MOUNTAINS

There are five main mountain systems in Tunisia (figure 8): the Kroumirie/Mogods chain in the north; the Tunisian Dorsal range from the west-center to Cap Bon; the High Tell - spread between the Kroumirie/Mogods and the Tunisian Dorsal; the mountains of the High Steppe in central Tunisia; and the Douirat mountains of the south. Most of the forests of Tunisia are located in the mountains and the steep rugged slopes provide sanctuary for many species of animals.

The climate in the mountains differs from the surrounding regions. Precipitation rates increase 20 mm for every 100 mm increase in altitude. The summits receive precipitation in the form of rain, hail and even snow. An important source of additional moisture is clouds and fog, which occur even in the dry summer seasons. Temperatures are also cooler in the mountains; especially the high mountains of the northwest.

Except for the Kroumirie/Mogods in the humid north, most of the mountain forests are degraded and severe erosion is common. Fuelwood cutting has caused much of the degradation and overgrazing accelerates erosion. Cultivation on the slopes also increases erosion - especially when the contours are not followed - and decreases habitat quality.

Thus, the factors to which mountain ecosystems are most sensitive include:

Erosion causing activities:

- Overgrazing
- Vegetation cutting for fuelwood and fodder
- Cultivation

Forest degradation:

- Cutting
- Soil loss

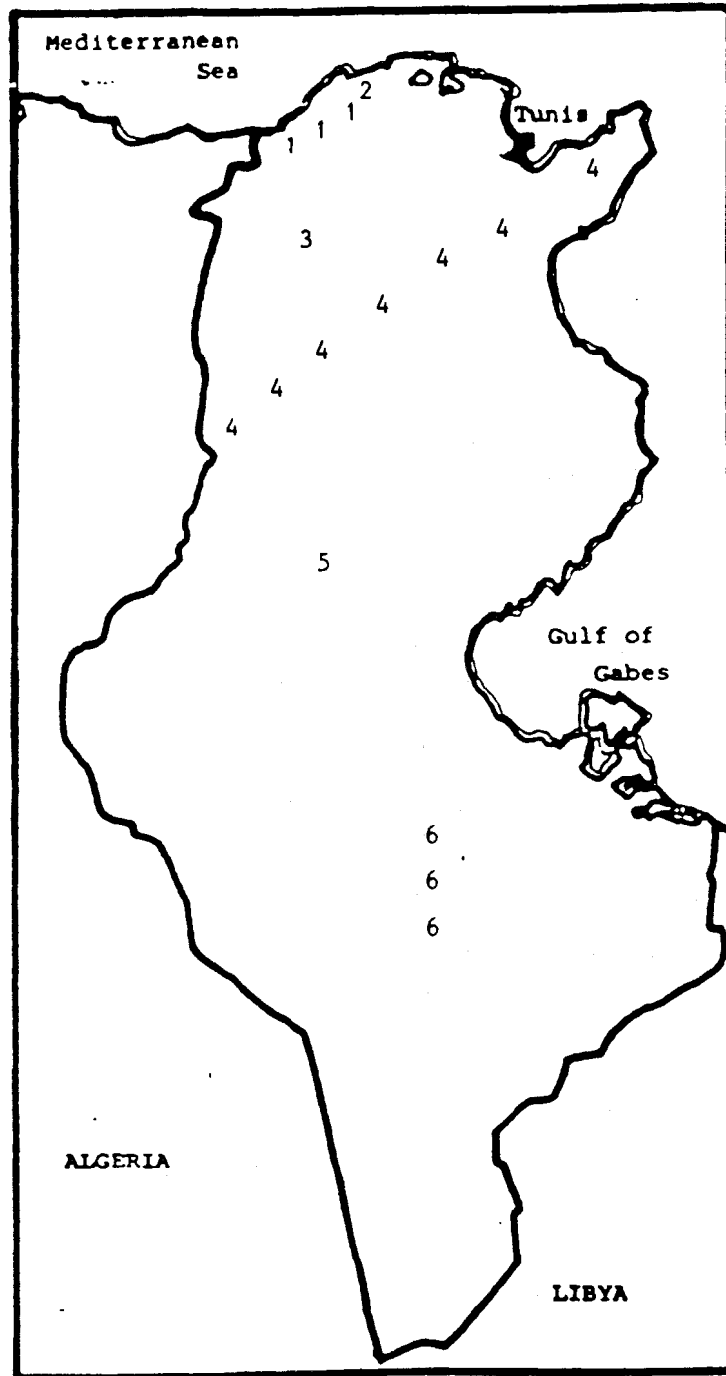
Alteration of fragile alpine meadows

3.4.1. Kroumirie/Mogods

The Kroumirie mountain range enters Tunisia at the northwest corner and extends northeast, to the north of Jendouba and Beja and parallel to the coast. At Nefza the mountains taper off and then rise up again as the Mogods, which extend to Bizerte. The average altitude varies from 400 to 800 m (ONUPAA 1985) and reaches 1203 m at Djebel Rhorra on the Algerian border.

The northwest is the coolest and wettest part of Tunisia. Temperature and precipitation in the region vary greatly with altitude and exposure. The Mediterranean Sea moderates the climate on the north slopes and the continental influence is very evident on the southern edge of the chain. Bioclimates characteristic of the Kroumirie/Mogods are variants of the Mediterranean Humid and Subhumid types.

Figure 8
Mountain Ranges of Tunisia



1. Kroumirie
2. Mogods
3. High Tell
4. Tunisian Dorsal
5. Mountains of the High Steppe
6. Douirat

The Kroumirie/Mogods are composed of limestone, sandstone and clay from in the oligocene era. Dominant soils are moderately acidic and often leached. Forest soils are heavy, hydromorphic and fairly rich in well decomposed humus (ONUPAA 1985). Poorer soils in unforested areas are finer and lighter sandy-limes. Secondary soils include heavy vertisols and hydromorphs at bases of slopes and brown calcareous soils.

Vegetation. A vast forest of zen oak Quercus canariensis and cork oak Quercus suber once covered the Kroumirie/Mogods. Smaller forests of Q. afares, kermes oak Q. coccifera and Pinus pinaster also grew. Clearing and cultivation in the lower valleys has reduced the extensiveness of the forests, but the Kroumirie/Mogods are still the most forested regions of Tunisia. Cork oak forest predominates, stretching from the Algerian border, throughout the Kroumirie and into the Mogods.

The variations in altitude, soil and climate encompassed by the range of the cork oak forests results in a diversity of associated vegetation types. Guenot and Schoenenberger (1965) described the primary associations and variants of the vegetation in northern Tunisia. The primary association on the higher mountains consists of cork oak with an understory of various proportions of:

<i>Erica arborea</i>	<i>Viburnum tinus</i>
<i>Cytisus triflorus</i>	<i>Rubus ulmifolius</i>
<i>Calycotome villosa</i>	<i>Myrtus communis</i>
<i>Cistus salviifolius</i>	

On lower mountains and slopes the understory contains many of the above species, but the more humid shrub types are replaced. There is also a greatly differing herb layer. Common associations are indicated by:

<i>Erica arborea</i>	<i>Pistacia lentiscus</i>
<i>Calycotome villosa</i>	<i>Myrtus communis</i>
<i>Cistus salviifolius</i>	<i>Phillyrea angustifolis media</i>
<i>C. monspeliensis</i>	

and a common variant that occurs on drier slopes is indicated by the presence of Lavandula stoechas and:

<i>Erica scoparia</i>	<i>Genista aspalathoides</i>
<i>Halimium halimifolium</i>	TA <i>G. ulcina</i>

In the Mogods, cork oak forests are often mixed with kermes oak, which becomes the dominant species in many locations. A common association includes the oaks and:

<i>Pistacia lentiscus</i>	<i>Viburnum tinus</i>
<i>Erica arborea</i>	<i>Rubus ulmifolius</i>
<i>Myrtus communis</i>	

TA = Tunisia/Algeria Endemic

A Lavandula stoechas variant similar to the one described above may occur on drier slopes. Where cork oak does not occur, kermes oak is often in association with:

Arbutus unedo	Cistus monspeliensis
Erica multiflora	Pistacia lentiscus

Near the coast the main association is indicated by kermes oak, Teucrium fruticans and dwarf palm Chamaerops humilis. On the high slopes and north facing ravines of the western part of the Kroumirie, abundant rain and cool temperatures create favorable conditions for a zen oak climax forest. Zen oak grows in dense stands, often with a closed canopy that restricts the growth of understory trees. More open stands contain shrubs, such as:

Cytisus triflorus	Myrtus communis
Erica arborea	Rubus ulmifolius
Crataegus oxycantha monogyna	

but the most abundant plants are herbs, including:

Agrimonia eupatoria	Achillea ligustica
Brachypodium sylvaticum	Rumex tuberosus
vNA Cyclamen africanum	Prunella vulgaris

In regard to vegetation diversity, zen oak forests include some interesting species groups at the limit of their range. The highest peaks of Tunisia are the lower altitudinal limits of some high altitude species, such as:

rNA Lapsana communis macrocarpa	Ilex aquifolium
.Urtica dioica	Circaea lutetiana
Carex silvatica	rNA Geum urbanum
v Ajuga reptans	Platanthera bifolia
Hieracium pseudo-pilosella	

In terms of longitudinal range, the zen oak forests of Tunisia are the eastern limit of the following species characteristic of the Kabylie mountains:

rNA Quercus afares	Festuca drymeja
Carex olbiensis	Scutellaria columnae
r Potentilla micrantha	rNA Doronicum atlanticum
Dianthus balbisii	Geranium atlanticum
Saxifraga veronicifolia	

There are also over 200 species of mushrooms and numerous ferns, such as:

r Blechnum spicant	Ophioglossum lusitanicum
Athyrium filix-femina	r Phyllitis scolopendrium
r Dryopteris aculeata	r Pteris longifolia
r D. filix-mas	

v = Very Rare NA = North Africa Endemic
r = Rare

Much of the Kroumirie/Mogods has been degraded from the climax vegetation type. Where the cork oak forest has been cleared, a maquis of heather (Ericaceae) forms (ONUPAA 1985). The characteristic species of the heather maquis include (Guenot 1965):

<i>Erica arborea</i>	<i>Briza maxima</i>
<i>Cistus monspeliensis</i>	<i>Koeleria pubescens</i>
<i>Calycotome villosa</i>	<i>Trifolium campestre</i>
<i>Pistacia lentiscus</i>	<i>Festuca coerulescens</i>
<i>Arbutus unedo</i>	<i>Cynosurus echinatus</i>
<i>Plantago serraria</i>	<i>Bellis silvestris</i>
<i>Hypochaeris radicata</i>	<i>Ampelodesma mauritanica</i>

or, there may be a variant typified by:

<i>Erica scoparia</i>	<i>Tuberaria vulgaris</i>
<i>Lavandula stoechas</i>	<i>Pteridium aquilinum</i>
<i>Halimium halimifolium</i>	<i>Hedysarum coronarium</i>

On the lower slopes of the Kroumirie, especially at the edges of the range, the maquis are more likely to include:

<i>Olea europaea oleaster</i>	<i>Chrysanthemum paludosum</i>
<i>Pistacia lentiscus</i>	<i>Mentha pulegium</i>
<i>Myrtus communis</i>	<i>Romulea linairesii</i>
<i>Genista ferox</i>	<i>Centaurium spicatum</i>
<i>Juncus bufonius</i>	<i>Gaudina fragilis</i>
<i>Cichorium intybus pumilum</i>	

or Lavandula variants. On drained soils, the following species are found:

<i>Calycotome villosa</i>	<i>Avena alba</i> var. <i>barbata</i>
<i>Genista tricuspidata</i>	<i>Hyparrhenia hirta</i>
<i>Trifolium angustifolium</i>	

In the Mogods, the maquis are still dominated by Olea and Pistacia (*Olea-lentiscus* maquis), but the other associated species are often quite different from those of the Kroumirie. Common associations include:

<i>Jasminum fruticans</i>	<i>Stellaria media</i>
<i>Rubus ulmifolius</i>	<i>Arum media</i>
<i>Asparagus albus</i>	<i>Arisarum vulgare</i>
<i>Galactites tomentosa</i>	<i>Ambrosia babsii</i>
<i>Cynosurus echinatus</i>	<i>Allium chanaemoly</i>
<i>Urtica pilulifera</i>	<i>Silybum marianum</i>
<i>Cerastium glomeratum</i>	<i>Cirsium scabrum</i>

Influences. The species composition and vegetation cover of the Kroumirie/Mogods have been changed from the original vast oak forests by timber harvesting; clearing for cultivation, pasture and homes; gathering of firewood, forage, medicinal and edible plant products; and manipulation

of water resources (dams, stream diversion). By 1943, French colonialists had harvested so much oak from the Kroumirie that no large stands of trees greater than 1 meter in diameter were left (Dir. For. 1965). Most of the wood was used for the railroads. In 1943 almost all of the trees were 10 to 50 years old, with only a few old groves left at the former Ain Draham National Park and scattered sparse inaccessible clumps in other areas.

In terms of biological diversity the highest, steepest, most inaccessible areas are those most likely to succeed toward the natural climax vegetation. Official protection of some other areas has resulted in diverse natural vegetation and favorable wildlife habitat. Even locations that are heavily influenced by people are important to the biological diversity if the the continuity of the oak forest is maintained. Starting from the west, sites of special interest in the Kroumirie/Mogods are described below.

3.4.1.1. El Feidja

36°15' N 8°17' E

About 60 km southwest of Tabarka the Tunisia/Algeria border curves westward to encompass the El Feidja - Djebel Rhorra massif. The summit of Djebel Rhorra (1203 m) is on the border, which puts the southwest slope in Tunisia. El Feidja is a large massif (over 20,000 ha) with many peaks and valleys ranging in altitude from 350 m to 1110 m at Djebel Statir.

On the high peaks is where the highest precipitation rates in North Africa occur (1500+ mm/year). Snow falls on the high peaks several times each winter and reaches the lower slopes an average of 4 to 7 times per year. Drizzle, mist and hail also add to the water regime, keeping the area humid, and many streams flow throughout the year.

A. Vegetation

Over 17,000 ha (85%) of El Feidja is forested. The higher slopes of the massif are the most favorable locations in Tunisia for zen oak. At the summit of Djebel Rhorra there is a 160 ha alpine meadow (Dir. For. 1965) - the largest of the few that exist in Tunisia. A grove of the rare Tunisia/Algeria endemic Quercus afares has also been reported to exist at El Feidja (Dir. For. 1976b). Another Tunisia/Algeria endemic plant reported for El Feidja is Genista ulcina (Pottier-Alapetite 1979).

Species adapted to the warmer temperatures and moderate rain of the cork oak stands and clearings include those typical of heather or *Olea-lentiscus* maquis and:

	<i>Prunella vulgaris</i>	<i>Ficaria verna</i>
	<i>Cynosurus polybracteatus</i>	<i>Allium triquetrum</i>
	<i>Genista ferox</i>	<i>Asphodelis microcarpus</i>
NA	<i>Medicago sativa eu-sativa</i>	<i>Smilax aspera</i>
	<i>Ampelodesma mauritanica</i>	<i>Daphne gnidium</i>
	<i>Centaurea africanus tagona</i>	<i>Helianthemum</i> sp.

NA = North African Endemic

Undergrowth in the zen oak stands contains (Dir. For. 1965, Peterken and Radford 1969):

<u>Shrubs:</u>	Ilex aquifolium	Cytisus triflorus
	Cerasus avium	Agrimonia eupatoria
<u>Herbs:</u>	Teucrium scorodonia	Smyrnum rotundifolium
v	Ajuga reptans	Asperula laevigata
r	Potentilla micrantha	Galium laevigata
r	Stellaria holostea	rNA Doronicum atlanticum
	Luzula Forsteri	Geranium atlanticum
r	L. campestris	Asphodelis cerasiferus
	Vicia sativa	r Lamium bifidum
r	V. disperma	Carex europea
rNA	Cyclamen africanum	Achillea liguistica
r	Sanicula europaea	Lathyrus sphearicus
		L. inconspicuus
<u>Grasses:</u>	r Melica uniflora	Anthoxanthum odoratum
	M. minuta	

The biological diversity of the El Feidja forests is indicated by some of the non-dominant species. There are Mid-European type species as well as those characteristic of the Mediterranean forest.

Mid-European Species:

Sisymbrium alliaria	Epilobium montanum
Agrimonia eupatoria	r Melica uniflora
Circaea lutetiana	Planthantha bifolia
Sanicula europea	

Mediterranean Forest Species:

Cardamine hirsuta	Scutellaria columnae
Hypericum afrum	Phlomis herba venti
H. australe	Specularia falcata
Lathyrus latifolius	Arisarum vulgare

There are also many temperate European non-forest species, such as

Lilium candidum	Asperula arvensis
Fumaria officinalis	Fedia cornucopiae
rNA Geum urbanum	Draba verna
Anthriscus sylvestris	Vicia sativa

r = Rare

NA = North Africa Endemic

Other non-forest associations include those of sandstone outcrops, permanent streams and alpine meadows:

Sandstone Outcrops:

Celtis australis	Polypodium vulgare
Acantha mollis	Potentilla splendens
Asplenium adiantum nigrum	Sedum coeruleum
A. trichotomanes	Selaginella denticulata
Ruscus hypophyllum	Umbilicus rozizentalis

Permanent Streams:

Salix purpurea-helix	Rubus fruticosus
Rosa canina	Polypodium vulgare
r Acer monspessulanum	Ranunculus aquatilis
Nerium oleander	Cyperaceae

Alpine Meadow:

Fissidens taxifolius	Bryum torquescens
Mnium unguatum	B. alpinum

Two additional rare plants that occur at El Feidja are Rubus incanescens and Rosa gallica.

B. Fauna

Mammals. The El Feidja massif has the highest concentration of the rare barbary deer Cervus elaphus barbarus in Tunisia. Approximately 1,400 deer inhabit 18,000 ha of forests and clearings in the area, feeding on herbs and mast. Wild boar, jackal, red fox, common genet, Algerian hedgehog and North African crested porcupine are also common. Occasionally, rare lynx-like caracal Caracal caracal are reported.

Birds. Abundant rock outcrops and cliffs at El Feidja provide habitat for diurnal and nocturnal raptors and other ledge or cavity nesting birds. Many migrating birds pass through the forest in the spring and fall, and there is also a rich diversity of sedentary species. Common birds reported for El Feidja (IUCN 1987) include:

Golden eagle	Green woodpecker	Chaffinch
n Short-toed eagle	Great spotted woodpecker	Blackcap
n Sparrowhawk	Turtle dove	Spotted flycatcher
Kestrel	Wood pigeon	r Firecrest
Tawny owl	Great tit	Wren
Cuckoo	Coal tit	Raven

r = Rare
n = Nesting Birds

C. Influences

Dense forest cover normally protects the steep slopes from erosion, but the forests have been altered many times by fires and human manipulation. More than 50% of the zen oak have been hit by flames (Dir. For. 1965), some of which was a result of the French-Algerian war. Local inhabitants, French colonialists and the Algerian army all exploited the forests, often leaving clearings or maquis that did not regenerate to oak. Firebreaks were also cut and re-opened every 3 years.

Past actions still influence the ecosystem today, and exploitation continues by the local residents. Cork harvesting - while not destructive to the oaks - results in trampled undergrowth and disturbance to the fauna. Other forest products, such as acorns and Myrtus communis branches are also harvested.

El Feidja was uninhabited until the late 1800s when the French arrived (Riney 1964). During the 1960s there were about 1,000 homes with 5,000 Tunisians who owned 2,500 cows, 6,000 sheep and goats and 600 equids. In some cases the occupations were illegal. To feed their animals the people herded them through c.5,000 ha to graze, and collected fodder. Estimated forage needs averaged 185% of the sustainable production in optimum conditions for the forest. This means that serious overgrazing has been occurring for many years, although the level may have decreased since the 1960s. Residents have also cleared plots for raising cereal crops - a practice not well adapted to the climatic conditions of the region.

Barbary deer were completely eliminated from the area between 1954 and 1962 (Riney 1964). After the deer became a protected species they immigrated to El Feidja from Algeria in 1962. Wild boar, doves and pigeons are still hunted in the area.

To further protect the deer a 417 ha reserve has been created. There are current proposals to create a 2517 ha national park at El Feidja to preserve the forests and fauna (see Section 5.4.6).

3.4.1.2. Ain Draham

Ain Draham is 40 km northeast of El Feidja and 26 km south of Tabarka. The region around the city is very mountainous, though not as high as El Feidja.

A. Vegetation

Northwest of Ain Draham, on the Algerian border, is Djebel Daraoui, which is forested to zen oak and cork oak (Radford and Peterken 1965). there are also several other zen oak forests up to several hundred hectares in size to the east of Ain Draham. One of those forests, Ain Zana (18 km SE of Ain Draham), contains a 5 ha grove of the rare

Tunisia/Algeria endemic Quercus afares. Associated vegetation includes:

Ilex aquifolium	Sanicula europaea
Cytisus triflorus	Brachypodium silvaticum
Erica arborea	Athyrium filix-femina
Arbutus unedo	r Potentilla micrantha
Luzula forsteri	Saxifraga veronicifolia
r Alliaria officinalis	r Viola odorata
r Dryopteris aculeata	Prunella vulgaris

r = Rare

Two stands of aleppo pine Pinus halepensis exist 3 km northwest and 5 km northeast of Fernana. Each stand is c.300 ha in size. The interspersation of the aleppo pine stands into the oak forest increases the ecotone, or transition zone, between the Kroumirie and the High Tell.

Biological diversity in the area is enhanced by the Dar Fatma bog (see Section 3.3.4.5) and somewhat by the Beni Mtir reservoir. The reservoir provides a freshwater rest area for migrating waterfowl and waders, but the deep water and unvegetated edges do not favor continual use by large numbers of animals. Downstream from the dam, the Oued Melah is vegetated by Nerium oleander, Laurus nobilis, Hypericum androsaemum and other riparian plants and it is reported to be used by mongoose and rare otters Lutra lutra.

B. Influences

Exploitation of forest vegetation and clearing for cultivation or development are the main factors affecting the ecosystems.

3.4.1.3. Tabarka

On the Mediterranean coast, Tabarka is the northwestern most city in Tunisia. The Kroumirie mountains drop abruptly to the sea to the west of Tabarka and subside more gently to the east.

A. Vegetation

Forests in the area are dominated by cork oak and occasionally contain zen oak and aleppo pine. Southwest of Tabarka there is a maritime pine Pinus pinaster ssp. renoui forest near the Algerian border. This 5,500 ha natural forest is the largest of its type in Tunisia. Cork oak is mixed in with the forest, but it does not grow well on the acidic soil. Other associated species include:

Erica scoparium	Pistacia lentiscus
E. arborea	Lavandula stoechas
Halimium halimifolium	Teucrium fruticans
Arbutus unedo	

B. Fauna

To the west of Tabarka is Ain Baccouch, an area containing 50 - 100 barbary deer. The site is forested to cork oak, with some zen oak and maritime pine (IUCN 1987) and has been designated a permanent reserve to protect it from hunting, exploitation and grazing (See Section 5.4.10).

3.4.1.4. Nefza

Where the Kroumirie ends and the Mogods begin, there is a valley containing the northward flowing Oued Madena and the City of Nefza. The Mogods are lower and not as steep as the Kroumirie and most of the lower slopes and valleys have been cultivated.

A. Vegetation

There are some well forested areas left in the region, such as the Belif forest. Belif is claimed to be one of the most productive cork oak forests in Tunisia. In 1974 the forest was hit by a tornado that destroyed most of the trees in its path. In 1987, dense vigorous regeneration covered the affected area. The regenerating stand is protected from grazing and other exploitation. Understory vegetation in the forest includes:

	Calycotome villosa	Daphne gnidium
	Crataegus oxycanthus monogyna	Asphodelus microcarpus
	C. azarolus	Rubus ulmifolius
vT	Teucrium radicans	Alnus glutinosa
r	T. pseudo-scorodonia	

At the north end of the Belif forest is the forest of M'hibes. Cork oak is dominant, but kermes oak is also common, and becomes dominant toward the coast. Associated species include:

Olea europaea oleaster	Teucrium fruticans
Pistacia lentiscus	Cistus salviifolius
Myrtus communis	C. monspeliensis
Erica arborea	Pteridium aquilinum
Chamaerops humilis	

Just south of Nefza at Djebel Abiod and further south at Djebel Sidi Ahmed are two mountain ranges dominated by carob Ceratonia siliqua and Olea-lentiscus formations, along with:

Rhamnus alaternus	Phillyrea angustifolia
R. lycioides ssp oleoides	ssp latifolia

South of Djebel Sidi Ahmed is Djebel Rhenza, the location of an isolated stand of aleppo pine and Arbutus unedo.

v = Very Rare T = Tunisia Endemic
r = Rare

B. Fauna

Between 50 and 150 barbary deer exist in the M'hibes forest (IUCN 1987). Wild boar, jackal, red fox, brown hare, and many species of bats and rodents also occur near Nefza.

C. Influences

Timber harvesting is carefully monitored by the Forestry Directorate, but there is an unknown amount of grazing and collection of fodder in the forests. Myrtus and Erica branches are also harvested. At M'hibes a 370 ha reserve has been created to protect the rare barbary deer.

3.4.1.5. Sejnane

Toward the eastern end of the Mogods, cork oak is replaced by kermes oak maquis. The cork oak that does occur is usually sparse, shows poor growth and is mixed with kermes oak and associated species. Between Sejnane and Tamra there is an example of such a maquis, including Erica scoparia, Myrtus communis and Genista ferox. In the clearings there are two uncommon plants that only occur in this area: Isoetes velata var. typica and the rare Tunisia/Algeria endemic Armeria spinulosa (Radford and Peterken 1969).

An example of the climax vegetation type can be seen at a place northeast of Sejnane by road MC51. Called "Sacred Wood" by Radford and Peterken (1969), the site centers around an old burial shrine. Out of respect for the shrine the trees are not cut, but livestock is brought into the forest and the ground is almost bare. The approximately 2 ha stand is dominated by:

<i>Quercus suber</i>	<i>Myrtus communis</i>
<i>Olea europaea oleaster</i>	<i>Daphne gnidium</i>
<i>Pistacia lentiscus</i>	<i>Calycotome villosa</i>

At the northeast end of the Mogods the hills are lower and gently sloping. Kermes oak is replaced by *Olea-lentiscus* maquis and cultivation at the eastern end until Ras el Ahmar on the coast. There, a large, isolated aleppe pine forest grows with an understory of kermes oak and:

<i>Pistacia lentiscus</i>	<i>Retama monosperma</i>
<i>Juniperus oxycedrus</i>	<i>Chamaerops humilis</i>
<i>J. phoenicea</i>	<i>Lycium</i> sp.

3.4.1.6. Djebel Ichkeul

On the south side of Lake Ichkeul (Section 3.3.1.1) is Djebel Ichkeul, an outlying mountain of the Mogods chain. The mountain has an altitude of 511 m and descends to Lake Ichkeul on the north side, the Sejnane marsh on the west, Djoumine marsh on the east and the Mateur plain to the south.

A. Vegetation

The mountain is dominated by an *Olea-lentiscus* maquis (UCL 1977) with *Phillyrea angustifolia* and *Smilax aspera* mixed in. The maquis is also interspersed with *Chamaerops humilis* on rocky ridges, and *Juniperus phoenicea* on the north side of the peak and in the northeast corner. *Euphorbia dendroides* dominates the maquis on the west and southeast sides. Other species of interest include:

T <i>Teucrium schoenenbergeri</i>	<i>Notholaena vellea</i>
T <i>Limonium boitardii</i>	<i>Ceratonia siliqua</i>
<i>Callitris articulata</i>	

Small, open glades of short turf grassland are interspersed in the maquis, mostly on the northwest side of the summit. The glades are vegetated by

<i>Hordeum maritimum</i>	<i>Lagurus ovatus</i>
<i>Ferula communis</i>	<i>Asphodelus microcarpus</i>

B. Fauna

The fauna of Djebel Ichkeul is similar to that described for Lake Ichkeul (Section 3.3.1.1)

C. Influences

Active quarries are disfiguring the south side of the mountain, and grazing also occurs there. The rest of the mountain and its vegetation is well protected. Djebel Ichkeul is included with Lake Ichkeul in the Ichkeul National park (see Section 5.4.2).

3.4.2. High Tell

Between the Kroumirie and the Tunisian Dorsal mountain ranges is an area of mountains and high plateaus called the High Tell. The mean altitude of the plateaus is 600 to 800 m and the higher mountain peaks pass 1000 m (ONUPAA 1985). The mountain chains are oriented SW-NE and are separated by depressions and cultivated plains. The soils of the region are mostly calcareous, but many locations contain sandstone, gypsum, marnes and alluvial deposits. Three main rivers run through the High Tell: Oued Mellegue, Oued Tessa, and Oued Siliana, all of which flow into the Medjerda. Bioclimates range from Subhumid in the northwest to Semi-arid in the south.

The High Tell is more affected by forest clearing and overgrazing than the Kroumirie/Mogods. Cultivation extends far up many of the slopes, and even onto some of the plateaus. Thus, the forest stands are broken up into discontinuous segments. Hunting of wild boar, brown hare, barbary

partridge, quail and doves occurs at a moderate level, but poaching is a serious problem. Barbary hyena and Cuvier's gazelles could disperse into the High Tell from the Tunisian Dorsal mountain range, but most of the habitat is either of poor quality or insufficiently protected.

3.4.2.1. Ghardimaou to Le Kef

In the northwest part of the High Tell, south of Ghardimaou, there are Olea-lentiscus maquis (Rubus ulmifolius variant in Humid bioclimates and Smilax aspera variant in Subhumid bioclimates) similar to those of the lower south slopes of the Kroumirie. South and east of the Olea-lentiscus maquis, aleppo pine becomes dominant. Aleppo pine occurs throughout the High Tell in association with various other species according to climate and soil factors.

On higher, less disturbed slopes aleppo pine is often mixed with holm oak Quercus ilex. In the Subhumid locations south of Ghardimaou and north of Teboursouk the pine and oak are associated with species groups

indicated by:	<u>Catananche coerulea</u>	or	<u>Colutea arborescens</u>
and containing	<u>Pistacia terebinthus</u>		<u>Arbutus unedo</u>
	<u>Anthyllis vulneraria</u>		<u>Phillyrea angustifolia media</u>
	<u>Lonicera implexa</u>		<u>Pistacia lentiscus</u>
	<u>Rubia peregrina</u>		<u>Juniperus oxycedrus rufescens</u>
	<u>Asplenium adiantum nigrum</u>		<u>Pistacia terebinthus</u>
			<u>Medicago tunetana</u>

Degraded areas of these associations will contain

<u>Rosmarinus officinalis</u>	<u>Cistus villosus</u>
<u>Fumana thymifolia</u>	<u>Cistus monspeliensis</u>
	<u>Helianthemum cinereum rubellum</u>

The summit of Djebel Medjembia (20 km NW of Le Kef) is vegetated to holm oak and Pistacia terebinthus without aleppo pine. Other associated species include:

<u>Ampelodesma mauritanica</u>	<u>Crataegus azarolus</u>
<u>Calycotome villosa</u>	<u>Bellis silvestris</u>
<u>Cistus villosus</u>	<u>Cheilanthes pteridioides</u>
<u>Pistacia lentiscus</u>	<u>Prasium majus</u>
<u>Phillyrea angustifolia media</u>	<u>Orchis provincialis</u>

This association also occurs at the summits of Djebel Serdj, Djebel Bargou and the plateau de Kessera in the Tunisian Dorsal mountain range. Southwest of the region of Subumid bioclimates there is a winding strip of land in the Semi-arid Superior bioclimate that is vegetated to aleppo pine and rosemary Rosmarinus officinalis. The pine is often poor in form and

sparse, and the rosemary is mixed with:

<i>Pistacia lentiscus</i>	<i>Teucrium pseudo-chamaepitys</i>
<i>Calycotome villosa</i>	<i>Bupleurum balansae</i>
<i>Globularia alypum</i>	<i>Lotophyllus argenteus</i>
<i>Cistus monspeliensis</i>	<i>Fumana ericoides</i>
<i>Erica multiflora</i>	<i>F. laevipes</i>
<i>Genista cinerea</i>	<i>F. thymifolia</i>

Other species such as *Ampelodesma mauritanica* and *Lygeum spartum* indicate marinous and gypsous soils, respectively. This type of vegetation extends from Sakiel Sidi Youssef on the Algerian border and winds its way to Djebel Touila, north of Le Kef. After that it is found on most of the mountains to the northwest as far as Tunis.

Another association found between Ghardimaou and Le Kef that occurs extensively throughout the High Tell is the group of aleppo pine and *Juniperus phoenicea*. Species characterizing this association include:

<i>Pitaranthos chloranthus</i>	<i>Fumana thymifolia</i>
<i>Rosmarinus officinalis</i>	<i>F. ericoides</i>
<i>Cistus libanotis</i>	<i>Avena bromoides</i>
<i>Globularia alypum</i>	<i>Teucrium pseudo-chamaepitys</i>
<i>Eberus pinnata</i>	

This association is also common in the Tunisian Dorsal mountain range and is characteristic of Semi-arid Inferior bioclimates. The aridity causes varying densities of aleppo pine and juniper, often resulting in very open stands.

The mountain ridges extending northeast from Le Kef are again in the Semi-arid Superior bioclimate and support associations of aleppo pine, holm oak and *Erica multiflora*. This vegetation type is scattered over several mountain ridges to the east and is characterized by:

<i>Rosmarinus officinalis</i>	<i>Lotophyllus argenteus</i>
<i>Globularia alypum</i>	<i>Genista cinerea</i>
<i>Bupleurum balansae</i>	<i>Avena bromoides</i>
<i>Fumana thymifolia</i>	<i>Sideritis incana</i>
<i>F. ericoides</i>	

3.4.2.2. Le Kef to the Tunisian Dorsal

The majority of the region to the south and east of Le Kef is cultivated. On the mountain tops and ridges are heavily grazed and manipulated stands of aleppo pine and associated vegetation. Most of the associations are more arid variants of those discussed above. Of special interest is the replacement of the aleppo pine - rosemary group by aleppo pine - *Juniperus phoenicea* ssp. *rufescens*. Many of the species characterizing the two groups are the same. When the aleppo - juniper group is degraded it is invaded by rosemary.

The aleppo pine - holm oak - Erica multiflora group is also altered in the southern areas to aleppo pine - holm oak - Erinacea anthyllis. The latter group has many species in common with the degraded variant of the former.

3.4.2.3. East of Teboursouk

Most of the hills are dominated by the aleppo pine - rosemary group described above. On the lower slopes of some of the hills a group of aleppo pine - juniper - Diploxys harra occurs. This is a group typical of Semi-arid Inferior bioclimates occurring in a region of mainly Semi-arid Superior vegetation types. Other species indicating the dry land vegetation type are:

Tunica illyrica ssp. angustifolius	Anabasis oropediorum
Artemisia herba alba	Stipa parviflora

Another interesting vegetation group east of Teboursouk is that of carob - Olea-lentiscus - Jasminum fruticans. This group is frequently accompanied by:

Arisarum vulgare	Bellevalia mauritanica
Arum italicum	Ambrosinia bassii
Rhamnus lycioides oleoides	

The terrain becomes lower and flatter to the east. Cultivation is predominate except on some hills occupied by aleppo pine and rosemary, or in depressions with halophile vegetation such as at Sebkheth Kourzia (Section 3.3.2.3).

3.4.3. Tunisian Dorsal

The Tunisian Dorsal is the northeastern extension of the Atlas mountains, which begin in Morocco, pass through Algeria and enter Tunisia at Bou Chebka, 35 km west of Kasserine. Guenod and Schoenenberger (1965) considered the Tunisian Dorsal as including the peaks of Djebels Chambi, Semmama, Tiouacha, Barbrou, Serdj, Bargou, Fkirine and Zagouan, which are oriented fairly regularly SW-NE. In this document the Tunisian Dorsal will be considered as including the above mentioned 'backbone' ridge and the adjacent mountains, such as Djebels Bireno, Serraguia, Oum Jeddour, Mrhila, Trozza, Ousselat, and Mansour. The range also extends beyond Djebel Zaghouan to Cap Bor and includes Djebels Ressas, Bou Kornine and Sidi Abder Rahmane. As the mountains extend northeast they gradually decrease in altitude. Djebel Chambi in the southwest is Tunisia's highest point at 1544 m while Dj. Sidi Abder Rahmane in the northeast has a maximum altitude of only 637 m.

The Tunisian Dorsal is composed primarily of calcareous rock. Soils are similar to those of the High Tell - calcimorph with many deposits of sand, gypsum and marne. Hot, dry summers and stormy precipitation patterns make the area especially vulnerable to erosion. Many of the south slopes are severely eroded and sediment loads in rivers are high. The three most important rivers originating in the range are the Oueds Nebhana, Marguelil (El Kerd) and Zeroud (El Hatob) all of which flow into Sebkhet Kelbia (Section 3.3.2.4).

Dominant forest species of the Tunisian Dorsal are holm oak and aleppo pine in the southwest and center, to which are added thuya Callitris articulata and kermes oak in the northeast. Holm oak often grows as a maquis 2-3 m tall on mountain summits or as an understory in aleppo pine forests on brown calcareous soils. Juniperus phoenicea is common in the understory of aleppo pine on poorer soils and at lower elevations. It becomes the characteristic species in degraded stands.

3.4.3.1. Djebel Chambi

35°13' N 8°43' E

Fifteen kilometers west of Kasserine is Dj. Chambi, essentially the first high peak of the Tunisian Dorsal as it enters from Algeria. From a summit altitude of 1544 m, Chambi drops to 565 m altitude at the base. Along with the typical substrates of the Tunisian Dorsal there are also deposits of zinc, galena, hematite (iron ore) and traces of coal in the Chambi massif (Dir. For. 1981).

The climate at Chambi is somewhat different from nearby Kasserine, since the precipitation rate increases 20 mm for every 100 m increase in altitude. Therefore the relatively dry plains (Semi-arid Superior) contrast greatly with the Subhumid summit, which receives c.500 mm annual precipitation in the form of rain, hail and snow with additional moisture from clouds and fog.

A. Vegetation.

An interesting succession of holm oak at the summit, passing aleppo pine on the slopes and reaching an esparto Stipa tenacissima steppe at the base exists at Chambi. The holm oak association of the summit includes (Peterken and Radford 1969, ORSTOM 1962, Dir. For. 1981):

	Paronychia argentea	Pistacia lentiscus
	Amelanchier ovalis	P. terebinthus
	Phillyrea angustifolia media	Cistus salviifolius
rNA	Sorbus aria	Pimpinella tragium
rNA	Cotoneaster racemiflora	Lamium longiflorum
	C. numularia	Alyssum montanum atlantica
	Prunus prostrata	Sideritis incana tunetana
	Rosa sicula	Silenopsis montana
v	Delphinium balansae	rNA Stipa fontanesii
rNA	Campanula atlantica	Astragalus armatus
	Atractylis humilis	Carex halleriana

The aleppo pine forest is accompanied by:

Retama sphaerocarpa	Teucrium pseudo-chamaepitys
Polygala rupestris	Astragalus monspessulanus
Ononis pusilla	A. fontanesii numidica
Erinacea anthyllis	Trisetaria flavescens
Inula montana	r Bromus squarrosus
Leuzea corifera	Juniperus oxycedrus rufescens

or

Rosmarinus officinalis	Cistus libanotus
Globularia alypum	Helianthemum cinereum rubellum
Fumana thymifolia	Avena bromoides
F. ericoides	Teucrium polium
F. laevipes	Coronilla minima

Other associations of interest (Dir. For. 1981) are characterized by:

- | | | |
|----|-------------------------|-------------------------------|
| 1) | Cistus villosus | Pistacia terebinthus |
| | Lonicera implexa | Bupleurum gibraltarium |
| | Calycotome villosa | Bellis silvestris |
| 2) | Ampelodesma mauritanica | Bupleurum balansae |
| | Ononis pusilla | B. spinosum |
| | Hedysarum pallidum | Juniperus oxycedrus rufescens |
| 3) | Stipa tenacissima | Thymus hirtus |
| | Juniperus phoenicea | Teucrium compactum |
| | Lotus creticus collinus | Thymelaea tartora raira |
| 4) | Artemisia herba alba | Plantago albicans |
| | A. campestris | Helianthemum hirtum ruficomum |
| | Genista microcephala | Pituranthos chloranthus |
| | Olea europaea oleaster | Thymelaea hirsuta |
| | Rhus tripartitum | Pistacia atlantica |
| | Retama raetam | Hedysarum spirosimum |

B. Fauna

Mammals. Fauna of Djebel Chambi are listed in Section 4 (Gouvernorat of Kasserine). Featured animals include approximately 200 Cuvier's gazelles Gazella cuvieri. After being almost extirpated from Tunisia during colonial times, the gazelles are now increasing in number and dispersing along the Tunisian Dorsal (H.P. Muller, pers. comm.). Aoudad Ammotragus lervia were extirpated from the park and have been reintroduced. Four males escaped from an acclimatization enclosure and six females and young are still in captivity. Hyena are common enough to have had a serious impact on the wild boar population. Local officials reported that an average of 10 hyenas are killed by vehicles on the roads near Kasserine each year.

Birds. Many raptors, including egyptian vultures and threatened peregrines, nest at Chambi. A wide variety of other forest and steppe species also occur in the area.

C. Influences

A 6723 ha national park was created at Chambi (Section 5.4.3) in 1980, which reduced most of the detrimental human influences on the environment. Some small fires still occur and park facilities are being constructed, but the ecosystem is in excellent condition. Fires actually improve the habitat for the gazelles and aoudad by creating small clearings with abundant herbs. Aleppo pine cones are collected annually for their seeds, which are eaten or sold to nurseries. This does not appear to significantly affect regeneration in the forest.

3.4.3.2. Djebel Bireno

Due north of Dj. Chambi and 35 km northwest of Kasserine is Dj. Bireno. Averaging 1100 m in altitude (maximum 1419 m), Bireno is formed of marne and limestone and has hard, often eroded, soils. The bioclimate is Semi-arid Superior.

A. Vegetation

At the summit the vegetation association is aleppo pine, holm oak and Juriperus oxycedrus rufescens. The pine is of poor form and rather sparse; the oak is 1-2 m tall. Descending down the slope, the pine is larger and denser and holm oak is replaced by other plants, such as rosemary and Ampelodesma mauritanica (on marnes). At the base of Bireno the pine is again small and sparse due to exploitation, clearing and drier conditions. Associated vegetation includes (ORSTOM 1962):

Globularia alypum	Cistus villosus
Retama sphaerocarpa	C. monspeliensis
R. raetam	Gerista argentea

with gypsous soils indicated by Lygeum spartum and drier locations indicated by esparto grass and juniper. Pastoral species include:

Artemesia herba alba	Hippocrepis scabra
A. campestris	Psoralea bituminosa
Medicago tunetana	Coronilla juncea
Lotus sp.	C. minima

B. Fauna

A long range of cliffs below the ridge on Dj. Bireno provides several favorable locations with ledges, cavities and caves for mammal dens or raptor nests. Mammals include hyena, jackal, red fox, wild boar, North African crested porcupine, Algerian hedgehog, gundi and bats. Birds include:

tr. Peregrine	Black redstart	Turtle dove
Barn owl	Black wheatear	Raven
Barbary partridge	Chaffinch	

C. Influences

In response to erosion problems, some terracing has been done on the steeper slopes. One fifth of the forest has been designated as regeneration forest to protect it from exploitation and grazing, thus enhancing the forest cover and reducing erosion. Although grazing is reduced somewhat in the regeneration forest, it still occurs there and throughout the forest. Other forest use includes harvesting rosemary branches for distillation and fuelwood collection.

3.4.3.3. Djebel Mrhilla

One of the mountains flanking the main 'backbone' of the Tunisian Dorsal is Dj. Mrhilla. It is located on the south side of the Dorsal, 10 km north of Sbeitla and 45 km northeast of Kasserine. The altitude is 1378 m at the highest summit and 1058 m at the second, southern peak. Slopes are rocky with many bare rock outcrops.

A. Vegetation

The vegetation associations are similar to those of Dj. Chambi (Guenot 1965), but Mrhilla is lower and has only been protected for 3 years, so it is more degraded. Aleppo pine grows fairly well at the summit, but the holm oak in the understory is stunted, deformed and very sparse. Eroded, thin soils result in many bare areas between the rosemary bushes on the slopes. Humus accumulations in the watersheds are indicated by Pistacia lentiscus and Phillyrea angustifolia. Juniperus phoenicea and esparto grass indicate the dryness of the slopes, and the base of the mountain is dominated by esparto grass and thermophiles like rosemary and Globularia alypum. A rare, North African endemic plant recorded for Mrhilla is Sorbus aria.

B. Fauna

Mammals living on Dj. Mrhilla include the North African endemic gundi, which is preyed upon by red fox and jackals. Other rodents, brown hare, bats, wild boar and occasional hyenas also occur in the area.

Birds include many species of diurnal and nocturnal raptors and:

Wood pigeon	Goldfinch	Black wheatear
Barbary partridge	Chaffinch	Nightingale
Crested lark	Hoopoe	Raven

C. Influences

Although Mrhilla has been protected for 3 years, some grazing still occurs.

3.4.3.4. Djebel Selloum

Another mountain flanking the main 'backbone' of the Tunisian Dorsal is Dj. Selloum, located 5 km southeast of Kasserine. The altitude is 1248 meters at the summit, which is quite blunt and approaches plateau form in some places. There are several bands of low cliffs (2 - 20 m) fringing the summit, and the lower slopes are interrupted by many rock outcrops.

The main vegetation associations are essentially the same as those on Dj. Mrhilla and similar fauna would also be expected. A plant of special interest is the Tunisian endemic Genista microcephala var. tunetana.

3.4.3.5. Djebel Ousselat

35°42' N 9°44' E

Forty km northwest of Kairouan is another outlying mountain of the Tunisian Dorsal. Dj. Ousselat has an altitude of 895 m, which descends steeply, with many cliffs, to the Low Steppes. Substrates of the south face are often dominated by marble. Soils are thin, dark and very rocky on the slopes.

A. Vegetation

Formerly, the dominant association was aleppo pine, Juniperus phoenicea, Diploaxis harra (Guenot 1965), but there is little aleppo pine remaining and the degradation stages are now dominant. On some slopes there is little soil, sparse juniper and few herbs. A common maquis association appears to be Olea-lentiscus, carob. Rosemary occurs, but is sparse in many areas. Nerium oleander grows along the stream beds and in moist locations on the slopes.

B. Fauna

Ousselat is important in terms of biological diversity because it is a nesting location for egyptian vultures, peregrines, and booted eagles. Many other raptors and other animal species occur on Djebel Ousselat (see Section 4, Gouvernorat of Kairouan).

C. Influences

A large marble quarry exists on the south side of the mountain. Grazing is so intense that by late summer little remains in the herb layer. In the prime raptor nesting areas, human disturbance would be detrimental to nesting success.

3.4.3.6. Djebel Serdj

35°56' N 9°33' E

Djebel Serdj is one of the main ridges of the Tunisian Dorsal. It lies 90 km northeast of Dj. Semmama, 20 km southeast of Siliana and 60 km northwest of Kairouan. At the highest peak the altitude is 1357 m.

A. Vegetation

The vegetation is particularly rich on Dj. Serdj. At the summit is a meadow association of herbs and shrubs (ORSTOM 1962) characterized by:

	<i>Prunus prostrata</i>	<i>Thymus algeriensis</i>
NA	<i>Centaurea incana</i>	<i>Teucrium polium</i>
	<i>C. lagascae</i>	<i>Armeria plantaginea</i>
	<i>Trifolium cherleri</i>	<i>Vicia onobrychioides</i>
	<i>Poa bulbosa</i>	<i>Anthyllis vulneraria</i>
*	<i>Anthoxanthum odoratum</i>	<i>Alyssum montanum</i>
	<i>Androsace maxima</i>	<i>Sideritis incana turetana</i>
*	<i>Hornungia petraea</i>	<i>Anthemis punctata</i>
*	<i>Geranium lucidum</i>	<i>Tulipa silvestris</i>
	<i>Ophrys lutea subfusca</i>	<i>T. australis</i>

* = Southern limit of geographical range

On north facing rock crests is an association characterized by:

rNA	<i>Draba hispanicus</i>	<i>Alyssum montanum</i>
	<i>Hornuga petraea</i>	<i>Sedum sp.</i>

In moist, shaded rocky areas, additional species are found, such as:

<i>Saxifraga tridactylites</i>	<i>Arabis auriculata</i>
<i>S. carpetana</i>	<i>A. turetana</i>

ORSTOM (1962) also described an association characteristic of high plateaus of the Tunisian Dorsal dominated by Bupleurum spinosum and

r = Rare

NA = North Africa Endemic

Astragalus fortanesii ssp. numidicus. Along permanent streams the vegetation tends to be composed of:

Populus alba	Ranunculus macrophylla
Fraxinus angustifolia	Vitis vinifera
Ulmus campestris	Carex remota
Rubus ulmifolius	Poa trivialis
Rosa sp.	Equisetum maximum
Nerium oleander	Glycera fluitans
Hedioscladium nodiflorum	

On the upper slopes there are a little over 1,000 cork oak growing far south of the normal range. There are also stands of the rare maple tree Acer monspessulanum growing in association with (ORSTOM 1962, Peterken and Radford 1969):

	Quercus ilex	Geranium robertianum purpureum
rNA	Sorbus aria	Tamus communis
	Rosa pouzini	Rubus ulmifolius
	Crataegus azarolus	Delphinium emarginatum
	Ranunculus ficaria	Lamium longiflorum numidicum
	Melandrium divaricatum	Scrophularia laevigata
	Brassica gravinae	r Arabis verna
	Vicia onobrychioides	Festuca ovina
vNA	Viola murbyana	Armeria plantaginea

Some of the lower slopes have holm oak dominated vegetation similar to that of Dj. Bargou (see following section) and others have vegetation typical of dry, degraded maritime to continental aleppo pine associations with marne and humus accumulations as described for Dj. Mansour. There are also about 1,500 ha of Maktar cypress Cupressus sempervirens ssp. numidica mixed with aleppo pine in the ravines.

B. Fauna

Fauna of the region is listed in Section 4 (Gouvernorat of Siliiana). Of special interest is an extraordinary population of bats in one of the caves (Assi, pers. comm.).

C. Influences

The forests are managed and exploited in a manner that is not detrimental to the overall vegetation cover. However, exploitation and grazing in some areas appears to have allowed serious erosion to start. The rare maple tree Acer monspessulanum and cork oak are in such low numbers that exploitation without serious regeneration efforts would threaten their continued presence.

3.4.3.7. Djebel Bargou

36°04' N 9°36' E

Northeast of Dj. Serdj and 20 km east of Siliiana is Djebel Bargou. The summit altitude is 1268 m and the slopes are moderate to steep. A range of cliffs approximately 10 - 50 m high, near the crest at Zehila, has several interesting caves and ledges.

A. Vegetation

The vegetation is very rich, with a high meadow association at the summit, similar to that described for Djebel Serdj in the previous section. Below the meadow is a holm oak dominated association (ORSTOM 1962), with Acer monspessulanum in some areas (as at Dj. Serdj) and other areas vegetated to:

<i>Pistacia terebinthus</i>	<i>Asplenium adiantum nigrum</i>
<i>Lonicera implexa</i>	<i>Geranium lucidum</i>
<i>Prasium majus</i>	<i>G. robertianum purpureum</i>
<i>Ruscus hypophyllum</i>	<i>Fumaria capreolata</i>
<i>Helianthemum glaucum</i>	<i>Cynosurus elegans</i>
<i>Alyssum serpyllifolium</i>	<i>Pimpinella tragium</i>
<i>A. montanum atlanticum</i>	<i>Satureja alpina</i> etc...

Streamside vegetation is also similar to that on Dj. Serdj, with some Typha angustifolia at the base of the mountain. In degraded locations, where the humus has been removed, holm oak is replaced by Aleppo pine and

<i>Rosmarinus officinalis</i>	<i>Erica multiflora</i>
<i>Globularia alypum</i>	<i>Erinacea anthyllis</i> etc...

In the lower pine forests, vegetation associations similar to those described for Dj. Mansour occur with continental species such as Juniperus oxycedrus replacing the maritime species. An association important in the Tunisian Dorsal is that of carob, *Olea-lentiscus*, Rhamnus lycioides ssp. oleoides maquis; with Myrtus communis and Crataegus azarolus mixed in on Dj. Bargou.

B. Fauna

Fauna are listed in Section 4 (Gouvernorat of Siliiana). Of special interest is the presence of North African crested porcupine, hyena and nesting peregrines.

C. Influences

Olives at the base of the mountain have been grafted and tended since Roman times. Edges of the lower streams are cultivated and grazing occurs throughout the year. Some rosemary branches are harvested for distillation, but not in great amounts, and the Myrtus is common enough for effective harvesting. In order to ensure an adequate forest cover to prevent erosion, woodcutting is not permitted. Many of the bare areas still show signs of erosion.

3.4.3.8. Djebel Mansour

36°17' N 9°42' E

North of the backbone ridge of mountains, 40 km southwest of Zaghouan and 20 km southwest of le Fahs is Djebel Mansour. The summit altitude is 678 m and the topography (moderate to steep slopes) and substrates (marne-calcareous) are typical of the Tunisian Dorsal. Two or three permanent springs affect the water regime of the slopes, locally favoring riparian plants. The bioclimate is Semi-arid Inferior.

A. Vegetation

Dj. Mansour is fairly well covered by aleppo pine, averaging 5-7 m tall. Low, shrubby holm oak is scattered in parts of the forest. Occasional clearings in the forest cover are dominated by rosemary and heather. The forest was burned in 1938 and there have been some selection cuts, which affect species composition. The general vegetation profile reported by ORSTOM (1962) is as follows:

Pinus halepensis
Quercus ilex

accompanied by thermophiles and calcicoles

<i>Rosmarinus officinalis</i>	<i>Genista argentea</i>
<i>Globularia alypum</i>	<i>G. cinerea</i>
<i>Eupleurum balansae</i>	<i>Teucrium polium</i>
<i>Fumana thymifolia</i>	<i>Eberus pinnata</i>
<i>F. laevipes</i>	<i>Avena bromoides</i> etc...

A maritime influence is shown by the presence of

<i>Erica multiflora</i>	<i>Fumana arbica</i>
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while the drier sites are characterized by

<i>Juniperus phoenicea</i>	<i>Stipa tenacissima</i>
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On marinous soils some species are replaced by *Ampelodesma mauritanica*. Humus accumulations are indicated by

<i>Pistacia lentiscus</i>	<i>Jasminum fruticans</i>
<i>Phillyrea angustifolia</i>	

Degradation caused by fires is indicated by

<i>Cistus villosus</i>	<i>Cistus monspeliensis</i>
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This vegetation profile is typical of the aleppo pine forests from Dj. Semmana to Dj. Fkirine.

B. Fauna

The fauna is composed of the species listed for mountainous areas in the Gouvernorat of Zaghuan (Section 4). Of special interest is the presence of North African crested porcupines and (rarely) hyenas.

C. Influences

Human influences include management cuts, occasional fuelwood gathering, and grazing. The soils are subject to erosion if the vegetation cover is removed.

3.4.3.9. Djebel Zaghouan

Immediately south of the city of Zaghouan and 57 km south of Tunis is Dj. Zaghouan. A series of moderate to steep slopes interspersed with rock outcrops and cliffs rise to a summit at 1295 m altitude. Many of the rocky dome outcrops fracture, break off, and fall, resulting in low cliffs and rock strewn slopes. Snow is common in the winter and the annual precipitation rate (450 - 500 mm) is higher than that of the surrounding area.

A. Vegetation

The high altitude, maritime and continental influences and northern location have resulted in a diversity of vegetation associations on Dj. Zaghouan. On the summit a sparse, low-shrub, meadow-like vegetation dominates. Holm oak dominates around the summit and the high slopes of the north side. The holm oak association is similar to that of Dj. Bargou, with the addition of Orchis provincialis, Coronilla valentina and Tulipa silvestris.

Parts of the holm oak forest are also characterized by the Acer monspessularus association described for Dj. Serdj. An aleppo pine forest similar to that of Dj. Mansour dominates the upper slope on the west side. Most of the lower slopes are characterized by degradation stages of the pine forest. The influence of the maritime climate on the vegetation results in the appearance of:

<i>Quercus coccifera</i>	<i>Erica multiflora</i>
<i>Callitris articulata</i>	<i>Fumana arbica</i>

The main degradation association for the lower slopes tends toward *Olea-lentiscus*, carob, with scattered groves of aleppo pine up to 7 m tall and:

<i>Pistacia terebinthus</i>	<i>Calycotome villosa</i>
<i>Jasminum fruticans</i>	<i>Phillyrea angustifolia media</i>

Occasional fires allow invasion of burned areas by

<i>Cistus monspeliensis</i>	<i>Ampelodesma mauritanica</i>
<i>C. villosus</i>	

Along the lower streams a Populus alba association dominates. Some aleppo pine, acacia, and Maktar cypress have been planted on the mountain.

A species of interest occurring in the maquis is Euphorbia dendroides. A rare Tunisian endemic species is Linaria reflexa var. doumeti. Peterken and Radford (1969) reported the following rare plants for Dj. Zaghouan:

<i>Phagnalon cynodon</i>	<i>Sinapsis pubescens</i> v. <i>polyclade</i>
<i>Lamium longiflorum</i>	<i>Saxifraga dichotoma</i> (very rare)

B. Fauna

Fauna of special interest are the many species of raptors that nest on ledges and in cliff cavities on Dj. Zaghouan, such as egyptian vulture, golden eagle, peregrine and kestrel (see Section 4, Gouvernorat of Zaghouan).

C. Influences

There have been some problems in the past with people collecting raptor eggs at Dj. Zaghouan. A special guardian is now assigned to the major nest sites during the breeding season. Small fires occur almost every year, but they are quickly located and extinguished, so they do little damage. The forest as classified as unmanaged, which means no exploitation or improvement cuts. In principle a large part of the north slope is closed to grazing, which reduces the grazing impacts, but does not eliminate them. Some members of the local ornithological association feel the site is important enough to be designated a national park.

3.4.3.10. Djebel Marchana, Dj. Zit, Dj. Bou Safra

Northeast of Zaghouan, just before the Tunisian Dorsal extends into Cap Bon, is a trio of mountains 350 - 500 m high. The mountains are characterized by moderate slopes with numerous rock outcrops. Substrates are diverse, including limestone, marne and gypsum covered by shallow, well drained soils.

A. Vegetation

At the summit of Dj. Zit, the vegetation is characteristic of holm oak stands. The maritime influence on the vegetation association has resulted in thuya and kermes oak replacing aleppo pine as the dominant tree species in most of the forests. A maritime influence is also indicated by the presence of Erica multiflora. The thuya forest on Dj. Zit contains many of the species associated with aleppo pine forests (as described for Dj. Mansour) as well as Lavandula stoechas and Erica arborea.

Djebel Marchana has a large *Olea-lentiscus maquis* on the south side (Gasser and Vernet 1958) and at Bou Safra the thuya forest is accompanied by:

Rosmarinus officinalis	Phalaris bulbosa
Calycotome villosa	Genista aspathaloides
Globularia alypum	Cistus monspeliensis
Ampelodesma mauritanica	C. villosus
Stipa tennacissima	Lygeum spartum

B. Fauna

Fauna of the 3 mountains is typical of that listed for mountainous areas in the Gouvernorat of Zaghouan (Section 4).

C. Influences

Djebel Bou Safra has been a permanent reserve since about 1980. Hunting, grazing and vegetation cutting are prohibited. Since there is a fair vegetation cover, erosion is not severe and terracing and planting has been done to reduce future problems. Removal of vegetation would leave the slopes very vulnerable to erosion.

3.4.3.11. Djebel Ressay

36°35' N 10°30' E

Djebel Ressay is 25 km southeast of Tunis. Sharp cliffs rise up from moderately steep slopes at the base to a peak 795 m in altitude.

A. Vegetation

Thuya is the dominant tree of Dj. Ressay, and it grows in association with garrigues composed of combinations of olea-lentiscus and (El-Hamrouni 1979):

<i>Quercus cocciferus</i>	<i>Rosmarinus officinalis</i>
<i>Calycotome villosa</i>	<i>Lavandula multifida</i>
<i>Periploca laevigata</i>	<i>Thymus capitatus</i>
<i>Rhamnus lycioides</i>	<i>Teucrium polium</i>
<i>Prasium majus</i>	<i>Genista cinerea</i> s. <i>cinerea</i>
<i>Jasminum fruticans</i>	<i>Erica multiflora</i>
<i>Cistus monspeliensis</i>	<i>Phillyrea angustifolia</i>
<i>Fraxinus dimorpha</i>	

and many species of herbs and grasses; notably:

<i>Brachypodium ramosum</i>	<i>Tamus communis</i>
<i>B. Distachyum</i>	<i>Dactylis glomerata</i>
v <i>Cyclamen persicum</i>	<i>Ampelodesma mauritanica</i>

There is also an association indicated by:

<i>Brassica cretica</i>	<i>Euphorbia dendroides</i>
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and a meadow association containing:

<i>Stipa capensis</i>	<i>Atractylis cancellata</i>
<i>Eryngium ilicifolium</i>	

B. Fauna

Djebel Ressay is of special interest as a prime nesting location for raptors. Recorded species include peregrine, kestrel and egyptian vulture. Other fauna that occur in the area are listed in Section 4 (Gouvernorat of Tunis).

v = Very Rare

C. Influences

The mountain slopes are grazed and some vegetation cutting may occur, but the steep cliffs protect the higher vegetation and the nesting sites.

3.4.3.12. Djebel Bou Kornine

36°42' N 10°20' E

In the west side of Hammam-Lif, 18 km southeast of Tunis, is the double-peaked Djebel Bou Kornine. From an altitude of 10 m, steep slopes rise to an elevation of 576 m at the highest peak. Limestone and marne substrates typical of the Tunisian Dorsal are weathered by almost 420 mm of annual precipitation at the base, which increases to 660 - 700 mm at the summit.

A. Vegetation

The dominant vegetation types of Bou Kornine are thuya forests and maquis, which cover 90% of the mountain. Average heights of thuya in the forested zones are 6-7 m. Stands of aleppo pine, pignon pine Pinus pinea, Acacia cyanophylla, Cupressus sp. and eucalyptus have been planted on various parts of the mountain. Other plant species occurring on Bou Kornine are listed in figure 9.

B. Fauna

The fauna of Bou Kornine is very diverse (see Section 4, Tunis). Of special interest is the occurrence of North African crested porcupine, wild boar, kaffir cat, several species of bats, threatened peregrine falcons and egyptian vultures. Cuvier's gazelles were observed in 1930.

C. Influences

The forest cover of Bou Kornine has protected the slopes from serious erosion problems, but terracing was done on some of the slopes to prevent possible future problems. There are a few plantations on the mountain and olive groves and vinyards at the base. Occasionally, caper Capparis spinosus buds and other forest products are collected, but the most disruptive human influence on the mountain is a series of 9 quarries extracting gypsum and construction material.

Djebel Bou Kornine is uninhabited and has been protected from grazing since 1929 (Peterken and Radford 1969). Part of the mountain was established as a national park on 17 February 1987. There are plans for management and construction of park facilities (see Section 5.4.5).

Figure 9

Flora of Djebel Bou Kornine
(after Dir. For. 1985, El-Hamrouni 1979)

Trees and shrubs:

<i>Arbutus unedo</i>	
<i>Callitris articulata</i>	<i>Pistacia lentiscus</i>
<i>Ceratonia siliqua</i>	<i>P. terebinthus</i>
<i>Crataegus azarolus</i>	<i>Quercus ilex</i>
<i>Myrtus communis</i>	<i>Q. coccifera</i>
<i>Olea europaea oleaster</i>	<i>Rhus</i> sp.
<i>Phillyrea angustifolia media</i>	<i>Tamarix</i> sp.

Low, woody plants:

<i>Antirrhinum majus</i>	<i>Lavandula multifida</i>
<i>Asparagus acutifolius</i>	<i>Lavatera olbia</i>
<i>Calycotome villosa</i>	<i>Lonicera implexa</i>
<i>Capparis spinosa</i>	<i>Nerium oleander</i>
<i>Chamaerops humilis</i>	<i>Opuntia ficus indica</i>
<i>Cistus libanotus</i>	<i>Periploca laevigata</i>
<i>C. monspeliensis</i>	<i>Prasium majus</i>
<i>Coronilla valentina</i>	<i>Rosmarinus officinalis</i>
<i>Ephedra brounailles</i>	<i>Ruscus hypophyllum</i>
<i>Erica multiflora</i>	<i>Ruta chalepensis</i>
<i>Genista</i> sp.	<i>Smilax aspera</i>
<i>Globularia alypum</i>	<i>Thymelea hirsuta</i>
<i>Jasminum fruticans</i>	<i>Thymus vulgaris</i>
<i>Kentrantus ruber</i>	<i>Zizyphus lotus</i>

Herbs and grasses:

<i>Aceras anthropophorum</i>	r <i>Ophrys scolopax</i>
<i>Allium cupani</i>	<i>O. sub-fusca</i>
<i>A. pariculatum</i>	<i>O. lenthredini fira</i>
<i>Ampelodesma mauritanica</i>	<i>Orchis anatolica</i>
<i>Arisarum vulgare</i>	<i>O. collinea</i>
<i>Arrhenatherum elatus</i>	<i>O. longioialis</i>
<i>Asplenium adiantum</i>	<i>O. provincialis</i>
<i>Brachypodium ramosum</i>	<i>O. papilionacea</i>
<i>Brassica cretica</i>	<i>Polypodium vulgare</i>
<i>Culchicum cupani</i>	<i>Ranunculus flammula</i>
v <i>Cyclamen persicum</i>	<i>R. spicatus</i>
<i>Ferula communis</i>	<i>Romulea bulbocadium</i>
<i>Gladiolus byzantinus</i>	<i>Scilla automnalis</i>
<i>Iris juncea</i>	<i>S. lingulata</i>
<i>I. planifolia</i>	<i>S. numidica</i>
<i>Leucoium automnale</i>	<i>Sedum coeruleum</i>
<i>Narcissus elegans</i>	<i>S. sediforme</i>
<i>Ophrys atlantica</i>	<i>Stipa tenacissima</i>
<i>O. fusea</i>	<i>Tulipa silvestris</i>
<i>O. lutea</i>	<i>Urginea maritima</i>

r = rare plants

v = very rare plants

On the large peninsula of Cap Bon is Dj. Sidi Abder Rahmane, which rises to an altitude of 637 m. Moderately steep slopes drop quickly to the Gulf of Tunis on the northwest side and level out to low plains to the southeast. The maritime influence moderates temperatures and results in fairly high annual rainfall augmented by frequent fog and high humidity.

A. Vegetation.

Conditions on Dj. Sidi Abder Rahmane previously favored a cork oak forest along the entire ridge, which is unusual since cork oak is more characteristic of the Kroumirie, far to the west. Now only a few cork oak stands remain. The current dominant species is kermes oak, which dominates the coastal climax vegetation from Bizerte to Nabeul (ORSTOM 1962). *Thuya* also dominates some forest stands on the southeast side and is dispersed in the forests and maquis throughout the mountain. Where the *thuya* or kermes oak forest has been degraded, an *Olea-lentiscus*, carob maquis is present. Small stands of aleppo pine and holm oak similar to those described for other mountains of the Tunisian Dorsal are found, as well as *Populus alba* associations along the rivers.

The cork oak forest contains several species characteristic of the Kroumirie, such as:

<i>Cytisus triflorus</i>	<i>Hypericum australe</i>
<i>Carex silvatica</i>	<i>Pteridium aquilinum</i>
<i>Ranunculus ficaria</i>	<i>Erica arborea</i>
<i>R. spicatus</i>	

as well as many other species more typical of Cap Bon and the varying conditions of soil, climate and altitude:

T <i>Brassica cretica atlantica</i>	<i>Acanthus mollis platyphyllus</i>
r <i>Dianthus rupicola hermaensis</i>	<i>Scabiosa farinosa</i>
TA <i>Centaurea gymnocarpa papposa</i>	<i>Anthyllis barba jovis</i>
<i>Smilax aspera</i> (humus)	<i>Gerista ulcina</i> (acid soils)
<i>Tamus communis</i> "	<i>Lavandula stoechas</i> "
<i>Juniperus oxycedrus</i> (sandy soils)	<i>Euphorbia bivora</i> (summit)

and degraded zones with:

<i>Rosmarinus officinalis</i>	<i>Juniperus phoenicea</i>
<i>Trifolium scabrum</i>	<i>Cistus villosus</i>
<i>Fumana thymifolia</i>	<i>Phagnalon rupestre</i>

Kermes oak often replaces cork oak in its characteristic associations or is found in a variety of other associations, which are described by ORSTOM (1962).

r = Rare

TA = Tunisia/Algeria Endemic

T = Tunisia Endemic

B. Fauna

Cap Bon is an important site for migrating raptors (Section 2.4) and many stop to rest on Dj. Sidi Abder Rahmane. Common fauna of Cap Bon are listed in Section 4 (Gouvernorat of Nabeul).

C. Influences

Dj. Sidi Abder Rahmane is uninhabited and timber harvesting is not allowed, but grazing is heavy and vegetation cutting is not uncommon. The high precipitation rates make the slopes sensitive to erosion when the vegetation cover is removed.

3.4.4. Mountains of the High Steppe

Between the Tunisian Dorsal and the chotts are many scattered mountain chains in the high steppe. Some of the chains are an extension of the Saharan Atlas (IUCN 1987). The general orientation of the mountain chains is E-W along the northern border of the chotts, and NE-SW near the Tunisian Dorsal. Varying in altitude from 600 m to over 1100 m, the mountains are generally rocky (calcareous) and eroded.

Low precipitation rates and an inland location give the mountains Semi-arid to Arid bioclimates. Most of the rain falls in winter cloudbursts and storms, which causes much of the water to run off the surface into seasonal streams. This runoff leaves less water for vegetation growth and increases erosion problems.

Vegetation. Formerly many of the mountains were forested to aleppo pine. Today most of the pine has disappeared, leaving only relics of the original forest with a few pine trees and a garrigue of Juniperus phoenicea. In general, the vegetation associations of the degraded mountain forest ecosystems include (ORSTOM 1962):

Juniperus phoenicea	Thymus algeriensis
Globularia alypum	Fumana thymifolia
Genista cinerea	Eberus pinnata
Lavandula multifida	Phagnalon rupestre
Periploca laevigata	Tulipa silvestris s. australis

or, on the high plateaus:

Rosmarinus officinalis	Globularia alypum
Cistus libanotis	Eberus pinnata
Helianthemum semi glabrum	Fumana thymifolia
Thymelea tarton-raira	F. ericoides
Avena bromoides	Astragalus incarus nummularium

In the region of Sidi Bou Zid - Gafsa, the forest relics often contain:

Olea europaea oleaster	Jasminum fruticans
Pistacia atlantica	Prasium majus
Fumana laevipes	Asplenium adiantum nigrum
Phillyrea angustifolia media	

Interspersed in the forest relic associations and dominating the vegetation of some of the mountains is esparto grass Stipa tenacissima. The lower slopes are dominated by esparto grass and Genista microcephala var. capetellata and the plains are characterized by an esparto grass steppe (see Section 3.5).

Fauna. Fauna of special interest in the mountains of the high steppe include the North African endemic gundi, North African crested porcupines, rare hyenas, occasional Cuvier's gazelles and aoudad. More common species include jackal, red fox, wild boar, genet, and numerous rodents (see Section 4, Gouvernorats of Sidi Bou Zid, Gafsa, Kasserine, Tozeur).

Influences. The scarcity of vegetation resources in the high steppe puts a high demand on the forage and woody plants in the mountains. Grazing is so heavy that herbs are often eaten before they drop seed and many of the woody plants have been hedged by livestock or cut for fuelwood. This leaves the ground bare and vulnerable to erosion when the first winter storms start.

The E-W oriented chain of mountains passing through Gafsa, to the north of and parallel to the chotts, separates the high esparto grass steppes from the more arid steppe areas of the south. Two locations of special interest along that chain are described below.

3.4.4.1. Djebel Bou Ramli

Djebel Bou Ramli is located 25 km northwest of Gafsa. A summit altitude of 1156 m makes Dj. Bou Ramli the highest of the mountains to the west of Gafsa. Rocky, calcareous slopes descend to esparto grass steppes on the north side and sebkhet on the south side.

A. Vegetation

Esparto grass grows over the entire mountain, in association with degraded populations of Juniperus phoenicea and holm oak at the summit, and Genista microcephala var. capitella and Artemisia campestris on the lower slopes. There are also associations of rosemary on the slopes. At the foot of the mountain, Farsetia aegyptiaca and Cladanthus arabicus grow with the esparto grass and extend into the surrounding plains. A number of rare species are also found in the rich flora of this arid mountain. (Peterken and Radford 1969).

B. Fauna

Fauna are characteristic of the Gafsa mountains (Section 4).

C. Influences

The mountain has been a protected area for many years, but the effectiveness of the protection has not been recently assessed. Any vegetation removal would affect species compositions and leave the slopes susceptible to increased erosion rates.

3.4.4.2. Djebel Bou Hedma

34°30' N 9°38' E

A southern mountain of special interest is Dj. Bou Hedma. Located 85 kilometers east of Gafsa and 45 km west of the coast, the mountain is in the transition zone between central and southern Tunisia (Pottier-Alapetite 1979). From a summit altitude of 790 m, the mountain descends fairly rapidly (slopes > 25%) to the foothills, which descend more gradually to the surrounding steppes. Marne and gypsum deposits in the calcareous massif are weathered to form the soils of the slopes and base.

A. Vegetation

At the summit of Bou Hedma, additional moisture from low clouds produces an Arid Superior bioclimate and results in vegetation groups typical of aleppo pine formations (Schoenenberger 1986). Above 600 - 700 meters, depending on the exposition, associations include:

Rosmarinus officinalis	Leuzea conifera
Globularia alypum	Fumana thymifolia
Genista cinerea	F. ericoides
Cistus libanotus	Bupleurum gibraltarium
Pistacia lentiscus	Helianthemum cinereum
Centaurea tenuifolia	H. virgatum
Phagnalon rupestre	H. semiglaurum

Below the summit and on the foothills is a vegetation group that characterizes climax juniper forests. Degradation of the climax forest is signified by the presence of esparto grass.

Juniperus phoenicea	Pituranthos scoparius
Rosmarinus officinalis	Thymus hirtus
Globularia alypum	Sedum sediforme
Stipa tenacissima	Teucrium ramosissimum
Fumana laevipes	Helianthemum hirtum

At the base of the mountain is a vegetation group associated with calcareous crusts and gypsous soils, with:

Astragalus armatus	Atractylis serratuloides
Anabasis oropediorum	Erodium hirtum
Gymnocarpos decander	Aristida ciliata
Tetrapogon villosus	Stipa parviflora
Helianthemum kahiricum	Hernearia fontanesii
Coris monspeliensis	Moricandia arvensis
Rhus tripartitum	Fagonia cretica

Schoenenberger (1986) also described associations found at springs (including the rare Sacchorum ravernae), streams, marshes and rocky faults. A complete plant list for the mountain and adjacent plain is given in the pre-project proposal for Bou Hedma National Park (Dir. For. 1980).

B. Fauna

Mammals. Bou Hedma has many mammals endemic to North Africa and some threatened species, such as aoudad, dorcas gazelles, slender-horned gazelles and sand cat Felis margarita (Dir. For. 1980). Other mammals that have been reported include jackal, genet, brown hare, desert hedgehog, sand fox Vulpes rupelli, kaffir cat, Saharan striped weasel Poecilictis libyca, and a variety of rodents and bats:

Rodents:	<i>Hystrix cristata</i>	Crested porcupine
NA	<i>Elephantulus rozeti</i>	Elephant Shrew
NA	<i>Ctenodactylus gundi</i>	Gundi
NA	<i>Gerbillus campestris</i>	Gerbils
	<i>G. nanus</i>	"
NA	<i>G. simori</i>	"
	<i>G. gerbillus</i>	"
	<i>G. pyramidum</i>	"
	<i>Pachyuromys duprasi</i>	"
NA	<i>Meriones shawi</i>	Shaw's jird
	<i>M. crassus</i>	
	<i>M. libycus</i>	Libyan jird
	<i>Psammomys obesus</i>	Sand rat
	<i>Mus musculus</i>	House mouse
	<i>Rattus rattus</i>	black rat
	<i>R. alexandrinus</i>	palm rat
	<i>Jaculus jaculus</i>	Lesser Egyptian jerboa
Bats:	<i>Rhinolophus mehelyi</i>	
	<i>R. euryale</i>	
	<i>Myotis blythioxygnathus</i>	
	<i>Eptesicus serotinus isabellinus</i>	
	<i>Plecotus austriacus aegypticus</i>	

Birds. A great variety of migratory and wintering birds occur at Dj. Bou Hedma and are listed in Section 4 (Gouvernorat of Sidi Bou Zid). Sedentary birds include a number of nesting raptors and passerine species (Dir. For. 1980) such as:

Short-toed eagle	Peregrine	Blue rock thrush
Long-legged buzzard	Kestrel	Rock dove
Borelli's eagle	Lanner falcon	Mourning wheatear
Golden eagle	Little swift	Black wheatear
Egyptian vulture	Crag martin	Rock sparrow

C. Influences

Grazing has had a strong influence on the species composition of Bou Hedma. The most dynamic grazed species (Schoenenberger 1976) are:

<i>Aristida ciliata</i>	<i>Periploca laevigata</i>
<i>A. obtusa</i>	<i>Lycium arabicum</i>
<i>Cenchrus ciliaris</i>	<i>Rhus tripartitum</i>
<i>Moricandia arvensis</i>	<i>Acacia raddiana</i>

while species like *Anabasis oropediorum* and *Gymnocarpos decander* are so severely affected by grazing that regeneration ceases.

Part of Dj. Bou Hedma and the adjacent steppe have been established as a national park. About 3,660 ha are fully protected and an additional 12,828 ha are regulated as a buffer zone (IUCN 1987). Animal reintroduction and other park management plans are being implemented (Section 5.4.4).

3.4.5. Douirat Mountains

In southern Tunisia, along the eastern border of the Grand Erg is a long chain of low mountains and high plateaus. The Douirat mountains are oriented N-S and range in altitude from 300 - 600 m. Due to the increased altitudes, the mountains are slightly cooler and receive more rain than the surrounding desert, but the annual precipitation is still only 200 - 300 mm.

Vegetation. Plant associations in the northern part of the Douirat mountains differ from those of the south in that the upper slopes from Matmata to Dj. Rhar el Jami (NW of Tataouine) are vegetated by degraded Juniperus phoenicea garrigues. Juniper is scarce on most of the mountains and may soon disappear completely. Other species of the association (ORSTOM 1962) include scattered:

Ceratonia siliqua	Rhus tripartitum
Olea europaea oleaster	Periploca laevigata
Pistacia atlantica	Calycotome villosa

and, more commonly, thermophiles and calcicoles:

Teucrium polium	Phagnalon saxatile
Rosmarinus officinalis	Cistus libanotis
Globularia alypum	Fumana thymifolia

and other species, such as:

Thymus capitatus	Gymnocarpos decander
T. hirtus	Helianthemum kahiricum
Coris monspeliensis	H. ruficonum
Atractylis serratuloides	Stipa parviflora
Genista microcephala	Herniaria fontanesii

On the lower slopes and on the mountains to the south, the vegetation groups indicate further degradation. The association of Arthrophytum scoparium and Artemisia herba-alba, Stipa tenacissima variant also contains:

Tetrapogon villosus	Farsetia aegyptiaca
Pennisetum elatum	Moricandia arvensis
Hyparrhenia hirta	

An overexploitation of the esparto grass and other vegetation has resulted in a vegetation stage characterized by the abundance of:

Gymnocarpos decander	Helianthemum kahiricum
Herniaria fruticosa	Atractylis serratuloides
Anabasis articulata oropediorum	

This vegetation stage represents an irreversible desertification process (Le Houerou 1959 in ORSTOM 1962), which seems to accelerate under demographic pressure.

Fauna of the Douirat mountains include gundi, Eliomys quercynus and other rodents, which are preyed upon by jackals, southern fox and a variety of raptors. More complete lists are given in Section 4 (Gouvernorats of Gabes, Mederine, Tataouine).

Influences. Intense pressure from grazing livestock and people gathering fuelwood and fodder has degraded the Douirat ecosystems to a very poor state. The mountains are important as a natural barrier between the desertic steppes and Grand Erg to the west and the Jaffare steppe to the east. Further degradation will increase the risk of desertification and dune formation in the steppes, as well as result in accelerated erosion on the mountains. In the Matmatas chain, more than 750,000 ha have been treated for erosion control (Dir. For. 1986).

3.5. STEPPES

The term steppe is often used to describe any large plain covered by low, discontinuous vegetation. This vague definition results in areas with very different characteristics being called steppes in various countries or continents of the world. To clarify the term in Tunisia, it has been suggested to label the steppe-like areas 'pre-deserts' or 'post-forests', which more clearly describes their successional stage and characteristics (Le Houerou 1969). However, in order to remain consistent with other literature on Tunisia and to facilitate grouping areas of similar characteristics, the common term 'steppe' will be used in this document with regional clarifiers, such as High Steppe, Low Steppe, and Subdesertic Littoral/Continental Steppe.

The definitive work on Tunisia's steppe vegetation was done by Le Houerou (1969). He described the four principle vegetation structures that characterize the 6 to 7 million hectares of steppe in Tunisia:

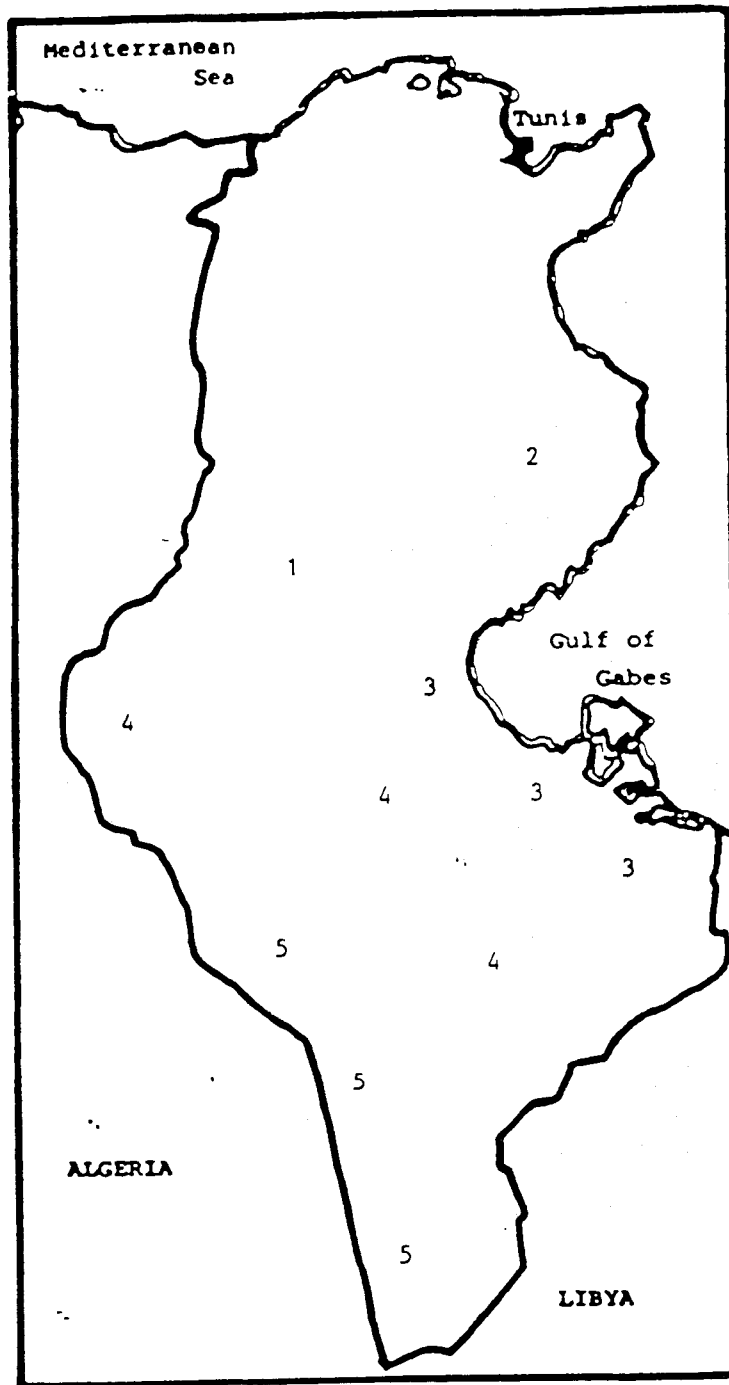
- Grass steppe: Steppes of esparto, Lygeum spartum, Atistida sp, etc.
- Lignous steppe: Steppes of Artemesia herba-alba or Rhantherium suaveolens.
- Halophile steppe: Wide bands of salt tolerant vegetation around the chotts (350,000 ha total).
- Wooded steppe or pseudo savannah: Steppes with scattered trees such as Acacia raddiana or Pinus halepensis.

The general regional categorization of steppe used in this document will also include the following more specific vegetation types distinguished by Le Houerou:

- Pseudo-steppe: Steppes of shrubs or 'scrub' from 0.5 to 3 m tall, including Retama raetam, Ephedra alata ssp. alenda, Calligonum comosum and Zizyphus lotus.
- Prairies: Seasonal herb formations of species such as Festuca arundinacea and Trifolium fragiferum along streams or in depressions.
- Meadows: Seasonal herbaceous formations in Subhumid or Semi-arid Superior bioclimates (ex. Poa bulbosa, Lolium perenne).
- Cultivated lands: Including orchards (800,000 ha), grains (1,500,000 ha) and fallow ground.

As thus defined, the steppes of Tunisia are those non-mountainous areas to the south and east of the Tunisian Dorsal and to the east of the Grand Erg (figure 10). Halophile steppe vegetation has been described in section 3.3.2. The following sections will describe the various general steppe regions of Tunisia.

Figure 10
Steppes and Grand Eastern Erg
of Tunisia



1. High Steppe
2. Low Steppe
3. Subdesertic Littoral Steppe
4. Subdesertic Continental Steppe
5. Grand Eastern Erg

Influences. The impacts of human actions have had a profound influence on the steppes. Much of the steppes of central Tunisia have been cultivated or exploited for esparto grass, and almost all of the steppe areas are grazed. Overgrazing has been estimated at 50% more than the sustainable production in central Tunisia and 25% in the south (Dir. For. 1986). This excessive pressure has resulted in the degradation of much productive land and makes the regions susceptible to desertification.

Tunisia is one of the most eroded Mediterranean countries and one of those most threatened by desertification (Dir. For. 1985). More than half the area of Tunisia is affected by desertification (Dir. For. 1977) and over 18,000 ha are lost to the desert each year; half of which is agricultural land. The three factors most responsible for the rapid desertification are: decreased forest vegetation (colonial harvesting, fuelwood collection, grazing); reduction and degradation of grazing lands (land lost to cultivation or overgrazed and lost to the desert); and agricultural practices (disc plowing, dry-farming methods and plowing against the contour on slopes). With desertification comes severe erosion and rainwater runoff (rather than percolation). The erosion and runoff cause floods, threaten communities, fill reservoirs, reduce subterranean water tables, ruin farmlands and steppe habitats, and wash out roads.

To combat desertification, the Tunisian government has attempted several types of projects, including range management, dune fixation, and soil and water conservation. Soil and water conservation projects usually deal with erosion control, such as terracing slopes; constructing embankments, low rock walls and other barriers to slow runoff; planting forage, soil-fixing plants, living hedges and windbreaks; and creating stock ponds to capture runoff on slopes (Dir. For. 1985).

Government projects for pasture improvement, regeneration of public grazing lands, erosion control and anti-desertification have met with varied levels of success. However, continued population growth is resulting in increasing pressure on lands decreasing in productivity and additional protection and improvement measures are needed.

The flora and fauna of the steppes are especially sensitive to:

Vegetation removal:

- Grazing, esparto grass harvesting

Water table manipulation

Hunting and Poaching

- Especially ungulates

3.5.1. High Steppe

The High Steppe is located roughly between the Tunisian Dorsal and Borj Maajer bel Abbes (north of Gafsa) and to the west of Maknassey in a region of high plains (over 400 m in altitude) divided by several mountain chains (see Section 3.4.4). Deep calcareous soils are dominant in the high steppe, but there are many areas with gypsous, marrous and saline

soils (ONUPAA 1985). Annual rainfall varies from 100 - 200 mm near Gafsa to 200 - 300 mm along the Tunisian Dorsal and northeast of Gafsa. Mountain summits in the same region receive 300 - 400 mm annual rainfall. Average temperatures vary from 16° C in the northwest to 19° C near Gafsa. As a result of the relatively low precipitation and the temperature the bioclimate is Arid Superior with a cool winter variant in the west part and a temperate winter variant in the east part of the High Steppe.

A. Vegetation

Vegetation of the High Steppes was once dominated by Juniperus phoenicea. Now juniper is only found on the plateaus and mountains, and the plains are covered by associations of esparto grass. On the heavier soils in the western part of the High Steppes the vegetation is dominated by esparto and Artemisia herba alba in association with (ORSTOM 1962, Le Houerou 1969):

Haloxyton tamariscifolium	Salvia aegyptiaca
Anabasis articulata	Plantago ovata
Carrichtera annua	Centaurea acaulis
Chrysanthemum fuscatum	Helianthemum hirtum ruficomum
Arthrophytum scoparium	

On lighter soils in the western High Steppe a secondary steppe of esparto and Artemisia campestris, joined by rosemary on higher ground, dominates. These soils are often planted to olives. Associated plants include:

Plantago albicans	Muricaria prestrata
Helianthemum ruficomum	Herniaria fruticosa
H. lippii sessiliflorum	Cutandia divaricata
Linaria aegyptiaca	Anacyclus cyrtolipidioides
Genista uniflora	Astragalus cruciatus
Launea residifolia	

In the southwest corner of the High Steppe there is a large area covered by an association of esparto grass and:

Helianthemum lippii	Plantago albicans
Aristida plumosa	Atractylis serratuloides

To the east, in the transition zone between the High Steppe and the Low Steppe are associations dominated by scattered jujube Zizyphus lotus and abundant Artemisia campestris, with combinations of:

Eragrostis papposa	Ifloga spicata
Stipa parviflora (on sand)	Fagonia kahirina
S. retorta	Astragalus cruciatus
S. lagascae pubescens "	Onopordon arenarium
Plantago albicans	Scabiosa arenaria
P. ovata	Aristida obtusa
Genista uniflora	Atractylis candida
Linaria aegyptiaca	A. flava citrina

In the southeast, heavier soils result in Artemisia herba alba being associated with jujube and combinations of esparto grass, Asparagus albus and Globularia alypum. Along the edge of the High Steppe, south of the above associations and extending into the Low Steppe is an association of Rhantherium Suaveolens with Dianthus crinitus and Artemisia campestris.

B. Fauna

Many of the animals found in the mountains descend into the plains to feed, drink, or as part of a migration pattern. Of special interest in the High Steppe are threatened houbara bustards, which nest in the eastern part of the region, and rare hyenas, which descend from the mountains to prey on wild boar. Common fauna are listed in Section 4 (Gouvernorats of Sidi Bou Zid, Kasserine, Gafsa).

C. Influences

A large paper mill is located in Kasserine. Esparto grass fibers are processed at the mill to produce a high quality paper. Of approximately 433,000 ha of dense esparto steppes in Tunisia, most are in the High Steppe and more than half are exploited for the mill (Dir. For. 1986). This exploitation, along with overgrazing and clearing for agriculture is having serious impacts on the natural vegetation of the region. Of the 124,000 ha of esparto steppe in the Sidi Bou Zid Gouvernorat, only one third is considered dense or moderately dense, another third is sparse and the final third is degraded (erosion, fires, cultivation). The Forestry Directorate has implemented regulations to protect the steppes from overharvesting, but overgrazing and cultivation are problems much more difficult to control. The paper plant also uses large quantities of water from the Oued Derb and releases various chemical compounds in its discharge.

3.5.2. Low Steppe

East of the High Steppe, north of Sebket Mechequigie and south of Enfida, a vast flat to gently undulating plain extends to the coast. Throughout the Low Steppe, the altitude is less than 250 m. Runoff from the High Steppe flows in several temporary rivers and settles in the many depressions in the Low Steppe, creating sebkhet (Section 3.3.2). Shallow soils form on calcareous crusts through much of the region, and in areas of higher precipitation, red Mediterranean soils form on hard limestone (ONUPAA 1985).

Most of the Low Steppe receives 200 - 300 mm annual rainfall, but the area south of Sfax receives less than 200 mm. Average temperatures of the region are near 19° C. Bioclimates vary from Semi-arid Inferior near the coast to Arid Inferior southwest of El Djem. Most of the inland portion of the Low Steppe has an Arid Superior bioclimate (Le Houerou 1966).

A. Vegetation

In the Arid Superior inland region, the dominant vegetation type is the jujube, Artemisia campestris, Eragrostis papposa association found in the eastern High Steppe. Associations of jujube, Artemisia herba alba and Asparagus albus, and of Rhantherium suaveolens also extend from the High Steppe along the southeastern edge of the Arid Superior zone of the Low Steppe.

The alluvial plains near Kairouan have fine textured soils that are often inundated and are vegetated to (Le Houerou 1969):

Beta macrocarpa	Silybum eburneum
Scolymus maculatus	

Around the sebkhet, along saline watersheds and in a large area surrounding Kairouan, the primary vegetation type is the halophile association described in Section 3.3.2. Gypsous soils to the northwest, south and southeast of Sebkhet Sidi el Hani are vegetated to the Cynara cardunculus, Lygeum spartum, Cynodon dactylon group. Along the coast, from Enfida to Sousse, the vegetation of the Semi-arid Inferior (mild winter variant) bioclimate is dominated by:

Artemisia herba alba	Arisarum vulgare
Stipa parviflora	Lavandula multifida
Zizyphus lotus	Phlomis floccosa
Helianthemum lippii	Echiochilon fruticosum
H. racemosum	Lygeum spartum
Atractylis serratuloides	

South of Sousse, the above vegetation is joined by variants indicated by Solanum sodomaeum or Cynodon dactylon and Artemisia herba alba, which are interspersed with areas of alluvial plains.

The Arid Superior region along the coast south of El Djem is vegetated to various associations of Artemisia, including:

Artemisia herba alba	Globularia alypum
A. campestris	Dianthus crinitus
Zizyphus lotus	Rhantherium suaveolens
Eragrostis papposa	Atractylis serratuloides
Asparagus albus	

or, near Sebkhet El Djem and the coast:

Trigonella anguina	Solanum sodomaeum
Lygeum spartum	

B. Fauna

The fauna of the Low Steppe is similar to that of the High Steppe and is listed in Section 4 (Gouvernorats of Kairouan, Sousse, Sfax). Of special interest are threatened houbara bustards, which nest near Kairouan.

C. Influences

Most of the inland area of the Low Steppe is cultivated and the coastal areas are cultivated and planted to olives. Therefore, the largest area of uncultivated habitat is composed of the sebkhet and zones with saline soils. Grazing is heavy throughout the region and poaching of brown hare and barbary partridge is common.

3.5.3. Subdesertic Littoral Steppe

South of the Low Steppe, the Subdesertic Littoral Steppe extends inland almost to Gafsa, then narrows south of Sebkheth er Noual to the area between Sebkheth el Hamma and the coast and extends south to Tataouine. At Tataouine, the border of the Subdesertic Littoral Steppe curves north and then southeast to the Libyan border. As with the Low Steppe, the altitude of the Subdesertic Littoral Steppe is less than 250 m; highest near the High Steppe and Douirat mountains and lowest near the coast. Substrates are limestone overlain by calcareous, gypsous and sandy soils.

Average annual precipitation in the region is from 100 to 200 mm and average annual temperatures are 19° to 20° C. Minimum winter temperatures average 6° C and maximum summer temperatures average 35° C. The bioclimate of the Subdesertic Littoral Steppe is Arid Inferior, mild winter variant.

A. Vegetation

Although the longitudinal and latitudinal range of the Subdesertic Littoral Steppe is large, the Mediterranean sea moderates the climate and the primary factor influencing the vegetation appears to be the inland extension. Coastal vegetation types have been described in Section 3.1.4. An interesting association that grows on uplands along the coast south of Kneiss is that of Zygophyllum album and Anarrhirum brevifolium. Near the coast a variant to Ononis natrix ssp. falcata is often found. The association also extends from an area inland of Kneiss in a band to the north of the Chotts that passes through Gafsa. As the Zygophyllum-Anarrhirum association extends inland, a variant to Moricardia arvensis appears.

Most of the Subdesertic Littoral Steppe is vegetated by associations characterized by combinations of:

- 1) Rhantherium suaveolens (300,000 ha total
and Artemisia campestris in Tunisia)

with sub associations of

Atractylis serratuloides or Lygeum spartum

- 2) Pituranthos tortuosus
and Haplophyllum vermiculaire

with a sub association of

Erodium glaucophyllum

- 3) Artemisia herba alba (350,000 ha)
and Arthrophytum scoparium

with sub associations of

Gymnocarpos decander and Stipa tenacissima
or Erodium glaucophyllum

North of Gabes is the additional association of:

Artemisia herba alba
Lygeum spartum
and Pteranthus dichotomus

South of Gabes, three other additional associations appear:

- 1) Rhantherium suaveolens (250,000 ha)
Asphodelis refractus
and Atractylis serratuloides
- 2) Aristida pungens
and Scrofularia saharae
- 3) Zizyphus lotus
and Retama raetam

West of Sebkhet Mansour, toward Gafsa, the previous associations are replaced by associations characterized by:

- 1) Arthrophytum schmittianum (~50,000 ha)
and Thymelaea microphylla

with variants to

Artemisia campestris and Diplotaxus harra

- 2) Hedysarum carnosum
Peganum harmala
- 3) Anabasis aphylla
Suaeda vermiculata

At the base of Djebel Bou Hedma, the vegetation in the southern part of the steppe area of the national park (Section 5.4.4) is represented by a psammophyte group. Species in the group (Schoenenberger 1986) include:

Rhantherium suaveolens	Centaurea dimorpha
Arthrophytum schmittianum	Argyrolobium uniflorum
Echiochilon fruticosum	Silene arenarioides
Artemisia campestris	Catanche arenaria
Marrubium deserti	Salsola vermiculata
Polygonum equisetiforme	Chrysanthemum trifurcatum
Nolletia chrysocomoides	Farsetia aegyptiaca
Eragrostis papposa	Brassica tournefortii
Danthonia forskahlii	Astragalus caprinus
Stipa tagascae	A. hamosus
Aristida plumosa	Ifloga spicata
A. purgens	Pituranthos tortuosus
Helianthemum lippi sessiflorum	

There is also a variant at Bou Hedma characterized by limonophytes. Cereal crops are planted in these areas. In dry years the soil is almost bare since Arthrophytum scoparium and Peganum harmala are often the only perennials. Other species include:

Artemisia herba alba	Limonium borduelli
Salvia aegyptiaca	Lonchophora capiomontana
Diploctaxus harra	Vicia montana
Eruca vescaria	Asteriscus pygmaeus
Vella annua	Enarthrocarpus clavatus
Cladanthus arabicus	Malva parviflora
Ajuga iva	Amberboa lippii
Medicago truncatula	Reseda decursiva
Trigonella polycerata	Stipa retorta

Schoenenberger (1986) also listed variants that appear on salty, gypsous and wet soils. Of special interest is a pseudo-savanna of Acacia raddiana that appears in some of the above associations. In the past, the entire region was covered by savanna (see Section 2.3, Flora). Now there are only c.10 ha left that are dominated by Acacia raddiana and some scattered trees in the Bled Talha region. The climax acacia pseudo-savanna is typically accompanied by:

Pistacia atlantica	Zizyphus lotus
Phus tripartitum	Periploca laevigata
Lavandula multifida	Lycium sp.
L. coronopifolia	

B. Fauna

The largest mammals of the most of the Subdesertic Littoral Steppe are jackals and fox. In some regions, such as Bou Hedma, dorcas gazelles and slender-horned gazelles also occur. Brown hare are common, as well as a variety of rodents, including Eliomys quercynus and the North African

endemic Shaw's jird. Many species of raptors hunt in the region, and the threatened houbara bustard is reported to nest there. Other species common to the Subdesertic Littoral Steppe are listed in Section 4 (Gouvernorats of Sfax, Sidi Bou Zid, Gafsa, Gabes, and Medinire).

C. Influences

Forage production is fairly high in associations of Rhantherium suaveolens and Artemisia campestris (200 Forage Units/ha), Rhantherium and Asphodelis refractus (100 FU/ha) and Arthrophytum schmittianum (180 FU/ha), but they are also overgrazed by 45 - 50 % (Le Houerou and Froment 1966). In the north part of the region, much of the steppe is cultivated, some of which is planted to olives. Cultivation by tractors with discs is a major cause of erosion in the Subdesertic Littoral Steppe. Ravines and sandy soil are often plowed, resulting in accelerated gully and dune formation. With the impacts of overgrazing added to poor farming practices, many areas are in danger of desertification.

To control desertification in degraded areas, windbreaks, soil stabilization plantings and watershed management practices have been implemented. Many of these areas are showing favorable results, but problems with species selection and plantation survival have reduced success in other locations.

Poaching of hare and partridge is a common practice. Understaffed and inadequately equipped enforcement agents are only able to reduce the level of poaching; they are by no means able to stop it. Habitat degradation combined with heavy hunting pressure (legal and illegal) are severely affecting the biological diversity of this region. The region has potential for a variety of plant associations and animal species (gazelles, addax, oryx and ostrich formerly occurred), but it is very sensitive to influences that remove vegetation, increase erosion or excessively decrease wildlife populations.

3.5.4. Subdesertic Continental Steppe: Gafsa, Jerid, Dahar

South of the three previously described steppes, the Subdesertic Continental Steppe extends south and west to the edge of the Sahara (Grand Eastern Erg). In this document, the region north of the chotts is called the Gafsa plains, south of Chott el Gharsa is Jerid and the remainder of the southeastern Subdesertic Continental Steppe is the Dahar plain (which also includes part of the Jaffara region). In the Subdesertic Continental Steppe, limestone substrates are overlain by sandy calcareous soils with many gypsous locations.

Unlike the Subdesertic Littoral Steppe, the Subdesertic Continental Steppe does not benefit greatly from the Mediterranean sea and only 100 - 200 mm rain falls annually. Temperatures are very high, averaging 19° to 20° C. Average summer maximums are near 40° C, with extremes over 50° C. Average winter minimums are 3-5° C. Along the north and east edge of the Subdesertic Littoral Steppe the bioclimate is Arid Inferior, with cool (north) and temperate (east) winter variants. East of Tataouine, Remada and Dehibat to the Libyan border, the bioclimate is Saharan Superior, temperate winter variant. The rest of the Subdesertic Continental Steppe (southwest portion) is Saharan Superior, cool winter variant.

A. Vegetation

Vegetation associations in the Gafsa plains are similar to those described for the part of the Subdesertic Littoral Steppe near Gafsa. More saline soils are indicated by the presence of Salsola vermiculata var. villosa and other halophytes. There are also variants to Linnaria fallax, Chrysanthemum fuscatum and esparto grass of the association of:

Artemisia herba alba
Arthrophytum scoparium
Gymnocarpus decander

Near Tozeur the vegetation associations are sparser and characteristic of Saharan bioclimates. An association of

Brocchia cinerea
Cornulacea monacantha
Cyperus conglomeratus

with sub associations to

Astragalus armatus tragacanthoides
and Aristida pungens

dominates near Tozeur. To the south and across a large region on the south side of Chott Djerid, there is an association of

Retama raetam
Arthrophytum schmittianum var schmittianum
and Suaeda vermiculata

Between the mountain range parallel to the northern edge of Chott Djerid and Djebel Tabaga is an association of

Traganum nudatum var. obtusatum
and Anabasis articulata var. articulata

At the northwest corner of the Dahar, along the east edge of the Retama, Arthrophytum, Suaeda association described above, are Tamarix stands on non saline soils and parcels vegetated to:

Calligonum comosum
and Anthyllis sericea ssp. henoniana

which also occur southeast of Tataouine. Along Djebel Tabaga and southeast of Tataouine are areas characterized by:

1) Rhantherium suaveolens
and Asphodelis refractus
with variants to
Savigny parviflora and Anthyllis sericea henoniana

- 2) *Stipa tenacissima* (450,000 ha)
Moricardia arvensis
Zygophyllum album
Anarrhinum brevifolium

The majority of the Dahar (2,100,000 ha) is vegetated to an association indicated by:

Anthyllis sericea ssp *henonia*
and *Gymnocarpos decander*

with sub associations to

Stipa lagascae *Stipa tenacissima*
or *Helianthemum lippii intricatum*

There are also some areas with halophile associations (Section 3.3.2) and associations of

Arthrophytum schmittianum
Retama raetam
and *Calligonum comosum*
or *Suaeda vermiculata*

In the center of the Dahar and on the west edge, forming the transition zone with the Sahara is

Arthrophytum schmittianum var. *prostratum*
and *A. scoparium* var. *scoparium*

B. Fauna

Fauna of the Subdesertic Continental Steppe are listed in Section 4 (Gouvernorats of Gafsa, Tozeur, Kebili, Medinine, Tataouine). Of special interest are slender-horned gazelles, dorcas gazelles, kaffir cat and threatened houbara bustards.

C. Influences

Influences on the ecosystem include overgrazing and clearing vegetation for cultivation of grains and orchards. Desertification and dune formation is a serious problem and some remedial actions are being taken (plantations, watershed control structures, terracing, encouragement of contour plowing). A national park/biosphere reserve has been proposed for the eastern part of the region, near Hamada, Djebel Toui and the Libyan border (see Section 5.4.7).

There is a current project attempting to establish a 'green belt' of orchards and new oases around Chott Jerid. Over 295,000 ha have already been affected by this program, which could produce very favorable results by slowing the rate of desertification and providing some fauna habitat (especially for birds). There is a danger, however, that the massive quantities of irrigation water used in this program could cause unexpected responses in the water tables (ex. dessication of distant oases).

3.6. GRAND EASTERN ERG: SAHARA

Along the southwest edge of Tunisia is part of the vast desert known as the Grand Eastern Erg, or the Sahara (figure 10). Little rain falls in the region; the average annual precipitation is 50 - 100 mm at the northern edge and only 20 - 50 mm for the rest. Many years can pass with no rain at all. Average temperatures are above 21° C, with summer maximums averaging above 40° C and winter minimums averaging below 3° C. Hot dry Sirocco winds sweep over the land for many days at a time in the summer. The harsh climate has led to the formation of vast areas of large sand dunes, which cover the Grand Eastern Erg.

The erg is sensitive to:

- Changes in rainfall patterns
- Vegetation removal
- Harvesting of rare species of fauna - especially ungulates

A. Vegetation

In such a forbidding area, the amount of vegetation that does exist is surprising. Between and on the dunes is a pseudo-forest association of Calligonum. There are from 1 to 10 "trees" per hectare, and many are 8-10 m tall (Le Houerou 1969, ORSTOM 1962). Species characteristic of the association are:

Calligonum arich	Aristida pungens
C. azel	Ephedra alata alenda
C. comosum	Cornulaca monacantha
rNA Genista saharae	Retama raetam

There are over 1,720,000 ha of dunes with the above association. On the eastern edge of the southern tip of Tunisia, there are an additional 760,000 ha with associations of:

- 1) Traganum nudatum microphyllum
Salsola vermiculata
with a variant to
Arthrophytum scoparium
and a sub association to
Anabasis articulata ascendens
- 2) Helianthemum confertum brachypodum
Calligonum comosum
- 3) Arvillea radiata
Antirrhinum ramosissimum

B. Fauna

Slender-horned gazelles inhabit the north and east edges of the region; gundi live in the higher zones and a variety of rodents, reptiles and insects can be found. Many species of birds are adapted to the desert conditions and others rest there during migration.

C. Influences

Human influences in the region are mostly limited to grazing by herds of camels and the use of Calligonum for fuelwood. While the annual forage production is only 2 Forage Units per hectare (compared to 200 FU/ha in the Rhantherium and Artemisia campestris steppes) overgrazing problems are much less than in the steppes (Le Houerou and Froment 1966). However, the advance of the desert into the adjacent regions is a serious problem facing Tunisia.

3.7. OASES

There are about 60,000,000 million m³ of water in the underground reservoirs of the Sahara (Pallas 1972). In places where some of that water rises to the surface, oases are formed. Oases also occur along streams and springs north of the Sahara proper. Oases vary in size from less than one hectare to well over one thousand hectares. The larger oases are cultivated intensively and are the locations of the major cities of the south: Sfax, Gabes, Mahares, Gafsa, Tozeur, Nefta, Douz, etc.

There are well over 75,000 ha of oases in Tunisia, most of which are subjected to some form of cultivation and over half of which are intensively managed. Some oases have been artificially created or expanded.

Oases are sensitive to:

- Water table manipulation
- Stream flow interruption
- Removal of palm trees
- Capture of migrating birds

A. Vegetation

Intensive cultivation makes it difficult to determine the native vegetation associations of the oases. A plant species associated with most oases is the naturalized date palm Phoenix dactylifera. Among the date palms in the inland oases north of Kebili and along the coast to Zarzis (including the island of Jerba) the vegetation is commonly characterized by:

Malva parviflora
Aizoon hispanicum
Peganum harmala

The oases at and near Gabes also contain the rare shrub Prosopis stephaniana (ORSTOM 1962). Due to the intense cultivation, the other plants associated with oases are usually crop weeds, but there are also ferns, such as Adiantum capillus veneris and

Grasses:

Paricum repens
Aeluropus littoralis
Echinochloa colera

Cyperaceae:

Carex extensa
Cyperus laevigatus

In and along the irrigation canals grow aquatic plants, including:

Potamogeton nodosus	Zarichella palustris
P. pectinatus	Typha angustifolia
r P. densus (Gafsa)	Ruppia maritima
r P. lucens "	

r = Rare

Near Kebili, oases occur naturally or have been created in areas previously vegetated by the association of:

Retama raetam
Arthrophytum schmittianum var. schmittianum
Suaeda vermiculata

B. Fauna

Mammals found in the oases reflect the presence of intensive cultivation and human disturbance. Rattus rattus and many other small rodents (gerbils, mice, etc.) occur, but the only large mammals are wild boars, which occasionally damage crops. Predators, such as jackals, fox and wild cats sometimes venture into the oases, but they are very secretive and often only remain for a short period of time.

Oases do provide an excellent resting for a variety of migrating birds and many sedentary species nest at the oases or enter to feed and drink. Fish occur naturally, and have been introduced, in many of the oases. The types of fish include:

Apharus	Gambusia
Barbus antinorii	Astatotilapia
Hemichromis	Tilapia (Sarotherodon)

C. Influences

As previously mentioned, the primary human influence on oasis ecosystems is intensive cultivation and irrigation. Wells drilled to irrigate new croplands have reduced water flows in some areas and resulted in the dessication or degradation of some oases. During the spring, migrating birds are often captured with snares in the oases (Grimmet 1987).

Many oases are threatened by the effects of desertification. Wind blown sand can be trapped by the palm trees and moving dunes can cover an oasis destroying the ecosystem. The Forestry Directorate has implemented protection measures at more than 50 oases, including planting 1,700 ha of windbreaks to protect some of the more economically important and inhabited areas.

4. BIOLOGICAL DIVERSITY DATA BY GOUVERNORAT

Tunisia is divided into 21 governmental units, or gouvernorats. In this section, summaries are given of the major ecosystems; specific sites, flora and fauna of interest; and factors influencing biological diversity in each gouvernorat. Specific sites are cross referenced to sections where more detailed information can be found. The headings 'Medicinal Plants' and 'Genetic Resource Plants' refer to Section 2.3.1.

The lists given are not complete, and sometimes the relative lengths may correspond more to research and reporting intensity than to comparative differences in biological diversity between gouvernorats. The summaries are intended to give baseline data and highlight environmental concerns, which can be used in preparing Environmental Assessments for projects targeted in the various gouvernorats. The summaries are also intended to facilitate the selection of priority areas for species or ecosystem specific conservation projects.

The gouvernorats are presented in the following order:

- A. BEJA
- B. JENDOUBA
- C. LE KEF
- D. SILIANA
- E. BIZERTE
- F. NABEUL
- G. TUNIS
- H. ZAGHOUAN
- I. KAIROUAN
- J. KASSERINE
- K. SIDI BOU ZID
- L. MAHDIA
- M. MONASTIR
- N. SOUSSE
- O. SFAX
- P. GABES
- Q. GAFSA
- R. KEBILI
- S. MEDENINE
- T. TATAOUINE
- U. TOZEUR

A. BEJA

Area: 355,000 ha

Major Ecosystems: Kroumirie/Mogod Mountains
High Tell
Coral Coast
Island
Medjerda Valley

Specific Sites Important to Biological Diversity:

Belif Forest: 15,000 ha cork oak forest (Section 3.4.1D)
Amdour Forest: 5,800 ha cork oak forest, north of Beja
Coral Coast: Section 3.1.1
Galite Archipelago and Reserve: 700 ha (Section 3.2.1)
Mhibes Reserve: Section 5.4.10
Lake Chitane: Section 3.3.4.1
Sidi Salem Reservoir: 4,600 ha (Section 3.3.3A)
Kasseb Dam Reservoir: 400 ha

Flora:

Natural Forest: 30,455 ha
Cork oak forest - Section 3.4.1D
Planted forest - 27,000 ha (50% managed forest)
Aleppo pine, pignon pine, maritime pine, eucalyptus
Maquis: 36,500 ha Olea-lentiscus (Section 3.4.2)
Coastal maquis (Section 3.1.1)
Degraded cork oak/aleppo pine forest (Section 3.4.1D)
Forest Clearings: 1,760 ha
Cultivated Plain: 230,000 ha

Rare and Endemic Plants:

v	<i>Alternanthera sessilis</i>	rNA	<i>Linum corymbiferum lambesaranum</i>
vNA	<i>Cyclamen africanum</i>	TA	<i>Gerista ulcina</i>
v	<i>Teucrium pseudo-scorodonia</i>	"	<i>Brassica cretica atlantica</i>
VT	<i>T. radicans</i>	"	<i>Reseda duriaena</i>
v	<i>Linaria flava</i>	"	<i>Rumex aristidis</i>
rNA	<i>L. pinnifolia</i>	T	<i>R. tunetanus</i>
r	<i>Ononis mitissima</i>	rTA	<i>Maresia malcolmoides</i>
r	<i>Coronilla atlantica</i>	TA	<i>Silene scabrida</i>
r	<i>Nymphaea alba</i>	TA	<i>S. tunetana</i>
r	<i>Lathyrus nissolia</i>	r	<i>S. neglecta</i>

v = Very Rare
r = Rare

NA = North Africa Endemic
TA = Tunisia/Algeria Endemic
T = Tunisia Endemic

Medicinal Plants:

<i>Capparis spinosa</i> (uncommon)	<i>Lavandula multifida</i>
<i>Myrtus communis</i>	<i>Asphodelis microcarpa</i>
<i>Rosmarinus officinalis</i>	<i>Erica</i> sp.
<i>Pistacia lentiscus</i>	

Beja (Continued)

Genetic Resource Plants:

Ceratonia siliqua
Olea europaea oleaster
Quercus ilex
Q. suber

Arbutus unedo
Crataegus azarolus
Rubus ulmifera
Hedysarum coronarium

Fauna:

Mammals:

Wild boar
Jackal
Red fox
Egyptian mongoose
Crested porcupine

Algerian hedgehog
Brown hare
Field mouse
Gerbillus campestris (gerbil)
Eliomys quercynus

Birds:

Great crested Grebe
Grey heron
White stork
Black kite
Buzzard
Long-legged buzzard
Marsh harrier
Kestrel
Quail
Barbary partridge
Coot
Moorhen
Pintail
Kentish plover
Woodcock
Slender-billed gull
Spanish sparrow
Spotless starling
Raven

Rock dove
Wood pigeon
Palm dove
Turtle dove
Swift
Bee eater
Green woodpecker
Bulbul
Great grey shrike
Woodchat shrike
Sardinian warbler
Dartford warbler
Spotted flycatcher
Black-eared wheatear
Blackbird
Nightingale
Great tit
Goldfinch
Chaffinch

Influences:

Myrtus communis harvesting
Cork harvesting
Cultivation, grazing
3 Fauna Reserves
Dune Stabilization - 20 km Littoral Cordon, 3,470 ha Planted
Prairie Creation - 613 ha

E. JENDOUBA

Area: 305,000 ha

Major Ecosystems: Kroumirie Mountains
High Tell
Coral Coast
Medjerda Valley

Specific Sites Important to Biological Diversity:

El Feidja: Oak forest, Fauna reserve, Section 3.4.1.1
Ain Draham: Oak forest (Section 3.4.1.2)
Ain Baccouch Reserve: Barbary deer
Dar Fatma Bog: 3 ha, (Section 3.3.4.5)
Maritime Pine Forest: Section 3.4.1
Reservoirs: Beni Mtir; Hammam Bourguiba; Bou Huertma

Flora:

Natural Forest:

Cork oak - 47,379 ha
Zen/Cork oak - 33,698 ha
Maritime pine - 5,500 ha
Aleppo pine - 9,500 ha

Planted Forest: 2,000 ha

Aleppo pine, cypress, eucalyptus, acacia

Maquis: 16,923 ha

Olea-lentiscus - Section 3.4.2
Degraded cork oak/aleppo pine forest 3.4.1D
Coastal maquis - Section 3.2.1

Cultivated: 145,000 ha

Rare and Endemic Plants:

v	Barbarea vulgaris	r	Rubus incanescens
v	Cardamine graeca	r	Potentilla micrantha
v	Ajuga reptans	r	Rosa gallica
vNA	Cyclamen africanum	r	Oronis mitissima
vNA	Teucrium atratum	r	O. alepecurioides
v	Arabis pubescens	r	Luzula campestris
r	Vicia disperma	r	Sanicula europaea
r	Acer monspessulanum	r	Lotus drepanocarpus
r	Medicago arabica	r	L. creticus commutatus
r	M. hispida microdon	r	Trifolium striatum
r	M. hispida brachycantha	T	Marrubium aschersonii
r	Vicia bithynica major	rT	Lathyrus brachyodus
r	V. altissima	rTA	Quercus afares
r	V. sicula	rNA	Erodium pachyrrhizum
r	Lathyrus niger	rNA	Ceum urbanum
r	Geranium columbinum	NA	Medicago sativa eu-sativa
r	Allaria officinalis	TA	Genista ulcina
r	Salix purpurea	TA	Sedum tuberosum
r	Castanea sativa	TA	Melilotus macrocarpa
r	Spergula arvensis	TA	Rumex aristidis
r	Cerastium caesptosum	TA	Silene scabrida
r	Fumaria bicolor	TA	Lepidium glastifolium
r	Teesdalia coronopifolia	TA	Biscutella raphnifolia
r	Stellaria holostea		

Jendouba (Continued)

Medicinal Plants:

Asphodelis cerasiferus	Fumaria officinalis
A. microcarpus	Pistacia lentiscus
Myrtus communis	Rosmarinus officinalis

Genetic Resource Plants:

Rubus ulmifolius	Crataegus monogyna
Arbutus unedo	C. azarolus
Olea europaea oleaster	Quercus ilex
Hedysarum coronarium	Q. suber

Fauna:

Mammals:

t	Barbary deer	r	Otter
	Wild boar		Egyptian mongoose
t	Hyena		Algerian hedgehog
	Jackal		Common genet
	Red fox		Brown hare
r	Caracal		Crested porcupine
	Kaffir cat		Field mouse

Birds:

	Grey heron		Bee eater
	Anatidae		Hoopoe
	Booted eagle		Green woodpecker
	Golden eagle		Great spotted woodpecker
r	Red Kite		Galerid larks
	Buzzard		Melodious warbler
n	Sparrowhawk		Blackcap
	Short-toed eagle		Sardinian warbler
	Kestrel	r	Firecrest
	Coot		Spotted flycatcher
	Barbary partridge		Blackbird
	Sandgrouse		Robin
	Little ringed plover		Coal tit
	Common sandpiper		Great tit
	Woodcock		Wren
	Wood pigeon		Chaffinch
	Turtle dove		Jay
	Cuckoo		Raven
	Eagle owl		Barn owl
	Long-eared owl		

Influences:

Myrtus communis and cork harvesting
 Limited tree cutting
 Firebreak creation and maintenance
 Cultivation, grazing, fuelwood and fodder collection
 Fires
 3 Reserves: El Feidja, Ain Baccouch, Dar Fatma (possibly)

v = Very Rare	NA = North Africa Endemic
r = Rare	TA = Tunisia/Algeria Endemic
t = Threatened	T = Tunisia Endemic
n = Nesting Birds	

C. LE KEF

Area: 455,000 ha

Major Ecosystems: High Tell
Medjerda Valley

Specific Sites Important to Biological Diversity:

Ouergha Forest: Holm oak/aleppo pine, Section 3.4.2
Oued Mellegue Reservoir: 1,000 ha, Section 3.3.3A

Flora:

Natural Forest: 86,107 ha
Aleppo pine, holm oak
Planted Forest:
Aleppo pine, cypress, eucalyptus, acacia
Maquis:
Olea-lentiscus
Degraded aleppo pine, holm oak forest
Juniper
Cultivated: 270,000 ha

Rare and Endemic Plants:

r	<i>Buffonia tenuifolia</i>	rT	<i>Trifolium squarrosum tunetana</i>
r	<i>Ionopsidium albiflorum</i>	TA	<i>Oreobliton thesioides</i>
r	<i>Silene conica</i>	TA	<i>Rupicapros numidicus</i>
A	<i>S. atlantica</i>		ssp. <i>sarcocaproides</i>
TA	<i>S. tunetana</i>		

Medicinal Plants:

	<i>Pistacia lentiscus</i>		<i>Erica scoparia</i>
	<i>Rosmarinus officinalis</i>		<i>Globularia alypum</i>

Genetic Resource Plants:

	<i>Ceratoria siliqua</i>		<i>Quercus ilex</i>
	<i>Olea europaea oleaster</i>		<i>Hedysarum coronarium</i>
	<i>Crataegus azarolus</i>		

Fauna:

Mammals:

	Wild boar		Algerian hedgehog
t	Hyena		Brown hare
	Jackal		Crested porcupine
	Red fox	NA	Shaw's jird
	Kaffir cat	NA	<u><i>Gerbillus campestris</i></u> (gerbil)
	Common genet		<u><i>Jaculus orientalis</i></u> (jerboa)
	Egyptian mongoose		

Le Kef (Continued)

Birds:

t	White stork	Wood pigeon
	Teal	Rock dove
	European wigeon	Stock dove
	Mallard	Turtle dove
t	Red kite	Sardinian warbler
	Black kite	Short-toed lark
	Golden eagle	Robin
	Booted eagle	Black-eared wheatear
	Buzzard	Blackbird
	Kestrel	Song thrush
	Quail	Mistle thrush
	Barbary partridge	Chaffinch
	Coot	Jay
	Stone curlew	Raven
	Black-bellied sandgrouse	

Influences: Minor rosemary harvesting
Grazing, cultivation
Dams

v = Very Rare
r = Rare
t = Threatened

NA = North Africa Endemic
TA = Tunisia/Algeria Endemic
T = Tunisia Endemic

D. SILIANA

Area: 495,000 ha

Major Ecosystems: High Tell
Tunisian Dorsal

Specific Sites Important to Biological Diversity:

Djebel Bargou: Section 3.4.3.7

Dj. Serdj: Section 3.4.3.6

Dj. Zitoun

La Khmes Reservoir

Flora:

Natural Forest: 13,700 ha

Aleppo pine, halm oak, Faktar cypress

Maquis: Juniper

Olea-lentiscus

Cultivated: 325,000 ha

Rare and Endemic Plants:

r	<i>Ononis biflora</i>	rNA	<i>Sorbus aria</i>
r	<i>Helilotus elegans</i>	rNA	<i>Linum corymbiferum lambesarium</i>
r	<i>Trifolium striatum</i>	rNA	<i>Cotoneaster racemiflora</i>
r	<i>Hedysarum humile fontanesii</i>	T	<i>Crepis tunetana</i>
r	<i>Lathyrus setifolius</i>	TA	<i>Silene tunetana</i>
r	<i>Ophrys scolopax</i>	rNA	<i>Acer monspessulanum</i>
r	<i>Ranunculus falcatus</i> ssp.	TA	<i>Rupicapros numidicus</i> ssp.
r	<i>Fumaria macrosepala</i>	TA	<i>Reseda dariaeana</i>
r	<i>Draba hispanica</i>	T	<i>Cupressus sempervirens</i> f.
r	<i>Arabis verna</i>	T	<i>Genista microcephala tunetana</i>
r	<i>A. parvula</i>	T	<i>Dianthus gaditanus</i>
T	<i>A. hirsuta</i>	NA	<i>Polygonum balansae</i>
r	<i>Spergula pertandra</i>	T	<i>Astragalus cruciatus aristidis</i>
r	<i>Rosa agrestis</i>	rT	<i>Plantago tunetana</i>

Medicinal Plants:

<i>Rosmarinus officinalis</i>	<i>Pistacia lentiscus</i>
<i>Myrtus communis</i>	<i>Cupressus sempervirens</i>
<i>Erica</i> sp.	<i>Tamarix</i> sp.

Genetic Resource Plants:

<i>Ceratonia siliqua</i>	<i>Quercus suber</i>
<i>Arbutus unedo</i>	<i>Q. ilex</i>
<i>Olea europaea oleaster</i>	<i>Crataegus azarolus</i>
<i>Rubus ulmifolius</i>	<i>Hedysarum coronarium</i>
<i>Vitis vinifera</i>	<i>H. pallidum</i>

D. SILIANA

Area: 495,000 ha

Major Ecosystems: High Tell
Tunisian Dorsal

Specific Sites Important to Biological Diversity:

Djebel Bargou: Section 3.4.3.7
Dj. Serdj: Section 3.4.3.6
Dj. Zitoun
La Khmes Reservoir

Flora:

Natural Forest: 13,700 ha
Aleppo pine, holm oak, Maktar cypress
Maquis: Juniper
Olea-lentiscus
Cultivated: 325,000 ha

Rare and Endemic Plants:

r	Ononis biflora	rNA	Sorbus aria
r	Melilotus elegans	rNA	Linum corymbiferum lambesanum
r	Trifolium striatum	rNA	Cotoneaster racemiflora
r	Hedysarum humile fortanessii	T	Crepis tunetana
r	Lathyrus setifolius	TA	Silene tunetana
r	Ophrys scolopax	rNA	Acer monspessulanum
r	Ranunculus falcatus ssp.	TA	Rupicapros numidicus ssp.
r	Fumaria macrosepala	TA	Reseda duriaeaana
r	Draba hispanica	T	Cupressus sempervirens f.
r	Arabis verna	T	Genista microcephala tunetana
r	A. parvula	T	Dianthus gaditanus
T	A. hirsuta	NA	Polygonum balansae
r	Spergula pentandra	T	Astragalus cruciatus aristidis
r	Rosa agrestis	rT	Plantago tunetana

Medicinal Plants:

Rosmarinus officinalis	Pistacia lentiscus
Myrtus communis	Cupressus sempervirens
Erica sp.	Tamarix sp.

Genetic Resource Plants:

Ceratonia siliqua	Quercus suber
Arbutus unedo	Q. ilex
Olea europaea oleaster	Crataegus azarolus
Rubus ulmifolius	Hedysarum coronarium
Vitis vinifera	H. pallidum

Siliana (Continued)

Fauna:

Mammals:

	Wild boar		Algerian hedgehog
t	Hyena		Crested porcupine
	Jackal	NA	Shaw's jird
	Red fox		<u>Gerbillus campestris</u> (gerbil)
	Kaffir cat		Field mouse
	Common genet		<u>Jaculus orientalis</u> (jerboa)
	Egyptian mongoose		Chiropidae
	Brown hare		

Birds:

	Great crested grebe		Eagle owl
r	Peregrine		Barn owl
r	Kestrel		Short-eared owl
	Coot		Sardinian warbler
	Woodcock		Rufous bushchat
	Wood pigeon		Blackbird
	Rock dove		Chaffinch

Influences:

Some rosemary harvesting
 Cultivation, grazing, erosion
 Dams
 Timber harvesting - Dj. Serdj
 Plantations
 Reserve - Air. Bou Saadia, 12 ha protected since 1901

r = Rare	NA = North Africa Endemic
t = Threatened	TA = Tunisia/Algeria Endemic
n = Nesting Bird	

E. BIZERTE

Area: 350,000 ha

Major Ecosystems: Mogod Mountains
Coast
Medjerda Valley
Mateur Plain

Specific Sites Important to Biological Diversity:

Ichkeul National Park: Sections 3.3.1A, 3.4.1F, 5.4.2

Lake Bizerte: Section 3.3.1B

Reservoirs: Oueds Sejrane, Melah, Joumine, Ghezala, Besbesia

Sacred Wood: Section 3.4.1.5

Oued Medjerda Estuary: Section 3.1.2B

Garaet Sejrane: Temporary wetland with several rare plants

Flora:

Natural Forest:

Cork oak, kermes oak, aleppo pine

Planted Forest: > 18,000 ha

Aleppo pine, pignon pine, eucalyptus

Maquis: Olea-lentiscus

Cultivated Land: 200,000 ha

Halophiles

Rare and Endemic Plants:

r Salix purpurea	r Lotus creticus commutatus
r Ranunculus parviflorus	r Echinodorus ranunculoides
r R. ophioglossum	rNA Ononis rosea
r Sparganium erectum	TA Sedum tuberosum
r Nymphaea alba	T Limonium boitardii
r Potamogeton lucens	T Silene barrattei
r P. natans	T Teucrium schoenenbergeri

Medicinal Plants:

Capparis spinosa	Erica sp.
Pistacia lentiscus	Tamarix sp.
Myrtus communis	Euphorbia sp.
Asphodelus microcarpus	

Genetic Resource Plants:

Ceratonia siliqua	Quercus suber
Olea europaea oleaster	Rubus ulmifolius
Arbutus unedo	Hedysarum coronarium

Bizerte (Continued)

Fauna:

Mammals:

	Buffalo	NA	Shaw's jird
	Wild boar		Field mouse
r	Otter		<u>Gerbillus campestris</u> (gerbil)
	Egyptian mongoose	NA	<u>Jaculus orientalis</u> (jerboa)
	Jackal		<u>Eliomys quercynus</u>
	Red fox		<u>Rhinolophus euryale</u> (bat)
	Brown hare		<u>R. ferrum-equinum</u> "
	Algerian hedgehog		<u>Myotis myotis</u> "
	Zorilla lybica		<u>Minopterus schreibersii</u> "
	Crested porcupine		<u>Arvicarthus barbarus</u>
			House mouse

Birds:

See Figure 7, Birds of Ichkeul

Reptiles and Amphibians (from UCL 1977):

Rana ridibunda	Lacerta ocellata
R. esculenta	Psammodromus algirus
Discoglossus pictus	Chalcides chalcides
Bufo bufo	C. ocellatus
B. viridus	Tarentola mauritanica
B. mauritanicus	Chamaeleon chamaeleon
Hyla arborea	Natrix maura (snake)
Pleurodeles poireti	Malpolon monspessularus "
Testudo graeca	Coronella girardica "
Clemmys leprosa	Vipera lebetina "
Emys broicolaris	

Influences:

Firebreak creation and maintenance
Myrtus harvesting
 Fish traps on Lake Ichkeul and Lake Bizerte
 Cultivation, grazing and erosion
 Dams on the rivers flowing into Lake Ichkeul
 Port activity
 Development

r = Rare NA = North Africa Endemic
 t = threatened TA = Tunisia/Algeria Endemic
 T = Tunisia Endemic

F. NABEUL

Area: 290,000 ha

Major Ecosystems: Tunisian Dorsal
Coastal

Specific Sites Important to Biological Diversity:

Djebel Sidi Abder Rahmane: Section 3.4.3.13
Djebel Korbous
Zembra Island: Section 3.2.2
Korba Lagoons, Sebkhets El Houaria and Fardjoura
Solimar Marshes: Section 3.1.2B
Oued el Abid
Reservoirs: Lebna, Somaa

Flora:

Natural Forest: Kermes oak, holm oak, cork oak
Planted Forest: Eucalyptus, acacia, aleppo pine, pignon pine
Maquis: Olea-lentiscus, retama
Cultivated Plain: 215,000 ha

Rare and Endemic Plants:

r	<i>Sanguisorba spinosa</i>	TA	<i>Reseda duriaea</i>
r	<i>Avena longiglumis</i>	TA	<i>Sedum tuberosum</i>
r	<i>Melilotus elegans</i>	T	<i>Scabiosa farinosa</i>
TA	<i>M. macrocarpa</i>	T	<i>Crepis tunetana</i>
r	<i>Silene neglecta</i>	rNA	<i>Juncus subnodulosus</i>
r	<i>S. sedoides</i>	NA	<i>Erodium hymeroides</i>
r	<i>Lavatera punctata</i>	rNA	<i>E. munbyanum</i>
v	<i>Sisymbrium polyceratum</i>	r	<i>E. maritimum</i>
r	<i>Sagina apetala ciliata</i>	NA	<i>Brassica cretica atlantica</i>
v	<i>Corvovulvulus cneorum</i>	T	<i>Linaria cossoni</i>
r	<i>Eragrostis trichophora</i>	v	<i>L. Pelleceriana</i>
r	<i>Echinodorus ranunculoides</i>	T	<i>Scabiosa farinosa</i>
v	<i>Exaculum pusillum</i>	rT	<i>Dianthus rupicola hermaensis</i>
r	<i>Jasione humilis</i>	v	<i>Centaurea eriophora</i>
r	<i>Iris xiphium</i>	vNA	<i>C. cinerarea gymnocarpa subv.</i>
r	<i>Koeleria splendens</i>	NA	<i>Gerista aspalathoides</i>
r	<i>Lolium temulentum</i>	rNA	<i>Bunium crassifolium</i>
r	<i>Airopsis tenella</i>	TA	<i>Lepidium glastifolium</i>
r	<i>Avellinia michelli</i>	T	<i>Silene barrattei</i>
v	<i>Aster tripolium</i>	v	<i>S. mollissima</i>
r	<i>Carex flacca eu-glauca</i>	r	<i>Cystopteris filix-fragilis ssp</i>
vNA	<i>Cyclamen africanum</i>	r	<i>Centunculus brinimus</i>
v	<i>Chaetorychia cymosa</i>	r	<i>Elatine hydropiper pedunculata</i>
r	<i>Meriophyllum spicatum</i>	r	<i>Helianthemum salicifolium ssp.</i>
r	<i>Salpichroa rhomboidea</i>	r	<i>Plantago coronopus ssp.</i>
v	<i>Senecio lividus</i>	r	<i>Succowia balearica</i>
v	<i>S. foliosus</i>	r	<i>Ranunculus parviflorus</i>
r	<i>Vicia sicula</i>	r	<i>Lathyrus annuus</i>
r	<i>V. disperma</i>	r	<i>Geranium clumbinum</i>
v	<i>Euphorbia squamigera</i>		

Nabeul (Continued)

Medicinal Plants:

Myrtus communis	Callitris articulata
Rosmarinus officinalis	Euphorbia sp.
Pistacia lentiscus	Erica multiflora

Genetic Resource Plants:

Ceratonia siliqua	Quercus sp.
Olea europaea oleaster	Vitis vinifera
Orchids: Ophrys apifera	Orchis palustris
O. bombyliflora	O. paters
Neotinia intacta	O. choriophora
Anacamptis pyramidalis	O. papilionacea
Himantoglossum hircinum	Serapias parviflora
	S. lingua ssp. eu-lingua

Fauna:

Mammals:

Wild boar (uncommon)	Black rat
Jackal	NA Shaw's jird
Red fox	NA <u>Gerbillus campestris</u> (gerbil)
Kaffir cat	<u>Jaculus orientalis</u> (jerboa)
Egyptian mongoose	Field mouse
NA European rabbit ssp.	<u>Eliomys quercynus</u>

Birds: See Figure 11

Influences:

Sparrowhawk trapping: Used for hunting, then released
 Hunting and poaching
 Pollution: Sewage discharge, dumping
 Dams
 Touristic development
 Grazing, cultivation, erosion

v = Very Rare
 r = Rare

NA = North Africa Endemic
 TA = Tunisia/Algeria Endemic
 T = Tunisia Endemic

Figure 11
 Birds of the Nabeul Gouvernorat
 (from Sraie 1977, ICBP 1987)

Gannet	Kestrel	Galerid larks
Grey heron	Lesser kestrel	Fan-tailed warbler
Little egret	Barbary partridge	Blackcap
t White stork	Quail	Whitethroat
Black stork	Coot	Bonelli's warbler
Crane	Moorhen	Chiffchaff
Greater flamingo	Black Winged-stilt	Goldcrest
Spoonbill	Oystercatcher	Spotted flycatcher
Glossy ibis	Avocet	Red-backed shrike
Shelduck	Ringed plover	Yellow wagtail
Mallard	Little ringed plover	Grey wagtail
Osprey	Kentish plover	Tree pipit
Black kite	Little stint	Water pipit
t Red kite	Temminck's stint	Swallow
Short-toed eagle	Redshank	House martin
Marsh harrier	Spotted redshank	Black redstart
Hen harrier	Greenshank	Redstart
Pallid harrier	Curlew sandpiper	Stonechat
Montagu's harrier	Common sandpiper	Moussier's redstart
Sparrowhawk	Black-tailed godwit	Blackbird
Levant sparrowhawk	Slender-billed gull	Nightingale
Buzzard	Mediterranean gull	Rufous bushchat
Long-legged buzzard	Little gull	Robin
Honey buzzard	Herring gull	Goldfinch
Lesser spotted eagle	Black tern	Chaffinch
Booted eagle	Little tern	Serin
Bonelli's eagle	Caspian tern	Oriole
Egyptian vulture	Palm dove	Duncock
Red-footed falcon	Roller	Spanish sparrow
Merlin	Bee eater	Raven
Hobby	Cuckoo	Great grey shrike
Eleonora's falcon	Hoopoe	Woodchat shrike
Saker falcon	Wren	
Lanner falcon	Lesser short-toed lark	
t Peregrine		

t = Threatened species

G. TUNIS

Area: 125,000 ha

Major Ecosystems: Coast: Gulf of Tunis
 Marine Lake
 Medjerda Valley

Specific Sites Important to Biological Diversity:

Lake Tunis: Section 3.3.1.3
Sebkhet Ariana: Section 3.3.2.1
Sebkhet Sedjoumi: 3.3.2.2
Oued Meleg Ponds
Bou Kornine National Park: Section 3.4.3.12 and 5.4.5
Djebel Ressay: Section 3.4.3.11

Flora:

Natural Forest: Thuya, holm oak
Planted Forest: Aleppo pine, eucalyptus, acacia, Maktar cypress
Maquis: Kermes oak, Olea-lentiscus
Cultivated Land: 65,000 ha
Halophiles

Rare and Endemic Plants:

v	Cyclamen persicum	NA	Genista aspalathoides
r	Ophrys scolopax	NA	Chamaerops humilis
r	Amaranthus gracilis	NA	Brassica cretica atlantica
r	Ononis biflora	TA	Spergularia marginata ssp.
r	O. pendula	TA	Silene tunetana
r	Ranunculus scleratus	TA	Melilotus macrocarpa
r	Vicia hirsuta	r	Onobrychis caput-galli
r	V. bithynica v. genuina		

Medicinal Plants:

Rosmarinus officinalis	Erica sp.
Myrtus communis	Euphorbia sp.
Pistacia lentiscus	Tamarix sp.
Globularia alypum	Opuntia ficus-indica
Capparis spinosa	Lavandula multifida

Genetic Resource Plants:

Olea europaea oleaster	Crataegus azarolus
Ceratornia siliqua	Quercus ilex
Arbutus unedo	

Tunis (Continued)

Fauna:

Mammals (found at Bou Kornine):

Wild Boar	NA	Shaw's jird
Jackal		<u>Suncus etruscus</u> (shrew)
Red fox		<u>Crocidura russula</u> "
Egyptian mongoose		<u>Rhinolophus euryale</u> (bat)
Common genet		<u>R. ferrum-equinum</u> "
Saharan striped weasel		<u>R. hipposideros minimus</u> "
Kaffir cat		<u>Myotis blythi oxygnathus</u> "
Brown hare		<u>Pipistrellus pipistrellus</u> "
Crested porcupine		<u>Eptesicus serotinus</u> "
Algerian hedgehog		<u>Miniopterus schreibersi</u> "
Striped rat		Field mouse
<u>Elionys quercynus</u>		<u>Jaculus orientalis</u> (jerboa)

NA Gerbillus campestris (gerbil)

Mammals Extirpated from the Region:

Cuvier's gazelle	Serval
Aoudad	Caracal
Hyena	

Birds: See Figure 12

Reptiles and Amphibians:

<u>Testudo graeca</u> (tortoise)	Psammodromis algirus
<u>Bufo mauritanicus</u> (toad)	Chalcides ocellatus
<u>B. viridis</u> "	<u>C. lineatus</u>
<u>Rana ridibunda</u>	Chamaeleon chamaeleon
<u>Discoglossus pictus</u>	Matrix maura (snake)
<u>Hyla meridionalis</u>	Coluber hippocrepis "
<u>Pleurodelis poiretti</u>	Malpolon monspessulanus "
<u>Tarantola mauritanica</u>	Macropotodon cucullatus "
<u>Stenodactylus petriei</u>	Vipera lebetina mauritanica "
<u>Lacerta ocellata</u>	

Scorpions:

Buthus occitanus	Scorpio maurus
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Influences:

Development: Filling Lake Tunis, tourism development
 Pollution: Sewage and chemical discharge, dumping
 Shipping Canals in Lake Tunis
 Fish Traps in Lake Tunis
 Bou Kornine National Park

v = Very Rare
 r = Rare

NA = North Africa Endemic
 TA = Tunisia/Algeria Endemic

Figure 12
Birds of the Tunis Gouvernorat

	Little grebe	Coot	Barn owl
	Great crested grebe	Lapwing	Eagle owl
	Black-necked grebe	Avocet	Short-eared owl
n	Cormorant	Black-winged stilt	Little owl
	Grey heron	Grey plover	Nightjar
	Cattle egret	Ringed plover	Swift
	Little egret	Kentish plover	Alpine swift
	Spoonbill	Little stint	Bee eater
	Greater flamingo	Redshank	Roller
tr	White stork	Greenshank	Kingfisher
	Crane	Curlew sandpiper	Hoopoe
	Greylag goose	Common sandpiper	Short-toed lark
n	Mallard	Wood sandpiper	Skylark
t	Marbled teal	Marsh sandpiper	Crested lark
	Teal	Dunlin	Far-tailed warbler
	Pintail	Ruff	warbler
	Shoveler	Black-tailed godwit	Blackcap
	Pochard	Snipe	Sardinian warbler
	Tufted duck	Stone curlew	Chiffchaff
t	White-headed duck	Slender-billed gull	Spotted flycatcher
	Osprey	Black-headed gull	Blue rock thrush
	Black kite	Mediterranean gull	Wheatears
n	Short-toed eagle	n Herring gull	Redstart
	Sparrowhawk	Gull-billed tern	NA Moussier's redstart
	Buzzard	Little tern	Robin
	Long-legged buzzard	Sandwich tern	Bluethroat
	Bonelli's eagle	Swallow	Luscinia megarhynchos
	Booted eagle	Crag martin	Cercotrichas galac
	Golden eagle	Meadow pipit	Blackbird
	Egyptian vulture	Water pipit	Song thrush
	Marsh harrier	Grey wagtail	Coal tit
	Peregrine	Yellow wagtail	Ortolan
	Hobby	White wagtail	Reed bunting
n	Kestrel	Great grey shrike	Chaffinch
	Barbary partridge	Woodchat shrike	Goldfinch
	Quail	Starling	Greenfinch
	Rock dove	Spanish sparrow	Linnet
	Turtle dove	Raven	Serin

t = Threatened
n = Nesting Bird

NA = North Africa Endemic

H. ZAGHOUAN

Area: 375,000 ha

Major Ecosystems: Tunisian Dorsal Mountains
Sebkhets
Medjerda Valley

Specific Sites Important to Biological Diversity:

Djebel Zaghoun: Section 3.4.3.9
Dj. Mansour: Section 3.4.3.8
Dj. Bou Safra: Section 3.4.3.10
Bir Mecherga Reservoir
Sebkhet Kourzia: 3.3.2.3

Flora:

Natural Forest: 32,000 ha
Aleppo pine, thuya
Planted Forest: 14,580 ha
Aleppo pine: 14,000 ha
Eucalyptus, acacia, Maktar cypress: 580 ha
Maquis: 23,685 ha
Olea-lentiscus, juniper, degraded aleppo pine forest
Cultivated: 245,000 ha

Rare and Endemic Plants:

v	Saxifraga dichotoma	NA	Genista aspalathoides
r	Acer monspessulanum	NA	G. tricuspidata
r	Rosa stylosa	TA	Lepidium glastifolium
T	Arabis hirsuta	TA	Reseda duriaeaana
T	Linaria scariosa	T	Sinapsis pubescens brachyloba
T	L. reflexa v. doumeti	r	Phagnalon cynodon

Medicinal Plants:

Rosmarinus officinalis	Euphorbia sp.
Globularia alypum	Erica sp.
Pistacia lentiscus	Asphodelus microcarpus
Callitris articulata	

Genetic Resource Plants:

Ceratonia siliqua	Hedysarum coronarium
Olea europaea oleaster	Jasminum fruticans

Fauna:

Mammals:

Wild boar	Egyptian mongoose
t Hyena (uncommon)	Common genet
Jackal	Algerian hedgehog
Red fox	Crested porcupine
Brown hare	<u>Suncus etruscus</u> (shrew)

Zaghouan (Continued)

Birds:

	Black-necked grebe	Common terr.
	Greater flamingo	Woodcock
	Mallard	Snipe
	Pochard	Wood pigeon
	Merlin	Rock dove
	Kestrel	Turtle dove
tn	Peregrine	Barn owl
	Golden eagle	Eagle owl
	Egyptian vulture	Galerid larks
	Griffon vulture	Sardinian warbler
	Barbary partridge	Redstart
	Quail	Wheatear
	Coot	Blackbird
	Lapwing	Chaffinch
	Little ringed plover	Serir
	Kentish plover	Goldfinch
	Little stint	Starling
	Greenshank	Raven
	Black-tailed godwit	

Influences:

Forest fires, firebreaks
 Hunting
 Cultivation, grazing, erosion
 Soil Conservation terracing
 Permanent reserves: Djebel Zaghouan (4,775 ha);
 Dj. Bou Safra - c.500 ha

v = Very Rare	NA = North Africa Endemic
r = Rare	TA = Tunisia/Algeria Endemic
t = Threatened	T = Tunisia Endemic
n = Nesting Bird	

I. KAIROUAN

Area: 665,000 ha

Major Ecosystems: Tunisian Dorsal Mountains
Low Steppe

Specific Sites Important to Biological Diversity:

Djebel Ousselat: Section 3.4.3.5
Air Chrichira
Sebkhet Sidi el Hari: Section 3.3.2.5
Lake Metbasta: Section 3.3.2.8
Reservoirs: Nebhana, Sidi Saad

Flora:

Natural Forest: Aleppo pine
Planted Forest: Aleppo pine, eucalyptus, acacia, cypress
Maquis: 40,000 ha
Rosemary, Degraded aleppo pine forest
Esparto Grass Steppe: 20,000 ha
Cultivated: 460,000 ha

Rare and Endemic Plants:

r Ranunculus scleratus	NA Polygonum balansae
r Atriplex tatarica	T Dianthus gaditanus
r Clinus lotoides	T Ferula tunetana
r Potentilla supina	T Astragalus cruciatus aristidis
r Rosa agrestis	

Medicinal Plants:

Capparis spinosa	Globularia alypum
Rosmarinus officinalis	Tamarix sp.
Pistacia lentiscus	

Genetic Resource Plants:

Ceratonia siliqua	Crataegus sp.
Olea europaea oleaster	

Fauna:

Mammals:

Wild boar	Egyptian mongoose
Hyena	Common genet
Jackal	Algerian hedgehog
Red fox	Crested porcupine
Brown hare	

Kairouan (Continued)

Birds:

	Little grebe	n	Barbary partridge
	Great crested grebe		Crane
	Black-necked grebe	tn	Houbara bustard
	Grey heron		Coot
n	Little egret		Rock dove
	Greater flamingo		Palm dove
	Mallard		Little owl
	Pintail		Barn owl
	Avocet		Hoopoe
	Black winged-stilt		Lesser short-toed lark
	Kentish plover		Short-toed lark
	Cream colored courser		Galerid larks
n	Collared pratincole		Skylark
	Stone curlew		Great grey shrike
	White-winged black tern		Black wheatear
	Little tern		Blue rock thrush
	Black-bellied sandgrouse		Rufous bushchat
	Marsh harrier		Fulvous babbler
	Bonelli's eagle	n	Rock sparrow
	Booted eagle		Spanish sparrow
tn	Peregrine		Starling
n	Kestrel		Raven
n	Egyptian vulture		

Influences:

Marble quarry: Djebel Ousselat
 Hunting and poaching
 Cultivation, grazing, erosion
 Soil Conservation terracing
 Dams on rivers flowing into Sebkheth Kelbia

r = Rare NA = North Africa Endemic
 t = Threatened T = Tunisia Endemic
 n = Nesting Birds

J. KASSERINE

Area: 800,000 ha

Major Ecosystems: Tunisian Dorsal Mountains
High Steppe

Specific Sites Important to Biological Diversity:
Djebels Chambi, Bireno, Mrhilla, Selloum: Secs. 3.4.3.1-4
Kechem el Kelb Reserve: Section 5.4.11

Flora:

Natural Forest: 151,000 ha
Aleppo pine, holm oak
Planted Forest: c.1,600 ha
Aleppo pine, eucalyptus, acacia
Maquis: 110,000 ha (often with aleppo pine)
Rosemary, juniper
Esparto Grassland: 173,000 ha
Cultivated: 105,000 ha

Rare and Endemic Plants:

v	Delphinium balansae	rNA	Cotoneaster racemiflora
r	Vicia villosa dasycarpa	rNA	Stipa fontanesii
r	Trigonella gladiata	rNA	Campanula atlantica
r	Leontice leontopetalum	rNA	Sorbus aria
r	Buffonia tenuifolia	NA	Polygonum balansae
r	Arenaria emarginata	T	Silene barrattei
rTA	Brassica dimorpha	T	Astragalus cruciatus aristidis
TA	Reseda alphonsii	T	Ononis natrix filifolia
TA	R. duriaeana	T	Genista microcephala tunetana
TA	Iberis odorata balansae	rT	Stipa lagascae letourneuxii
TA	Rupicapnos numidicus ssp.	T	Dianthus gaditanus

Medicinal Plants:

Globularia alypum	Pistacia lentiscus
Artemisia campestris	Retama raetam
Rosmarinus officinalis	

Genetic Resource Plants:

Olea europaea oleaster	Quercus ilex
Arbutus unedo	Crataegus azarolus

Kasserine (Continued)

Fauna:

Mammals:

	Wild boar	Saharan striped weasel
	Aoudad (reintroduced)	<u>Eliomys quercynus</u>
t	Cuvier's gazelle	Norway rat
t	Hyena	Black rat
	Jackal	House mouse
	Red fox	NA Shaw's jird
	Kaffir cat	<u>Gerbillus campestris</u> (gerbil)
	Common genet	NA <u>Jaculus orientalis</u> (jerboa)
	Algerian hedgehog	<u>Rhinolophus mehelyi</u> (bat)
	White hedgehog	<u>R. euryale barbarus</u> "
	Brown hare	<u>R. Hipposideros minimus</u> "
	Crested porcupine	<u>Myotis blythis oxygnathus</u> "
NA	Gurdi	<u>Pipistrellus kuhli</u> "
		<u>P. pipistrellus</u> "

Birds: See Figure 13

Reptiles and Amphibians:

	<u>Discoglossus pictus</u>	<u>Agama mutabilis</u>
	<u>Bufo viridis</u> (toad)	<u>Psammotromus algirus</u> (lizard)
	<u>B. mauritanicus</u> "	<u>Acanthodactylus sp.</u> "
	<u>Rana ridibunda</u> (frog)	<u>Lacerta sp.</u> "
	<u>Testudo graeca</u>	<u>Vipera lebetina</u> (snake)
	<u>Maurenys caspica</u>	<u>Cerastes cornatus</u> "
	<u>Sterodactylus petrici</u>	<u>Psammophis sibilans</u>
	<u>Tarentola mauritanica</u>	<u>Chamaeleon chamaeleon</u>

Influences:

Forest fires and firebreaks
 Fuelwood cutting; some timber exploitation
 Cultivation, overgrazing, erosion
 Esparto grass and rosemary harvesting
 Dune formation: minor problem
 Soil conservation: terracing (30,000 ha), runoff control
 Agricultural development
 Grazing land improvement
 Reserves: Chambi N.P. (Section 5.4.3)
 Kechem el Kelb Reserve (Sec. 5.4.11)

v = Very Rare
 r = Rare
 t = Threatened

NA = North Africa Endemic
 TA = Tunisia/Algeria Endemic

Figure 13
Birds of the Kasserine Gouvernorat
(from Dir. For. 1981)

t Red kite	n Short-toed lark	Rock thrush
n Black kite	n Lesser sht-td lark	Wheatear
n Short-toed eagle	n Calandra lark	n Desert wheatear
■ Sparrowhawk	n Woodlark	n Black-eared wheatear
n Long-legged buzzard	n Skylark	n Mourning wheatear
n Bonelli's eagle	n Crested lark	n Red-rumped wheatear
n Booted eagle	n Thekla lark	n Black wheatear
n Golden eagle	n Swallow	Black redstart
n Egyptian vulture	n Crag martin	Redstart
m Griffon vulture	Sand martin	n Moussier's redstart
m Marsh harrier	House martin	n Robin
m Montagu's harrier	Tree pipit	Bluethroat
Lanner falcon	Meadow pipit	Nightingale
tn Peregrine	n Tawny pipit	Rufous bushchat
Barbary falcon	Grey wagtail	Blackbird
Hobby	White wagtail	Ring ouzel
n Kestrel	Yellow wagtail	Song thrush
n Barbary partridge	n Great grey shrike	Mistle thrush
n Quail	n Woodchat shrike	n Blue tit
Pin-tailed sandgrouse	Reed warbler	n Corn bunting
Black-bellied sandgrouse	Great reed warbler	n Cirl bunting
n Rock dove	Melodious warbler	Ortolan
n Stock dove	n Olivaceous warbler	n Chaffinch
n Turtle dove	n Whitethroat	n Greenfinch
n Barn owl	Garden warbler	Trumpeter finch
n Eagle owl	Blackcap	Linnet
Long-eared owl	n Orphear warbler	n Serin
m Scops owl	n Sardinian warbler	Crossbill
n Little owl	Spectacled warbler	n Spanish sparrow
European nightjar	Willow warbler	n House sparrow
t Red-necked nightjar	Chiffchaff	Rock sparrow
Swift	Wood warbler	Starling
Pallid swift	Bonelli's warbler	Spotless starling
Alpine swift	Spotted flycatcher	Golden oriole
n Bee-eater	Pied flycatcher	Raven
Roller	Whinchat	
n Hoopoe	n Blue rock thrush	

n = Nesting Birds
t = Threatened Species

K. SIDI BOU ZID

Area: 705,000 ha

Major Ecosystems: Low Steppe
High Steppe
Mountains
Sebkhets

Specific Sites Important to Biological Diversity:

Bou Hedma N. P.: Sections 3.4.4.2, 3.3.5.3, and 5.4.4
Sebkhets Sidi Mansour and en Noual: Section 3.3.2.7
Sebkhet Mechguig: Section 3.3.2.8

Flora:

Natural Forest: Aleppo pine, holm oak
Planted Forest: Aleppo pine, eucalyptus, acacia
Maquis: Juniper
Esparto Grassland: 124,000 ha
Cultivated: 345,000 ha

Rare and Endemic Plants:

r	Saccharum ravennae	T	Dianthus gaditanus
r	Arenaria emarginata	T	Marrubium aschersonii
r	Lotus conimbricensis	TA	Rupicapros numidicus
r	Biscutella didyma		ssp. apula

Medicinal Plants:

Pistacia lentiscus	Tamaria gallica
Rosmarinus officinalis	Asphodelus sp.
Globularia alypum	Artemisia sp.

Genetic Resource Plants:

Olea europaea oleaster	Acacia raddiana
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Fauna:

Mammals:

t	Dorcas gazelle	NA	Gundi
t	Slender-horned gazelle	NA	Shaw's jird
t	Aoudad		Desert jird
	Addax (reintroduced)		Gerbils (6 species)
	Scimitar-horned oryx "		Sand rat
	Jackal		Black rat
r	Sand fox		Palm rat
	Red fox		House mouse
	Kaffir cat		Lesser Egyptian jerboa
r	Sand cat		Jerboa
	Common genet		Bats: (5 species)
r	Saharan striped weasel	r	Desert hedgehog
	Brown hare		Elephant shrew
	Crested porcupine		

Sidi Bou Zid (Continued)

Birds: See Figure 14

Reptiles and Amphibians (from Blanc and Sraie 1987):

Rana ridibunda	Cerastes vipera	(snake)
Bufo viridis (toad)	C. cerastes	"
B. mauritanicus "	Echis carinatus	"
Discoglossus pictus	Malpolon moilensis	"
Testudo g. graeca	Sphalerosophis diadema	"
Tarentola mauritanica	Naja h. haje	"
Tropicolotes tripolitanus	Psammophis sp.	"
Stenodactylus stenodactylus	Coluber hippocrepis	"
Agama mutabilis	Varanus griseus	
Uromastix acanthinuris	Scincus scincus	(skink)
Chamaeleon chamaeleon	Chalcides o. ocellatus	"
Psammodromus algiris rollei	Eumeces algeriensis	"
Fremias oliveri	E. schneideri	"
Acanthodactylus boskianus	Scincopus fasciatus	"
Ophisops occidentalis	Sphenops boulengeri	"

Influences:

Hunting and Poaching

Esparto grass harvesting: 10 - 15% of national total

Cultivation, overgrazing, erosion

Pasture improvement: 20,000 ha planted to cactus, acacia
atriplex, etc.

Boa Hedma N.P.

r = Rare
t = Threatened

NA = North Africa Endemic
TA = Tunisia/Algeria Endemic
T = Tunisia Endemic

Figure 14
 Birds of the Sidi Bou Zid Gouvernorat
 (from Dir. For. 1980)

Black kite	Hoopoe	Chiffchaff
Short-toed eagle	Wryneck	Wood warbler
Sparrowhawk	Temminck's horned lark	Bonelli's warbler
Buzzard	Hoopoe lark	Spotted flycatcher
Long-legged buzzard	Short-toed lark	Pied flycatcher
Honey buzzard	Lesser short-toed lark	Collared flycatcher
Booted eagle	Desert lark	Stonechat
Bonelli's eagle	Bar-tailed desert lark	Whinchat
Golden eagle	Dupont's lark	Blue rock thrush
Egyptian vulture	Calandra lark	Rock thrush
Griffon vulture	Thick-billed lark	Wheatear
Marsh harrier	Skylark	Desert wheatear
Montagu's harrier	Crested lark	Isabelline wheatear
Pallid harrier	Swallow	Blackeared wheatear
Lanner falcon	Crag martin	Mourning wheatear
t Peregrine	Sand martin	Red-rumped wheatear
Kestrel	House martin	Black wheatear
Barbary partridge	Tree pipit	Black redstart
Quail	Meadow pipit	Redstart
t Houbara bustard	Red-throated pipit	Moussier's redstart
Dotterel	Tawny pipit	Robin
Stone curlew	White wagtail	Nightingale
Cream colored courser	Grey wagtail	Bluethroat
Spotted sandgrouse	Yellow wagtail	Rufous bushchat
Pin-tailed sandgrouse	Great grey shrike	Blackbird
Black-bellied sandgrouse	Woodchat shrike	Song thrush
Rock dove	Reed warbler	Fulvous babbler
Turtle dove	Great reed warbler	Blue tit
Palm dove	Aquatic warbler	Wren
Great-spotted cuckoo	Sedge warbler	Corn bunting
Cuckoo	Fan-tailed warbler	House bunting
Barr owl	Scrub warbler	Ortolan
Eagle owl	Icterine warbler	Chaffinch
Long-eared owl	Melodious warbler	Goldfinch
Scops owl	Olivaceous warbler	Greenfinch
Little owl	Whitethroat	Linnet
Nightjar	Garden warbler	Trumpeter finch
t Red-necked nightjar	Blackcap	Serin
Egyptian nightjar	Orphean warbler	Spanish sparrow
Swift	Sardinian warbler	Rock sparrow
Little swift	Subalpine warbler	Spotless starling
Pallid swift	Desert warbler	Starling
Alpine swift	Spectacled warbler	Golden oriole
Bee-eater	Marmora's warbler	Raven
Roller	Willow warbler	

t = Threatened Species

L. MAHDIA

Area: 280,000 ha

Major Ecosystems: Low Steppe
 Coast
 Sebkhets

Specific Sites Important to Biological Diversity
 Gulf of Hammamet: Section 3.1.3
 Sebkhet Moknine: Section 3.3.2.8

Flora:

Steppe: Artemisia. Mostly cultivated to grains and olive groves
Cultivated: 200,000 ha
Halophiles: 10,000 ha

Rare and Endemic Plants:

NAS Limoriastrum guyonianum

Medicinal Plants:

Artemisia sp.	Solanum sodomaeum
Phoenix dactylifera	Lavandula multifida

Fauna:

Mammals:

Jackal	Algerian hedgehog
Red fox	NA Shaw's jird
Brown hare	Gerbils

Birds: Similar to Gabes migrants (Figure 15)

Influences:

Cultivation, overgrazing, erosion
Settling pond overflow into Sebkhet Moknine

NAS = Endemic to North African Sahara
NA = Endemic to North Africa

M. MONASTIR

Area: 105,000 ha

Major Ecosystems: Low Steppe
Coast: Gulf of Hammamet

Specific Sites Important to Biological Diversity:
Kuriate Island: Section 3.2.3
Lake Monastir: Section 3.3.1.4
Monastir Salt Ponds: Section 3.3.1.5

Flora:

Steppe: Artemisia. Mostly cultivated to grains and olive groves
Cultivated: 80,000 ha
Halophiles

Endemic Plant: NAS Limoniastrum guyonianum

Medicinal Plants:

Artemisia sp.	Pistacia lentiscus
Phoenix dactylifera	Lavandula multifida
Solanum sodomaeum	Tamarix sp.

Genetic Resource Plant: Crataegus azarolus

Fauna:

Mammals:

Jackal	NA	European rabbit ssp. (Kuriate)
Red fox	NA	<u>Gerbillus campestris</u> (gerbil)
Algerian hedgehog	NA	Shaw's jird
Brown hare		

Birds: Gulfs of Hammamet and Gabes waders (Section 3.1.3 & 4) and:

Little grebe	Herring gull
Grey heron	Lesser black back
Little egret	Slender-billed gull
Greater flamingo	n Little tern
n Shelduck	Collared pratincole
Sardinian warbler	Skylark
Lesser short-toed lark	Spectacled warbler
Mediterranean gull	Brambling

Influences: Cultivation, grazing, erosion
Pollution: Sewage discharge, dumping

n = Nesting Birds NAS = North African Sahara Endemic
NA = North Africa Endemic

N. SOUSSE

Area: 235,000 ha

Major Ecosystems: Low Steppe
Coast: Gulf of Hammamet

Specific Sites Important to Biological Diversity:

Sebkhets: Kelbia, Haulk el Menzel, Sidi Khalifa,
Menzel Dar Bel Ouar (Sections 3.3.2.4 & 8)
Oued Essed: Section 3.3.4.4

Flora:

Steppe: Artemisia. Mostly cultivated to grains and olive groves

Cultivated: 170,000 ha

Halophiles

Planted Forest: Eucalyptus, aleppo pine

Maquis: Olea-lentiscus, juniper

Rare and Endemic Plants:

v	<u>Oronis viscosa sieberi</u>	NAS	<u>Limoniastrum guyonianum</u>
r	<u>Melilotus elegans</u>	T	<u>Silene barrattei</u>
T	<u>Dianthus gaditanus</u>	T	<u>Astragalus cruciatus aristidis</u>
T	<u>Marrubium aschersoni</u>		

Medicinal Plants:

<u>Artemisia sp.</u>	<u>Lavandula multifida</u>
<u>Phoenix dactylifera</u>	<u>Pistacia lentiscus</u>
<u>Solanum sodomaeum</u>	<u>Tamarix sp.</u>
<u>Rosmarinus officinalis</u>	

Genetic Resource Plant: Olea europaea oleaster

Fauna:

Mammals:

Jackal	Brown hare
Red fox	NA <u>Shaw's jird</u>
Algerian hedgehog	NA <u>Gerbillus campestris</u> (gerbil)

Sousse (Continued)

Birds: Gulfs of Hammamet and Gabes waders (Sections 3.1.3 & 4) and:

	Gannet	Pratincole
	Little Egret	Cream colored courser
	Grey heron	Little tern
	Nightheron	Caspian tern
	Spoonbill	Black tern
	Greater flamingo	Black-bellied sandgrouse
	Mallard	Palm dove
tn	Marbled teal (Kelbia)	Little owl
	Shelduck	Bee eater
	Wigeon	Hoopoe
	Pintail	Swallow
	Shoveler	Lesser short-toed lark
tn	White-headed duck (Kelbia)	Galerid larks
	Crane	Great grey shrike
	Eleonora's falcon	Fan-tailed warbler
	Barbary partridge	Olivaceous warbler
	Water rail	Wheatear
	Coot	Black-eared wheatear
	Moorher	Black wheatear
	Purple gallinule	Desert wheatear
	Little gull	Black redstart
	Herring gull	Raven

Influences:

Gravel removal from Oued Essed
 Pollution: Sewage, dumping
 Cultivation, grazing, erosion
 Dams on rivers flowing into Sebkheth Kelbia

v = Very Rare	NAS = North African Sahara Endemic
r = Rare	NA = North Africa Endemic
t = Threatened	T = Tunisia Endemic
n = Nesting Birds	

O. SFAX

Area: 770,000 ha

Major Ecosystems: Low Steppe
Coast: Gulf of Gabes
Wetlands
Island

Specific Sites Important to Biological Diversity:

Thyna Salines: Section 3.3.1.6
Sebkhets: El Djem, Baradaa, El Gherra (Secs. 3.3.2.6 & 8)
Kerkennah Island: Section 3.1.4

Flora:

Steppe: Artemisia and Jujube. Mostly cultivated to grains and olives
Cultivated: 295,000 ha
Halophiles

Rare and Endemic Plants:

r	<u>Tretadicielis tenalla</u>	NAS	<u>Limoniastrum guyoniarum</u>
r	<u>Vicia villosa pseudo-cracca</u>	T	<u>Oronis natrus filifolia</u>
r	<u>Spergularia salina leiosperma</u>	T	<u>Marrubium aschersonii</u>
		T	<u>Crepis tunetana</u>

Medicinal Plants:

<u>Artemisia sp.</u>	<u>Solanum sodomaeum</u>
<u>Globularia alypum</u>	<u>Phoenix dactylifera</u>

Fauna:

Mammals:

Jackal	Brown hare
Red fox	NA Shaw's jird
Algerian Hedgehog	NA <u>Jaculus orientalis</u> (jerboa)

Birds: Gulf of Gabes waders and waterfowl (see Figure 15) and

Crane	Woodlark
tr. White-headed duck (El Djem)	Meadow pipit
Stone curlew	White wagtail
Cream colored courser	Great grey shrike
n. Collared pratincole	Robin
Rock dove	Stonechat
Palm dove	Moussier's redstart
Hoopoe	Blackbird
Barbary partridge	Song thrush
Swallow	Fulvous babbler
Short-toed lark	Chaffinch
Lesser short-toed lark	Starling
Crested lark	Spotless starling
Skylark	Spanish sparrow

P. GABES

Area: 695,000 ha

Major Ecosystems: Coast
Subdesertic Littoral Steppe
Subdesertic Contintal Steppe
Douirat Mountains
Oases

Specific Sites Important to Biological Diversity:

Gulf of Gabes: Section 3.1.4
Matmata: Section 3.4.5
Oases: Gabes, Mareth, Metaouia, El Hamma (Section 3.7)
Sebkhet el Hamma: Section 3.3.2.11

Flora:

Steppe: Rhantherium/Artemisia
Halophiles
Planted Forest: 1,500 ha of eucalyptus and acacia
Esparto grassland: 40,000 ha
Cultivated Steppe: 65,000 ha

Rare and Erdemic Plants:

v	Coronopus lepidioides	NAS	Limoriastrum guyoniarum
r	Peganum harmala garamantum	T	Ferala tunetara
r	Morettia canescens	TL	Isatis aleppica
r	Vicia villosa dasycarpa	TA	Reseda duriaeaana
r	Monsonia nivea	TL	Gerista microcephala var.
r	Delphinium p. pubescens	TA	Zygophyllum cornutum
r	Rumex pictus	TA	Silene reticulata
r	Ceratophyllum submersum	T	Dianthus gaditarus
r	Fumaria parviflora	T	Lathyrus numidicus
r	Prosopis stephaniana	NA	Teucrium alopecuros
		T	Marrubium aschersonii

Medicinal Plants:

Artemisia sp.	Peganum harmala
Phoenix dactylifera	Asphodelus sp.
Retama raetam	Tamarix sp.
Rosmarinus officinalis	Globularia alypum

Genetic Resource Plants:

Ceratonia siliqua (Matmata)	Olea europaea oleaster
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Gabes (Continued)

Fauna:

Mammals:

	Wild boar (uncommon)		Common genet
r	Aoudad (N of El Hamma)		Crested porcupine
t	Dorcas gazelle (Chott)		Brown hare
t	Hyena (very uncommon)	NA	Gundi
	Jackal	NA	Shaw's jird
	Red fox		Rats
	Sand fox		<u>Eliomys quercynus</u>
	Algerian hedgehog		Chiropidae

Birds: See Figure 15

Endemic crustacean:

Thermosbaena mirabilis (Sebkhet El Hamma)

Influences:

Pollution: Discharge, dumping, chemical industries
Water manipulation: pumping, irrigation
Hunting and poaching: Hare, partridge, gazelles, aoudad
Commercial fishing
Cultivation, overgrazing, erosion
Desertification: 2,300 ha threatened by dunes
Plantations: Dune fixation and soil stabilization
Soil conservation terracing
Pasture improvement: Forage planting
Pasture reserve: 5,000 ha

v = Very Rare	NAS = North African Sahara Endemic
r = Rare	NA = North Africa Endemic
t = Threatened	TA = Tunisia/Algeria Endemic
T = Tunisia Endemic	TL = Tunisia/Libya Endemic

Figure 15

Birds of the Gabes Gouvernorat

Little grebe	• Curlew sandpiper	Kingfisher
Great crested grebe	• Dunlin	Hoopoe
Black-necked grebe	Ruff	Short-toed lark
Cory's shearwater	Broad-billed sandpiper	Wryneck
Gannet	Black-tailed godwit	Sand martin
• Cormorant	Bar-tailed godwit	Crested lark
Squacco heron	Whimbrel	Swallow
n* Little egret	t Slender-billed curlew	House martin
Great white egret	• Curlew	Meadow pipit
Little bittern	• Grey plover	Wood pipit
Purple heron	* Little stint	Tawny pipit
Grey heron	Spotted redshank	Red-throated pipit
Glossy ibis	n* Redshank	Water pipit
t* White stork	* Greenshank	White wagtail
Black stork	Green sandpiper	Yellow wagtail
Spoonbill	Marsh sandpiper	Grey wagtail
* Greater flamingo	Wood sandpiper	Robin
n* Shelduck	Common sandpiper	Black redstart
• Wigeon	• Turnstone	Moussier's redstart
Gadwall	Woodcock	Nightingale
Mallard	Sanderling	Whinchat
Pochard	Knot	Rock thrush
Teal	Lapwing	Song thrush
Pintail	Red-necked phalarope	Stonechat
Garganey	Pomarine skua	Isabelline wheatear
Shoveler	Arctic skua	Wheatear
Marsh harrier	Great skua	Red-rumped wheatear
Her. harrier	* Mediterranean gull	Mourning wheatear
Buzzard	Little gull	Blackbird
Long-legged buzzard	Black-headed gull	Rufous bushchat
Golden eagle	n* Slender-billed gull	Aquatic warbler
Osprey	Common gull	Reed warbler
Kestrel	Lesser black back	Far-tailed warbler
Merlin	Herring gull	Marmora's warbler
Lanner falcon	Great black backed gull	Spectacled warbler
t Peregrine	Kittiwake	Sardinian warbler
Egyptian vulture	n Little tern	Subalpine warbler
Barbary partridge	Gull-billed tern	Chiffchaff
Quail	n Black tern	Whitethroat
Moorhen	White-winged black tern	Blackcap
Coot	• Caspian tern	Fulvous babbler
• Crane	Lesser-crested tern	Great grey shrike
t Houbara bustard	Whiskered tern	Woodchat shrike
Oystercatcher	Sandwich tern	Corn bunting
Black-winged stilt	n Common tern	Reed bunting
n* Avocet	* Grey plover	Trumpeter finch
Stone curlew	Golden plover	Linnet
Little ringed plover	Dotterel	Goldfinch
Ringed plover	* Kertish plover	Greenfinch

Figure 15 (Continued)

Roller	Barn owl	Serin
Rock dove	Scops owl	Chaffinch
Palm dove	Little owl	Siskin
Turtle dove	Short-eared owl	Spotless starling
Bee eater	Swift or pallid swift	Spanish sparrow
Oriole	White-rumped swift	Starling
Skylark	Spotted flycatcher	Wood warbler
Calandra lark	Collared flycatcher	Olivaceous warbler
Lesser short-toed lark	Pied flycatcher	Sedge warbler
Thick-billed lark	Raven	

n = nesting birds

t = threatened species

* = > 1% of population of flyway or biogeographical region

Q. GAFSA

Area: 705,000 ha

Major Ecosystems: Subdesertic Littoral Steppe
Subdesertic Contintal Steppe
Low Steppe
Mountains
Oases

Specific Sites Important to Biological Diversity:

Bou Hedma National Park (in part): Section 5.4.4
Orbata Reserve and Mountain
Djebels: Bou Ramli, Sened
Sebkhets: El Guettar, El Aquila
Oases: Gafsa (2057 ha), Lalla (700 ha), El Guettar (527 ha)

Flora:

Planted Forest: Aleppo pine, eucalyptus, acacia
Maquis: Juniper, retama
Esparto Grassland: 119,000 ha
Cultivated: 190,000 ha
Steppe
Halophiles

Rare and Endemic Plants:

r	Anabasis aphylla	NA	Limoniastrum guyonianum
r	Ranunculus falcatus incurvus	rNA	Ononis rosea
r	R. falcatus eu-falcatus	T	O. natrix filifolia
r	Telephium sphaerospermum	TA	Reseda alphonsii
T	Ferula tunetana	TA	R. duriaeara
T	Astragalus cruciatus aristidis	TA	Oreoblitor thesioides

Medicinal Plants:

Artemisia sp.	Lavandula multifida
Rosmarinus officinalis	Retama raetam
Globularia alypum	Tamarix sp.

Genetic Resource Plant: Olea europaea oleaster

Fauna:

Mammals:

t	Dorcas gazelle	NA	Gundi
t	Slender-horned gazelle	NA	Shaw's jird
t	Aoudad		Desert jird
	Crested porcupine		Sand rat
	Jackal		Black rat
r	Sand fox		Palm rat
	Red fox		House mouse
	Kaffir cat		Lesser Egyptian jerboa
r	Sand cat		Jerboa
	Common genet		Bats (5 species)
r	Saharan striped weasel	r	Desert hedgehog
	Brown hare		Elephant shrew
			Gerbils

Gafsa (Continued)

Birds: Similar to Sidi Bou Zid (see Figure 14), plus:

Grey heron	Bearded vulture (Redeyef)
t White stork	Crane
Shelduck	Moorhen
Mallard	Stock dove
Teal	

Influences:

Hunting and poaching
Esparto grass harvesting
Cultivation, grazing, erosion, desertification
Soil Conservation: Terraces, embankments, plantations
Reserves: Bou Hedma N.P. - 4500 ha in the Gouvernorat
Orbata - 260 ha, dorcas gazelles, ostrich
Dj. Sened - Hunting and grazing prohibited

r = Rare	NAS = North African Sahara Endemic
t = Threatened	NA = North Africa Endemic
T = Tunisia Endemic	TA = Tunisia/Algeria Endemic

R. KEBILI

Area: 2,035,000 ha

Major Ecosystems: Subdesertic Contintal Steppe
Grand Eastern Erg
Chott
Oasis

Specific Sites Important to Biological Diversity:

Ksar Ghilane
Artificial Lakes: Section 3.3.2.15
Chott Jerid: Section 3.3.2.13
Kebili-Douz Oases: 15 in Gouvernorat (6,000 ha)

Flora:

Maquis: Juniper degradation
Steppe: Rhartherium, Arthrophytum
Cultivated: 292,000 ha

Rare and Endemic Plants:

rNAS	Astragalus gombiformis	TA	Reseda alphonsii
rNA	Genista saharae	TA	R. duriaeana
T	Anarrhinum brevifolium	TA	Zygophyllum cornutum

Medicinal Plants:

Retama raetam	Asphodelis sp.
Phoenix dactylifera	Euphorbia sp.

Fauna:

Mammals:

t	Dorcas gazelle (Dj. Tebaga)	Kaffir cat
t	Slender-horned gazelle	Egyptian mongoose
t	Aoudad (uncommon)	Brown hare
	Jackal	Crested porcupine (N of Chotts)
	Red fox	NA <u>Gerbillus simoni</u> (gerbil)
	Fennec fox	

Birds:

Greater flamingo	Black-bellied sandgrouse	
Bittern	Little owl	
Mallard	Long-eared owl	
Wigeon	Hoopoe lark	
Gadwall	Crested lark	
Pintail	Great grey shrike	
Shoveler	White wagtail	
Teal	Scrub warbler	
Moorhen	Sardinian warbler	
t	Houbara bustard	Stonechat
	Barbary partridge	Desert wheatear
	Rock dove	Mourning wheatear
	Palm dove	Spanish sparrow
	Turtle dove	Raven

Kebili (Continued)

Influences:

Hunting (lakes) and poaching (gazelles and hares)
Charcoal making from Calligonum
Water manipulation: Deep wells, lake creation
Cultivation, grazing (esp. camels), erosion
Region most menaced by desertification in Tunisia
Soil Conservation - Anti-desertification: Windbreaks,
plantations, tabias, dune stabilization

r = Rare	NAS = North African Sahara Endemic
t = Threatened	NA = North Africa Endemic
T = Tunisia Endemic	TA = Tunisia/Algeria Endemic

S. MEDENINE

Area: 845,000 ha

Major Ecosystems: Subdesertic Littoral Steppe
Subdesertic Continental Steppe
Dourat Mountains
Coast: Gulf of Gabes
Oasis
Island

Specific Sites Important to Biological Diversity

Hamada: Proposed Desert Park (Section 5.4.7)
Djerba Island: Section 3.2.6
Sebkhet el Melah: Section 3.3.2.9
Bahiret el Bibane: Section 3.3.1.7
Djebel Mogor
Garaet Bou Grara: Coastal bay
Oasis El Halouf: Section 3.7

Flora:

Steppe: Artemisia, Rhantherium
Maquis: Juniper degradation (sparse)
Esparto Grassland: 125,600 ha
Cultivated: 160,000 ha

Rare and Endemic Plants:

rNA	<u>Gerista saharae</u>	r	<u>Pegaron harmala garamantum</u>
r	<u>Colchicum richii</u>	r	<u>Spergularia salina leiosperma</u>
NAS	<u>Limoniastrum guyonianum</u>		

Medicinal Plants:

Retama raetam	Plantago sp.
Artemisia sp.	Asphodelus sp.
Phoenix dactylifera	Opuntia ficus-indica

Fauna:

Mammals:

t	Dorcas gazelle	NA	Gundi
	Jackal	NA	Shaw's jird
	Red fox	NA	<u>Gerbillus campestris</u> (gerbil)
	Fennec fox		<u>Eliomys quercynus</u>
	Desert hedgehog		Sand rat
	Brown hare		

Medinine (Continued)

Birds: Gulf of Gabes waders and waterfowl (See Figure 4) and:

Short-toed eagle	Barbary partridge
Osprey	Cream colored courser
Lanner falcon	Stone curlew
Lesser kestrel	Sandgrouse (5 species)
Kestrel	Calandra lark
Griffon vulture	Crested lark
Lappet-faced vulture	Thekla lark
Bonelli's eagle	Desert lark
Booted eagle	Hoopoe lark
Long-legged buzzard	Great grey shrike
Marsh harrier	Fulvous babbler
Houbara bustard	Raven

Influences:

Hunting and poaching (gazelles and hares)
Shoreline Development
Cultivation, grazing, erosion, desertification
Soil Conservation Anti-desertification work: plantations,
and dune fixation (700 ha)
Proposed Desert Park at Hamada: 10,000 - 12,000 ha

r = Rare
t = Threatened

NAS = North African Sahara Endemic
NA = North Africa Endemic

T. TATAOUINE

Area: 3,600,000 ha

Major Ecosystems: Subdesertic Continental Steppe
Douirat Mountains
Grand Eastern Erg

Specific Sites Important to Biological Diversity:

Jereir - Oued Ouni: Proposed Biosphere Reserve (Section 5.4)

Flora:

Steppe: Rhantherium, Artemisia, Aristida, Arthrophytum
Desert (Erg): c.1,000,000 ha dominated by Calligonum
Cultivated: 50,000 ha
Halophile

Rare and Endemic Plants:

v	Diploaxis acris	E	Calligonum azel
v	Farsetia hamiltonii	E	C. arich
r	Delphinium p. pubescens	TL	Isatis aleppica
vNAS	Randonia africana	T	Ononis natrix filifolia
r	Monsonia nivea	rNAS	Pseuderacaria clavata

Medicinal Plants:

Retama raetam	Phoenix dactylifera
Artemisia sp.	

Fauna:

Mammals:

t	Dorcas gazelle	Sand cat
t	Slender-horned gazelle	Saharan striped weasel
t	Aoudad (uncommon)	Brown hare
t	Hyena (uncommon)	NA Gundi
	Jackal	NA Shaw's jird
	Red fox	NA Gerbillus campestris (gerbil)
	Sand fox	NA Jaculus orientalis (jerboa)
	Fennec fox	<u>Eliomys quercynus</u>

Birds:

	Long-legged buzzard	Great grey shrike
t	Red kite	White wagtail
t	Peregrine	Black wheatear
	Griffon vulture	White-crowned black wheatear
	Barbary partridge	Mourning wheatear
	Turtle dove	Moussier's redstart
	Pir-tailed sandgrouse	Spanish sparrow
	Spotted sandgrouse	Raven
	Galerid larks	

Tataouine (Continued)

Influences:

Hunting and poaching: About 800 individuals
Cultivation, overgrazing, erosion, desertification
Soil Conservation - Anti-Desertification work:
Plantations (acacia, eucalyptus), tabias,
dirt windbreaks, pasture improvement,
small parcel irrigation

v = Very Rare
r = Rare
t = Threatened
T = Tunisia Endemic

NAS = North African Sahara Endemic
NA = North Africa Endemic
TL = Tunisia/Libya Endemic
E = Grand Eastern Erg Endemic

U. TOZEUR

Area: 610,000 ha

Major Ecosystems: Subdesertic Contintal Steppe
Mountain
Chott
Oasis

Specific Sites Important to Biological Diversity:

Chotts Jerid and El Gharsa: Sections 3.3.2.13 & 14
Oases: Tozeur, Nefza, Tamirza (Section 3.7)

Flora:

Maquis: 12,000 ha degraded juniper
Steppe: Artemisia
Halophile: 221,000 ha
Oasis: 7,000 ha
Cultivated: 50,000 ha

Rare and Endemic Plants:

r	Monsonia nivea	rNA	Genista saharae
r	Delphinium orientale	TA	Reseda duriaeaana

Medicinal Plants:

Globularia alypum	Lavandula multifida
Rosmarinus officinalis	

Fauna:

Mammals:

t	Dorcas gazelle	Wild boar (oases)
t	Aoudad	Kaffir cat (uncommon)
t	Hyena (uncommon)	Desert hedgehog
	Jackal	Brown hare
	Red fox	Crested porcupine

Birds:

	Shelduck	Palm dove	Black wheatear
	Kestrel	Crested lark	Black-eared wheatear
t	Houbara bustard	Hoopoe lark	Mourning wheatear
	Barbary partridge	Desert lark	Rock bunting
	Sandgrouse (5 sp)	White wagtail	Spanish sparrow

Influences:

Cultivation, overgrazing, erosion, desertification
Oasis creation and extension
Water table manipulation: Irrigation
Soil Conservation work: Windbreaks, plantations, dune
stabilization

r = Rare NA = North Africa Endemic
t = Threatened TA = Tunisia/Algeria Endemic

5. BIOLOGICAL DIVERSITY PROTECTION

5.1. GOVERNMENT INSTITUTIONAL STRUCTURE

The Ministry of Agriculture is the government agency most responsible for managing and protecting biological diversity and forests. Also providing important services are the Ministry of Health, which includes the National Office of Environmental Sanitation. The National Educational Education Ministry includes the Institute of Scientific and Technical Research (INRST) and its Center for Arid Zone Studies (CEZA), and the National Environmental Board, which advises on environmental policy, legislation and other related activities.

Under the Ministry of Agriculture are several Directorates charged with environmental protection and enforcement. These include (Grant 1980):

Directorate of Forests (Direction des Forets)

Activities: Forestry legislation and management

Sub-Directorate of Hunting and National Parks (Sous Direction de la Chasse et Parcs National)

Activities: Establishment of national parks and reserves
Species protection

Directorate of the Environment (Direction de l'Environnement)

Activities: Input on environmental legislation
Establishment of protected areas and species

Directorate of Water and Soil Resources (Direction des Ressources en Eau et en Sol)

Activities: Research on erosion control and hydrology

Directorate of Fisheries (Direction des Peches)

National Scientific and Technical Institute of Oceanography and Fisheries (Institut National Scientifique et Technique d'Océanographie et de Peche - INSTOP)

Activities: Research on oceanography, fisheries, marine biology, aquaculture

ORSTOM Mission to the Ministry of Agriculture (Mission d'ORSTOM aupres du Ministere de l'Agriculture)

Activities: Studies on earth sciences and phyto-ecology

Directorate of Research, Training and Instruction of Cadres (Direction de l'Enseignement de la Recherche et de la Formation des Cadres)

Includes:

National Agronomic Institute (Institut National Agronomique de Tunisie - INAT)

Institute of Agronomic Research (Institut National de la Recherche de Tunisie - INRAT)

Institute of Forestry Research (Institut National de Recherches Forestieres - INRF)

Center for Research and Rural Works (Centre de Recherches et du Genie Rural)

Arid Regions Institute (Institute des Regions Arides - IRA)

Office of Environmental Affairs

Activities: Coordination of all national and international environmental affairs

The Pasteur Institute (Institut Pasteur de Tunis) conducts research in parasitology and is concerned with the impact of bacterial water pollution. The institute provides educational information to the general public. There are also some quasi-governmental agencies concerned with environmental research and protection. These include the University of Tunis (especially the Faculty of Sciences and the Scientific Research Center), the Federation of Regional Hunting Associations and the Association for the Protection of Nature and the Environment (Association Tunisienne pour la Protection de la Nature et de l'Environnement - ATPNE). The ATPNE has the following functions:

- a) Protect flora, fauna, soils, air and natural sites
- b) Public conservation education (especially youth)
- c) Contribute to environmental protection legislation
- d) Promote creation of nature reserves
- e) Collaborate with other nature protection organizations
- f) Use all legal means to oppose projects that endanger nature or natural equilibrium.

5.2. NON GOVERNMENTAL ASSOCIATIONS

A non-governmental ornithological association called the Friends of Birds (Association des Amis des Oiseaux - AAO) has formed in Tunis. Members participate in environmental education and protection, field activities and encourage proper governmental protection measures.

A National committee for the Man and the Biosphere (MAB) program has also been organized. Biosphere reserves were designated in 1977 at Bou Hedma, Ichkeul, Chambi and Zembra.

Several international conservation organizations and assistance agencies have conducted research and provided consultants and funding for conservation projects in Tunisia. These include:

- International Waterfowl Research Bureau (England): Consulting, wetland projects
- International Council for Bird Protection (England)
- Worldwide Fund for Nature (WWF): Ichkeul National Park ecomuseum, Bou Hedma N.P. reintroductions, wetland research (Kneiss)
- British Museum: Ichkeul N.P. ecomuseum
- International Union for Nature Conservation (Switzerland)
- European Economic Community: Funded Ichkeul water management studies

- German-Tunisian Society (GTZ): Bou Hedma N.P. management and animal reintroductions; fencing of reserves (El Feidja); forestry management
- University College London: Ichkeul N.P. management plan.
- Peace Corps: Assisted with Bou Kornine N.P. management planning
- World Bank: Environment-related loans

5.3. ENVIRONMENTAL LEGISLATION

During the colonial period a set of legislation was established for the protection of the environment. After independence these laws were mostly replaced or updated (IUCN 1987). Although not always enforced, there are a fair number of post-colonial laws to protect the environment. Legislation has been passed protecting, or regulating the use of:

Fresh water	Fisheries
Sea water	Wildlife/wildlands
Soil	Non renewable resources
Land use	Hazardous substances
Vegetation	Solid waste disposal

Some of the more important laws regarding conservation of biological diversity are the hunting and fishing regulations and those listed below (after: Grant 1980); especially the forestry code.

Water

Decree 1933 (since modified): regulates conservation and utilization of public waters. Prohibits discharge of pollutants into public domain waters and activities liable to pollute water sources.

A Municipal law of Tunis prohibits discharge of refuse or any noxious substance into canals, sewers or rivers. Discharge into the sea from tourist resorts is prohibited.

Signatory to the Barcelona Convention of the Mediterranean Sea Against Pollution (16 Feb. 1976). Agreed to control dumping of pollutants from ships and to combat oil spills and other harmful substance pollution.

Signatory to Protocol for the Protection of the Mediterranean Sea Against Pollution from Land Based Sources (1979). Agreed to control release of land-based pollutants and to eliminate release of certain specified chemicals.

Soil and Land Use

Decree 1949 (modified 1956): On land with a slope > 20%, certain land uses can be prohibited in favor of conservation of the vegetation cover, and/or the landowner can be required to construct soil and water conservation structures.

Law No. 58-105, 1958: On slopes > 2% agricultural activities must be carried out along the contours and erosion control measures must be implemented.

Law No. 59-48, 1959: Insufficiently or inadequately cultivated land can be sequestrated (this can work against environmental conservation).

Forests and Vegetation

Law No. 58-83, 1958: Limits the raising of goats.

Law No. 59-143, 1959: Promotes destruction of jujube trees (Zizyphus lotus). This law is detrimental to the native flora.

Law No. 66-60, 1966: The Forestry Code. Regulates the conservation and exploitation of forest resources, including reforestation, dune stabilization, and esparto grassland management. Enables establishment of national parks and protected areas.

Wildlife

Regulations of 1966: Several regulations concerning the protection of birds and hunting.

JORT No. 44, 1984: General policies of national parks.

Article 58-60, 1958: Forestry Legislative Texts. Grazing, shooting and fishing can be restricted in protected areas.

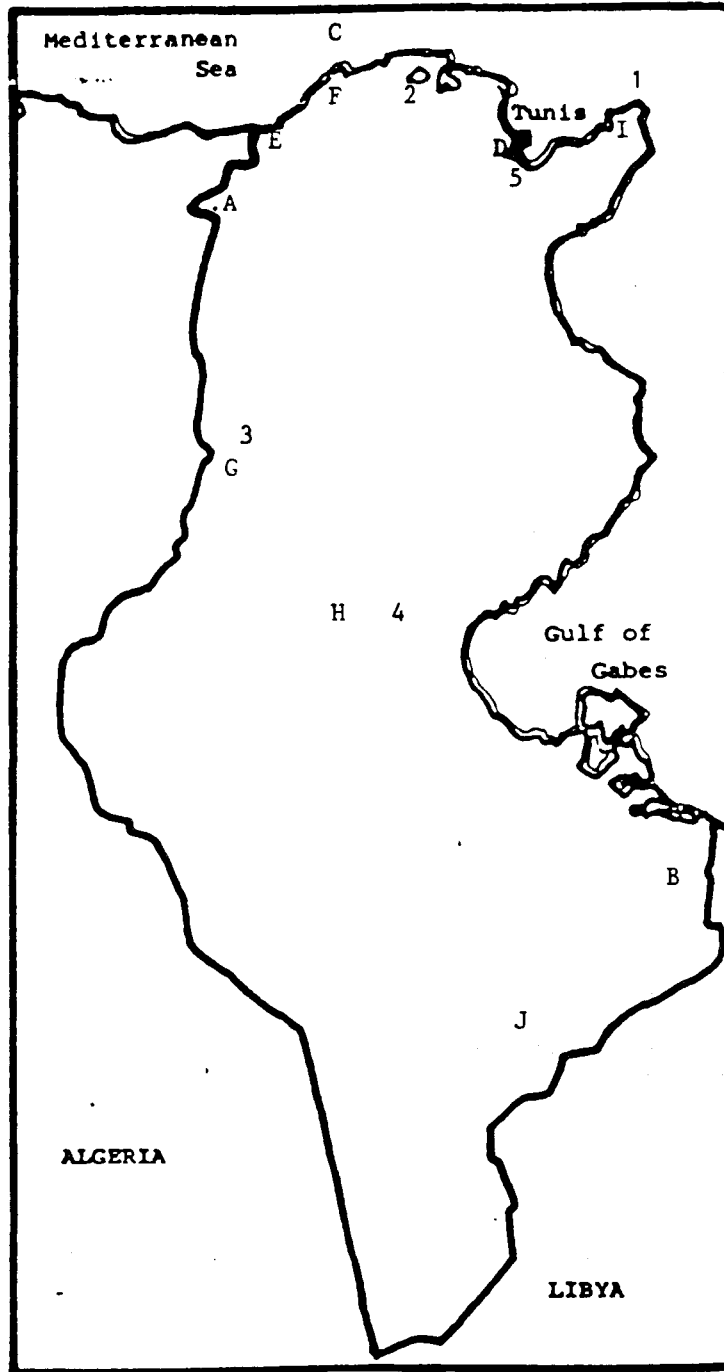
5.4. NATIONAL PARKS AND PROTECTED AREAS

Article 58 of Tunisian Law No. 66-60 states that 'Natural regions or sections of regions for which it is important for scientific regions, and characterized in a general manner of social utility to assure their maintenance in their natural state can be designated national parks or analog reserves.' Parks and reserves are created by presidential decree. General management policies of national parks were published in the Official Journal JORT No. 44 in 1984.

The Ministry of Agriculture is responsible for administration and management of protected areas. The Directorate of the Environment is responsible for general co-ordination and the Forestry Directorate is in charge of administration and management (IUCH 1987). Unfortunately, both agencies are limited in staff and finances, and cooperation between the two is poor. Marine reserves and parks have been under the jurisdiction of the Commisariat General of Fisheries and the Ministry of Defense since the islands were occupied by the military in 1979.

Each national park has an administrator and several guardians assigned to protect the site. Protected reserves are the responsibility of the regional foresters, game wardens (Guards de Chasse) and specially assigned guardians.

Figure 16
Parks and Reserves of Tunisia



1. Zembra N.P.
2. Ichkeul N.P.
3. Chambi N.P.
4. Bou Hedma N.P.
5. Bou Kornine N.P.
- A. El Feidja Reserve
- B. Hamada - Sidi Toui Proposed N.P.
- C. Galite Reserve
- D. Lake Tunis Protected Wetland
- E. Ain Baccouch Reserve
- F. Mhibes Reserve
- G. Kechem el Kelb Reserve
- H. Orbata Reserve
- I. Dar Chichou Reserve
- J. Jenein - Oued Ouni Proposed Biosphere Reserve

One of the goals of the national park program is to have a park representing each of the major ecosystems in Tunisia. There are currently 5 national parks, 2 proposed parks, and 9 protected reserves (figure 16). Non-governmental sources have recommended the establishment of additional protected areas at 19 other locations (IUCN 1987), including the Dar Fatma bog, 2 lagoons, 12 sebkhetts and chotts, 3 coastal areas and Kuriate island.

The fauna and flora of most of the national parks and reserves are discussed in section 3. A good directory of the national parks and reserves was produced by the IUCN (1987).

5.4.1. Zembra National Park and Biosphere Reserve 4030 ha

The islands of Zembra and Zembretta were designated Tunisia's first national park in 1977 by decree No. 77-340. The ecosystem is described in Section 3.1.2.

A hotel and bungalows were constructed on Zembra and up to 200 people were present daily in the summers before 1979. The islands became a military base in 1979 and all tourism and national park management was halted (IUCN 1987). From the 1960s to 1976 there was a maritime research center on Zembra, but it has been occupied by the Marine Nationale since 1979. Some limited research has been conducted in recent years and there are proposals to re-establish guided tours and limited stays on the island.

Military control reduces the detrimental effects on the ecosystem caused by tourists and fishermen, but the military personnel themselves may be disrupting the environment. Primary needs of Zembra national park are currently the re-delegation of management to the Forestry Directorate and the assignment of adequate park personnel.

5.4.2. Ichkeul National Park and Biosphere Reserve 10,775 ha

Lake Ichkeul (Section 3.3.1.1) and Djebel Ichkeul (Section 3.4.1.6) were established as a national park by Law No. 80-1608 in December 1980. Ichkeul N.P. is the only site in the world to have the triple distinction of being declared a biosphere reserve (1977), included on the list of Wetlands of International Importance (Ramsar Convention) and as a World Heritage site (1980).

An ecomuseum (information center) has been constructed on Dj. Ichkeul with assistance from the British Museum and the WWF. The museum is intended to educate the public about this very important ecosystem and to promote sensible touristic use and awareness on the part of local residents.

The lake is the single most important wetland for birds in North Africa, yet it is currently threatened by 6 dam projects on the rivers that provide Ichkeul with fresh water. A reduction in freshwater input would result in increased saltwater input through Oued Tinja. Changes in

...levels and salinity would severely reduce the habitat value of Lake Ichkeul (see Section 3.3.1.1). Therefore a water control sluice and overflow weir are needed on Oued Tinja, and a program for periodic releases from some of the dams should be negotiated. Hydrologic modeling (Hollis 1986) indicates that to maintain the current salinity levels and vegetation components of Ichkeul, the lake area must be reduced by 20-35%. Specifics on construction and location of the embankment needed for such a project are given in SOGREAH (1985) and Hollis (1986). A final decision must be made soon on a strategy for saving the ecology of Lake Ichkeul.

5.4.3. Chambi National Park and Biosphere Reserve

6723

The mountain park at Djebel Chambi was created by Decree No. 80-1 in 1980. Dj. Chambi is the highest mountain of Tunisia and contains rare plants and fauna of interest (Section 3.4.3.1). The park has been fenced to protect the ecosystem and an ecomuseum is being built for public education. The park is in need of permanent, on-site staff and a better access road. Current visitor use is low, but with proper management and facilities the park is certain to be one of the main attractions of the region.

5.4.4. Bou Hedma National Park and Biosphere Reserve

16,488 ha

Decree No. 80-1606 established Bou Hedma N.P. in December 1980. A remnant pseudo-savanna of *Acacia raddiana* is protected by the park as well as several rare ungulates (see Section 3.4.4.2 and 3.5.3). The GTZ is very involved with this park, and they are providing assistance with planning, an ecomuseum and the reintroduction of addax, scimitar-horned oryx and ostriches to the park. The reintroduction project is being done in cooperation with several European zoos. About 1500 ha have been fenced as a strict reserve to protect the habitat and the released animals. Sociological studies are also being directed by the GTZ to assist the local population and improve the park-community interaction.

5.4.5. Bou Kornine National Park

1940 ha

The newest of the five national parks is Bou Kornine, established in February 1987 by Decree No. 87-282. The park is dominated by thuya *Callitris articulata*, a tropical relict species. A General Management Plan and budget have been prepared for the park, but little has been done due to financial restrictions and the pressing needs of the other parks. Plans include an ecomuseum, picnic/recreation areas and educational trails. The close proximity of the capitol city, Tunis, makes Bou Kornine an ideal site for public education.

5.4.6. Proposed National Park at El Feidja

2517 ha

There is currently a 417 ha fenced to protect the barbary deer of El Feidja (Section 3.4.1.1). The fence was erected in 1966 with the help of the GTZ. Since then, there has been almost no human disturbance in the reserve and the deer population has increased significantly. To accommodate the increasing deer population and protect the rest of the diverse fauna and flora, a 2517 ha area is being considered for a national park. The area is populated by about 160 families (IUCN 1987), but the wooded portions are uninhabited.

Current facilities at El Feidja include a forestry post with a small museum and an enclosure for holding injured deer and public display. If a national park is created there will be need for a general management plan, a park headquarters, staff, vehicles, remodeling of the museum, and equipment.

5.4.7. Proposed National Park at Hamada and Djebel Sidi Toui 12,000 ha

Although Bou Hedma N.P. is in an arid region, a true desert ecosystem is missing from Tunisia's national park network. Therefore a national park - biosphere reserve has been proposed for the area around Djebel Sidi Toui (see Section 3.5.4). The south foot of the djebel has been protected from grazing for about 20 years, with dramatic vegetation response, and some of the last remaining unspoiled steppe is in the project area (IUCN 1987).

The GTZ, ATPNE and MAB committee are involved in the research and preparatory planning for the park. There is currently an experimental station of the Medenine IRA in the area, where camel/vegetation interactions are being studied. IRA facilities are likely to be used in the future park. The national contribution to the reserve has been 91,600 Tunisian Dirars. The budget is used for personnel, wells, range improvement outside the reserve and protection of the reserve, but an additional 66,000 US dollars is still needed for equipment, training and a consultant (Min. Agr. 1985).

5.4.8. Galiton Reserve

650 ha

The islands of Galiton (27 ha) and La Fouchelle (14 ha) and a 0.5 sea mile radius in the Galite archipelago were designated as a strict nature reserve in 1980. There is internationally important fauna, including monk seals and nesting Eleonora's falcons and Audouin's gulls, on the archipelago and diverse marine fauna, including red coral, that is being threatened by the local population, visiting fishermen and recreational divers (see Section 3.1.1).

Better public awareness of the reserve is needed, which would include installing regulation notices on the island of Galite and informing diving outfitters. An enforcement staff should also be trained and equipped. Equipment would include 'Zodiac' type boats and motors, binoculars, radios and, ideally, diving equipment, so diving activities could be monitored and coral harvesting and spearfishing could be prevented in the reserve.

5.4.9. Lake Tunis Protected Wetland

4500 ha

Lake Tunis was designated a Protected Wetland in 1980. This status does not necessitate habitat improvement actions, although they are allowed; however, actions that degrade the environment should be stopped. Lake Tunis is especially important because endangered birds (including marbled teal, white-headed duck and peregrine) and important numbers of other waterfowl and waders use the lake for feeding and nesting. The close proximity to Tunis enhances the conservation education value of the lake.

Unfortunately, the close proximity to Tunis also make the space valuable for development, and in spite of the Protected Wetland status, over 900 ha have been filled to provide a location for the construction of a new section of city. The project will eventually fill over one-third of this important wetland and the habitat quality of the rest of the lake may be degraded.

The development project has advanced too far to be stopped now, so mitigation should be sought to improve the rest of the lake. Improvements could involve increasing water circulation in the lake or excluding human activity around the island of Chikly.

5.4.10. Ain Baccouch and Mhibes Reserves

Along the Kroumirie mountain range, a 90 ha area at Ain Baccouch (Section 3.4.1.4) and a 370 ha area at Mhibes (Section 3.4.1.5) have been fenced to protect the endangered barbary deer. Ain Baccouch contains 50 - 100 deer, which is a large herd for the size of the reserve, so there are plans to enlarge the reserve to 370 ha. Both reserves are dominated by cork oak forest and Ain Baccouch contains some maritime pine. Continued maintenance of the fences and surveillance of the reserves are current management concerns.

5.4.11. Kechem el Kelb Reserve

300 ha

In 1970 a reserve was fenced on the mountain adjacent to Djebel Chambi to protect the resident Cuvier's gazelles. Endangered hyenas also live in the reserve. The fence was erected to keep the humans and livestock out, but it does not keep the gazelles in, and some crop damage has been reported by local farmers. Current management priorities include: maintenance of the fence, surveillance of the reserve and ensuring that adequate food and water are available to the animals. A large water catchment has been constructed to supply drinking water and palatable cactus has been planted outside the reserve to draw the gazelles away from farm crops.

5.4.12. Orbata Reserve

260 ha

A 260 ha area at the base of Djebel Orbata was fenced in 1969 to protect dorcas gazelles and their habitat. Since then, ostrich and European daim were introduced to the reserve and have been increasing in numbers. The gazelles, ostrich and daim are too numerous to be supported by the natural vegetation, so small irrigated garden plots are cultivated to produce alfalfa and other forage.

A number of animals (mostly non-native) are kept in a small zoo at a corner of the reserve to provide public education and a recreation area. The adjacent mountain is also protected from hunting and grazing, but little active management is done.

5.4.13. Dar Chichou Managed Reserve

100 ha

In 1964 a reserve was created at Dar Chichou on the Cap Bon peninsula. The 3 remaining female Ichkeul buffalo (see Section 2.4) were brought to the reserve and an Italian male buffalo was imported to start a breeding program. The program was successful and a small herd was retained at Dar Chichou when the rest of the buffalo were reintroduced to Ichkeul N.P. European daim are also kept in the reserve.

5.4.14. Proposed Biosphere Reserve at Jenein - Oued Ouri

360,000 ha

A large area of Subdesertic Continental Steppe (Section 3.5.4) south of Remada has been recommended to be established as a Biosphere Reserve. The area contains a variety of desert flora and fauna threatened by cultivation, overgrazing and desertification. Biosphere Reserves are not strict reserves throughout, so a variety of projects designed to encourage sensible land use and combat desertification should be implemented. Currently the project is not a high priority of the Forestry Directorate.

6. SUMMARY OF PRIORITY CONSERVATION NEEDS

Although the Government of Tunisia and conservation organizations (national and international) have been working towards protection and enhancement of biological diversity for many years, there are still a great number of environmental problems in need of action. The following outline of recommended actions is prioritized in relation to the preservation of biological diversity and tropical forests. (U) denotes urgent problems that will soon result in a rationally significant loss of biological diversity if action is not taken; (VU) denotes very urgent problems that should be given top priority; (N) denotes needed actions to maintain the current biological diversity; and (D) indicates desirable actions to enhance the national biological diversity.

This list is by no means complete. There are numerous other projects suggested in the text of this document and recommended by other sources. The object here is to give an outline of projects that could and should be started immediately, and would have tangible results for important fauna, flora and ecosystems. National conservation and environmental education priorities may differ.

Action should be taken on the following subjects:

Flora

1. Inventory of National Flora (N): Needed to complete baseline data and genetic resource information base, for use in conservation planning and research. It would be desirable to include a species use assessment and status report in the inventory. If a complete inventory is not possible, a flora checklist should be made.
2. Establishment of National Herbarium (D): Can be done during inventory.
3. Creation of Botanic Gardens (D): Enables genetic resource protection and research.

Fauna

1. Improvement of Law Enforcement Capabilities (U): More and better equipped game wardens (Guards de Chasse) are needed. Equipment needed includes:
 - Vehicles
 - Observation equipment
 - Communications equipment
2. Control of Illegal Trade (N): Includes stringent enforcement of CITES guidelines and control of local 'souk' (market) commerce in wildlife products.

National Parks and Reserves

1. **Increased Funding (N):** Protected areas should receive higher priority in budget planning. Financial needs include:
 - Operating budgets for each park
 - Salaries for on-site staff
 - Equipment funds: vehicles, administration and management equipment
2. **Improved Public Access (D):** To promote environmental awareness each park should have:
 - Education programs
 - Tourism promotion
 - Improved access roads and facilities

Ecosystem Protection

1. **Coastal Zones:**
 - A. **Pollution Control:**
 - Upgrade pollution control legislation
 - Strengthen enforcement
 - Provide technology and means to comply with legislation to major pollution sources (chem. industries, public sewage & trash systems)
 - B. **Coral Coast (N):**
 - Study extent and impacts of coral harvesting
 - C. **Gulf of Gabes (N):**
 - Protection of Kreiss intertidal zone (preferably as a Ramsar site)
2. **Galite Island:**
 - (U) Monk seal status report and protection measures
 - (N) Increased protection of marine fauna
3. **Wetlands:**
 - A. **Lake Ichkeul (VU):** The following amelioration projects have been proposed, but funds for implementation are lacking.
 - Fill the canal in the Djoumine marsh
 - Construct a water control sluice and overflow weir at Oued Tinja
 - Release water from reservoirs when lake level is below 10 cm ASL
 - Decide on final conservation strategy (may involve decreasing lake area by 20-35%)
 - B. **Sebkhet Kelbia (U):**
 - Initiate a program for water release from upstream reservoirs
 - C. **Dar Fatma Bog (N):**
 - Designation as a Protected Reserve
 - Fence maintenance
 - Complete flora and fauna study
 - D. **Oued Essed (D):**
 - Designation as a Protected Reserve for conservation education

4. Mountains:

A. Bou Kornine N.P.: See also Recommendations for Part II.

- (N) Install forest protection fence by Hammam Lif
- (N) Increase management capacity through provision of equipment and vehicles (total proposed park budget is approx. 175,000 Dinars)
- (D) Initiate environmental education program, including an ecomuseum (approximate cost 60,000 Tunisian Dinars) and trails
- (D) Increase fauna diversity through reintroductions fauna formerly found in the park (aoudad, Cuvier's gazelles)

B. El Feidja (D):

- Upgrading of status and management to that of National Park

C. Djebel Ichkeul (D):

- Removal of the quarries

D. Djebel Zaghouan (D):

- Increase and upgrade protection

5. Steppes:

A. Anti-desertification (VU): Implement the National Anti-desertification Strategy (Min. Agr. 1985); especially:

- Increase dune stabilization, erosion control and reforestation
- Improve range management and agricultural practices

B. Bou Hedma N.P.(N):

- Increase Acacia raddiana savanna protection and propagation

C. Proposed Desert National Park (D):

- Designation of area as a national park
- Equip for proper management (estimated initial cost: US 66,000)

PART II
TROPICAL FORESTS

1. INTRODUCTION

Before the oligocene era the climate of Tunisia was tropical (El-Hamrouni 1978). Fossil flora at Ichkeul consists of 26% tropical elements, such as:

Salix canariensis	Sapindus sp.
Cassia sp.	Pittosporum sp.

During the epoch of the Capsienne civilization, 15,000 years ago, Tunisia still had luxurious abundant vegetation that supported many species of animals that are no longer found in Africa north of the Sahara including elephants, rhinoceroes, lions and bears (Dir. For. 1976).

Changing climates, including the periods of the great glaciations, brought many Mediterranean, Saharan and European elements and even some boreal elements to the forest flora. The last great climate change was 7000 years ago. Since that time, most of the changes in forest area and species composition have been caused by man.

The present climate and dominant forest species are Mediterranean, but there are still some tree and shrub species with tropical affinities. Two primary remnants of the tropical forests are thuya Callitris articulata and Chamaerops humilis; others include (Peyerimhoff 1941):

Zizyphus (the genus in general)	Rhus sp.
Acacia raddiana (Saharo-tropical)	Myrtus communis
Periploca laevigata " "	Jasminum fruticans
Ericaceae (Erica arborea grows in sub-Saharan Africa)	Lycium sp
	Ficus carica (introduced)

Of the above species, only thuya and Acacia raddiana are true native tree species, and neither form what would be considered tropical forests by many definitions. However, according to the definition used for FAA amendments 118 and 119 (State Cable 1183241, 1987) tropical forests include "all tree and woody shrub formations, whether open or closed, occurring in humid, subhumid or semi-arid uplands or lowlands". Roughly the northern 25% of Tunisia is in the above bioclimates, so there are about 4 million ha that could support "tropical forests" by the above definition. Much of that land is cultivated, developed or occupied by steppe vegetation, but there are c.680,000 ha with woody vegetation (Dir. For. 1976). Species in those areas include those previously mentioned with tropical affinities (except A. raddiana, which occurs in arid areas) and all of the major forest species (mostly Mediterranean elements).

PART II

TROPICAL FORESTS

2. FOREST TYPES

In the area concerned there are 368,000 ha of true natural forest (dominated by tree species), but less than 270,000 ha are in good condition. The remainder of the 680,000 ha is occupied by artificial forest (plantations) and "maquis" (woody shrub formations). Major forest types include:

A. Callitris articulata (thuya) c.30,000 ha

Thuya is a SW Mediterranean species almost endemic to North Africa. Apart from the Maghreb (Tunisia, Algeria, Morocco) there are only rare stands in SE Spain and Malta. Optimum growth occurs in Semi-arid bioclimates with a maritime influence and 400 - 500 mm annual rainfall. In Tunisia, thuya is distributed north of a line from Enfida to the east of Medjez el Bab. This includes the south part of Cap Bon and the northeast part of the Tunisian Dorsal mountain range, up to Tebourba and Sbikha. Cap Bon is the eastern limit of the range of thuya in North Africa. As the wooded areas of Malta are progressively eliminated, the 30,000 ha of thuya in Tunisia that are isolated from other stands in Algeria become increasingly important to the range of this remnant tropical species. Often growing in association with thuya are other species with tropical affinities, such as:

Chamaerops humilis (dwarf palm)
Myrtus communis

B. Quercus suber (cork oak) c.80,000 ha

This West Mediterranean species is found in Portugal, Italy and the Maghreb. Cork oak grows best in areas with light, heat and annual rainfall greater than 800 mm. In Tunisia it is most common on warm slopes in the Khroumirie/Mogod mountain chains of the northwest region, but there are also small stands at Djebel Serdj, Dj. Teboursouk and Cap Bon. From an original range of 130,000 ha there are now less than 55,000 ha of prime cork oak forest - a 60% reduction (Dir. For. 1976). In the past trees were harvested for railroad ties, mine timbers and charcoal. Oaks are still cut for timber, but harvesting is much better controlled. Cork is harvested from mature trees every 10-12 years and tanning bark is obtained from older trees. Acorns are collected for domestic consumption and livestock feed. Associated species with tropical affinities include:

Chamaerops humilis
Myrtus communis
Erica (3 species)

C. Quercus canariensis (Zen oak) c.10,000 ha pure

Zen oak is native to Portugal, Spain and the Maghreb. The best growing conditions are at altitudes higher than 700m on deep soils. Cool, moist ravines with northern exposures may contain zen oak down to sea level. In Tunisia it grows in the most humid zones of the Khroumirie mountains, especially near the Algerian border. There are c.30,000 ha mixed with cork oak in addition to the pure stands. Zen oak produces better timber than cork oak and therefore has been heavily exploited in the past. Myrtus communis is commonly found in the understory.

D. Quercus afares Groves

This rare species is a North Africa endemic whose major distribution is in Algeria (12,000 ha). Optimum growing conditions are found in Humid bioclimates above 900 m altitude. There are some groves in Tunisia at El Feidja, El Ghorra and Air Zana, which are probably vestiges of an ancient Quercus afares forest (El-Hamrouni 1978).

E. Quercus ilex (holm oak) Groves and mixed

Native to the central and western Mediterranean basin, holm oak is commonly found at altitudes higher than 900 m. In Tunisia it often assumes a bush-like physiognomy and grows in aleppo pine dominated forests, but trees 6-8 m tall do exist. There are some small pure stands at El Belda (north of Ghardimaou) and on mountain tops. In the early 1900s there were c.20,000 ha of holm oak dominated forest (Dir. For. 1931). Harvesting for fuelwood resulted in the loss of many of the pure stands and increased erosion.

F. Quercus coccifera (kermes oak) 10,000 ha

Ranges from Portugal to Greece and Morocco to Syria. Growing best in Sub-humid, temperate zones (but found in Humid to Semi-arid zones) with maritime influence, it usually is only 1-3 m tall. Occurs in Tunisia in frost-free coastal maquis from Tabarka to Hammamet and inland on Djebel Mansour and Dj. Teboursouk.

G. Pinus pinaster (maritime pine) c.5000 ha

In Tunisia, maritime pine only grows naturally between Tabarka and Algeria, but it has been planted in many coastal areas. In natural stands it is often in association with cork oak. The former range was over 10,000 ha, but a decision to cut all trees greater than 1 m in diameter in the early 1900s reduced the quality and area of the forests.

H. Pinus halipensis (aleppo pine)

200,000 ha

Aleppo pine is the forest tree with the largest area in Tunisia. It grows across the country, but is most common in the Tunisian Dorsal mountains where the annual rainfall is 400 - 600 mm and the bioclimate is Semi-arid or Arid. Conditions are most favorable near Kasserine, and in the High Tell near Le Kef. The present area covered is only one-fourth of the natural range of aleppo pine. Most of the reduction is due to human pressure for fuelwood, timber, agricultural land and grazing areas. In the northeastern part of its range, aleppo pine often grows in association with Erica multiflora.

I. Cupressus sempervirens f. numidica (Maktar cypress) Groves

Maktar cypress is considered endemic to Tunisia, but there are some doubts regarding its true origin. There are only three small natural stands growing in the Kessera forest of the Tunisian Dorsal mountain range, but it has been widely planted in windbreaks.

J. Miscellaneous

Other forest species include ash Fraxinus angustifolia, elm Ulmus campestris, alder Alnus glutinosa and aspen Populus alba and P. nigra. These species are commonly found along rivers in association with pine or oak forests. Small stands of rare Montpellier maple Acer monspessulanum grow at the summits of Djebel Zaghuan, Dj. Bargou and Dj. Serdj in the Tunisian Dorsal.

K. Maquis

Degraded forests are often vegetated by maquis of shrubs and low trees. In the north, heather Erica sp. forms a fairly large proportion of the understory of cork oak forests. When the oak is removed a maquis of heather remains and increases in density. A common maquis association on hot expositions in subhumid to arid bioclimates is characterized by:

<u>Olea europaea</u> (wild olive)	<u>Pistacia lentiscus</u>
<u>Ceratonia siliqua</u> (carob)	<u>Jasminum fruticans</u>

Wild olive and carob are categorized as Mediterranean elements (El Hamrouni 1978) with tropical affinities (Peyerimhoff 1941). The association is found in Subhumid to Arid bioclimates where the yearly rainfall is from 200 to 800 mm.

Degraded aleppo pine forests often support a maquis of Juriperus oxycedrus and J. phoenicia on high slopes and summits or rosemary Rosmarinus officinalis on the slopes and lowlands. There are c.300,000 ha of rosemary maquis in Tunisia, often mixed with other forest associations.

3. STATUS OF TUNISIAN FORESTS

Only 3% of the non-desert area of Tunisia is covered by forests. Even if maquis are included there is still only 6% coverage, which makes Tunisia one of the Mediterranean forests poorest in forests (Dir. For. 1986). The optimum forest coverage for a country is 20% (El-Hamrouni 1978). To attain that level would require massive reforestation efforts on 2,000,000 ha of land. Obviously this is an extremely difficult goal to reach, especially since the trend has actually been toward deforestation.

A government study (Dir. For. 1984) reported 108,000 ha conducive to reforestation in northern Tunisia, of which only 56,000 ha are truly likely to produce successful results from planting. The rest of the areas available for reforestation are either heavily grazed, saline or desertic.

In 1910 forests covered 1,250,000 ha, but by 1975 the area was reduced to 500,000 ha. In the Mogod mountains one-third of the forest cover was removed in 10 years with disastrous consequences for soil conservation. Much of this loss can be attributed to the massive forest harvesting operations during the colonial period and inaccurate survey methods. However, between 1975 and 1985 an additional reduction of 132,000 ha occurred - a rate of over 13,000 ha per year. At the current rate, the forests of Tunisia could disappear in less than a century.

Causes of deforestation include poor timber harvesting practices, erosion, clearing for agriculture and grazing lands and constant pressure for forest products, such as fuelwood and forage. At Djebel Semmama, in the Tunisian Dorsal, 77% of the yearly forest production disappears to local residents (El-Hamrouni 1978). An estimated 7,336,000 cubic meters per year (ONUPAA 1985) are needed to supply the national demand for wood (87% of which is fuelwood). The potential sustainable production of 485,000 ha of natural and artificial forest is only 4.4% of the total demand.

In 1984 a total of 2,817,000 m³ or 38% of the estimated demand was taken from the forests, indicating a deficit in annual forest production. An additional 360,000 m³ was imported (FAO 1986) to meet the demand for industrial wood, which still left 59% of the fuelwood demand unmet. A demand of that magnitude invariably results in widespread unauthorized fuelwood collection and forest degradation. Other forest products harvested in 1984 include:

Cork	7,400,000 kg
Rosemary	58,000 ha
Myrtus communis	9,000 ha
Capers	4,500 ha
Seeds (pine)	32,000 kg
Dwarf palm	> 350 tons
Heather (Erica sp)	unknown

Between 1890 and 1973, 2.7 million ha of grazing lands were put under cultivation, forcing herders to bring their livestock to the forests to graze (Dir. For. 1976). After the trees or shrubs have been cut, intensive grazing by domestic livestock disrupts the regeneration process. Grazing also occurs in uncut stands, stopping the natural replacement of old and dying trees. In 1976 more than 50% of the pine and oak were of declining age; therefore, 20 - 50% should have been regenerated.

From 1962 to 1984 an average of 9400 ha/year were planted (ONUPAA 1985), but this practice has been changing the forest species composition and still falls short of the deforestation rate. Trees commonly selected for planting are fast growing non-native species of eucalyptus, acacia and pine. Some species native to Tunisia are planted, but often this is done outside the normal range of the species.

4. FOREST PROTECTION

A current policy of the Forestry Directorate is to designate 20% of all forests as regeneration forests, thus prohibiting grazing and harvesting of forest products. Reforestation on public lands is being increased to increase the harvestable resource and to control erosion. In addition, law 66-256 of 23 December 1986 requires that at least 2% of the area of each private property be reforested. While these policies and laws are good in theory, the actual results have fallen short of their goal due to financial, administrative, demographic and sociological problems.

In order to conserve some of the important forest areas and their associated flora and fauna, several reserves and national parks have been established. Those protected areas are discussed in Section 5.4 of Part I (Biological Diversity survey of Tunisia).

The 'tropical forests' of Tunisia could be improved or protected by assisting with planning, training, equipment and staff in the areas of:

- Reforestation (increased yearly planting of appropriate species)
- Proper forest management (planning, protection, forest improvement practices)
- Species selection (planting species compatible with the natural ecosystems)
- Upgrading protection of reserves and parks (see biological diversity annex). Of special interest in regard to tropical forests is Bou Korrine National Park, which is dominated by thuya forests. A General Management Plan and budget have been proposed, but not implemented due to lack of finances.

GLOSSARY

Anatid - Birds of the Anatidae family; specifically, swans, geese and ducks.

Archipelago - A group of islands.

ASL - Above Sea Level; used in place of NGT (Niveau General de Tunisie).

Djebel - The arabic term for mountain.

Garrigue - The french term for open, low brushfields composed of woody plants often less than 50 cm tall.

Halophile - Salt tolerant plants.

Halophyte - Plants with high salt concentrations in their leaves.

Herpetofauna (also Herpes) - Reptiles and amphibians.

Hygrophile - Plants that grow on wet soils.

Maghreb - The arabic term for the region of North Africa including Morocco, Algeria and Tunisia.

Maquis - The french term for dense brushfields dominated by small trees or shrubs from 2 to 5-8 m tall.

Nitrophile - Plants that grow best on soils with high nitrogen concentrations.

Olea-lentiscus formation - A plant association dominated by Olea europaea and Pistacia lentiscus.

Oued - The arabic term for river.

Siroccó - Hot, dry winds that originate in the Sahara.

Sward - Open areas dominated by low woody plants; shorter and sparser than in garrigues.

Waders - Birds that feed on shorelines or wade into the water; includes birds commonly called shorebirds.

Waterfowl - In this text the term includes most birds that usually swim while feeding: Anatids, coots, moorhens, etc.

Xerothermic - Plants tolerant to dry conditions.

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A N N E X E S

1. Rare, Very Rare and Endemic (Partial Listing) Plants of Tunisia
2. Mammals of Tunisia
3. Birds of Tunisia
4. Heiligenhafer Criteria

A N N E X 1

RARE, VERY RARE AND ENDEMIC (PARTIAL LISTING) PLANTS OF TUNISIA

Legend

- r = Rare
- v = Very Rare
- T = Tunisia Endemic
- TA = Tunisia/Algeria Endemic
- NA = North Africa Endemic
- NAS = North African Sahara Endemic
- S = Sahara Endemic
- A = Algeria Endemic

- K = Kroumirie Mountains
- M = Mogod Mountains
- TD = Tunisian Dorsal Mountains
- VM = Medjerda valley
- CB = Cap Bon
- NE = Northeast Tunisia
- TC = Central Tunisia
- TS = Southern Tunisia

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ANNEX 1

RARE, VERY RARE AND ENDEMIC (Partial Listing) PLANTS OF TUNISIA

Species	Status	Distribution
<i>Abutilon theophrasis</i>	v	K, NE
<i>Acer monspessulanum</i>	r	TD
<i>Aegilops triuncialis</i>	r	TD
<i>Agropyron repens</i> var. <i>glaucum</i>	r	TD
<i>Agrostis reuteri</i>	r	K, TD
<i>Aiopsis tenella</i>	r	CBK
<i>Ajuga reptans</i>	v	K
<i>Alliaria officinalis</i>	r	K
<i>Alopecurus myosuroides</i>	r	TC
<i>A. pratensis</i> ssp. <i>brachystachys</i>	vNA	K, TD
<i>Alteranthera sessilis</i>	v	M
<i>Althaea ludwigii</i>	r	TS
<i>A. officinalis</i>	r	TS
<i>Alyssum scutigerum</i>	vNA	TD
<i>Amaranthus gracillis</i>	r	NE
<i>Amberboa crupinoides</i> var. <i>lybica</i>	v	TS
<i>Anabasis aphylla</i> ssp. <i>africana</i>	r	TS
<i>Anacyclus valentinus</i>	r	TS, TC
<i>Anagallis tenella</i>	r	K
<i>A. monelli</i> ssp. <i>collina</i>	r	NE, TD
<i>Anarrhinum brevifolium</i>	r	TC, TS
<i>Androcymbium gramineum</i>	rS	TC, TS
<i>Archusa aegyptiaca</i>	r	TS
<i>Andropogon distachyus</i>	r	K, M
<i>Anthemis montana</i>	vNA	TD
<i>A. cotula</i>	v	TC
<i>Anthoxanthum gracile</i>	r	K, NE
<i>Antinoria agrostidea</i>	r	K
<i>Antirrhinum ramosissimum</i>	vS	TS
<i>Anvillea radiata</i>	vNA	TS
<i>A. r.</i> var. <i>australis</i>	vNA	TS
<i>Apera interrupta</i>	r	K
<i>Arabis verna</i>	r	TD, K
<i>A. parvula</i>	r	TD
<i>A. pubescens</i>	r	K
<i>Arenaria emarginata</i>	vNA	TC
<i>A. grandiflora</i>	r	TD
<i>Aristida acutiflora</i>	r	TS
<i>Artemisia vulgaris</i>	v	
<i>Armeria spinulosa</i>	rNA	M
<i>Arundo plinii</i>	r	TC, NE
<i>Asphodelus acaulis</i>	rNA	TD
<i>Asplenium petrarchae</i>	r	TD
<i>Aster tripolium</i>	v	CB
<i>Asteriscus graveolens</i>	vS	TS

Annex 1 (Continued)

Species	Status	Distribution
<i>Astragalus gombiformis</i>	rNAS	TS
<i>A. cruciatus</i> ssp. <i>aristidis</i>	T	
<i>A. falciformis</i>	TA	
<i>A. monspessulanus</i>	TA	
<i>Astrocarpus sesamoides</i>	v	M
<i>Atriplex tatarica</i>	v	TC
<i>Avellinia michelii</i>	r	CB
<i>Avena longiglumis</i>	r	TS
<i>A. fatua</i>	r	TS
<i>Balansea glaberrima</i>	v	K
<i>Barbarea vulgaris</i>	v	K
<i>Bellevalia ciliata</i>	r	TD
<i>Elechnum spicant</i>	r	K
<i>Bothriochloa ischaemum</i>	r	NE
<i>Brachiaria multica</i>	rNA	K
<i>Brassica dimorpha</i>	r	TD
<i>Brassica cretica</i> ssp. <i>atlantica</i>		T
<i>Bromus racemosus</i> ssp. <i>commutatus</i>	r	K,TC
<i>B. squarrosus</i>	r	TD
<i>B. intermedius</i>	r	TC,K
<i>Buffonia tenuifolia</i>	r	TD
<i>Bunium crassifolium</i>	rNA	CB
<i>Bupleurum fruticosum</i>	r	VM
<i>Butomus umbellatus</i>	r	M
<i>Calendula monardi</i>	rNA	NE,CB
<i>Campanula filicaulis</i> ssp. <i>reboudiana</i>	rNA	TC
<i>C. atlantica</i>	rNA	TS
<i>Cardamine graeca</i>	v	K
<i>Carex depressa</i>	r	K
<i>C. flacca</i> var. <i>eu-glauca</i>	r	CB
<i>C. hordeistichos</i>	r	TD
<i>C. pallescens</i>	r	K
<i>C. pseudo-cyperus</i>	r	
<i>Carthamus calvatus</i>	rNA	TD
<i>Carum montanum</i>	vNA	TD
<i>Castanea sativa</i>	r	K
<i>Centaurea amara</i> ssp. <i>angustifolia</i>	r	K
<i>C. a.</i> ssp. <i>ropalon</i>	rNA	NE
<i>C. cineraria</i> var. <i>gymnocarpa</i>	vNA	CB
<i>C. eriophora</i>	v	CB
<i>C. seridis</i> var. <i>maritima</i>	r	TC,TS
<i>Centunculus brinimus</i>	r	CB
<i>Cerastium caespitosum</i>	r	K
<i>Ceratophyllum submersum</i>	r	NE,TS
<i>Chaetorychia cymosa</i>	v	CB

Annex 1 (Continued)

Species	Status	Distribution
<i>Chondrilla juncea</i>	r	NE
<i>Chrysanthemum clausonis</i>	r	K
<i>Cichorium intybus</i> ssp. <i>eu-intybus</i> var. <i>glabratum</i>	r	TD,TC
<i>Cistus villosus</i> var. <i>tauricus</i>	r	VM
<i>Cleonea lusitanica</i>	r	TD
<i>Colchicum ritchii</i>	r	TS
<i>C. autumnale</i>	r	K,NE
<i>Convolvulus cneorum</i>	v	CB
<i>C. humilis</i>	r	NE,TD
<i>Coronilla atlantica</i>	r	K,VM
<i>C. valentina</i> ssp. <i>pentaphylla</i>	r	M
<i>Corynephorus articulatus fasciculatus</i>	r	TD
<i>Coryza naudinii</i>	r	K,M
<i>Cotoneaster racemiflora</i>	rNA	TD
<i>Crepis clausonis</i>	vNA	K
<i>C. turetana</i>	T	CB,TC
<i>Crypsis aculeata</i>	r	K,NE,TC
<i>C. alopecuroides</i>	r	K,M
<i>Cteropsis pectinella</i>	r	TD
<i>Cutandia philistaea</i>	r	TC,TS
<i>Cyperus polystachius</i>	rNA	NE
<i>Cyclamen africanum</i>	vNA	K,M,CB
<i>C. persicum</i>	v	NE,TD
<i>Cynosurus peltiari</i>	r	K
<i>C. elegans</i> ssp. <i>obliquatus</i>	r	K
<i>Cystopteris filix fragilis eu-fragilis</i>	r	CB
<i>Cytisus monspeliensis</i>	r	K
<i>Dactylis glomerata</i> var. <i>typica</i>	r	K
<i>Datura metel</i>	r	TC,NE
<i>Daucus reboudii</i>	vNA	K
<i>D. Durieua</i>	v	TS
<i>Delphinium balansae</i>	v	TD
<i>D. orientale</i>	r	TS
<i>D. pubescens</i>	r	TS
<i>Dianthus rupicola</i>	r	CB
<i>Dichanthium annulatum</i>	r	TS,TC
<i>Diplotaxis acris</i>	v	TS
<i>Doronicum atlanticum</i>	rNA	K
<i>Dorycinium pentaphyllum</i>	v	M
<i>Draba hispanica</i>	rNA	TD
<i>Dryopteris filix-mas</i>	r	K
<i>D. aculeata</i>	r	K
<i>D. villarsii</i>	r	TD
<i>Echinodorus ranunculoides</i>	r	M,K,CB

Annex 1 (Continued)

Species	Status	Distribution
<i>Echium arenarium</i>	v	TC
<i>E. suffruticosum</i>	rNA	TC
<i>Elatine absinastrum</i>	r	K
<i>E. hydropiper</i> var <i>pedunculata</i>	r	M, CB
<i>Enneapogon brachystachyus</i>	r	TC
<i>E. scaber</i>	r	TS
<i>Ephedra major</i>	r	TD, TS
<i>Eragrostis trichophora</i>	r	TC, CB
<i>Erigeron trilobus</i>	r	TS
<i>Erodium pachyrrhizum</i>	rNA	K
<i>E. murbyanum</i>	rNA	CB
<i>E. maritimum</i>	r	CB
<i>Euphorbia allepica</i>	r	NE
<i>E. amygdaloides</i> var <i>biennis</i>	rNA	K
<i>E. atlantica</i>	rNA	K, VM
<i>E. biumbellata</i>	r	K
<i>E. paniculata</i>	rNA	K
<i>E. squamigera</i>	v	CB
<i>Exaculum pusillum</i>	v	K, M, CB
<i>Ferula tunetana</i>	T	TC, TS
<i>Festuca paniculata</i>	r	K
<i>Filago heterantha</i> ssp <i>cupaniana</i>	r	K
<i>Forestia hamiltonii</i>	v	TS
<i>Fragaria vesca</i>	r	K
<i>Frankenia corymbosa</i>	rNA	TC, TS
<i>F. pallida</i>	vNA	TC, TS
<i>Fumana calycina</i>	rNA	TD
<i>Fumaria bicolor</i>	r	K
<i>F. macrosepala</i>	r	TD
<i>F. densiflora</i> ssp. <i>bracteosa</i>	r	TS
<i>F. parviflora</i>	r	TS
<i>Galium pusillum</i>	v	TD
<i>G. verticillatum</i>	v	TD
<i>Genista saharae</i>	rNA	TS
<i>G. microcephala</i> var <i>genuina</i>	A	
<i>G. m.</i> var <i>tunetana</i>	T	
<i>G. ulcina</i>	TA	
<i>Geranium clumbinum</i>	r	K, CB
<i>G. pyrenaicum</i>	r	TD
<i>Geum urbanum</i>	rNA	K
<i>Glinus lotoides</i>	r	TC
<i>Graphalium luteo-album</i>	vNA	K
<i>Gomphocarpus fruticosus</i>	r	
<i>Gonidimon tartaricum</i>	v	TD

Annex 1 (Continued)

Species	Status	Distribution
<i>Halogeton alopecuroides</i>	r	TS
<i>Hedysarum humile</i> var <i>fontanesii</i>	r	
<i>Helianthemum helianthemoides</i>	rNA	TD
<i>H. rosmarinifolium</i> ssp <i>ehrembergii</i>	r	TC, TS
<i>H. salicifolium</i> ssp <i>intermedium</i>	r	DB
<i>H. vesicarium</i>	r	TS
<i>Helioscandium inundatum</i>	r	K
<i>Heliotropium luteum</i>	vS	TS
<i>Hemarthria compressa</i> ssp <i>altissima</i>	r	NE, K
<i>Heteropogon contortis</i>	r	TC
<i>Hippocrepis humide</i>	r	TD
<i>H. minor</i> ssp. <i>brevipetala</i>	r	
<i>Holcus setosus</i>	r	K
<i>Hypochaeris procumbens</i> ssp <i>duriaei</i>	r	TC, TD
<i>Hypericum androsaemum</i>	r	K
<i>Hyoscyamus niger</i>	r	TD
<i>Ionopsidium albiflorum</i>	r	K, TD
<i>Iris foetidissima</i>	r	K
<i>I. subbiflora</i>	r	TC
<i>I. Ungulularis</i>	r	K
<i>I. xiphium</i>	r	CB
<i>Jasione humilis</i>	r	CB
<i>Juncus subnodulosus</i>	rNA	CB
<i>Knaulia arvensis</i>	r	TD
<i>Koeleria rohlfsii</i>	rNA	TS
<i>K. splendens</i>	r	CB, TD
<i>Lactua muralis</i>	v	K
<i>L. viminea</i> var <i>chondrilliflora</i>	v	TD
<i>Lamium bifidum</i>	r	K
<i>L. mauritanicum</i>	vNA	
<i>Lapsana communis</i> ssp <i>macrocarpa</i>	rNA	K
<i>Lasiopogon muscoides</i>	r	TC, TD
<i>Lathyrus annuus</i>	r	CB
<i>L. articulatus</i> ssp <i>eu-clymenum</i>	r	K
<i>L. brachyodus</i>	rT	K
<i>L. nissolia</i>	r	K
<i>L. numidicus</i>	T	
<i>L. setifolius</i>	r	TD
<i>L. niger</i>	r	K
<i>Launaea angustifolia</i> var <i>squarrosa</i>	rNS	TS
<i>L. acanthoclada</i>	v	TD
<i>Lavatera flava</i>	r	VM, NE
<i>L. punctata</i>	r	NE
<i>L. stenopetala</i>	vNA	NE

Annex 1 (Continued)

Species	Status	Distribution
<i>Leersia hexandra</i>	rNA	K
<i>Leontice leontopetalum</i>	r	NE,TD
<i>Limoniastrum guyonianum</i>	NAS	
<i>Limonium spathulatum</i>	v	K
<i>L. boitardi</i>	T	NE
<i>Linaria aegyptiaca</i> ssp <i>battandieri</i>	r	TC,TS
<i>L. arvensis</i>	r	TD,TC,TS
<i>L. cossoni</i>	T	CB
<i>L. cymbalaria</i>	r	NE
<i>L. dissita</i>	vNA	TC
<i>L. elatine</i>	r	K
<i>L. flava</i>	v	K
<i>L. minor</i>	r	TC,TS
<i>L. paradoxa</i>	vT	TC,TS
<i>L. pedunculata</i>	v	TS
<i>L. pellecerania</i>	v	CB
<i>L. pinnifolia</i>	rNA	M,K
<i>L. reflexa</i> var. <i>doumeti</i>	rT	TD
<i>L. virgata</i> ssp <i>algeriensis</i>	v	TC
<i>Linum corymbiferum</i> ssp. <i>aristides</i>	r	TD,K
<i>L. corymbiferum</i> ssp. <i>lambesaranum</i>	rNA	M,TD
<i>Lolium temulentum</i>	r	K,CB,TC
<i>Lotus conimbricensis</i>	r	TC
<i>L. creticus</i> ssp <i>commutatus</i>	r	K,NE
<i>L. drepanocarpus</i>	r	K,M
<i>Ludwigia palustris</i>	r	K,M
<i>Luzula campestris</i>	r	K
<i>Lycopsis orientalis</i>	r	TS
<i>Lysimachia cousiniana</i>	vNA	K
<i>Lythrum nummularifolium</i>	r	K
<i>Magydaris panacifolia</i>	v	NE
<i>Mantisalca salmantica</i>	v	TD
<i>Maresia malcolmioides</i>	rNA	K,M
<i>Marrubium aschersonii</i>	T	K,NE,TC
<i>Marsilea aegyptiaca</i>	r	TS
<i>Matricaria tridentata</i>	rNA	TC,TS
<i>Medicago arabica</i>	r	K
<i>M. hispida</i> var <i>microdon</i>	r	K
<i>M. h.</i> var. <i>reticulata</i>	r	TD
<i>M. h.</i> var. <i>brachyacantha</i>	r	K
<i>M. tuberculata</i>	r	TD
<i>Melica uniflora</i>	r	K
<i>Melilotus elegans</i>	r	TC,CB,TD
<i>Mentha longifolia</i>	v	TD
<i>Molinia caerulea</i>	r	VM
<i>Molucella spirosa</i>	v	NE

Annex 1 (Continued)

Species	Status	Distribution
<i>Monsonia nivea</i>	r	TS
<i>Moretica canescens</i>	r	TS
<i>Myosotis micrantha</i>	v	TD
<i>M. pusilla</i>	r	TS
<i>Myriophyllum spicatum</i>	r	CB
<i>Nardurus maritimus</i> var. <i>aristatus</i>	r	TD
<i>Nepeta algeriensis</i>	vNA	K
<i>N. apulei</i>	r	K,NE
<i>Nigella arvensis</i>	r	TC
<i>Nymphaea alba</i>	r	K
<i>Odontites fradini</i>	vNA	M
<i>Oligomeris linifolia</i>	r	TS
<i>Omphalodes linifolia</i>	v	NE
<i>Onobrychis caput-galli</i>	r	
<i>Oronis alepecuroides</i>	r	K,TC
<i>O. biflora</i>	r	NE,TD
<i>O. mitissima</i>	r	K,M
<i>O. natrix</i> ssp. <i>filifolia</i>	T	
<i>O. pendula</i>	r	NE
<i>O. rosea</i>	rNA	TS
<i>O. viscosa</i> ssp. <i>sieberi</i>	v	TC
<i>Oropordon acaule</i>	v	TD
<i>Orosma echinatum</i>	v	TS
<i>Ophrys atlantica</i>	r	TD
<i>O. scolopax</i> ssp. <i>cornuta</i>	r	TD
<i>Orchis longicornu</i>	r	K,CB,TD
<i>O. elata</i>	r	
<i>O. palustris</i>	r	
<i>O. simia</i>	r	
<i>Oryzopsis paradoxa</i>	r	NE,TD
<i>Pancratum foetidum</i>	rT	TC
<i>Paronychia chabloziana</i>	T	
<i>Peganum harmala</i> var. <i>garamantum</i>	r	TS
<i>Pennisetum dichotomum</i>	r	TS
<i>Phleum phleoides</i>	r	TD
<i>Phlomis bovei</i>	vNA	M
<i>Phyllitis scolopendrium</i>	r	K
<i>P. hemionitis</i>	r	TD
<i>Pinus pinaster</i>	r	K
<i>Plantago coronopus</i> ssp. <i>purpurescens</i>	r	CB
<i>P. tunetana</i>	rT	TD
<i>Potamogeton densus</i>	r	TS
<i>P. lucens</i>	r	TD
<i>P. natans</i>	r	VM

Annex 1 (Continued)

Species	Status	Distribution
<i>Potentilla micrantha</i>	r	K
<i>P. supina</i>	r	TC
<i>Prosopis stephaniana</i>	r	TC, TS
<i>Pseuderucaria clavata</i>	r	TS
<i>Psilurus incurvus</i>	r	TD
<i>Pteris longifolia</i>	rNA	K
<i>Pulicaria crispa</i>	r	TS
<i>Putoria calabrica</i>	r	TD
<i>Pyrus syriaca</i>	r	M, VM
<i>Quercus afares</i>	rNA	K
<i>Randonia africana</i>	vNAS	TS
<i>Rapistrum rugosum</i> ssp eu-rugosum	r	NE, TC
<i>Ranunculus falcatus</i> ssp eu-falcatus	r	TD, TS
<i>R. f.</i> ssp. <i>incurvus</i>	r	TD, TS
<i>R. parviflorus</i>	r	CB, M
<i>R. scleratus</i>	r	NE, TC
<i>Reseda lutea</i> ssp eu-lutea	r	NE, TD
<i>R. alphonsii</i>	TA	
<i>R. duraeana</i>	TA	TC
<i>Rhamnus frangula</i>	v	K
<i>Rosa agrestis</i>	r	TD
<i>R. gallica</i>	r	K
<i>R. micrantha</i>	r	
<i>R. stylosa</i>	r	TD
<i>Rubus incanescens</i>	r	K
<i>Rumex pictus</i> ssp <i>bipinnatus</i>	rNA	TS
<i>R. taretarus</i>	T	
<i>Rynchospora glauca</i>	r	K
<i>Saccharum ravennae</i>	r	TC
<i>Sagina apelata</i> ssp <i>ciliata</i>	r	CB
<i>Salpichroa rhomboidea</i>	r	CB, TD
<i>Salvia jaminiana</i>	vNA	TS
<i>S. phlomoides</i>	r	TD
<i>S. sclaraea</i>	v	NE
<i>S. tingitana</i>	v	NE
<i>Sambucus ebulus</i>	r	TD
<i>S. niger</i>	r	TD
<i>Sanguisorbia spinosa</i>	r	CB
<i>Satureia fontanesii</i>	r	NE
<i>Saxifraga dichotoma</i>	v	TD
<i>Scabiosa orenata</i> ssp <i>typica</i>	v	TD
<i>S. farinosa</i>	T	K, CB
<i>Scilla obtusifolia</i>	r	NE
<i>Sclerochloa dura</i>	r	NE, TD

Annex 1 (Continued)

Species	Status	Distribution
<i>Scleropoa hemipoa</i>	r	TC
<i>Scorzonera laciniata</i> ssp <i>intermedia</i>	r	TD
<i>Sedum tuberosum</i>	TA	
<i>Senecio cineraria</i> var <i>typicus</i>	r	CB
<i>S. foliosus</i>	v	CB
<i>S. jacobea</i> ssp <i>barbarae-folies</i>	r	NE,M,CB
<i>S. lividus</i>	v	CB
<i>Serapias lingua</i> ssp <i>durioei</i>	NA	NE
<i>Seseli nanum</i>	r	TD
<i>S. varium</i> var <i>atlanticum</i>	rNA	TD,TC
<i>Serratula pinnatifida</i>	v	TD
<i>Shenopus ehrenbergii</i>	r	TC,TS
<i>Sideritis incana</i> var. <i>tunetana</i>	T	
<i>Sieglingia decumbens</i>	r	K
<i>Silene atlantica</i>	v	TD
<i>S. barrattei</i>	T	
<i>S. cerastoides</i>	r	TD,TC,TS
<i>S. conica</i> var <i>australis</i>	r	TD
<i>S. mollissima</i>	v	CB
<i>S. neglecta</i>	r	KM,CB
<i>S. sedoides</i>	r	CB
<i>Sisymbrium polyceratum</i>	v	CB
<i>Solanum dulcamara</i>	r	M,TD
<i>Solidago virga aurea</i>	v	K
<i>Sorbus aria</i>	rNA	TD
<i>Sorghum halepense</i>	r	TD
<i>Sparganium erectum</i>	r	CB,M
<i>Spartina peters</i>	r	TC
<i>Specularia hybrida</i>	r	NE,TD
<i>Spergula arvensis</i>	r	K
<i>S. pentandra</i>	r	TD
<i>Spergularia salina</i> var <i>leiosperma</i>	r	TC,TS
<i>Sporobolus tourneuxii</i>	rT	TS
<i>Stachys duriaei</i>	vNA	TD
<i>S. maritima</i>	v	K
<i>S. marrubifolium</i>	r	K
<i>Stipa fontanesii</i>	rNA	TD
<i>Stellaria holostea</i>	r	K
<i>Succowia balearica</i>	r	TD,CB
<i>Tamarix balansea</i>	r	TS
<i>Taraxacum obovatum</i>	v	TD
<i>T. microcephalum</i>	vNA	TD
<i>Teesdalia cronopifolia</i>	r	K,VE
<i>Telephium sphaerospermum</i>	v	TS

Annex 1 (Continued)

Species	Status	Distribution
<i>Teucrium atratum</i>	vNA	K
<i>T. polium</i> ssp. <i>flavovirens</i>	r	TS,TC
<i>T. pseudo-scorodonia</i>	v	M
<i>T. radicans</i>	vT	M
<i>T. schoenerbergri</i>	r	VM
<i>Themeda triandra</i>	rNA	M,NA
<i>Thymelaea tartonraira</i> var. <i>genuina</i>	r	TD
<i>T. sempervirens</i>	T	TS
<i>Tolpis barbata</i> ssp. <i>eu-barbata</i>	r	K,M
<i>Tragopogon porrifolius</i> var. <i>australis</i>	v	TD
<i>Trapa natans</i>	v	NE
<i>Tretadictis tenalla</i>	r	TC,TS
<i>Trifolium juliani</i>	rNA	TD
<i>T. squarrosum</i> ssp. <i>tunetanum</i>	rNA	TD
<i>T. striatum</i>	r	K,TD
<i>Triglochin maritimum</i>	r	NE
<i>Trigonella gladiata</i>	r	TD
<i>Tulipa clusiana</i>	r	NE
<i>Utricularia exoleta</i>	v	M
<i>U. vulgaris</i>	v	M
<i>Valerianella chlorodonta</i>	rNA	TD
<i>V. pumilla</i>	r	TD
<i>Veronica cymbalaria</i> var. <i>panormitana</i>	rNA	TD
<i>V. serpyllifolia</i>	v	K
<i>Vicia altissima</i>	r	K,M
<i>V. benghalensis</i>	r	CB,TC
<i>V. bithynica</i>	r	TD,K
<i>V. disperma</i>	r	CB
<i>V. hirsuta</i>	r	TD
<i>V. sicula</i>	r	K,CB
<i>V. tetrasperma</i> ssp. <i>tetrasperma</i>	r	TD
<i>V. villosa</i> ssp. <i>dasycarpa</i>	r	TC,TS
<i>V. v.</i> ssp. <i>pseudo-cracea</i>	r	TC,NE
<i>Viola munbyana</i>	vNA	TD
<i>V. odorata</i>	r	TD
<i>Wahlerbergia iobelioides</i>	r	TD
<i>Xanthium cavanillesii</i>	r	NE
<i>X. italicum</i>	r	K
<i>Zizyphora capitata</i>	v	TD
<i>Z. hispanica</i>	v	TD
<i>Zygophyllum cornutum</i>	TA	

ANNEX 2

MAMMALS OF TUNISIA

A. Species Present

<u>Common Name:</u>	<u>Scientific Name:</u>	<u>Status:</u>
Common dolphin	<i>Delphinus delphis</i>	
Monk seal	<i>Monachus monachus</i>	r
Water buffalo	<i>Bubalis bubalis</i>	(T)C
Barbary deer	<i>Cervus elaphus barbarus</i>	tC
Dorcas gazelle	<i>Gazella dorcas</i>	tC
Cuvier's gazelle	<i>G. cuvieri</i>	tC
Slender horned gazelle (rhim)	<i>G. leptoceros</i>	tC
Aoudad (barbary mountain sheep)	<i>Ammotragus lervia</i>	tC
Wild Boar	<i>Sus scrofa barbarus</i>	
Barbary hyena (striped hyena)	<i>Hyaena hyaena</i>	tC
Common jackal	<i>Canis aureus</i>	
Red fox	<i>Vulpes vulpes</i>	
Sand fox	<i>V. ruppelli</i>	
Fennec fox	<i>Fennecus zerda</i>	C
Kaffir cat	<i>Felis sylvestris libyca</i>	C
Southern Kaffir cat	<i>F. s. ocreata</i>	C
Sand cat	<i>Felis margarita</i>	C
Caracal	<i>Caracal caracal</i>	r
Serval	<i>Leptailurus serval</i>	?C
Lynx	<i>Lynx lynx pardinus</i>	?C
Otter	<i>Lutra lutra</i>	rC
Egyptian mongoose	<i>Herpestes ichneumon</i>	
Common genet	<i>Genetta genetta</i>	
Saharan striped weasel	<i>Poecilictus libyca</i>	C
Weasel	<i>Mustela nivalis</i>	C
European polecat	<i>Mustela putorius</i>	?C
Striped polecat	<i>Ictonyx striata</i>	?C
Brown hare	<i>Lepus capensis</i>	
European rabbit (NA subspecies)	<i>Oryctolagus cuniculus algiris</i>	NA
Algerian hedgehog	<i>Erinaceus algirus</i>	
Desert hedgehog	<i>Paraechinus aethiopicus</i>	
White hedgehog	<i>Aethichinus algirus</i>	?C
North African elephant shrew	<i>Elephantulus rozeti</i>	NA
Shrew sp.	<i>Suncus etruscus</i>	
Shrew sp.	<i>Crocidura russula</i>	
Bat	<i>Minopterus schreibersii</i>	C
"	<i>Pipistrellis pipistrellis</i>	C
"	<i>Rhinolophus mehelyi</i>	
"	<i>R. euryale</i>	C
"	<i>R. ferrum-equinum</i>	C
"	<i>R. hipposideros</i>	C
"	<i>Myotis blythioxygnathus</i>	
"	<i>M. myotis</i>	
"	<i>Eptesicus serotinus isabellinus</i>	
"	<i>Plecotus austriacus aegypticus</i>	

Annex 2 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>	<u>Status:</u>
North African crested porcupine	<i>Hystrix cristata</i>	C
Gurdi	<i>Ctenodactylus gurdi</i>	CNA
Shaw's jird	<i>Meriones shawi</i>	NA
Libyan jird	<i>M. libycus</i>	
Jird sp.	<i>M. crassus</i>	
Gerbil	<i>Gerbillus campestris</i>	NA
"	also <i>Dipodillus campestris</i>	
"	<i>G. nanus</i>	
"	<i>G. simoni</i>	NA
"	<i>G. gerbillus</i>	
"	<i>G. pyramidum</i>	
"	<i>Pachyuromys duprasi</i>	
Sand rat	<i>Psammomys obesus</i>	
Black rat	<i>Rattus rattus</i>	
Palm rat	<i>R. alexandrinus</i>	
Norway rat	<i>R. norvegicus</i>	
Striped rat	<i>Lemniscomys barbarus</i>	
Lesser Egyptian jerboa	<i>Jaculus jaculus</i>	C
Jerboa sp.	<i>J. orientalis</i>	C
Field mouse	<i>Apodemus silvaticus</i>	
'Lerot'	<i>Eliomys quercynus</i>	C

B. Large Mammals Extirpated From Tunisia

<u>Common Name:</u>	<u>Scientific Name:</u>
Addax (recently reintroduced)	<i>Addax nasomaculatus</i>
Scimitar-horned oryx "	<i>Oryx dammah</i>
Hartebeest	<i>Alcelaphus buselaphus</i>
Cheetah	<i>Acininx jubatus</i>
Barbary lion	<i>Panthera leo</i>
Barbary leopard	<i>Panthera pardus</i>
Barbary ape	<i>Macaca sylvana</i>
North African elephant (1st cent.)	<i>Loxodonta africana</i>

r = Rare
t = Threatened
C = CITES list
NA = North Africa Endemic
? = Reported in literature, but current presence is questionable

ANNEX 3

BIRDS OF TUNISIA

<u>Common Name:</u>	<u>Scientific Name:</u>
Great crested grebe	Podiceps cristatus
Black-necked grebe	P. nigricollis
Little grebe	Tachybaptus ruficollis
Manx shearwater	Puffinus puffinus
Cory's shearwater	Calonectris diomedea
Storm petrel	Hydrobates pelagicus
Gannet	Sula bassana
Shag	Phalacrocorax aristotelis
Cormorant	P. carbo
Pygmy cormorant	P. pygmeus
Grey heron	Ardea cinerea
Purple heron	A. purpurea
Great white egret	Egretta alba
Little egret	E. garzetta
Cattle egret	Bubulcus ibis
Squacco heron	Ardeola ralloides
Night heron	Nycticorax nycticorax
Little bittern	Ixobrychus minutus
Bittern	Botaurus stellaris
Spoonbill	Platalea leucorodia
Glossy ibis	Plegadis falcinellus
White stork	Ciconia ciconia
Black stork	C. nigra
Greater flamingo	Phoenicopterus ruber
Bar-headed goose	Anser indicus
Snow goose	A. caerulescens
Greylag goose	A. anser
Bear goose	A. fabalis
White-fronted goose	A. albifrons
Barnacle goose	Branta leucopsis
Shelduck	Tadorna tadorna
Ruddy shelduck	T. ferruginea
Mallard	Anas platyrhynchos
Gadwall	A. strepera
Wigeon	A. penelope
Teal	A. crecca
Garganey	A. querquedula
Pintail	A. acuta
Shoveler	A. clypeata
Marbled teal	A. angustirostris
Red-crested pochard	Netta rufina
Tufted duck	Aythya fuligula
Pochard	A. ferina
Ferruginous duck	A. nyroca

Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Red-breasted merganser	<i>Mergus serrator</i>
White-headed duck	<i>Oxyura leucocephala</i>
Osprey	<i>Pandion haliaetus</i>
White-tailed eagle	<i>Haliaeetus albicilla</i>
Red kite	<i>Milvus milvus</i>
Black kite	<i>M. migrans</i>
Black-shouldered kite	<i>Elanus caeruleus</i>
Short-toed eagle	<i>Circaetus gallicus</i>
Sparrowhawk	<i>Accipiter nisus</i>
Levant sparrowhawk	<i>A. brevipes</i>
Buzzard	<i>Buteo buteo</i>
Long-legged buzzard	<i>B. rufinus</i>
Honey buzzard	<i>Pernis apivorus</i>
Bonelli's eagle	<i>Hieraetus fasciatus</i>
Booted eagle	<i>H. pennatus</i>
Golden eagle	<i>Aquila chrysaetos</i>
Lesser spotted eagle	<i>A. pomarina</i>
Tawny eagle	<i>A. rapax</i>
Egyptian vulture	<i>Neophron percnopterus</i>
Bearded vulture	<i>Gypaetus barbatus</i>
Lappet-faced vulture	<i>Torgos tracheliotus</i>
Griffon vulture	<i>Gyps fulvus</i>
Marsh harrier	<i>Circus aeruginosus</i>
Hen-harrier	<i>C. cyaneus</i>
Pallid harrier	<i>C. macrourus</i>
Montagu's harrier	<i>C. pygargus</i>
Saker falcon	<i>Falco cherrug</i>
Lanner falcon	<i>F. biarmicus</i>
Peregrine	<i>F. peregrinus</i>
Barbary falcon	<i>F. pelegrinoides</i>
Eleonora's falcon	<i>F. eleonora</i>
Hobby	<i>F. subbuteo</i>
Merlin	<i>F. columbarius</i>
Red-footed falcon	<i>F. vespertinus</i>
Lesser kestrel	<i>F. naumanni</i>
Kestrel	<i>F. tinnunculus</i>
Barbary partridge	<i>Alectoris barbara</i>
Quail	<i>Coturnix coturnix</i>
Crane	<i>Grus grus</i>
Demoiselle crane	<i>Anthropoides virgo</i>
Andalusian hemipode	<i>Turnix sylvatica</i>
Little bustard	<i>Otis tetrax</i>
Houbara bustard	<i>Chlamydotis undulata</i>
Water rail	<i>Rallus aquaticus</i>
Spotted crake	<i>Porzana porzana</i>
Little crake	<i>P. parva</i>
Baillon's crake	<i>P. pusilla</i>

Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Corncrake	<i>Crex crex</i>
Moorhen	<i>Gallinula chloropus</i>
Allen's gallinule	<i>Porphyryla alleni</i>
Purple gallinule	<i>Porphyrio porphyrio</i>
Coot	<i>Fulica atra</i>
Oystercatcher	<i>Haematopus ostralegus</i>
Black-winged stilt	<i>Himantopus himantopus</i>
Avocet	<i>Recurvirostra avosetta</i>
Ringed plover	<i>Charadrius haiticula</i>
Little ringed plover	<i>C. dubius</i>
Kentish plover	<i>C. alexandrinus</i>
Golden plover	<i>Pluvialis apricaria</i>
Grey plover	<i>P. squatarola</i>
Dotterel	<i>Eudromias morinellus</i>
Turnstone	<i>Arenaria interpres</i>
Lapwing	<i>Varellus varellus</i>
Broad-billed sandpiper	<i>Limicola falcinellus</i>
Curlew sandpiper	<i>Calidris ferruginea</i>
Dunlin	<i>C. alpina</i>
Temminck's stint	<i>C. temminckii</i>
Little stint	<i>C. minuta</i>
Knot	<i>C. canutus</i>
Sanderling	<i>C. alba</i>
Red-necked phalarope	<i>Phalaropus lobatus</i>
Redshank	<i>Tringa totanus</i>
Spotted redshank	<i>T. erythropus</i>
Greenshank	<i>T. nebularia</i>
Marsh sandpiper	<i>T. stagnatilis</i>
Common sandpiper	<i>T. hypoleucos</i>
Wood sandpiper	<i>T. glareola</i>
Green sandpiper	<i>T. ochropus</i>
Ruff	<i>Philomachus pugnax</i>
Curlew	<i>Numenius arquata</i>
Slender-billed curlew	<i>N. tenuirostris</i>
Whimbrel	<i>N. phaeopus</i>
Black-tailed godwit	<i>Limosa limosa</i>
Bar-tailed godwit	<i>L. lapponica</i>
Woodcock	<i>Scolopax rusticola</i>
Great snipe	<i>Gallinago media</i>
Jack snipe	<i>Lymnocyptes minimus</i>
Snipe	<i>Gallinago gallinago</i>
Stone curlew	<i>Burhinus oedicephalus</i>
Collared pratincole	<i>Glareola pratincola</i>
Cream-coloured courser	<i>Cursorius cursor</i>
Great skua	<i>Stercorarius skua</i>
Arctic skua	<i>S. parasiticus</i>
Pomarine skua	<i>S. pomarinus</i>

Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Audouin's gull	<i>Larus audouinii</i>
Slender-billed gull	<i>L. genei</i>
Black-headed gull	<i>L. ridibundus</i>
Little gull	<i>L. minutus</i>
Mediterranean gull	<i>L. melanocephalus</i>
Herring gull	<i>L. argentatus</i>
Lesser black-back	<i>L. fuscus</i>
Great black-back	<i>L. marinus</i>
Common gull	<i>L. carus</i>
Kittiwake	<i>Rissa tridactyla</i>
Gull-billed tern	<i>Gelochelidon nilotica</i>
Caspian tern	<i>Hydroprogne tschegrava</i>
Royal tern	<i>Sterna maxima</i>
Lesser crested tern	<i>S. bengalensis</i>
Sandwich tern	<i>S. sandvicensis</i>
Common tern	<i>S. hirundo</i>
Little tern	<i>S. albifrons</i>
Black tern	<i>Chlidonias niger</i>
White-winged black tern	<i>C. leucopterus</i>
Whiskered tern	<i>C. hybrida</i>
Razorbill	<i>Alca torda</i>
Puffin	<i>Fratercula arctica</i>
Little auk	<i>Alle alle</i>
Spotted sandgrouse	<i>Pterocles senegallus</i>
Crowned sandgrouse	<i>P. coronatus</i>
Pin-tailed sandgrouse	<i>P. alchata</i>
Black-bellied sandgrouse	<i>Pterocles orientalis</i>
Rock dove	<i>Columba livia</i>
Stock dove	<i>C. oenas</i>
Woodpigeon	<i>C. palumbus</i>
Turtle dove	<i>Streptopelia turtur</i>
Palm dove or laughing dove	<i>S. senegalensis</i>
Namaqua dove	<i>Oena capensis</i>
Great spotted cuckoo	<i>Clamator glandarius</i>
Cuckoo	<i>Cuculus canorus</i>
Barn owl	<i>Tyto alba</i>
Eagle owl	<i>Bubo bubo</i>
Long-eared owl	<i>Asio otus</i>
Short-eared owl	<i>A. flammeus</i>
Scops owl	<i>Otus scops</i>
Little owl	<i>Athene noctua</i>
Tawny owl	<i>Strix aluco</i>
Nightjar	<i>Caprimulgus europaeus</i>
Red-necked nightjar	<i>C. ruficollis</i>
Egyptian nightjar	<i>C. aegyptius</i>
Swift	<i>Apus apus</i>
Pallid swift	<i>A. pallidus</i>

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Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Alpine swift	<i>A. melba</i>
Little swift	<i>A. affinis</i>
Bee-eater	<i>Merops apiaster</i>
Blue-cheeked bee-eater	<i>M. superciliosus</i>
Roller	<i>Coracias garrulus</i>
Kingfisher	<i>Alcedo atthis</i>
Hoopoe	<i>Upupa epops</i>
Green woodpecker	<i>Picus viridis</i>
Great spotted woodpecker	<i>Dendrocopos major</i>
Lesser spotted woodpecker	<i>D. minor</i>
Wryneck	<i>Jynx torquilla</i>
Shore lark	<i>Eremophila alpestris</i>
Temminck's horned lark	<i>E. bilopha</i>
Hoopoe lark	<i>Alaemon alaudipes</i>
Short-toed lark	<i>Calandrella cinerea</i>
Lesser short-toed lark	<i>Calandrella rufescens</i>
Desert lark	<i>Ammomanes deserti</i>
Bar-tailed desert lark	<i>A. cincturus</i>
Dupont's lark	<i>Chersophilus duponti</i>
Calandra lark	<i>Melanocorypha calandra</i>
Thick-billed lark	<i>Rhamphocorys clot-bey</i>
Woodlark	<i>Lullula arborea</i>
Skylark	<i>Alauda arvensis</i>
Crested lark	<i>Galerida cristata</i>
Thekla lark	<i>G. theklae</i>
Swallow	<i>Hirundo rustica</i>
Crag martin	<i>H. rupestris</i>
Sand martin	<i>Riparia riparia</i>
House martin	<i>Delichon urbica</i>
Tree pipit	<i>Anthus trivialis</i>
Meadow pipit	<i>A. pratensis</i>
Red-throated pipit	<i>A. cervinus</i>
Water pipit	<i>A. spinoletta</i>
Tawny pipit	<i>A. campestris</i>
White wagtail	<i>Motacilla alba</i>
Grey wagtail	<i>M. cinerea</i>
Blue-headed & yellow wagtail	<i>M. flava</i>
Common bulbul	<i>Pycnonotus barbatus</i>
Black-headed bush shrike	<i>Tchagra senegala</i>
Great grey shrike	<i>Lanius excubitor</i>
Woodchat shrike	<i>L. senator</i>
Red-backed shrike	<i>L. collurio</i>
Hedgesparrow or dunnock	<i>Prunella modularis</i>
Grasshopper warbler	<i>Locustella naevia</i>
Savi's warbler	<i>L. luscinioides</i>
Reed warbler	<i>Acrocephalus scirpaceus</i>
Great reed warbler	<i>A. arundinaceus</i>

Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Moustached warbler	<i>A. melanopogon</i>
Aquatic warbler	<i>A. paludicola</i>
Sedge warbler	<i>A. schoenobaenus</i>
Cetti's warbler	<i>Cettia cetti</i>
Fan-tailed warbler	<i>Cisticola juncidis</i>
Scrub warbler	<i>Scotocerca inquieta</i>
Icterine warbler	<i>Hippolais icterina</i>
Melodious warbler	<i>H. polyglotta</i>
Olivaceous warbler	<i>H. pallida</i>
Whitethroat	<i>Sylvia communis</i>
Garden warbler	<i>S. borin</i>
Blackcap	<i>S. atricapilla</i>
Orphean warbler	<i>S. hortensis</i>
Sardinian warbler	<i>S. melanocephala</i>
Tristram's warbler	<i>S. deserticola</i>
Desert warbler	<i>S. rana</i>
Subalpine warbler	<i>S. cartillans</i>
Spectacled warbler	<i>S. conspicillata</i>
Marmora's warbler	<i>S. sarda</i>
Dartford warbler	<i>S. undata</i>
Willow warbler	<i>Phylloscopus trochilus</i>
Chiffchaff	<i>P. collybita</i>
Wood warbler	<i>P. sibilatrix</i>
Bonelli's warbler	<i>P. bonelli</i>
Goldcrest	<i>Regulus regulus</i>
Firecrest	<i>R. ignicapillus</i>
Spotted flycatcher	<i>Muscicapa striata</i>
Pied flycatcher	<i>Ficedula hypoleuca</i>
Collared flycatcher	<i>F. albicollis</i>
Stonechat	<i>Saxicola torquata</i>
Whinchat	<i>S. rubetra</i>
Blue rock thrush	<i>Monticola solitarius</i>
Rock thrush	<i>M. saxatilis</i>
Wheatear	<i>Oenanthe oenanthe</i>
Desert wheatear	<i>O. deserti</i>
Isabelline wheatear	<i>O. isabellina</i>
Black-eared wheatear	<i>O. hispanica</i>
Mourning wheatear	<i>O. lugens</i>
Red-rumped wheatear	<i>O. moesta</i>
White-crowned black wheatear	<i>O. leucopyga</i>
Black wheatear	<i>O. leucura</i>
Black redstart	<i>Phoenicurus ochuros</i>
Redstart	<i>P. phoenicurus</i>
Moussier's redstart	<i>P. moussieri</i>
Robin	<i>Erithacus rubecula</i>
Bluethroat	<i>Luscinia svecica</i>
Nightingale	<i>L. megarhynchos</i>

Annex 3 (Continued)

<u>Common Name:</u>	<u>Scientific Name:</u>
Rufous bushchat	<i>Cercortichas galactotes</i>
Blackbird	<i>Turdus merula</i>
Ring ouzel	<i>T. torquatus</i>
Fieldfare	<i>T. pilaris</i>
Redwing	<i>T. iliacus</i>
Song thrush	<i>T. philomelos</i>
Mistle thrush	<i>T. viscivorus</i>
Fulvous babbler	<i>Turdoides fulvus</i>
Long-tailed tit	<i>Aegithalos caudatus</i>
Coal tit	<i>Parus ater</i>
Great tit	<i>P. major</i>
Blue tit	<i>P. caeruleus</i>
Short-toed treecreeper	<i>Certhia brachydactyla</i>
Wren	<i>Troglodytes troglodytes</i>
Corn bunting	<i>Emberiza calandra</i>
House bunting	<i>E. striolata</i>
Rock bunting	<i>E. cia</i>
Cirl bunting	<i>E. cirrus</i>
Ortolan	<i>E. hortulana</i>
Reed bunting	<i>E. schoeniclus</i>
Brambling	<i>Fringilla montifringilla</i>
Chaffinch	<i>F. coelebs</i>
Goldfinch	<i>Carduelis carduelis</i>
Siskin	<i>C. spinus</i>
Greenfinch	<i>C. chloris</i>
Hawfinch	<i>Coccothraustes coccothraustes</i>
Trumpeter finch	<i>Rhodopechys githaginea</i>
Linnet	<i>Acanthis cannabina</i>
Serir	<i>Serinus serinus</i>
Crossbill	<i>Loxia curvirostra</i>
Spanish sparrow	<i>Passer hispaniolensis</i>
House sparrow	<i>P. domesticus</i>
Desert sparrow	<i>P. simplex</i>
Rock sparrow	<i>Petronia petronia</i>
Starling	<i>Sturnus vulgaris</i>
Spotless starling	<i>S. unicolor</i>
Golden oriole	<i>Oriolus oriolus</i>
Jay	<i>Garrulus glandarius</i>
Magpie	<i>Pica pica</i>
Raven	<i>Corvus corax</i>
Brown-necked raven	<i>C. ruficollis</i>
Jackdaw	<i>Corvus monedula</i>

ANNEX 4

HEILIGENHAFEN CRITERIA
(Reprinted from: Carp 1980)

1. Criteria pertaining to a wetland's importance to populations and species

A wetland should be considered internationally important if it:

- a) regularly supports 1% (being at least 100 individuals) of the flyway or biogeographical population of one species of waterfowl;
or
- b) regularly supports either 10,000 ducks, geese and swans, or 10,000 coots, or 20,000 waders (Limicolae);
or
- c) supports an appreciable number of an endangered species of plant or animal;
or
- d) is of special value for maintaining genetic and ecological diversity because of the quality and peculiarities of its flora and fauna;
or
- e) plays a major role in its region as the habitat of plants and of aquatic and other animals of scientific or economic importance.

2. Criteria concerned with the selection of representative or unique wetlands

A wetland should be considered internationally important if it:

- a) is a representative example of a wetland community characteristic of its biogeographical region;
or
- b) exemplifies a critical stage or extreme in biological or hydromorphological processes;
or
- c) is an integral part of a peculiar feature.

3. Criteria concerned with the research, educational or recreational values of wetlands

A wetland should be considered internationally important if it:

- a) is outstandingly important, well-situated and well equipped for scientific research and education;
or
- b) is well-studied and documented over many years and with a continuing program of research of high value, regularly published and contributed to by the scientific community;
or
- c) offers special opportunities for promoting public understanding and appreciation of wetlands, open to people from several countries.

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Annex 4 (Continued)

4. Criteria concerned with the practicality of conservation and management

Notwithstanding its fitness to be considered as internationally important on one of the Criteria set out under 1, 2 and 3 above, a wetland should only be designated for inclusion in the List of the Ramsar Convention if it:

- a) is physically and administratively capable of being effectively conserved and managed;
and
- b) is free from the threat of major impact of external pollution, hydrological interferences and land use or industrial practices.
- c) A wetland of national importance only may nevertheless be considered of international importance if it forms a complex with another adjacent wetland of similar value across an international border.