Annex 2.5.1

EIA screening for the "NREA concession-ary area" with special emphasis on Flora and Fauna (except Avi-Fauna)

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0. Executive Summary

The EIA study was undertaken to determine the potential environmental impacts of wind power development in the 656 km² NREA concessionary area, which shall be used for wind power development in the order of up to 3000 MW. During the

about ecological features of the project area, including any nature conservation designation, habitats, flora and fauna present (or likely to be present) including conservation status and biodiversity value, likely impact of the proposed development and to recommend avoidance, mitigation and compensation measures to the extent required.

The study includes field investigation of the ecological setting of the proposed site, the flora, the vegetation, the fauna and the ongoing human activities. As the NREA project area is located in a major flyway area of migrating birds ornithological impacts are assessed in a separate study, which is based on autumn and spring field monitoring. Accordingly, avifauna aspects are not subject of this study.

The study shows that the implementation wind energy projects in the NREA area will have no serious impacts on the biodiversity and other environmental characteristics of the site. Not a single species, plants or animals recorded in the area or expected to occur in it, is not included in the Red Data Lists, both internationally or nationally. Moreover, the nature of windparks, which leaves most of the wind park area untouched, is not critical to the rare existing fauna (not considering avifauna) and flora, in that area, if basic mitigation measures will be considered, such as

- good housekeeping and good workmanship practice during construction,
- avoidance of spillages, especially of oils from the machinery parks during construction,
- reconstruction of the landscape to nead conditions, such levelising of excavations, refilling of cuts, etc.
- domestic waste water treatment and waste collection from service buildings to be probably erected in the

A few potential impacts were investigated. Solutions and/or mitigations were recommended.

1. Introduction an objectives

The objective of this study was to assess the extent of environmental impacts in the NREA concessionary area caused by a possible wind park utilisation and to judge the environmental compatibility of such a project under consideration of eventually required mitigation measures/compensation, being important for determining the feasibility of the overall wind power development in that area. In detail the study was to

- make a rapid inventory of the ecological features of the project area including any nature conservation designation, habitats, flora and fauna present (or likely to be present) including conservation status and biodiversity value, likely impact of the proposed development and to recommend avoidance, mitigation and compensation measures.
- to determine whether there would be any environmental impact that would be an obstacle for wind power development and that requires
  - mitigation or
  - restriction of the project.

2. Nature of the Project

A future wind park would be developed in rows with a distance between each row around 1000 m, a distance between turbines around 260 m and a turbine height up to the upper blade tip of about 100m. The size of foundations would not be more 20 x 20 m and a maximum of 4 m depth. Depending on the type of selected wind turbine transformer stations may be contained inside the wind turbine towers or a small transformer compact station might be placed next to each turbine. The housing of such compact station would be not more than 2 m x 6 m. Power cable trenches will be attached along the rows near to turbines, having a depth of about 1.5 m and a width of not more than 2.5 m. Inside the trenches plastic pipes with diameter of 5 cm for the control cables will be placed on top of the power cables. The power cables will be connected to a central substation with an area of about 300 m x 300 m adjacent to the wind farm. For larger distances 69 kV overhead lines instead of cables may be constructed. Within the wind park earth roads of about 4. 5 m width will be constructed, consisting of compacted desert material. The compacted area will be enlarged next to each wind turbine to a size of about 25 x 20 m for the erection of the wind turbines.

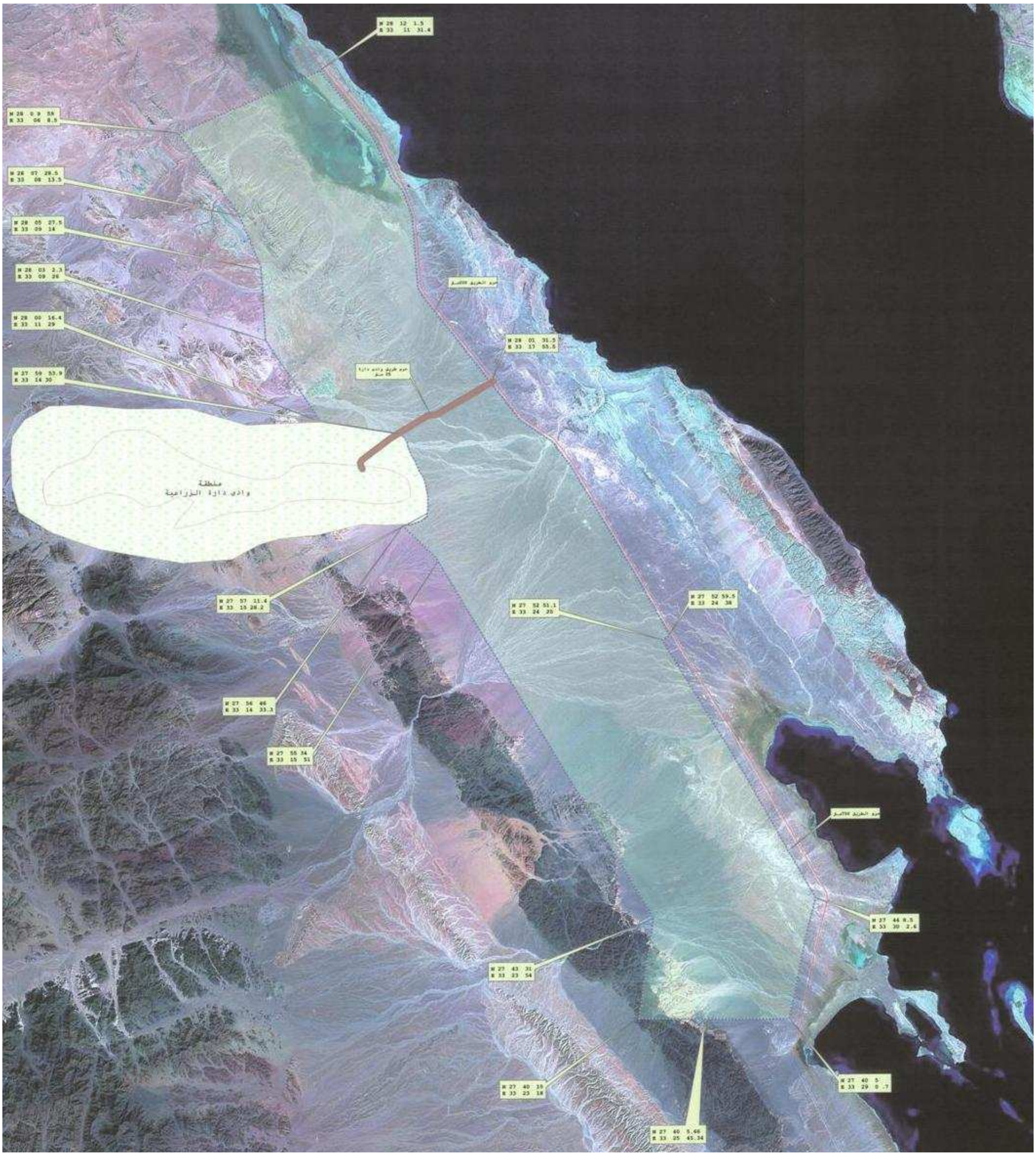
Wind turbines shall not be placed inside Wadi areas

In addition, two service buildings especially for accommodation, maintenance probably next to the main coastal road.

3. The Site

The “NREA area” is located to the West of the Hurghada - Suez road and extending about 70 km from North to South and about 9 to 10 km to the inland. The area starts about 60 km North of Hurghada. The definition of the area considers already the results of discussion held between the different ministries. Accordingly, the defined area reflects already the requirements of the Ministry of Petrol and of the Ministry of Agriculture and excluded areas of competing or conflicting activities such as the agricultural and settlement area at Wadi Dara or a corridor along the Hurghada - Suez road of 200 to 500 m, to secure ongoing activities and existing pipelines. The “NREA area” is shown on the satellite map (Fig. 1) in little bright contrast. The Wadi Dara exclusion area is the white area in the west of the area.

Figure 1: Satelite map of the "NREA area"



4. Methodology

4.1 Desk Study

A desk study was carried out to determine for the study area:

- any nationally or internationally designated nature conservation areas present
- any nationally or internationally protected /threatened/rare species of flora/fauna present
- any commercially important specie**s**

4.2 Field Survey

The project area was studied on the available maps. A short visit was paid to previously established projects for wind farms along the Zaáfrana-Ras Gharib road to be aware of the situation expected after the implementation of a future wind power project.

The field survey was carried out from 14th to 18th of July. During this survey the biodiversity components were assessed such as habitats, plants and animals as well as the environmental setting, the ongoing human activities, the expected impact of the project activities on the environment, including biodiversity. The assessment was carried along representative transsections:

- Along one 70 km long central corridor in the middle of the NREA concessionary area at distances of 5 km each from the western and the eastern border.
- Along 5 west east trans-sections distributed over the NREA area.

The assessment included the following:

- The ongoing human activities
- The habitat features in the different parts of the project area. This was undertaken, wherever there is a change in the habitat features, either in the level or the plant life.
- The plant life, including identification of present species, their distribution and their assemblage in plant communities. The possible impact of the project activities on the recorded plant species. The economic significance of any recorded species is assessed.
- The animal life was assessed depending on the direct observation, tracks, burrows and scats. Wherever there is vegetation, one expects the possibility of the presence of some animals. The main animal groups were looked for, e.g. mammals (including carnivores, rodents and lagomorphs), reptiles, arthropods including insects and scorpions. The possible impact of the project implementation on the animal life was assessed.
- Assessment of the possible impacts of the project on these components.

5. Environmental Setting of the Project Area

5.1 Geomorphology

The “NREA area” is a desert area. Only at very limited spots some very scattered desert vegetation is observed. The southern part of about 55 km (reaching to about 5 km to the north of the Wadi Dara road) is almost completely consisting of desert plains formed by the extraordinary wind. This area is crossed by two main Wadis, the Wadi Dibb and the Wadi Dara. However, due to the high wind speeds and the large sand transport/ sedimentation potential, the Wadi beds are not pronounced at most of the wadi courses.

The northern part of the NREA area shows both, undulated land and gravel desert plains. The western side of this northern area shows hills up to 250 m height.

The ground surface in most of the area is covered with compact angular gravels and pebbles forming what can be called desert armour.

The level of the whole project area above sea level ranges from 9 m below sea level in the north eastern side to hills and slightly elevated mountains rising to levels of 250 m in the west.

It should be noted that the parts below or near sea level or those higher than 100 m will not be used for wind turbines. Only flat or slightly undulated desert gravel plans will be used

5.2 Habitats in the Site

The area of the site encompasses different habitats. Each of these habitats has its own characteristic features. Consequently, the plant and animal lives are different in the various habitats.

The habitats recognized in the site:

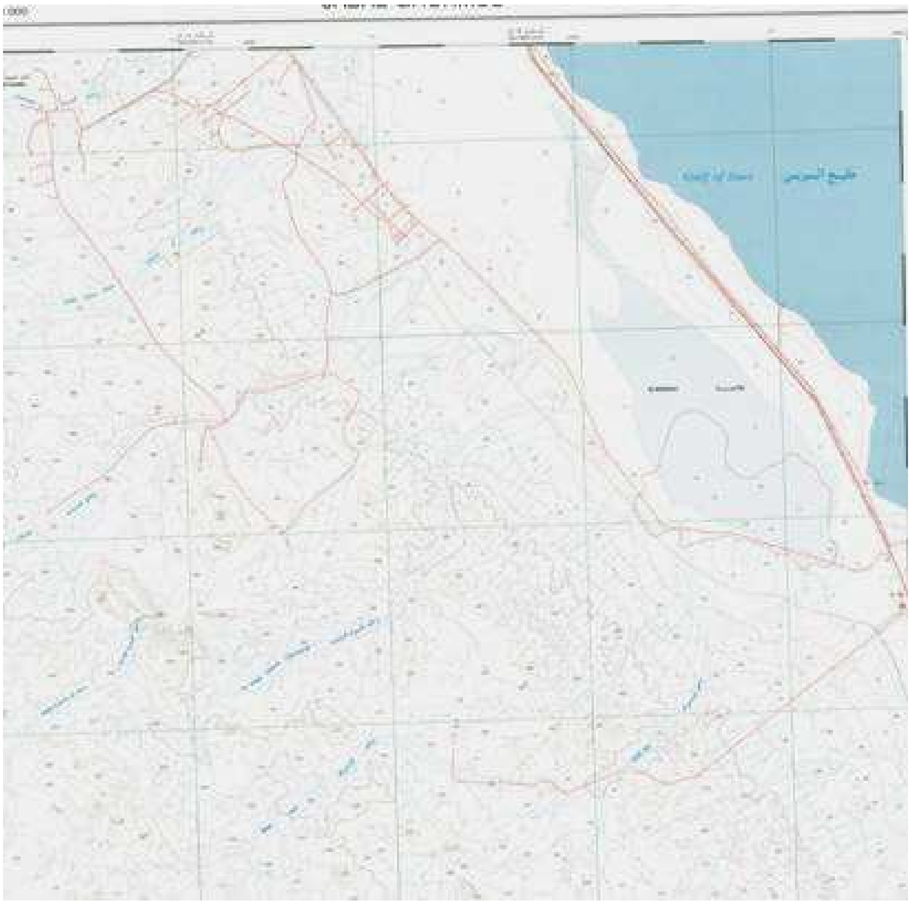
1. Sebkhas (Saline habitats): (*Al Mallaha*)

This habitat is usually occupying land below sea level as well that at a level less than 5 m above sea level. The main saline area in the site extends from north west to south east in the north eastern corner of the site. (Map. 1). This sebkha occupies a piece of land with a breadth of 4 km at maximum and length extending for 8 km from north to south. It is a pear shaped land tapering towards the south.

Zonation of the landscapes and habitats within the sebkha area is usually clear. It s affected by the level of land above sea level and the depth f the water table. Such factors affect the plant and animal life. The sebkhas can be classified as follows:

a) Elevated habitats occupied by a community dominated by ***Tamarix passerinoides***. The dominant plant forms phytogenic mounds as high as 3 m and a diameter of more than 10 m. The mounds harbour dead individuals with exposed roots and stems. This occurs along the eastern side of the sebkha (Photos 2 and 3).

Figure 2: Jabal Ghurmool area showing the *sabkha* depression below sea level in the north eastern corner of the project area



b) Elevated habitats along the western side of the sebkha supporting a plant growth dominated by ***Nitraria retusa***. The plant forms mounds reaching more than 5 m in height and 10 m in diametre.

c) Flat wide area is devoid of plant cover. This habitat is usually located at a level below those occupied by the ***Tamarix*** and ***Nitraria*** communities. The ground surface is covered by a thick brownish, sometimes cracked, layer. This layer is composed of mixed sand and salt. It is usually wet. (Photo 5)

d) Brine with salt crust at a lower level, where water is shallow. No plant life in this habitat. (Photo 6)

e) Free saline water in the deepest part of the sebkha. It is devoid of and plant cover. (Photo 6)

It is to be noted that this habitat will not be considered for the wind farm. It is soft and slippery.

2. Wadi Downstreams

The project area is dissected with rill lines representing the drainage lines crossing the site from west to east. Some of these runnels are relatively conspicuous. These are the downstream ends of some wadis e. g. Wadi Dara, Wadi Dibb, Wadi Abo Mesallah and Wadi Abu Jad. These wadis reach the Ras

Ghareb-Hurghada road and cross it towards the sea. Spillways are constructed to allow the drainage water flowing towards the sea. . However, due to the high wind speeds and the large sand transport/ sedimentation potential, the Wadi beds are not pronounced at most of the wadi courses.
These wadis harbour relatively denser vegetation, i. e. about 2-7% cover. It is to be noted that the growth of this vegetation is sporadic depending on the very rare rainfall accidents.
Plant communities dominated by Ochradenus baccatus, Haloxylon salicornicum, and Zygophyllum coccineum are observed in these wadis.

3. Gravely Desert Plains

The major part of the project area is represented by flat, wind eroded gravely and pebbly plains. These are devoid of plant cover. The surface of the ground is compact in many places and covered by pebbles, gravels and small angular stones. One can differentiate two habitats within these plains: slightly undulated plains completely barren from vegetation and plains with hilly land. The hills may rise to 10 m or more. These hills create habitats receiving sand deposits. This may allow the growth of very thin plant cover.

4. Hills

Proceeding landward in the project area, the land becomes hilly. Such a habitat seems to be less favourable for the project due to higher infrastructure efforts. This habitat is devoid of plant cover. . It is usually around 100 m above sea level.

5. Mountains

Along the western margin of the project area, the ground rises to more than 250 m above sea level in some locations This sector of the area will be excluded from the project.
These are considered mountainous areas.

They are barren and it is excluded from the area favourable for implantation of the project.

5.3 Climate

The most near meteorological station is at the Hurghada airport, at a distance of about 100 km from the centre point of the NREA concession area. The main characteristics are average maximum temperature ranging from 20 C° (January) to 33 ℃ (Aug ust) and average minimum temperatures ranging from 13℃ (January) to 28 ℃ (August), an average a nnual precipitation of about 4 mm in the winter months, relative humidity in the order of 30 to 40 % and a zero cloudiness almost all through the year. Wind speeds can be derived from NREA's own measuring stations. Extreme gust wind speeds are in the order of 35 m/s. The average wind speed at 25 m height is about 11 m/s.

The area is hyper-arid with a very sporadic annual rainfall. The average annual rainfall is 3. 0 mm. The rainfall is variable from year to year. It is characterized by its irregularity both in time and space. The local topography is an important factor in redistributing of the rainfall. This occurs through runoff water, which accumulates in microhabitats low as regards local topography. This allows the growth of a very thin plant cover.

6. Present Human Activities in the Site of the Wind Farm

The site has been witnessing a lot of different human activities. Doubtless these activities have their impact on the biodiversity components in the site. Among these activities, one mentions the following:

- Oil companies Activities:
  - Oil and Gas Pipelines
  - Off-road vehicles for seismic investigations
  - Oil spills
  - Constructions; road and buildings mainly at the eastern border of the wind park; the buildings of the Egyptian Petrol Company in the Northeast extend into the NREA area; inside the concessionary area only smaller buildings at the asphalt mixing plant exist,.
  - Extension of water pipes carrying water from wells from the western side to the east along the Ras Ghareb - Hurghada road
- Quarries: Crossing the area continuously for transport of materials obtained from the quarries to the east of the site
- Military activities, especially adjacent to the area in the South
- Agriculture: Only weel outside the project area to the west, i. e. Wadi Dara, there are farms depending on the water from the wells in wadi Dara.
- Grazing: Very limited due to the lack of palatable plants. However, camels crossing the site left their traces especially below the canopies of the very few Acacia trees.
- Fuel-wood Gathering: Though the vegetation is very sparse, yet cutting of branches from the Acacia trees was practiced since many years. Now there is nothing to be collected.
- Asphalt mixing station disturbing the soil.

The impact of the previous and ongoing activities has been evident on the following:

- Disappearance and fragmentation of some habitats
- Disappearance of plant and animal species
- Changes in the environments, consequently disappearance of some biota.

It is noteworthy that the natural conditions, especially the climatic ones, are very influential on the biodiversity of the site. These include:

- The drastic dry conditions represented by the deficiency of water resources (rainfall). Rainfall is scarce, irregular in both time and space. In exceptionally rainy years, there may be runoff water collecting in low parts as regards local topography. This may lead to the growth of some plants. However, these plants are subjected to long dry periods leading to their death.
- The high wind velocity in the site. Such a factor plays an important role in the severe erosion of the soil. The ground surface in the site is mainly covered by compact layer of pebbles and gravels. These represent a desert armour. This prevents the permeation of rain water to the subsoil. The high wind velocity removes the seeds and other propagules. So, the chance for seeds to germinate and establish themselves is very poor. It is interesting to mention that fruits of *Acacia* are trapped by the dead dry branches felling from the trees.

Despite the presence of some human activities, yet they are not conflicting with the use of the site for the project. This is mainly due to the fact that favourable sites for the project are usually not favourable for other activities.

The favourable sites for the project are usually not favourable for other activities.

7. Flora - List of Plant Species Recorded in the Site

7.1 Trees

- *Acacia raddiana* A very rare tree in the site. Its occurrence is confined of the southern part of the site. Within the southern part, where it occurs, it has been found that 12 trees can be found in an area of 25 km^2. It is interesting to note that numerous fruits are fund on he ground below the canopy of the trees, where they are trapped by the dead fallen branches. A few green branches occur o the trees, usually near the ground surface.
- If the wind farm is established in the southern sector, there is a possibility to avoid the sparse Acacia trees. It is interesting to mention that some young trees were observed in the rills along which the old trees grow.

7.2 Shrubs

- Tamarix sp. (T. passerinoides). *Athl- Tartfa*. This very common species, in the site as well in the region along the Red Sea coast and many sites in Egypt, is a salt-secreting halophyte. It forms phytogenic mounds of considerable height. It occurs mainly along the borders of the *Sebkha* in the north eastern corner of the site. Due to severe wind erosion, the buried stems of the plant in the body of the mound are exposed. The plant forms a community common in the Red Sea region. The plant growth dominated by this species occurs in saline habitats. Associated species are few and of very low cover. These include: *Nitraria retusa* and *Zygophyllim album.*
- **Nitraria retusa (Forsk.) Asch. Ghakad - Ghrdak.** A halophytic plant that grows along the margins of the *sebkha* in the north eastern corner of the site. It forms high phytogenic mounds, reaching a height of 3 meters or more. The plant has succulent leaves.

7.3 Undershrubs

7.3.1 Halophytes

Salsola longifolia Suweid. A halophytic plant with succulent leaves. The old leaves are over-loaded with salts, then fall down. The shedding of old salt-loaded leaves is a way by which the plant gets rid of excessive salts. It is partial death for the sake of survival. It grows I salt affected habitats along the less saline habitats in the sebkha area. Oozing of water from the water pipe lines causes the growth of this plant, the water is brackish and its evaporation leads to the concentration of water in the soil, a proper habitat for such species.

Zygophyllum album L. *Rotreit Abyadh*. It is halophyte with succulent leaflets and petioles. The plant forms phytogenic mounds in saline habitats along the margins of the sebkha. However on less saline soils than those supporting *Tamarix* or *Nitraria.*

7.3.2 Xerohpytes

Crotalaria aegyptiaca Benth. A leguminous undershrub. It forms sometimes big mounds. The plant occurs in wadi rills and runnels receiving runoff water in rainy years. It occurs in particular habitats where water oozes from the water pipe lines. There are no symptoms of grazing on the recorded plants.

Zilla spinosa Pranl. Sillah. The plant occurs in runnels and shallow drainage lines in the site, which are very shllow. The plants recorded are dead. It seems that in exceptionally rainy years, there is a chance for the growth of some individual. These desiccate due to lack of water supply and die**.**

Haloxylon salicornicum (Moq.) Bunge ex Boiss. Rimth. The plant occurs in rills and shallow drainage lines or on flat gravely plains. The plant forms phytogenic mounds by collecting the wind-drifted sand. The tail of the mounds points to the wind direction.

Zygophyllum coccineum L. *Rotreit* . It is succulent undershub that grows in depressions where water accumulates. It is observed along the water pipeline crossing the site from west to east. Oozing water gives ample room for the growth of some desert plants, including *Zygophyllum coccinem*. It is a common plant in the limestone habitats in the Eastern Desert, including he Red Sea coastal zone.

Pergularia tomentosa *Ghalaqa*. It is a plant with broad leaves with milky sap, and is used in folk medicine. Its occurrence in the site is confined to a runnel in its southern part. The plant forms small mounds. However, due to long dry period over years, the plants are dying and their buried stems are exposed due to wind erosion.

Cleome droserifolia (Forssk.) Del. Samwa. The plant has yellow greenish leaves with glandular airs attracting a lot of flies. The recorded individuals occur in a narrow drainage line and form phytogenic mounds. The plant is used in folk medicine for diabetes. The few recorded individuals are confined to a narrow drainage line in the southern part of the sector.

Aerva javanica Raá. One individual of this desert undershrub was recorded in a drainage line in the southern part of the site.

Ochradenus baccatus The plant is a leafless undershrub. In many cases it is drying partially or completely. It forms mounds. In some areas, where water oozes from the pipeline, the plants are flowering. It occurs in many parts of th site. The plant s a common desert undershrub in the Eastern desert of Egypt.

Fagonia arabica *Showeika*. The plants is a low growing herbaceous spiny undershrub. It has been dead in many cases. It is expected that the numerous dead individuals grew after the last exceptionally considerable rainfall. The cessation of rainfall for many consecutive years leads to their death. It is a common plant in the deserts of Egypt

Tribulus terrestris L. *Hasak*. The plant is a small herbaceous perennial plant. It was found once near the water pipe line.

7.3.3 Desert Grasses

Stipagrostis plumosa Nasy. A herbaceous grass growing in microhabitats near the water pipe. A few individuals were recorded.

7.3.4 Ephemeral Plants

Erodeum laciniatum It is an annual desert plant that rows only I he rainy season. In the site, the oozing of water from the pipe line lead to the germination of seeds of some desert plants, including this annual plant. It is found dead.

7.3.5 Perennial (Aquatic-Saline) Grasses

Phragmites australis (Cav.) Trind. Ex Steud. *Hagnah or Boos*
This plant is a plant of wetland. The oozing seepage of water from the water pipe causes permanent wet microhabitat along many points. This resulted in a habitat suitable for the`growth of ***Phragmites australis***. This specific microhabitat is the result of human activity, the extension of water pipe lines.

8. Vegetation - Plant Communities in the Site

Some of the recorded plant species dominate assemblages that form plant communities. Each of these communities has its particular habitat with special habitat features and conditions**.**

Generally, the plant communities in the site can be divided into the following categories, classified according to the dominant species that give the communities their physiognomy and the characteristics of habitats supporting these communities.

8.1 Halophytic Plant Communities

- Tamarix passeniroides community
  This community abounds in sites bordering the low-lying sabkha. The dominant plants forms high phytogenic mounds. The associated species are on the margins of the community; including Nitraria retusa and Zygophyllum album. Due to severe wind erosion, the buried plant organs in the body of the mound are uncovered. Dead plant parts are common on these mounds.
- Nitraria retusa community
  This community occrs in sites with high salinity bordering the low-lying sabkha. The dominant plant forms huge phytogenic mounds. The associated species are represented by a few individuals of Zygophyllum album.
- Salsola longifolia community
  The dominant plant occurs as big green undershrubs. The community occurs on flat habitats with slightly saline soil. The plant forms phytogenic mounds. It is usually present along runnels and man-made depressions, especially along pipe-lines.

8.2 Xerophytic Plant Communities

- Ochradenus baccatus community
  The dominant plant is a leafless shrublet. The community occurs in runnels and shallow wadi beds. It forms phytogenic mounds. The associates include desert perennial plants as Zilla spinosa. It is to be noted that Zilla is dead. The dead Zilla plants appeared in one of the exceptionally rainy years. They died due to the continuity of dry period for many years.
- Zygophyllum coccineum community
  The dominant plant is very common desert succulent perennial in the limestone country of the Eastern esert and the ed Sea zone. The growth of the plant is confined to sandy habitats. Associates are perennial and annual herbs.
- Haloxylon saliconicum community
  The dominant plant is desert succulent plantforming huge phytogenic mounds. The community appears in sandy depressions and runnels crossing the desert gravelly plains. He mpunds are conspicuous due to their presence in the gravel plains. Some Acacia trees may appear in this community. One should note that the Acacia trees do not form a plant community. They are few sparse individuals. Within an area of ca. 25 sq. km, one finds 12 Acacia trees in the site where they grow. Due to their height in a treeless habitat, they seem to be conspicuous.

8.3 Wetland Plant Communities

- Phragmites australis community
  This community is niot a desert one. However, due to the seepage of water from the pipe-line crossing the area from west to east, there is an opportunity for this plant to grow profusely.

9. Fauna

The fauna composition of the project site can be classified into two main categories; namely: vertebrate and invertebrate animals. The following text classifies each major animal group, explains tentatively the systematic list of the fauna observed or expected to occur in the area supported with the tabulation of specific items and some ecological data to certain species are taken.

9.1 Invertebrates

Six species were observed in the project area or in the near farm land in Wadi Dara. These are arthropods. Scorpionida (scorpion) is represented by only one species; the Yellow scorpion. Diptera and Hymenoptera are orders represented by two species in the project site. Only one species from order Coleoptera was found in the project site (Table 1).

Table 1: Systematic list of arthropods observed in the project site or in the adjacent farm

Order	Family	Species
Coleoptera	Tenebrionidae	Tentyrina bohmi
Hymenoptera	Formicidae	Cataglyphus bicolor
		Monamorium subobacum
Diptera	Muscidae	Musca domestica
		Tabanus gratus
Scorpionida	Buthidae	Leiurus quinquestriatus
4	**4**	**6**

9.1.1 Scorpions

Two individuals of only one species of the scorpions (Yellow Scorpiuon) were captured from the farm area of Wada Dara adjacent to the western margin of the project site. ***Leiurus quinquestriatus* (Hemprich and Ehrenberg, 1828)**, **Yellow scorpion**: The main characteristic feature is the blackish colour of last segment of the tail. One of the dangerous scorpion species in the world and is common in Egypt. The sting of this scorpion is followed by sharp pain, restlessness, excessive salivation, lacrymation and accelerated respiration. Muscular convulsions and paralysis may ensue; death is due to respiratory or heart failure (Gueron and Yarom, 1970; Efrati, 1978).

9.1.2 Insects

Individuals of three different orders of insects were observed in the study area. These includes a small beetle: *Tentyrina bohmi* (Coleoptera), a small ant*: Monamorium subobacum* and a large ant*: Cataglyphus bicolor* (Hymenoptera) and other two species belonging to order Diptera; namely House Fly: *Musca domestica* and Blue Fly: *Tabanus gratus*.

9.2 Vertebrates

The vertebrates in the site comprise reptiles and mammals. Both groups are expected to be repre-

sented by different species. Direct observation could not show the presence of these species. But other evidences were used as well as the previous records. The species record, either previous or present indirect observations shows that five reptiles and seven mammals are apt to occur in the site (Table 2).

Table 2: Systematic list of terrestrial reptile and mammal species expected to occur in the project site

Order	Family	Species
Reptiles		
• Squamata	Agamidae	Agama agama spinosa
	Gekkonidae	Hemidactylus turcicus
		Tropioiclotes steudneri
	Lacertidae	Acanthodactylus boskianus
• Ophidia	Viperidae	Cerastes cerastes
Mammals		
• Lagomorpha	Leporidae	Lepus capensis
• Rodentia	Gerbillidae	Gerbillus gerbillus
		Meriones crassus
	Muridae	Mus musculus
		Acomys cahirinus
• Carnivora	Canidae	Vulpes vulpes
		Vulpes rueppelli
5	**8**	**12**

10. Species Account

10.1 Reptiles

Agama agama spinosa Gray, 1831
Common names: Gray's Agama, Hardun El Bahr El Ahmar.
Distribution: Egypt, Erritrea, Ethiopia and Somaliland. In Egypt: Eastern Deseand the northern part of the Western Desert.
Description: Nostril is very close to the end of snout. Tongue is broad, fleshy and not deeply forked. Enlarged spines are on sides of head and neck.
Habitats and ecology: Inhabits rocky areas including lower slopes of wadis in the Eastern Desert. It appears to occupy the ecological niche used by *Laudakia stellio* in the mountains of South Sinai.
Status: Lower Risk.

***Hemidactylus turcicus* (Linnaeus, 1758)**
Common names: Turkish Gecko, Warty Gecko, Bors Manzeli.
Description: A relatively small and slender gecko of pale colour with a slender neck and dorsal tubercle rows. Scales of dorsal region granular with 14-16 longitudinal series of trihedral tubercles. Ventrals are rounds, flat and scarcely imbricate. Tail is slightly flattened with pointed transverse tubercle rows; regenerated with small granular scales. Broad transverse scales below. The colour is light brown, rosy brown, sand-coloured yellowish or grayish above with darker spots. Large transverse spots may be arranged in longitudinal rows or bands.
Ecology: Mostly associated with human dwellings. In Egypt it is the most common house gecko.
Status: Lower Risk (least concern).

***Tropiocolotes steudneri* (Peters, 1869)**
Common names: Steudner's Gecko, Steudner's Pgmy Gecko, Bors Taht El Hagar.
Distribution: North Africa, from the Algerian Sahara to Egypt and the Sudan, and eastward to Sinai arid extreme southwestern Asia. In Egypt: Western, Eastern and Sinai Deserts.
Description: A dwarf gecko with slender toes and large imbricate scales; they are smooth on the venter and mostly smooth on the back. Trunk colour with dark transversal bands which can be missing. Tail with 12 or 13 dark bands that are somewhat broader than their interspaces, or of equal breadth.
Habitats and ecology: It inhabits desert areas, where it is usually found under rocks or dry vegetation.
Status: Lower Risk (least concern).

***Acanthodactylus boskianus* (Daudin, 1802)**
Common names: Bosc's Lizard, Sogongor Khashin.
Distribution: Widespread throughout North Africa and southwestern. In Egypt: Common throughout desert areas and margins of Nile Valley and Delta.
Description: One of the largest species of the genus *Acanthodactylus* are strongly keeled, increasing in length from shoulders to the posterior back where they can attain 1x2 mm. Scales in distinct transversal and longitudinal rows, the lateral ones is oblique, converging backwards and forming chevrons with pointed angles. Ground colour is cryptic and depending on the surroundings. Tail base of males is strongly thickened than of females.
Ecology: A diurnal deserts species preferring sparely vegetated areas with gravel and stones but less often sand. It is equally numerous in some of the most extreme desert areas and at desert margins of cultivated lands of the Nile Valley and Delta. Small populations are found in isolated patches of desert in the central delta. It feeds on a large variety of insects and other invertebrates.
Status: Lower Risk (least concern).

***Cerastes cerastes* (Linnaeus, 1758)**
Common names: Horned Viper, Greater Cerastes Viper, Haiya Moqarana.
Distribution: North Africa and southwestern Asia. In Egypt: Suitable habitats throughout the Western, Eastern and Sinai Deserts.
Description: Head is broad, more or less triangular, flat and markedly distinct from neck. Snout is rather short and broad. Eyes are moderately large and directed laterally with vertical pupil. Usually with a single large, ribbed and horn-like scale above each eye. The colour i s very variable but the basic of the dorsum is sand-coloured yellow. The females attain a larger total length than the males.
Habitats and ecology: A strictly nocturnal viper inhabiting more variable desert habitats than those of C. *vipra,* including rocky, gravel and sandy deserts, but never in areas of sand dunes. It feeds on rodents, lizards and small birds.
Status: Low Risk (least concern).
Remarks: Some individuals have two horns located above the eyes and are made of a single spine each. Hornless individuals are also common. Horned and hornless individuals are found in males and females of all age groups from the same locality or even the same brood. The percentage of horned to hornless individuals in a population differs from one area to another. When angry, the horned viper rubs the scales of one side of its body over those of the other producing a loud and rather characteristic sound.

10.1.1 Reptilian Habitats

Table 3 shows the reptiles in the habitat types of the project site in addition to another species inhabiting the buildings in the project site as well as any other constructions adjacent to the project site. House Gecko, *Hemidactylus turcicus* is the commensally species with human so it is found in human settlements. Two of the reptile species inhabiting Sabkha habitat, another inhabiting gravel plain, and one of them inhabiting gravel plain as well as wadi downstream habitats.

Acanthodactylus boskianus is a lizard seen in the area for the first time that was seen around the shrub of *Zygophyllum coccineum* close to the water pipe line.

Table 3: List of reptilian species expected to be found in the project area

Species	Habitat types			Evidence	Previous Record
	SB	GP	WD		
Agama agama spinosa	-	++	-	Previously Record	Marx, 1958
Tropiocolotes steudneri	-	+	+	Previously Record	Saleh, 1997
Acanthodactylus boskianus	+	-	-	Observed	First record
Cerastes cerastes	+	-	-	Tracks	Marx, 1958

(-=absent; + = present up to three times; ++ = present up to five times; +++ = present more than five times) (SB= Sebkha; GP=Gravely plains, WD= Wadi downstreams)

10.2 Mammals

Lepus capensis Linnaeus, 1758
Common names: Hare, Arnab Gabali.
Distribution: Lepus capensis is widely distributed Europe, Asia and Africa. In Egypt: The species, which is represented by at least four subspecies, is widely distributed throughout the country with the exception of the extremely dry desert areas. In Eastern Desert, Lepus capensis aegyptius has been

recorded from several localities in the northern two-thirds of Eastern Desert.
Description: A desert hare with very soft pelage. Ear is extremely long and lower margin of its external opening above level of crown of head. Hind limb is considerably longer than fore limb. Tail is short. Feet are digitigrade with four functional toes and one vestigial. Claws, palm and sole are concealed by fur.
Comparison: Lepus capensis aegyptius differs from other Egyptian subspecies in having a larger proportion of individuals with anterior border of ear tip black, from sinaiticus is more yellowish or brownish dorsum and shorter ear, from isabellinus in having shorter tail and from rothschildi in paler colour and generally larger dimensions.
Habitats and ecology: Vegetated desert. Mostly nocturnal species (particularly in summer months) and spending the day in clumps of vegetation. Desert hares appear to feed on a great variety of plants. Among common plants in Mediterranean belt that are eaten by hares are Retama raetam, Lycium sp, and Zygophyllum coccineum (Osborn & Helmy, 1980).
Status: Lower Risk, least concern.

Gerbillus gerbillus (Olivier, 1801)
Common names: Lesser Gerbil, Bayoudi.
Distribution: *Gerbillus gerbillus* is widely distributed in Libya, Palestine, Egypt, Sudan, and parts of Niger, Uganda, Mauritania, Chad, and Mali. In Egypt, it is the most common and widely distributed gerbil being found in all suitable habitats in the Western, Eastern and Sinai deserts.
Description: Small yellowish orange common gerbil, slightly smaller than *G. andersoni*. Adult head and body length average 88 mm; tail 123 mm; foot 30 mm; ear 13 mm; weight 23 g. Dorsum slightly darker than side, contrasted further in some specimens by brownish tipped hairs, especially on rump. Color of side not extending onto foreleg or further than thigh on hind limb. Ear and sole not pigmented. Tail bicolored and brush is moderately conspicuous. White supraorbital and postauricular markings and white rump patch is prominent. Ear length is less than one-half hind foot length.
Comparison: *Gerbillus gerbillus* is paler than both *G. andersoni* and *G. pyramidum* and is much smaller than the later.
Habitats and ecology: It inhabits palm groves and sand dune areas and cultivated desert areas (Osborn and Helmy, 1980). It is a nocturnal gerbil, feeding on seeds, roots and leaves of desert plants, as well as insects (Basuony, 1993). Burrows are made in flat sandy areas rarely under plants.
Status: Lower Risk, least concern.

Meriones crassus
Common names: Silky Jird, Sundevall's Jird, Jarad.
Distribution: *Meriones crassus* is widely distributed in Asia, Algeria, Libya, Egypt, Sudan and Nigeria. In Egypt, it is the most common and widely distributed jird being found in all suitable habitats in the Western, Eastern and Sinai deserts. The nominate subspecies occurs in the Western Desert, Eastern Desert and Sinai Peninsula.
Description: Large jird with long, soft dorsal pelage. Adult head and body length average 136 mm; tail 133 mm; foot 34 mm; ear 18 mm; weight 80 g. Dorsum pale yellowish brown, side with narrow, buff-colored areas, hairs of venter and feet white. Mystacial and circumorbital areas pale; postauricular patch conspicuous, white. Tail faintly or not bicolored, white or buffy below, upper surface as dorsum, with conspicuous black apical brush. Ear, sole and claws not pigmented. Sole is partly haired.
Habitats and ecology: It inhabits wadis and coastal areas of Sinai Peninsula where there is vegetation and human habitation or past activity (Osborn and Helmy, 1980). It is both nocturnal and diurnal (depending on the season), feeding on seeds, roots and leaves of desert plants (Basuony, 1993). Burrows are made in barren, stony, gravelly or flat sandy areas.
Status: Lower Risk, least concern.

Mus musculus (Brants, 1827)

Common names: House Mouse, Far, Sisi.
Distribution: A cosmopolitan species. In Egypt, *Mus musculus* is distributed in Mediterranean coastal belt, Nile Valley and Delta and oases of Western Desert, Red Sea coastal towns, Suez Canal area, and the Sinai Peninsula. Both commensal and wild populations have been recorded throughout the country. In Sinai, *Mus musculus* has been recoded from El Arish, Oyun Musa, El Tor (Osborn and Helmy, 1980) and the Gulf of Aqaba coast (Saleh and Basuony, 1998).
Description: Small murid with dorsum gray or brownish, venter white to buffy. Adult head and body length average 84 mm; tail 84 mm; foot 19 mm; ear 14 mm; weight 22 g. pelage soft, dorsal color varying from gray and tawny to light and dark brown. Side with or without narrow, clear tawny border. Belly white too buffy. Hair of ear, suborbital spot and postauricular patch are slightly paler than color hairs. Tail indistinctly bicolored, brownish above, whitish below.
Comparison: *Mus muscullus* can be distinguished from most other Egyptian mice by small size; lack of contrasting head, side, and rump markings; and tail lacking a brush.
Habitats and ecology: It inhabits houses, tents, grain stores, gardens and salty areas. It is a nocturnal species. Burrow is shallow and usually under shrubs.
Status Lower Risk, least concern.

Acomys cahirinus (De Winton, 1901)
Common names: Egyptian Spiny Mouse, Abu Shoaka.
Distribution: Western Sind, southern Iran, southern Asia, Arabia, Jordan, Palestine/Israel, Cyprus, Crete, Egypt, Libya, Mauritania, Morocco; Sudan south through Ethiopia, Somalia, Kenya and Tanzania and west to Nigeria and southern Algeria. In Egypt: there are six subspecies inhabited the Egyptian landforms, subspecies *cahirinus* is found in the Nile Delta and Valley.
Description: Small- to medium-size murids with prominent pigmented ears. Dorsal pelage is spinous and the spine is V-shaped in cross section. Tail with broad conspicuous annulations alternating with bristles. Tail usually longer than head and body. Dorsal colour is brownish, blackish or slate not reddish. Palm, sole and tail are not black in colour.
Comparison: *Acomys cahirinus cahirinus* can be distinguished from other subspecies on bases of its melanistic or slate colour and tail not bicoloured or indistinctly bicoloured.
Habitats and ecology: It is considered to be almost completely commensal because it is the commonest mouse in buildings and houses. Some have been taken in gardens and date groves. It is utilizes a variety of plants and seeds for foods. Dates are the staple diet in some areas.
Status: Low risk (least concern).

Vulpes vulpes (Linnaeus, 1758)
Common names: Red Fox, Nile Fox, Taalab, Abu Hussein.
Distribution: Eastern North America, British Isles, Europe, Asia (northern and southwestern), Saudi Arabia, Egypt west to Morocco and Sudan. In Egypt, red fox is distributed throughout the country.
Description: Large fox. Dorsal stripe is reddish to reddish brown, 50-80mm wide, extending from eye to basal one-third of the tail, broadest on shoulders (forming a "cross") and on pelvis, darkened between ear and shoulder by black and black-tipped guard hairs. Grizzling due to long guard hairs with blackish tips and white subterminal bands, occurs over entire dorsum, is most pronounced on shoulder and hip and occurs on cheek, throat and chest. Side is grizzled gray and yellowish. Throat and belly are brownish, blackish or white. Dark stripe from mystacial area to eye is indistinct. Ear is relatively large and black posteriorly. Tail is long, bushy and club-shaped; reddish or brownish dorsally; paler ventrally, hairs buffy with dark tips; gland on upper base marked with blackish hairs; tip white. Foreleg with prominent, elongate and black marking. Hair of palm and sole are not covering pads.
Comparison: *Vulpes vulpes* differs from *Vulpes rueppelli* in darker colour, back of ear being black instead of pale brown, venter blackish instead of white, presence of black mark on foreleg, larger average dimensions, more prominent cranial ridges and less inflated bulla.
Habitats and ecology: It is a strict inhabitant of sandy areas of Western Mediterranean Coastal Desert.

It is not strictly nocturnal and is commonly seen during daylight hours. Burrows are made in sandy hillocks under vegetation and palm groves. Feeds on insects, rodents, lizards as well as birds (Basuony, 1998).
Status: Low Risk, least concern.
Remarks: Osborn and Helmy (1980) showed that the subspecific status of the red fox in Egypt is *aegyptiaca* that found in Western and Eastern Deserts, however, recently another subspecies, *arabica*, was recorded from south Sinai by Saleh and Basuony (1998). Red fox subspecies inhabited the Nile Delta might be *aegyptiaca*.

Vulpes rueppelli rueppelli (Schinz, 1825)
Common names: Rueppell's Sand Fox, Taalab, Abu Hussein.
Distribution: Afghanistan, Iran, Jordan, Saudi Arabia, Egypt, Sudan, Somalia, Libya and Algeria. In Egypt, sand fox is distributed in Eastern and Western Deserts.
Description: Small fox. Ear is large, pale brown or rufous posteriorly. Tail is long, bushy, clup-shaped. Tip of tail is white. Dorsum grizzled reddish, side buff gray and venter whitish. Anterior foreleg and outer side of hindleg pale reddish buff. Back of foreleg from elbow to palm and back of thigh and sole reddish brown. Hair of palm and sole are partly covering pads. bushy, clup-shaped. Tip of tail is white. Dorsum grizzled reddish, side buff gray and venter whitish. Anterior foreleg and outer side of hindleg pale reddish buff. Back of foreleg from elbow to palm and back of thigh and sole reddish brown. Hair of palm and sole are partly covering pads.
Comparison: *Vulpes rueppelli* differs from *Vulpes vulpes* in paler colour, back of ear being pale brown instead of black, venter whitish instead of black. In comparison with Vulpes zerda, *Vulpes rueppelli* is larger, much darker, has a longer tail and white tail tip instead of black. From *Vulpes pallida* of Sudan, *Vulpes rueppelli* is distinguishable by reddish colour, long ears, and lack of black mark on foreleg and tail tip being white instead of black.
Habitats and ecology: Sand fox inhabited the area south of coast, particularly in vegetated areas, isolated acacia groves, palm groves and oases. The analysis of the stomach contents of the sand fox revealed only three main food item of three categories (insects, invertebrates and reptiles). Although *Vulpes rueppelli* is a nocturnal animal, it sometimes seen during the day.

Footprint of *Vulpes rueppelli*.

Status: Lower Risk, least concern

10.2.1 Mammalian Habitats

The recorded mammal species in the project site can be found in different habitats. Table 4 shows the distribution of these species in the various habitats. In addition to these species, there are two commensally species inhabiting settlements in the project site or adjacent toit. These are House Mouse Mus musculus and Egyptian Spiny Mouse Acomys cahirinus.

Table 4: List of mammalian species expected to be found in the project area.

Species	Habitat types SB	GP	WD	Evidence	Previous record
Lepus capensis	+++	++	++	Tracks	Osborn and Helmy (1980)
Gerbillus gerbillus	+++	+++	+++	Tracks	
Meriones crassus	+	-	-	Tracks	
Vulpes vulpes	+++	-	-	Tracks and scats	
Vulpes reuppelli	-	++	++	Tracks	

(-=absent; + = present up to three times; ++ = present up to five times; +++ = present more than five times) (SB= Sebkha; GP=Gravely plains, WD= Wadi downstreams)

10.3 Threatened Species in the Deserts of Egypt

Table 5 shows the threatened terrestrial species of both reptiles and mammals in the Egyptian desert, globally (according IUCN categories) and nationally (according to their status in Egypt). It is worth to note that no species recorded or expected tio be in the project site is in the list.

Table 5: Threatened Terrestrial Reptiles of Egypt and Their Global and National Status

Species	Status Globally (IUCN)	Nationally (in Egypt)
Laudakia stellio stellio	DD	VU
Laudakia stellio brackydactyla	LR/lc	VU
Uromastyx ocellatus ocellatus	DD	VU
Uromastyx ocellatus ornatus	DD	EN
Uromastyx acanthinurus	LR/lc	VU
Philochortis intermedius	DD	CR
Acanthodactylus pardalis	LR/lc	VU
Mabuya vittata	LR/lc	VU
Eumeces schneideri	DD	VU
Eryx jaculus	LR/lc	CR
Dasypeltis scabra	LR/lc	CR
Testudo kleinmanni	EN	CR
Crocidura floweri	EN	
Crocidura oliveiri	VU	
Crocidura suaveolens	DD	EN
Rhinolophus mehelyi	VU	
Rhinolophus hipposideros	VU	
Meriones sacramenti	EN	VU
Meriones tristrami	DD	VU
Pachyuromys duprasi	DD	VU
Eliomys melanurus	VU	CR
Hystrix cristata	DD	CR
Hystrix indica	DD	CR
Spalax leucodon	DD	VU

Species	Status	
	Globally (IUCN)	**Nationally (in Egypt)**
Allactaga tetradactyla	DD	CR
Jaculus orientalis	DD	VU
Canis lupus	LC	EN
Vulpes zerda	LC	EN
Ictonyx libyca	LR/lc	EN
Genetta genetta	LR/lc	VU
Felis silvestris	DD	EN
Felis chaus	DD	VU
Caracal caracal	LC	CR
Panthera parades	LC	CR
Acinonyx jubatus	VU	CR
Hyaena hyaena	LR/nt	EN
Proteles cristata	LR/lc	CR
Equus asinus	CR	CR
Capra nubiana	EN	VU
Gazella dorcas	VU	EN
Gazella leptoceros	EN	CR
Ammotragus lervia	VU	CR

CR= critically endangered; EN= endangered; VU= vulnerable; LR/lc= Low Risk (least concern); DD= data defecient.

The above-mentioned data and information show clearly that no species recorded or expected to occur in the project site is threatened. All the recorded or expected to occur in the site are of least concern

10.4 Protected Areas and Protected Species

There are no protected areas in the proposed project site. The species recorded in the proposed site, plants or animals are not protected by any legislation or law. They are among the most common biota in the country. At the south-eastern part the NREA area is neighboured to the protected area "Red Sea Northern Islands". However, the minimum distance between the border of the NREA area and the protected area is one kilometre.

11. Land Use

The NREA area does not contain any human settlements. Except petrol activities in the south eastern part and the north eastern part of the area (already taken care of by an agreement between NREA and the GPC) a small asphalt plant and water wells at the north-western border there is no socio-economic activity in the area. The area does not contain any sites valued for their historic, scenic, cultural or archaeological significance.

The buildings occur only along the highway from Ras Ghareb to Hurghada. These are the building for water distribution piped from the Kureimat (The Nile Valley), building belonging to the oil companies, and military small buildings.

12. Socio-Economic Issues

There is no settlement within the NREA, a wind park project would not have influence on health and safety or would cause any land displacement. In any case, the character of a wind power project would allow avoiding displacement, even if the area would be scarcely settled. A wind park project would not be in conflict with ongoing petrol activities in the area. The coordination is taken care of by an agreement concluded between NREA and the General Petroleum Company. A Wind power project would create employment. During the construction phase also unskilled workers from the different parts of the country and from the governorate would be required.

13. Waste Water

The construction of service buildings with apartments for operating staff and of a central substation would generate some domestic waste water. These buildings would be constructed near to the Hurghada - Ras Ghareb Road and would be connected to the water pipeline Hurghada - Ras Ghareb.

It is estimated that the number of persons working and/or living in the area will be less than 100, once the NREA area would be fully developed. Accordingly, the daily generation of waste water should be not more than 10 m^3. Waste water treatment will be carried out by a compact treatment plant. The treated and stabilised waste water will be infiltrated to the desert ground at sufficient distance of the installations. Due to high absorption and cleaning capacity of desert sand soils and due to lack of groundwater and groundwater utilisation, there would be not any harm to the environment.

Waste water treatment will be carried out by a compact treatment plant.

14. Solid Waste

Solid waste generated during the construction phase would consist mainly of packing material such as wood, paper carton, and plastic. This material will be collected and disposed of according to accepted standards.

Domestic waste generated during the operation phase shall be collected and disposed of in a regular scheme. This shall be coordinated with domestic waste collection at Ras Ghareb.

Domestic waste generated during the operation phase shall be collected and disposed of in a regular scheme.

15. Air Quality

The wind power project will not have effects to air quality. The lower end of blade tips of wind turbines will be at least 20 m above the surface. Accordingly, there will be no effects to increased dust transport. It is interesting to mention that the high wind velocity in the area leaves no fine particles on the ground surface. During the construction phase there would be increased movement of cars causing some dust, which has effects only to the direct surrounding of the cars. During wind park operation only very few cars would be passing a wind park, thus making air quality effects negligible. In any case there will be no adverse effect to air quality outside the NREA area.

The wind power project will not have effects to air quality.

16. Noise

Noise emissions will depend on the wind turbine selected for the individual projects. In any case the ambient noise level of wind turbines would be below 35 decibel, if a distance to settlements of 400 m will be kept.

The ambient noise level of wind turbines would be below 35 decibel, if a distance to settlements of 400 m will be kept

17. Traffic

Any wind power project within the NREA area would not cause any traffic problems affecting settlements or existing roads.

18. Consideration of Alternatives

Wind parks have to be placed in areas with high wind energy potentials. The “NREA area” at Gabal el Zayt is selected according to such favourable wind conditions. Accordingly there is no alternative with equivalent conditions.

19. Biodiversity and Conservation

The present survey and assessment show that:

- There are no nationally or internationally designated nature conservation areas present in the proposed site.
- There are no nationally or internationally protected /threatened/rare species of flora/fauna present in the proposed site.
- There are no commercially important species

20. Recommendations

The present study of the ecology, flora, fauna of the proposed site shows that the following practices and applications will completely alleviate any probable adverse impact on the biodiversity of the site:

20.1 Monitoring Plan

It is recommended that a follow up of the few *Acacia* individuals in the proposed site are monitored as regards their life, vigour and sustainability.

Monitoring of the expected vegetation appearing after the establishment of the turbines is necessary to help assessment of such activities in the future.

20.2 Environmental Management Plan

- Management of the waste water and solid waste resulting from the establishment of buildings along the highway for personnel working in the project after implementation
- Management of the distribution of the turbines to avoid wadi runnels, especially those harbouring *Acacia* trees.

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22. Photos

Photo 1: Wind Turbines in Za'afrana Area

Photo 2: Mounds formed by Tamarix Passerinoides along the Margin of the Sebkha (Mallaha). Note the Water in the Lowest Part of the Mallaha

Photo 3: Wind erosion uncovering the buried parts of the Tamarix

Photo 4: Huge Mounds Formed by Nitraria Retusa (Ghraqad) along the Margins of the Sebkha

Photo 5: **Zygophyllum album forming mounds, in the foreground; while Nitraria retusa is forming a huge mound in the background in the western side of the sebkha (Mallaha).**

Photo 6: **The sebkha (Mallaha) with crusts of mixed sand-clay and salt covering the ground surface. Note that this habitat is devoid of plant cover due to high salinity. Depressed parts are covered with saline water and brine.**

Photo 7: Gravely desert plains covered with gravels and pebbles forming a desert armour preventing the growth of any plant cover.

Photo 8: The ground surface of the gravely desert plains showing the compact gravels and pebbles covering it.

Photo 9: The hilly area to the west of the project site. Note the gravel cover of the ground surface and sand accumulations in runnels dissecting the hills.

Photo 10: Haloxylon salicornicum trapping the drifted sand to form mound in limited locations in the gravel plains

Photo 11: Depressions along the drainage lines filled with sand. In exceptionally rainy years, there is ample room for the growth of some desert plants. Haloxylon salicornicum forms mounds of trapped sand around its body.

Photo 12: Depressions representing the downstreams of drainage system where run-off water collects. The water-borne material is formed of fine- sediments, which are cracked after drying. The vegetation is composed of Ochradenus baccatus and dead individuals of Zilla spinosa. Such habitat occurs near the highway between Ras ghraeb and Hurghada

Photo 13: A lonely Acacia raddiana tree in the vast barren gravel plain

Photo 14: Acacia raddiana fruits falling from the tree and protected from wind by the falling dead branches. Fruits contain fertile seeds.

Photo 15: Off-road vehicles crossing the area causing the disturbance of the soil surface

Photo 16: The margins of the sebkha (mallaha) are covered with drifted sand. However, the wet subsoil appears after crossing the area with vehicles.

Photo 17: Seepage of water from the water pipe line results in the growth of Zygophyllum coccineum.

Photo 18: Water seepage from the water pipe line resulted in the growth of Phragmites australis. Zygophyllum coccineum grows vigorously due to continuous water supply

Photo 19: The tracks of mammals near the oozing water from the water-pipe line.

Photo 20: Camel dung on the ground surface below the canopy of Acacia tree. Camels and Bedouin have stops in the limited shade of the Acacia tree. Camels may feed on the falling fruits of Acacia.

Photo 21: Oil pipe lines crossing the area causing oil spills and pollution of the soil in addition to its disturbance along the pipe line.

Photo 22: A small asphalt mixing station in the project site.

Photo 23: Simmondsia chinensis (Jojoba) cultivated in the farms to the west of the project area.

Photo 24: Cultivated date palm in the farms depending on water from the wells in Wadi Dara

Photo 25: An Acacia raddiana tree suffering from previous cutting for fuel. It is to be noted that the tree produces young branches near the ground surface.

Annex 2.5.2

Ornithological Field Monitoring Report

ARAB REPUBLIC OF EGYPT

MINISTRY OF ELECTRICITY AND ENERGY
NEW AND RENEWABLE ENERGY AUTHORITY
(NREA)

FEASIBILITY STUDY FOR A LARGE WIND FARM

AT GULF OF ZAYT

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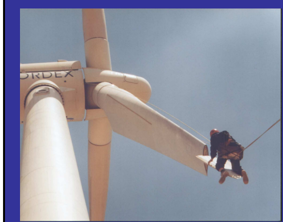

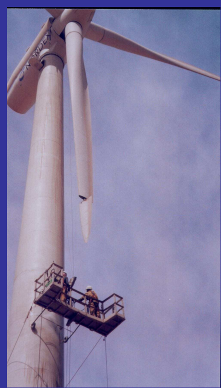

Ornithological Field Monitoring Report

September 2007

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Deutsche Energie-Consult
Ingenieurgesellschaft mbH

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Contents

Appendix 1

1. Introduction

The New and Renewable Energy Authority intends to use the "NREA concessionary area" for wind power development. This area is located in the coastal desert west of the Gulf of Zayt and west of the main Hurghada – Suez road. It has a size of 650 km^2, a length of 70 km and a width of 10 km and less. The area is characterised by excellent wind conditions with average wind speeds of more than 10 m/s in 50 m above the ground.

To the West the area it is framed by the foothills of the Red Sea Mountains. To the East it is framed by a 200 m corridor (in the North) and a 500 m corridor (in the South) along the Hurghada – Suez road, followed by the road itself and up to 8 km wide plains up to the foothills of the Gabal El Zayt mountain chain with 460 m high mountains. The Gabal El Zayt mountain chain is located directly at the Red Sea coast. This mountain chain is considered to be an important stepping stone for gliding birds migrating during spring to Sinai. The concessionary area itself consists of dry desert except for an area in the north with a salt depression (Sebkha). An overview on the location of the area is shown in Fig. 1.

An about 100 km long coastal stripe between Ras Gharib and the Ras Gemsa island area with the Gabal el Zayt mountains in between was registered with Bird Life International as an Important Bird Area for migrating birds. This area is for a larger stretch adjacent to the NREA concessionary area and it was presumed that environmental impacts caused by wind energy utilisation in the neighbouring NREA concessionary area might be signify-cant. For that reason, within the frame of a feasibility study, an ornithological specialist study was to be carried out based on one autumns and one spring field monitoring in the concessionary area. This report deals with the description of field monitoring programme and includes the daylight and radar observation. A detailed data evaluation and Impact Assessment report was carried out by ecoda, Dr. Bergen. This report called "Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt" is submitted as a separate report.

2. Field observations

2.1 General

Field observations were carried out under guidance of a senior ornithologist (Dr. Hilgerloh), who advised and supervised 2 teams of 2 field ornithologists each. In addition one radar ornithologist had been assigned, who operated the radar (Ship radar Furono, FR-2125) at the observation site S1 (see Fig.1).

2.2 Standardised daytime field observations

The focus of daytime observations was on soaring and gliding birds as these birds have limited flight ability/are less manoeuvrable, have larger body size and spans and therefore are considered to be significantly more vulnerable by wind power plants than other bird species. Basic for the work concept was the fact that within the concessionary area only a central corridor was certified to be free of mines and thus available for the study. In addition observations could be carried out from the Hurghada – Suez road at the eastern border of the NREA area. In order to assure a safe identification of soaring and gliding birds in the desert airs (sometimes dusty or suffering from optical heat swimming) the regular observation distance had been set to up to 2500 m. Thus, the NREA area was investigated on the basis of birds recorded within 2.5 km from the observation sites, i.e. in circles of 19.6 km^2 being reference areas.

Accordingly, along the central corridor, 13 observation sites were established at distances of 5 km from each other. An additional line with 13 observation points was established along the road running along the eastern border of the concessionary area (Fig. 1). Because of the distance of 5 km between the sites and the observation range of 2.5 km, observation circles of about 20 km^2 succeeded one another from south to north.

The observation point S1 was selected to be close to the radar site in order to be able to calibrate migration altitude monitoring by radar during systematic observations and to train observers accordingly.
The autumn field monitoring was performed from August 20th to October 29th, 2006. At the beginning, regular daytime observations were possible up to the road to Wadi Dara Village, i.e. up to observation point M9 in the middle corridor. Mine clearing for the northern 4 middle points was finished on September 10th, 2006. Only then the whole middle corridor was observed. The spring observations were performed from February 20th to May 6th, 2007.

Two observation teams, each consisting of two persons, were formed and a rotation schedule was set up according to which all the sites were visited at all different hours between sunrise and sunset, thus targeting to get a representative distribution of spatial and temporal observation samples. In the average each site was observed every third day for about one hour. One team worked from sunrise to noon, the other from noon to sunset. Observation periods were principally 60 minutes, but during autumn there was a phase during which the sites were monitored for 40 minutes every time. Each team searched the sky for birds using binoculars of 10 x 40 magnification. For the detailed identification of the birds telescopes with magnifications from 20x to 60x were used.

The following parameters were determined and documented:

- start of observation,
- end of observation,
- exact time of observation,
- kind of species,
- number of birds,
- momentary flight direction,
- flight height of the birds always considering the height of the lowest bird in case of flocks,
- distance from observer,
- direction from observer,
- visibility (km),
- cloud cover (%),
- type of cloud,
- wind direction,
- wind speed (Bft).

In order to assure a proper quality of the field observations the following measures were taken:

- Estimations of the flight height and distances of the birds were calibrated by laser binoculars (Geovid 10 x 40 and 7 x 40 magnification) and by radar.
- Distances over 1 km from the observer were calibrated by reference distances to features, which were measured by GPS.
- Calibration of height estimations of the field observers were done twice during 4 hours at the radar.
- During the first weeks the composition of the teams changed regularly in order to avoid methodological differences.

Nevertheless, the observation data still contain a certain error margin, as many variables are not measured but estimated such as migration height, distances, and number of birds in large flocks.

In autumn, a total of 458.6 observation hours was recorded. Each of the sites M1 to M9 and S1 to S13 was observed 23 – 28 times, the northern part (M10 to M13) was observed 16 – 19 times. During spring a total of 604.4 hours of observation hours were recorded. Each of the sites was visited 22 - 26 times.

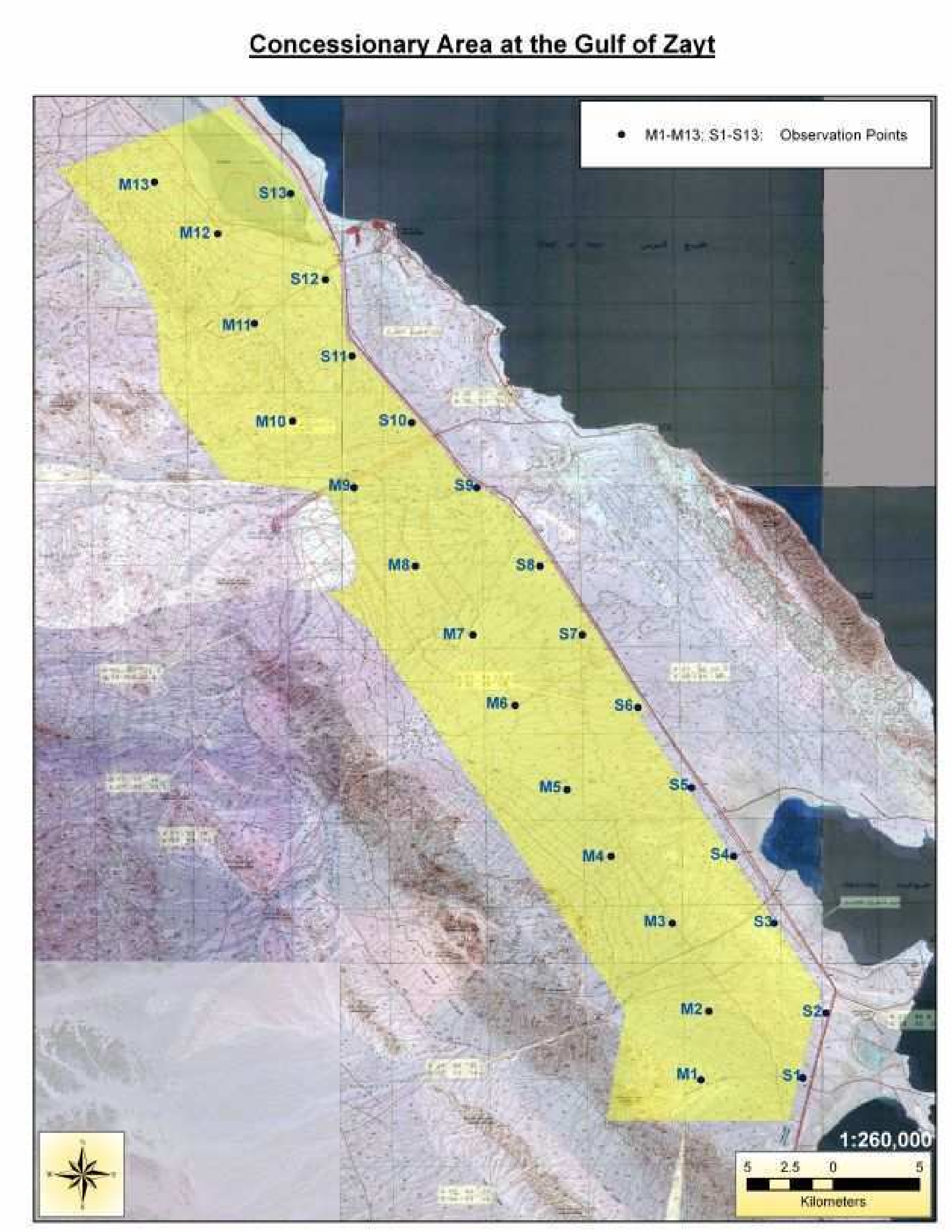

Fig. 1: Observation sites in the NREA concessionary area

2.3 Radar observations

Radar observations of nocturnal migration were performed close to the southern border of the concessionary area (27.69ºN, 033.49ºE) at observation point S1. The radar was fixed on a stand which permitted a manual adjustment of the rotation plane. The radar beam rotated vertically in order to evaluate the height distribution of nocturnal birds. The observation period lasted from August 27 to October 20 in autumn 2006 and from March 14 to May 4 in spring 2007. Single and agglomerated (summary of ten beam revolutions) pictures of the radar screen were stored by a PC software programme. The radar location can bee seen from Fig.2.

Data processing of radar observations started with the selection for analysis of one agglomerated image every ten minutes. The processing of the images is carried out in several steps: each echo was digitalised. The height coordinates of each echo were calculated for further analysis of the frequency distribution of migration height of the individual echoes of the radar pictures. No correction factor was used with respect to the decreasing detection ability of the radar with increasing distance (Eastwood 1967).
The flight altitudes were analysed of 36,420 birds (from 28 nights) in the autumn season and of 10,820 birds (from 19 nights) in spring.

Fig. 2: The radar in vertical position to the right, the office in the van to the left

3. Bird species observed

3.1 Local bird species

Almost all bird species found in the area do not stay the whole year but appear there twice a year on migration. The chief group of local birds were the sandgrouse, mainly Spotted sandgrouse (*Pterocles senegallus*), along with Brown-necked raven (*Corvus ruficollis*) and a few Bar-tailed desert larks (*Ammomanes tincturus*), Hoopoe larks (*Alaemon alaudipes*) and Pale crag martins (*Ptyonoprogne fuligula*).

3.2 Migrating soaring birds

The majority of birds observed during the daytime observations were soaring and gliding birds, such as storks and raptors. An overview on the species is given in Table 1 below:

species	English name	species	English name
Pelecanus onocrotalus	White pelican	Buteo b. vulpinus	Steppe buzzard
Bubulcus ibis	Cattle egret	Buteo rufinus	Long-legged buzzard
Ardea ralloides	Squacco heron	Aquila heliaca	Imperial eagle
Egretta gularis	Western reef heron	Aquila nipalensis	Steppe eagle
Ardea cinerea	Grey heron	Aquila clanga	Spotted eagle
Nycticorax nycticorax	Night heron	Aquila pomarina	Lesser spotted eagle
Ardea purpurea	Purple heron	Hieraetus pennatus	Booted eagle
Ciconia ciconia	White stork	Circaetus gallicus	Short-toed eagle
Ciconia nigra	Black stork	Pandion haliaetus	Osprey
Platalea leucorodia	Spoonbill	Falco vespertinus	Red-footed falcon
Plegadis falcinellus	Glossy ibis	Falco tinnunculus	Kestrel
Phoenicopterus ruber	Flamingo	Falco subbuteo	Hobby
Milvus migrans	Black kite	Falco naumanni	Lesser kestrel
Neophron percnopterus	Egyptian vulture	Falco peregrinus	Peregrine
Circus pygargus	Montagu's harrier	Falco p. pelegrinoides	Barbary falcon
Circus macrourus	Pallid harrier	Falco biarmicus	Lanner falcon
Circus aeruginosus	Marsh harrier	Grus grus	Common crane
Accipiter nisus	Sparrowhawk	Merops apiaster	Bee-eater
Accipiter brevipes	Levant sparrowhawk	Merops persicus	Blue-cheeked bee-eater
Pernis apivorus	Honey buzzard		

Tab. 1: List of observed soaring and gliding bird species

The duration of migrating periods is deducted from the first and the last sighting during autumn and spring. Corresponding information are summarised in Appendix No. 1. Moreover, in Appendix 2 information on the earliest and latest sighting during the day is given.

Other day migrating species recorded during the field observations were cormorants, waders and small birds, mainly passerines.

3.3 Night migration – Radar monitoring

The flight altitudes were analysed of 36,420 birds (from 28 nights) in the autumn season and of 10,820 birds (from 19 nights) in spring. Most birds were of small size. It can be assumed that they were passerines. The species involved in the observations cannot be identified by the radar. They are known from observations during the day and bird ringing and include species such as Reed warbler (*Acrocephalus scirpaceus*), Sedge warbler (*Acrocephalus schoenobaenus*), Willow warbler (*Phylloscopus trochilus*), Lesser whitethroat (*Sylvia curruca*), Spotted flycatcher (*Muscicapa striata*), Common redstart (*Phoenicurus phoenicurus*) and Masked shrike (*Lanius nubicus*).

Nocturnal passerine migrants fly in a broad front between Eurasian breeding areas and African wintering quarters. Height distribution depends on wind conditions. Birds tend to fly low in headwinds and high in tailwinds. Songbirds are especially sensitive to the turbulences created by turbines. Radar observation of nocturnal migration revealed that a large number of small birds crossed the area. The maximum observed were 3000 birds passing through a one km zone in one hour (autumn).

Autumn migration

During autumn migration nocturnal migrants were very selective in the choice of flight altitude. Migrants concentrated between 200 and 400 m (Fig. 3), where they found optimal flight conditions (Alerstam & Hedenstroem 1998). 8.6% of the birds flew in the assessment air layer of the first 200 m and 91.4% flew above 200 m (Fig. 4).

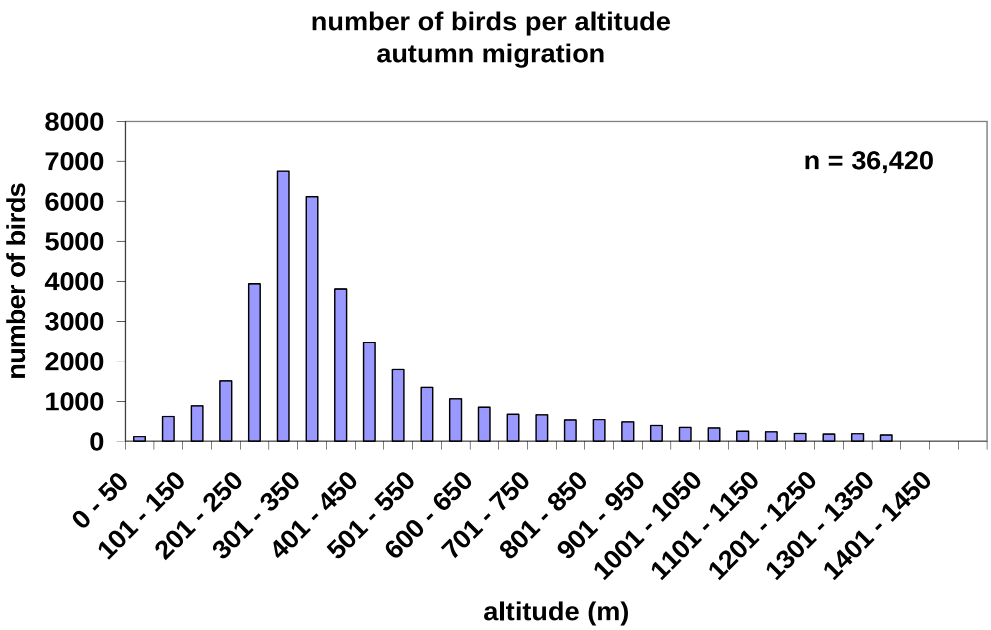

Fig. 3: Number of nocturnal migrants per altitude class of 50 m during autumn season

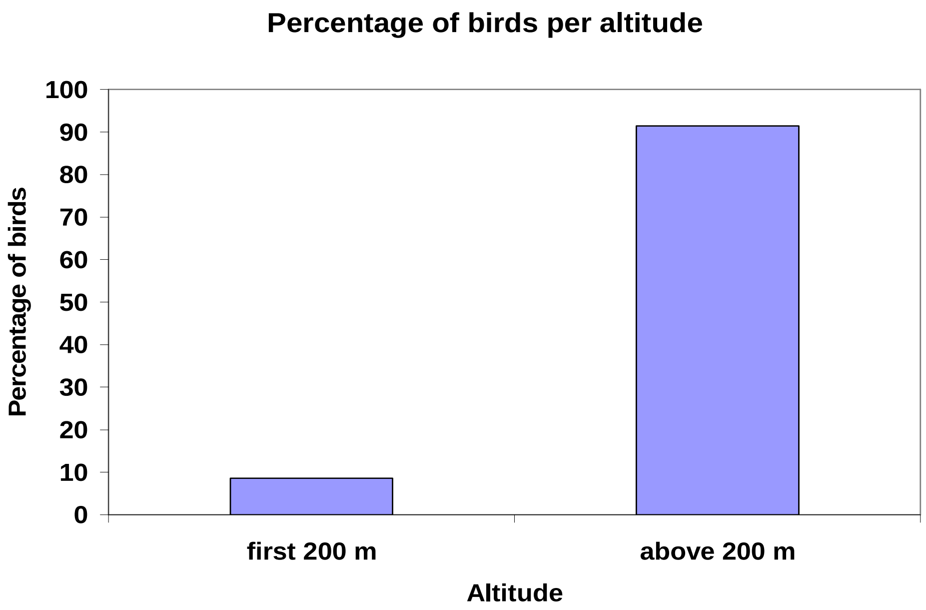

Fig. 4: Percentage of birds in and above the first 200 m air layer during autumn season

Spring migration

In most nights during spring migration, birds encountered strong headwinds. However, every few days (5.5 plus minus 4 days) wind direction changed for 1 – 2 days towards more southerly directions. Winds came from southerly directions 16% of the time. Southerly winds blew with half the force of the northerly. About 28.9% of the detected birds were flying in the first 200 m (Fig. 5 and 6). About 19 % of the detected birds were flying in the first 150 m.

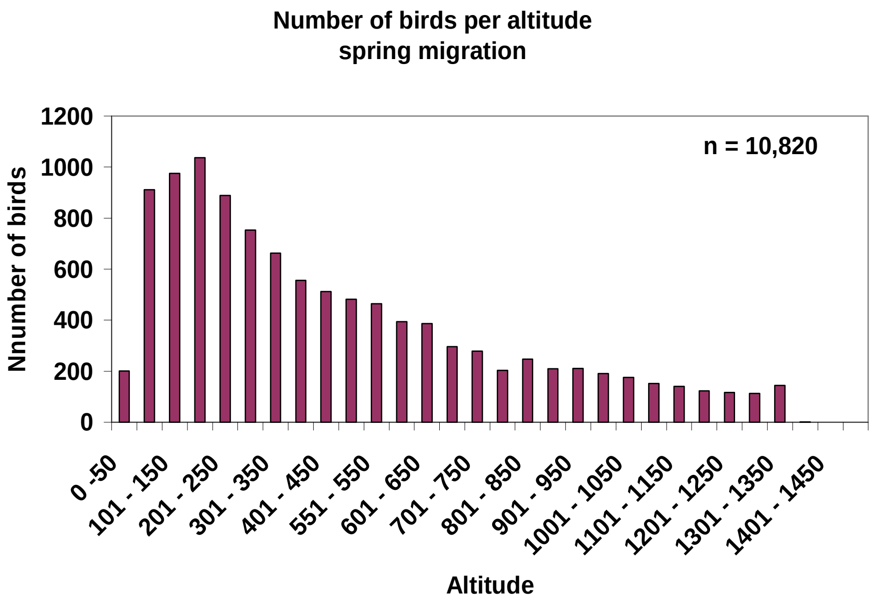

Fig. 5: Number of nocturnal migrants in altitude classes of 50 m during spring

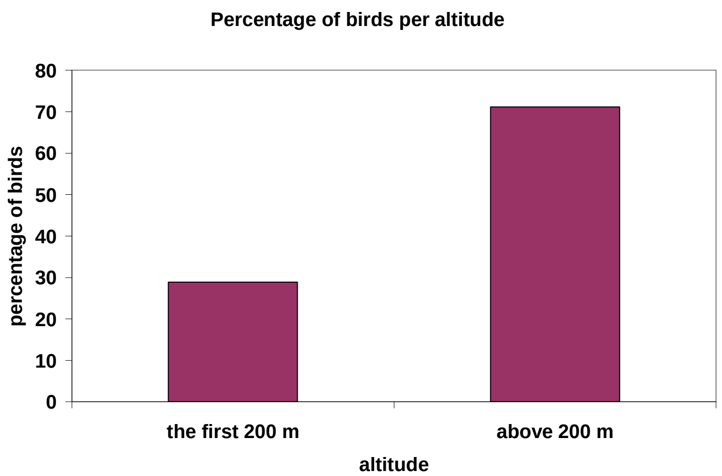

Fig. 6: Percentage of nocturnal migrants in the first 200 m and above 200 m during spring season

4. Summary

This report describes the field monitoring and the methodology applied. The focus of observations was to soaring and gliding birds as these species are presumed to be significantly more endangered by wind power because of their limited manoeuvrability. The data evaluation and the corresponding assessment of likely or possible environmental impacts is subject to a separate report of Dr. Bergen, ecoda, “Ornithological Expert Opinion as Part of the Feasibility Study for a large Wind Farm at Gulf of Zayt, Egypt”.

Moreover, this report describes the monitoring of nocturnal migrants. Radar observations carried out at the southern border of the NREA concessionary area showed that a very high number of nocturnal migrants – mainly passerines - cross the area. Nocturnal passerine migrants are broad front migrants. Their height distribution depends mainly on prevailing wind conditions. Numbers of nocturnal birds observed during autumn were significantly higher during autumn (36,420 during 28 nights), when they were flying with the wind and in higher altitudes. Birds observed during spring (10,820 during 19 nights) were flying in lower altitudes mainly against the wind. About 19 % were flying within the first 150 m.

Appendix 1

Migration season	**AUTUMN**	**SPRING**
Species	First to last sighting	First to last sighting
White pelican	8/26 – 10/26	02/21 – 05/06
Squacco heron		05/02
Western reef heron	10/16 – 10/26	02/23 – 05/04
Grey heron	08/23 – 10/12	
Night heron	09/06	
Purple heron	09/06 – 10/12	04/13
White stork	08/21 – 10/29	02/23 – 05/06
Black stork	09/07 – 10/26	02/23 – 05/06
Spoonbill	09/28 – 10/05	
Glossy ibis	10/29	
Flamingo		02/23 – 04/06
Black kite	08/24 – 10/26	02/23 – 05/06
Egyptian vulture	09/19 – 09/29	02/26 – 05/02
Montagu's harrier	09/03 – 10/07	03/27 – 05/06
Pallid harrier	09/08 – 10/25	02/23 – 04/26
Marsh harrier	08/23 – 10/27	03/19 – 05/05
Sparrowhawk	09/12 – 10/27	04/01 – 05/04
Levant sparrowhawk	09/19 - 10/26	3/30 - 5/02
Honey buzzard	08/22 – 10/15	04/17 – 05/06
Steppe buzzard	09/07 – 10/27	02/20 – 05/06
Long-legged buzzard	09/17	02/23 – 05/04
Imperial eagle		03/12
Steppe eagle		02/20 – 05/02
Spotted eagle		03/14 – 04/16
Lesser spotted eagle	09/07 – 09/07	02/20 – 05/06
Booted eagle	09/08 – 10/10	02/28 – 05/06
Short-toed eagle	09/08 – 09/24	02/23 – 05/02
Osprey	09/10 – 10/13	03/28 – 04/17
Red-footed falcon	09/10 – 10/10	
Kestrel	09/14 – 10/27	02/23 – 05/06
Hobby	09/08 – 10/29	03/22 – 03/31

Migration season	**AUTUMN**	**SPRING**
Species	First to last sighting	First to last sighting
Lesser kestrel	09/22 – 10/03	03/17 – 05/06
Peregrine		03/20 – 04/29
Barbary falcon	10/08	04/26
Lanner	10/3	03/27 – 04/02
Common crane		02/22 – 04/12
Bee-eater	09/20 – 10/05	04/12 – 05/05

The first and last sighting of each species within the systematic autumn and spring observation periods. One date only means a singular observation.

Annex 2.5.3

Ornithological Expert Opinion as part of the Feasibility Study for a large wind farm at Gulf of Zayt

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Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt

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Dortmund, November 5th 2007

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1 Introduction

1.1 Background and Aim of the Report

Due to the good wind conditions in the area of the Gulf of Suez, the New and Renewable Energy Authority (NREA) under the Ministry of Electricity and Energy has developed plans for several wind farms along the western bank of the gulf. In terms of wind conditions, the Gulf of Zayt area is one of the best regions. In order to assess the potential utilization of wind energy, a feasibility study ("Feasibility Study for a large Wind Farm at Gulf of Zayt") will be realized during 2007 by the Joint Venture Deutsche Energie-Consult Ingenieurgesellschaft mbH / Fichtner GmbH & Co. KG. A main objective of the feasibility study is to assess possible impacts on birds. In order to collect baseline data of migration in the concessionary area, an intensive field study was carried out during autumn 2006 and spring 2007.

The main purposes of this report are

- to analyze the collected baseline data,
- to describe migration patterns of relevant species in a quantitative way,
- to identify and assess possible impacts regarding development of wind power within the concessionary area and finally
- to recommend mitigation measures in order to minimize possible conflicts.

1.2 Concessionary Area

The concessionary area is situated in the coastal desert west of the Gulf of Zayt and west to the main Zafarana-Hurghada road. It has a size of 650 km^2, a length of 70 km and a width of 10 km and less. To the west it is framed by the foothills of the Red Sea Mountains. To the east it is framed by a 200 m corridor (in the north) and a 500 m corridor (in the south) along the Hurghada-Suez road, followed by the road itself and 4 to 8 km wide plains up to the foothills of the Gabal El Zayt mountain chain with 460 m high mountains. The Gabal El Zayt mountain chain is located directly at the Red Sea coast, The concessionary area consists of dry desert except for an area in the north with a salt depression (sebkha).

2 Methods

2.1 Data Collection

Between August 20th and October 29th 2006 (autumn migration) as well as between February 20th and May 6th 2007 (spring migration), standardized daytime field observations were done. In order to cover the whole concessionary area, 26 observation sites were selected. Along the central corridor of the concessionary area 13 observation sites were established at distances of 5 km from each other [M-line: M01 - M13]. An additional line [S-line: S01 - S13] with 13 observation points was established along the road running along the eastern border of the concessionary area (see Figure 2.1).

Additionally, nocturnal migrants were also monitored by radar close to the southern border of the concessionary area. This paper does not include the results of these radar observations. A description of data collection can be found in a separate report (Ornithological Field Monitoring).

2.2 Data Analysis

2.2.1 Observation Time

The analysis comprises 596 observation units from autumn 2006 and 616 observation units from spring 2007 (Table 2.1). The total observation time amounts to 459 hours (mean: 46 min. per unit) in autumn 2006 and 603 hours (mean: 59 min. per unit) in spring 2007. The mean observation time per site is 17.64 hours in autumn 2006 and 23.17 hours in spring 2007.

2.2.2 Relevant Species

In a first step we defined species which can be regarded as especially vulnerable to collision strikes or other negative impacts caused by wind turbines: these are mainly large birds (first of all, birds of prey, storks and pelicans) which during daytime principally migrate by soaring and gliding. Soaring and gliding birds seem to be especially vulnerable because of their restricted flight agility. Furthermore, these long-lived species are susceptible to any additional cause of mortality because their rate of annual off-spring is so low. Several of the 39 relevant species that were included in the analysis, are of international, European or national conservation concern (see Annex I). Six species are of special interest within the impact assessment as they have an unfavourable conservational status according to the IUCN Red List of Threatened Species (see Annex I): Egyptian vulture (*Neophron percnopterus*, Endangered), Greater spotted eagle (*Aquila clanga*), Eastern imperial eagle (*Aquila heliaca*), Lesser kestrel (*Falco naumanni*; all Vulnerable) as well as Pallid harrier (*Circus macrourus*) and Red-footed falcon (*Falco vespertinus*; both Near Threatened).

Small migrating birds (passerines) were not considered in the analysis.

Figure 2.1: Illustration of the extent of the concessionary area and the location of the 26 observation sites

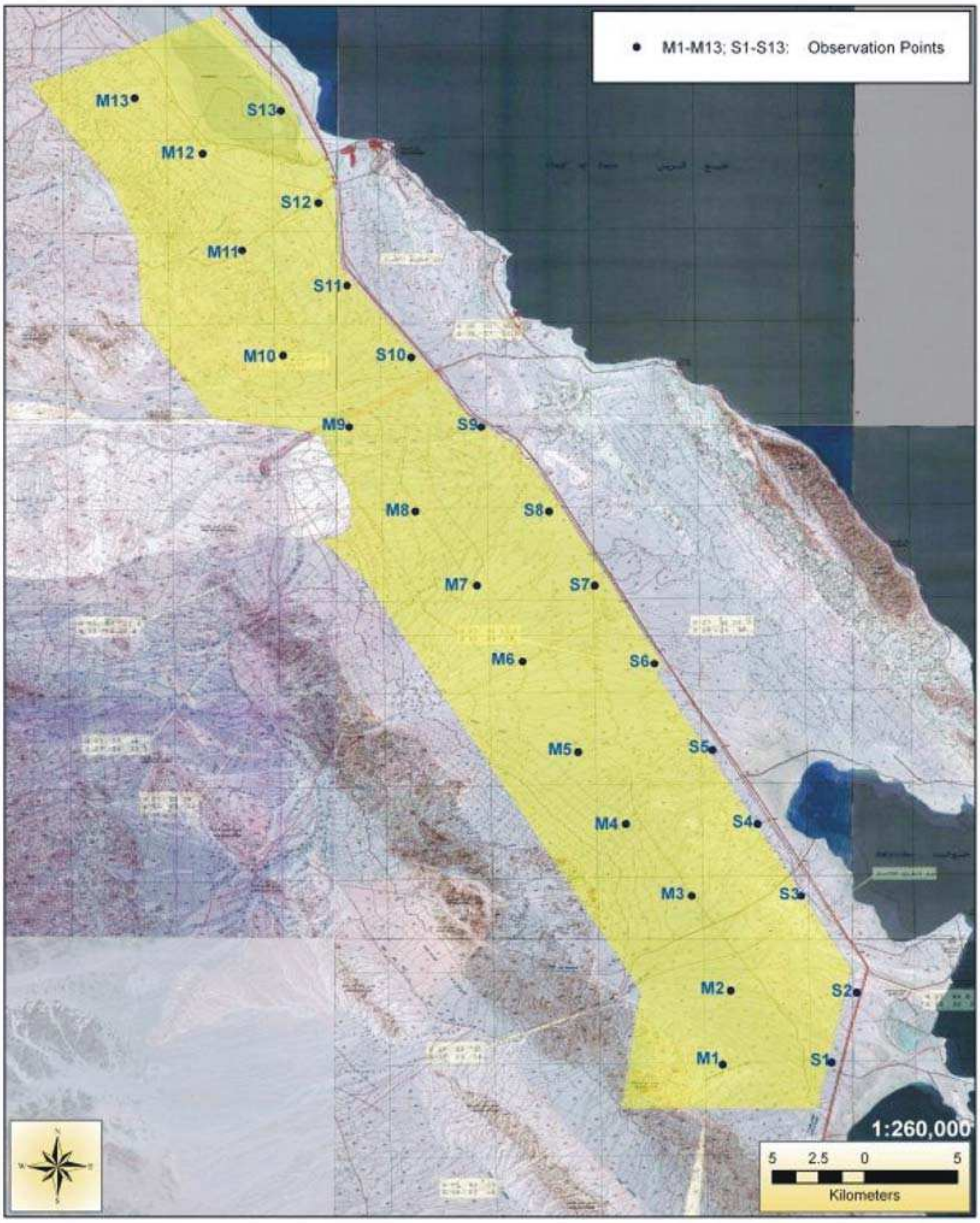

Table 2.1: Observation time at the different observation sites (obs. site) in autumn 2006 and spring 2007 (h (obs.) - observation hours; n (obs.) - number of observation units; n (days) - number of different days with observation)

autumn 2006			
obs. site	h (obs.)	n (obs.)	n (days)
M01	19.67	25	25
M02	18.93	24	24
M03	18.00	23	22
M04	18.00	23	22
M05	17.38	24	23
M06	18.67	24	23
M07	18.58	24	22
M08	19.08	25	24
M09	18.00	23	23
M10	13.25	19	17
M11	11.88	17	17
M12	11.02	16	16
M13	11.48	16	16
total	213.95	283	

autumn 2006			
obs. site	h (obs.)	n (obs.)	n (days)
S01	28.08	28	28
S02	18.63	24	23
S03	20.58	26	24
S04	19.73	26	24
S05	19.67	25	25
S06	20.28	26	26
S07	21.08	27	26
S08	18.42	24	24
S09	17.82	24	24
S10	16.22	23	22
S11	14.33	19	18
S12	16.00	21	20
S13	13.82	20	20
total	244.67	313	

spring 2007			
obs. site	h (obs.)	n (obs.)	n (days)
M01	25.38	26	26
M02	22.47	24	24
M03	20.88	22	22
M04	21.50	22	22
M05	21.50	22	22
M06	21.28	22	22
M07	21.75	22	22
M08	24.50	25	25
M09	23.75	24	24
M10	24.75	25	25
M11	23.75	25	25
M12	25.50	26	26
M13	24.00	24	24
total	301.02	309	

spring 2007			
obs. site	h (obs.)	n (obs.)	n (days)
S01	23.75	24	23
S02	22.75	23	23
S03	22.67	23	23
S04	24.00	24	24
S05	21.70	22	22
S06	23.05	24	24
S07	22.83	23	23
S08	22.00	22	22
S09	23.00	23	23
S10	22.93	24	24
S11	24.00	24	24
S12	25.00	25	24
S13	25.70	26	25
total	303.38	307	

2.2.3 Resting Birds

In a second step observations of resting birds were separated from the baseline data. Frequency and spatial distribution of resting birds are also presented in Chapter 3, so these results will be considered in the impact assessment section.

2.2.4 Standardized Daytime Field Observations

Field ornithologists were able to recognize soaring birds up to distances of at least 2.5 km. Nevertheless, under good viewing conditions it was possible to detect great flocks and even single birds at distances greater than 2.5 km from the observer. Since standardized observations were not possible beyond this distance, all birds migrating at distances above 2.5 km from the observer were excluded from the data set. The frequency and spatial distribution of these birds are presented in Chapter 3.1.3 and 3.2.3 (non-standardized observations — unless birds were migrating outside the concessionary area), so these results will be considered in the impact assessment section.

Another problem in the analysis resulted from the location of the observation sites S01 to S13 at the eastern boundary of the concessionary area. As a consequence, birds migrating at distances below 2.5 km but outside the concessionary area (mainly in eastern directions from the observer, see Table 2.2) had to be excluded from the data set. In contrast, the monitored area (2.5 km x 2.5 km x 3.14 = 19.63 km^2) of every observation site along the M-line lay within the concessionary area. In order to make migration rates at observation sites between the M- and S-line comparable, correction factors for the area portion within the concessionary area were introduced (Table 2.2).

Table 2.2: Overview of the used "area-correction"- factors according to the relative portion of observed area within the concessionary area

site	"excluded directions"	relative portion	correction factor
S01	NNE, ENE, E, ESE, SSE, S	50.0%	2.00
S02	NNE, ENE, E, ESE, SSE	50.0%	2.00
S03	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S04	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S05	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S06	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S07	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S08	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S09	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S10	NNW, N, NNE, E, ENE, ESE	50.0%	2.00
S11	N, NNE, ENE, E, ESE	62,5%	1.60
S12	NNE, ENE, E, ESE	75,0%	1.33
S13	N, NNE, ENE, E, ESE	62,5%	1.60

Number of Migrating Birds, Species Composition and Flock Size

In order to characterize bird migration within the concessionary area we calculated the total number of birds for each relevant species. Furthermore, we used the number of recordings as a further variable to describe migration patterns. A single recording can either be an individual or a flock (independent of the number of birds). The number of recordings is an important variable because it is not influenced by flock size. In contrast, a single but great flock has a strong effect on the variable "number of birds". Therefore, the number of recordings gives additional information about migratory activity and continuity as well as on species-specific migration behaviour.

In order to estimate the effect of flock size on the data set we defined five different classes:

1) 1 individual, 2) 2 - 10, 3) 11 - 100, 4) 101 - 1,000 and finally 5) > 1,000 individuals

For each class we added up the total number of birds / recordings.

Altitude of Migration and Flight Directions

We identified altitude distribution of migration i) for all relevant species and ii) species-specific for the most numerous species in three different classes:

1) < 100 m, 2) 100 - 199 m, 3) ≥ 200 m above ground

For each class we added up the total number of birds / recordings.

We identified flight directions of migrating birds / recordings in four different directions:

1) northern (NW, NNW, N, NNE, NE) 2) eastern (ENE, E, ESE), 3) southern (SW, SSW, S, SSE, SE) and 4) western (WSW, W, WNW)

For each class we added up the total number of birds / recordings for i) the whole concessionary area, and ii) site-specific for four parts of the concessionary area:

1) northern part (M11-M13 & S11-S13), 2) northern middle part (M08-M10 & S08-S10), 3) southern middle part (M05-M07 & S05-S07) and 4) southern part (M01-M04 & S01-S04)

Migratory Activity

In order to describe migratory activity within the concessionary area we calculated the migration rate (birds / recordings per hour) for each observation unit. Subsequently, we were able to assess the frequency distribution of different classes of migration rate. Therefore, we matched the migration rate of each observation unit to one of the following migration rate classes:

1) 0.0, 2) 0.1 - 9.9, 3) 10.0 - 99.9, 4) 100.0 - 999.9 and 5) > 999.9 birds per hour

as well as

1) 0.0, 2) 0.1 - 1.9, 3) 2.0 - 4.9, 4) 5.0 - 9.9, 5) 9.9 - 19.9 and 6) > 19.9 recordings per hour

Furthermore, we calculated average migration rate over all observation units i) for the whole concessionary area and ii) for the M-line and the S-line separately. Since migration rates showed no normal distribution we used not only the mean, but also the median.

Temporal and Spatial Distribution of Migratory Activity

In order to analyze changes in migratory activity over the whole period of investigation we assembled an average daily migration rate for every day of observation.

In order to analyze changes in migratory activity during the day we matched the migration rate of each observation unit to one of the following time periods:

autumn 2006: 1) 05:30-09:29, 2) 09:30-13:29 and 3) 13:30-17:30 o'clock

spring 2007: 1) 05:00-09:59, 2) 10:00-13:59 and 3) 14:00-18:00 o'clock

In this step the begin of the observational period is the decisive factor. Thus, the analysis leads to a relatively rough estimation of migratory activity during the day. Furthermore, we did not consider summertime in this analysis. Since the switch to summertime was on April 27th 2007 only less than 10 % of all spring observation units are affected. As a consequence, the effect of the results should be quite small. In contrast, in autumn 2006 about 36 % of all observation units were done before the switch to wintertime on September 21st. Thus, there might be a slight effect on the results.

Since migration within the concessionary area was distributed irregularly over time, and a small number of large flocks had a strong effect on the data set (see Chapter 3), it is not possible to describe the spatial distribution of migratory activity using an average migration rate for each observational site. The mean is not a valid measure because the migration rate did not display a normal distribution. The resulting high standard deviation (see Chapter 3.1.1 & 3.2.1) demonstrates a lack of explanatory power of the mean. A measure used regularly to describe a non-normal distribution is the median. In this study, however, the median is zero or close to zero most of the times, so that it is a useless value for comparing migration rates at different observation sites.

Considering these circumstances we used the total number of birds / recordings to analyze the spatial distribution of migratory activity. Since observation time differed at the 26 sites we introduced a correction factor. We calculated the total number of birds / recordings at each observation site for the average observation time over all 26 sites. This was 17.64 hours in autumn 2006 and 23.17 hours in spring 2007 (see Chapter 2.2.1 and Table 2.3).

Birds Migrating at Altitudes below 200 m

In accordance with the precautionary principle we suppose that wind turbines (with a maximum height of about 100 m) will not affect birds migrating at an altitude of 200 m or above. Thus, we calculated the afore mentioned variables (as appropriate) for all birds / recordings migrating at altitudes lower than 200 m above ground — with special focus on the spatial distribution of migratory activity.

Since migration within the concessionary area was distributed irregularly over the time, and observation time at each site was short (compared to the whole migration period), it is not certain if the data set represents a reliable sample of migration at the 26 observation sites. Moreover, the

analysis shows that a small number of large flocks had a strong effect on the data set (see Chapter 3.1.1 & 3.2.1). As a consequence, it is possible that migratory activity at one site is very high (because of a great flock), whereas it might be very low at the next site (although the flock migrated over this site, too). To minimize such effects that might have occurred by chance and might not represent regular migratory patterns, we calculated a "smoothened" number of birds / recordings for each observation site. Thus, we summed the total number of site n and half of the number of site n-1 and n+1 and divided the sum by two: x_n "smoothened" = $(x_n+0,5^*x_{n-1}+0,5^*x_{n+1})/2$.

Table 2.3: Overview of the used "time-correction"- factors according to the average observation time (xh (obs.))

autumn 2006			
obs. site	h (obs.)	xh (obs.)	corr. fac.
M01	19.67	17.64	0.90
M02	18.93	17.64	0.93
M03	18.00	17.64	0.98
M04	18.00	17.64	0.98
M05	17.38	17.64	1.01
M06	18.67	17.64	0.94
M07	18.58	17.64	0.95
M08	19.08	17.64	0.92
M09	18.00	17.64	0.98
M10	13.25	17.64	1.33
M11	11.88	17.64	1.48
M12	11.02	17.64	1.60
M13	11.48	17.64	1.54

autumn 2006			
obs. site	h (obs.)	xh (obs.)	corr. fac.
S01	28.08	17.64	0.63
S02	18.63	17.64	0.95
S03	20.58	17.64	0.86
S04	19.73	17.64	0.89
S05	19.67	17.64	0.90
S06	20.28	17.64	0.87
S07	21.08	17.64	0.84
S08	18.42	17.64	0.96
S09	17.82	17.64	0.99
S10	16.22	17.64	1.09
S11	14.33	17.64	1.23
S12	16.00	17.64	1.10
S13	13.82	17.64	1.28

spring 2007			
obs. site	h (obs.)	xh (obs.)	corr. fac.
M01	25.38	23.17	0.91
M02	22.47	23.17	1.03
M03	20.88	23.17	1.11
M04	21.50	23.17	1.08
M05	21.50	23.17	1.08
M06	21.28	23.17	1.09
M07	21.75	23.17	1.07
M08	24.50	23.17	0.95
M09	23.75	23.17	0.98
M10	24.75	23.17	0.94
M11	23.75	23.17	0.98
M12	25.50	23.17	0.91
M13	24.00	23.17	0.97

spring 2007			
obs. site	h (obs.)	xh (obs.)	corr. fac.
S01	23.75	23.17	0.98
S02	22.75	23.17	1.02
S03	22.67	23.17	1.02
S04	24.00	23.17	0.97
S05	21.70	23.17	1.07
S06	23.05	23.17	1.01
S07	22.83	23.17	1.01
S08	22.00	23.17	1.05
S09	23.00	23.17	1.01
S10	22.93	23.17	1.01
S11	24.00	23.17	0.97
S12	25.00	23.17	0.93
S13	25.70	23.17	0.90

3 Results

3.1 Autumn 2006

3.1.1 Standardized Daytime Field Observations — General Migration Patterns

3.1.1.1 Number of Migrating Birds, Species Composition and Flock Size

During standardized field observations in autumn 2006, a total of 39,687 birds from 28 relevant species were recorded within the concessionary area (see Annex III). With almost 62 % of all migrating birds the number of individuals along the S-line was higher than along the M-line (Figure 3.1), although the observed area was smaller (mostly twofold, see Table 2.2). The difference was mainly caused by White storks (*Ciconia ciconia*), which migrated more numerously and frequently along the S-line (see Annex III). Thus, White storks represent more than 51 % of all birds along the S-line, while the portion along the M-line is about 31 %. The only other species, which occurred quite numerously, yet in a markedly lower number, was Honey buzzard (*Pernis apivorus*; Figure 3.1). Four species of special interest (due to their Red List Category, see Chapter 2.2.2) occurred in very low numbers: Pallid harrier (81 individuals), Lesser kestrel (31 individuals), Red-footed falcon (3 individuals) and Egyptian vulture (6 individuals) (Note that there might have been further individuals of these species, which might be found under Harriers (*Circus spec.*), Falcons (*Falco spec.*) or undetermined raptors (see Annex III)).

In autumn 2006 a total of 1,117 recordings were made within the concessionary area (see Annex III). Again, the number of recordings was higher along the S-line (Figure 3.1). Both, along the M- and the S-Line, the most frequently seen species was Honey buzzard (about 13 % and 23 % of all recordings, respectively). Other species which occurred comparably often but in markedly lower frequencies were Harriers and White storks (Figure 3.1). These species together constitute more than 78 % of all recordings.

Although large flocks occurred rarely, they have a strong effect on the data set. On the whole there were only twelve flocks with more than a thousand individuals, representing more than 51 % of all migrating birds (Figure 3.2). In contrast, the fraction of birds migrating individually was about 56 % of all recordings but not much more than 1 % of all birds (Figure 3.2). Together single birds plus flocks with up to ten individuals constitute 82 % of all recordings.

3.1.1.2 Altitude of Migration and Flight Directions

The majority of all birds used altitudes above 199 m (Figure 3.3). By contrast, almost 50 % of all recordings occurred below 100 m. This difference was mainly caused by Harriers, which usually migrated individually (and thus had little influence on the variable "number of birds") at altitudes below 100 m (Figure 3.3). This result applies to the Pallid harrier as well.

Contrary to Harriers, White storks migrated most numerously above 199 m. Nevertheless a portion of about 28 % of all birds was recorded below 100 m, and the number of recordings was highest at altitudes below 100 m, indicating a difference in flight altitude of small flocks on the one hand and great flocks on the other hand: small flocks tended to fly lower.

Considering both, number of birds as well as number of recordings, Honey buzzards seemed to prefer altitudes higher than 199 m, although they were quite common at altitudes below 100 m, too (Figure 3.3).

Lesser kestrels, apart from Pallid Harrier another species of special interest, were seen within every category, but seemed to prefer altitudes above 199 m. Since Egyptian vulture and Red-footed falcon were very rare, the data gives no reliable information about altitude distribution of these species.

The majority of birds migrating through the concessionary area in autumn 2006 had southern flight directions (Figure 3.4, mainly south to southwest). Less than 10 % of all birds migrated in eastern, northern and western directions. Taking all recordings into account, the pattern is consistent.

In the southern middle part (M05-M07 & S05-S07) of the concessionary area a small, but notable fraction of flights in western direction occurred (Figure 3.4).

3.1.1.3 Migratory Activity

In approximately 50 % of all observation units not a single individual of one of the 39 relevant species passed through the part of the concessionary area under observation (Figure 3.5). Furthermore, in over 30 % of all observation units migration rate was lower than 10.0 birds per hour, whereas in about 6 % of all observation units a high migration rate (> 100 birds per hour) was recorded on the monitored area (19.63 km^2). Although the fraction of observation units without any relevant individual was somewhat lower along the S-line, overall there was no considerable difference in the frequency distribution of migration rate along the M- and the S-line.

Consequently, no migration or a low migration rate was detectable during most observation units, even if migratory activity is described by the variable "recordings per hour". The number of observations with a high migration rate (> 19.9 recordings per hour) was very low (Figure 3.5).

Mean migration rate for all observation units and sites was about 104 birds per hour with a standard deviation of about 700 birds per hour (M-line: 56 ± 324 birds/h, S-line: 147 ± 913 birds/h). This high standard deviation clearly shows that the mean is not a valid measure to describe migratory activity within the concessionary area (see Chapter 2.2.4).

Using the median as a measure, we obtain an average migration rate of 1.25 bird per hour (1. quartile: 0.0 bird/h, 3. quartile: 7.5 birds/h), indicating i) a high variance in migratory activity between observation units, and ii) a low migration rate during most observation units. The average

migration rate for the M- and the S-line was 0.0 and 3.0 birds/h, respectively, with a high variance again (Figure 3.6).

Mean migration rate for all observations units and sites was 3.3 recordings per hour with a standard deviation of 6.7 recordings per hour (M-line: 2.0 ± 4.4 recordings/h, S-line: 4.5 ± 8.0 recordings/h). Using the median as a measure, we obtain an average migration rate of 1.0 recording per hour (1. quartile: 0.0 recording/h, 3. quartile: 4.0 recordings/h). The average migration rate for the M- and the S-line was 0.0 and 2.0 recordings/h, respectively (Figure 3.6).

These results clearly show that migratory activity was markedly higher along the S-line.

3.1.1.4 Temporal and Spatial Distribution of Migratory Activity

As migration rates differed significantly between observation units, so did daily migration rates. Nevertheless, migration showed a clear pattern during the entire investigation period. Almost 97 % of all birds and almost 63 % of all recordings occurred during the first month of observations (August 20th and September 20th). Yet even within this period, observation units with a very low or no migration of relevant species occurred. After this period, which comprises about 35 % of all observation units, single birds and small flocks dominated migration. The largest flock recorded after September 20th had 150 individuals.

By contrast, the number of recordings was quite low within the first two weeks of observation (as well as during the last six weeks). Between September 7th and October 5th, making up about 46 % of all observation units, roughly 76 % of all recordings occurred.

Since migration rate differed significantly between observation units, there was also a high variation in migration rates throughout the day. Nevertheless, analyzing migration rate in relation to period of day, there is a weak tendency of lower migration rates during midday (Figure 3.7).

The total number of birds (corrected for time and area, see Chapter 2.2.4) differed significantly between observation sites as well as between M- and S-line. The number of birds and the number of recordings along the S-line was markedly higher (mostly twofold and more) than along the M-line (Figure 3.8 and 3.9).

Along the M-line there were some sites with a medium to high total number of migrating birds (M01, M03, M05, M06, M08), whereas the numbers of birds at other sites were rather low (Figure 3.8). The total number of recordings at observation sites along the M-line mostly was between 20 and 40, with higher numbers at M02, M03, M11 and M12. Thus the high number of birds at M01, M05 and M06 is attributable to a few large flocks. To summarize, the analysis of migratory activity shows no clear spatial pattern along the M-line.

The very high number of birds at S07 mainly resulted from three flocks of White Storks with more than 1,500 individuals each. Furthermore, the numbers of birds were very high at S01 to S04 and at S12. Considerably lower numbers were detected especially at S05, S10, S11 and S13 (Figure 3.9).
The total number of recordings at observation sites along the S-line mostly was between 60 and 80, with very high numbers at S01 and S02. In short, migration seemed to be very high in the southern part (S01 to S04), while there was no clear spatial pattern in the rest of the concessionary area.

3.1.2 Standardized Daytime Field Observations - Birds Migrating at Altitudes below 200 m

3.1.2.1 Number of Migrating Birds, Species Composition and Flock Size

During standardized field observations in autumn 2006 a total of 16,311 birds from 27 relevant species were recorded within the concessionary area at altitudes below 200 m (see Annex IV). With 64 % of all migrating birds, the number of individuals along the S-line was higher than along the M-line (see Figure 3.10), despite the smaller size of the observed area (mostly twofold, see Table 2.2). The difference was caused by White storks which make up for more than about 54 % of all birds along the S-line, while the portion along the M-line was about 26 %. The only other species numerously occurring at altitudes below 200 m was Honey buzzard (Figure 3.10). These two species constitute up to 95 % of all migrating birds.
In contrast to the number of birds, the number of recordings was slightly higher at the M-line (Figure 3.10). Both, along the M- and the S-Line, the most frequently detected species were Honey buzzard and Marsh harrier (*Circus aeruginosus*). Undetermined Harriers as well as White storks and Falcons occurred often but at markedly lower frequencies (Figure 3.10). These species constitute about 85 % of all recordings.

Species of special interest occurred at low to very low numbers at altitudes below 200 m: Pallid harrier (62 individuals), Lesser kestrel (11 individuals) Red-footed falcon (2 individuals) and Egyptian vulture (2 individuals). (Note that there might have been further individuals of these species, which might be found under Harriers (*Circus spec.*), Falcons (*Falco spec.*) or undetermined raptors; see Annex IV.)

Although large flocks occurred rarely, they have a strong effect on the data set. All in all there were only four flocks with more than thousand individuals constituting about 37 % of all migrating birds (Figure 3.11). In contrast, the fraction of birds migrating individually is about 63 % of all recordings but make up only about 3 % of all birds. Together single birds and flocks with up to ten individuals constitute over 87 % of all recordings.

3.1.2.2 Flight Directions

The distribution of flight directions of birds / recordings at altitudes below 200 m shows no distinctive difference to the overall distribution (see Figure 3.4). The majority of birds had southern flight directions, mainly south to southwest.

3.1.2.3 Migratory Activity

In about 64 % of all observation units no individual of one of the 39 relevant species passed through the observed part of the concessionary area at altitudes below 200 m (Figure 3.12). Furthermore, in over 25 % of all observation units migration rate was relatively low (< 10 birds per hour), whereas in about 3 % of all observation units a high migration rate (> 100 birds per hour) was recorded. There is no substantial difference in the frequency distribution of migration rate at the M- and the S-line.

Consequently, no migration or a low migration rate occurred in most observation units, even if migratory activity is described with the variable "recordings per hour". The number of observations with a high migration rate (> 19.9 recordings per hour) was very low (Figure 3.12).

Mean migration rate over all observation units and sites was about 28 birds per hour (on the monitored area of 19.63 km^2) with a standard deviation of about 185 birds per hour (M-line: 21 ± 151 birds/h, S-line: 34 ± 211 birds/h).

Using the median as a measure, we obtain an average migration rate of 0.0 bird per hour (1. quartile: 0.0 bird/h, 3. quartile: 1.5 birds/h), indicating i) a high variance in migratory activity between observation units, and ii) a very low migration rate at altitudes below 200 m on most days.

Mean migration rate over all observations units and sites was 1.5 recordings per hour with a standard deviation of 3.5 recordings per hour (M-line: 1.4 ± 3.8 recordings/h, S-line: 1.5 ± 3.1 recordings/h). Using the median as a measure, we obtain an average migration rate of 0.0 recording per hour (1. quartile: 0.0 recording/h, 3. quartile: 1.5 recording/h).

3.1.2.4 Spatial Distribution of Migratory Activity

As in the overall sample, the total number of birds at altitudes below 200 m (corrected for time and area, see Chapter 2.2.4) differed significantly between observation sites and between M- and S-line. The number of birds as well as the number of recordings along the S-line were markedly higher (mostly twofold and more) than along the M-line (Figure 3.13 and 3.14).

At M03, M06 and M08 medium to high numbers of birds were recorded, which was caused by single flocks of 800 or more White storks. By contrast, the total number of birds was quite low at all other sites along the M-line.

The total number of recordings at observations sites along the M-line mostly lay between 10 and 30, with higher numbers at M02 and M03 (Figure 3.13). In summary, the analysis of migratory activity at altitudes below 200 m shows no clear spatial pattern along the M-line.
Along the S-line considerably higher numbers of birds were detected at S01 to S03 and S07 (Figure 3.14), whereas the numbers of birds were quite low at six sites (S05, S06, S08, S10, S11 and S13). A high number of recordings occurred at S01 to S03. Regarding S07, it is obvious that the high numbers of birds resulted from a few larger flocks. In summary, migration at altitudes below 200 m seemed to be very high in the southern part (S01 to S03), while there was no clear spatial pattern in the rest of the concessionary area.

The spatial distribution of species of special interest migrating at altitudes below 200 m is given in Figure 3.15. Pallid harrier occurred at almost all observation sites in low numbers, whereas the other species mostly occurred individually at a few sites.

The average smoothened number of birds / recordings over all 26 observation sites was 976 ± 1,032 birds and 40 ± 32 recordings. Again, the number of birds / recordings along the S-line was markedly higher than along the M-line (Figure 3.16, 3.17 and Annex Xai and Xaii).
After smoothening the data the number of birds along the M-line shows no clear spatial pattern (Annex Xai). Numbers of birds / recordings were about average or considerably lower. Still, the lowest number of birds (and recordings) occurred at M10 to M13 (as well as at M01, Figure 3.16).
Along the S-line numbers of birds / recordings were definitely above average at S01 to S03 (Figure 3.17), whereas it was medium to low at the other sites (except for S07). Thus, apart from the southern part of the concessionary area, autumn migration shows no clear spatial distribution along the S-line.

3.1.3 Non-Standardized Observations of Migrating and Resting Birds within the Concessionary Area

3.1.3.1 Migrating Birds within the Concessionary Area

During standardized field observations in autumn 2006 a total of 31,569 birds from 16 relevant species were recorded at distances of more than 2.5 km to the observer (Annex V). White stork, which constitutes almost 84 % of all birds, was the dominant species. The only other frequently occurring species were Honey buzzard, White pelican (*Pelecanus onocrotalus*) and Black stork (*Ciconia nigra*) but all at markedly lower numbers (about 8 %, 6 % and 2 % of all birds, respectively).

Honey buzzard was the most frequent species at about 30 % of all recordings. Other species or groups of species which occurred often but in markedly lower frequencies, were White stork (20 %), Harriers (19 %), undetermined raptors (12 %) and Black stork (9 %). Consequently, these species or groups of species constitute 90 % of all recordings.

Thus, species composition of birds observed at distances of more than 2.5 km from the observer seems to be comparable to the data set, which was obtained by standardized observations.

3.1.3.2 Birds Resting within the Concessionary Area

During standardized field observations in autumn 2006 a total of 6,843 resting birds were seen at distances below 2.5 km to the observer. White stork was the dominant species (6,823 individuals). Resting White storks occurred primarily in the southern part of the concessionary area (Figure 3.18), but in low numbers at observation site M11 and S12 too. Apart from White storks, single Harriers as well as two Black storks and Honey buzzards were recorded resting within the concessionary area.

Another 28 resting birds were seen at distances above 2.5 km to the observer.

3.2 Spring 2007

3.2.1 Standardized Daytime Field Observations — General Migration Patterns

3.2.1.1 Number of Migrating Birds, Species Composition and Flock Size

During standardized field observations in spring 2007 a total of 95,067 birds from 31 relevant species were recorded within the concessionary area (see Annex VI). With 54 % of all migrating birds the number of individuals along the S-line was somewhat higher than along the M-line (see Figure 3.19), despite the smaller size of the observed area (mostly twofold, see Table 2.2). The difference was mainly caused by a single flock of 25,000 White storks at observation site S07. Thus, White storks constitute almost 42 % of all birds along the S-line, while the portion along the M-line was about 23 %. Other species, which occurred often but in markedly lower numbers, were Steppe buzzard (*Buteo buteo vulpinus)*, Levant sparrowhawk (*Accipiter brevipes*) and Common crane (*Grus grus*; Figure 3.19). These four species constitute up to 94 % of all migrating birds. Levant sparrowhawks and — to a lower degree — Steppe buzzards were recorded mainly along the M-line (88 % and 66 % of all individuals, respectively).

Five species of special interest occurred in low numbers: Spotted eagle (8 individuals), Eastern imperial eagle (1 individual), Pallid harrier (11 individuals), Lesser kestrel (20 individuals) and Egyptian vulture (54 individuals). (Note that there might have been further individuals of these species, which might be found under Eagles (*Aquila spec.*), Harriers, Falcons or undetermined raptors; see Annex VI.)

In contrast to the number of birds, the number of recordings was higher at the M-line (see Figure 3.19). Both, along the M- and the S-Line, the most frequently seen species was Steppe buzzard (22 % and 23 % of all recordings, respectively). Other species, which occurred often but at markedly lower frequencies, were Steppe eagle (*Aquila nipalensis*) and Black kite (*Milvus migrans*; Figure 3.19). These three species constitute more than two-thirds of all recordings.

Although large flocks occurred quite seldom, they have a strong effect on the data set. All in all there were only twelve flocks with more than thousand individuals, which constitute more than 50 % of all migrating birds (see Figure 3.20). In contrast, the share of individually migrating birds is about 45 % of all recordings but not much more than 1 % of all birds (see Figure 3.20). Single birds and flocks with up to ten individuals together constitute over 80 % of all recordings.

3.2.1.2 Altitude of Migration and Flight Directions

The majority of all birds / recordings used altitudes above 199 m (Figure 3.21). The portion of recordings in the lowest altitude class is about twice as much as the portion of birds, indicating a difference in flight altitude of single birds and small flocks on the one hand and great flocks on the other: single birds and small flock tended to fly lower.

The altitude distribution differed slightly between species: Eagles usually migrated distinctly higher than 199 m (Figure 3.21). Only a small number of Eagles were recorded at altitudes below 100 m. In contrast, Steppe buzzards were quite common in altitudes below 199 m, although they seemed to prefer altitudes above 199 m, too (Figure 3.21). The above-mentioned difference in flight altitude in consideration of flock size obviously resulted from migrating behaviour of Steppe buzzard (see Figure 3.21). White storks migrated most frequently above 199 m (Figure 3.21). Nevertheless, a portion of about 20 % was recorded below 100 m. Differences of flight altitude in consideration of flock size of White Storks seemed to be rather small.

As shown above for all Eagles, also Spotted Eagle and Eastern imperial eagle, two species of special interest, clearly preferred flight altitudes above 199 m. Only one individual (of nine) was recorded at an altitude below 199 m. This result applies to Egyptian vulture as well: 46 of 54 individuals used flight altitudes above 199 m. By contrast, all Pallid harriers (11 individuals) migrated at altitudes below 100 m. And also Lesser kestrels, another species of special interest, seemed to prefer altitudes below 100 m (15 of 20 individuals).

The majority of birds migrating through the concessionary area had northern flight directions (NW to NE; Figure 3.22). Less than 10 % of all birds migrated in eastern, southern or western directions. Considering all recordings, the pattern is comparable.

In the southern (M01-M04 & S01-S04) and northern (M11-M13 & S11-S13) part of the concessionary area, northern directions dominated even more. Flights in eastern and western directions were very rare in the northern part (Figure 3.22). In contrast, eastern directions — towards Gabal el Zayt — were sometimes recorded further south. Western flight directions — towards the Red Sea Mountain chain — occurred mainly in the middle part of the concessionary area (M05-M10 & S05-S10), but were not very common. The portion of flights in northern directions was conspicuously lower at sites M08-M10 & S08-S10, whereas the relative abundance of birds flying in southern directions (mainly southeast) was higher. This result can be attributed to a small number of large flocks because the relative abundance of recordings (with southern directions) was low.

In the northern part of the concessionary area (M11-M13 & S11-S13) about 52 % of all birds (35 % of all recordings) were flying approximately parallel to the coast of the Red Sea with a northwest or north-northwest flight direction.

3.2.1.3 Migratory Activity

In over 40 % of all observation units no individual of one of the 39 relevant species passed through the observed part of the concessionary area (Figure 3.23). Furthermore, in about 30 % of all observation units, migration rate was comparably low (< 10 birds per hour), whereas in 15 % of all observation units a high migration rate (> 100 birds per hour) was detected. There is no considerable difference in the frequency distribution of migration rate at the M- and the S-line.

Consequently, no migration or a low migration rate occurred in most observation units, even if migratory activity is given as the variable "recordings per hour". The number of observations with a high migration rate (> 19.9 recordings per hour) was very low (Figure 3.23).

Mean migration rate over all observation units and sites was about 235 birds per hour with a standard deviation of about 2,121 birds per hour (M-line: 145 ± 516 birds/h, S-line: 325 ± 2,960 birds/h). The high standard deviation clearly shows that the mean is not a valid measure to describe migratory activity within the concessionary area (see Chapter 2.2.4).

Using the median as a measure, we obtain an average migration rate of 2.0 birds per hour (1. quartile: 0.0 bird/h, 3. quartile: 25.8 birds/h), indicating i) a high variance in migratory activity between observation units, and ii) a low migration rate on most days. The average migration rate for the M- and the S-line was 1.0 and 2.0 birds/h, respectively, again with a high variance (Figure 3.24).

Mean migration rate over all observations units and sites was 6.1 recordings per hour with a standard deviation of 12.0 recordings per hour (M-line: 4.6 ± 8.5 recordings/h, S-line: 7.5 ± 14.5 recordings/h). Using the median as a measure, we obtain an average migration rate of 1.6 recording per hour (1. quartile: 0.0 recording/h, 3. quartile: 6.1 recordings/h). The average migration rate for the M- and the S-line was 1.0 and 2.0 recordings/h, respectively (Figure 3.24).

3.2.1.4 Temporal and Spatial Distribution of Migratory Activity

As migration rate differed significantly between observation units, there was a very high variation in daily migration rates, too. Consequently, the migration rate shows no clear pattern over the whole period of investigation. Nevertheless, there is a weak tendency of higher migration rates between March 18th and April 26th. During this period, which covers about 53 % of all observation units, about 87 % of all birds and 74 % of all recordings were observed. But observation units with a very low or no migration of relevant species still occurred during this period. Furthermore, even before and after this period a high daily migration rate was occasionally recorded.

Since migration rates differed significantly between observation units, there was a high variation in migration rates throughout the day as well. As a consequence, concerning the period of day, migration rate shows no clear pattern. Nevertheless, there is a weak tendency of lower migration rates in the afternoon (Figure 3.25).

The total number of birds (corrected for time and area, see Chapter 2.2.4) differed significantly between observation sites.
Along the M-line at M02 and M07 high numbers of birds were recorded, whereas the numbers of birds at M11 to M13 and especially at M01 were rather low (Figure 3.26). The total number of recordings at observation sites along the M-line was mostly between 80 and 100, with higher numbers at M03, M06 and M07 and conspicuously lower numbers at M01 and M02. Thus the high number of birds at M02 must be attributed to a few large flocks. In summary, the analysis of migratory activity shows no clear spatial pattern along the M-line.
The very high number of birds at S07 resulted from a single flock of 25,000 White Storks. Considerably low numbers of birds were detected especially at S05 and S13 (Figure 3.27). Furthermore, at S05 and at S10 to S13 the numbers of recordings were rather small. Disregarding the low numbers of recordings at S05, migration seemed to be high in the southern and middle part of the concessionary area (S01 to S09) and lower at S10 to S13.
The number of recordings along the S-line was markedly higher (mostly twofold and more) than along the M-line, while there was no clear difference between M- and S-line in the number of birds (Figure 3.26 and 3.27).

3.2.2 Standardized Daytime Field Observations — Birds Migrating at Altitudes below 200 m

3.2.2.1 Number of Migrating Birds, Species Composition and Flock Size

During standardized field observations in spring 2007 a total of 27,649 birds from 29 relevant species were recorded within the concessionary area at altitudes below 200 m (see Annex VII). With 60 % of all migrating birds, the number of individuals along the M-line was somewhat higher than along the S-line (see Figure 3.28; but note the smaller observed area of sites along the S-line). White storks constituted nearly 40 % of all birds along the M-line, while the portion along the S-line was almost 25 %. The only other species which occurred quite numerously at altitudes below 200 m was Steppe buzzard (Figure 3.28). These two species constitute about 88 % of all migrating birds.
In contrast to the number of birds, the number of recordings was higher along the S-line (Figure 3.28). Both, along the M- and the S-Line, the most frequently seen species was Steppe buzzard. Another species, which occurred often but in a markedly lower frequency, was Black kite (Figure 3.28). These two species constitute two-thirds of all recordings.
Species of special interest occurred in low to very low numbers at altitudes below 200 m: Spotted eagle (1 individual), Pallid harrier (10 individuals), Lesser kestrel (20 individuals) and Egyptian vulture (8 individuals). (Note that there might have been further individuals of these species, which might be found under Eagles, Harriers, Falcons or undetermined raptors; see Annex VII.)
Although large flocks occurred rarely, they have a strong effect on the data set. All in all there were only four flocks with more than a thousand individuals, constituting more than 36 % of all migrating

birds (see Figure 3.29). By contrast, the fraction of birds migrating individually was about 51 % of all recordings but not much more than 2 % of all birds. Together single birds and flocks with up to ten individuals constitute over 86 % of all recordings.

3.2.2.2 Flight Directions

The majority (about 60 %) of birds / recordings at altitudes below 200 m had northern flight directions (NW to NE; Figure 3.30). But, compared to the whole sample (Figure 3.22) northern flight directions occurred less often. At altitudes below 200 m, eastern and southern directions constituted between 15 % and 20 % of all birds / recordings, and thus were more frequent than in the whole sample. Flights in western directions were very rare.

In the southern part of the concessionary area (M01-M04 & S01-S04) the northern directions dominated even more, and over 26 % of all birds took eastern directions (Figure 3.30). Obviously, these individuals were heading towards Gabal al Zayt, presumably to cross the Red Sea. Eastern directions were recorded in the other parts of the concessionary area, too. In the middle parts (M05-M10 & S05-S10) it must have been mainly single birds, because the relative frequency of recordings was much higher compared to the relative frequency of birds.

In the middle parts (especially at M08-M10 & S08-S10) southern flight directions occurred quite often (Figure 3.30). Most of these birds took a southeast direction and thus were presumably heading towards Gabal el Zayt after having migrated along the Red Sea Mountain chain in northern directions. There must have been some larger flocks with eastern flight directions, because the relative frequency of recordings was much lower compared to the relative frequency of birds.

Western flight directions — towards the Red Sea Mountain chain — occurred mainly in the northern middle part of the concessionary area (M05-M10 & S05-S10).

In the northern part of the concessionary area (M11-M13 & S11-S13) about 42 % of all birds (35 % of all recordings) at altitudes below 200 m were flying approximately parallel to the coast of the Red Sea with a northwest or north-northwest flight direction.

3.2.2.3 Migratory Activity

In about 54 % of all observation units no individual of one of the 39 relevant species passed through the observed part of the concessionary area at altitudes below 200 m (Figure 3.31). Furthermore, in about 30 % of all observation units migration rate was relatively low (< 10 birds per hour), whereas in about 6 % of all observation units a high migration rate (> 100 birds per hour) was recorded. There is no considerable difference in the frequency distribution of migration rates at the M- and the S-line.

Consequently, no migration or a low migration rate occurred in most observation units, even if migratory activity is given by the variable "recordings per hour". The number of observations with a high migration rate (> 19.9 recordings per hour) was very low (Figure 3.31).

Mean migration rate over all observations units and sites was about 46 birds per hour with a standard deviation of about 280 birds per hour (M-line: 55 ± 356 birds/h, S-line: 36 ± 174 birds/h). Using the median as a measure, we obtain an average migration rate of 0.0 bird per hour (1. quartile: 0.0 bird/h, 3. quartile: 3.0 birds/h), indicating i) a high variance in migratory activity between observation units, and ii) a very low migration rate at altitudes below 200 m on most days.

Mean migration rate over all observations units and sites was 2.0 recordings per hour with a standard deviation of 4.5 recordings per hour (M-line: 1.7 ± 3.8 recordings/h, S-line: 2.3 ± 5.1 recordings/h). Using the median as a measure, we obtain an average migration rate of 0.0 recording per hour (1. quartile: 0.0 recording/h, 3. quartile: 2.0 recordings/h).

3.2.2.4 Spatial Distribution of Migratory Activity

The total number of birds at altitudes below 200 m (corrected for time, see Chapter 2.2.4) differed significantly between observation sites (Figure 3.32 & 3.33).

Especially at M02 a very high number of birds was recorded, having been caused by a single flock of 5,500 White storks. Consequently, the number of recordings at M02 was on an average level (Figure 3.32). Furthermore, a higher number of birds occurred at M05 and — to a lower degree — at M04 and M10, whereas it was rather low at M01, M03, M08 and M11 to M13. The total number of recordings at observations sites along the M-line mostly was between 30 and 50, with higher numbers at M06 and M10 and lowers numbers at M01, M11 and M12. In summary, the analysis of migratory activity at altitudes below 200 m shows no clear spatial pattern along the M-line.

Along the S-line considerably higher numbers of birds were detected at S07 to S09 (Figure 3.33), whereas the numbers of birds was lower especially at S05, but also at S02 S04, S06, S11 and S13. The total number of recordings at observations sites along the S-line mostly was between 90 and 110, with higher numbers at S03, S04 and — to a certain degree — at S07 and S08. In contrast, the number of recordings at S05, S10, S11 and S13 were conspicuously below average. Consequently, the high numbers of birds at S07 to S09 resulted from larger flocks, while at S03 and S04 a comparably great number of birds migrated individually or in small flocks.

The number of recordings along the S-line was markedly higher (mostly twofold or more) than along the M-line, while there is no clear difference in the number of birds.
The spatial distribution of species of special interest shows no clear spatial pattern (Figure 3.34). All species occurred mostly singularly at a few sites.
The average smoothened number of birds / recordings over all 26 observation sites was 1,441± 1,002 birds and 72 ± 40 recordings. Again, the number of recordings along the S-line was markedly higher (mostly twofold or more) than along the M-line, while there is no clear difference in the number of birds (Annex Xbi and Xbii). After smoothening the data, the number of birds along the M-line shows a clear spatial pattern with high numbers of birds in the south (M01 to M05) and a lower number in the north (M11 to M13) (Figure 3.35 and Annex Xbi).

3.2.3 Non-Standardized Observations of Migrating and Resting Birds within the Concessionary Area

3.2.3.1 Migrating Birds

During standardized field observations in spring 2007 a total of 64,199 birds from 18 relevant species were recorded at distances above 2.5 km to the observer (see Annex VIII). White stork, which constitutes nearly 77 % of all birds, was the dominant species. The only other species, which occurred abundantly, was Steppe buzzard (about 9% of all birds).
Steppe buzzard was the most frequent species with 30 % of all recordings. Other species or groups of species, which occurred quite often but in markedly lower frequencies, were Eagles, Common crane and Black kite. These four (groups of) species constitute up to 59 % of all recordings.

3.2.3.2 Resting Birds

During standardized field observations in spring 2007 a total of 1,902 resting birds were seen at distances below 2.5 km and another 13,890 birds at distances above 2.5 km to the observer. With about 91 % of all birds, White stork was the dominant species. Furthermore, some Common cranes (5 % of all individuals) and some Western reef herons (0,5 %) as well as single Steppe buzzards (1,7 %) were recorded.
Large flocks of White storks were recorded around the observation sites M04: three flocks with 8,000, 1,000 and 700 individuals each. Since observation of the two last-mentioned flocks occurred on one morning within two hours at adjacent sites, we cannot be sure if the same individuals were recorded twice (to some extent). Another large flock with 2,900 individuals rested near observation site M10 (Figure 3.37). Smaller flocks of more than 200 individuals were seen at M13 and S13 and flocks of less than 100 individuals at other sites (Figure 3.37).
Furthermore, between M01 and M06 some resting flocks of Common cranes and smaller flocks at other sites occurred. Spatial distribution of resting birds / flocks shows no clear pattern.

4 Assessment of the Importance of the Concessionary Area

4.1 General Migration Patterns

During the investigation between autumn 2006 and spring 2007 a high number of migrants passed through the concessionary area. In autumn 39,687 birds were recorded during 459 hours of observation. In addition, 31,569 birds migrated at distances above 2.5 km from the observer (Annex III & V). In spring the number of birds was even higher: 95,067 birds were observed during 604 hours, and another 64,199 birds migrated at distances above 2.5 km (Annex VI & VIII). Migratory activity within the concessionary area was much higher than at an observation site northwest of Zafarana, which was passed by 4,582 birds during 111 hours of observation within a four-week period in spring 2007 (BERGEN 2007).

White stork was the dominant species: in autumn about 83 % and in spring about 65 % of all birds were White storks (Figures 3.1 & 3.19). Other species recorded in noteworthy numbers were Honey buzzard (13 %) in autumn as well as Steppe buzzard (17 %) and Levant sparrowhawk (7 %) in spring. Other groups such as Harriers, Eagles or Falcons occurred in comparably small numbers.

Regarding the number of recordings, species composition was completely different: most recordings were due to Honey buzzard (36 %), Marsh harrier (18 %) in autumn as well as Steppe buzzard (45 %), Steppe eagle (12 %) and Black kite (10 %) in spring.

A comparison between the number of birds and the number of recordings indicates that

- White storks occurred quite rarely, but often in great flocks, which is quite typical for this species. In fact, the total number of White Storks was 32,938 in 83 flocks in autumn, amounting to an average flock size of 397 individuals, and 61,504 in 71 flocks in spring, amounting to an average flock size of 866 individuals.
- Levant sparrowhawks occurred even less (12 and 26 recordings during autumn and spring, respectively), but then mostly in great flocks, which is quite typical for this species, too.
- Honey buzzards, Black kites, Steppe eagles and, to a lower degree, Steppe buzzards regularly migrated individually or in small flocks.
- Harriers usually migrated individually.

The majority of birds migrated at altitudes above 199 m (59 % in autumn and 71 % in spring, see Figures 3.3 & 3.21). Nevertheless, 28 % (autumn) and 18 % (spring) of all birds were recorded below 100 m. By contrast, the share of recordings was lower at altitudes above 199 m and significantly higher at altitudes below 100 m. In autumn the number of recordings was actually highest at altitudes below 100 m (49 %). The differences in altitude distribution between birds and recordings indicate that single individuals and small flocks migrated at lower altitudes than larger flocks. This result is mainly due to Harriers migrating alone at low altitudes as well as to White storks (Figure 3.3). We

cannot exclude, however, that this finding is biased to a certain degree because flocks having more individuals are easier to detect at higher altitudes than single birds.
Autumn migration tended to occur at lower altitudes than spring migration owing to birds (especially White storks, see Figure 3.3) entering the concessionary area at low altitudes after having crossed the Red Sea.
Altitude distribution clearly differs between species:

- White storks migrated most numerously above 199 m. Still, a share of about 28 % (autumn) and 20 % (spring) of all birds was recorded below 100 m. The altitude distribution in spring fits very well to the findings of ORNIS CONSULT (2002). But during autumn 1998 and 1999 found a much higher portion of White storks (40,7 %) migrating at altitudes below 100 m than in this study.
- ORNIS CONSULT (2002) found that most Honey buzzard migrate high (above 200 m) in spring, but low (below 100 m) in autumn. Especially along the coast from Ras Gharib to Gabal el Zayt, high densities of low flying Honey buzzards were recorded (after crossing the Red Sea). The observations in autumn 2006 and spring 2007 do not confirm these findings. In autumn most Honey buzzards (54 %) used altitudes above 199 m, while this species did not occur in relevant numbers during spring migration. The different results might be explained by the fact that Honey buzzards (as well as White storks) had quickly gained altitude at Gabal el Zayt before entering the concessionary area (ORNIS CONSULT 2002 for Black stork). Furthermore, migration patterns are influenced by weather and wind conditions and thus may vary between years.
- In spring 2007 most Steppe buzzards migrated at altitudes above 199 m (59 %). Nevertheless a noteworthy share (22 %) of birds was recorded below 100 m. At KfW / DANIDA wind farm near Zafarana the proportion of birds below 100 m was rather low (4.9 %, BERGEN 2007), in accordance to the findings of ORNIS CONSULT (2002): 9.4 % of all Steppe Buzzards flew below 100 m. The higher portion of low flying Steppe buzzards within the concessionary areas might be due to birds crossing the coastal plains in eastern or southern directions alt low altitudes, heading for Gabal el Zayt.
- In accordance with ORNIS CONSULT (2002) Eagles were most frequently seen at altitudes above 199 m and Harriers migrated usually below 100 m.

In spite of the high number of migrants, there seemed to be no or low migration of relevant species over longer periods: in about 50 % (autumn) and 40 % (spring) of all observation units not a single of the 39 relevant species passed through the observed area, indicating that migration within the concessionary area was i) quite irregularly distributed over time, and ii) dominated by large flocks (as shown by Figures 3.2 & 3.20, large flocks have a strong effect on the data set, although they rarely occurred). As a consequence, migratory activity shows a high variation at every observation site as well as between different observation sites.

4.2 Importance of the Concessionary Area for Migration

4.2.1 Basic Considerations of Migration along the Red Sea Coast

In autumn there seem to be three major routes for large migrants:

1. A great number of birds cross the Gulf of Suez from the southern point of Sinai to Hurghada (MEYBURG & MEYBURG 2002). It was found that Ras Mohammed in South Sinai is a major bottleneck for migrating White Storks in autumn. A total of 275,743 individuals were counted by CELMINS in 1998 (BAHAL EL DIN unpubl.). CELMINS estimated that 390,000 to 470,000 birds occur in the area. But the majority of storks did not cross the Gulf of Suez in this area. Only about 87,700 storks or 30 % were observed crossing at Ras Mohammed (BAHAL EL DIN unpubl.). During the same season large numbers of White storks were seen reaching the western coast of the Red Sea at Gabal el Zayt. Also, ATTUM (according to MEYBURG & MEYBURG 2002) argued that the majority of storks cross further northwest from El Yora to Gabal el Zayt where the Gulf is substantially narrower (see also ORNIS CONSULT 2002). Therefore, in autumn Gabal el Zayt is considered to be a major bottleneck for White storks and other soaring species (e. g. Black stork, Honey buzzard). Although not well documented, ORNIS CONSULT (1999) argued that Gemsa bay, which is used as a resting site, might be the main crossing point for storks and other soaring birds in autumn. ORNIS CONSULT (2002) pointed out that large migrants arrive at the western coastline in a broad front between Gabal el Zayt in the north and up to Hurghada in the south – influenced by wind directions (see also MEYBURG et al. 2002). BAHAL EL DIN (unpubl.) also mentioned that Storks too were reported arriving at Hurghada, and that there is a need for surveys within the area between Hurghada and Safaga (and further south).
2. Large concentrations of soaring birds can also be found at Suez. These birds bypass the Gulf of Suez entirely at Suez in the north, heading further south along the Red Sea Mountain chain.
3. Finally, large migrants breeding in Asia mainly use a third migratory route along the eastern coast of the Red Sea along the Arabian Peninsula and cross the sea further south at Bab-el-Mendeb towards to Djibouti and Ethiopia. (e. g. Steppe eagle, MEYBURG et al. 2003 and MEYBURG & MEYBURG 2007).

During the northward spring migrations, two major streams appear to exist: one following the Red Sea coast up from Sudan, and another following the Nile Valley as far north as Qena crossing the Eastern Desert to the coast of the Red Sea. Both streams converge at the Gulf of Suez (ORNIS CONSULT 1999, see also MEYBURG et al. 2000 and MEYBURG et al. 2003). The migratory route over the Red Sea to Bab-el-Mendeb does not play a major role during spring migration. Consequently, at the western coast of the Golf of Suez bird numbers are much higher in spring than in autumn.

After reaching the western coast of the Gulf of Suez, birds either cross the southern Gulf to the Sinai or continue up the coast to Suez. Thus, in spring there are three bottlenecks along the coast, where large numbers of soaring birds congregate: at Suez, Ain Sukhna and Gabal el Zayt (ORNIS CONSULT 1999, BAHAL EL DIN unpubl.). Gabal el Zayt is the only mountain ridge adjacent to the coast in the southern

Gulf of Suez. Consequently, it serves as a stepping-stone for soaring birds using thermals to cross the Gulf of Suez (BirdLife International 2005). In spring, soaring birds, coming from the Red Sea Mountain chain and often flying at low altitudes, cross the coastal plain to Gabal el Zayt. Migration paths of these birds shift depending on weather and wind conditions. At Gabal el Zayt birds gain altitude in thermal uplifts before crossing the Gulf. Consequently, in spring Gabal el Zayt is thought to be the main crossing point for White storks, Honey buzzards and Levant sparrowhawks (Ornis Consult 1999, Bahal El Din unpubl.).
Nevertheless, Ornis Consult (2002) found much higher numbers of White storks avoiding the sea-crossing in spring (compared to the situation in autumn) and continuing north along the Red Sea Mountains to Suez. Furthermore, in spring the majority of other species, like Steppe buzzard, Black kite or Steppe eagle, are believed to follow the Red Sea Mountains north to Suez town, while a smaller proportion tries to cross the Gulf of Suez further south (if the northern wind is not too strong, Ornis Consult 2002).

Since most migrating species are of international conservation interest, Gabal el Zayt is nominated as an Important Bird Area (IBA) by BirdLife International. The IBA site consists of a narrow (about 10 km), 100-km-long strip extending along the Gulf of Suez / Red Sea coast, from Ras Gharib in the north to the bay of Ghubbet El Gemsa in the south (BirdLife International 2005). The concessionary area is situated in the west adjacent to the IBA, but is — as far as we know — not a part of the IBA (although we have no detailed information about the accurate boundaries of the IBA). Still, the importance of the area does not end at artificial boundaries of the IBA or the concessionary area. The results discussed above (Chapter 4.1) are in accordance with these basic considerations of migration patterns along the Red Sea and reveal that the concessionary area itself is of great importance. Bearing in mind that the observed migrants are only a fraction of the whole migration, the results of the investigation definitely showed that the concessionary area is situated within one of the most important migratory routes for birds, which are breeding in Europe, the Middle East and Asia and are wintering in tropical and southern Africa. Consequently, the concessionary area has a very high significance for migration of several bird species, which are of international conservational interest.

4.2.2 Preliminary Remarks to Spatial Differentiated Assessment

Commonly the importance of a site is assessed by two criterions: 1. the number of migrating birds / recordings, and 2. the conservational status (IUCN-Red List Category) of migrating species. In this process, species that are exposed to a higher threat are of special interest. As mentioned in Chapter 2.2.2, such species are Egyptian vulture (Endangered), Spotted eagle, Eastern imperial eagle, Lesser kestrel (all Vulnerable), as well as Pallid harrier and Red-footed falcon (both Near Threatened). The numbers of representatives of these species recorded within the concessionary area, however, was rather small and their spatial distribution showed no definite spatial pattern. All species occurred mostly singularly at a few sites. This means the conservational status of a species cannot qualify as a decisive criterion in assessing the significance of the concessionary area in a spatially differentiated way. As a consequence, the number of birds (heavily influenced by only one species: White stork) / recordings remains as the only criterion for assessment.

As discussed above, migration within the concessionary area was i) irregularly distributed over time, and ii) dominated by large flocks. Due to the high variation of migration and the short observation time at each site, it is not certain if the data set represents a valid sample of migration at the 26 observation sites. Thus, for statistical reasons it cannot be approved to extrapolate the observed numbers of birds in order to obtain a valid estimate of the overall migratory activity. Thus it does not seem advisable to assess the significance of each observation site in a strictly quantitative way. Furthermore, spatial patterns of migration through the desert plains of the concessionary area are influenced by weather and wind conditions and thus may vary among years. In summary, it is problematical to predict migratory activity at each of the 26 monitored areas (with 19.63 km^2 each) in a reliable way. Following the basic considerations mentioned in Chapter 4.2.1, it is possible to arrive at a rough estimate only of the spatial distribution of migration within the concessionary area and a first assessment of the importance of different parts of the concessionary area for migration (with special regard to migration at altitudes below 200 m). For this reason we used three classes: important, very important and extremely important for bird migration. However, statistical evidence of the assessment has to remain limited and calls for a conservative judgement.

4.2.3 Assessment of Spatially Differentiated Importance

Based on basic considerations and on the results obtained in this study, the spatial distribution of migration within the concessionary area can be described as follows (the following assessment is limited to migration below 200 m, but should be valid for all migratory activity):

Autumn Migration

In autumn we can expect a very high migratory activity in the southern and central part of the concessionary area, especially in those parts close to the coast, covered in the study by observation sites S01 to S07, because we can suppose large numbers of migrants to cross the Gulf of Suez from the south of Sinai and to arrive at the western coastline in a broad front between Gabal el Zayt in the north and up to Hurghada in the south. Additionally, birds cross the Gulf near Suez following the western coast of the Red Sea and thus migrating through the concessionary area in south-eastern direction.

In fact, the smoothened number of birds / recordings at altitudes below 200 m was highest at S01 to S03 (Figure 3.17). As mentioned above, after the crossing of the Gulf of Suez, many soaring birds arrive tired, flying at low altitudes and often landing in large numbers. White storks were commonly seen resting at the bay adjacent to S03 and S04. Furthermore, higher numbers occurred at S07 and S08 (Figure 3.17).

In contrast, the number of birds / recordings at altitudes below 200 m along the M-line was much lower (Figure 3.16), indicating that most birds (the great flocks of White storks and Honey buzzards) took a southern direction after arriving at Gabal el Zayt. Nevertheless, at least some birds (possibly species which usually migrate individually or in smaller flocks) seem to migrate in south-western or western direction (between M05 and M07, see Figure 3.4) heading for the foothills of the Red Sea Mountains. So, these birds cross the concessionary area between M01 and M06. In addition, ORNIS CONSULT (2002) reported that high densities of storks flying below 100 m were regularly recorded over the coastal plains west and southwest of Gabal el Zayt and that sometimes storks landed on the plains (see also Figure 3.18) as well as on the beach. Thus, taking into account that spatial distribution might vary from year to year, it is fully justified to regard the southern and central part of the concessionary area (S01 to S07 and M01 to M06) as extremely important for autumn migration.

It seems unlikely that a large number of birds, after crossing the Gulf of Suez, pass the concessionary area at observations site north of M06 and S07. Most birds recorded in the northern part of the concessionary area should have taken the migratory route along the western coast of the Gulf. Still, we cannot exclude that birds enter the area from northeast at S08 or S10 under certain circumstances. Thus, in terms of a conservative judgement is seems appropriate to regard the area around M07 to M09 and S08 to S10 as very important for autumn migration.

For the far north of the concessionary we can suppose to find birds which take the migratory route along the western coast of the Red Sea. This part of the area consists of large desert plains, which extend very far into the inland in western direction. Thus, compared to the south the terrain opens out, so there seems to be no reason to suppose that there might be a recognizable topographical bottleneck. In fact, the smoothened number of birds / recordings at altitudes below 200 m was comparatively low to very low (Figure 3.16 & 3.17). Especially, the lowest number of birds / recordings was observed at M10 to M13. Consequently, this part of the concessionary area can be regarded as important for autumn migration.

Spring Migration

In spring we can expect a very high migratory activity in the southern part of the concessionary area, specifically from observation sites S01 to S06 and M01 to M05, because we can expect that both streams of migrants coming from the south converge at the Gulf of Suez (see Chapter 4.2.1). A large number of migrants head for Gabal el Zayt in order to gain height and subsequently cross the Gulf of Suez from there. Although some birds might take a more eastern route to Gabal el Zayt, most birds have to pass through the southern part of the concessionary area, at least at observation site S01 to S03.

Surprisingly, at observation sites S01 to S05 the smoothened number of birds at altitudes below 200 m was comparably low, while the smoothened number of recordings below 200 m was high (see Figure 3.36). By contrast, at M01 to M06 the smoothened number of birds was high (above average), while we the smoothened number of recordings was low (like at all sites along the M-line). We suggest that these findings can be explained by the following hypotheses (which are not exclusive and thus might combine):

- Regarding total migration in the southern part of the concessionary (Figure 3.27) it became obvious that the number of birds at S01 to S04 was high indicating that migratory activity at these sites predominately occurred at altitudes above 199 m. Furthermore, the difference pattern at S01 to S05 in the smoothened number of birds on the one hand and the smoothened number of recordings on the other clearly shows that migration at altitudes below 200 m was dominated by single birds or small flocks, whereas larger flocks seemed to occur seldom below 200 m. This is in accordance to our findings that large flocks tend to fly at higher altitudes (see Chapter 3.2.1.2). In summary, there was a high migratory activity at S01 to S04, which was caused by large flocks at altitudes above 199 m.
- Considering the high smoothened number of birds at altitudes below 200 m at M01 to M06 we additionally suggest that at least a portion of migrants coming from the south might initially head for the Red Sea Mountains instead of flying directly to Gabal el Zayt. It is well known that, for example, White storks land in the foothills of the Red Sea Mountains to rest for the night (ORNIS CONSULT 2002). Afterwards these birds might either follow the Red Sea Mountain chain to go for

Suez, or cross the coastal plains (and thus the concessionary area) to head for Gabal el Zayt. This would also explain the high smoothened number of birds migrating at S07 and to S09 at altitudes below 200 m (see Figure 3.36).

Therefore, during spring we can expect large numbers of birds coming from the south and passing through the area between S01 to S06 and / or M01 to M05 in north-eastern direction directly heading for Gabal el Zayt. Additionally, in the area between S01 to S09 and / or M01 to M09 we can expect

- birds coming from the Red Sea Mountains and passing through the concessionary area in eastern direction heading for Gabal el Zayt;
- birds coming from the south and passing through the concessionary area in northern direction following the western coast of the Gulf up to Suez; and finally
- low numbers of birds avoiding the sea-crossing at Gabal el Zayt, passing through the concessionary area in western or north-western direction to rest on the foothills of the Red Sea Mountains. (As shown in Figures 3.30 a notable portion (about 10 %) of birds / recordings passing through the concessionary area at M08 to M10 and S08 to S10 at altitudes below 200 m had a western flight direction. We can find this pattern at sites M05 to M07 and S05 to S07, too, if we consider flight direction of all migrating birds / recordings (see Figure 3.22).)

Consequently, acknowledging that spatial distribution might vary from year to year it is reasonable to regard the southern and central part of the concessionary area (S01 to S09 and M01 to M09) as extremely important for spring migration.

From a topographical point of view it seems unlikely that a large number of birds pass the concessionary area north of M09 and S09 in order to head for Gabal el Zayt in the southeast. Most birds recorded in the northern part of the concessionary area might have taken the migratory route along the western coast of the gulf up to Suez. Nevertheless, as Figure 3.30 shows, a sizeable portion of birds / recordings passing through the concessionary area at M08 to M13 and S08 to S13 at altitudes below 200 m had a southern and an eastern flight direction. Apparently, birds had followed the Red Sea Mountain chain so far north that they had to fly in south-eastern directions to reach the Gabal el Zayt. (Strong northern head winds that are common during spring, might have been another factor.)

Regarding migratory activity in the northern part of the concessionary area there is no prominent difference along the S-line (S10 to S13, see Figure 3.36), while migratory activity seemed to be lower at M12 and M13 compared to M10 and M11 (see Figure 3.35). Thus, in terms of a conservative estimate is seems appropriate to classify the area around S10 to S13 as well as around M10 and M11 as very important, while the area around M12 and M13 can be regarded as important for spring migration.

Table 4.1 gives an overview of the importance of the different parts of the concessionary area for autumn and spring migration. If we combine importance of autumn and spring migration it is reasonable to separate the concessionary area into three different sections:

- a northern section (M11 to M13 and S11 to S13) being important,
- a northern central section (M09 and M10 as well as S09 and S10) being very important and
- a central and southern section (M01 to M08 and S01 to S08) being extremely important for bird migration.

Table 4.1: Importance of the different parts of the concessionary area for autumn and spring migration and combined for total migration (red: extremely important; orange: very important; yellow: important)

obs. site	autumn	spring	total	obs. site	autumn	spring	total
M13	yellow	yellow	yellow	S13	yellow	orange	yellow
M12	yellow	yellow	yellow	S12	yellow	orange	yellow
M11	yellow	orange	yellow	S11	yellow	orange	yellow
M10	yellow	orange	orange	S10	orange	orange	orange
M09	orange	red	orange	S09	orange	red	orange
M08	orange	red	red	S08	orange	red	red
M07	orange	red	red	S07	red	red	red
M06	red	red	red	S06	red	red	red
M05	red	red	red	S05	red	red	red
M04	red	red	red	S04	red	red	red
M03	red	red	red	S03	red	red	red
M02	red	red	red	S02	red	red	red
M01	red	red	red	S01	red	red	red

4.2.4 Assessment of Species-Specific Importance

The results of the investigation clearly show that most parts of the concessionary area are of international importance for bird migration, especially for the migration of White storks and Honey buzzards in autumn, but also for migration of Steppe buzzards, Steppe eagles, Levant sparrowhawks, Black kites, Common cranes, Black storks and other birds of prey (*e.g.* Egyptian vulture, Spotted eagle, Lesser spotted eagle, Eastern imperial eagle, Short-toed eagle, which occur in lower numbers due to their small populations).

The region is not a bottleneck for Lesser kestrel, Pallid harrier and other Harriers, which migrate on a broad front between breeding and wintering sites. Ornis Consult (1999) pointed out that Falcons are very active fliers and are not dependent on thermals, so that they can cross the Gulf of Suez everywhere. Consequently, Falcons are not concentrated at any location. Harriers as well as Sparrowhawks are soaring birds that do rely on thermals to a limited extent and are able to cross large bodies of water. Harriers do not even avoid crossing the Mediterranean Sea.

4.3 Importance of the Concessionary Area as a Resting Area

It is well known that Ghubbet el Zayt and Ghubbet el Gemsa, two large shallow bays with extensive intertidal mud and sand flats, located outside the concessionary area south of Gabal el Zayt, are very important resting sites for a large number of birds in autumn as well as in spring (especially for White storks but also for waterfowl and waders). Moreover, in the very north of the concessionary area around observation site S13, several pools of hyper-saline water and larger patches of salt marsh serve as a resting site for some species (*e.g.* White stork, White pelican and Western reef heron).

Occasionally, resting birds used the concessionary area itself:

In autumn 2006 one large flock of 6,550 White storks rested around observation site S01. We suggest that this observation can be attributed to the proximity to Ghubbet el Zayt and Ghubbet el Gemsa. Few individuals and smaller flocks of less than 150 storks were recorded at five other sites (total 273 individuals). We suggest that these were mainly tired birds, which entered the concessionary area at low altitudes after crossing the Gulf of Suez. Other species resting within the concessionary area mostly occurred individually (a total of 48 individuals). All resting birds continued migration after a short period of time (a few hours at most).

In spring 2007 large flocks of 700 to 8,000 White storks rested around observation sites M04 and M10, respectively, and some smaller flocks of less than 300 individuals at different sites along the M-line. We assume these were mainly tired storks that were struggling with the strong headwind. This might also apply to some flocks of less than 250 Common cranes resting at different sites along the M-Line. An observation of a single flock of 500 individuals at S13 can be referred to hyper-saline water and larger patches of salt marsh serving as a resting site. Other species resting within the concessionary area mostly occurred individually or in small flocks (a total of 1,506 individuals).

In summary, almost all parts of the concessionary area do not fulfil the qualities of a typical resting site of storks or other species and thus is not believed to have a great importance as a resting area. Tired birds struggling with strong headwinds (in spring) or after crossing the Gulf (in autumn) occasionally use the desert plains for a short period of time. The southeast, which is located near Ghubbet el Zayt and Ghubbet el Gemsa (S01 and S04) and the very northeast with its water pools and patches of salt marsh (S13) appear to be more suitable as a resting site for White storks or Common cranes. Clearly, the concessionary area does not serve as a resting site for birds of prey.

5 Bird-Wind Turbine Interactions

In recent years the construction of wind turbines has given rise to much controversy relating to bird conservation issues, mainly in Europe and the United States.

Considering utilization of wind energy within the concessionary area, the major potential hazards to birds are collision risk and mortality as well as a barrier effect. Other possible impacts of wind turbines like displacement due to disturbance or direct habitat change and loss can be neglected, because the concessionary area, which is characterized by practically no vegetation and very dry climatic conditions with large differences in temperature between night and day, does not serve as a breeding, wintering or resting site for one of the relevant species. Although resting birds might occur within the concessionary area occasionally, they do not constantly use particular parts of it and only rest for a short period of time.

5.1 Collision Risk and Mortality

Wind turbines seem to add an obstacle for bird movements and research has shown that birds fly into rotor blades. Although some studies have recorded bird collisions, other studies give evidence that birds could detect the presence of wind turbines and generally avoid them (see below).

5.1.1 Results of Collision Risks at Different Wind Farms

ERICKSON et al. (2001) collected data from many studies conducted at different wind farms in the U.S. The results indicate an average of 2.19 avian fatalities per turbine per year in the U.S. for all species combined and 0.033 raptor fatalities per turbine per year. At different wind farms in Europe the annual number of dead birds per turbine varies between 0.04 (PERCIVAL 2000) and 35.00 (EVERAERT et al. 2002) depending on site characteristics and bird densities. MADDERS & WHITFIELD (2006) pointed out that simply presenting mortality rates per turbine or per installed MW, in the absence of further information on the abundance of birds (or birds at risk of death), does little to inform about the collision risk by a wind farm. And LANGSTON & PULLAN (2004) suggested that a low collision rate per turbine does not necessarily mean that collision mortality is insignificant, especially in wind farms comprising several hundreds or thousands of turbines.

Comparably high mortality rates due to collision have been recorded at large wind farms in areas with high concentrations of birds: Altamont Pass in California (ORLOFF & FLANNERY 1992, HUNT 1995, SMALLWOOD & THELANDER 2004, THELANDER & SMALLWOOD 2007) and in the Campo de Gibraltar region (Cádiz) in Spain (BARRIOS & RODRIGUEZ 2004). In particular, large numbers of raptors have collided with wind turbines at these sites, including substantial numbers of Golden eagles (*Aquila chrysaetos*) and Griffon vultures (*Gyps fulvus*). These wind farm areas are characterized by large numbers of turbines

(c. 7,000 at Altamont and 256 at Cádiz, which are often closely packed together) and by predominantly small turbines with lattice towers and high-speed rotors relatively close to the ground (PERCIVAL 2005). Both areas are located in mountainous surroundings, support important food resources and, consequently, high densities of birds, which thus are susceptible to collisions with turbines.
As with Altamont or Cádiz, most of all investigated wind farms affect stationary (breeding or wintering) birds and / or small passerines migrating at night. Thus, there is a great lack of information about collision risks for migrating birds, in particular about migrating raptors or other large birds.

During a 14-month study, which included two autumn migration periods, only two bird carcasses were found at a wind farm (66 turbines) near the Strait of Gibraltar: a Griffon vulture, which is a stationary (wintering) bird species in the region, and a Short-toed eagle (*Circaetus gallicus*). JANSS (2000) estimated that about 45,000 Griffon vultures and 2,500 Short-toed eagles fly over the wind farm per year.

In contrast to these findings BARRIOS & RODRIGUEZ (2004), during a one-year period at a wind farm (called "PESUR", 190 turbines) located less than 10 km away from the above mentioned study area, found 28 Griffon vultures, twelve Common kestrels (*Falco tinnunculus*), three Lesser kestrels, two Short-toed eagles, one Black kite and two White storks. The authors estimated a mortality rate of 0.36 raptors per year per turbine. Considering the number of turbines, such increases in mortality rates may be significant for some birds, especially large, long-lived species with a generally low annual productivity and long maturation. BARRIOS & RODRIGUEZ (2004) concluded that mortality at wind power plants reflects a combination of site-specific (wind-relief interaction), species-specific and seasonal factors.

During a three-year study (2000-2002) 13 wind power plants containing 741 turbines were studied in Navarra (Spain; LEKUONA & URSÚA 2007). Thirty seven study plots containing 277 turbines were selected for fatality searches and behavioural bird observations. Overall 345 bird fatalities were recorded. Most dead birds were raptors (72.8 %) with the Griffon vulture representing 63.1 % of raptor fatalities. Most raptors were killed during spring (March to June). By contrast, all three Lesser kestrels were found during postbreeding migration, because there was a postbreeding roost near a wind plant.

At the wind farm "Al Koudia" (84 turbines) in northern Morocco, corpse searches were done over a three-month period in 2001 (EL GHAZI et al. 2001). Only two carcasses were found in autumn 2001 (one Pallid Swift (*Apus pallidus*) and one Woodlark (*Lullula arborea*), but no raptor or large bird). In autumn 2000 four other birds (mainly local, stationary species) were found by chance. It must be mentioned that the results might lead to an underestimation of collision risk, because no correction factors (*e.g.* for search efficiency or scavenger activity) were used.

At a wind farm (220 turbines) at the western bank of the Gulf of Suez (Egypt) corpse searches were carried out over a four-week period in spring 2007 (BERGEN 2007). Body parts, feathers and bones of three birds were found, which had died weeks or months ago — possibly by collision with a turbine. No fresh bird corpse was found. Due to the characteristics of the study area and the high intensity of investigation, search efficiency and / or scavenger were not regarded to play an important role. Thus, the results strongly indicate that the number of collisions was very low if not zero throughout the period of investigation. It must be pointed out, however, that the study is limited due to the short period of investigation.

5.1.2 Factors Influencing Vulnerability to Collision

The risk of collision depends on a broad range of external and internal factors (JOHNSON et al. 2000).

5.1.2.1 Weather, Visibility and Season

Collision risk seems to be greatest in poor flying conditions, such as strong winds that affect the birds' ability to control flight manoeuvres, or in rain, fog, and on dark nights when visibility is reduced (WINKELMAN 1992, LANGSTON & PULLAN 2004). But collisions occurred in conditions of good visibility, too: all of the 68 collisions at turbines of the above mentioned wind farm "PESUR" occurred on clear days (BARRIOS & RODRIGUEZ 2004); and collision of Vultures occurred rarely in strong winds, indicating little manoeuvrability by the Vultures (see below).
At the wind farm "PESUR" all Vultures died between October and April, with 66.7 % of all accidents taking place between December and February (although the Griffon vulture is a resident species in the region). BARRIOS & RODRIGUEZ (2004) assumed that the seasonal pattern of Vulture deaths might be explained by flight behaviour. As is known, Griffon Vultures need vertical air currents to gain heights. In winter low temperatures make thermals scarcer. Birds are thus constrained to gain height with slope updrafts, whose force on most winter days may be insufficient to lift Vultures well above the ridge, thereby exposing them to wind turbines.

5.1.2.2 Site-specific Factors

It is quite obvious that a higher collision rate is to be expected at locations with high bird densities (LANGSTON & PULLAN 2004), especially by species vulnerable to collision. When comparing wind energy facilities, it appears that birds tend to be killed at rates that are proportional to their relative abundance among wind farms (SMALLWOOD & THELANDER 2004). However, there are several wind farms where the correlation between bird usage and fatality is low (ERICKSON et al. 2001). An investigation at several wind power plants in Spain also confirmed that the relative abundance of species does not predict the relative frequency of fatalities (LEKUONA & URSÚA 2007).

CALIFORNIA ENERGY COMMISSION (2002) and ORLOFF & FLANNERY (1992) suggested that the abundance of ground squirrels within the Altamont Pass Wind Resource Area might significantly increase raptor foraging, and thus collision risk. Within some wind farms in Navarra (Spain), Vultures and Kites were apparently killed because of the nearby livestock carcass and dump sites (LEKUONA & URSÚA 2007).

HOWELL & DI DONATO (1991) identified significant topographical features associated with collision mortality. Notably mountain passes and hill shoulders, which tend to be the preferred crossing places for soaring species, were associated with multiple collisions.

Field studies in the Altamont Pass resource Area have clearly shown that not all turbines have an equal probability of causing one or more raptor fatality (MORRISION et al. 2007). While some turbines were involved in multiple fatalities, others killed none. Fifteen turbine strings, which are located in highly complex topographic areas, were responsible for 60 % of all raptor fatalities: 80 % of Red-tailed hawk (*Buteo jamaicensis*) and 100 % of Golden eagle.

The 190 wind turbines at the wind farm "PESUR" — which prompted a relatively high number of collisions (BARRIOS & RODRIGUEZ 2004) — are arranged in rows along the ridges of mountains or hills, too. However, the wind farm which is less than 10 km away from "PESUR" and which is arranged in a similar way, yielded evidence of only very few collision victims (DE LUCAS et al. 2004).

5.1.2.3 Turbine-specific Factors

ORLOFF & FLANNERY (1992) suggested that the high collision rate at Altamont Pass might be correlated to the lattice towers of the wind turbines which provide many perches, thus attracting birds, particularly raptors, into the collision-risk zone. However, recent investigation showed that perching on wind turbines is a less important factor contributing to mortality than previously suspected (SMALLWOOD & THELANDER 2004).

PERCIVAL (2005) assumed that collision risk at small turbines with high-speed rotors and with the turbines often packed closely together is higher.

Differences in collision rates also appear between turbines within a single wind farm although the same turbine type is used: in the wind farm "PESUR" a single group of 28 turbines (from 190) was responsible for 57 % of Griffon vulture mortality. These turbines were arranged in two rows with little space between consecutive turbines (BARRIOS & RODRIGUEZ 2004). However, little or no risk was recorded for five turbine rows having exactly the same windwall spatial arrangement.

SMALLWOOD & THELANDER (2004) found that wind turbines were most dangerous at the ends of turbines strings, at the edges of gaps in strings, and at the edges of clusters of wind turbines. Furthermore, the most isolated wind turbines killed disproportionately more birds.

5.1.2.4 Species-specific Factors

Manoeuvrability and flight behaviour might be crucial factors to explain differences in collision risks between species (DREWITT & LANGSTON 2006).

Especially soaring birds, like Griffon vulture or Golden eagle, are believed to be particularly vulnerable to collision with wind turbines (LANGSTON & PULLAN 2004), because of their lower manoeuvrability and their dependence on thermals. In contrast, at "PESUR" other soaring birds, such as Common buzzards (*Buteo buteo*) or Short-toed eagles, often circled together with Vultures in slope updrafts but did not closely approach the turbine blades and rarely collided with them. BARRIOS & RODRIGUEZ (2004) suggest that these species have lower wing loads than Vultures, and make a more efficient use of the ascending currents, gaining altitude quicker and farther from the turbines.

ORNIS CONSULT (1999) subdivided soaring birds into four different categories depending on manoeuvrability and flight behaviour. On the basis of this classification we can deduce the vulnerability of different species to collision (see Table 4.2).

Table 5.1: Assessment of species-specific vulnerability to collision depending on manoeuvrability and flight behaviour (according to ORNIS CONSULT 1999)

category	description	species	vulnerability to collision
very passive fliers	very dependent on thermals, generally not able to cross large bodies of water	Egyptian vulture, Short-toed eagle and all Eagles of the genus Aquila	very high
less passive fliers	less dependent on thermals, able to cross limited bodies of water	Buzzards, Kites, Honey buzzard, Storks, Cranes and Pelicanes	medium to high
less active fliers	rely on thermals to a limited extent able to cross large bodies of water	Harriers and Sparrowhawks	low to medium
very active fliers	not dependent on thermals, able to cross the Gulf of Suez at any point	Falcons	very low

Nevertheless, collision risk seems to depend not only on manoeuvrability and flight behaviour but also to a large (or maybe larger) extent on species-specific avoidance behaviour.

The high number of collided Common kestrel (a very active flier that does not depend on lifting air currents) and maybe Griffon vultures too, might be explained with the absence of avoidance behaviour. At "PESUR" Kestrels sometimes perched on lattice towers, and Vultures frequently flew at close distance to the blades, or between two adjacent turning turbines (BARRIOS & RODRIGUEZ 2004). Soaring flights at low wind speeds and crossing flights that commenced below blade height increased the risk of collision, as Vultures showed little reaction to the turbine with only 2 % altering their approaching flight pattern.

In the wind farm at the western bank of the Gulf of Suez the majority of birds migrating at altitudes below 100 m showed clear avoidance behaviour in the presence of the wind turbines (BERGEN 2007). While Steppe buzzards predominately changed flight direction and avoided to enter the wind farm area altogether, most Black kites increased altitudes and subsequently entered the wind farm at heights above rotor blades but also at heights of the area swept by the rotor. Thus, they passed over or through the wind farm. Furthermore, the results of the study indicate that birds migrating individually are less sensitive to the presence of wind turbines than flocks. Large flocks seem to avoid wind turbines at greater distances.

The preferred altitude of migration is likely to be another factor effecting collision risk in a species-specific way. Most birds of such species that tend to migrate at altitudes above 199 m (*e.g.* Eagles), are unlikely to come close to the area swept by rotors of wind turbines (if we assume a maximum turbine height of about 100 m). Other species that prefer to migrate at altitudes around turbine height, might often come into the range of rotors and hence face a risk to collide.

There are indications that migrating passerines might be vulnerable to collision, especially when migrating at night (because of poor visibility; LANGSTON & PULLAN 2004). Collisions of passerines were recorded at several wind farms (*e.g.* ERICKSON et al. 2001). But mass collisions, which occurred at lighthouses during some nights, were not documented at wind turbines. Until now, collision risk of nocturnal migrants is not well studied due to methodological problems (LANGSTON & PULLAN 2004). Furthermore, it does not seem to be a major concern, possibly for several reasons:

- Usually nocturnal migration by passerines is at altitudes well above turbine height (*e.g.* ALERSTAM 1990), so there is a very low potential for these birds to come into the collision risk zone. We can suggest that nocturnal migrants should be most vulnerable during take-off soon after sunset and during descent. Furthermore, birds facing strong headwinds, forcing them to fly at lower altitudes, might increase the risk of collision.
- Due to the large populations of most passerine species, they are not of major conservational interest. Results from studies in the United States indicate that the levels of fatalities are not considered significant enough to threaten local or regional population levels (STERNER et al. 2007).
- Most passerines have an r-selected reproductive strategy: individuals are short-lived, mature rapidly, have many offspring and a high adult and juvenile mortality. Consequently, additional mortality caused by wind turbines is unlikely to have a significant effect on populations of most passerine species.
- Mortality of passerines seems to be much higher at other man-made structures compared to mortality at wind turbines (ERICKSON et al. 2001).

5.1.2.5 Individual Factors

Finally, collision risk might be influenced by individual attributes of a bird (*e.g.* age, experience or fitness). It is quite obvious that the risk of collision varies depending on the stage of a bird's annual cycle (breeding, roosting or migrating).

Some studies indicate that immature birds are more vulnerable than adults, a phenomenon which may be attributed to the inexperience of younger birds. However, within the Altamont Pass Wind Resource Area most Golden eagle mortalities were not juveniles but subadults and non-breeding adults (CALIFORNIA ENERGY COMMISSION 2002).

At "PESUR" (as well as at "Al Koudia") victims were usually species with resident populations rather than species appearing during migration (EL GHAZI et al. 2001, BARRIOS & RODRIGUEZ 2004).

5.1.3 Conclusion

Many studies have shown that birds are generally able to avoid collisions with wind turbines and do not simply fly into them blindly (*e.g.* DIRKSEN et al. 1998, DE LUCAS et al. 2004, DESHOLM 2006). Nevertheless, at a few locations relevant numbers of collision victims were found, leading to significant increases in mortality rates and possibly to population decreases.

As shown, the scale of collision depends on a wide range of factors which — in some cases — correlate with each other. It is quite plausible that a combination of factors (*e.g.* flight behaviour, wind speed and relief of location) influences collision risk. As a consequence, it is very difficult to transfer the results obtained at a particular wind farm to another. At present, there is insufficient information available to form a reliable judgement on the scale of collision at a proposed wind farm.

5.2 Barrier Effect

There are several reliable studies indicating that wind turbines have a disturbing effect on birds and hence may act as barriers to bird movement.

During a 14-month study at a wind farm (66 turbines in a single row on top of a mountain ridge) near the Strait of Gibraltar, 72,000 migrating birds were recorded during about 1,000 hours of observation from fixed observation points (JANSS 2000). The most abundant species were Black kites, White storks, House martins (*Delichon urbica*) and Swallows (*Hirundo rustica*). Most of the migrating birds observed were passing over the wind farm, but at a higher average altitude than over two control areas. Average flight altitude at the wind farm was more than 100 m above ground. Almost 72 % of all soaring birds (n = 16,225) displayed changes in flight direction in the wind farm area (DE LUCAS et al. 2004, DE LUCAS et al. 2007). Raptors appeared to be accustomed to the presence of turbines and many birds flew close to turbines (DE LUCAS et al. 2004).

During a behavioural study at thirty seven study plots containing 277 turbines most birds (58.6 %) flew very low (< 5 m). 24.1 % of all birds showed panic behaviour in the risk zone, 20,3 % a sudden change of flight, and 15,6 % a slight change of flight (LEKUONA & URSÚA 2007).

At the wind farm “Al Koudia” (84 turbines) in northern Morocco, autumn migration was observed over a three-month period in 2001 (EL GHAZI et al. 2001). Most birds (depending on species up to 100 %) showed clear avoidance behaviour in the presence of the turbines.

At a wind farm (220 turbines) at the western bank of the Gulf of Suez, the behaviour of migrating birds was observed over a four-week period in spring 2007 (BERGEN 2007). In the vicinity of the wind farm most birds (almost 88 %) used altitudes above 100 m, showed no clear reaction in presence of wind turbines and migrated over the wind farm. Most birds (over 83 %) migrating at altitudes below 100 m showed a clear reaction to the presence of wind turbines.

Black kites most often increased altitude and subsequently entered the wind farm at heights above rotor blades but also at heights swept by the rotor. Thus, they passed over or through the wind farm. Some birds reacted to the presence of wind turbines with a combined vertical and horizontal behaviour. But change in flight direction alone was recorded relatively rarely. Accordingly, less than 11 % of all Black kites did not pass the wind farm. In contrast, Steppe buzzards did not change altitude in relevant numbers. The majority of birds changed their flight direction, so that they subsequently did not enter the wind farm area. Thus, Steppe buzzards seem to regard the whole wind farm as a barrier. Consequently, Steppe buzzards appear to be more sensitive to the presence of wind turbines, whereas Black kites might be more vulnerable to collision.

The proportion of recordings of Black kites changing altitude was markedly lower than the proportion of birds, indicating that birds migrating individually or in small flocks are less sensitive to the presence of wind turbines than flocks. The analysis of behaviour of Steppe buzzards presents similar patterns.
Harriers usually migrated alone only few meters above ground. In the presence of wind turbines most Harriers showed no conspicuous reaction and simply flew through the wind turbines at heights below the rotor blades. A relevant number of birds (about 42 %) changed flight direction. As a consequence, one-third of migrating Harriers did not enter the wind farm area. Nevertheless, since the number of migrating Harriers was very low the findings must be treated with caution.
The results demonstrate that migrating birds were able to detect the presence of wind turbines and thus to react in an appropriate way depending on external (*e.g.* weather conditions) and internal (*e.g.* altitude, physical capabilities) factors. Birds at altitudes above 100 m simply migrated over the wind farm without any noticeable reaction. Birds at altitudes below 100 m became aware of the presence of wind turbines and apparently avoided them by changing their flight direction or increasing altitude. Sometimes birds seemed to avoid turbines in operation and purposefully approached a turbine not in operation and subsequently passed by.
A flight reaction of a bird in the vicinity of a turbine was recorded only twice. Irrespective of a bird's motivation (migrating, flying, hunting, resting) or of weather conditions, an appreciably irritated bird or a bird in a critical situation that might have led to a collision or to loss of flight control never occurred. Since the investigation refers to a rather short period, which did not cover the main migrating period of all species, results have to be verified.

Further studies have shown that birds alter their route to avoid flying through on- and offshore wind farms (*e.g.* DIRKSEN et al. 1998, OSBORN et al. 2000, DESHOLM & KAHLERT 2005). However, there are also locations where large numbers of birds regularly fly through wind farms without diverting around it (*e.g.* EVERAERT et al. 2002).

PERCIVAL (2005) assumed that the ecological consequences of such a barrier effect are unlikely to be a problem at small wind farms. DREWITT & LANGSTON (2006) suggest that none of the barrier effects identified so far have significant impacts on populations. However, under certain circumstances barrier effects might lead to population level impacts indirectly, *e.g.* where a wind farm effectively blocks a regularly used air route between nesting and foraging areas, or where several wind farms interact cumulatively. Then large wind farms or a number of wind farms might lead to increased energy expenditure for birds and thus might reduce annual survival rates and / or breeding output (FOX et al. 2006, LANGSTON et al. 2006). In summary, until now it is quite difficult to judge whether avoidance behaviour causes a significant effect on individuals and, ultimately, on populations.

6 Impact Assessment

6.1 General Remarks

As discussed in Chapter 4.2.2 it is quite difficult to predict migratory activity at each of the 26 observation sites in a reliable way. Due to the high variation of migration and the short observation time at each site it is not certain if the data set represents a valid sample of migration at the 26 observation sites. Moreover, spatial patterns of migration through the desert plains of the concessionary area are influenced by weather and wind conditions and thus may vary between years. For statistical reasons it is not approvable to extrapolate the observed numbers of birds at each observation site in order to obtain a valid estimation of migratory activity. Consequently, it is not recommendable to use the 1 %-criterion — which was originally used to define areas according to the RAMSAR Convention (see www.ramsar.org) — for a spatially differentiated impact assessment. Furthermore, an estimate of the whole flyway population remains uncertain to some degree (at least for some species to a noticeable degree). Finally, the 1 %-criterion reflects the quality of an area in terms of nature conservation, but it does not consider the sensibility of birds to wind turbines. Hence, it is not possible to estimate possible impacts of a proposed project using the 1 %-criterion. Collision risk, for instance, is not always correlated with the abundance of birds (see Chapter 5.1.1). Similarly, any other quantitative threshold (*e.g.* in order to distinguish migratory activity at different observation sites) is not a valid measure for the impact assessment.

As shown in Chapter 5, collision rate depends on several factors and until now the cause-and-effect chain of collision is poorly understood. Very little is known about collision risk for migrating birds.
There have been a few attempts to predict collision rate at a given wind farm with mathematical models (TUCKER 1996, BAND 2000, BAND et al. 2007). Modelling collision risk under the Band model is a two-stage process. Stage 1 estimates the number of birds that fly through the rotor-swept area. Stage 2 predicts the proportion of these birds that will be hit by a rotor blade. The reliability of the collision model is limited by difficulties in gathering appropriate field data and by the large numbers of assumptions necessary during the modelling process, notably the level of collision avoidance. As a consequence, care must be taken not to overstate the model outputs. Nevertheless, MADDERS & WHITFIELD (2006) pointed out that alternative methods for estimating collision risk are less transparent or more subjective and at least vulnerable to the same potential biases. In contrast, CHAMBERLAIN et al. (2006) suggest that the value of the Band collision risk model in estimating actual mortality rates is questionable until species-specific and state-specific avoidance probabilities can be better established. Therefore, the authors do not recommend the use of the model without further research into avoidance rates. LANGSTON & PULLAN (2004) sum up that collision risk models provide a potentially useful means of predicting the scale of collision attributable to wind turbines in a given location, but

only if they incorporate actual avoidance rates in response to fixed structures and post-construction assessment of collision risk at wind farms that do proceed, to verify the models.

In summary, it is very difficult for several reasons to assess collision risk as well as avoidance behaviour, which might lead to increased energy expenditure, caused by a proposed wind power plant within the concessionary area. Thus, the following impact assessment should be regarded as a rough qualitative prediction of possible impacts, which needs to be specified by further field investigations.

6.2 Assessment of Possible Impacts on Large Migrating Birds

6.2.1 Predicting Collision Risk

If the results of the existing investigations considering collision risk are transferred to a proposed wind power plant within the concessionary area, we can expect the following:

- Most migrating birds will fly over the wind power plant because the majority of recorded birds used altitudes above 199 m in autumn and spring.
- Most Harriers will migrate through the area of the wind power plant at altitudes below rotor height because they tend to migrate at altitudes below 100 m, commonly near ground (Figure 3.3; see also BERGEN 2007).
- Most birds will be aware of turbines and will be able to avoid them.

  The existing investigations show clear species-specific avoidance behaviour by the observed birds (see Chapter 5.1.2.4 and 5.2). Steppe buzzards, for instance, seem to regard the whole wind farm as a barrier. In comparison to Black kites, Steppe buzzards appear to be more sensitive to the presence of wind turbines. As a consequence, Black kites might be more vulnerable to collision with wind turbines than Steppe buzzard (BERGEN 2007). According to WHITFIELD & MADDERS (2006) preliminary estimates for five different species of birds of prey lead to avoidance rates between 96.9 and 99.9 %.
- Collision risk will be higher for very passive fliers, like Eagles, which are less manoeuvrable (see Table 5.1.2.4). However, a preferred migration altitude above 199 m might mask their higher vulnerability to collision.
- Collision rate will be higher in spring because migrants frequently face strong headwinds, affecting the birds' ability to control flight manoeuvres (furthermore, migrants are more frequent in spring). By contrast, in autumn tailwinds or side winds predominate.
- Bad visibility conditions are not supposed to be a major factor increasing collision rate within the concessionary area, neither in autumn nor in spring.

- On the one hand, compared to other areas, the collision rate is believed to be higher because of the high migratory activity within the concessionary area. It is reasonable to assume that collision risk is higher in areas with high bird densities, although there is not always a strict correlation between collision rate and abundance of birds (see Chapter 5.1.1).
- On the other hand, collision risk might be lower because the desert plains are obviously the direct opposite of a highly complex topographic area, in which collision risk seems to be higher. Within the concessionary area there are no topographical features like ridges, mountain passes or hill shoulders that tend to be associated with multiple collisions.

  Exo et al. (2005) pointed out that migration generally occurs above the collision risk zone of the rotors, if wind turbines are erected in lowland. In contrast, about 50 % of all migrating birds used altitudes below 100 m at a site near Tanger (Morocco) which is located on a ridge (Exo et al. 2005).

  Furthermore, collision risk is assumed to be lower, because the desert plains obtain rather bad foraging conditions for birds of prey. Large migrants do not usually forage within the concessionary area.

  Finally, since daytime temperatures within the concessionary area are high during migration periods, thermals are not believed to be a limiting factor. There should be a number of vertical air currents allowing birds to gain altitude.
- Collision rate in the southern and central part of the concessionary area (M01 to M08 and S01 to S08) will be higher than in the northern part because of higher bird densities.

  Furthermore, the opportunities of avoiding turbines are better in the northern part which is a homogeneous area lacking topographical constraints. By contrast, in the southern and central part many birds come from or head for Gabal al Zayt, which is a crucial topographic site for crossing the Red Sea.

To conclude, according to species- and site-specific factors there are several reasons to expect a comparably low collision risk at a proposed wind farm within the concessionary area. But, because of the enormous numbers of migrating birds (at least in the southern part) and the critical conservation status of some species (see Annex I), we cannot generally exclude collision rates leading to additional mortality capable of causing significant population effects for some species.

6.2.2 Assessing the Weight of Collision Risk

To assess the weight of collision risk it is advisable to consider the total population of a species. Apparently, a low additional mortality (*e.g.* by a wind power plant) might be compensated in large populations, whereas even low numbers of fatalities can cause a population decrease in small populations. Considering their global population, Greater spotted eagle and Eastern imperial eagle are the most vulnerable species (Table 6.1), which occurred in very small numbers within the concessionary area (see Annex III & VI). But since it is not possible to estimate the number of fatalities at a proposed wind farm, we are not able to determine the absolute weight of collision risk.

Table 6.1: Estimates of global population of species of special conservational interest (according to BirdLife International 2007)

species	IUCN-Red List	estimates of global population	
Greater spotted eagle	Vulnerable	2,500 - 9,999	pairs
Eastern imperial eagle	Vulnerable	2,500 - 9,999	pairs
Pallid harrier	Near Threatened	9,000 - 15,000	pairs
Lesser kestrel	Vulnerable	50,000 - 60,000	individuals
Red-footed falcon	Near Threatened	300,000 - 800,000	individuals
Egyptian vulture	Endangered	20,000-49,000	individuals

As an approximation to the weight of collision risk and possible effects on population level of different species, the following assumptions might be valuable:

- A wind power plant within the concessionary area is not believed to affect populations of Harriers, and thus of Pallid harrier. Collision risk seems to be very low for Harriers because they often migrate below the area swept by rotors of wind turbines. In fact, in different wind farms in the United States, no (or only very few) fatalities were recorded for Northern harrier, which frequently hunts below the 9 m minimal blade height (Sterner et al. 2007). In Germany also only two Harriers were found after collision with a turbine until now (Dürr unpubl.). Bearing in mind that migration of Harriers is not concentrated to the concessionary area, additional mortality caused by wind turbines is not believed to have population effects.
- It is unlikely that a wind power plant within the concessionary area will affect populations of Lesser kestrel, because Lesser kestrels are very active fliers (Table 5.1) and migrate over a large front and thus are not concentrated within the concessionary area. Nevertheless, a possible absence of avoidance behaviour, like investigations indicate for Common kestrel, might increase the risk of collision.
- An effect on populations of Eagles, and thus of Spotted Eagle and Eastern Imperial eagle, seems to be unlikely, too. At the western coast of the Gulf of Suez, the majority of Eagles tend to migrate at

altitudes above 199 m (Figure 3.21; see also Ornis Consult 2002, Bergen 2007). Thus, we suggest that most birds do not come close to the area swept by rotors of wind turbines (assuming a maximum turbine height of about 100 m), so that collisions occur rarely despite the comparably low manoeuvrability of Eagles. (Note that this might completely different at breeding sites of Eagles, as known from wind farms in Europe; see Follestad et al. 2007, Dürr unpubl.)

- Collision rates, which might have significant population effects, cannot be excluded for frequent species like White stork or Honey buzzard despite their comparably high levels of total population. These species, which were recorded in very high numbers, seem to prefer altitudes above 199 m. Still, relevant numbers of birds were also recorded at lower layers. Thus, an indeterminate portion of these species might come into the range of rotors and hence face collision risk.

  Collisions of White stork and other species migrating in large flocks, however, should occur very rarely because large flocks seem to avoid wind turbines at greater distances (and, besides that, typically use higher altitudes). Yet if a flock does enter a wind farm, then a great number of victims is to be expected.
- According to the relatively high number of Griffon vulture fatalities in Spanish wind farms, which indicate the absence of avoidance behaviour, a relevant collision risk must be expected for Egyptian vulture. Moreover, Egyptian vultures are very passive fliers, depending strongly on thermals.

Bearing in mind the uncertainty of predictions and the critical conservational status of some species, establishing a wind power plant within the concessionary area will include a notable risk potential for populations (at least for some species). Currently it is not possible to give a reliable quantitative estimation on the weight of species-specific collisions at a wind power plant within the concessionary area.

6.2.3 Predicting and Assessing the Weight of Barrier Effect

While avoidance behaviour reduces collision risk, it could result in wind farms acting as barriers to bird movement (*e.g.* DREWITT & LANGSTON 2006).

The concessionary area is characterized by desert plains, extending from the foothills of the Red Sea Mountains over at least 10 km to the coast. Consequently, the open area leaves enough space to avoid a wind power plant. In the southern part the distance between the foothills of the Red Sea Mountains and the coast is the smallest. Furthermore, in spring birds are forced to head for Gabal el Zayt if they intend to cross the Red Sea, and in autumn they come from Gabal el Zayt in order to fly to the Red Sea Mountains. By contrast, there are no topographical constraints in the northern part of the concessionary area because north of observation site M08, the Red Sea Mountains recede further inland and the terrain opens up.

In summary, we do not expect a wind power plant acting as a complete barrier that might interrupt migration or separate migration paths. This estimation applies specifically to the northern part of the concessionary area, but also to the southern part.

In order to avoid a wind power plant, birds might change horizontal flight direction which obviously leads to additional expenditure of energy. Assuming a 5 km long string of wind turbines located perpendicular to a bird's flight path, we suggest that the additional flight distance caused by avoiding the wind power plant will not be much more than 5 km. We cannot exclude that this might decrease the fitness of (perhaps already weak) individuals, but considering the efforts of migration it seems unlikely that a relevant number of birds is affected, for instance:

- White storks need between 8 to 15 weeks to cover a total distance of 10,000 km or more between breeding and wintering area. The average length of daily migration varies between 150 and 300 km.
- In Israel, Egypt and Sudan, average distance of daily migration of two tracked Lesser spotted eagles was 207 km (MEYBURG et al. 2001). For the entire northward migration (more than 8.000 km) it took a bird about 8 weeks. The average daily flight distances of Lesser spotted eagles varies between 144 km and 214 km per day (MEYBURG et al. 2004a).

  Furthermore, MEYBURG et al. (2002) recorded an adult female of Lesser spotted eagle which initially migrated to the southern point of the Sinai Peninsula in 1997. One day after arrival it changed direction and flew 280 km northwest along the eastern coast of the Red Sea straight to Suez. In 1998 it repeated the detour to the southern tip of the Sinai Peninsula and back north to Suez. The reasons why the bird did not cross the Gulf from the southern tip of Sinai (which is about 66 km wide at this point) but took a detour of 500 km, remain unclear. Unfortunately, no information about the bird's breeding output is given in MEYBURG et al. (2002).

- Extremely long stretches were recorded of an Egyptian vulture that flew in southwest Egypt, northwest Sudan and northeast Chad a total of 1,017 km in two days (MEYBURG et al. 2004b). The average migration path within another period of seven days was 185 km per day.

Thus, an additional flight path of 5 km seems unlikely to have a relevant impact on a bird's fitness. Moreover, there is no need to assume that an additional flight path would be covered unexceptionally by active flight, consuming much more energy than gliding.

Another option to avoid a wind power plant is to change (mostly to increase) altitude and subsequently to migrate above the critical zone of the wind turbines. As mentioned before, we do not expect thermals to be a limiting factor within the concessionary area. There should be a number of vertical air currents allowing birds to gain altitude. Hence, there is no reason to assume that increasing altitude will be accomplished only by active flight.

Since weather conditions (especially wind speed and direction) should be nearly the same within the whole concessionary area, we do not expect that birds will face additional headwinds or other unfavourable conditions as a consequence of avoiding a wind power plant.

In summary, although it is very difficult to estimate the degree of additional energy expenditure, it seems unlikely that avoidance behaviour might produce a significant effect on populations. However, as some uncertainty remains and, furthermore, cumulative effects should be taken into consideration, mitigation measures should be implemented in order to minimize possible impact.

6.3 Synopsis — Final Recommendations

LANGSTON & PULLAN (2004) pointed out that, as a precautionary measure, it should be avoided to locate a wind power plant in international or national sites for nature conservation or other areas with large concentrations of birds, such as points of migration crossing. According to PERCIVAL (2005) it is important to avoid developing wind farms at sites i) with high-density raptor populations where collisions could be significant, and ii) with high densities of other species vulnerable to a low level of additional mortality where their susceptibility to wind turbine collision may be high.

It is indisputable that Gabal El Zayt mountain chain and the concessionary area are located at one of the most important migration routes with high densities of raptors, other large migrants and other birds. The investigations carried out in autumn 2006 and spring 2007 clearly show that most parts of the concessionary area are of international importance for migration (Chapter 4.2.3), although results indicate a spatial gradient with an extreme importance in the south. Some species migrating through the concessionary are of international conservation concern and a number of species are of European or national conservation concern (see Annex I).

Consequently, in terms of strict bird conservation aspects it is highly recommended to avoid construction of wind power plants within the whole concessionary area. Regarding a process, in which competing environmental interests must be weighted against each other, the concessionary area can be divided into three zones according to the importance of the area for migration (Table 4.1) and hence according to the weight of expected environmental impact:

- Zone I consists of the southern and central part of the concessionary area (M01 to M08 and S01 to S08) with an extreme importance for migration (see Chapter 4.2.3). Within Zone I the construction of a wind power plant has to be strictly banned.
- Zone II borders on Zone I in the north and stretches over 10 km northwards (M09 to M10 and S09 to S10). Since a great number of birds coming from or heading for Gabal el Zayt do not cross this zone, a comparably lower migratory activity can be expected. Nevertheless, a very high number of birds /recordings at altitudes below 200 m can be noted in this zone, at least occasionally (see for instance S09 in Figure 3.33). Consequently, we do not recommend this zone for wind power development, unless further ornithological investigations might indicate that the environmental impact of wind power utilization in this part of the area could be kept at a tolerable minimum.
- Zone III consists of the very north of the concessionary area (M11 to M13 and S11 to S13) and has obviously the lowest importance for migration. Nevertheless, migratory activity at altitudes below 200 m can be above average (see for instance S12 in Figure 3.33). Consequently, any wind farm installation in this area would require technical avoidance and mitigation measures to the best practicable standard. Moreover, a detailed post-construction monitoring programme has to be implemented to assess whether impacts of the wind farm remain at an acceptable level or additional measures are necessary to minimize or eliminate unacceptable impacts.

6.4 Mitigation Measures

6.4.1 Current Knowledge

As a general recommendation, mitigation measures developed to avoid impacts should be given priority over those that reduce impacts or compensate for impacts. Apparently a key factor in avoiding impacts is a careful turbine placement (macro-siting), that is to say ensuring that key areas of conservation importance and sensitivity are avoided.

JOHNSON at al. (2007) distinguish between three primary types of mitigation measures to reduce collision risk at wind turbines: i) modification of turbines and other wind power plant structures, ii) modifying the siting of entire wind farms as well as placement of individual turbines, and iii) modification of habitats.

i) Modification of turbines and other wind power plant structures

Perching by raptors on wind turbines has been implicated in higher rate of mortality (ORLOFF & FLANNERY 1992). Although not all investigations support this assumption (*e.g.* THELANDER & RUGGE 2000, SMALLWOOD & THELANDER 2004), installation of turbines with tubular towers and avoiding other structures suitable for perching are simple measures to reduce raptor activity within an area and hence collision risk.

Due to the large rotor-swept area, collision risk is believed to be higher at taller turbines. Nevertheless, ORLOFF & FLANNERY (1992) found no relationship between height of turbines and risk of collision. Furthermore, in other studies shorter turbines appear to have even higher collision rates (CALIFORNIA ENERGY COMMISSION 2002). Obviously, other factors (slope, topography, proximity to prey, species concerned, status of species (breeding, resting, migrating)) play a more important role for collision mortality (see also HÖTKER 2006). Thus, regarding turbine height, mitigation measures should be site-specific and be dependent on the group of species most likely at risk (JOHNSON at al. 2007).

Lighting of turbine is believed to increase the risk of collision on man-made structures by attracting and disorientating birds (*e.g.* DREWITT & LANGSTON 2006). This is mostly a problem for nocturnal migrants (primarily passerines) during poor visibility conditions. According to UGORETZ (2001), birds are more sensitive to and even appear attracted to red light. Quickly flashing white strobe lights appear to be less attractive. The consensus among researchers is to avoid lighting turbines when and where possible (JOHNSON et al. 2007). If lighting is crucial, the current advice is to use the minimum number of intermittent flashing white lights of lowest effective intensity (DREWITT & LANGSTON 2006).

Research with captive American kestrels (*Falco sparverius*) and Red-tailed hawks indicates that painting turbine blades can increase blade visibility in a variety of conditions. Based on experiments with several patterns painted on blades, MCISAAC (2001) recommended a pattern with square-wave black-and-white bands that run across the blade. HODOS (2003) have proposed that motion smear may reduce the ability of raptors and other birds to see turbine blades. Thus, motion smear might be a

reason for collisions during daytime, in which the visual faculty of birds is actually good. Motion smear occurs primarily at the tips of the blades, and may make blades virtually transparent at high velocities. Anti-motion smear patterns may increase the visibility of turbine blades at distances at which raptors could still safely manoeuvre away from them. Studies with captive raptors indicate that a single, solid black blade paired with two white blades (or a single-blade, thin-stripe pattern) is the most visible stimulus (HODOS 2003).

Since most diurnal birds, including raptors, are probably able to detect Ultra Violet (UV) light, there have been efforts to reduce collision risk by painting turbine blades with UV reflective paint (KREITHEN & SPRINGSTEEN 1996, MCISAAC & KREITHEN 1996, see also JOHNSON et al. 2007). However, YOUNG et al. (2003), who tested this hypothesis in Foot Creek Rim (Wyoming) wind plant, found no evidence that there is a difference in bird use, collision risk or mortality (which was generally low) between turbine blades with a UV-light reflective paint and those painted with conventional paint.

Scare or warning devices that emit sounds have been used at airports or agricultural fields to deter birds. Most studies of these devices have found that birds become habituated to the devices, reducing the long-term effectiveness of these techniques (JOHNSON et al. 2007). However, migrating birds are unlikely to habituate to sounds.

If there are a few critical turbines within a large wind farm or if collision risk is limited to certain (short) periods of time, a temporal shutdown of critical wind turbines might be another option to reduce or eliminate bird collisions (*e.g.* LANGSTON et al. 2006).

Finally, for certain problematic turbines associated with unacceptable mortality due to their location or other factors, the only suitable form of mitigation may be removal of the these turbines.

Apart from modification of turbines DREWITT & LANGSTON (2006) recommend installing transmission cables underground (especially in areas of high bird concentrations) and to mark overhead cables using deflectors.

ii) Modification of the siting of entire wind farms as well as placement of individual turbines

Drewitt & Langston (2006) recommend avoiding alignment of turbines perpendicular to main flight paths of birds and providing corridors between clusters, aligned with main flight trajectories, within large wind farms. Also Hötker (2005) and Exo et al. (2005) suppose that maintaining gaps within large wind power plants could decrease impacts. Gaps might enable migrating birds to avoid turbines and to pass a large wind power plant safely. Consequently, shorter turbine strings may mitigate a barrier effect (de Lucas et al. 2007). However, effects of such corridors need to be tested (Langston et al. 2006).

Orloff & Flannery (1992) reported, however, that end-row turbines had higher fatality rates than turbines within strings. Also Smallwood & Thelander (2004) found that wind turbines were most dangerous at the ends of turbine strings, at the edge of gaps in strings, and at the edges of clusters of wind turbines. Other studies found no significant difference in the rate of mortality at end-row versus other turbine locations (*e.g.* Howell & Noone 1992, Thelander & Rugge 2001). Higher collision rates found at end-row turbines might be related to topographical features (ridges, slopes or hill shoulders), where turbine strings end, or to other factors (prey availability).

California Energy Commission (2002) indicated that turbines spaced closely together might enhance collision risk by making it more difficult for a large bird to clear the space between blades. Barrios & Rodriguez (2004) found most fatalities and risk situations at two strings with little space between consecutive turbines, indicating that more space might reduce collision risk.

In summary, the relationship between spatial configuration of turbines and higher fatalities (including impacts of end-row versus mid-row turbines, differently sized gaps between turbines in a string, and clustering versus open configurations) remains uncertain (Sterner et al. 2007).

iii) Modification of habitats

Several authors (*e.g.* Johnson et al. 2007, Sterner et al. 2007) recommend the following habitat modifications in order to minimize impacts:

- avoid natural or artificial perching sites;
- avoid establishing areas with high natural food sources;
- avoid structures within a wind power plant that might attract birds (*e.g.* waste dump);
- reduce local food sources (as a management option in some wind farms).

Since the concessionary area is neither a breeding nor a feeding area for relevant species, modification of habitat does not seem to be an appropriate measure to minimize impacts, and hence needs no detailed consideration.

Although a lot of mitigation measures have been proposed, many have not yet been tested or have only been tested on a small-scale basis.

6.4.2 Recommendations

If a wind power plant will be proposed in Zone III of the concessionary area as a result of a process in which competing environmental interests must be weighted against each other, the following mitigation measures are strongly recommended:

- Avoid wind turbines with a maximum height of more than about 100 m, because the majority of birds migrate well above 100 m (Figure 3.3 & 3.21).
- Avoid turbines with lattice towers in order to reduce suitable perching sites.
- Avoid lighting of turbines. If lighting of turbines is absolutely required, use the minimum number of intermittent flashing white lights of lowest effective intensity (DREWITT & LANGSTON 2006).
- Paint turbine blades to increase blade visibility according to HODOS (2003): a single, solid black blade or a single blade with thin stripe patterns paired with two white blades.
- Avoid small turbines with high-speed rotors and with turbines closely packed together.
- Maintain a corridor aligned with main flight directions (south-southeast in autumn and north-northwest in spring) with a breadth of more than 1 km between wind farms at reasonable distances.
- Implement a detailed post-construction monitoring programme in order to
    i) verify the assumptions gathered within the impact assessment and determine significant deviations from predicted impacts;
    ii) determine the weight and significance of proposed impacts (especially collision rate);
    iii) examine behaviour of migrating birds in the vicinity of the proposed wind power plant;
    iv) examine the conditions in which collisions occur and the cause-and-effect chain of collisions;
    v) test the effectiveness of mitigation measures;
    vi) (if so) identify critical wind turbines;
    vii) (if necessary) maintain further mitigation measures (acoustical deterrents, temporal shutdown of critical turbines);
    viii) (if necessary) remove problem turbines associated with unacceptable mortality.

    Important references for an adequate monitoring program can be found in NATIONAL WIND COORDINATING COMMITTEE (1999), DREWITT & LANGSTON (2006), BAND et al. (2007), BERGEN 2007, FOLLESTAD et al. 2007, MORRISON et al. (2007) and STRICKLAND et al. (2007).

7 Summary

The New and Renewable Energy Authority (NREA) under the Ministry of Electricity and Energy has developed plans for several wind farms along the western bank of the Gulf of Suez. In order to assess the potential utilization of wind energy in the Gulf of Zayt area, a feasibility study will be realized during 2007. Since construction of wind turbines has given rise to much controversy relating to bird conservation issues, a main topic of the feasibility study is to assess possible impacts on birds, especially on the migration of large birds such as birds of prey, storks, pelicans and cranes. In order to collect baseline data of migration within the 650 km^2 large concessionary area, an intensive field study was performed during autumn 2006 and spring 2007.

The main purposes of this report is i) to analyze the collected baseline data, ii) to describe migration patterns of relevant species in a quantitative way, iii) to identify and assess possible impacts of wind power utilization within the concessionary area, and finally iv) to recommend mitigation measures in order to minimize possible conflicts.

During the investigation a high number of large migrants passed trough the concessionary area. For instance, during standardized field observations in spring 2007, 95,067 birds from 31 relevant species were observed within 604 hours. The majority of birds migrated at altitudes above 199 m, nevertheless, 28 % in autumn 2006 and 18 % in spring 2007 were recorded below 100 m.
Despite the high number of migrants, there seemed to be no or low migratory activity of relevant species over large periods, indicating that migration within the concessionary area was i) distributed irregularly over time, and ii) dominated by large flocks. As a consequence, migratory activity shows a high variation at every as well as between different observation sites. Moreover, observation time at each site was quite short (compared to an entire migration period). Consequently, it is not certain if the data set provides a representative sample of migration at the 26 observation sites.

It was already known that the concessionary area is located at one of the most important migration routes. The results of the investigation clearly show that most parts of the concessionary area are of international importance for migration (at least for several species). Based on basic considerations as well as on the results obtained in this study, it is reasonable to separate the concessionary area into three sections, with the north being important and the south being extremely important.
Almost all parts of the concessionary area do not fulfil the qualities of a typical resting site for Storks or other species and thus is not thought to be of considerable importance as a resting area.

There are two possible impacts of a wind power plant on migrating birds: collision risk and barrier effect.

According to species- and site-specific factors, there are several reasons to expect a comparably low collision risk at a proposed wind farm within the concessionary area. But because of the enormous number of migrating birds (at least in the southern part) and the critical conservational status of some species, we cannot generally exclude collision rates leading to additional mortality, which in turn might cause significant population effects for some species (*e.g.* Egyptian vulture, White stork or Honey buzzard). Hence, bearing in mind the uncertainty of predictions, establishing a wind power plant within the concessionary area will entail a noticeable risk potential. Currently it is not possible to give a reliable quantitative estimate on the weight of species-specific collisions at a wind power plant within the concessionary area.

In contrast, it seems unlikely that avoidance behaviour caused by barrier effects might produce a significant effect on populations, although it is very difficult to estimate the degree of additional energy expenditure.

Consequently, in terms of strict bird conservation aspects it is highly recommended to avoid construction of a wind power plant within the whole concessionary area. In terms of a process in which competing environmental interests must be weighted against each other, the concessionary area can be divided into three zones according to the importance of the area for migration and hence according to the weight of expected environmental impact.

Within Zone I, which consists of the southern and central part of the concessionary area, the construction of a wind power plant must be strictly banned. Regarding Zone II, which borders on Zone I in the north and stretches over 10 km northwards, construction of a wind power plant is not recommended unless further ornithological investigations might indicate that the environmental impact could be kept to a tolerable level. Any wind farm installation in Zone III, which consists of the very north of the concessionary area, would require technical avoidance and the recommended mitigation measures to the best practicable standard. Moreover, a detailed post-construction monitoring programme has to be carried out to assess whether impacts of the wind farm will remain at an acceptable level or additional measures will be necessary to minimize or eliminate unacceptable impacts.

Final Declaration

We confirm that this report was prepared impartially and according to the best and latest state of knowledge. Data analysis was conducted with most possible accuracy.

Dortmund, November 5th 2007

Dr. Frank Bergen

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Annex

I Relevant species, which were included in the analysis

no.	trivial name	scientific name	IUCN-Red List	SPEC
1	Levant sparrowhawk	Accipiter brevipes	Least Concern	2
2	Sparrowhawk	Accipiter nisus	Least Concern	Non-SPEC
3	Spotted eagle	Aquila clanga	Vulnerable	1
4	Eastern imperial eagle	Aquila heliaca	Vulnerable	1
5	Steppe eagle	Aquila nipalensis	Least Concern	3
6	Lesser spotted eagle	Aquila pomarina	Least Concern	2
7	Grey heron	Ardea cinerea	Least Concern	Non-SPEC
8	Purple heron	Ardea purpurea	Least Concern	3
9	Squacco heron	Ardeola ralloides	Least Concern	3
10	Cattle egret	Bubulcus ibis	Least Concern	Non-SPEC
11	Steppe eagle	Buteo buteo vulpinus	Least Concern	Non-SPEC
12	Long-legged buzzard	Buteo rufinus	Least Concern	3
13	White stork	Ciconia ciconia	Least Concern	2
14	Black stork	Ciconia nigra	Least Concern	2
15	Short-toed eagle	Circaetus gallicus	Least Concern	3
16	Marsh harrier	Circus aeruginosus	Least Concern	Non-SPEC
17	Pallid harrier	Circus macrourus	Near Threatened	1
18	Montagu's harrier	Circus pygargus	Least Concern	non SPEC^{E}
19	Western reef heron	Egretta gularis	Least Concern	not evaluated
20	Lanner falcon	Falco biarmicus	Least Concern	3
21	Lesser kestrel	Falco naumanni	Vulnerable	1
22	Peregrine	Falco peregrinus	Least Concern	Non-SPEC
23	Barbary falcon	Falco pelegrinoides	Least Concern	Non-SPEC
24	Hobby	Falco subbuteo	Least Concern	Non-SPEC
25	Kestrel	Falco tinnunculus	Least Concern	3
26	Red-footed falcon	Falco vespertinus	Near Threatened	3
27	Common crane	Grus grus	Least Concern	2
28	Booted eagle	Hieraaetus pennatus	Least Concern	3
29	Bee-eater	Merops apiaster	Least Concern	3
30	Blue-cheeked bee-eater	Merops persicus	Least Concern	Non-SPEC
31	Black kite	Milvus migrans	Least Concern	3
32	Egyptian vulture	Neophron percnopterus	Endangered	3
33	Night heron	Nycticorax nycticorax	Least Concern	3
34	Osprey	Pandion haliaetus	Least Concern	3
35	White pelican	Pelecanus onocrotalus	Least Concern	3
36	Honey buzzard	Pernis apivorus	Least Concern	non SPEC^{E}
37	Flamingo	Phoenicopterus ruber	Least Concern	not evaluated
38	Spoonbill	Platalea leucorodia	Least Concern	2
39	Glossy ibis	Plegadis falcinellus	Least Concern	3

IIa Explanation of different categories of “The IUCN Red List of Threatened Species” (International Union for the Conservation of Nature and Natural Resources) http://www.iucnredlist.org/)

ENDANGERED (EN)
A species is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)
A species is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)
A species is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)
A species is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.

IIb Explanation of different categories of conservation status of all wild birds in Europe (BirdLife International)
http://www.birdlife.org/action/science/species/birds_in_europe/index.html

SPEC 1
European species of global conservation concern

SPEC 2
Unfavourable conservation status in Europe, concentrated in Europe

SPEC 3
Unfavourable conservation status in Europe, not concentrated in Europe

NON-SPEC^{E}
Favourable conservation status in Europe, concentrated in Europe

NON-SPEC
Favourable conservation status in Europe, not concentrated in Europe

III Total number of birds / recordings (rec.) migrating within the concessionary area in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	5	5	11	7	16	12
2	Accipiter nisus	1	1	4	4	5	5
3	Accipiter spec.	2	2	4	4	6	6
4	Aquila pomarina	1	1	3	3	4	4
5	Ardea cinerea	0	0	11	3	11	3
6	Ardea purpurea	0	0	26	2	26	2
7	Buteo buteo vulpinus	5	5	20	10	25	15
8	Buteo rufinus	0	0	1	1	1	1
9	Buteo spec.	2	1	5	3	7	4
10	Ciconia ciconia	12,457	21	20,481	62	32,938	83
11	Ciconia nigra	160	9	221	19	381	28
12	Circaetus gallicus	1	1	1	1	2	2
13	Circus aeruginosus	120	94	136	110	256	204
14	Circus macrourus	33	30	49	38	82	68
15	Circus pygargus	35	32	38	22	73	54
16	Circus spec.	32	31	41	35	73	66
17	Egretta gularis	0	0	1	1	1	1
18	Falco biarmicus	0	0	1	1	1	1
19	Falco naumanni	18	10	13	11	31	21
20	Falco pelegrinoides	0	0	1	1	1	1
21	Falco subbuteo	7	7	6	6	13	13
22	Falco tinnunculus	6	6	11	11	17	17
23	Falco vespertinus	1	1	2	2	3	3
24	Falco spec.	13	12	26	24	39	36
25	Hieraaetus pennatus	3	3	2	2	5	5
26	Merops apiaster	14	3	138	6	152	9
27	Milvus migrans	23	12	14	10	37	22
28	Neophron percnopterus	4	4	2	2	6	6
29	Pandion haliaetus	3	3	1	1	4	4
30	Pelecanus onocrotalus	164	4	45	1	209	5
31	Pernis apivorus	2,139	148	3,084	252	5,223	400
32	Platalea leucorodia	0	0	19	1	19	1
33	Raptor spec.	6	6	14	9	20	15
	total number	15,255	452	24,432	665	39,687	1,117

IV Total number of birds / recordings (rec.) migrating at altitudes below 200 m within the concessionary area in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	3	3	2	2	5	5
2	Accipiter nisus	1	1	1	1	2	2
3	Accipiter spec.	1	1	1	1	2	2
4	Aquila pomarina	1	1	3	3	4	4
5	Ardea cinerea	0	0	11	3	11	3
6	Ardea purpurea	0	0	26	2	26	2
7	Buteo buteo vulpinus	4	4	2	2	6	6
8	Buteo rufinus	0	0	1	1	1	1
9	Buteo spec.	0	0	3	2	3	2
10	Ciconia ciconia	4,186	12	8,880	37	13,066	49
11	Ciconia nigra	150	7	80	6	230	13
12	Circus aeruginosus	96	79	110	91	206	170
13	Circus macrourus	28	25	34	29	62	54
14	Circus pygargus	33	30	35	19	68	49
15	Circus spec.	27	26	31	27	58	52
16	Egretta gularis	0	0	1	1	1	1
17	Falco biarmicus	0	0	1	1	1	1
18	Falco naumanni	7	7	4	4	11	11
19	Falco pelegrinoides	0	0	1	1	1	1
20	Falco subbuteo	6	6	3	3	9	9
21	Falco tinnunculus	5	5	8	8	13	13
22	Falco vespertinus	1	1	1	1	2	2
23	Falco spec.	7	7	17	17	24	24
24	Hieraaetus pennatus	1	1	1	1	2	2
25	Merops apiaster	0	0	20	1	20	1
26	Milvus migrans	18	8	3	3	21	11
27	Neophron percnopterus	1	1	2	2	3	3
28	Pandion haliaetus	3	3	0	0	3	3
29	Pelecanus onocrotalus	8	1	0	0	8	1
30	Pernis apivorus	1,257	91	1,161	119	2,418	210
31	Platalea leucorodia	0	0	19	1	19	1
32	undetermined raptor	4	4	1	1	5	5
	total number	5,848	324	10,463	390	16,311	713

V Total number of birds / recordings (rec.) migrating at distances above 2.5 km from the observer in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	1	1	0	0	1	1
2	Ardea purpurea	62	1	28	1	90	2
3	Ardea spec.	0	0	3	1	3	1
4	Buteo buteo vulpinus	7	6	1	1	8	7
5	Ciconia ciconia	13,959	24	12,472	33	26,431	57
6	Ciconia nigra	297	14	345	11	642	25
7	Circus aeruginosus	29	13	22	15	51	28
8	Circus macrourus	7	7	1	1	8	8
9	Circus pygargus	1	1	8	4	9	5
10	Circus spec.	9	8	9	6	18	14
11	Egretta spec.	4	1	0	0	4	1
12	Falco spec.	2	1	1	1	3	2
13	Milvus migrans	6	1	2	2	8	3
14	Nycticorax nycticorax	0	0	15	1	15	1
15	Pandion haliaetus	1	1	1	1	2	2
16	Pelecanus onocrotalus	1,703	6	25	1	1,728	7
17	Pernis apivorus	1,822	47	640	37	2,462	84
18	Plegadis falcinellus	35	1	0	0	35	1
19	undetermined raptor	18	15	33	20	51	35
	total number	17,963	148	13,606	136	31,569	284

VI Total number of birds / recordings (rec.) migrating within the concessionary area in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	5,641	18	759	8	6,400	26
2	Accipiter nisus	20	17	38	37	58	54
3	Accipiter spec.	13	10	6	4	19	14
4	Aquila clanga	6	4	2	2	8	6
5	Aquila heliaca	1	1	0	0	1	1
6	Aquila nipalensis	593	180	633	131	1,226	311
7	Aquila pomarina	100	50	63	33	163	83
8	Aquila spec.	221	51	70	26	291	77
9	Ardea purpurea	0	0	3	1	3	1
10	Bubulcus ibis	0	0	1	1	1	1
11	Buteo buteo vulpinus	10,963	558	5,485	601	16,448	1,159
12	Buteo rufinus	25	18	35	19	60	37
13	Buteo spec.	11	10	23	4	34	14
14	Ciconia ciconia	21,602	40	39,902	31	61,504	71
15	Ciconia nigra	262	26	454	14	716	40
16	Circaetus gallicus	41	36	36	31	77	67
17	Circus aeruginosus	13	13	14	13	27	26
18	Circus macrourus	6	5	5	5	11	10
19	Circus pygargus	4	4	2	2	6	6
20	Circus spec.	1	1	3	3	4	4
21	Falco biarmicus	2	2	0	0	2	2
22	Falco naumanni	11	10	9	9	20	19
23	Falco pelegrinoides	1	1	3	3	4	4
24	Falco peregrinus	1	1	1	1	2	2
25	Falco subbuteo	1	1	2	2	3	3
26	Falco tinnunculus	13	10	18	16	31	26
27	Falco spec.	8	8	8	8	16	16
28	Grus grus	2,444	16	2,218	17	4,662	33
29	Hieraaetus pennatus	66	49	33	23	99	72
30	Merops apiaster	26	2	26	2	52	4
31	Merops persicus	10	1	0	0	10	1
32	Merops spec.	6	1	6	2	12	3
33	Milvus migrans	600	149	621	112	1,221	261
34	Neophron percnopterus	45	26	9	5	54	31
35	Pandion haliaetus	2	2	4	4	6	6
36	Pelecanus onocrotalus	503	5	257	3	760	8
37	Pernis apivorus	631	61	405	26	1,036	87
38	undetermined raptor	14	3	6	3	20	6
	sum	43,907	1,390	51,160	1,202	95,067	2,592

VII Total number of birds / recordings (rec.) migrating at altitudes below 200 m within the concessionary area in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	53	4	143	5	196	9
2	Accipiter nisus	10	8	30	29	40	37
3	Accipiter spec.	7	4	3	3	10	7
4	Aquila clanga	1	1	0	0	1	1
5	Aquila nipalensis	38	26	70	27	108	53
6	Aquila pomarina	13	9	9	8	22	17
7	Aquila spec.	17	9	10	3	27	12
8	Ardea purpurea	0	0	3	1	3	1
9	Bubulcus ibis	0	0	1	1	1	1
10	Buteo buteo vulpinus	4,412	265	2,280	409	6,692	674
11	Buteo rufinus	5	5	17	15	22	20
12	Buteo spec.	8	7	1	1	9	8
13	Ciconia ciconia	10,859	16	6,825	14	17,684	30
14	Ciconia nigra	55	7	101	4	156	11
15	Circaetus gallicus	8	8	11	11	19	19
16	Circus aeruginosus	9	9	13	12	22	21
17	Circus macrourus	6	5	4	4	10	9
18	Circus pygargus	4	4	4	4	8	8
19	Circus spec.	1	1	2	2	3	3
20	Falco biarmicus	2	2	0	0	2	2
21	Falco naumanni	13	12	7	7	20	19
22	Falco pelegrinoides	1	1	1	1	2	2
23	Falco peregrinus	0	0	1	1	1	1
24	Falco subbuteo	1	1	1	1	2	2
25	Falco tinnunculus	12	9	18	16	30	25
26	Falco spec.	5	5	7	7	12	12
27	Grus grus	78	4	478	6	556	10
28	Hieraaetus pennatus	8	8	9	7	17	15
29	Merops apiaster	26	2	26	2	52	4
30	Merops spec.	6	1	6	2	12	3
31	Milvus migrans	248	72	522	80	770	152
32	Neophron percnopterus	6	5	2	2	8	7
33	Pandion haliaetus	0	0	2	2	2	2
34	Pelecanus onocrotalus	503	5	251	2	754	7
35	Pernis apivorus	130	21	242	12	372	33
36	undetermined raptor	2	1	2	1	4	2
	sum	16,547	537	11,102	702	27,649	1,239

VIII Total number of birds / recordings (rec.) migrating at distances above 2.5 km from the observer in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	840	2	60	1	900	3
2	Accipiter nisus	2	1	0	0	2	1
3	Aquila nipalensis	80	30	102	11	182	41
4	Aquila pomarina	14	6	1	1	15	7
5	Aquila spec.	239	45	31	9	270	54
6	Buteo buteo vulpinus	5,119	95	395	25	5,514	120
7	Buteo rufinus	18	4	11	2	29	6
8	Buteo spec.	12	4	3	2	15	6
9	Ciconia ciconia	30,623	25	18,796	13	49,419	38
10	Ciconia nigra	91	5	284	6	375	11
11	Ciconia spec.	60	1	163	2	223	3
12	Circaetus gallicus	8	8	1	1	9	9
13	Circus spec.	1	1	1	1	2	2
14	Grus grus	2,757	17	2,719	14	5,476	31
15	Hieraaetus pennatus	3	2	0	0	3	2
16	Milvus migrans	287	27	12	3	299	30
17	Neophron percnopterus	5	3	0	0	5	3
18	Pelecanus onocrotalus	274	7	515	2	789	9
19	Pernis apivorus	4	2	150	1	154	3
20	undetermined raptor	502	13	16	8	518	21
	total number	40,939	298	23,260	102	64,199	400

III Total number of birds / recordings (rec.) migrating within the concessionary area in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	5	5	11	7	16	12
2	Accipiter nisus	1	1	4	4	5	5
3	Accipiter spec.	2	2	4	4	6	6
4	Aquila pomarina	1	1	3	3	4	4
5	Ardea cinerea	0	0	11	3	11	3
6	Ardea purpurea	0	0	26	2	26	2
7	Buteo buteo vulpinus	5	5	20	10	25	15
8	Buteo rufinus	0	0	1	1	1	1
9	Buteo spec.	2	1	5	3	7	4
10	Ciconia ciconia	12,457	21	20,481	62	32,938	83
11	Ciconia nigra	160	9	221	19	381	28
12	Circaetus gallicus	1	1	1	1	2	2
13	Circus aeruginosus	120	94	136	110	256	204
14	Circus macrourus	33	30	49	38	82	68
15	Circus pygargus	35	32	38	22	73	54
16	Circus spec.	32	31	41	35	73	66
17	Egretta gularis	0	0	1	1	1	1
18	Falco biarmicus	0	0	1	1	1	1
19	Falco naumanni	18	10	13	11	31	21
20	Falco pelegrinoides	0	0	1	1	1	1
21	Falco subbuteo	7	7	6	6	13	13
22	Falco tinnunculus	6	6	11	11	17	17
23	Falco vespertinus	1	1	2	2	3	3
24	Falco spec.	13	12	26	24	39	36
25	Hieraaetus pennatus	3	3	2	2	5	5
26	Merops apiaster	14	3	138	6	152	9
27	Milvus migrans	23	12	14	10	37	22
28	Neophron percnopterus	4	4	2	2	6	6
29	Pandion haliaetus	3	3	1	1	4	4
30	Pelecanus onocrotalus	164	4	45	1	209	5
31	Pernis apivorus	2,139	148	3,084	252	5,223	400
32	Platalea leucorodia	0	0	19	1	19	1
33	Raptor spec.	6	6	14	9	20	15
	total number	15,255	452	24,432	665	39,687	1,117

IV Total number of birds / recordings (rec.) migrating at altitudes below 200 m within the concessionary area in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	3	3	2	2	5	5
2	Accipiter nisus	1	1	1	1	2	2
3	Accipiter spec.	1	1	1	1	2	2
4	Aquila pomarina	1	1	3	3	4	4
5	Ardea cinerea	0	0	11	3	11	3
6	Ardea purpurea	0	0	26	2	26	2
7	Buteo buteo vulpinus	4	4	2	2	6	6
8	Buteo rufinus	0	0	1	1	1	1
9	Buteo spec.	0	0	3	2	3	2
10	Ciconia ciconia	4,186	12	8,880	37	13,066	49
11	Ciconia nigra	150	7	80	6	230	13
12	Circus aeruginosus	96	79	110	91	206	170
13	Circus macrourus	28	25	34	29	62	54
14	Circus pygargus	33	30	35	19	68	49
15	Circus spec.	27	26	31	27	58	52
16	Egretta gularis	0	0	1	1	1	1
17	Falco biarmicus	0	0	1	1	1	1
18	Falco naumanni	7	7	4	4	11	11
19	Falco pelegrinoides	0	0	1	1	1	1
20	Falco subbuteo	6	6	3	3	9	9
21	Falco tinnunculus	5	5	8	8	13	13
22	Falco vespertinus	1	1	1	1	2	2
23	Falco spec.	7	7	17	17	24	24
24	Hieraaetus pennatus	1	1	1	1	2	2
25	Merops apiaster	0	0	20	1	20	1
26	Milvus migrans	18	8	3	3	21	11
27	Neophron percnopterus	1	1	2	2	3	3
28	Pandion haliaetus	3	3	0	0	3	3
29	Pelecanus onocrotalus	8	1	0	0	8	1
30	Pernis apivorus	1,257	91	1,161	119	2,418	210
31	Platalea leucorodia	0	0	19	1	19	1
32	undetermined raptor	4	4	1	1	5	5
	total number	5,848	324	10,463	390	16,311	713

V Total number of birds / recordings (rec.) migrating at distances above 2.5 km from the observer in autumn 2006

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	1	1	0	0	1	1
2	Ardea purpurea	62	1	28	1	90	2
3	Ardea spec.	0	0	3	1	3	1
4	Buteo buteo vulpinus	7	6	1	1	8	7
5	Ciconia ciconia	13,959	24	12,472	33	26,431	57
6	Ciconia nigra	297	14	345	11	642	25
7	Circus aeruginosus	29	13	22	15	51	28
8	Circus macrourus	7	7	1	1	8	8
9	Circus pygargus	1	1	8	4	9	5
10	Circus spec.	9	8	9	6	18	14
11	Egretta spec.	4	1	0	0	4	1
12	Falco spec.	2	1	1	1	3	2
13	Milvus migrans	6	1	2	2	8	3
14	Nycticorax nycticorax	0	0	15	1	15	1
15	Pandion haliaetus	1	1	1	1	2	2
16	Pelecanus onocrotalus	1,703	6	25	1	1,728	7
17	Pernis apivorus	1,822	47	640	37	2,462	84
18	Plegadis falcinellus	35	1	0	0	35	1
19	undetermined raptor	18	15	33	20	51	35
	total number	17,963	148	13,606	136	31,569	284

VI Total number of birds / recordings (rec.) migrating within the concessionary area in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	5,641	18	759	8	6,400	26
2	Accipiter nisus	20	17	38	37	58	54
3	Accipiter spec.	13	10	6	4	19	14
4	Aquila clanga	6	4	2	2	8	6
5	Aquila heliaca	1	1	0	0	1	1
6	Aquila nipalensis	593	180	633	131	1,226	311
7	Aquila pomarina	100	50	63	33	163	83
8	Aquila spec.	221	51	70	26	291	77
9	Ardea purpurea	0	0	3	1	3	1
10	Bubulcus ibis	0	0	1	1	1	1
11	Buteo buteo vulpinus	10,963	558	5,485	601	16,448	1,159
12	Buteo rufinus	25	18	35	19	60	37
13	Buteo spec.	11	10	23	4	34	14
14	Ciconia ciconia	21,602	40	39,902	31	61,504	71
15	Ciconia nigra	262	26	454	14	716	40
16	Circaetus gallicus	41	36	36	31	77	67
17	Circus aeruginosus	13	13	14	13	27	26
18	Circus macrourus	6	5	5	5	11	10
19	Circus pygargus	4	4	2	2	6	6
20	Circus spec.	1	1	3	3	4	4
21	Falco biarmicus	2	2	0	0	2	2
22	Falco naumanni	11	10	9	9	20	19
23	Falco pelegrinoides	1	1	3	3	4	4
24	Falco peregrinus	1	1	1	1	2	2
25	Falco subbuteo	1	1	2	2	3	3
26	Falco tinnunculus	13	10	18	16	31	26
27	Falco spec.	8	8	8	8	16	16
28	Grus grus	2,444	16	2,218	17	4,662	33
29	Hieraaetus pennatus	66	49	33	23	99	72
30	Merops apiaster	26	2	26	2	52	4
31	Merops persicus	10	1	0	0	10	1
32	Merops spec.	6	1	6	2	12	3
33	Milvus migrans	600	149	621	112	1,221	261
34	Neophron percnopterus	45	26	9	5	54	31
35	Pandion haliaetus	2	2	4	4	6	6
36	Pelecanus onocrotalus	503	5	257	3	760	8
37	Pernis apivorus	631	61	405	26	1,036	87
38	undetermined raptor	14	3	6	3	20	6
	sum	43,907	1,390	51,160	1,202	95,067	2,592

VII Total number of birds / recordings (rec.) migrating at altitudes below 200 m within the concessionary area in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	53	4	143	5	196	9
2	Accipiter nisus	10	8	30	29	40	37
3	Accipiter spec.	7	4	3	3	10	7
4	Aquila clanga	1	1	0	0	1	1
5	Aquila nipalensis	38	26	70	27	108	53
6	Aquila pomarina	13	9	9	8	22	17
7	Aquila spec.	17	9	10	3	27	12
8	Ardea purpurea	0	0	3	1	3	1
9	Bubulcus ibis	0	0	1	1	1	1
10	Buteo buteo vulpinus	4,412	265	2,280	409	6,692	674
11	Buteo rufinus	5	5	17	15	22	20
12	Buteo spec.	8	7	1	1	9	8
13	Ciconia ciconia	10,859	16	6,825	14	17,684	30
14	Ciconia nigra	55	7	101	4	156	11
15	Circaetus gallicus	8	8	11	11	19	19
16	Circus aeruginosus	9	9	13	12	22	21
17	Circus macrourus	6	5	4	4	10	9
18	Circus pygargus	4	4	4	4	8	8
19	Circus spec.	1	1	2	2	3	3
20	Falco biarmicus	2	2	0	0	2	2
21	Falco naumanni	13	12	7	7	20	19
22	Falco pelegrinoides	1	1	1	1	2	2
23	Falco peregrinus	0	0	1	1	1	1
24	Falco subbuteo	1	1	1	1	2	2
25	Falco tinnunculus	12	9	18	16	30	25
26	Falco spec.	5	5	7	7	12	12
27	Grus grus	78	4	478	6	556	10
28	Hieraaetus pennatus	8	8	9	7	17	15
29	Merops apiaster	26	2	26	2	52	4
30	Merops spec.	6	1	6	2	12	3
31	Milvus migrans	248	72	522	80	770	152
32	Neophron percnopterus	6	5	2	2	8	7
33	Pandion haliaetus	0	0	2	2	2	2
34	Pelecanus onocrotalus	503	5	251	2	754	7
35	Pernis apivorus	130	21	242	12	372	33
36	undetermined raptor	2	1	2	1	4	2
	sum	16,547	537	11,102	702	27,649	1,239

VIII Total number of birds / recordings (rec.) migrating at distances above 2.5 km from the observer in spring 2007

no.	species	M-line		S-line		total (M- & S-line)	
		birds	rec.	birds	rec.	birds	rec.
1	Accipiter brevipes	840	2	60	1	900	3
2	Accipiter nisus	2	1	0	0	2	1
3	Aquila nipalensis	80	30	102	11	182	41
4	Aquila pomarina	14	6	1	1	15	7
5	Aquila spec.	239	45	31	9	270	54
6	Buteo buteo vulpinus	5,119	95	395	25	5,514	120
7	Buteo rufinus	18	4	11	2	29	6
8	Buteo spec.	12	4	3	2	15	6
9	Ciconia ciconia	30,623	25	18,796	13	49,419	38
10	Ciconia nigra	91	5	284	6	375	11
11	Ciconia spec.	60	1	163	2	223	3
12	Circaetus gallicus	8	8	1	1	9	9
13	Circus spec.	1	1	1	1	2	2
14	Grus grus	2,757	17	2,719	14	5,476	31
15	Hieraaetus pennatus	3	2	0	0	3	2
16	Milvus migrans	287	27	12	3	299	30
17	Neophron percnopterus	5	3	0	0	5	3
18	Pelecanus onocrotalus	274	7	515	2	789	9
19	Pernis apivorus	4	2	150	1	154	3
20	undetermined raptor	502	13	16	8	518	21
	total number	40,939	298	23,260	102	64,199	400

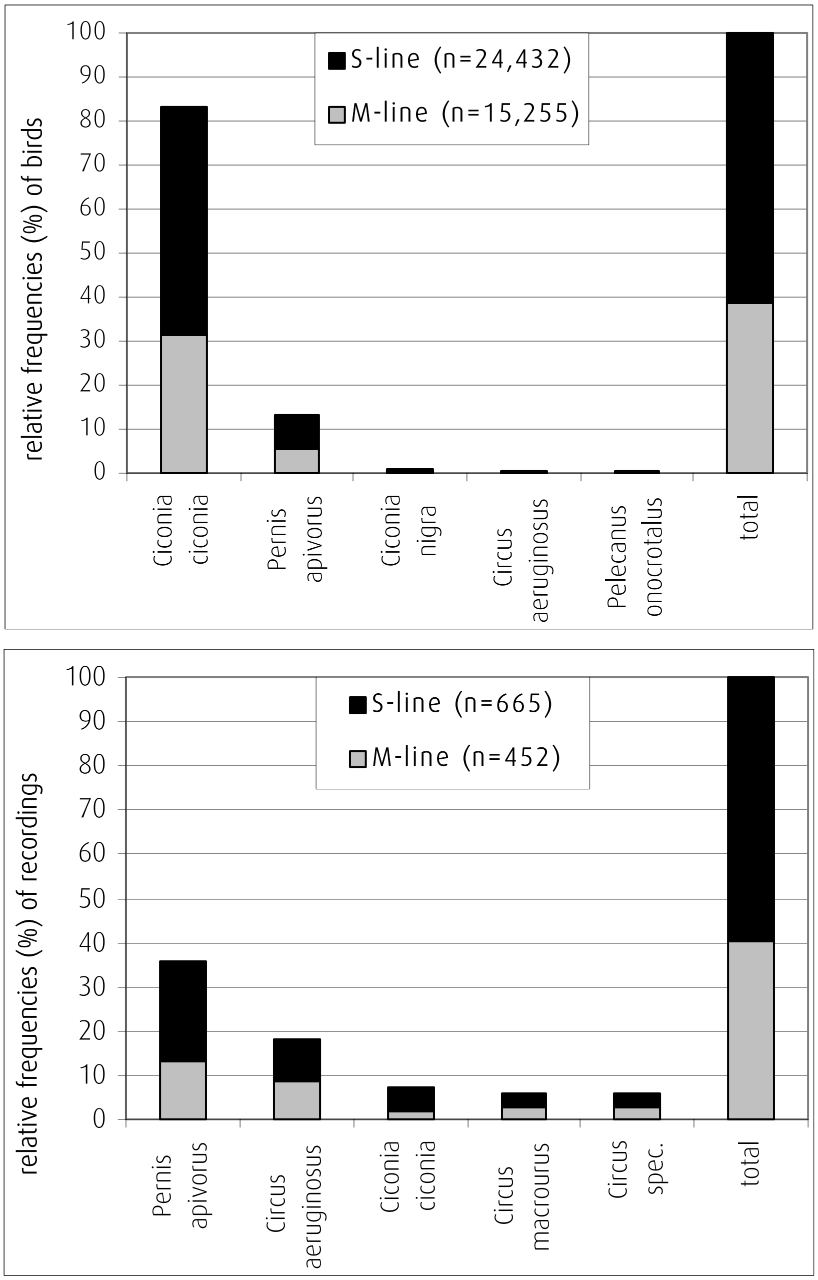


Figure 3.1: Relative frequencies of all birds (above) / recordings (below) migrating within the concessionary area for the five most numerous and frequent species (autumn 2006, separated for M- and S-line)

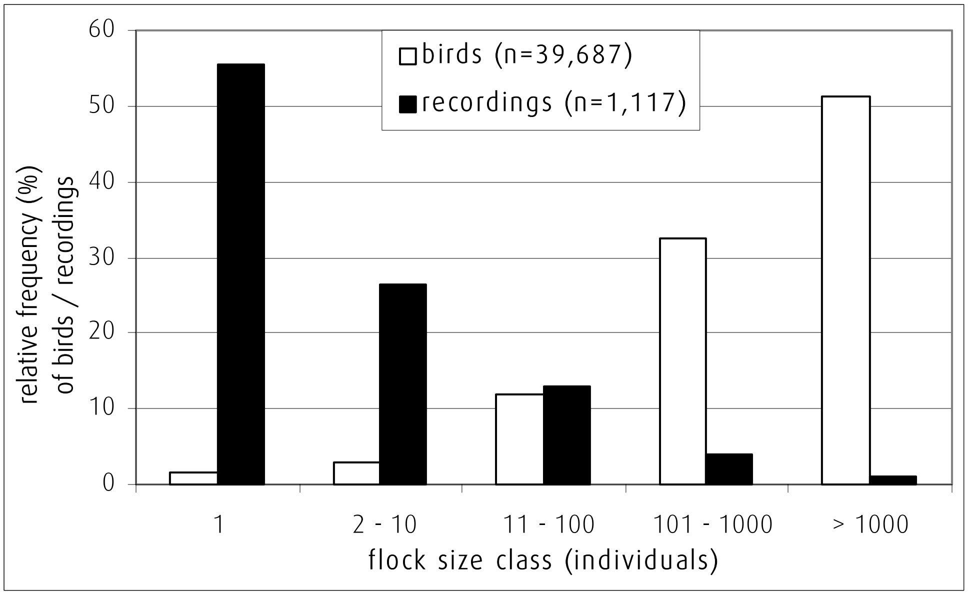


Figure 3.2: Relative frequency of all birds / recordings within the concessionary area in consideration of flock size (autumn 2006)

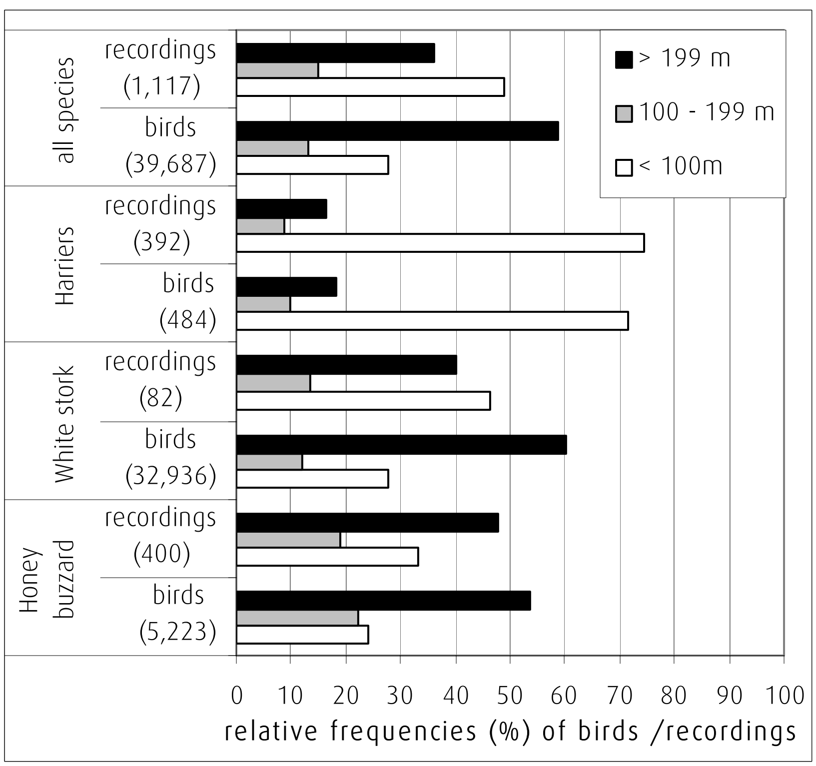


Figure 3.3: Relative frequencies of i) all species, ii) Harriers, iii) White storks and iv) Honey buzzards migrating at different flight altitudes through the concessionary area (autumn 2006)

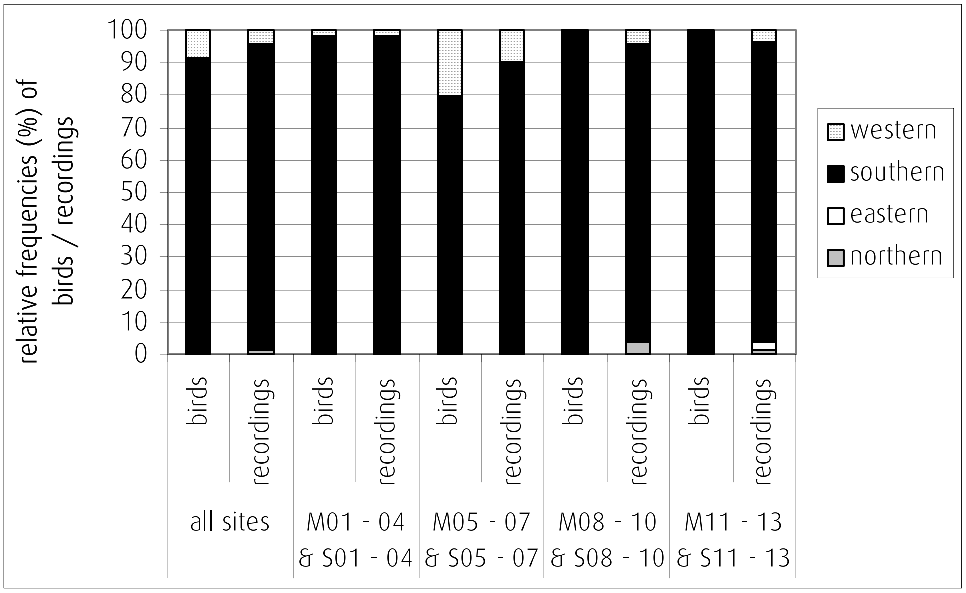
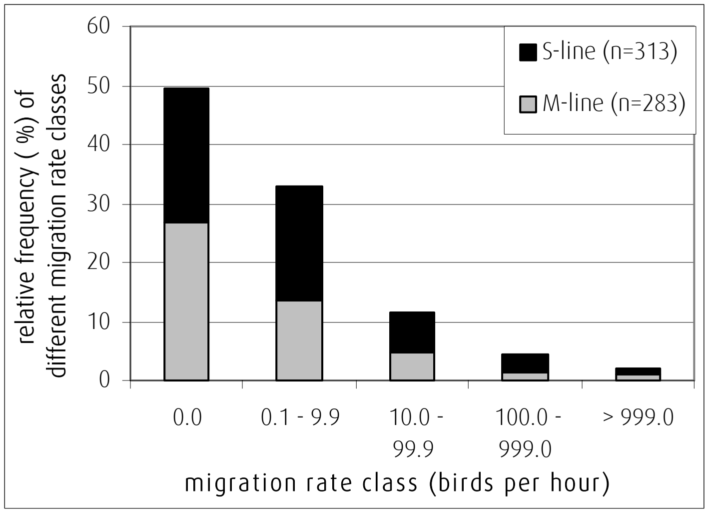


Figure 3.4: Relative frequencies of birds / recordings migrating with different flight directions within the whole concessionary and in different parts of the concessionary area (autumn 2006)



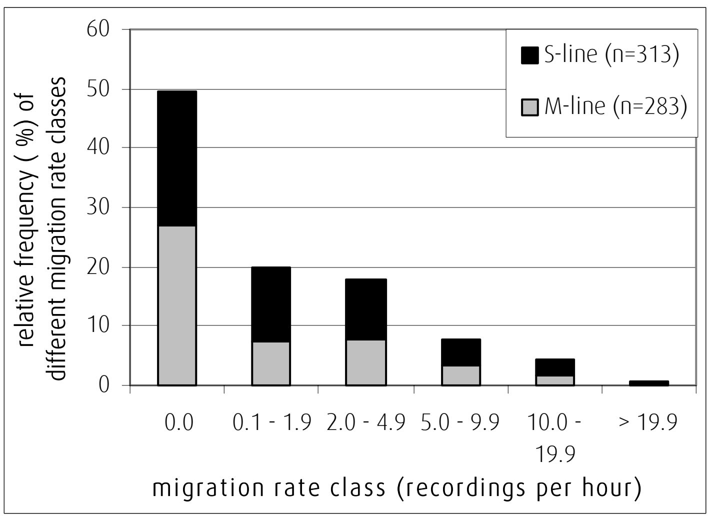


Figure 3.5: Frequency distribution of different migration rate classes in autumn 2006 (birds (above) / recordings (below) per hour; without “area-correction” - factor for S-line data set, see Chapter 2.2.4)

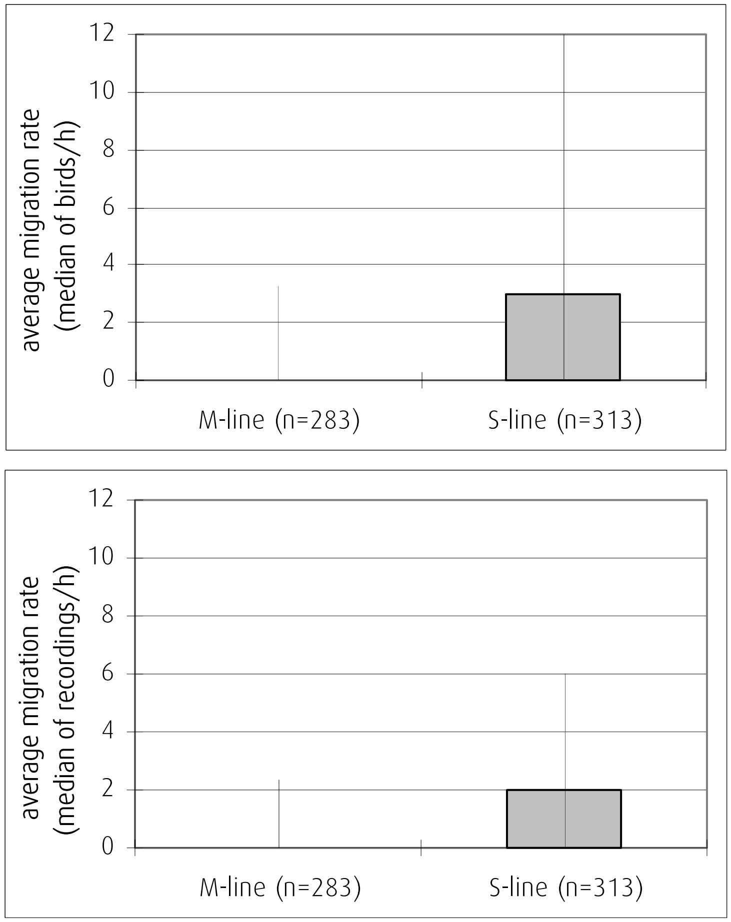
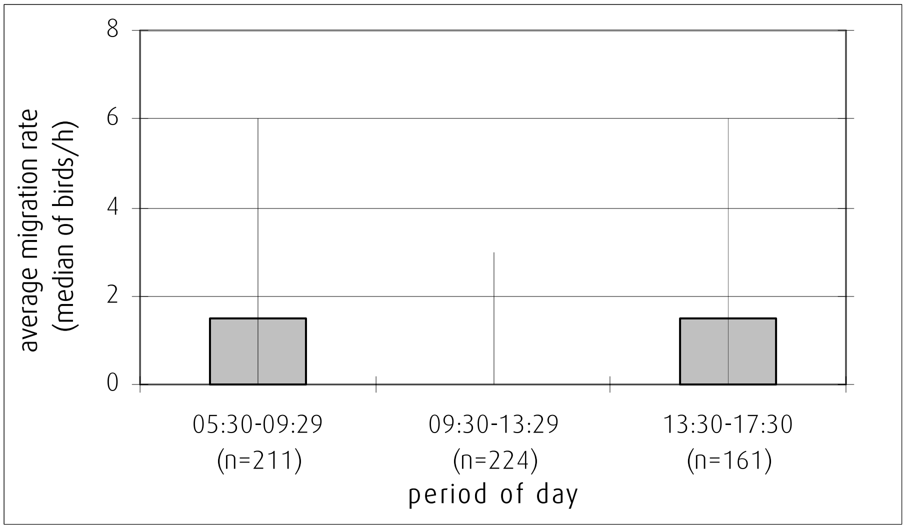


Figure 3.6: Average migration rate in autumn 2006 along the M-line and the S-line (median, 1. and 3. quartile of birds (above) / recordings (below) per hour; with "area-correction" - factor for S-line data set, see Chapter 2.2.4)



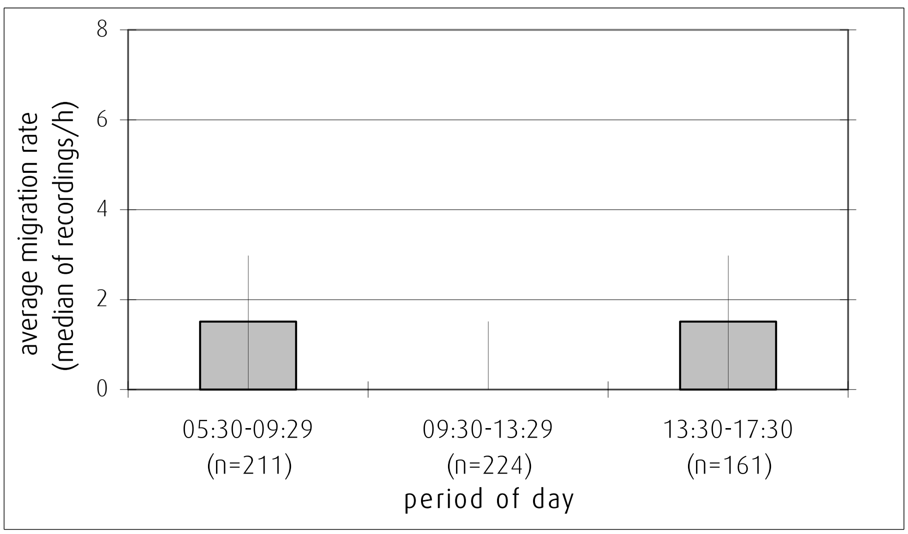


Figure 3.7: Average migration rate in autumn 2006 in three different periods of the day (median, 1. and 3. quartile of birds (above) / recordings (below) per hour; without "area-correction" - factor for S-line data set, see Chapter 2.2.4)

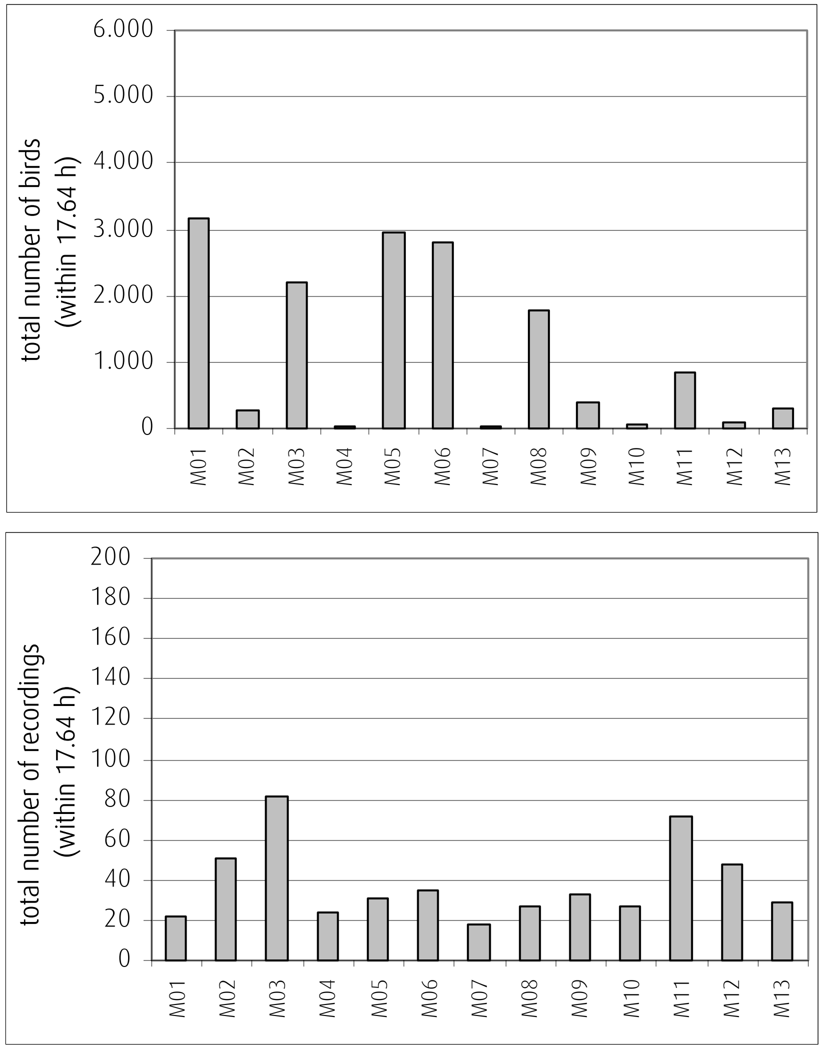


Figure 3.8: Total number of birds / recordings in autumn 2006 at the different observation sites along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

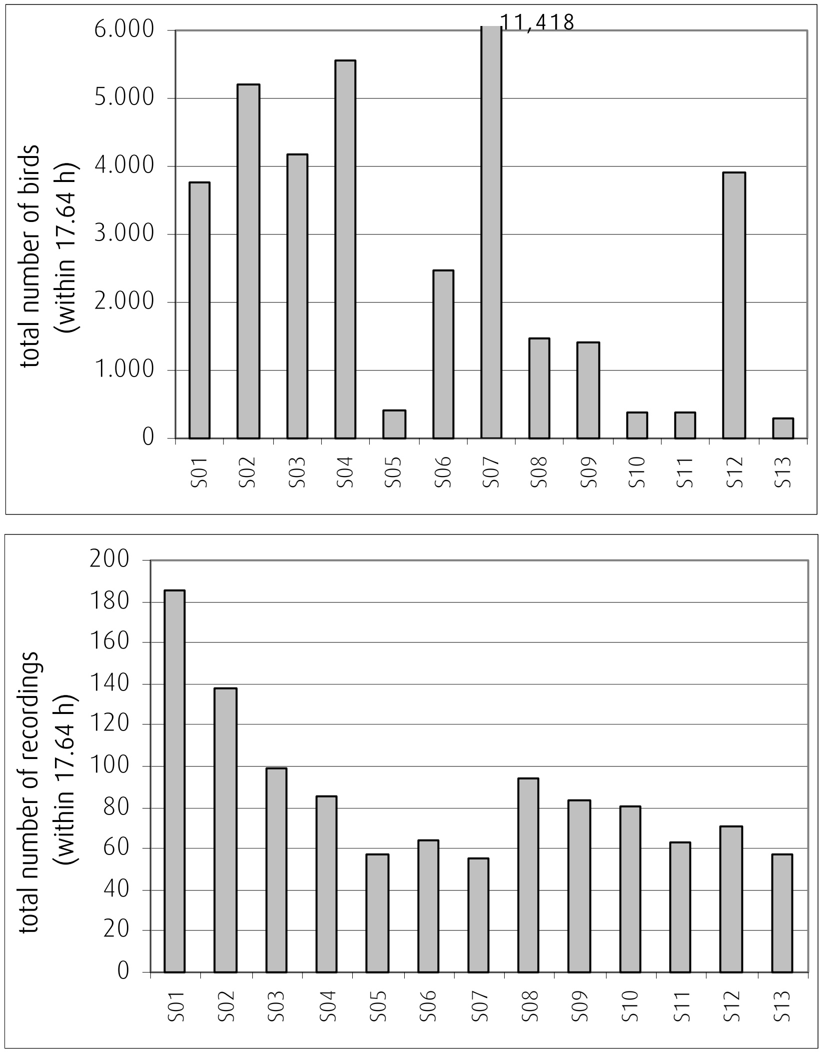


Figure 3.9: Total number of birds / recordings in autumn 2006 at the different observation sites along the S-line (with "area-correction"- and "time-correction"- factor, see Chapter 2.2.4)

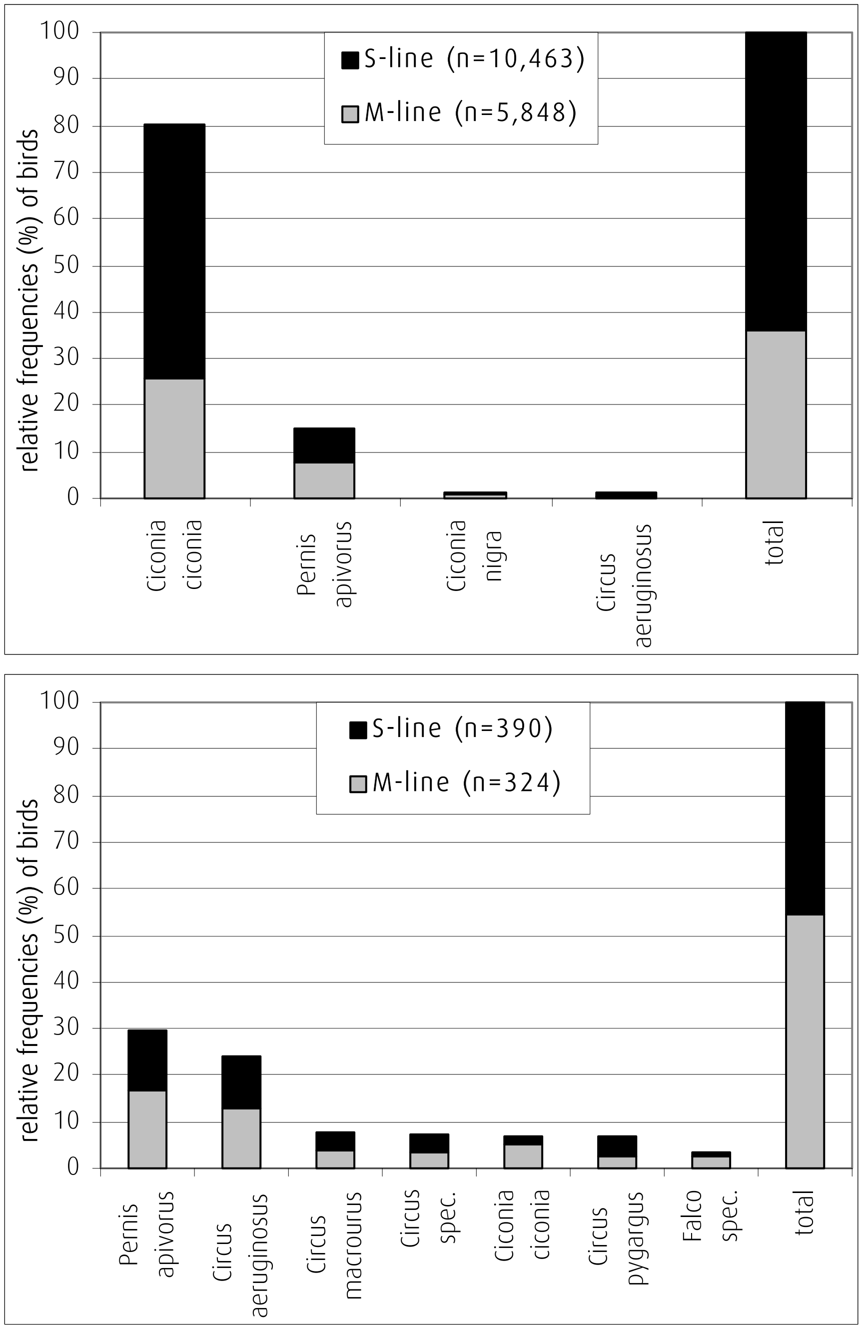


Figure 3.10: Relative abundance of all birds (above) / recordings (below) at altitudes below 200 m within the concessionary area for the four most numerous and the seven most frequent species (autumn 2006, separated for M- and S-line)

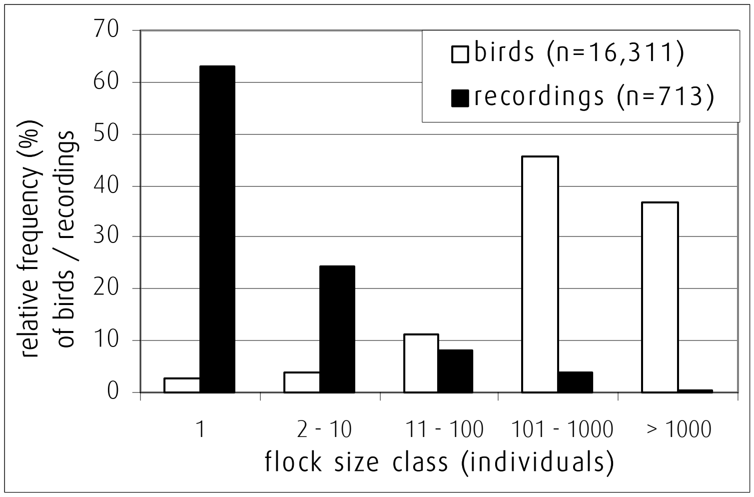
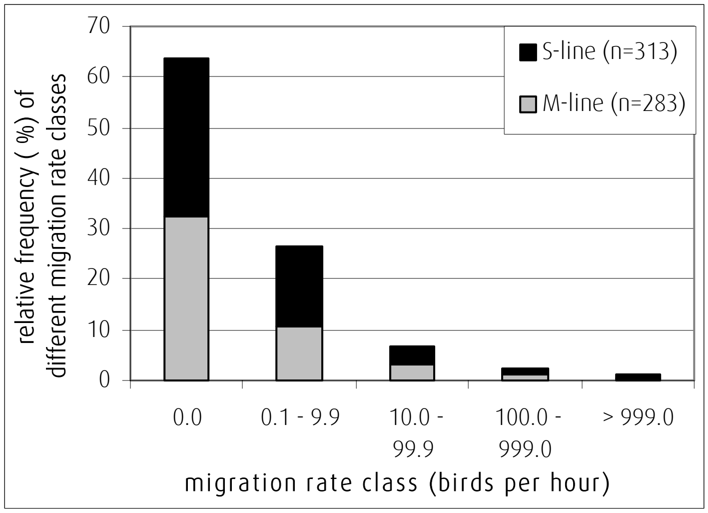


Figure 3.11: Relative frequency of all birds / recordings at altitudes below 200 m within the concessionary area in consideration of flock size (autumn 2006)



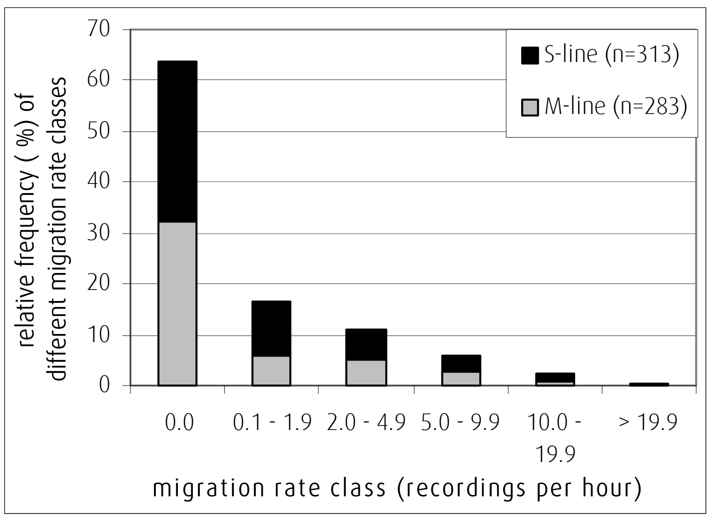


Figure 3.12: Frequency distribution of different migration rate classes in autumn 2006 (birds (above) and recordings (below) at altitudes below 200 m per hour; without "area-correction" - factor for S-line data set, see Chapter 2.2.4)

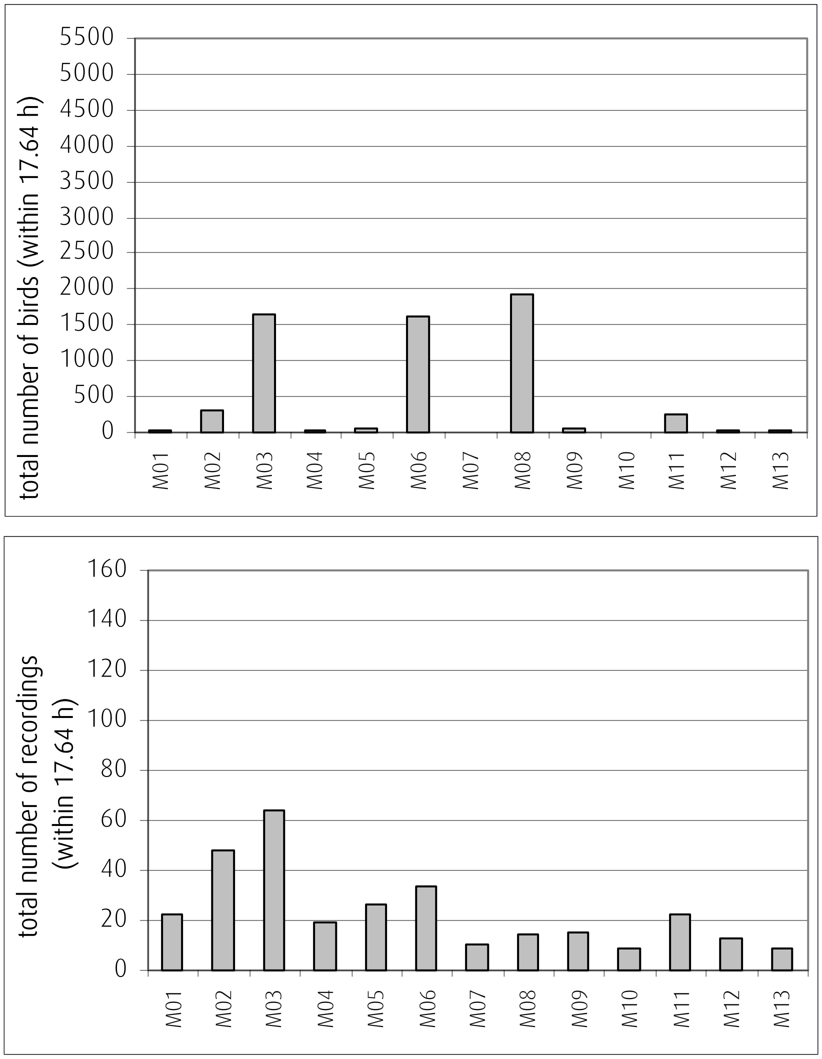


Figure 3.13: Total number of birds / recordings in autumn 2006 at altitudes below 200 m along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

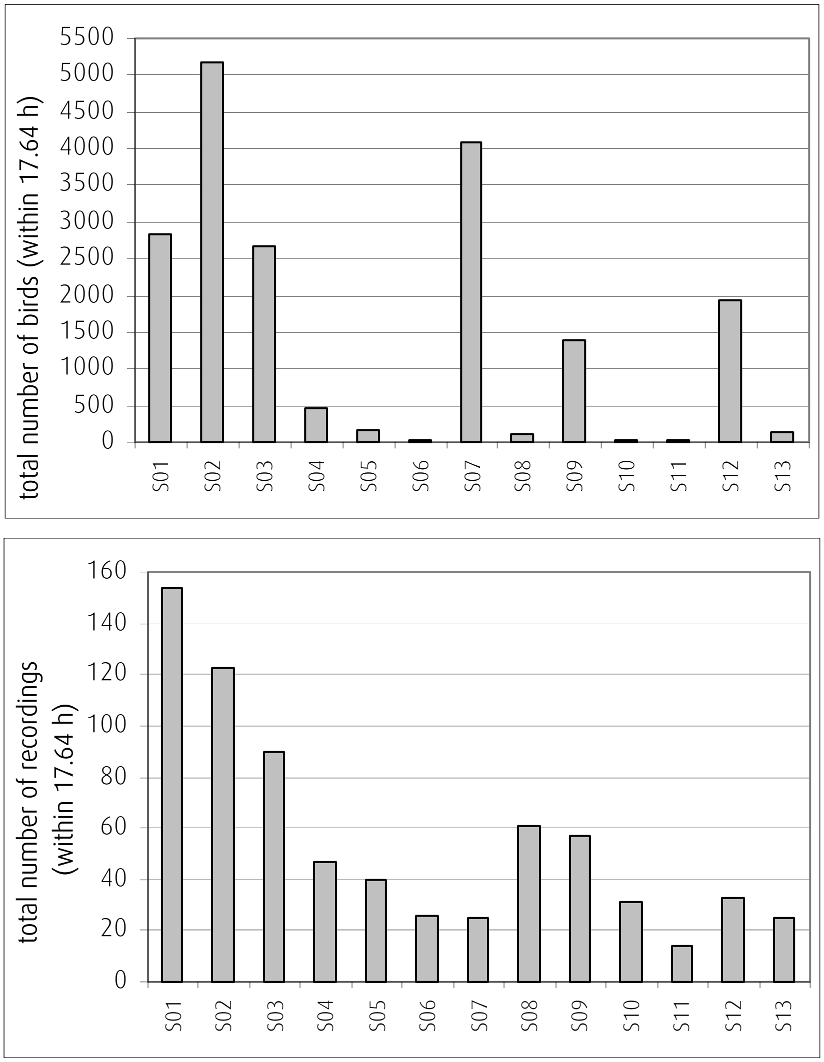


Figure 3.14: Total number of birds / recordings in autumn 2006 at altitudes below 200 m along the S-line (with “area-correction”- and “time-correction”- factor, see Chapter 2.2.4)

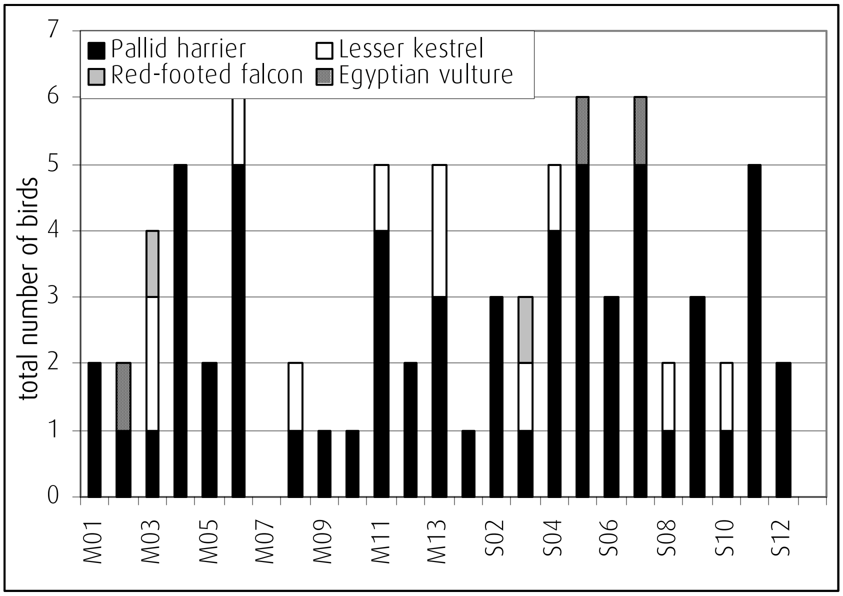
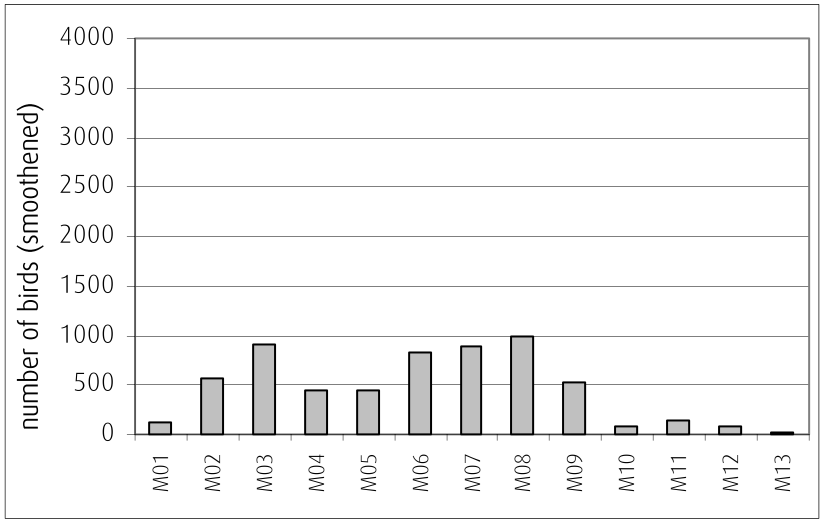


Figure 3.15: Total number of species of special interest in autumn 2006 at altitudes below 200 m along the M- and the S-line (without “area-correction”- and without “time-correction”- factor, see Chapter 2.2.4)



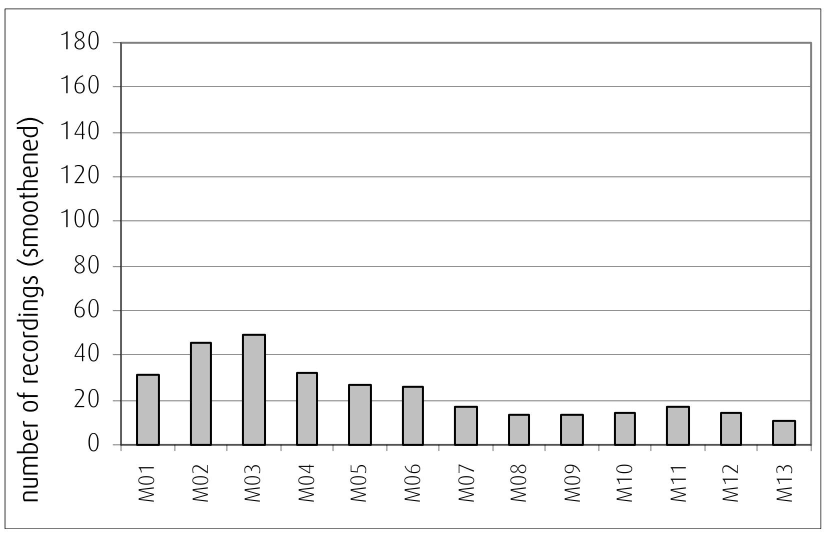


Figure 3.16: Smoothened number of birds (above) / recordings (below) in autumn 2006 at altitudes below 200 m along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

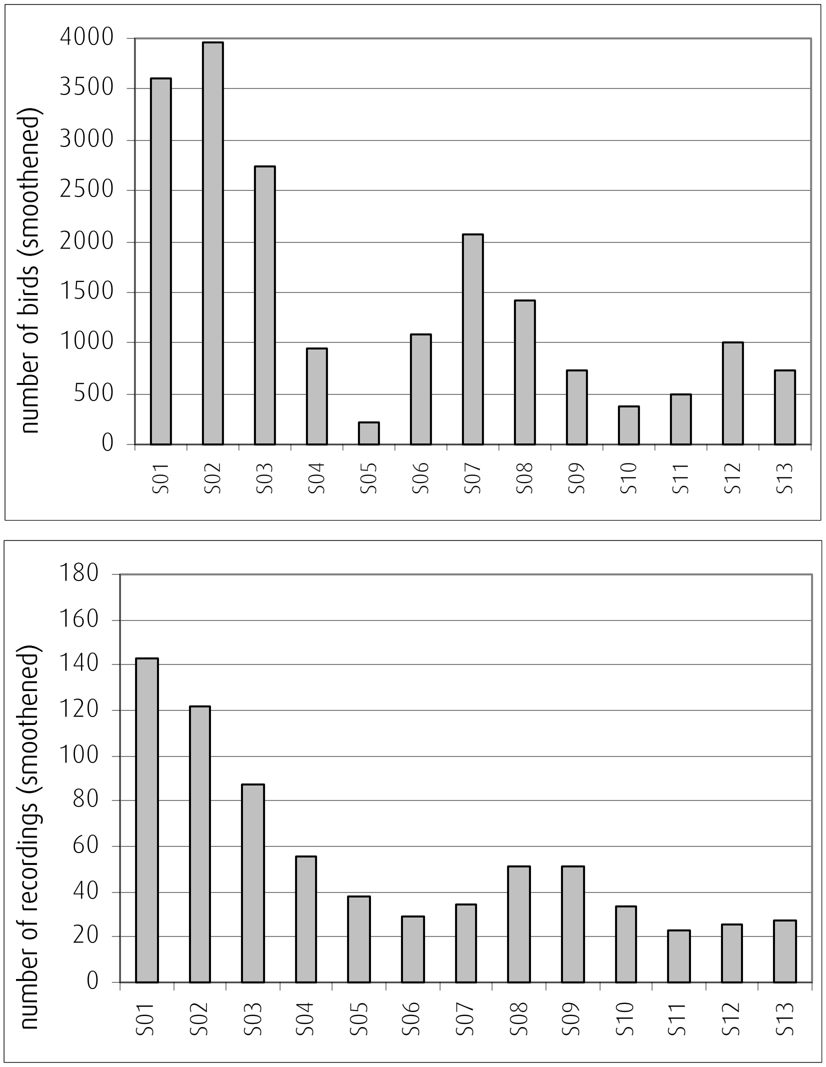


Figure 3.17: Smoothened number of birds (above) / recordings (below) in autumn 2006 at altitudes below 200 m along the S-line (with "area-correction"- and "time-correction"- factor, see Chapter 2.2.4)

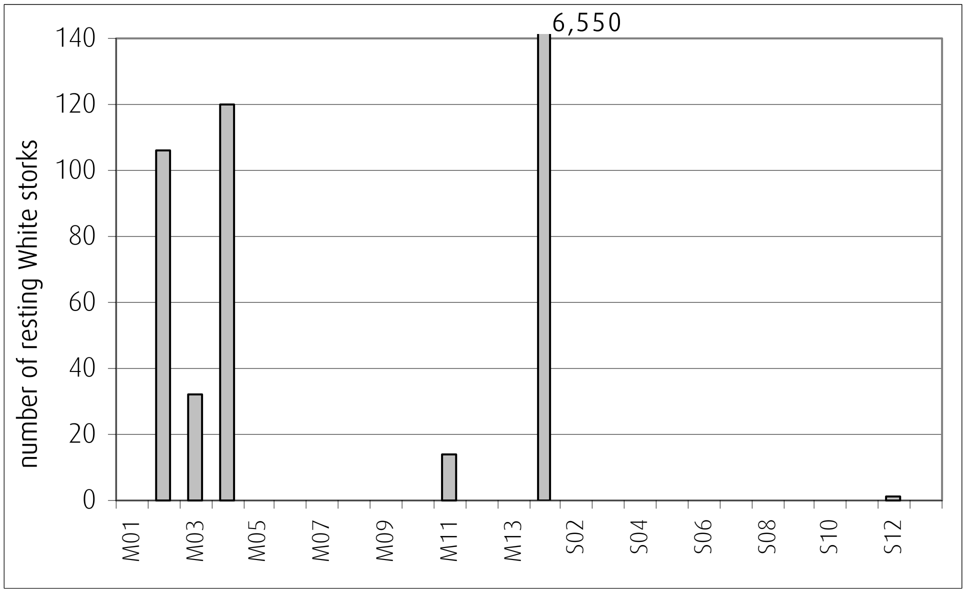
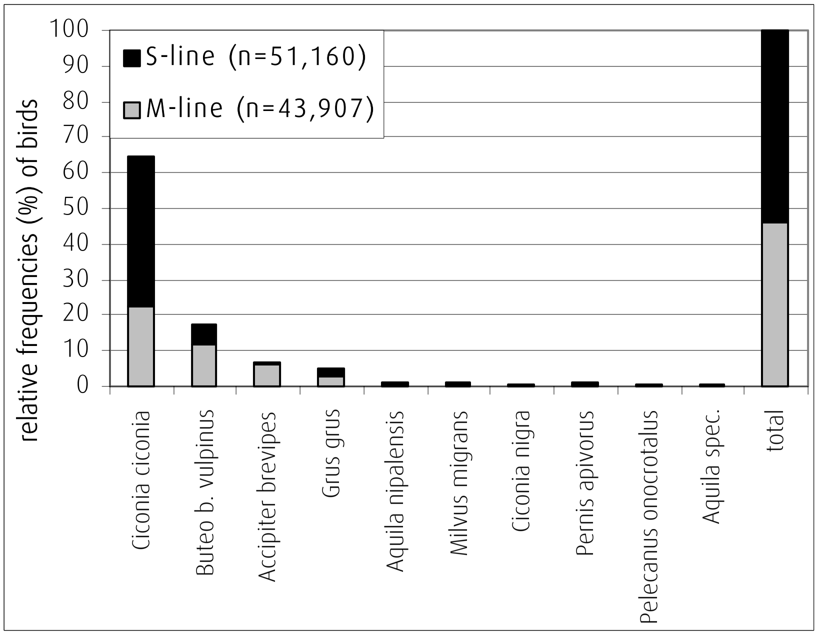


Figure 3.18: Spatial distribution of resting White storks within the concessionary area in autumn 2006



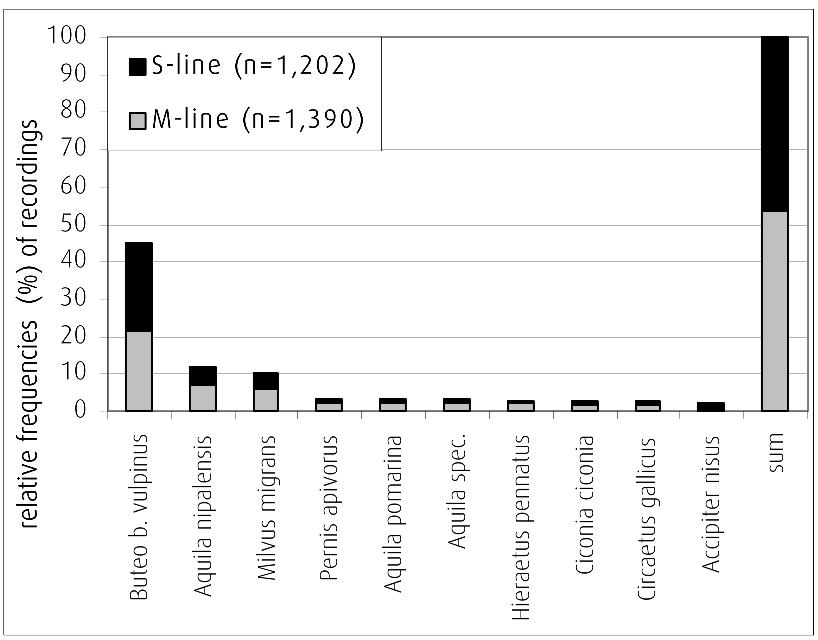


Figure 3.19: Relative frequencies of all birds (above) / recordings (below) migrating within the concessionary area for the ten most numerous and frequent species (spring 2007, separated for M- and S-line)

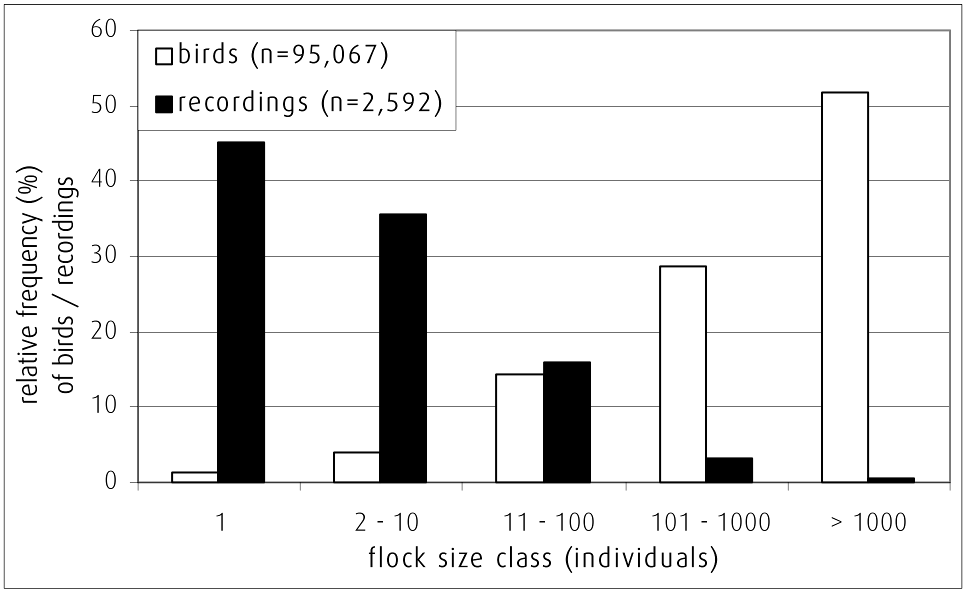


Figure 3.20: Relative frequency of all birds / recordings within the concessionary area in consideration of flock size (spring 2007)

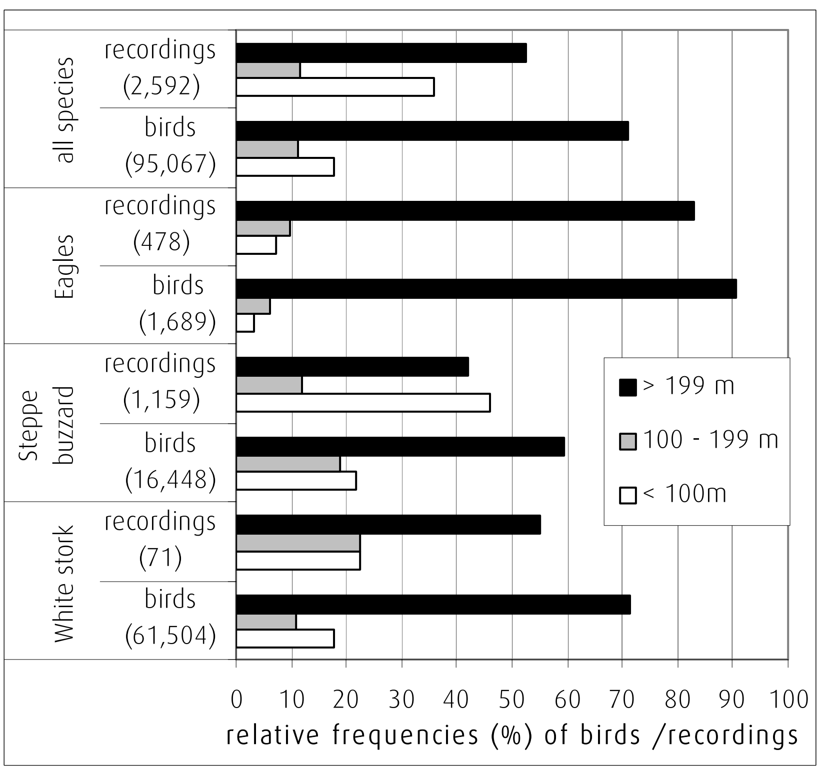


Figure 3.21: Relative frequencies of i) all species, ii) Eagles, iii) Steppe buzzards and iv) White storks migrating at different flight altitudes through the concessionary area (spring 2007)

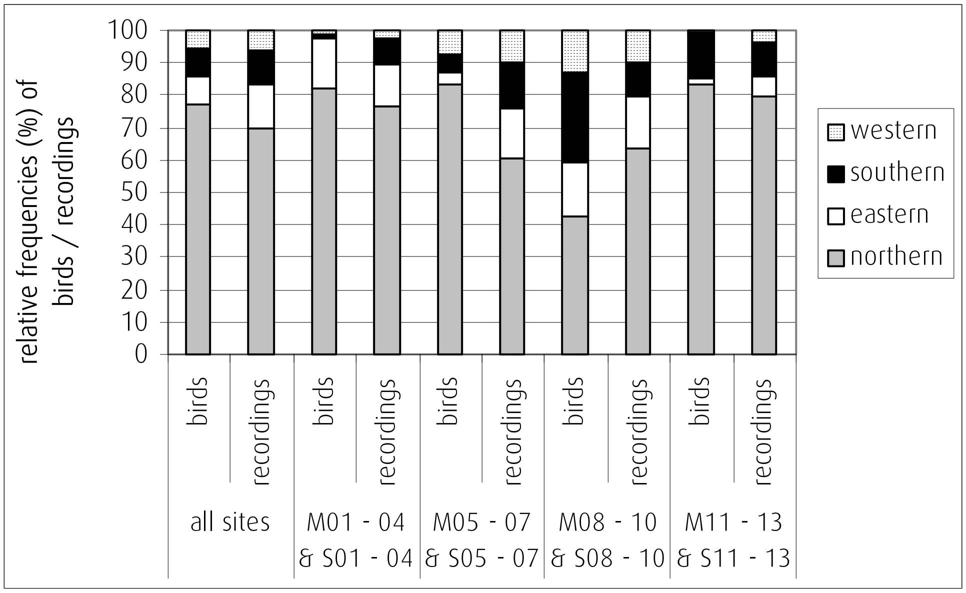


Figure 3.22: Relative frequencies of birds / recordings migrating with different flight directions within the whole concessionary and in different parts of the concessionary area (spring 2007)

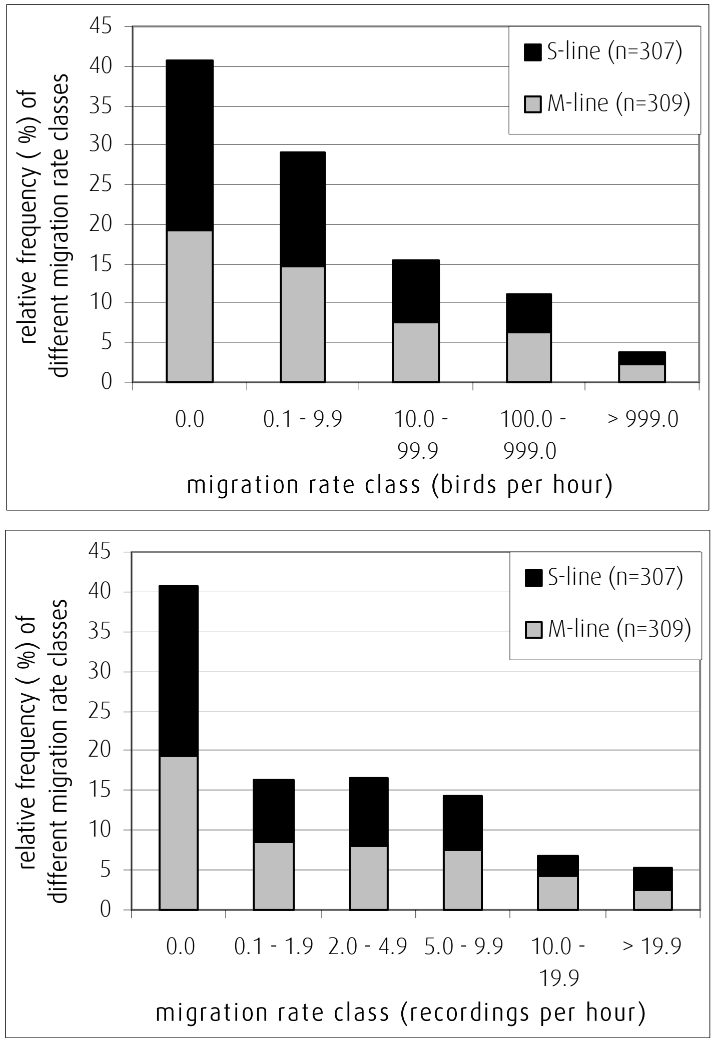


Figure 3.23: Frequency distribution of different migration rate classes in spring 2007 (birds (above) / recordings (below) per hour; without “area-correction” - factor for S-line data set, see Chapter 2.2.4)

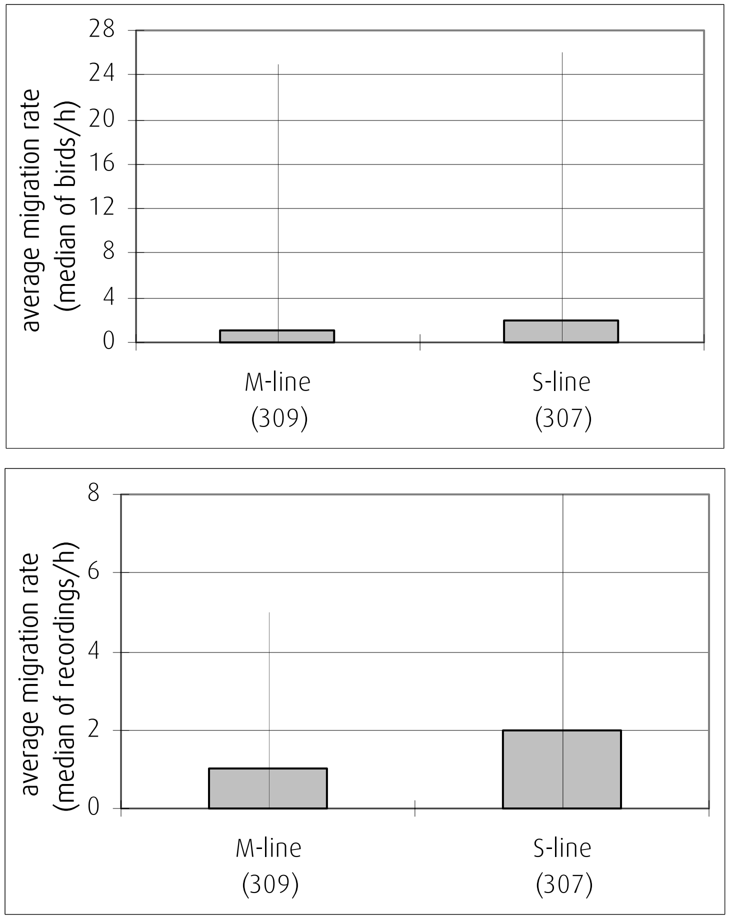
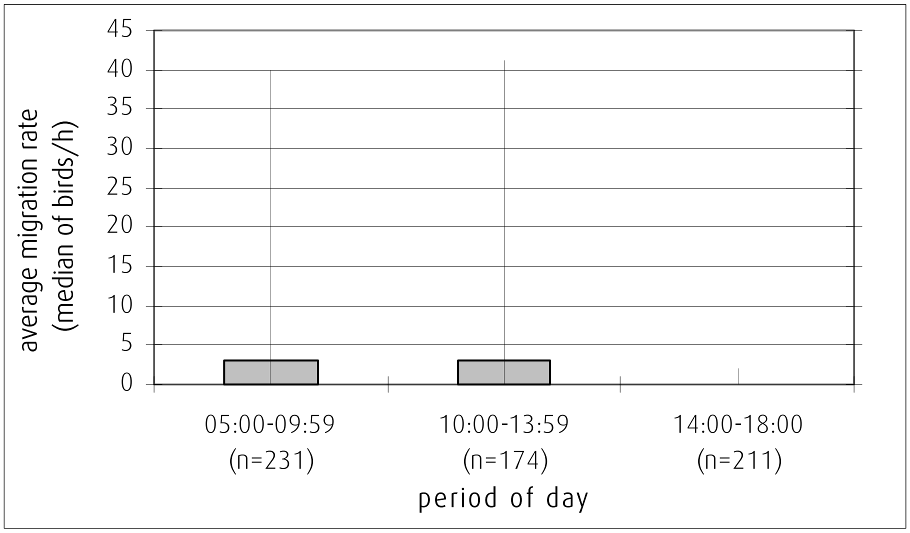


Figure 3.24: Average migration rate in spring 2007 along the M-line and the S-line (median, 1. and 3. quartile of birds (above) / recordings (below) per hour; with "area-correction" - factor for S-line data set, see Chapter 2.2.4)



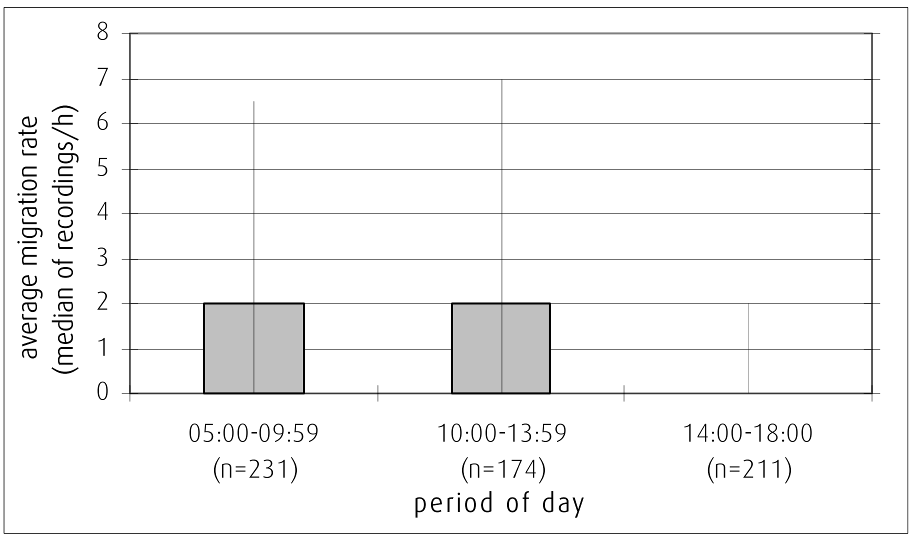


Figure 3.25: Average migration rate in spring 2007 in three different periods of the day (median, 1. and 3. quartile of birds (above) / recordings (below) per hour; without “area-correction” - factor for S-line data set, see Chapter 2.2.4)

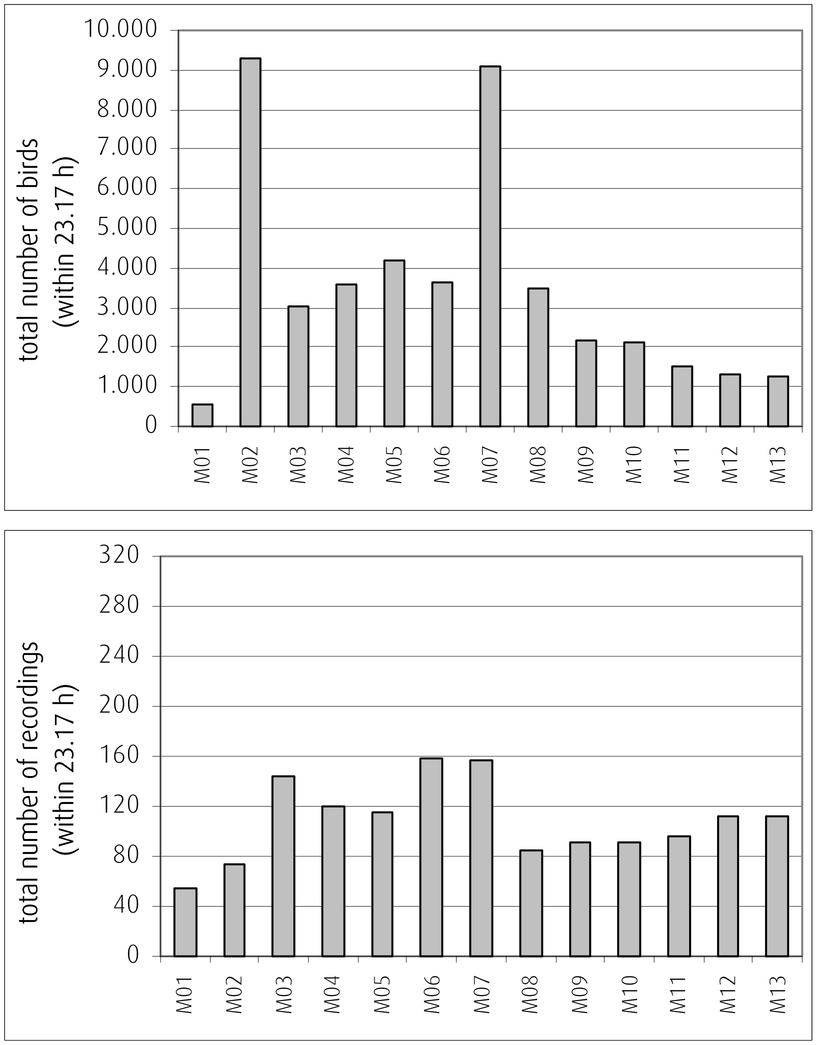


Figure 3.26: Total number of birds / recordings in spring 2007 at the different observation sites along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

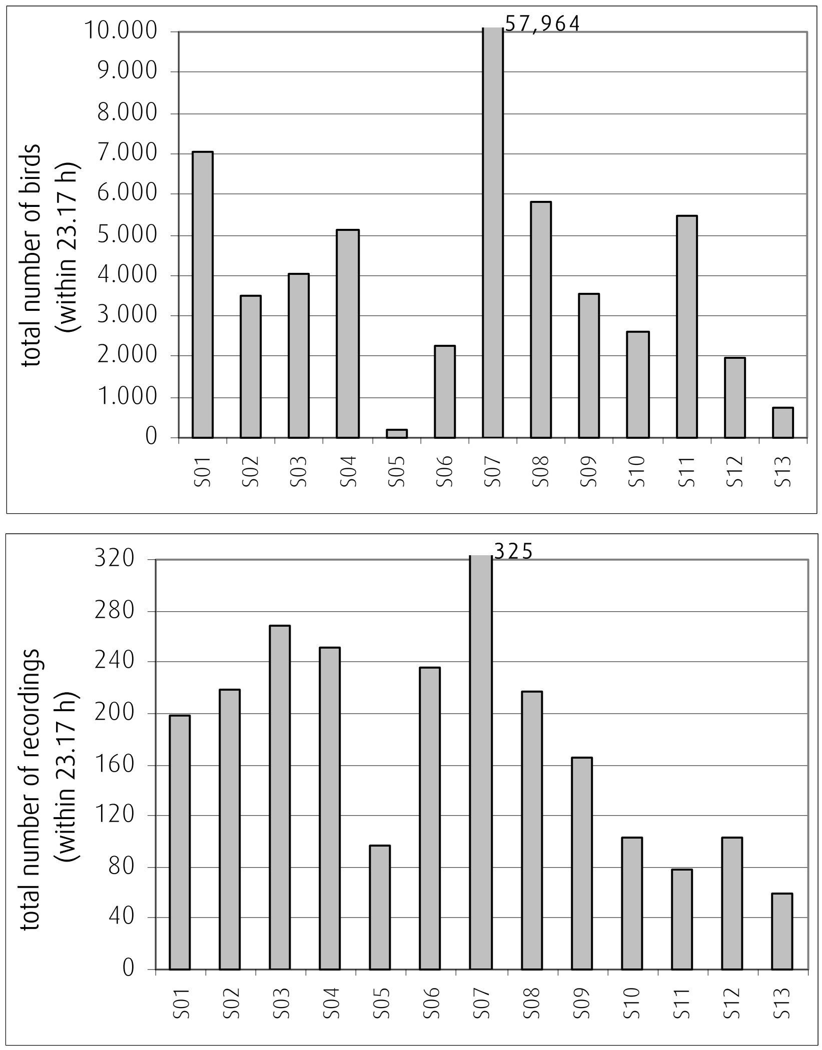
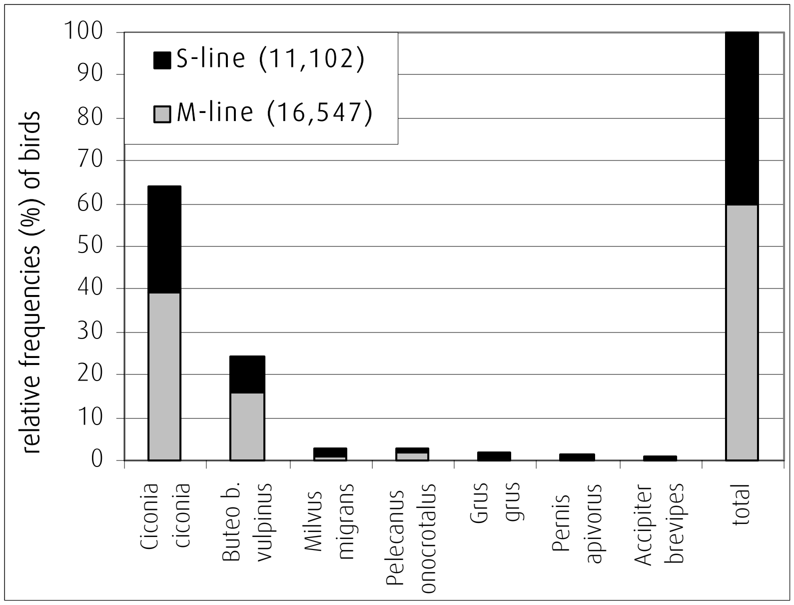


Figure 3.27: Total number of birds / recordings in spring 2007 at the different observation sites along the S-line (with “area-correction”- and “time-correction”- factor, see Chapter 2.2.4)



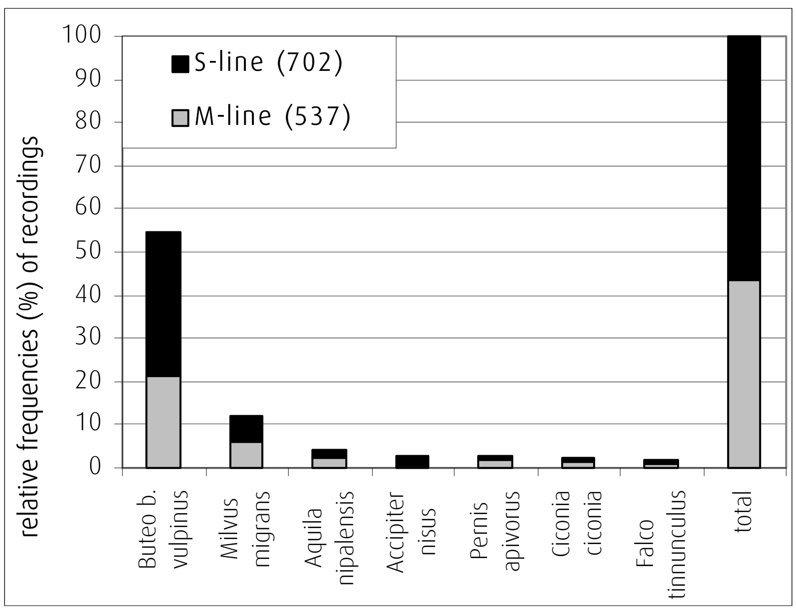


Figure 3.28: Relative frequencies of birds (above) / recordings (below) at altitudes below 200 m within the concessionary area for the seven most numerous and frequent species (spring 2007, separated for M- and S-line)

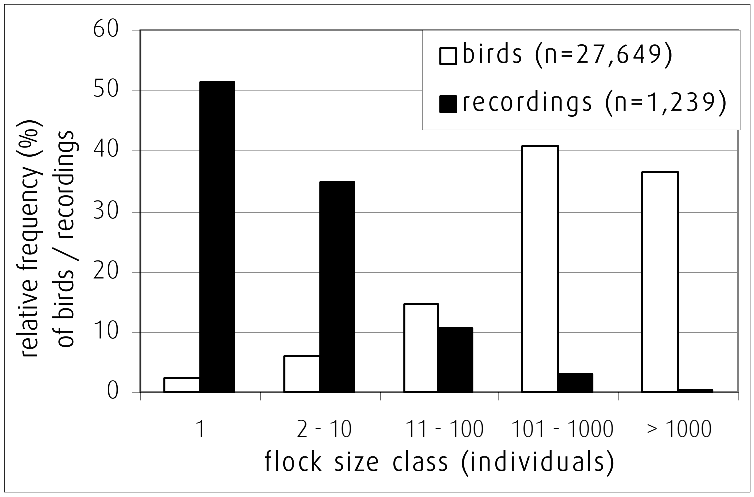


Figure 3.29: Relative frequency of all birds / recordings at altitudes below 200 m within the concessionary area in consideration of flock size (spring 2007)

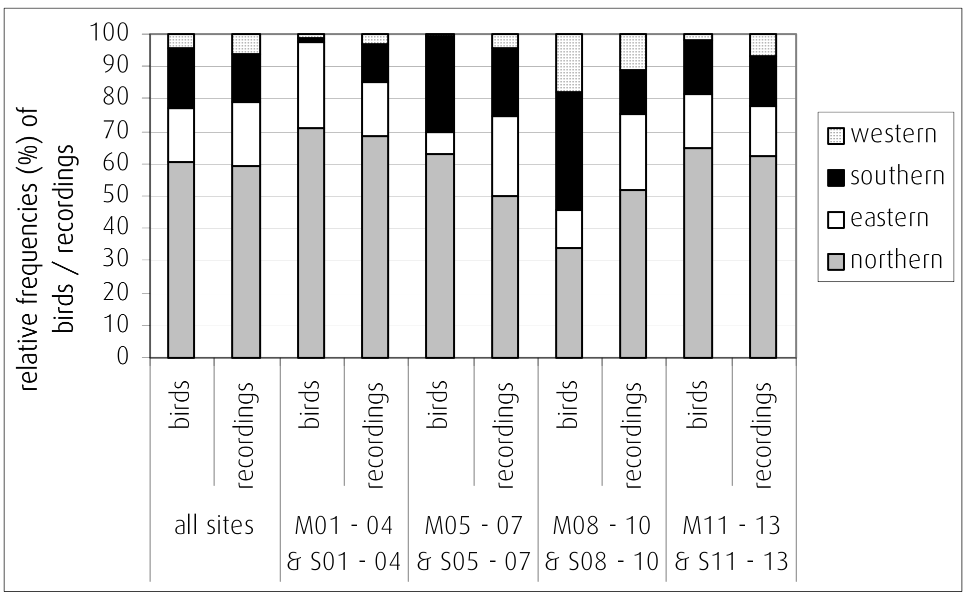
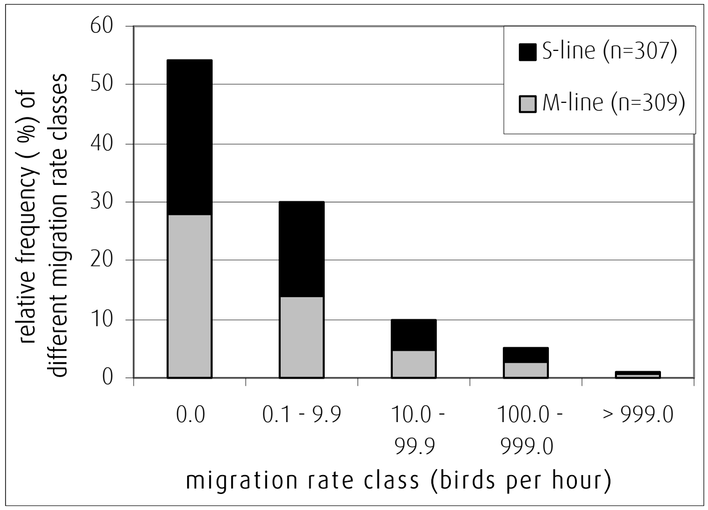


Figure 3.30: Relative frequencies of birds / recordings migrating at altitudes below 200 m with different flight directions within the whole concessionary and in different parts of the concessionary area (spring 2007)



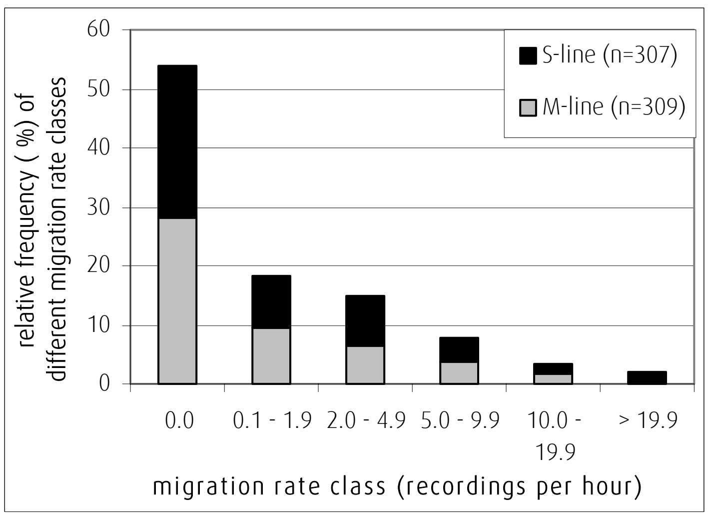


Figure 3.31: Frequency distribution of different migration rate classes in spring 2007 (birds (above) and recordings (below) at altitudes below 200 m per hour; without "area-correction" - factor for S-line data set, see Chapter 2.2.4)

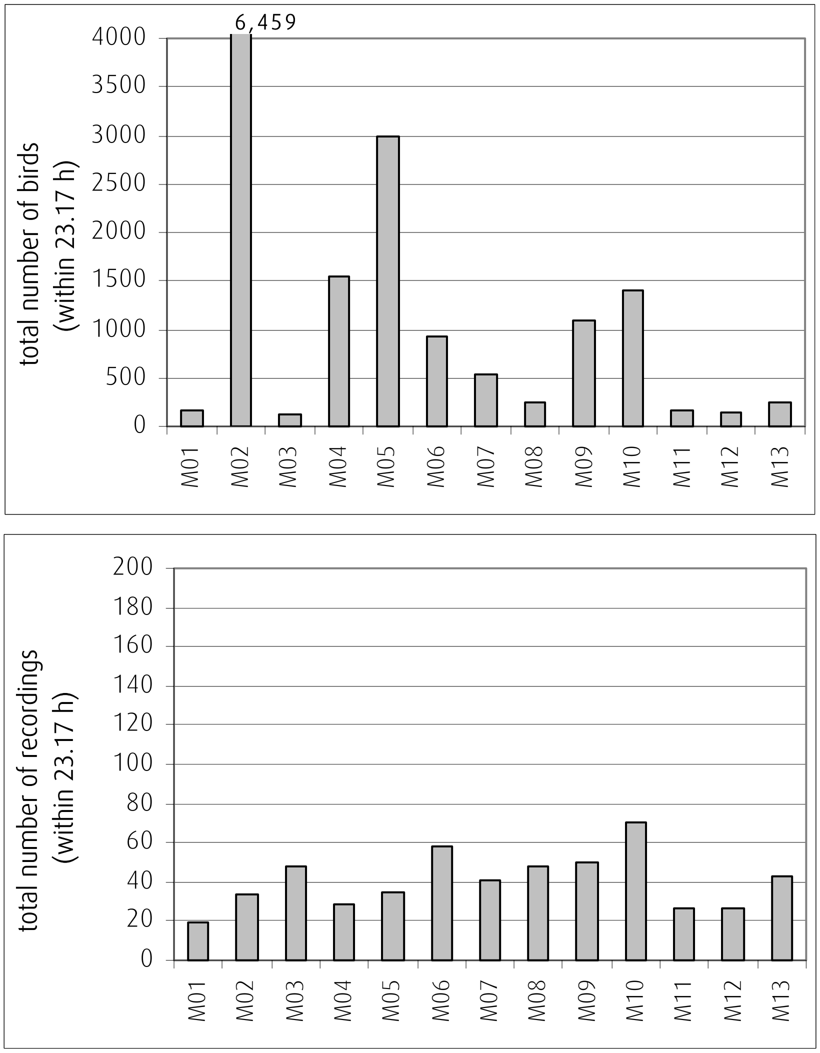


Figure 3.32: Total number of birds / recordings in spring 2007 at altitudes below 200 m along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

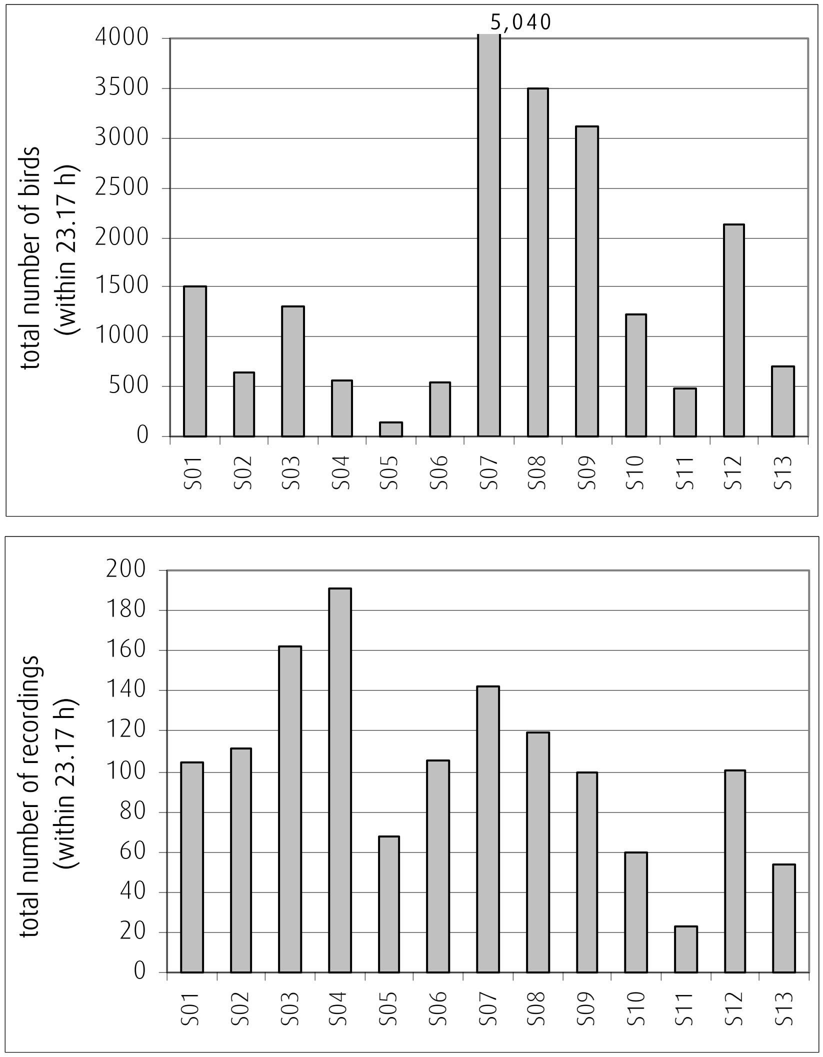


Figure 3.33: Total number of birds / recordings in spring 2007 at altitudes below 200 m along the S-line (with "area-correction"- and "time-correction"- factor, see Chapter 2.2.4)

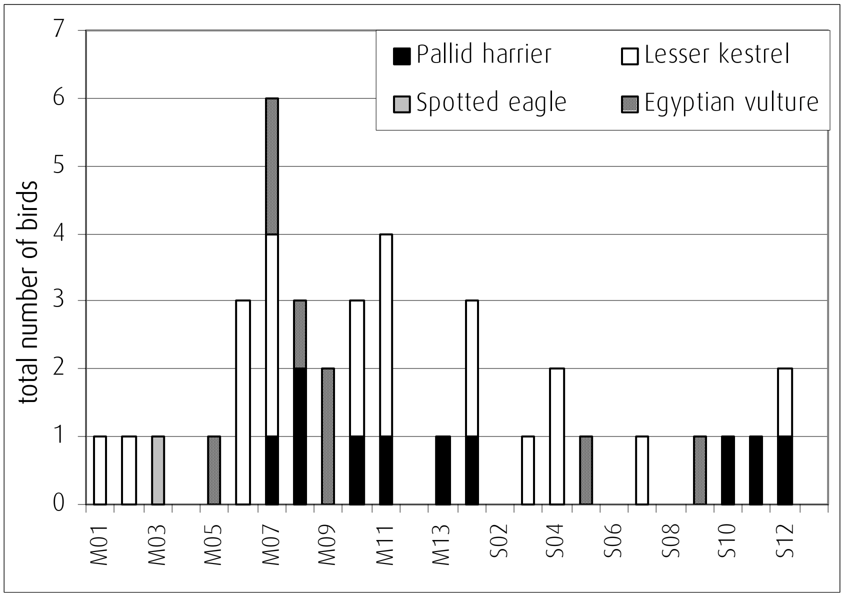


Figure 3.34: Total number of species of special interest in spring 2007 at altitudes below 200 m along the M- and the S-line (without "area-correction"- and without "time-correction"- factor, see Chapter 2.2.4;)

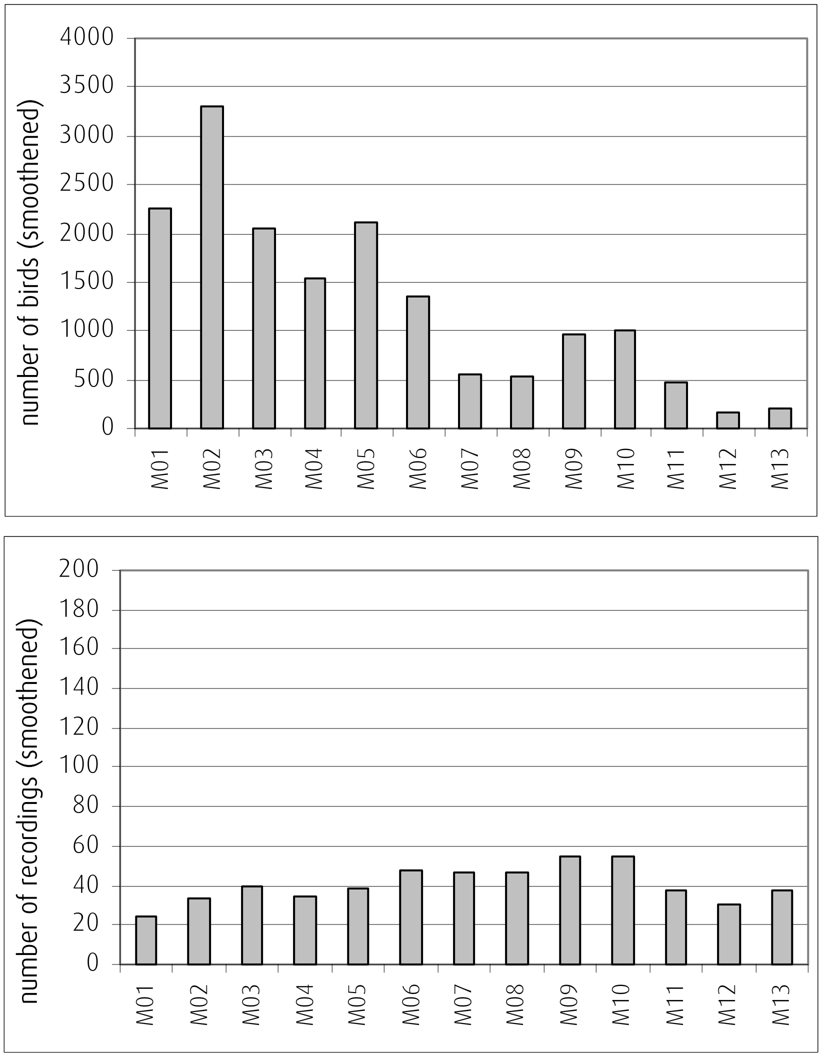


Figure 3.35: "Smoothed" number of birds (above) / recordings (below) in spring 2007 at altitudes below 200 m along the M-line (with "time-correction" - factor, see Chapter 2.2.4)

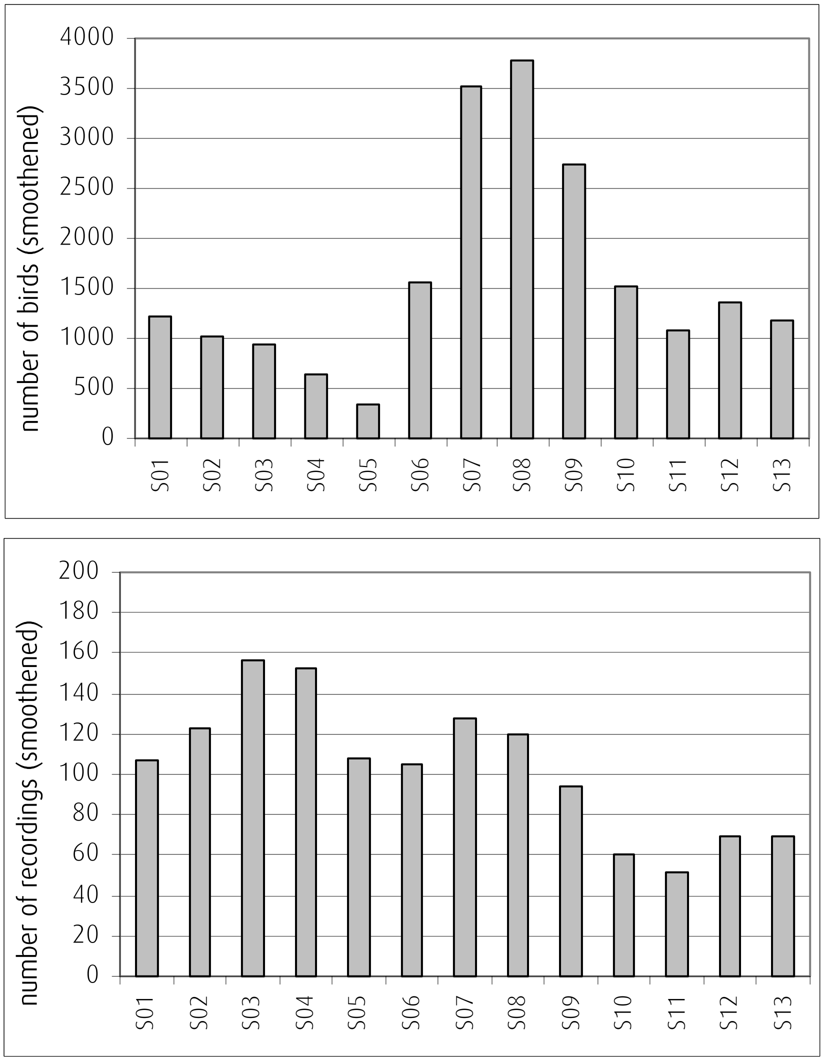


Figure 3.36: “Smoothed” number of birds (above) / recordings (below) in spring 2007 at altitudes below 200 m along the S-line (with “area-correction”- and “time-correction”- factor, see Chapter 2.2.4)

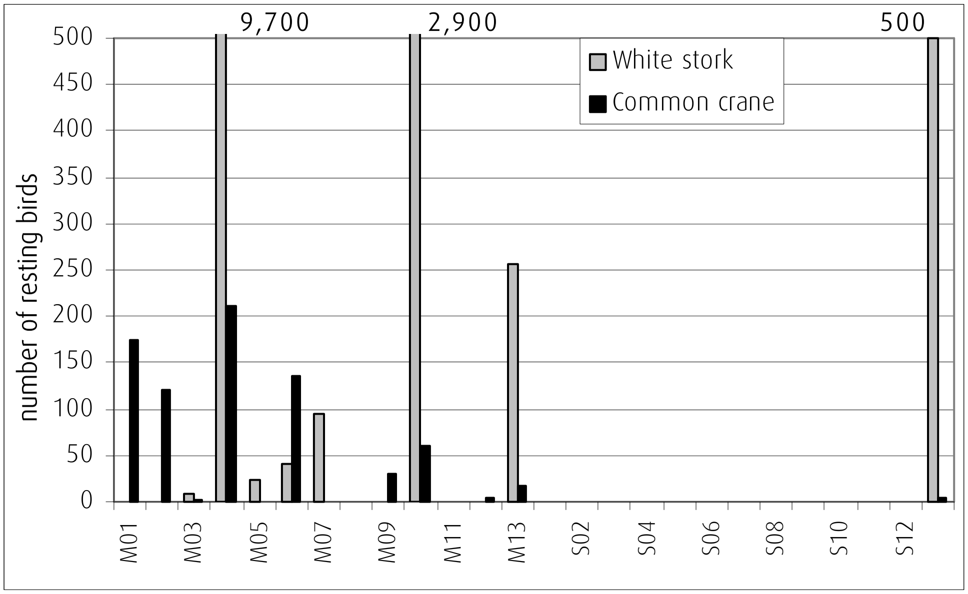


Figure 3.37: Spatial distribution of resting White storks and Common cranes within the concessionary area in spring 2007

- **Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt**

ecoda UMWELTGUTACHTEN

- **Map Xai**

  Spatial distribution of smoothened number of birds in autumn 2006 (see text)

- Legend

concessionary area

Smoothened number of birds within 17.64 h of observation

1 - 99 individuals
100 - 499 individuals
500 - 999 individuals
1,000 - 1,499 individuals
1,500- 1,999 individuals
2,000 - 2,499 individuals
2,500 - 2,999 individuals
3,000 - 3,499 individuals
3,500 - 3,999 individuals

0 2.5 12.5 km

Scale 1 : 250,000

N

- **Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt**

ecoda
UMWELTGUTACHTEN

- **Map Xaii**

Spatial distribution of smoothened number of recordings in autumn 2006 (see text)

- Legend

concessionary area

Smoothened number of recordings within 17.64 h of observation

1 - 14 recordings
15 - 29 recordings
30 - 44 recordings
45 - 59 recordings
60 - 74 recordings
75 - 89 recordings
90 - 104 recordings
105 - 119 recordings
> 119 recordings

0 2.5 12.5 km

N

Scale 1 : 250,000

- **Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt**

ecoda UMWELTGUTACHTEN

- **Map Xbi**

Spatial distribution of smoothened number of birds in spring 2007 (see text)

- Legend

concessionary area

Smoothened number of birds within 23.17 h of observation

1 - 99 individuals
100 - 499 individuals
500 - 999 individuals
1,000 - 1,499 individuals
1,500- 1,999 individuals
2,000 - 2,499 individuals
2,500 - 2,999 individuals
3,000 - 3,499 individuals
3,500 - 3,999 individuals

0 2.5 12.5 km

Scale 1 : 250,000

N

Ornithological Expert Opinion as a part of the Feasibility Study for a large wind farm at Gulf of Zayt, Egypt

ecoda UMWELTGUTACHTEN

Map Xbii

Spatial distribution of smoothened number of recordings in spring 2007 (see text)

Legend

concessionary area

Smoothened number of recordings within 23.17 h of observation

1 - 14 recordings

15 - 29 recordings

30 - 44 recordings

45 - 59 recordings

60 - 74 recordings

75 - 89 recordings

90 - 104 recordings

105 - 119 recordings

> 119 recordings

0 2.5 12.5 km

N

Scale 1 : 250,000

Annex 2.5.4

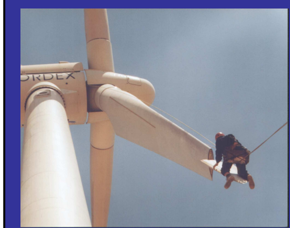
Ornithological Investigations
Summary of Findings

ARAB REPUBLIC OF EGYPT

MINISTRY OF ELECTRICITY AND ENERGY

NEW AND RENEWABLE ENERGY AUTHORITY (NREA)

FEASIBILITY STUDY FOR A LARGE WIND FARM AT GULF OF EL ZAYT



financed by

KfW-Entwicklungsbank

Ornithological Investigations
Summary of Findings

August 15th, 2007

decon
Deutsche Energie-Consult
Ingenieurgesellschaft mbH

FICHTNER
ENGINEERING SERVICES AND CONSULTANCY

General

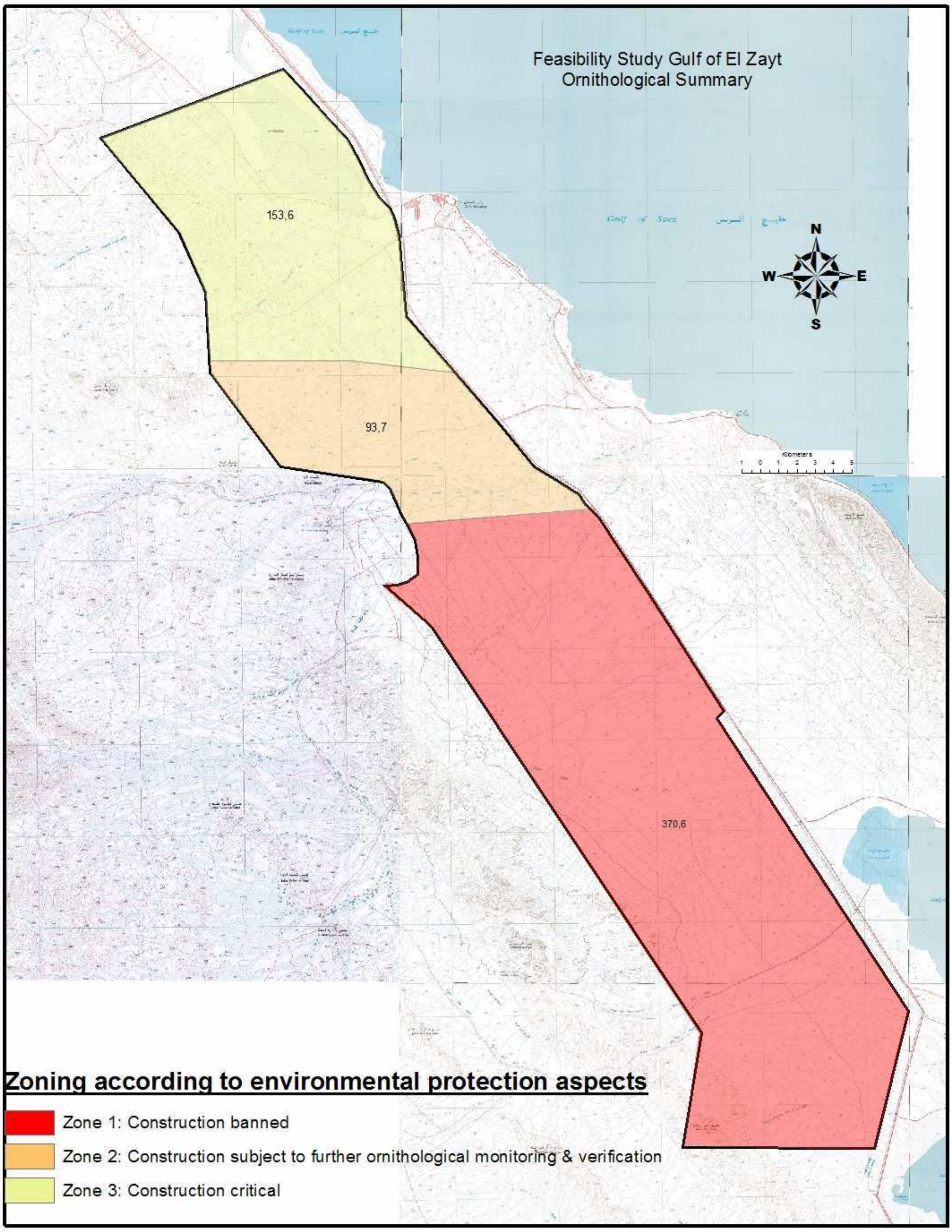
The project area extends over 70 km from South to North and about 9 km West to East adjacent to the Gabal el Zayt area, which is a registered IBA area. It is situated on one of the most important flyways between tropical Africa, Europe and the Middle East. The ornithological judgement is based on one spring and one autumn field monitoring, carried out from 26 observation points equally distributed over the project area in distances of 5 km to each other. The observation points had been attended at equally distributed daytimes by two observation teams working in shift in order to achieve representative samples. While the samples for the individual observation points had to remain quite small a good spatial resolution was achieved. Almost all of the project area is located on plains. Accordingly, no very pronounced flyway corridors were observed. A major influence to the shape of migration routes seems to be exercised by weather/wind conditions. Considering above, i.e. small observation samples for individual sites and not very pronounced migration routes inside the project area, the statistical evidence of the one year field observation data has to remain limited and calls for conservative judgement.

The judgement of the area is mainly based on the occurrence of soaring and gliding migrants, as these less manoeuvrable species are more endangered by wind park constructions. From the strict ornithological standpoint it is highly recommended to avoid construction of wind parks in the overall area. Considering competing environmental interests, such as bird protection and renewable energy generation and implied CO_2 avoidance, the NREA area is zoned according to the weight of the expected environmental impact. The zones are shown in Figure 1 enclosed.

Zone 1: Wind Park Construction is banned

This part belongs to the main migration corridor heading towards Sinai. Local differences of migration density within this zone are considered to be accidental, as migration routes vary according to wind conditions.

Figure 1: Ornithological Zoning



Zone 2: Construction Subject to Further Ornithological Monitoring and Verification

In this area of about 94 km² heavy migration in the direction of the coastal mountain chain, Gabal El Zayt, was recorded during spring. Apparently, birds had followed the mountain chain of the foothills of the Red Sea Mountains so far north that they had to fly in south-easterly directions to reach the coastal mountains. That means that this zone is situated in the border area of the Zone 1 and might even belong to it. Based on the findings of the one year ornithological investigations an utilisation of this area for wind power development has to be rejected. Further ornithological monitoring and verification may lead to revised results.

Zone 3: Construction critical

In the Yellow Zone there is no immediately recognisable topographical bottleneck. The terrain opens out and offers the birds more room to manoeuvre. Most birds moving through here are heading in the direction of Suez. Any wind farm installation in that area would require technical avoidance/mitigation measures at the plants and in the infrastructure itself as to the best practicable standard. Moreover, a careful post installation monitoring programme needs to be executed to assess, whether the impacts in a wind park will remain on acceptable level or whether additional measures will have to be carried out.

Consequences for the development of wind energy in the NREA area:

From the ornithological findings the following conclusions are drawn by the Consultant:

According to the ornithological assessment a wind park construction in the Zone 1 shall be definitely banned. This is valid as well for Zone 2 (about 94 km²), but there is still a chance that further ornithological monitoring may justify some wind power development in this zone. From the present point of view these two areas have definitely to be excluded.

The frame conditions for a possible wind power development in Zone 3 for the expansion stage 2011/2012 can be seen from Figure 2. The total area of Zone 3 is about 154 km². Out of that the following portions are critical with regard to wind power development:

- A low land zone with some salt lakes in the Northeast, a Sebkha, would be unfavourable for wind power development as it would require extraordinary construction measures at significantly elevated costs. Moreover, this area is ecologically more sensitive than the vast desert grounds of the overall area. It is under control of the Egyptian Petrol Company, which has all rights on it for an unlimited period. This olive

green coloured area (Figure 2) shall be kept free from wind power development. The non-utilisation of that area would have a positive ornithological side effect as it would deliver additional resting and manoeuvring areas for birds and would keep the minimum distance between a Wind Park and the sea shores to more than 2 km.

- The adjacent blue-gray area of about 37 km² as well is under complete control of the Egyptian Petrol Company (EPC) for an indefinite period. Unless an agreement with EPC on sustainable wind power utilisation is achieved, this area cannot be considered for wind energy utilisation.
- Deducting a “mountainous” portion, i.e. an area with hills at altitudes of 100 m to about 200 m above sea level, which is unfavourable for wind power development due to high construction cost, the usable land would be about 67 km² (Figure 2, green coloured area). A rough estimate based on a general spacing of 14 x D to the main wind direction and 4 x D perpendicular to that showed that this area can accommodate 420 MW, e.g. KfW 200 MW and JBIC 220 MW. Although this estimate considers already smaller contingencies (about 5 %), one has to consider the undulated relief of some portions and the need to avoid Wadi Beds for erection. This will necessarily lead to local variation of spacing in some areas.

Transmission bottlenecks for a first stage wind power development

For the wind power development stage 2010/2001 it is assumed that the double circuit 230 kV transmission line Hurghada to Zafarana will be available. At that stage the nominal installed power at Zafarana would be 540 MW. Load flow calculations with n-1 assumptions according to generally accepted standards (one circuit out of operation because of defects or line cleaning) showed bottlenecks in case of the shut down of one circuit between Zafarana and Sokhna and full wind power generation. In that case 20 % of the Zafarana Wind Power would have to be routed towards Hurghada allowing an additional feed in at the Gulf of Zayt of 300 MW only. This bottleneck can be taken care off either

- technically by reinforcement of the Zafarana transmission lines (e.g. additional line from Zafarana to the central power grid), or
- economically by considering loss of production during Zafarana – Sokhna TL circuit shut down and during high wind power production times. If considering a JBIC and an EIB/KfW wind park at the Gulf of Zayt area with a total installed power of 420 MW this would lead to a loss of wind energy production in the order of 2 %.