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Biodiversity and conservation of Wildlife at the Wafra area in Kuwait

Hanan Al-Khalifa[1*], Afaf Al-Nasser[1], Mohammad Safar Abbas[2] & Jamal Dashti[1]

[1]Kuwait Institute for Scientific Research, P.O. Box 24885, 13109 Safat, Kuwait; email: hkhalifa@kisr.edu.kw
[2]Joint Operation (JO)-Wafra, Kuwait Oil Company, Kuwait
[*]Corresponding author

ABSTRACT In response to the increasing needs to conserve wildlife and to enhance biodiversity, the Joint Operations-Wafra (JO-Wafra) protected their natural environment by fencing and dedicating areas for conservation of biological diversity. The main objective of this study is to conduct a wildlife baseline assessment in the oilfields of JO-Wafra and to identify potential habitats of endangered or threatened species that could occur on site. The wildlife survey covered the winter and early spring seasons. Although short and insufficient to provide a detailed assessment, the field data collected indicated significant differences in the number of individuals and wildlife fauna species within the fenced and unfenced oilfields. It also showed that the fenced JO-Wafra has rich and diverse wildlife fauna species, an indication of ecological health. In addition to JO-Wafra oilfield, it is recommended to protect the South Umm Guddair (SUG) oilfields from livestock grazing and wildlife hunters. The protected area could, therefore, increase wildlife habitats and might harbor some endangered wildlife species. It is also recommended to connect the two oilfields with native shrubs and trees planted along the road, to serve as "green corridor", shelter and additional source of food for the animals of both oilfields.

KEY WORDS Endangered wildlife; Oil fields; Wildlife fauna; Wildlife habitat; Wildlife monitoring.

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INTRODUCTION

Biological diversity refers to the variety of life forms including the genes they contain, and the ecosystems they form.

There are three different levels of biodiversity: genetic diversity which refers to the variety of genetic material contained in all the individuals, species diversity which refers to the variety of living species and ecosystem diversity which refers to the variety of habitats and ecological processes. In other words, it is reflected by the variety of all forms of life on earth, which provides the building blocks for human existence.

The total number of species (defined as a population of organisms which are able to interbreed freely under natural conditions) is estimated to range from 5 million to 100 million globally; though less than 1.7 million have actually been described (BUDEST, 1993; FEPA, 2003; Maffi, 2005; Sarkar, 2006).

Biodiversity conservation is of a major importance internationally because humans derive their food, medicines and industrial products from biological diversity of the wild and its domesticated components. It also gives future generations the opportunity to enjoy nature. In addition, biodiversity is important for the recycling of essential elements, such as carbon, oxygen, and nitrogen.

It is also responsible for mitigating pollution, protecting watersheds and combating soil erosion; accordingly, experiencing and increasing our kno-

wledge about biodiversity transforms our values and beliefs (McGregor, 1994; FEPA, 2003; Borokini et al., 2010).

The state of Kuwait covers an area of about 17600 Km^2 at the north-eastern corner of the Arabian peninsula, between 28° 30' N and 30° 05' N in latitude and between 46° 33' E and 48° 35' E longitude. Kuwait's environment is characterized by scarcity of rainfall (100 mm/yr) and extreme temperature variations throughout the year.

The summer temperature is very hot (over 40-50°C), while the winter is cool to mild with a mean temperature of 12.7°C. The water resources are very limited in Kuwait. There is no fresh surface water supply and very limited renewable groundwater. The adverse climate conditions of the state of Kuwait affected its biological diversity and environmental ecosystems (Omar et al., 2001). The desert of Kuwait has long been known as an important source of food, livestock grazing and wildlife hunting. Desert plants were used for fuel and medication purposes.

Urbanization, rapid increase in population, overgrazing, recreation usage, environmental factors, and destruction due to Iraqi invasion in 1990 are main contributing factors to the ecological degradation of the country (McGregor, 1994; Omar, 2000; Selby, 2005). Biodiversity conservation has become one of the challenging priorities for many countries, including the state of Kuwait, to combat species extinction. The State of Kuwait ratified the International Convention on Biodiversity and the National Strategy for Biodiversity Conservation was adopted in order to conserve and enhance biological diversity in the country. Numerous wildlife research studies were conducted in the State of Kuwait. From all these studies, information on flora and fauna of Kuwait has been collected.

A list of desert animals has been prepared. Also, threatened desert animals and those to be extinct were identified such as Houbara Bustard (*Chlamydotis undulata macquennii*), Desert Monitor (*Varanus griseus*), Ostrich (*Struthio camelus*) and Arabian Oryx (*Oryx leucoryx*) (KISR., 1999; Delima et al., 2005; Zaman et al., 2005).

In December 1922, a partitioned neutral zone (PNZ) was established by agreement between the Kingdom of Saudi Arabia and the State of Kuwait, in order to allow tribesmen from both countries to use this favorite grazing ground (Chichester, 2000).

In 1938-1940, oil was discovered from the Al-Burgan area, near PNZ. In 1948, a 60 year concession was granted by the Kuwait government to the Aminoil, a small group of oil companies to explore and exploit the Kuwait side of the PNZ. Similarly in 1949, the Getty Oil Company (formerly Pacific Western Oil Corporation) gained grants from the Kingdom of Saudi Arabia (KSA) to explore the PNZ (KSA side).

The Joint Operations (JO) was born in 1960 when the two oil companies formed a joint committee to oversee and supervise their operations with the resultant productions divided equally to both parties: the Kuwait Oil Company (KOC), which operates the Kuwaiti concession and the Texaco Incorporated, Saudi Arabian Texaco (SAT) that operates the Saudi Arabian concession.

The 3,600 Km^2 partitioned neutral zone oilfields were not spared during the Iraqi invasion of Kuwait in 1990. The oil wells were destroyed and burned contributing to the environmental catastrophe man had ever known. In 1999-2002, the perimeter fence around the JO-Wafra main oilfield was constructed to prevent livestock grazing and wildlife hunters from the area.

This resulted to the gradual rehabilitation of the flora and fauna in the oilfield. Literature on the wildlife fauna of the Wafra area is very limited. Example is the "Insect Fauna of Kuwait" by Al-Houty (1989), when some insect samples were collected in the Wafra area.

An environmental impact review prepared by Chichester (2000) described the fauna of the upland deserts and sabkha of the Partitioned Neutral Zone (PNZ) as "Over 220 species of birds have been observed in the PNZ in recent years… fauna of the upland deserts and sabkha includes common insects; ants and beetles; lizards and snakes; such as Sand Boa, Rat Snake, Blue-throated Agamid, Desert Monitor, and Dhub. Small, nocturnal mammals include Jerboa, Jirds, Desert Fox, and Long-eared Hedgehog".

The current study involves fauna baseline assessment within the JO-Wafra territories with the following main objectives: assess the wildlife fauna in JO-Wafra main area; and compare the quality of habitat inside and outside the JO-Wafra main area. The work has been implemented between Kuwait Institute for Scientific Research (KISR) and Kuwait Gulf Oil Company (KGOC).

MATERIALS AND METHODS

The wildlife fauna study commenced in December 2005 and terminated in March 2006. This report covers only the study period (i.e. from January to March, 2006), wherein 15 field data collection exercises were performed with a total of 345 field data collected from 11 selected wildlife (fauna) study sites, within the fenced JO-Wafra main oilfield and the unfenced SUG (South Umm Guddair) oilfield. Selections of wildlife study sites at the JO-Wafra oilfield were performed during reconnaissance surveys. The criteria used in selecting the possible wildlife study sites were: (1) type of habitat that include soil and vegetation cover; and (2) location within the oilfield, disturbed or undisturbed (see Table 1).

Several wildlife survey methodologies were implemented to study the wildlife biodiversity, namely: 1) Line Transects (LT): of 5 km to record animals within a specific habitat type. 2) Pitfall Trapping (PFT): to catch ground crawling animals such as reptiles and invertebrates. 3) Baited Mammal Trap Line: is usually a one kilometer long trap line. The large mammal trap (MTL) is placed between two small mammal traps (MTS) at a distance of 250 meters. 4) Mark-Release-Recapture (MRR): to estimate the population dynamics of an area. MRR models were developed for field studies in which the count statistics are numbers of marked and unmarked animals caught (Nichols, 1992; Grenwood, 2000).

Types of habitat	Wildlife study sites number
1.Habitat with good vegetation cover	2, 3, 4, 8, 9 and 10
2.Habitat with poor vegeta tion cover	1 and 5
3.Windblown sand covered habitat	6 and 7
4.Overgrazed and unprotec ted habitat	11

Table 1. Different Wildlife study sites according to types of habitat.

RESULTS

From December 2005 to March 2006, 17 trips were made to the JO-Wafra main (fenced) and the unfenced South Umm Guddair (SUG) oilfields. A total of 15 field data collecting exercises were performed. This included line transects, baited mammal trappings and pitfall trappings, conducted over at least three consecutive days (Table 2; Figs. 1-2).

Line Transects (LT): a total of 49 LT exercises were performed, covering the winter and early spring periods of the country. It was noticeable that during the last days of line transect exercises, more birds were observed and even the shy Red fox (*Vulpes vulpes*) was recorded. This may be due to the rise in temperature and the pleasant spring weather in the air. More than 34 species of wildlife fauna were recorded from the line transects performed.

These included 27 species of birds, one species of mammal, one species of reptile and more than six species of invertebrates (butterflies, dragonflies, flies and ground hoppers). Table 3 lists the species recorded during line transect exercises at the JO-Wafra oilfields. The list is not conclusive, as it was taken during winter and early spring seasons.

No. of Field Trips	Type of Trips	Location of Trips
2	Field orientations, reconnaissance, site selections and installation of field study equipment e.g., mammal traps and pitfall traps with drift fences	JO-Wafra main and SUG oilfield (south Um Guddair)
15	Field data collection resulting to the following field data collected: 49 from line transects (LT) 148 from two (x2) small mammal traps at each study site 74 from one (x1) large mammal trapping at each study site 74 from pitfall traps in association with drift fences (1x5) at each study site	11 wildlife (fauna) study sites within the fenced JO-Wafra and the unfenced SUG oilfields

Table 2. Trips made by Wildlife Survey Team to JO-Wafra Oilfields.

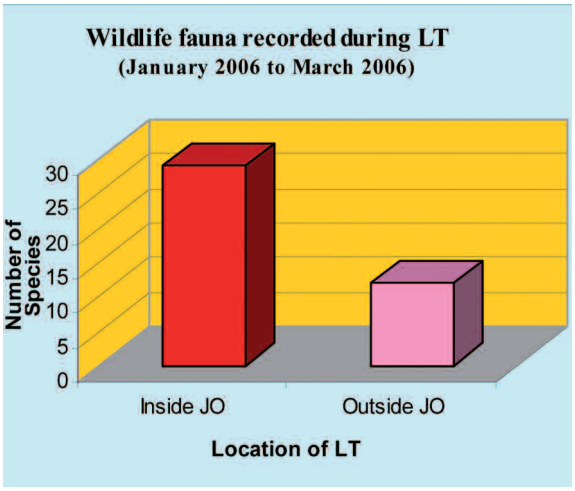

Figure 1. Wildlife species recorded during line transect inside and outside JO-Wafra oilfields

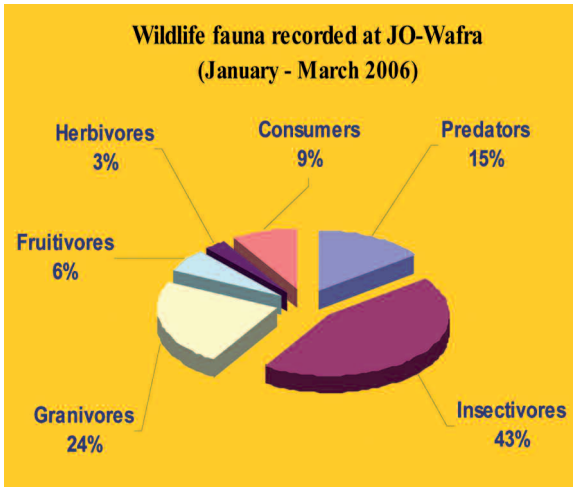

Figure 2. Different trophic levels in the wildlife fauna recorded at JO-Wafra oilfields from January to March 2006.

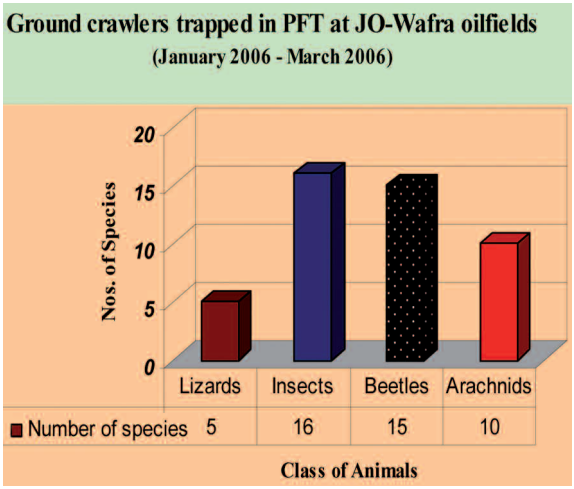

Figure 3. Classes of animal species trapped in PFT at JO-Wafra oilfields.

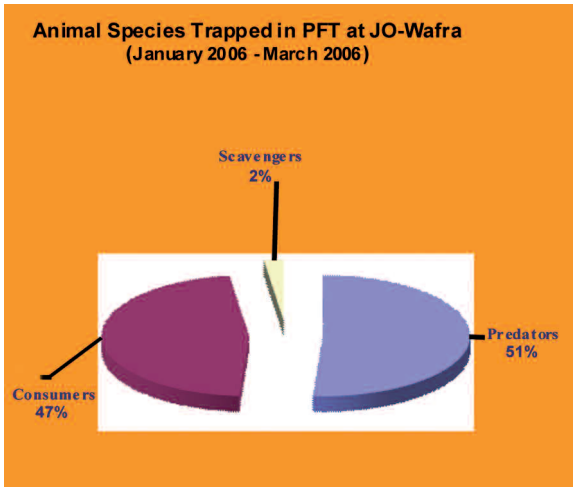

Figure 4. Animals recorded from PFT at JO-Wafra are shown according to their trophic levels.

More animal species are expected to be recorded if the survey covers the four seasons, especially the two migration periods of the country. Except for the residents, such as the Black-crowned finch lark, Crested lark, House sparrow and the Feral pigeon, the birds might only be over wintering in the country e.g., Tawny pipit, Short-eared owl, Blue rock thrush, Pied wheatear, Woodchat shrike, Great grey shrike, and Hoopoe lark among others.

The list is only 7.7% from the total number of bird species recorded in the country. The Black-crowned finch larks (*Eremopterix nigriceps*) were recorded breeding at study area, while both the Crested larks (*Galerida cristata*) and the Isabelline wheatears (*Oenanthe isabellina*) were also observed displaying courting behaviors.

Pitfall trappings: there were 64 pitfall trapping exercises performed at the fenced main JO-Wafra and the unfenced SUG oilfields. More than 46 animal species were recorded during these exercises, including 10 species of arachnids; lizards (5 species); beetles (15 species); and 16 species of insects (Figs. 3-4 and Table 4). Baited mammal trappings: there were seven (x7) mammal trapping exercises performed at the JO-Wafra study sites, for the duration of the study period.

		Study Site				
SN	**Animal Species**	**G**	**SLT**	**NLT**	**G**	**SUG**
1	Black-crowned Finch Lark, *Eremopterix nigriceps* (Gould, 1839)	x	x	x		
2	Barn swallow, *Hirundo rustica* (Linnaeus, 1758)				x	x
3	Blue Rock-Thrush, *Monticola solitaries* (Linnaeus, 1758)	x	x			
4	Lepidoptera sp. 1	x	x	x		
5	Chiffchaff, *Phylloscopus collybita* (Vieillot, 1817)			x		
6	Cream-coloured courser, *Cursorius cursor* (Latham, 1787)	x				
7	Crested lark, *Galerida cristata* (Linnaeus, 1758)	x	x	x	x	x
8	Arabian babbler, *Turdoides squamiceps* (Cretzschmar, 1827)	x	x	x		
9	Desert wheatear, *Oenanthe deserti* (Temminck, 1825)	x	x	x		
10	Dhub, *Uromastyx microlepis* (Blanford, 1874)	x	x	x		
11	European roller, *Coracias garrulous* (Linnaeus, 1758)	x	x	x		
12	Feral pigeon, *Columba livia* (J.F. Gmelin, 1789)	x	x	x	x	x
13	Great grey shrike, *Lanius excubitor* (Linnaeus, 1758)	x	x	x	x	x
14	Ground hopper, *Tetrix undulata* (Sowerby, 1806)	x				
15	Hoopoe, *Upupa epops* (Linnaeus, 1758)	x				
16	Greater Hoopoe lark, *Alaemon alaudipes* (Desfontaines, 1789)	x	x	x		
17	House sparrow, *Passer domesticus* (Linnaeus, 1758)	x	x	x		
18	Isabelline wheatear, *Oenanthe isabellina* (Temminck, 1829)	x	x	x	x	x
19	Kestrel, *Falco tinnunculus* (C.L. Brehm, 1855)	x	x	x		
20	Northern wheatear, *Oenanthe oenanthe* (Linnaeus, 1758)	x	x	x		x
21	Olivaceous warbler, *Iduna pallida* (Hemprich et Ehrenberg, 1833)	x	x	x		
22	Pallid harrier, *Circus macrourus* (S.G. Gmelin, 1770)	x	x	x		
23	Pied wheatear, *Oenanthe pleschanka* (Lepechin, 1770)	x	x	x	x	x
24	Red-backed shrike, *Lanius collurio* (Linnaeus, 1758)	x	x	x	x	x
25	Red fox, *Amphicoma vulpes vulpes* (Fabricius, 1792)	x				
26	Sand martin, *Riparia riparia* (Linnaeus, 1758)					x
27	Short-eared owl, *Asio flammeus* (Pontoppidan, 1763)				x	x
28	Short-toed eagle, *Circaetus gallicus* (Gmelin, 1788)	x	x	x		
29	Short-toed lark, *Calandrella brachydactylal longipennis* (Eversmann, 1848)	x	x	x		
30	Stable flies, *Stomoxys calcitrans* (Linnaeus, 1758)	x	x	x	x	x
31	Sundevall jird, *Meriones crassus* (Sundevall, 1842)			x		
32	Swift, *Apus barbatus* (Sclater, 1866)		x			x
33	Tawny pipit, *Anthus campestris* (Linnaeus, 1758)	x	x	x		
34	Turtle dove, *Steptopelia turtur* (Linnaeus, 1758)	x				

Table 3. Animal species recorded during line transect at the JO-Wafra Oilfield. Legend: G=General line transect. SLT=South LT. NLT=North LT. SUG= Unfenced JO-Wafra oilfield LT.

		Study Site										
SN	**Animal species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	Arabian darkling beetle, *Pemelia arabica* (Kaszab 1982)	x	x	x	x	x	x	x	x	x	x	x
2	Brilliant ground weevil, *Bembidion* sp.		x					x			x	
3	Camel spider, *Galeodis arabs* (Koch, 1842)	x	x	x	x	x	x	x	x	x	x	x
4	Capsid bug, *Eurydema ornatum* (Linnaeus, 1758)							x				
5	Centipede, *Craterostigma* sp.	x			x							
6	Churchyard beetle, *Blaps kollari* (Seidlitz G von, 1896)								x			x
7	Desert runner, *Cataglyphis niger* (Andre, 1981)	x	x	x	x	x	x		x			
8	Domino beetle, *Anthia duodecimguttata* (Bonelli, 1813)	x	x	x	x	x	x	x	x	x	x	x
9	Elevated stalker, *Adesmia stoeckleini* (Koch, 1940)	x	x	x	x	x	x	x	x	x	x	x
10	Giant black ant, *Camponotus xerxes* (Forel, 1904)	x	x	x	x	x	x	x	x	x	x	
11	Golden-tipped ant, *Camponotus sericeus* (Forel, 1904)	x	x	x	x	x	x	x	x	x	x	
12	Ground mantis, *Eremiaphila braueri* (Krauss, 1902)											x
13	Hairy capsid bug, *Tropinota squalida* (Scopoli, 1763)											x
14	Joker bee, *Parachistus pulchellus* (Greathead, 1980)					x				x		
15	Jumping spider, Salticidae			x			x		x			
16	Lesser scarab, *Mnematium* sp.		x	x	x				x			
17	Lesser yellow scorpion, *Uroplectes alstoni* (Purcell, 1901)				x							
18	Long-legged spider, Pholcidae	x	x	x	x	x	x	x	x	x	x	x
19	Mesopotamian beetle, *Sepidium mesopotamicum* (R.,1904)				x	x		x	x			
20	Mosquito, *Anopheles pharoensis* (Theobald, 1901)											x
21	Opossum beetle, *Mesostena puncticollis* (Solier, 1835)	x	x	x	x	x	x	x	x	x	x	x
22	Orb-weaver spider, Araneidae	x	x	x	x	x	x	x	x	x	x	
23	Pill bug, *Armadillidium vulgare* (Latreille, 1804)		x	x			x				x	
24	Pinstripped ground weevil, *Ammocleonus aschabadensis* (Ft.,1884)	x	x		x							
25	Pitted beetle, *Adesmia cancellata* (Klug, 1830)	x	x	x	x	x	x	x	x	x	x	
26	Meloe "Queen", *Meloe omanicus* (Kaszab, 1983)		x	x							x	
27	Rack beetle, *Tentyrina palmeri* (Crotch, 1872)	x	x	x	x	x	x	x	x	x	x	x
28	Rock gecko, *Bunopus tuberculatus* (Blanford, 1874)			x		x	x	x	x	x	x	
29	Sand gecko, *Stenodactylus doriae* (Blanford, 1874)										x	
30	Saber-toothed beetle, *Scarites guineensis* (Dejean, 1831)				x							
31	Scorpion (Black), *Androctonus crassicauda* (Olivier, 1807)							x				x
32	Seville row beetle, *Paraplatyope arabica* (Koch, 1965)	x										
33	Short-nosed lizard, *Mesalina brevirostris* (Blanford, 1874)			x	x	x	x	x	x	x	x	
34	Silverfish, *Thermobia domestica* (Packard, 1837)	x	x				x	x	x			
35	Small black ant, *Monomorium gracillimum* (Smith, 1861)	x	x	x	x	x	x	x	x	x	x	x

SN	Animal species	Study Site										
		1	2	3	4	5	6	7	8	9	10	11
36	Small red ant, *Monomorium pharaonis* (Linnaeus, 1758)	x	x	x	x	x	x	x	x	x	x	x
37	Scutte lizard, *Acanthodactylus scutellatus* (Audouin, 1827)			x	x	x	x	x	x	x	x	
38	Schmidt lizard, *Acanthodactylus schmidti* (Haas, 1957)				x	x			x			
39	Tiger moth, *Utetheisa pulchella* (Linnaeus, 1758)		x									
40	Ugly trox, *Scleron sulcatum* (Kulzer, 1956)							x				
41	Variable stalker, *Adesmia cothurnata* (Forskal, 1775)	x	x	x	x	x	x	x	x	x	x	x
42	Winged ant, *Podalonia* sp.							x				
43	Wolf spider, Lycosidae							x		x		
44	unidentified moth		x	x					x			
45	unidentified larva	x		x	x							
46	Lepidoptera sp. 2				x				x			

Table 4. List of animal species trapped at different PFT in JO-Wafra Oilfields.

The twenty two (x22) MTS trapped 15 rodents from one species (*Meriones crassus*). Whereas the collapsible Tomahawk traps (MTL) trapped one species (feral dog). There were seven rodent recaptures and three of the feral dog, which is 'trap happy' because it was recaptured every trapping exercises. Table 5 shows the animal species trapped and caught during mammal trapping exercises at the JO-Wafra oilfields.

Mark-release-recapture (MRR): the field data collection exercises were performed during the winter, when the temperature ranged from 3^0C to 8^0C and during early spring, when the temperatures started to rise (14^0C to 18^0C). Therefore, the field data collected is not representative of the entire population of each study site but indicative only for the duration of the study period.

There were 32 trapping exercises performed at the JO-Wafra oilfields. This includes eight exercises each for the PFT; baited MTS1; MTS2; and MTL. These trapping exercises caught a total of 74 wildlife fauna (including recaptures) from different study sites at JO-Wafra. Five (5) species of lizards were caught in the PFT, namely: *Mesalina brevirostris* (27 individuals); *Acanthodactylus scutellatus* (x8); *A. schmidtii* (x2); and 22 geckos (*Stenodactylus slevini* and *Bunopus tuberculatus*).

Nine recaptures were recorded for the lizards during pitfall trappings; the first three species of the above-mentioned lizards were recorded to be active in winter, while the two species of geckos were trapped only when the ambient temperature at the study sites were higher at around 20^0C.

The fringed-toed lizards i.e. *A. scutellatus* and *A. schmidtii* seemed to be concentrated only at the low lying soot covered habitat, with good vegetation cover. The two species of geckos: *S. slevini* and *B. tuberculatus* were trapped in the PFT only at the start of spring, when the temperatures at the study sites were higher. These species were recorded during the last two exercises. Two (2) species of mammals (*Meriones crassus* and *Canis domesticus*) were trapped during baited mammal trapping exercises.

There were 19 Sundevall jirds (*Meriones crassus*) captured by the small mammal traps from eight study sites within the JO-Wafra main oilfield. Seven re-captures were recorded.

DISCUSSION AND CONCLUSIONS

The current study was conducted to assess the wildlife fauna in JO-Wafra main area; and to compare the quality of habitat inside and outside the JO-Wafra main area. The work has been implemented between Kuwait Institute for Scientific Research (KISR) and Kuwait Gulf Oil Company (KGOC).

Seventeen field visits to the JO-Wafra oilfields were undertaken by the wildlife team, to perform 15 field data collection exercises that resulted in 444 field data collected. The oil fires that occurred during the Iraqi invasion of Kuwait were the main cause of diversity loss in the country. It had significant effect on species and ecosystem, this effect shifted species distribution and caused reductions in population size that could be due to reduction in survival and fecundate rates.

This negative effect is well documented in other studies that investigated similar items (Da Fonseca et al., 2005; Parmesan, 2006; Fischlin et al., 2007). Conserving wildlife and biodiversity is increasingly recognized as an essential element of life. Its importance involves production of plants and animals for food, providing recreational resources, flood and pest control, providing chemicals for treatments. Accordingly, biodiversity conservation is strongly related to finance, economy and poverty degree in a society.

Petts & Platt (1990) demonstrated that most of the benefits derived from wildlife and biodiversity conservation are potentially quantifiable and can significantly add to the economy of a society. Many worldwide studies in the literature relate biodiversity to social poverty (Adams et al., 2004; Treves et al., 2005; Fisher & Christopher, 2007). Consequently, wildlife and biodiversity conservation became a priority in the world.

The approach of protecting natural resources and increasing extent of protected areas has been described and used in other worldwide studies to conserve wildlife and biodiversity (McNeely & Schutyser, 2003; UNEP, 2006). In addition to resource protection, the current study also applied the technique of monitoring wildlife populations. It involves collecting, analyzing, and interpreting ecosystem information. Such techniques develop wildlife and natural resource management approaches. Monitoring wildlife and ecosystems provide information that managers and companies such as Kuwait Oil Company can use to adjust or modify their commercial activities so that they minimize negative effect on natural resources. These techniques have been used worldwide to conserve wildlife and biodiversity (Adger et al., 2003; Fischlin et al., 2007).

The field data collected showed that the fenced JO-Wafra main oilfield has rich and diverse wildlife fauna species, which suggests that ecological health in this area is significantly better than the unfenced and unprotected SUG oilfields.

Although short and insufficient to provide a detailed assessment of the studied areas, the field data collected showed that the fenced JO-Wafra main area is rich and diverse in wildlife fauna, indicating significant ecological health compared to the unfenced and overgrazed South Umm Guddair oilfield, which is located approximately 29 kilometers northwest of the main oilfield. The field data collected also indicated that additional surveys and monitoring activities for the wildlife at the JO oilfields are necessary and conducted to cover the different climatic seasons and migration periods of the country.

The field data collected showed that there are at least four types of wildlife habitats at the JO-Wafra oilfields: high and low lying habitat with good vegetation cover; high and low lying habitat with poor vegetation cover; windblown sand covered habitat; and over-grazed and unprotected habitat. The first three types of habitats are located inside the fenced oilfield, while the latter is at the unfenced South Umm Guddair (SUG) oilfield. Because of the perimeter fence constructed in 2000, the JO-Wafra main oilfield enjoyed protection from livestock grazing and wildlife hunters.

This has brought to the gradual rehabilitation of the flora and fauna within the perimeter fence. There were more than 78 wildlife fauna species recorded at the JO-Wafra main oilfield. This includes the 19 species (24.36%) of wildlife fauna recorded at the unfenced SUG oilfield. The timing of the field data collection might have impact on the numbers of individuals and fauna species recorded from both study areas because desert animals tend to hibernate during winter and only come out during spring. It is suggested and recommended that the SUG oilfield be fenced and protected from livestock overgrazing and wildlife hunters. The two oilfields then could be connected with native shrubs and trees planted along the road.

The fenced SUG and the additional plants will augment and increase the possible areas for resting, feeding and even breeding of some threatened and endangered migrating fauna that pass through the country during their migration movements (examples are the Houbara bustard, *Chla-*

*mydotis undulata macquenni*i and the Imperial eagle, *Aquila heliaca*). The Houbara bustard because of the size of its habitat requirement may become the "umbrella" species in the wildlife conservation program. In other words, the presence of Houbara bustard bird in any habitat reflects richness in biodiversity in that habitat (Gregory, 2005). Accordingly, it is important that wildlife conservation programs are oriented specifically at particular species of most concern such as Houbara bustard. Such programs should be implemented based on regional, national and international scope (Young, 1997; Mawdsley et al., 2009).

The weather during the field data collection exercises (occurrences of rains and low temperature) might have impact on the animals' availability. Ectothermic (cold blooded) animals tend to hibernate during cold weather (winter) and come out only from hibernation when the temperature is favorable (spring). This could be true because the Sand gecko (*Stenodactylus slevini*) and the Rock gecko (*Bunopus tuberculatus*) were trapped only during the PFT trapping exercises in March, when the temperature in the oilfields had risen to above 20^0C, whereas most of the beetles, ants and the fringe-toed lizards, such as *Acanthodactylus scutellatus*; *A. schmidtii*; and *Mesalina brevirostris* were trapped when the temperatures in the field ranged from 3^0 to 8^0C.

The large percentage of predators (51%) of animals recorded from the PFT indicated good supply of prey or food resources i.e. consumers 47% and scavengers 2%. The low numbers of captures in the baited mammal trappings were expected because of the timing of the field exercises, winter. Desert animals tend to hibernate during winter and come out during spring and summer (examples are hedgehog, gerbil, jerboa, etc.). More animal species are expected to be recorded if the survey was to cover the four seasons, especially the two distinct migration periods of Kuwait.

Expanding the survey period and applying more conservation strategies and programs is recommended in future work. No conservation program or strategy is optimal, some strategies have to be oriented to a specific target. Development of a set of strategies or approaches that complement each other is sometimes important to create useful conservation tools and to fulfill requirements needed for an appropriate wildlife conservation approach.

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