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Status and Conservation of the Leopard on the Arabian Peninsula

الحفاظ على النمر العربي ووضعيته في شبه الجزيرة العربية.



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Cover photo: Arabian Leopard at the Breeding Centre for Endangered Arabian Wildlife, Sharjah, UAE. **Photo:** Jane-Ashley Edmonds and Kevin Budd.

Foreword

The rapid disappearance of the Arabian Leopard, along with so much of its main prey, from large areas of their former range in the Arabian Peninsula represents a major setback for conservation of biodiversity in the region.

Full details of former status and abundance are lacking, but it can be supposed that distribution once extended over all the mountainous parts of the Arabian Peninsula. As the reports from each range state included here indicate, the current situation is critical. In the worst case, only three populations widely scattered across the Peninsula now survive. The actual situation may be slightly more favourable, with other remnant populations surviving in remote areas, but these must be small and fragmented and their long-term viability uncertain.

The Arabian leopard formed a major item on the agenda of the first Conservation Workshop for the Fauna of Arabia held at the Breeding Centre for Endangered Arabian Wildlife in Sharjah in 2000 and it has continued to feature regularly at the annual meetings held since then.

Over the last few years, it has been very encouraging to witness the development of a successful captive breeding programme based here in Sharjah and with the cooperation of other facilities from around the region. The offspring produced by the programme serve as a safeguard against the total extinction of the Arabian leopard and potentially provide stock for releases at some point in the future.

The challenge facing all of us now is to translate this success to the leopard population in the wild. Compilation of this report is an important initial step in this process by bringing together all that is currently known and highlighting the many important gaps in knowledge that remain to be filled.

The task now is to formulate and, crucially, to enact, measures that will enable first the survival, and then the recovery of the Arabian leopard. The projected range-wide Conservation Strategy and Action Plan for the Arabian leopard will achieve the first part of this task. It will then become the responsibility of governments to ensure that resources are applied to realise the recommended actions so that the nimr can reclaim its place as the top predator through the mountains of the Arabian Peninsula.

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The Leopard in the Arabian Peninsula – Distribution and Subspecies Status

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Historically it was considered that there were four subspecies of leopards in the Arabian region. Today *P. p. jarvisi* no longer occurs and the ranges of *P. p. tulliana* and *P. p. saxicolor* have severely contracted north. Only *P. p. nimr*, the Arabian leopard, remains. Morphological data suggests *nimr* to be the smallest of the leopards and a distinct subspecies but this has yet to be conclusively confirmed by genetic evidence. Recent records give a bleak picture of the status of *P. p. nimr*. A few individuals survive in the Judean Desert and Negev Highlands while in the Arabian Peninsula leopards are known from just one location in the Republic of Yemen and one in the Sultanate of Oman. In Yemen the leopards of the Al Wada'a area are under great pressure from killing and from capture for trade. In Oman the situation is much more hopeful and the leopards of the Dhofar Mountains have benefited from comprehensive conservation measures. While the possibility, however remote, of the existence of other relict populations cannot be ruled out the need for urgent conservation action across the region is obvious given the reality that the Arabian leopard may soon be reduced to two, or even just one population in the wild.

النمر في شبه الجزيرة العربية: الأنواع والتوزيع المكاني والوضع الحالي

ملخص

في الماضي عاشت أربعة أنواع من النمر في المنطقة العربية. أما اليوم فقد اختفى أحدها، وأدت الظروف إلى نزوح نوعين باتجاه الشمال في حين بقي النمر العربي المعروف لاتينيا باسم *باردوس* وتشير المعلومات المتوفرة حول الشكل البنيوي إلى أن النمر هو أصغر النمر وأميزها، ويجري حاليا التثبت من هذا الأمر عبر الفحص الجيني.

قدمت السجلات المنشورة في الأونة الأخيرة صورة واضحة حول وضع النمر العربي في منطقة شبه الجزيرة العربية حيث اتضح وجود تعداد صغير من النمر في صحراء النجف الواقعة إلى الشمال، وفي الجنوب توجد النمر العربية في كل من الجمهورية اليمنية وسلطنة عمان. ففي اليمن تعيش النمر في منطقة الودعة وتعرضها تهديدات حقيقية كالقتل والإمساك بها للمتاجرة. أما في سلطنة عمان فيبدو الوضع أكثر إشراقا حيث استفادت النمر التي تستوطن جبال ظفار من تدابير الصون الشاملة.

بالرغم من ضآلة إمكانية وجود تعدادات جيدة أخرى من النمر العربية في المنطقة إلا أن هذا الأمر لا يمكن استبعاده. ومن هنا تبرز الحاجة لاتخاذ إجراءات عاجلة للحفاظ على هذا النوع النادر وخصوصا إذا ما نظرنا إلى حقيقة أن تعدادات النمر العربية في البراري قد تتناقص قريبا إلى اثنين أو حتى واحد.

Introduction

The leopard *Panthera pardus* once occurred throughout much of Arabia (Harrison & Bates 1991). However, over the past 100 years it has become increasingly threatened as a result of the depletion of its prey base, killing by hunters and shepherds and vulnerability of ever decreasing population size. The leopard is globally red listed as Least Concern, but *P. p. nimr* is classified as Critically Endangered (IUCN 2004) and is listed on Appendix I of the Convention on International Trade in Endangered Species (CITES).

Hemprich & Ehrenberg (1833) first described *Felis nimr*, based on an Abyssinian skin and partly on an Arabian one. By the middle of the 20th century it was generally considered that there was evidence for four subspecies in Arabia; *P. p. jarvisi* in Sinai to the west, *P. p. saxicolor* in Iraq to the north, *P. p. tulliana* from Syria south to the Dead Sea in the Levant with *P. p. nimr* extending over most of the region from the Jordan valley south and east to Oman and Yemen (Harrison 1968). In this paper we use published work and some new data

to shed light on the historical distribution and current occurrence of *Panthera pardus* in the region and attempt to clarify the "subspecies" issue.

Distribution

Panthera pardus jarvisi

Pocock (in Harrison 1968) in 1932 described *P. p. jarvisi* from Sinai although the exact locality and origin of the specimen is not known. Harrison (1968) considered that the range of *P. p. jarvisi* extended south through the Hejaz of Saudi Arabia but later Harrison & Bates

(1991) described *P. p. jarvisi* as occurring only in Sinai and 'is probably little more than the local variant of *nimr*'.

Osborn & Helmy (1980) report a single specimen examined from Sinai but of unknown locality and list numerous published records and reports for the peninsula from 1872 to the early 1950s. Substantiated reports from recent years are lacking. In 1995, Saleh *et al.* (1995) who surveyed Ras Mohammed, Nabaq and Abu Gallum protected areas, reported tracks in Wadi El Omiyed and also reported that in May 1995 an adult leopard was caught in a leg-hold trap near the western boundary of Abu Gallum. In 1997 Prof. Ibrahim Helmy sighted a leopard near Abu Durba. In December 1997 there was a report of a leopard being sighted in Wadi Eltala and later the same month in Wadi Elgars, being a branch of Wadi Eltala (Ibrahim 1998). A camera-trapping programme and survey started in 1999 (Spalton 1999) has found no evidence of leopards in St. Katherine Protectorate or elsewhere in Sinai (Hussam El Alqamy, personal communication February 2006).

Nowell & Jackson (1996) recorded *P. p. jarvisi* as being in Sinai and extending east to the Judean desert. However, Ilani (1990) who radio-tracked leopards in the late 1970s and early 1980s reported that the leopards of the Judean desert and Negev Highlands were neither *P. p. jarvisi* or *P. p. tulliana* but resembled closest *P. p. nimr*. Shoemaker (1997) states that surveys conducted in December 1992 produced a maximum estimate of 8-10 leopards. Recent estimates based on molecular scatology are of a minimum of a male and two females in the Judean Desert and four males and one female in the Negev Highlands (Perez *et al.* 2006).

Panthera pardus tulliana

There are numerous reports of this subspecies in Syria, Palestine and Jordan in the late 19th and early 20th centuries (Harrison 1968). In Jordan records come from north of Aqaba, south of Petra and Wadi Zarqa Ma'en (Hardy 1947) and the most recent report was in 1987 (Qumsiyeh *et al.* 1993). In Nowell & Jackson (1996) *P. p. tulliana* is considered as the Anatolian leopard and only occurring in western Turkey. Harrison (1968) reports this subspecies in the Galilee area close

to Lebanon where it is believed that the last specimen, an old male, was killed in 1965 (Mendelssohn 1990). Harrison & Bates (1991) cite reports that this subspecies is clearly flourishing further south in the Judean Hills (Ilani 1988) and that it occurs in the West Bank (Ilani 1986) although Ilani (1990) believes the subspecies of the Judean Desert to be *P. p. nimr*.

Panthera pardus saxicolor

The type locality for this subspecies is Asterabad in southern Iran where it was described in 1927. Its range is considered to extend east to Afghanistan and Turkmenistan (Nowell & Jackson 1996) and west to Turkey (Borner 1977). There is little evidence of this subspecies in the Arabian Peninsula region, the most southern records coming from a low lying area at Rawa on the Euphrates and yet further south on the floodplain of the Tigris at Kut al Imara in Iraq (Harrison 1968).

Panthera pardus nimr

As Harrison (1968) accounts, Hemrich and Ehrenberg's (1833) *Felis nimr* was based principally on an Arabian skin from the 'mountains in the vicinity of Qunfida, Asir, Saudi Arabia' and Pocock (1932), nearly 100 years later, proposed that this form might occur on both sides of the Red Sea. However, Harrison, who had access to additional information, did not agree and considered the S. Arabian leopard, *Panthera pardus nimr*, as distinct and that any extension across the Red Sea was doubtful.

Kingdom of Saudi Arabia

Harrison (1968) reported specimens only from the Asir mountains (where the type specimen was obtained) that run southeast towards Yemen. He considered specimens from the Hajaz (to the north-west) to be *P. p. jarvisi*. However, later Harrison & Bates (1991) referred to just one subspecies, *P. p. nimr*, for the leopards of the Hajaz and the Asir.

In 1982 a live-leopard was seen in Wadi Hiswa in the Asir (Gasperetti *et al.* 1985), while Nader (1989) reported on killings of leopards and the collection of leopard remains in the 1970s and 1980s and concluded that if they remain in the Kingdom they would be in the Asir mountains. One year later

Biquand (1990) reported on a survey of the Asir concluding that they were probably present although they made no sightings. In a subsequent paper Nader (1996) reported a small population still in the Hijaz and one also in the Asir, although no evidence was presented. Judas *et al.* (2006) report just four confirmed records since 1999 although three were based on evidence of tracks and live-stock killing and only in the fourth case, near the Yemen border, were remains of two leopards photographed in 1999. A recent paper by Al-Johany (2007) based on a survey from 1998 to 2001 concluded that the number of leopards in Saudi Arabia was greater than widely believed and included 65 sightings by local informants. However, none of the records or sightings was substantiated by photographic or other evidence and since that time field surveys and camera trapping programs have failed to confirm the continuing presence of leopards.

A number of leopards were captured in the wild between 1997 and 2003 and subsequently acquired by the National Wildlife Research Centre (NWRC), Taif and other private collections. However, Judas *et al.* (2006) suggest that all, with the possible exception of a young male in 1997, were captured in Yemen.

In conclusion, irrefutable evidence that leopards still occur in the Kingdom is lacking. The last substantiated record appears to have been the two animals found dead in 1999 near the Yemen border.

Republic of Yemen

Sanborn & Hoogstraal (1953) reported that the species was scarce but widespread while Harrison (1968) reports on several specimens of leopard from the mountains around Aden and Beihan. Obadi (1993) reports the killing of leopard during the late 1970s and early 1980s in the area of Lodar northeast of Aden.

Al Jumaily *et al.* (2006) provide details of post-1990 records for five broad clusters from areas in the north close to the Saudi border to the south in the Mahra Governorate and close to the Oman border. However, most capture records are from the area of Al Wada'a about 120 km north of the capital where Lagrot & Lagrot (1999) also reported signs of leopard as well as captures. A

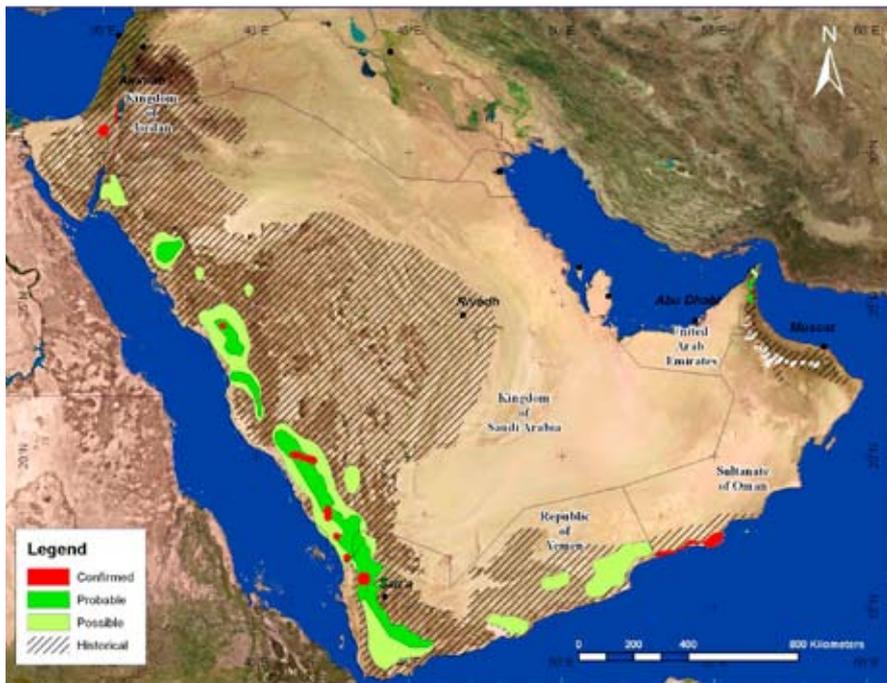


Fig. 1. Former and current (since 1990) distribution information for the leopard on the Arabian Peninsula. Confirmed records: Confident evidence or hard facts, such as dead specimens (with body, skin, etc. available), photo-trap pictures, and genetic analyses (e.g. from scats). Probable records: All records confirmed by any evidence or by a trained person. Possible or unconfirmed records: All not confirmed or not confirmable reports. This includes especially hearsay and direct observations.

spate of live-captures seems to have commenced in the early 1990s when a young female was killed in a leopard trap and her male offspring taken into captivity in Sana'a from where it was sold to the Breeding Centre for Endangered Arabian Wildlife, Sharjah in 1995 (Jongbloed 2001). In subsequent years at least 10 wild caught leopards entered zoos in Sana'a or Ta'iz (Budd 2003) and at least nine were reported to have come from the Al Wada'a area (EPAA 2000). Further animals were moved to the Breeding Centre for Endangered Arabian Wildlife, Sharjah and in 2002 an animal was wild caught and presumably sold to the Al Wathba Cheetah Breeding Centre, Abu Dhabi (Budd 2003).

Sultanate of Oman

In the Dhofar Mountains of southern Oman, leopards were known from the monsoon woodlands of Jabal Qara (Thomas 1932) and a specimen was collected from Jabal Samhan (Harrison 1968). It was from Jabal Samhan that leopards were captured in 1985 to establish the first captive breeding group (Usher Smith 1985). In northern Oman a single skin was obtained from the Al Hajar range (Harrison 1968) where

in 1976 what is believed to be the last leopard was found killed. Specimens were recovered from the Musandam peninsula during a spate of killing in the early 1980s and the last confirmed report is of two animals killed in 1997 (Spalton *et al.* 2006b).

Camera-trap studies have confirmed the continuing presence of leopard in Jabal Samhan, Dhofar (Spalton & Willis 1999) where over 200 photographs of 17 leopards were obtained during the years 1997-2000 (Spalton *et al.* 2006a). Ongoing camera-trapping has also confirmed the presence of 9-11 leopards in Jabals Qara and Qamar that run west from Samhan to the Oman-Yemen border. A number of these leopards were fitted with GPS satellite collars and tracked in 2001-2005 (Spalton *et al.* 2006b).

United Arab Emirates

Harrison (1971) reports the presence of leopard from the mountains of the northern Emirates that border Musandam in Oman. In 1986 at least one leopard was killed in the same mountains and in 1991 a male was caught alive near Masafi while in 1992 one was shot in Wadi Bih (Jongbloed 2001). The male

from Masafi joined the collection at the Breeding Centre for Endangered Arabian Wildlife, Sharjah but has not participated in the breeding programme. A survey in 1995 found tracks of leopards at one site and stated that there may be 20 'or far less' adults in the mountains (Stuart & Stuart 1995).

A survey in the Emirate of Ras al-Khaimah in 1999 and 2000 found some signs of leopard but were not confirmed by camera-traps deployed at the same time (Llewellyn-Smith 2002). There is a report of a leopard being killed on the UAE side of the Musandam Peninsula in February 2001 (EPAA 2003) but photographs or carcass remains seem to be unavailable.

Figure 1 shows the confirmed, probable, possible and historical range of *P. p. nimr*.

Morphological and Molecular Genetic Variation

Miththapala *et al.* (1996), using molecular genetic analysis, grouped seven putative central Asian subspecies including *P. p. nimr*, *P. p. jarvisi*, *P. p. tulliana* and *P. p. saxicolor* together as the revised subspecies *P. p. saxicolor*. However, their analysis included material from only two of the seven subspecies: *P. p. sindica* (Baluchistan leopard) and *P. p. saxicolor* and the latter were represented entirely by a zoo-bred population.

This assessment was revisited by Uphyrkina *et al.* (2001) who used new genetic methods and additional samples. They had no material from *P. p. jarvisi* or *P. p. tulliana* and had one sample for *P. p. nimr* and three new samples for *P. p. saxicolor* that had not been used by Miththapala *et al.* (1996). Their work confirmed the proposed subspecies of *P. p. saxicolor* but tentatively considered *P. p. nimr* as a subspecies writing that 'populations of *P. p. nimr* appear to have been isolated for quite a long time, accumulating multiple diagnostic sites that distinguish it from any other subspecies'. The single sample of *P. p. nimr* was obtained from Tel Aviv University but originated from somewhere in south Arabia.

A study conducted at the Breeding Centre for Endangered Wildlife, Sharjah (J. Williamson, pers. comm.) looked at possible differences between leopard from northern Arabia (UAE & northern

Table 1. Specimens of *Panthera pardus* from the region

Location	Year	Subspecies	Alive/ dead	Sex	Weight (kg)	Overall length (mm)	Length of tail (mm)	Reference
Jordan	1911	<i>tulliana</i>	Dead	F		2060	750	Harrison 1968
Judean desert	1979	<i>nimr</i>	Alive	M	29.5	1990	820	Ilani 1980
Judean desert	1979	<i>nimr</i>	Alive	F	23.5	1920	790	Ilani 1980
Judean desert	1979	<i>nimr</i>	Alive	F	22.0	1684	754	Ilani 1980
Iran		<i>saxicolor</i>	Dead		86.0	2130	-	Kiabi <i>et al.</i> 2002
Iran		<i>saxicolor</i>	Dead		66.0	2120	-	Kiabi <i>et al.</i> 2002
Iran		<i>saxicolor</i>	Dead			2040	-	Kiabi <i>et al.</i> 2002
Iran		<i>saxicolor</i>	Dead			1750	-	Kiabi <i>et al.</i> 2002
Iran		<i>saxicolor</i>	Dead			2000	-	Kiabi <i>et al.</i> 2002
Iraq	1951	<i>saxicolor</i>	Dead	M		2591	940	Harrison 1968
Iraq	-	<i>saxicolor</i>	Dead	-		2261	914	Harrison 1968
Oman	1947	<i>nimr</i>	Dead	-		1965	787	Harrison 1968
Oman	-	<i>nimr</i>	Dead	-		2007	813	Harrison 1968
Oman	2001	<i>nimr</i>	Alive	F	18.0	1600	670	OACE unpublished data
Oman	2001	<i>nimr</i>	Alive	M	26.0	1570 [#]	540	OACE unpublished data
Oman	2001	<i>nimr</i>	Alive	M	34.0	2030	850	OACE unpublished data
Oman	2001	<i>nimr</i>	Alive	M	24.0	1820	770	OACE unpublished data
Oman	2003	<i>nimr</i>	Alive	M	18.0*	-	-	OACE unpublished data
Oman	2003	<i>nimr</i>	Alive	F	19.0	-	-	OACE unpublished data
Saudi Arabia	1955	<i>nimr</i>	Dead	F		1778	737	Harrison 1968
Saudi Arabia	1963	<i>nimr</i>	Dead	-		1676	660	Harrison 1968
Saudi Arabia	-	<i>nimr</i>	Dead	-		1600	660	Harrison 1968
Sinai	1900	<i>jarvisi</i>	Dead	-		2108	737	Harrison 1968

* sub-adult; # tail damaged; OACE: Office of the Adviser for Conservation of the Environment, Oman

Oman) and southern Arabia. These areas are both mountainous but are separated by open desert and gravel plains where the movement of animals between the populations may not have occurred or at best been very rare. The study used both mitochondrial DNA and nuclear DNA techniques but found no evidence to support species differentiation between northern and southern leopards. However, sample sizes of northern leopards were small (mitochondrial DNA n=3, nuclear DNA n=2). Other studies carried out by the King Khaled Wildlife Research Center, Saudi Arabia have been inconclusive (Judas *et al.* 2006) and a study in Oman has just commenced (Al Ansari *et al.* 2005).

Morphological data is generally lacking but based on measurements for overall length and some weight data and including specimens from Iran (Table 1), *P. p. saxicolor* seems to be larger and heavier than the other three subspecies. While sample sizes for *jarvisi* (n = 1) and *tulliana* (n = 1) are very small

this difference was significant for *saxicolor* and *nimr* ($P = 0.004$, $df = 17$). Body length of *nimr* did not vary significantly between those of the Judean desert, Saudi Arabia and Oman.

Discussion

It seems that once three subspecies of leopard occurred in the region. *P. p. nimr* is the principal leopard of the region and of the Arabian Peninsula in particular. *P. p. saxicolor* is a species of central Asia whose range extended south to southern Iraq and Jordan. *P. p. tulliana* occurred from Turkey through Syria to Lebanon. *P. p. jarvisi* probably never occurred but was actually *P. p. nimr*. Today *P. p. saxicolor* and *P. p. tulliana* seem no longer to occur in the region as their ranges have contracted north. Genetic studies seem to have established that *P. p. saxicolor* is distinct from other subspecies. This is supported by morphological data that suggests this principally Asian subspecies is larger than other subspecies from the

region. However, for the other subspecies genetic studies have not come close to resolving the subspecies debate. The proposal by Miththapala (1996) to lump the other species of the region has little scientific base since it did not include any material from populations of *P. p. nimr*; *P. p. jarvisi* or *P. p. tulliana*. Similarly Uphyrkina *et al.*'s (2001) tentative suggestion of *nimr* as a subspecies has little credibility as it was based on a single sample.

Further genetic studies may help resolve subspecies issues. However, while we await such studies we should consider the likely reality that *P. p. nimr* is the only surviving subspecies in the region and that it does not occur elsewhere. In the Negev Highlands and Judean Desert numbers are very small and in the Arabian Peninsula it is restricted to Yemen and Oman. In Yemen leopards face severe persecution in the wild and in the last 10 years many have entered captive collections in the country and elsewhere in the region. However, there

still remains an opportunity for *in situ* conservation. In Oman the situation is more encouraging with ongoing conservation programmes but the total number in the wild is likely to be less than 200.

Whatever further evidence emerges as to the distribution and subspecies status of the leopard in the region the reality is that the Arabian leopard or 'nimr' in Arabic has largely gone from the region and if it is to survive in the wild it will most likely be in the mountains of southern Arabia, and in particular in the Dhofar Mountains of Oman.

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The Leopard in Jordan

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Leopards have been reported from several localities in Jordan. The last confirmed report dates from 1987. There have been occasional unconfirmed reports since. Recent field surveys have failed to find signs of leopard presence.

هناك العديد من التقارير التي تشير إلى مشاهدة النمر العربي في الأردن، وتم إعداد آخر تقرير في شأن ذلك عام 1987، وقد فشل آخر مسح ميداني تم القيام به مؤخرا في إيجاد أية مؤشرات تؤكد وجود النمر العربي في الأردن.

Distribution

Leopards were reported as more common than the cheetah by Tristram (1866, 1888) in many areas of Jordan and Palestine. Ernst Schmitz recorded five leopards shot near Jerusalem in the first decade of the 20th century (Hardy 1947). Aharoni (1930) reported a leopard killed between Ramallah and Emmaus. Another animal was killed on the Palestinian-Lebanese frontier and a cub was secured near Safad, west of Lake Galilee (Hardy 1947, Qumsiyeh 1996, Qumsiyeh *et al.* 1993). Hardy (1947) stated that leopards still inhabited the wadi south of Petra and Wadi Zarqa Ma'an as well as an individual shot at Ain Ghidyan, north of Aqaba. Harrison (1968) reported a specimen shot west of Ma'an. Lehmann (1965) reported several observations west of the Dead Sea. A leopard was killed by a Bedouin in Wadi Darajah, in the desert east of the Dead Sea in October 1965 (Blake 1966). Clarke (1977) listed the following localities as previous reports of the leopard from Jordan; Petra, Wadi Zarqa Ma'an, Ain el Taba, Ain Buweirdeh, and Ma'an. The latest report of the leopard came from an observation in the Tafilah area where it attacked and killed sheep during February 1987 (Amr & Disi 1988, Qumsiyeh *et al.* 1993). Figure 1 shows these localities. Sporadic local reports have been received since then, possibly referring to vagrants, but remain unconfirmed. A field visit by the authors in 2005 with local rangers failed to find any signs of leopard presence.

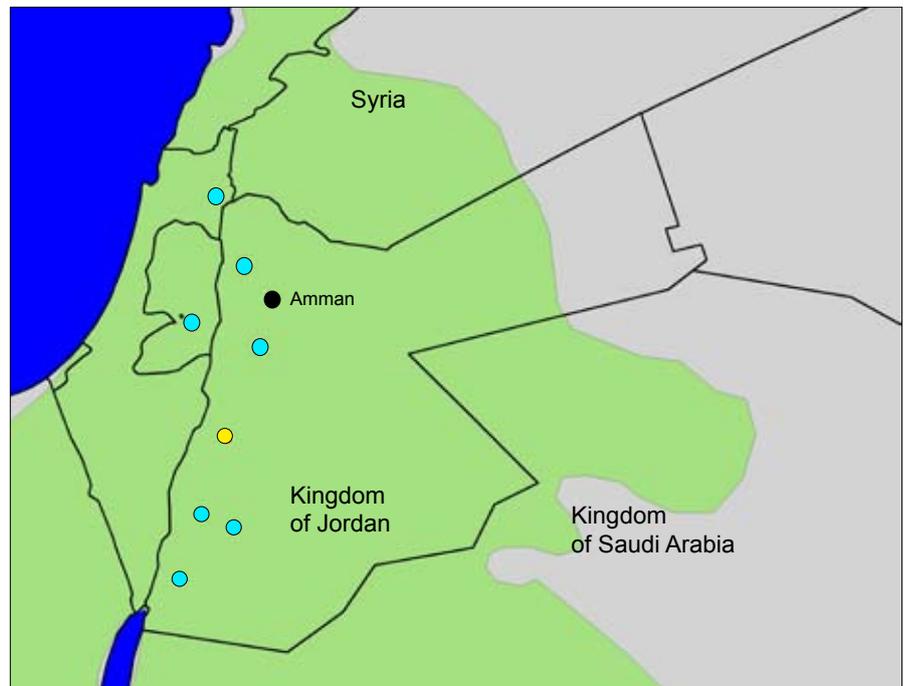


Fig. 1. Former distribution of leopard in Jordan. Presumed former range (green), 1987 record (yellow dot) and historical records (blue dots).

Leopards became rare after the turn of the twentieth century and by the second half of the century it was almost extinct from Jordan. Major causes of extinction are habitat loss, hunting and reduced prey availability. Habitat loss is mainly due to the rapid increase in the human population and development projects associated with this growth. Hunting has been a feature for millennia for sport and out of fear for man and his domestic animals. Most large-size prey items for the leopard

have become rare, especially in the second half of the 20th century.

Habitat

Three protected areas totaling 1,300 km² (Wadi Rum, Dana, and Wadi Mujib) are sited along the historical range of the leopard, and a fourth is proposed.

Prey

Nubian ibex *Capra nubiana* occur in Wadi Mujib Wildlife Reserve and

Wadi Rum Protected Area. Mountain gazelle *Gazella gazella* is now considered extinct in Jordan. Historical range of the species is along the western mountain range bordering the Rift Valley. A small number of dorcas gazelles *Gazella dorcas* occur in Wadi Araba and Wadi Rum Desert in the south of the country. Other possible prey items inhabiting the same historical range of the leopard include rock hyrax *Procavia capensis*, and Cape hare *Lepus capensis*.

Legal Status

Leopards are protected by law. Ibex and all gazelle species are also strictly protected.

Conflicts and Public Awareness

Leopards were hunted for different reasons. According to interviews with local people who live in areas where leopards used to exist, the main reason for hunting was related to the social traditions at that time. A person who could hunt or kill a leopard would be acknowledged by the tribe as a distinguished and brave man.

In 1999, a local guide from Wadi Rum showed us a leopard trap, known locally as *margabah* (Fig. 2) that was used by his grandfather to catch leopards. The trap was made of stones and had two openings. The bait hung from the middle of the trap and when the leopard tried to take the bait, the stone doors of the trap closed and trapped the leopard inside.

People and Institutions

The Royal Society for Conservation of Nature (RSCN) is responsible for establishment and management of protected areas, research, cooperation with international agencies, enforcement of wildlife protection laws and administration of hunting.

Recommendations

During the past couple of years there



Fig. 2. A leopard trap (called *margabah* by the local population) Eastern Desert – Jordan (Photo M. Qarqaz).

have been rumours of leopards crossing the borders from the Saudi side and Palestine, but a recent short field visit could not confirm these. However, in one area close to Dana Nature Reserve in Tafilah, habitats are still relatively untouched and seem to be very suitable for leopards due to the rugged landscape and presence of wadis and rocky cliffs which might provide very good shelter and forage for leopards. This is also the area where the last sighting of leopards came from. It is recommended to survey this area thoroughly and place some camera traps if possible.

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Status of the Arabian Leopard in Saudi Arabia

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The historic range of the Arabian Leopard presumably extended over a large part of Saudi Arabia. Analysis of the scarce historic and recent records suggests that the range has decreased by 90 % since the beginning of the 19th century, with an annual rate of range loss close to 10 % in the last 15 years. During the period 1998-2003, 19 reports were recorded, of which only 4 can be confirmed, distributed in 2 main areas. 1) the escarpment of the Asir Mountains between Al Baha and Abbah (600-2400 m), where high prey density may still be found near permanent water flows, and 2) the drier Hijaz Mountains north of Madinah (< 2000 m), where potential prey density is low. Considering home range sizes and densities calculated for other leopard populations in different ecological contexts, the potential population was estimated at 60-425 individuals in a range of 4000-19,635 km². Population viability analysis projected a mean time for first extinction of 11.3 years from 1998. The decline is mainly attributed to habitat fragmentation and degradation and direct persecution. The increase in over-grazing, and encroachment into once remote areas by road construction since the 1970s have induced important biodiversity loss affecting the whole food chain. Prey availability has decreased throughout leopard range, which has presumably led the leopard to alter its diet towards live-stock and other domestic animals. This increases the unpopularity of the species, and persecution by local people. The leopard is officially protected in Saudi Arabia; however, despite the high proportion of land protection (4.1 % of the country), there is an obvious lack of protected areas that encompass the leopard's remaining range. Recommendations stress the need for extensive surveys to update current status and distribution of the Leopard, and to develop *ex situ* and *in situ* conservation programs.

وضع النمر العربية في المملكة العربية السعودية جاكي جوداس، باتريك بالات ، عبدالرحمن خوجه وأحمد البوق

الملخص:

التوزيع الجغرافي التاريخي للنمر العربية في المملكة العربية السعودية من المحتمل أنه يغطي مساحات كبيرة منها. ويظهر التحليل للإشارات التاريخية النادرة والتسجيلات الحالية ميلا الى انحسار توزيعها بنسبة 90% منذ بداية القرن التاسع عشر الميلادي. بمعدل انخفاض سنوي للانتشار بحوالي 10% خلال الخمسة عشر سنة الماضية. خلال الفترة من 1998-2003م سجل 19 إشارة عن تواجد النمر العربية. منها أربعة فقط يمكن تأكيدها. وتتوزع في منطقتين رئيسيتين (1) المنحدرات الجبلية لسلاسل جبال عسير بين الباحة وأبها (600-2400م)، حيث يتوقع توفر كثافة عالية من الفرائس قرب منابع المياه الدائمة. (2) في جبال الحجاز الجافة في شمال المدينة (حوالي 2000 م) حيث احتمال انخفاض كثافة الفرائس. واستنادا على قطاعات التحرك والكثافة لمجموعات من النمر الأخرى في بيئات مختلفة من دراسات سابقة. قدرت أعداد النمر في المملكة بشكل تقريبي بين 60-425 نمر في مساحات بين 4000-19.635 كم². وقد حددت تحليلات للمجموعات القابلة للحياة للنمر في المملكة زمن متوسط لبداية انقراضها قدر بـ 11.3 سنة من 1998م. الانحسار مرتبط بشكل أساسي بتفتت البيئات وتدهورها، وللمعاناة المباشرة، وزيادة الرعي الجائر، والانتهاكات البيئية للمناطق النائية عبر إنشاء الطرق من السبعينيات الميلادية 1970م، كل ذلك فاقم من فقدان التنوع الاحيائي، مما أثر على كامل السلسلة الغذائية، وانخفض توفر الفرائس في كامل نطاق التوزيع للنمر العربية، والذي من المحتمل أنه دفع النمر لتبديل غذائها باتجاه المواشي والحيوانات المستأنسة الأخرى. زاد ذلك من انخفاض التعاطف الشعبي مع النمر واستهدافها من السكان المحليين. النمر محمية وفق أنظمة المملكة العربية السعودية. وبالرغم من ارتفاع مساحة المناطق المحمية لمساحة المملكة (4.1% من المساحة الكلية) فإن هناك ندرة منها في المناطق المتبقية للتوزيع الجغرافي للنمر. تركز التوصيات على الحاجة الماسة لإجراء مسوحات حقلية لتحديث تقرير وضع النمر الحالي ومعلومات توزيعها الجغرافي ولتطوير برامج لحمايتها في البرية والأسر.

Status and distribution

Historically, the Arabian leopard *Panthera pardus nimr* was probably found in a large part of Saudi Arabia, excluding sand dune areas (Nafud, Rub al Khali). Its range extended all along the mountains bordering the Red Sea coast, from the Jordan border in the north to

Yemen in the south (Gasperetti et al. 1985, Harrison & Bates 1991). Early travelers on the pilgrimage route to Mecca (Lady Anne Blunt 1881, Dougherty 1888, Carruthers 1909) reported its presence inland in the Hail area and a review of the Saudi toponymy (site na-

mes composed of "nimr") suggested that its distribution could have extended inland as far east as the Riyadh region.

The Arabian leopard may currently be found in only small isolated populations in remote and rugged areas of the western Sarawat and Hijaz Mountains.

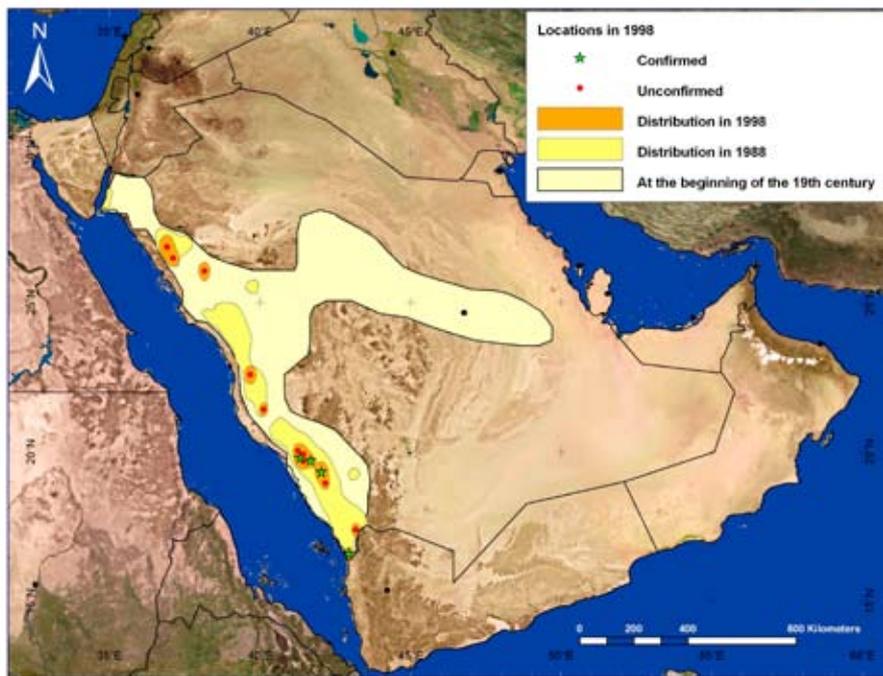


Fig. 1. Distribution change of the Arabian Leopard in Saudi Arabia from the beginning of the 19th century to 1998. Light yellow: distribution at the beginning of the 19th century; middle yellow: distribution in 1988; dark yellow: distribution in 1998. Green stars confirmed presence in 1998, red dots unconfirmed presence in 1998.

In this study, during the period 1998 to 2003, leopards were reported from 19 locations, of which 4 can be considered confirmed (Appendix I). Fourteen of these locations are distributed in 2 main areas, whereas the other 5 are isolated, single reports (Fig. 1). The most important area, in number of reports and size, is located in the Asir Mountains (Fig. 2) between Al Baha and Abha along a large steep escarpment, about 250 km long and 20–30 km wide. At 3 locations (Jibal Shada, Al Atifa and Wadi Khatayn), presence of the species was confirmed by killings, several reports of sightings from different witnesses, livestock killed, and presence of tracks and signs. The most recent record was obtained in Wadi Khatayn (south of Biljurashi) in 2002. However, camera traps deployed in the area during 2002 and 2003 failed to obtain pictures of leopards. The second most important area is located near Al Wahj, north of Madinah, in the Hijaz Mountains. In spite of several reports of the presence of leopards here, none could be clearly confirmed. A recent survey (Budd 1999) did not produce any more evidence, although leopard presence was strongly suspected. Four of the isolated locations, 3 in the Asir mountains and 1 near Jebel Nahr (Hijaz

mountains), could also not be confirmed (R. Ajaj, pers. comm.). The fifth location (P. Paillat, pers. comm.) in Samtah near the Yemen border was documented in 1999 with pictures of 2 individual leopards killed.

A survey conducted between 1996 and 2002, based on enquiries among local shepherds and hunters, listed 65 sightings of leopards at 42 sites (Al-Johany 2007) mainly distributed in the Hijaz mountains (around Madinah and Al-Ula) and secondarily along the Asir mountains. These unconfirmed records largely overlapped the possible range assessed for the period 1990–2005 in this status review.

The total potential range in 1998 was estimated to cover between 4,000 km² (considering only the 4 confirmed locations) and 29,724 km² (all locations), with 19,635 km² and 10,089 km² in the Asir and Hijaz mountains respectively (see Judas *et al.* 2004 for details of the analysis). Comparing ecological studies of leopard conducted in areas of Africa with comparable rainfall (Bothma & Le Riche 1984, Stander *et al.* 1997), with preliminary results of radio-tracked leopards in Oman (A. Spalton, pers. comm.), and considering a likely gradual fall-off in density towards the

edge of the distribution range (Brown 1984, Caughley *et al.* 1988), the potential leopard population in 1998 was estimated to range between 60 and 425 individuals. Based on the distribution ranges estimated for different periods (Judas *et al.* 2004), the leopard's range has decreased by around 90 % since the beginning of the 19th century with an annual rate of range loss close to 10% in the last 15 years. With such a rate of decrease, the potential population size in 2004 could range between 16 and 111 individuals for the whole of Saudi Arabia. Population viability analyses using Vortex 8.42 (Lacy *et al.* 2001) projected a mean time to first extinction of 11.3 years as from 1998, that is, two years from now.

Threats

The decrease in Arabian leopard populations is mainly due to habitat fragmentation, habitat degradation and direct persecution. In Saudi Arabia, habitat loss began several centuries ago with tree cutting to meet the wood demands of growing iron and copper industries (Collenette 1999). This was already largely developed by the 16th century. Tree cutting and deforestation still occur in the southern Hijaz Mountains for charcoal production, an important local industry (Biquand *et al.* 1990). In the last twenty years, government policy has encouraged the expansion of pastoralism and agricultural intensification so as to achieve national self-sufficiency in the production of meat and agricultural products. Construction of new tracks and roads in the escarpment has enabled encroachment into once remote areas. Considerable development of highways occurred between 1985 and 1990 (Gasperetti & Jackson 1990). Along these new access roads, unplanned and uncontrolled urban development has been taking place without any Environmental Impact Assessment and/or management plan. Rehabilitation and irrigation of terraces and water supplies with tanks allowed otherwise unsustainable development and intensified encroachment upon natural habitats.

The diversity, abundance and distribution of leopard prey species are declining all over the Kingdom, alongside habitat loss. Abundant and well distributed in former times, gazelles and ibex

have been extirpated from many areas, and remaining populations reduced to a few individuals by over-hunting. Widespread use of firearms has intensified the process. Where gazelles and ibex still occur, hunting parties are regularly organised during the summer (e.g. at Al Fiqrah, Biquand *et al.* 1990). Hyrax, thought to be an important part of the leopard's diet, is also heavily hunted. Even if the species still appears to be well distributed within the Asir Mountains, high hunting pressure will undoubtedly reduce their abundance significantly. Overgrazing by goats, sheep, camels and feral donkeys increased in the 1970s, and contributed significantly to biodiversity loss. Excessive use of vegetation reduced plant diversity, which, in turn, affects the whole food chain from primary producers to top predators.

Direct persecution, through pursuit of trophies or other products, and livestock protection, is the third important threat weighing on the leopard population's fate. Sport hunting is a common practice in Saudi Arabia. Leopards do not often appear to be the sought-after game, but are recognized as valuable hunting trophies that honour the bravery of the hunter (Seddon 1996). In the same way, Bedus who killed animals such as wolf, caracal, hyena, baboon and leopard in wadis around their camp hung them on trees at the roadside, presumably as a demonstration of their skill. However, many killings of leopards can be attributed to livestock protection. When preying on goats, sheep, young camels or other domestic animals, leopards interfere with human activities and are seen as direct competitors (Nader 1996). With the decrease of natural prey species, they have no choice but to alter their diet to livestock, which increases their unpopularity. In most cases, they are also considered as a threat to humans. As a result, leopards are hunted in all their range (Biquand & Boug 1989) using different methods. Poisoning was common in the 1980s, when the Ministry of Agriculture distributed free anticoagulant rat killer. This poison was mixed with crushed glass and metal particles to induce internal haemorrhage (Biquand *et al.* 1990, Biquand & Boug 1992). This practice seems to have stopped around 1985, un-



Fig. 2. Presence of leopards is still reported around Jebel Khurs in the Asir Mountains (Al Baha area; Photo J. Judas).

like trapping. Old fashioned rock traps were largely used in the past. Leopards caught in such traps, or walled in their lair with stone and cement, were left to starve to death or to reach a weak condition, then killed (Gasperetti *et al.* 1985). Rock traps are no longer used, but have been replaced by metal cage traps that are easy to carry and move in the field, baited with goat meat. Shooting and poisoning were considered as the main causes of decline by Nader (1989).

Recognition by local people that wildlife can represent a source of profit also prompts them to kill or catch leopards. As long as benefits were fairly low, leopard remains were presumably sold as extra income and leopards were not killed specifically for this purpose. The fat was collected and sold for medicinal purposes (Nader 1996). Skins and teeth were available in the souk of Khamis Mushayt in 1985. The skin was sold for US\$ 270. In 1994, the National Wildlife Research Centre (NWRC) was informed that a skin was for sale in Abu Dhabi market for US\$ 15,000. In 1997, one live leopard was sold at auction for US\$ 4,800 in Al Khawbah market near the Yemen border. A live leopard can be sold for up to US\$ 50,000. Existence of a market for live animals (Fig. 3) with increasing prices eases the development of traffic. One young female was sold on the black market from Yemen to Saudi Arabia in April 2001; two other animals

coming from Yemen were sold in Saudi Arabia in summer 2001. The different threats weighing on leopard survival are strongly interrelated and can only be solved if tackled in their entirety.

Habitat

Leopards in Saudi Arabia are now confined to remote and rugged areas of the Sarawat Mountains, shared between the Hijaz in the north and the Asir in the south. The Hijaz mountains consist of a broken chain that rarely exceeds 2,000m a.s.l. and receives very little rainfall (<200mm/year, Child & Grainger 1990). Higher elevations are vegetated with Mediterranean *Juniperus phoenicia*, with the slopes being broken by dry wadis, where leopards have been reported. In the Asir mountains, leopards live along the steep escarpment, parallel to the Red Sea coast, that drops from up to 2,400 m to around 600 m a.s.l. The top of the escarpment and highlands are heavily built up and cultivated (Evans 1995). The craggiest and highest parts are shaded by Afro-tropical juniper cloud-forest *Juniperus procera*, whereas gentler slopes are covered by dry vegetation associations of *Acacia asak-Commiphora* spp. or *Acacia seyal-Commiphora* spp. with succulent plants (*Adenium obesum* or species of Euphorbiaceae). Steep slopes of volcanic rock, poorly vegetated, alternate with impressive bare granite



Fig. 3. Sacred baboon *Papio hamadryas*, potential prey of the leopard, caught in a trap set by local people to catch leopard in wadi Khatan. Illegal trapping represents an important threat on the species in Saudi Arabia (Photo J. Judas).

boulders (Jabal Shadah, Wadi Oshar, Fig. 4). These areas offer suitable shelter and shade, such as caves and tree cover that leopards need (Kingdon 1997). In Al Atifa area, they use steep rocky slopes half way up the escarpment, where a network of caves has formed under huge rocks fallen from the cliffs. The valley beds at the foot of the escarpment are generally densely wooded with tree species reaching 10-12 m in height (*Ziziphus*, *Ficus*). Despite the fact that higher elevations of the Asir mountains (>2,000 m, south of Al Baha) can receive a considerable amount of rainfall (>500 mm/year), permanent waterholes or rivers are rare. It has been suggested that the presence of permanent water all year long could be a typical habitat requirement of leopard (Edmonds *et al.* 2002, Harrison & Bates 1991). However, the presence of water where leopards still occur could be the result of range reduction rather than a necessary condition. Leopards will drink every day when possible, but can survive without water for months (Haltenorth & Diller 1985). Permanent water promotes development of rich vegetation and so higher food availability at all food chain levels, which would favor leopard existence. In Wadi Khatayn and Wadi Oshar, south of Biljurashi, a permanent river, which allows the development of a rich wildlife and potential prey, appear

to be particularly favorable for leopards. Narrow gorges with evergreen vegetation (*Phoenix reclinata* palm trees, and the rare *Mimops angustifolia*) contain waterholes up to mid-summer and many fresh and shaded rocky crevices. Moreover, the remoteness of these sites limits human disturbance.

Protected Areas

Historically, Saudi Arabia has a long local community-based tradition of control and use of natural resources through the "hima" system (Evans 1994). For example, the Hima Al Fiqrah, where leopards could presumably still survive, ensured habitat protection in order to maintain traditional honey production (Biquand *et al.* 1990). No grazing was allowed, except for a few local livestock. However, this system is increasingly neglected in the whole Kingdom due to population growth and spread associated with transport of water and livestock fodder.

Since 1986, Saudi Protected Areas, established following IUCN criteria, are managed by the National Commission for Wildlife Conservation and Development (NCWCD) in Riyadh. Emphasis is given to in situ conservation which aims to maintain and recover viable populations of wild species in nature within their known natural range (Abuzinada 2003). This system of protected areas

also provides a legal framework since hunting and wood cutting are prohibited inside them. Sixteen Protected Areas have been created so far, mainly terrestrial, covering 90,017 km², i.e. 4.1 % of the country's area. However, the former presence of leopards has only been revealed in Raydah and Jebel Shadah, covering 9 km² and 50 km² respectively.

Prey species

The diet of the Arabian Leopard has never been studied in Saudi Arabia. Scat analyses in similar habitats of Oman (Muir-Wright 1999) showed that the main prey species were, in order of importance, the Arabian gazelle *Gazella gazella*, Nubian ibex *Capra ibex*, Cape hare *Lepus capensis*, rock hyrax *Procavia capensis*, bird species, porcupine *Hystrix indica*, Ethiopian hedgehog *Paraechinus aethiopicus*, small rodents and insects. In Palestine, the diet was mainly composed of hyrax and ibex (90 %) and porcupines (5 %; Ilany 1990). In Saudi Arabia, Child & Grainger (1990) also suggested that diet could be mainly composed of hyrax and similar size prey. Nubian ibex and gazelles could have been an important part of the diet of leopards in the past, but nowadays, the distribution range of these ungulates is reduced to small isolated populations. In order to survive, leopards have no choice but to alter their diet according to prey availability. Hyrax are still quite common in the western part of the kingdom, and leopards in parts of Africa have been shown to prey mainly on this species (Stuart & Stuart 1995). Whether or not predation on primates occurs in the Asir Mountains is debatable. Broken skulls of sacred baboons *Papio hamadryas* discovered under rock shelters of Wadi Khatayn (South of Al Baha) indicate that predation does occur, but the predator has not been clearly identified. Kummer *et al.* (1981) suggested that predation upon monkeys is presumably rare, whereas recent changes in baboon ranging habits have been attributed to leopard population change (Biquand *et al.* 1989). If they do occur, attacks on baboons should be at night when they are asleep among rocks (Shortridge 1934 cited in Kingdon 1977). Since leopards are known to be an opportunistic predator, we can suppose that they will also prey upon species like partridges

(*Ammoperdix heyi*, *Alectoris melanoccephala* and *A. philbyi*), porcupines, hares and even fishes, frogs and turtles that are still abundant in some places. Nevertheless, following the general decrease of wildlife populations and reduction in natural habitat, leopards have also shifted their diet towards domestic animals (Fig. 5) that are a much easier prey to catch. Predation upon goats, sheep, young camels and feral donkeys has been reported (Biquand 1989, Biquand & Boug 1992). Leopards may also prey on domestic dogs at night around or even inside camps. Leopards may sometimes scavenge. A local Bedu mentioned a leopard briefly seen at night in headlights, fleeing from the carcass of a mammal that had been hit by a car on the Biljurashi escarpment.

Domestic animals

Livestock production is widely distributed all over the kingdom. Mixed herds of sheep and goats may number up to 500, but are more often in the order of 200 in open areas and around 100 in rugged areas. Grazing systems are extensive. Herds are left all day long to graze in natural vegetation patches and taken by shepherds between these patches, sometimes helped by sheepdogs. In the mountains they used to move along slopes of wadis. However, herds do not spend the night alone on the field anymore, but return to the camp, where they receive additional fodder like alfalfa. More than 40 years ago, people used to spend the night in the mountains and put the lambs into small stone corrals to protect them from predators (leopards, caracals, hyenas or wolves) or to prevent them suckling so as to be able to milk ewes more efficiently. Grazing rotations are walked on a daily basis, but also depend on seasons and green vegetation patches that are highly variable in the arid environment. The grazing range of a herd used to be limited by daily walking distances. However, development of roads made new temporary settlements possible in previously remote areas. Movement of herds is assisted by trucks and the expense is supported by the government (Nasser & Esber 1995). In many cases, Saudi livestock owners have other income as well as keeping livestock and let the control of flocks to Sudanese or Ethiopian shepherds.



Fig. 4. Wadi Khatan near Biljurashi. Granite boulder rocks interspersed by densely vegetated riverbeds represent a typical leopard habitat in the escarpment of the Asir Mountains (Photo J. Judas).

Legal Status

Arabian leopard is classified as Critically Endangered in the IUCN Red List, and listed in CITES Appendix I. The GCC (Gulf Cooperation Council) agreement endorsed in December 2001 included the Arabian Leopard in its policies of cross border conservation. In Saudi Arabia, hunting is restricted under the National Hunting Law, Decree No M/26 dated 25/5/1398 (2/5/1978) and decree No 457 dated 13/3/1399 (10/2/1979). Decree No M/22 from 1986 sets out NCWCD's official remit for protected areas, and Decree No 128 from 1995 concerns regulations governing a "Wildlife Protected Areas System" including selection, establishment and management of wildlife protected areas (Seddon 1996). All forms of hunting are officially prohibited in Protected Areas managed by NCWCD, but the presence of leopards has been attested from only 2 of them. A Wild Animals and Birds Hunting Act, an Act on the Trade in Endangered Wildlife Species and their Products, and an Environmental Code have been promulgated in 1999, 2000 and 2002, respectively (Mésochina, pers. comm.).

Conflicts and Public awareness

The public awareness programme aims

to induct a conservation ethic in farmers and the public. Contacts are established with local people, but on an irregular basis. NCWCD has produced posters on threatened animals of the kingdom, that are not specifically designed for the leopard conservation, but that include the species. NCWCD has developed a training centre where people (rangers, teachers etc) from Saudi Arabia or the other Gulf States can receive information and training on environmental monitoring, environmental management, and techniques of field study. A stuffed leopard is on display in the Natural History Museum at NCWCD. NWRC has produced two short video reports in relation to leopard conservation.

People and institutions

Three organisations are involved in leopard conservation in Saudi Arabia:

- The National Commission for Wildlife Conservation and Development (NCWCD) is a governmental agency, directed by Prof. Dr. A. Abuzinada, established in Riyadh in 1986 by Royal Decree No. M/22 and which has the mandate to "Develop and implement plans to preserve Wildlife in its natural ecology". The NCWCD has created two committees: The Carnivore Advisory Group (CAG) under the chairman of Dr. I. Nader and

Table 1. Origin of Arabian Leopards acquired by the NWRC

Studbook reference	Micro-chip	Name	Origin	Place of capture	Event	Date	Birth date	Sex	Age (years)
stdbk #20	00-0070-012E	Rachid	wild	Wadi Oshar (ev. Yemen)		16.05.97	~1996	M	10
					transfer to Sharjah	06.05.03			
stdbk #23	00-0070-02DF	Al-Jezira	wild	Yemen (Wa'ada)		22.07.98	~1995	M	11- 12
					transfer to Sharjah	20.11.00			
					return to Taif	05.05.03			
stdbk #28	00-01C70FD6	Lina	captive	BCEAW	birth	18.01.00	18.01.00	F	7
					transfer fo NWRC		30.04.06		
stdbk #30	00-0070-06E7	Aicha	wild	?		28.04.00	Feb-99	F	8
stdbk #46	00-01CD-B059	Kadeeja	wild	?		22.04.01	~1991	F	16
					transfer to Sharjah	06.05.03			
stdbk #49	00-01CE-3DE4	Samtah	wild	Jizan area (ev. Yemen)		21.05.02	~1999	F	8
					transfer to Sharjah	30.04.06			
stbk #57	00-060D-561D	Morkel	captive	BCEAW	birth	16.05.03	16.05.03	M	3
					transfer to NWRC	30.04.06			

supervision of the secretary General of NCWCD, Prof. Dr. A. Abuzinada, and The Arabian Leopard Working group, constituted on 7 January 1996.

- The National Wildlife Research Centre (NWRC), created in 1988 in Taif, is in charge of captive breeding and reintroduction of viable populations of houbara bustard and Arabian oryx in Saudi Arabia. A programme of leopard captive breeding (Fig. 6) and field investigations has been initiated. An Arabian Leopard Captive Breeding Working Group (ALCBWG) has been created in relation with NCWCD.

- The King Khaled Wildlife Research Centre (KKWRC) located in Tumamah, 30 km north-west from Riyadh, is mainly involved in conservation and captive breeding of gazelles and ibex. Genetic analyses of leopard samples have been initiated.

Ongoing work

Conservation strategy

On 26 February 2001, the Arabian Leopard Working Group of the NCWCD defined a conservation strategy and recognized that *in situ* conservation was the most appropriate means of protec-

ting the species, and *ex situ* captive breeding will provide a genetic backup of the gene pool (Joubert 2001).

Captive breeding

Four individuals are currently kept in NWRC and three have been loaned for breeding purpose to the Breeding Centre for Endangered Arabian Wildlife, Sharjah. In order to develop the captive breeding programme in NWRC, new facilities are under construction with private funds received from Prince Faysal bin Saud bin Mohammed al Saud. Construction of three such breeding units, totalling 9 separate cages, has been planned over 5 years as well as the setting up of a natural enclosure to rear captive-bred young in semi-captivity.

Genetic analyses

Genetic analyses have been initiated in 1998 in KKWRC with the aim of clarifying the taxonomic status of the Arabian subspecies *P. p. nimr* (Hammond *et al.* 1997). In 2000, 101 samples from 13 of the 27 subspecies have been collected, most of them from specimens in the Arabian Peninsula. First analyses focused on DNA sequencing by PCR amplification (Winney *et al.* 1999). Analyses were stopped through technical problems and lack of funding.

Field surveys

NWRC staff promptly visit places where signs of presence are reported. Field surveys and camera-trapping were con-



Fig. 5. Goat killed by a leopard in wadi Khatan. The increasing rarity of typical prey species forces leopards to prey more and more often on livestock, which reinforces conflict with local human populations (Photo J. Judas).

ducted in 2002 and 2003 in Wadi Oshar (down to Biljurashi escarpment, south of Al Baha), where sightings and signs of activity have recently been reported. Two infra-red camera traps, on loan from BCEAW, were installed from April 5 to June 8, 2002 and 3 from March 7 to May 31, 2003, totalling 338 trap nights and allowing us to obtain 396 pictures. Unfortunately, no pictures of leopards were obtained.

Recommendations

Field investigations and ecological study
Updating the status and distribution based on extensive surveys of remaining wild populations needs to be urgently undertaken. All potentially suitable sites have to be investigated. Areas where the presence of leopards has recently been reported should be targeted as priority sites for conservation.

Efficiency of conservation programmes and population management would be greatly improved with accurate knowledge of the ecology of the Arabian subspecies. Field surveys should firstly focus on population assessment using the camera trapping technique, which appears to be efficient for leopard surveys in Oman. A second step would be to gather information on the number of individuals per sub-population, to determine range use pattern, home range size, activity pattern, habitat requirements, food requirement (prey species), prey availability, relation predator-prey (such as seasonal movements of ibex and gazelles), competition with other predators (caracal, hyena, wolf), conflict with man.

The proper organization of ecological studies would require the full time appointment of at least one PhD student and/or one researcher and a team of field workers with appropriate funding. Important material means should be available to capture and mark wild animals, and conduct radio-tracking or satellite-tracking studies.

To assure long term survival of the wild populations, population viability analysis should be developed to project populations trends with regularly updated data. This would require:

- an understanding of population dynamics;
- study of dispersal rates and quantify movements between populations;



Fig. 6. Leopard's accommodation in the National Wildlife Research Center – Taif, Saudi Arabia (Photo O. Coupepy - NWRC, Taif).

- establishment of long-term monitoring with regular periodic surveys (camera trapping);
- assessment of the gene pool by determining genetic identity from blood and scats (DNA microsatellite mapping).

Socio-economic survey

Socio-economic surveys should assess the effect of leopard predation on livestock (number, species killed and economic cost). Compensation measures for kills of domestic animals should be examined, including solutions for proper identification of the causes of death, and for regular fundraising. Human activities in areas used by leopards, need to be described and quantified to modify the conservation plan.

In situ conservation: Protected Areas

Presence of leopards has been reported in only 2 protected areas, both too small to provide any efficient conservation. New key sites have to be identified and secured through establishment of new protected areas in order to assure viability of the last remaining populations. In the actual state of knowledge, we suggest concentrating conservation efforts on the Biljurashi escarpment, between Al Mikwah and Nimrah, from where the most recent records come, as well as Al Atifah area. Several areas (Wadi Aleb, Jibal Bani Yub, north of Badr, Himat Al Fiqrah) already mentioned

as potential sites for leopard conservation (Child & Grainger 1990), should receive particular attention. Minimum critical size and management plans of Protected Areas have to be carefully considered (see Judas *et al.* 2004 for suggestions). As a further step, potential sites for reintroduction, population reinforcement or translocation would have to be identified, if requested, according to the updated results of population status and distribution.

Ex situ conservation: Captive breeding

Captive breeding facilities in NWRC are currently too small to develop a captive breeding and reintroduction programme. New facilities with a large enclosed area are on the way to being implemented. This would allow us to capture remaining individuals for captive breeding and release purposes, if the population is thought not to be no longer viable. A structure or company able to help the NWRC has to be identified (Espie & Bertschinger 2001) and financial funding should be planned to assure the construction of facilities and the functioning of the project (food, veterinary care, researchers, technicians and labourers, staff training, materials). The captive breeding structure can generate some funds, through opening to visitors or by stimulating private sponsors. Captive breeding could also contribute to development of a genetic fingerprinting method for individual identification and



Fig. 7. Arabian leopard Rashid from the National Wildlife Research Centre (NWRC) in Ta'if, Saudi Arabia on breeding loan in the Breeding Centre for Endangered Arabian Wildlife, Sharjah, UAE (Photo J. Edmonds).

scat analysis of hairs for prey identification, to collect and freeze semen for genetic management of captive animals and conservation of genetic diversity, and to improve knowledge of reproduction, physiology, pathology, behaviour in captivity (Sutherland 1998, Joubert 2001).

Political support

Numerous efforts should be made at the political level to reinforce legislation, to create mechanisms of policy implementation and fund raising. All national institutions involved in land management or whose activities affect leopard conservation, have to be approached, cooperative actions reinforced and information exchange increased. Leopard conservation in Saudi Arabia also requires the support of international institutions or NGOs to intercede with local communities.

Public awareness

Public awareness programs have to be initiated and developed in "leopard areas", to involve local people in a clearly defined strategy. Brochures mentioning the high conservation profile of the Arabian leopard, its CITES position, hunting laws in force and penalties, could be distributed in schools, police stations, and shops. Development of the captive

breeding programme could be used to make the Saudi public aware of leopard conservation, and to collect funds.

Management plan & long term conservation strategy

A management plan should include benefits for local communities with replacement of activities that disrupt ecological processes by others that preserve habitats or restore them. Trade-off between social, economic and ecological interests is necessary. Protected Area management should involve local people by creating a consultative committee of local representatives for bottom-up regulation in harmony with top-down ones. The socio-economic importance of biodiversity has to be assessed to define a national programme of sustainable rural development (Child 2003). This should include maintenance of ecological productivity, a principle underlying all sustainable management plans. Efficiency of implemented measures has to be controlled (adaptive management).

Animals in captivity

Seven leopards have been acquired by the NWRC during the last 7 years (Table 1). Four are currently kept in NWRC, and three have been loaned to BCEAW in Sharjah (Fig. 7).

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Appendix 1. Leopard records in the last 5 years (1998 – 2003)

Site	Latitude	Longitude	References	Year	Reliability	Information type
Al Atifa	19.317	42.033	Paillat & Khoja 1998	1998	u	reported
Malgocta near Tanumah	18.954	42.156	Rachid Ajaj Pers. comm.	1998	u	reported
Bada	26.850	36.900	Budd 1999	1999	u	reported
Jibal Shada	19.800	41.333	Budd 1999	1999	c	livestock killed
Bada	26.850	36.900	Budd 1999	1999	u	reported
Bada	26.850	36.900	Budd 1999	1999	u	reported
Jibal Shada	19.800	41.333	Budd 1999	1999	u	reported
Jibal Ward	26.483	37.100	Joubert 2001	1999	u	reported
Al Atifa	19.317	42.033	Lagrot and Lagrot 1999	1999	c	tracks & signs
Al Atifa	19.317	42.033	Lagrot and Lagrot 1999	1999	u	reported
Samta	16.592	42.940	Paillat comm pers.	1999	c	killed
Jibal Nis	20.033	41.250	Joubert 2001	2000	u	reported
Wadi Khatayn	19.705	41.671	J. Judas	2002	c	tracks & signs
Marbble village	19.924	41.437	J. Judas	2002	u	reported
Tallan, wadi dava	17.390	43.170	Rachid Ajaj Pers. comm.	2002	u	reported
near Jibal Shada	19.683	41.433	Rachid Ajaj Pers. comm.	2002	u	reported
Jibal Nahr	26.042	38.141	Rachid Ajaj Pers. comm.	2002	u	reported
Wargan	22.584	39.668	Rachid Ajaj Pers. comm.	2002	u	reported
Jibal Kabkab	21.418	40.108	Rachid Ajaj Pers. comm.	2003	u	reported

u: unconfirmed record, c: confirmed record

Status Report on Arabian Leopard in Yemen

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The assumption that the historical range of the leopard in Yemen formerly extended through all or most of the mountainous areas of the country seems to be reasonable. Since 1990 reports on the occurrence and distribution of the Arabian leopard in Yemen are generalized, and all post 1990 records can be grouped in five broad clusters. 1. The northern part of the western highlands (Wada'a, Saada to the Saudi border and Kuff Shammar in Hajja). 2. The central part of the western highlands (Al Hayma, Jebel Bura'a and Jebel Raymah). 3. South western region (Radfan to Al Koor and possibly extending west to Taizz). 4. Central Yemen (Wadi Hajar, possibly with Wadi Hadhramaut). 5. Al Mahra region in the East.

Due to lack of sufficient information on various aspects of the leopard's life in Yemen, extensive field work is urgently needed to assess the status of this animal. Since the animal is facing great threat, strict protection measures are urgently needed. Major threats to leopards include 1. depletion of their prey, 2. direct persecution through killing, 3. habitat degradation. Immediate action to control these threats are needed, priorities are: 1. Establish the current status of the leopard and its prey. 2. Provide effective protection for the Arabian leopard and its prey. 3. Take immediate protection measures once surveying sub-populations are identified. 4. Set up an Arabian Leopard Working Group to develop a conservation strategy. 5. Develop a good captive breeding programme. 6. Initiate long term education and public awareness. 7. Strongly discourage further live capture and hunting.

إن الافتراض بأن انتشار النمر العربي في اليمن قد امتد في كل أو معظم المناطق الجبلية يبدو أمراً مقبولاً. فجميع تسجيلات تواجد وانتشار النمر العربي التي ظهرت في التقارير منذ العام 1990 هي معلومات عامة، أما التسجيلات التي ذكرت بعد 1990 فيمكن وضعها في خمس مجموعات رئيسية. 1- المنطقة الشمالية للمرتفعات الغربية (وادعة وصعدة امتداداً إلى الحدود السعودية ووصولاً إلى قفل شمر في حجة). 2- الجزء الأوسط من المرتفعات الغربية (الحيمة وجبل برع وجبل ريمة). 3- المنطقة الجنوبية الغربية (من ردفان إلى الكور مع احتمال امتدادها غرباً إلى تعز). 4- المنطقة الوسطى (وادي حجر ومن المحتمل وادي حضرموت). 5- منطقة المهرة التي تقع شرق البلاد.

نظراً لعدم توفر معلومات كاملة عن مختلف جوانب حياة النمر العربي في اليمن فإن الحاجة ملحة للقيام بدراسات حقلية لتحديد الوضع الحالي لهذا الحيوان. ونظراً لأن النمر يواجه تهديدات كثيرة فإن هناك حاجة ملحة لاتخاذ التدابير اللازمة لحمايته بالسرعة القصوى، وتشمل التهديدات الرئيسية ما يلي: 1- اصطياد الحيوانات التي يتغذى عليها النمر في الطبيعة، 2- القتل المباشر للنمر، 3- تدهور البيئات التي يعيش فيها. وللسيطرة على هذه المهددات بالسرعة المطلوبة فإنه يجب تطبيق الأولويات الآتية: 1- تحديد الوضع الحالي للنمر وفرائسه. 2- توفير الحماية له وللحيوانات التي يفترسها. 3- اتخاذ سبل الحماية الضرورية بمجرد تحديد تجمعاته الثانوية. 4- إنشاء مجموعة عمل من المتخصصين لوضع استراتيجية الحماية. 5- تطوير برامج الإكثار في الأسر. 6- البدء ببرامج تعليم وتوعية بعيدة المدى. 7- عدم التشجيع باصطياده.

Status and Distribution

Information on the historical distribution of leopards *Panthera pardus nimr* in Yemen is sparse and fragmentary, with only a small number of specific records. Nevertheless, it is generally assumed that the historical range of the leopard in Yemen extended through all the mountainous areas of the country, from the Saudi border south along the

western escarpment, then east to the border with Oman. The linear distance measures around 500 km from north to south and a further 900 km from east to west and represents a potentially extensive area of former range.

Some reports relate to skins purchased in markets that have only a vague place of origin. Caution is additionally needed

because skins and live animals of many species have traditionally been imported from northeast Africa into Yemen. For example Hunter (1877) referred to leopard skins imported into Aden for sale to ship passengers. Morrison-Scott (in a footnote to Thesiger 1949) said that two Arabian leopard skins he examined were 'a good match' for one from So-

malia, so differentiating skins of Arabian leopards from those originating in northeast Africa may be difficult.

Harrison (1968) quoted an early sight record in 1843 and listed four specimens obtained at localities north and northeast of Aden. These were: west of Beihan; Jebel Dasha near Dhala; Mahfid; and the Aulaqi Kaur. In the same general area, Bury (1911) reported hearing a leopard in Wadi Hatib, between Nisab and Dathinah. Thesiger (1949) observed leopard tracks in Wadi Makhya, north of Wadi Hadhramaut. Scott (1942) saw a captive animal in Sana'a and obtained a skin said to have been procured locally; he also mentioned a leopard recently captured in the vicinity of Ta'iz. Sanborn & Hoogstraal (1953) described leopards as 'scarce but widespread' in the highlands of western Yemen, and Harrison (1968) said this also applied to their status in the mountains north of Aden.

Obadi (1993a, b) said that leopards occurred from Habil Jabr, east of Radfan, to the Al-Kaur mountains in Abyan province and reported that 22 leopards had been killed there during 1979-86 by villagers around Lawdar. This area described covers about 180-200 km, east to west, and lies north-east and east of Aden. Some of the specimens listed by Harrison (1968) were also obtained in this region.

Evans (1994) said that leopards were rare in the hills surrounding Wadi Hajar in central-southern Yemen. Jennings (1997) reported four leopards shot in the previous few years in southern and eastern Yemen, without giving detailed localities.

El-Mashjary (1995) and Lagrot & Lagrot (1999) provided recent records from Wada'a, an area situated about 120 km north of Sana'a and containing 20 villages, the largest of which is Al-Gasem (16°00'N/43°57'E, 2,380 m). Leopard records consisted of field signs, livestock killed and leopards trapped. Several leopards have been captured subsequently in Wada'a, the latest one in early 2005 (Galal Al Harogi pers. comm.), indicating continued occurrence there.

Recent survey work carried out by one of the authors [AKN] in Bura'a protected area found no signs or local reports of leopards. A field survey in

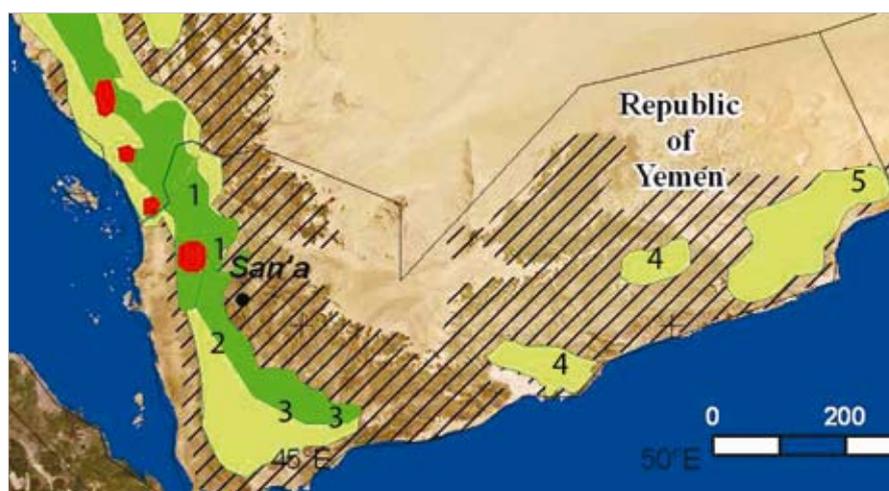


Fig. 1. Distribution of Leopards in the Republic of Yemen. For the numbers in the map, see text.

May 2005 in part of Wadi Hadhramaut revealed that the last leopard had been shot about 15 years earlier and some local people who were questioned did not know the animal (EPAA 2005).

According to local reports collated by the Environmental Protection Authority in Sana'a, leopards are present in seven localities: between Sa'dah and the northern border with Saudi Arabia; Kufi Shammar, in Hajjar Governorate; Al Hayma, east of Manakhah; Jebel Bura'a and Jebel Raymah; between Ta'iz and Aden; Hadhramaut; Al Mahra.

It is difficult to give an accurate summary of current leopard status in Yemen, given the absence of recent survey data. However, all the above post-1990 records and reports can be grouped into five broad geographical clusters (Fig. 1):

1. The northern part of the western highlands (Wada'a, Kufi Shammar, and the area between Sa'dah and the Saudi border).
2. The central part of the western highlands (Al Hayma, Jebel Raymah, and possibly Jebel Bura'a).
3. Southwest Yemen. This comprises the area from Radfan to Al Kaur, as described by Obadi (1993a, 1993b), and possibly extending northwards to mountains in the vicinity of Ta'iz. It is possible that some of the captive leopards held in Ta'iz zoo came from a nearby locality.
4. Central-southern Yemen (Wadi Hajar and Hadhramaut). It seems likely that leopards have been extirpated

from the central part of Hadhramaut. However, the lower part of this huge wadi system, Wadi Masilah, has not yet been surveyed for large mammals. It is remote, largely uninhabited and contains a 130-km long stretch of flowing water (F. Krupp, pers. comm.). There is also no recent information from the wadis north of Hadhramaut such as the area around Minwakh and Zamakh where ibex are reported to be present.

5. Al Mahra, in eastern Yemen. Hauf Forest and nearby mountains share similar habitat to that in the adjacent mountains of Dhofar. Leopards have been recorded in Oman within a few kilometres of the border (Spalton *et al.* 2006) and ibex are reported to occur on the Yemen side (Evans 1994. Showler 1996).

However, the above reports vary in data quality and may be out of date. It is likely that some or even many of these sites no longer hold leopards, or that only small remnants survive. In fact, the only site where leopard presence has been definitely confirmed during the last two years is Wada'a. This is a relatively small area and one where leopards have been regularly trapped. Un-notified trapping must surely at least equal the number of reported cases. Removal of animals from the wild, either live captured or killed, cannot be sustained indefinitely. Field work is urgently needed to assess the status of leopards in each of these areas and the extent of isolation between them.



Fig. 2. Wadi Hadhramout in Yemen (Photo P. Vercammen).

There are no estimates of past or present numbers, but the population is generally considered to be small and fragmented. The few published sources agree that leopards are rare in Yemen. El-Mashjary (1995) said that large mammals had been seriously depleted during the 20th century and that leopards were rarely seen. Stuart & Stuart (1996) suggested that leopard numbers were very low. Al-Jumaily (1998) said that leopards could be close to extinction. The current population trend is assumed to be declining, based on reductions in prey species and the scarcity of reports.

Threats

The major threats to leopards in Yemen are direct persecution and depletion of the prey base through uncontrolled hunting. Firearms are widely available, wildlife is heavily hunted and populations of all large mammals have declined in recent decades (Varisco *et al.* 1992, El-Mashjary 1995, Al-Jumaily 1998, UNDP/UNEP/GEF 2001).

Leopards are killed and trapped by livestock owners in some areas. Obadi (1993a, 1993b) reported that villagers in the Lawdar area had killed 22 leopards during 1979-86 in retaliation for attacks on goats and he saw skins of five leopards. He also reported that people in Umdrib village had killed three

leopards during one night in June 1983. These were presumably a female with two cubs. Figures from Wada'a are divergent. El-Mashjary (1995) said more than 100 leopards had been trapped by shepherds in Wada'a over the previous 20 years to protect their livestock, while Lagrot & Lagrot (1999) quoted the local sheikh as saying that 10 leopards (9 males, 1 female) had been caught during the last 10 years. Leopards are captured in stone traps called *margaba*. The traps resemble an igloo in shape, 120cm high and 200cm long, with a long flat stone suspended above the entrance by a rope, which is attached to a piece of meat at the far end of the trap. Eight traps were sited at the top of a cliff above the wadi, and close to the inhabited area. Some of the leopards caught in this area have ended up in captivity, while others have been killed; their fat and skin may be used as medicine against rheumatism and skin disease (El-Mashjary 1995, Lagrot & Lagrot 1999). Leopards are still being captured here occasionally including one in spring 2005.

There has been a tradition of exhibiting captive leopards in towns in Yemen. Hunters still occasionally catch leopards for trade purposes and according to anecdotal reports, the price for a captive Arabian leopard may have risen to US\$15,000. Three leopards from

Yemen were sold in Saudi Arabia in 2001 (Judas *et al.* 2006). It is impossible to estimate accurately the number of leopards captured and sold or exported. Increasing public awareness work may be having some effect in limiting the extent of illegal killing and live capture.

Habitat degradation and destruction also affect much of the country. Overgrazing, unrestricted cutting of forests and scrub for fuel and building, and a growing human and livestock population increasingly impact upon the environment and pose a threat to terrestrial biodiversity in general (Varisco *et al.* 1992, UNDP/UNEP/GEF 2001).

As sub-populations become smaller and more isolated, movement of individuals between them, and thus gene flow, is increasingly restricted and dispersal distances grow larger. Such demographic factors will gain in significance as leopard numbers become further depleted.

Habitat

The western mountains extend for over 500km from north to south and parallel to the Red Sea. These mountains rise steeply from the Tihamah coastal plain and contain many peaks over 3,000 m in elevation, including Jabal al-Nabi Shu'ayb (3,666 m), the highest point on the Arabian Peninsula. The central part of the range consists of hills and basins at altitudes of 2,000-2,750 m that fall away gradually on the eastern side to the desert interior. The western escarpment is intensively cultivated, usually by means of extensive terraces and it is cut by numerous, deep valley systems. The seven largest wadis contain water throughout the year and are partially wooded with trees and shrubs such as *Cordia abyssinica*, *Breonadia salicina* and *Ficus* species (Scholte 1992). Wadi Rijaf has luxuriant riparian forest with trees up to 20m including species of *Ficus*, *Mimusops*, *Tamarindus*, and *Trichilia* (Cowan 2004). The mountains become more rounded to the south around Ta'iz. Natural vegetation here has been extensively degraded, but some *Euphorbia ammak* scrub occurs in the southern part of the escarpment (Cornwallis & Porter 1982) and a few pockets of juniper woodland (*Juniperus* spp.) remain, for example on Jabal Iraf, between Aden and Ta'iz (Martins 1996).

Wada'a, in the northern part of the western highlands was described by Lagrot & Lagrot (1999) as a dry, rocky mountain with two wadis several kilometres apart and covering about 600 km². El-Mashjary (1995) said the area contained 20 villages and a steep rocky gorge.

A series of arid mountains, hills and plateaux extends across southern Yemen. Rugged hills and mountains with peaks above 2,000 m run eastwards along the interior of southern Yemen to the northeast of Aden. An extensive, barren desert plateau, around 1,000-1,200 m in elevation, the *jol*, extends eastwards from Shabwa, dropping away northwards to the sands of the Rub al Khali. This plateau is deeply dissected by a complex series of wadis, some of which contain permanent water. The longest and most extensive of these is the Wadi Hadhramaut-Wadi Masilah system, which runs west-east then southeast into the Gulf of Aden. Former leopard habitat in Wadi Hadhramaut consists of deep wadis incised into the plateau with long stretches of cliff and blocks of fallen rock. Drier slopes hold a sparse vegetation of *Acacia* spp., *Lycium shawii*, *Zizyphus* spp. In the wadi beds a few permanent fresh water pools and springs occur along with pools of a temporary nature: location and duration of the latter vary with rainfall. These are surrounded by groves of trees including figs (*Ficus salicifolia*, *F. populifolia*) and date palms *Phoenix dactylifera*. Hauf Forest in Al Mahra Governorate is dominated by *Anogeissus dhofarica*, *Commiphora habessinica* and *Adenium obesum* (Martins 1996).

Forest cover in general was once much more extensive than at present, but trees have been systematically cut down for fuel over the centuries, and forests are now almost absent, except for the 30,000 ha Hawf Forest in Al Mahra and 4,100 ha Bura'a Forest in Al Hudaidah. Scattered *Acacia* and *Commiphora* savanna woodland occurs sporadically along the coast and in some inland areas, but rapidly thins out eastwards into the desert.

The climate is generally hot, though modified by altitude. Frost and snow are not uncommon in winter at high elevations (Cornwallis & Porter 1982). Precipitation may reach 650 mm annually in the western highlands, with rainy

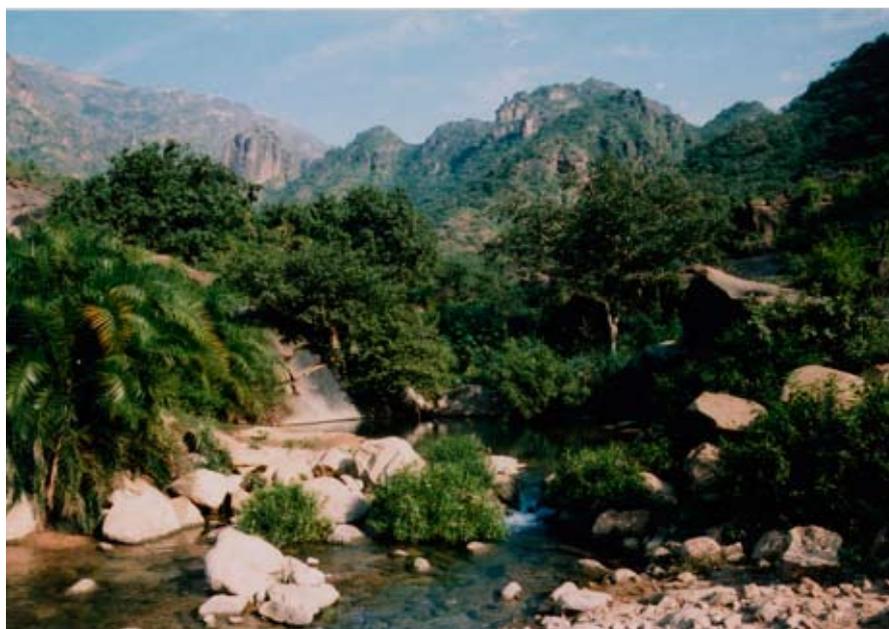


Fig. 3. Bura'a in the western mountains of Yemen (Photo A. K. Nasher).

periods in spring and summer. Southern and eastern Yemen are much hotter and more arid, except for the extreme east where there is a short summer rainy season.

Prey Species

There is no information on leopard diet in Yemen but several potential prey species occur. Nubian ibex *Capra nubiana* have a scattered distribution in southern and eastern Yemen (Al-Jumaily 1998, Evans 1994, Showler 1996, UNDP/ UNEP/GEF 2001). However, as long ago as 1915 the ibex was considered rare and had already disappeared from some areas of former range (Harrison 1968). Ibex are still distributed across southern Yemen but numbers have been depleted by hunting. In Hadhramaut there is a long tradition of ibex hunting and horns are traditionally placed on the corners of houses. Ibex are still present in Hadhramaut but numbers have fallen to low levels. Mountain gazelle *Gazella gazella* is the only widespread gazelle species whose range overlaps that of the leopard to a significant degree. Arabian sand gazelle *Gazella subgutturosa marica* prefers sand dune habitats and has only been recorded in the north and northeast, so its range is unlikely to overlap that of the leopard. Two other species, *Gazella bilkis* and *G. saudiya*, are extinct. All gazelle populations in Yemen have been severely depleted

by overhunting (Mallon & Al-Safadi 2001).

Hamadryas baboons *Papio hamadryas* occur in the western mountains and highlands northeast of Aden (Harrison & Bates 1991, Al-Jumaily 1998). However, it has not yet been established that Arabian leopards, which are very small in size for this species, actually prey on baboons. Gasperetti *et al.* (1985) observed that baboons living in social groups would be a formidable prey, and suggested that leopards would only be able to take them on rare occasions when an individual baboon became isolated.

Several medium-sized mammals that were recorded in leopard diet in southern Oman by Muir-Wright (1999) are widely distributed in Yemen: Rock hyrax *Procapra capensis*, Cape hare *Lepus capensis*, porcupine *Hystrix indica*, and hedgehogs *Paraechinus aethiopicus* and *P. hypomelas* (Harrison & Bates 1991, Al-Jumaily 1998). Small carnivores could in theory also form part of leopard diet. Species available in Yemen comprise golden jackal *Canis aureus*, three species of foxes *Vulpes vulpes*, *V. rueppellii*, *V. cana*; three cats *Felis silvestris*, *F. margarita*, *Caracal caracal*; honey badger *Mellivora capensis*; two mongooses *Bdeogale crassicauda*, *Ichneumia albicauda*, and one viverrid *Genetta felina*. All apparently occur at low densities (Harrison & Bates 1991,



Fig. 4. Rock hyrax have been identified as leopard prey. They are widespread in Yemen (Photo Ch. Breitenmoser-Würsten).

Al-Jumaily 1998) and some do not occur in leopard habitat. It is also unclear whether these species could form a significant part of the diet or whether they would only constitute an occasional prey item. Potential prey also includes birds such as partridges *Alectoris philbyi*, *A. melanocephala* and *Ammoperdix heyi*, sandgrouse *Pterocles* spp. and other ground-living birds, as well as larger reptiles such as *Uromastyx* spp. Leopards are known to prey on livestock but there are few details on the frequency of attacks or extent of depredations.

Domestic Animals

Livestock are an integral part of the rural economy. Sheep and goats are kept everywhere, with smaller numbers of camels, donkeys, and horses. Camels are more frequent in the south and drier parts of the interior. Leopards are known to prey on livestock on occasion but there are few details on the frequency or the impact of these attacks. There are no analyses to show the extent of leopard predation on domestic animals.

Local people in Wada'a said that leopards began to attack livestock once gazelles disappeared, about 20 years previously, according to El-Mashjary (1995). They used to take 3-4 goats a month, but on one occasion a leopard killed 45 goats in a single attack. (Obadi (1993a, b) reported retaliatory killing of leopards by shepherds in the Lawdar

area. There is no government compensation scheme for livestock losses, though at least one local leader is reported to operate a private scheme. Numbers of domestic animals are increasing, along with the human population.

Legal Status

The leopard and its prey species are legally protected, but enforcement is weak or lacking, especially in remote areas. Several protected areas in Yemen have been proposed and two are being implemented (UNDP/UNEP/GEF 2001). Wadi Rijaf PA in the western highlands contains hamadryas baboon, porcupine and striped hyena, but leopards probably no longer occur (Cowan 2004). Bura'a Protected Area is also situated in the western highlands. Hawf Forest on the eastern border may contain leopards but their presence needs confirmation. An ibex reserve has been proposed in Wadi Hadhramaut, where leopards were last recorded up to 15-20 years ago.

Conflicts and Public Awareness

Some villagers believe that leopards pose a threat to their livestock and El-Mashjary (1995) quoted local people in Wada'a as saying that leopards are aggressive and dangerous.

Work to raise awareness of the plight of the leopard is increasing. Several posters on various aspects of Yem-

en's biodiversity including leopards and prey have been produced by the Sharjah Environment and Protected Areas Authority (EPAA) and distributed in cooperation with the Environmental Protection Authority.

People and Institutions

The Environmental Protection Authority (EPA) is the government agency responsible for co-ordinating wildlife research, environmental education and legislation. The Biology Department of the University of Sana'a has conducted some mammal surveys of Yemen. NGOs involved in the conservation of wildlife include the Yemeni Biological Society, established in 2001, and the Yemen Society for the Protection of Wildlife (or Wildlife Yemen), founded in 2002.

Ongoing Work

EPA collects local reports of leopards. A programme of cooperation between EPA and EPAA Sharjah has included production of publicity materials, assistance with captive breeding, field surveys and training. A preliminary investigation of Hauf Forest by a joint Yemeni-Omani team took place in May 2006 and further work is planned.

Nine leopards are currently held at Sana'a and Ta'iz zoos. Breeding took place at both zoos in 2003 but the young died in both cases, as well as one adult in Sana'a. Successful breeding took place at Sana'a zoo in 2004. Veterinary assistance and management advice and training have been provided to Sana'a Zoo by the Breeding Centre for Endangered Arabian Wildlife, Sharjah. Some captive animals have been sent from Sana'a to BCEAW to take part in the captive breeding programme, and are entered in the international studbook.

Recommendations

Action is needed at all levels to conserve the Arabian leopard and its prey in Yemen. The highest priority for action is a programme of field surveys to establish current distribution and status. This information is fundamental to the development of a comprehensive conservation programme.

Field surveys

- Investigate at the earliest opportunity the current situation in Wada'a, the

only site where leopards are known to exist at present. Information required includes basic habitat parameters; numbers of leopards trapped; the frequency of attacks on livestock. Protection measures and awareness-raising activities should be instigated to stem further losses from the wild population.

- Conduct rapid assessment surveys in all areas where leopards have been recently reported (see above). Follow up with more detailed surveys where positive indications of leopard presence are found. Surveys should utilise the full range of field techniques to accelerate data collection: sign surveys (tracks, scrapes etc), molecular scatology, camera trapping, structured local interviews as appropriate.
- Take immediate protective measures once any surviving sub-populations are identified.
- Provide a training programme in field techniques for local rangers and staff, backed up by written materials (i.e. a basic survey handbook).

Captive Breeding

- Develop the captive breeding programme in line with the best international standards.
- Extend training in captive management and veterinary techniques to Ta'iz Zoo.
- Integrate all leopards currently in captivity, notably those in Ta'izz, into the international captive breeding programme.

Education and Awareness

- Develop a long-term education and public awareness programme through schools, posters and the media.
- Strongly discourage further live capture and hunting through all possible measures.

Ecological Research

- Collect and collate information on home range size, habitat use, dispersal, diet.

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Fig. 5. Bura'a in the western mountains of Yemen (Photo Abdul Karim Nasher).

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Status Report for the Arabian Leopard in the Sultanate of Oman

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Once widespread in the mountains of Oman the Arabian leopard disappeared from the Hajar range in 1976 and has not been recorded in the Musandam Governorate since 1997. However, it continues to survive through much of the Dhofar Mountains.

The first significant step to conserve the Arabian leopard was taken in 1985 when the region's first captive breeding group was established. Further important steps were taken in 1997 when Jabal Samhan, a part of the Dhofar Mountains, was declared a Nature Reserve. In the same year the Arabian Leopard Survey was launched and since that time field surveys, camera-trapping and tracking of leopards fitted with GPS satellite collars has not only revealed vital information on the ecology of this species but has helped to keep this flagship species in the public eye.

While new work, from ecotourism initiatives to molecular scatology, is underway further bold steps need to be taken if we are to conserve Oman's and perhaps the regions' last wild Arabian leopard population. Undoubtedly the most important of these is to urgently safeguard the leopards and associated biodiversity of Jabal Samhan Nature Reserve with innovative measures that bring real benefits to the local people.

تقرير حول وضع النمر العربي في سلطنة عمان

ملخص

عاش النمر العربي في الماضي في مختلف السلاسل الجبلية لسلطنة عمان. وفي عام 1976م اختفى من سلسلة جبال الحجر، كما لم تسجل له مشاهدات في محافظة مسندم منذ عام 1997م. ومن يمن الطالع أنه لا يزال يعيش في معظم جبال ظفار حتى اليوم.

تم اتخاذ أولى الخطوات لصون النمر العربي في سلطنة عمان في عام 1985م بتأسيس أول مجموعة من النمر المراباة في الأسر. كما اتخذت خطوات هامة أخرى في عام 1997م حيث تم الإعلان عن جبل سمحان الذي يمثل جزء من جبال ظفار كمحمية طبيعية. كما تم في نفس العام تدشين مسح النمر العربي حيث تم منذ ذلك الحين إجراء مسوحات ميدانية وتصوير النمر بالكاميرات فحية والإمساك ببعض النمر وتطويرها بأطواق محتوية على أنظمة ملاحية فضائية عن طريق ارتباطها لاسلكيا بالأقمار الاصطناعية، الأمر الذي وفر معلومات أساسية حول أيكولوجية النمر العربي وساعد في توجيه الأنتظار نحو هذا الحيوان البري النادر.

في حين يتضمن العمل الحالي مبادرات للسياحة البيئية ودراسة جزيئات براز النمر، إلا أن الأمر لا يزال بحاجة إلى اتخاذ المزيد من الخطوات الجريئة إذا ما أردنا المحافظة على آخر تعداد للنمر العربية في السلطنة وربما في المنطقة بوجه عام. ولاشك بأن أهم هذه الخطوات هي الإسراع في تأمين الحماية للنمر والتنوع الأحيائي المصاحب في محمية جبل سمحان الطبيعية مع الأخذ بعين الاعتبار وضع تدابير خلاقة تعود بالنفع على السكان المحليين.

Taxonomy and nomenclature

Specific name: *Panthera pardus*, Linnaeus 1758. Subspecific name: *Panthera pardus nimr*, Hemprich & Ehrenberg 1830. Other names: nimr (Arabic throughout Oman, including Katheeri and Shuhi), aqeydhar (Sahil Al Jazir, Central Region (Jenebi)), qeydhar (Jebali and Mahri).

Status, distribution and development

Detail of distribution records given in Appendix A. In northern Oman leopards once occurred in the massive Hajar range (Harrison 1968) and it is likely they were widespread. However, few records exist and the last confirmed report was of a dead animal in 1976 near Rustak. Today the leopard is considered to be absent from the Hajar range (Anon 1997).

In the Musandam Peninsula there was a spate of reports of illegal killings of leopards in the late 1970s and early 1980s. In 1980 alone eight leopards were reported killed by local shepherds. Further killings occurred in the 1990s, the most recent record is of two leopards caught in a leghold trap and then shot, by citizens from outside Oman, on Omani territory in October 1997. There are no confirmed sightings since that time although there have been reports of further killings in adjacent territory of the United Arab Emirates (UAE) as recently as 2001 (Jongbloed 2001). Recent camera-trapping projects in the UAE have not been successful (CBSG 2002). Illegal hunting and illegal persecution by local shepherds have probably been the main contributors to the demise of the leopard. If the leopard is still present in Musandam and the northern Emirates then numbers are likely to be in single figures (CBSG 2002).

In the Dhofar Mountains the presence of leopards was recorded by Thomas (1932) and Thesiger (1949). Founders for the first captive breeding group of Arabian leopard, established at the Breeding Centre for Omani Mammals in Muscat, were caught in Jabal Samhan in 1985 (Usher-Smith 1985). In 1995 David Willis succeeded with camera-traps to photograph leopards in Jabal Samhan and during the years 1997-2000 the Arabian Leopard Survey recorded 17 individuals using camera-traps (Fig. 2; Spalton & Willis



Fig. 1. Historical (hatched), confirmed (red) and possible (green) occurrence of Arabian leopard in Oman.

1999, Spalton *et al.* 2006). Since 2000 an ongoing programme of camera-trapping and satellite tagging of leopards has confirmed the continuing presence of leopards elsewhere in the mountains of Dhofar, from Salalah west to the border with Yemen (Office of the Adviser for Conservation of the Environment [OACE], unpubl. data). Illegal killing by local shepherds is probably the primary threat to leopards in Dhofar.

Habitat

While we do not know what constitutes prime habitat it is likely that the woodlands, scrub and grasslands of Dhofar were once, and still may be, the best habitat for leopards. Woodland, dominated

by *Anogeisus dhofarica*, predominates on many parts of the steep south-facing escarpment of Jabals Qara and Qamar. The canopy is relatively open and ground cover is good. Above the woodlands are tall grasslands, which cover the plateau (Reade *et al.* 1980). While neither the woodlands nor grasslands support medium or large sized wild herbivores the areas do support smaller species such as rock hyrax *Procapra capensis jayakari* and although not documented smaller mammals, birds and reptiles are likely to be widespread. However, these areas also have the greatest density of people and domestic stock that has led to rapid degradation of these habitats over the last 20 years (Ghazanfar 1999).



Fig. 2. Leopard pair camera-trapped in Jabal Samhan Nature Reserve (Photo A. Spalton).

Today the best habitat for the leopard is likely to be the Acacia dominated scrub of the southern escarpment of Jabal Samhan (Fig. 3) and the semi-desert of the interior and northern aspects of Jabals Samhan, Qara and Qamar that lie outside the monsoon area. Here herbivores including Nubian ibex *Capra ibex nubiana* and Arabian gazelle *Gazella gazella* still survive and densities of people and livestock are low (OACE, unpubl. data). The declaration of Jabal Samhan as a Nature Reserve has increased the level of protection of the leopard and its habitat.

The mountains of northern Oman (Musandam and the Hajar range) must today be considered to be marginal habitat for the leopard. Although the Arabian tahr is still relatively common in the Hajar mountains (Insall 1999) other herbivores, particularly the gazelle, have gone from many areas. Hyraxes are not found in northern Oman and thus medium sized prey species are virtually absent. Over-browsing and grazing by goats and feral donkeys has degraded the vegetation as has clearing for houses and road building in recent years (Ghazanfar 1999).

The only protected area within the range of existing leopard populations is Jabal Samhan Nature Reserve (NR). Declared by Royal Decree in 1997 it covers 4,500 km². Rangers of the Ministry of Regional Municipalities, Environment & Water Resources (MRMEWR) operate within the reserve.

Prey species

A provisional study by Muir-Wright (1999) of 74 leopard scats collected in Jabal Samhan NR found the following 9 prey groups, given here in decreasing order of importance: - Arabian gazelle, Nubian ibex, Cape hare *Lepus capensis cheesmani*, rock hyrax, birds, Indian crested porcupine *Hystrix indica*, Ethiopian hedgehog *Paraechinus aethiopicus*, small rodents and insects. Since 1999 a further 200 scats have been collected and pooled with the existing 74 scats for a further analysis by the University of Aberdeen. Results have yet to be published.

Ibex were the most frequently recorded ungulate during three years of camera trapping work of the Arabian Leopard Survey in Jabal Samhan (Fig. 4). They were found throughout the wadis and high plateau but were not recorded on the face of the southern escarpment (Spalton et al. 2006). Ibex are also present in the dry areas of Jabal Qara and Qamar (MRMEWR, unpublished records). However, nothing is known of any population trend. Gazelle were also recorded in Jabal Samhan although only on the high plateau. Hyrax, porcupine and hedgehog were recorded in Samhan and except for hedgehog have also been camera-trapped in Jabal Qamar. Hyrax colonies are seen throughout the Dhofar mountains in spite of the fact that they are still hunted for their meat in Jabals Qara and Qamar (OACE, unpubl. data). Arabian red-legged partridge *Alectoris*

melanocephala, small rodents and reptiles are ubiquitous in the Dhofar mountains.

The Arabian leopard, like the African leopard, is likely to be an opportunist and may on occasions take other species such as Blanford's fox *Vulpes cana* and African small-spotted genet *Genetta felina grantii* although scat analysis found no supporting evidence (Muir-Wright 1999). Similarly leopards in Jabal Samhan might also take goats, young camels and young donkeys while to the west (Jabals Qara and Qamar) cattle might occasionally be preyed upon.

Domestic animals

The peoples of Jabal Qara and Qamar have traditionally herded cattle on the mountain pastures as a form of livelihood (Reade *et al.* 1980). Numbers were limited by natural factors such as the absence of perennial water, the need to provide food supplement (dried sardines) during winter months and the presence of biting flies during the monsoon (Lawton 1978). These coupled with the management of stock on a tribal basis prevented numbers from exceeding the carrying capacity of the Jabal. The peoples of Jabal Samhan traditionally raised camels and goats. The increased availability, after 1970, of services such as veterinary care, subsidized feed, improved water supplies and new sources of income that allowed the purchase of additional animals catalysed rapid increases in livestock numbers and particularly in numbers of camels (Zaroug 1983). The main perceived problem is the intrusion of camels into cattle grazing areas, not just seasonally but throughout the year (Morris 1986). While cattle and goats still tend to be corralled at night time, camels are not and are thus on the jabal year round and 24 hours a day. During the monsoon cattle are corralled during daytime, because of biting flies, and thus are grazed and watered at night.

Sale in Reade *et al.* (1980) reported, "...leopards do kill domestic stock and are thus a menace to pastoral people...". This is likely to be the case and many, if not most, people consider the leopards a threat to their domestic stock. However, nothing is known of the frequency that leopard actually take livestock. The likelihood of livestock predation is gre-

atest in Jabals Qara and Qamar where camera trapping and satellite tracking has shown leopard ranging close to settlements and in areas of high density of domestic stock (OACE, unpubl. data). In 2001 and 2002 local people reported leopard to have killed camels in an area of Jabal Qamar (A. S. Bait Said, unpubl. data). Camera trapping in the same area in 2002 proved that leopards were indeed present as were caracal *Caracal caracal schmitzi*, striped hyaena *Hyaena hyaena sultana* and Arabian wolf *Canis lupus arabs* (OACE, unpubl. data). In Jabal Samhan there was no evidence of domestic species in the diet of the leopard (Muir-Wright 1999).

Legal status

In Oman the leopard is protected from hunting and capture (Ministerial Decision 101/02, Royal Decrees 111/96, 75/98, 114/2001 & 6/2003). Under Royal Decree 6/2003 the penalty for hunting or capture of leopard, an Appendix 1 species, is imprisonment for not less than six months and not exceeding 5 years and a fine not less than R.O. 1000 and not exceeding R.O. 5000.

Of the key prey species of the leopard the Arabian gazelle and Nubian ibex are all also on Appendix 1 of Royal Decree 6/2003. All other species are also protected by law and are listed on Appendix 2 of Royal Decree 6/2003.

Red List status is as follows: Global: CR C2a (IUCN 1996a). National: CR D, C2a (Terrestrial Mammal Group, Directorate General of Nature Conservation, MRMEWR).

Protection status: Global: CITES Appendix 1 (IUCN 1996b).

Conflicts and public awareness

The primary conflict is that the leopard



Fig. 3. Woodland habitat of the Dhofar mountains (Photo A. Spalton).

will on occasions take domestic animals. The frequency of such livestock killing is unknown and in many cases the leopard is probably often blamed for kills by wolves and more often for livestock losses where no clear cause can be identified. Nevertheless the general and widely held view is that the leopards prey upon domestic stock. The knowledge that the leopard is protected has led local people to request compensation from the concerned government bodies. There is no scheme for compensation at this time and this issue is itself a source of potential conflict. The recruitment of rangers from areas within the range of the leopard by the MRMEWR has helped gained some support for conservation efforts. The establishment of Jabal Samhan Nature Reserve has led to little conflict in resource use since few local people enter the reserve. However, the-

re is a need to manage the activities of frankincense harvesters in the reserve. Public awareness programmes have been carried out by MRMEWR and OACE locally and nationally. At a national level numerous brochures, booklets and other materials have been published and distributed. In 2001 and 2002 MRMEWR public relations staff accompanied by rangers visited six schools in the areas around Jabal Samhan Nature Reserve and in Jabals Qara and Qamar. At each school they gave presentations to the children on the wildlife of Dhofar with particular emphasis on the leopard. Similar presentations have been made to two gatherings of local people in Jabal Qamar. A booklet on Jabal Samhan Nature Reserve was printed in 2001 and distributed to the general public.

The Office of the Adviser for Conservation of the Environment (OACE) produced a short video documentary, a booklet, a poster and six information panels on the work of the Arabian Leopard Survey in Jabal Samhan Nature Reserve. This material was exhibited at a forum on Desertification held in Salalah in March 2002 and at the annual Khareef Festival since 2004.

People and institutions

The primary authority for conservation of Oman's wildlife is the MRMEWR, and in particular the Directorate General for Nature Conservation in Muscat

Table 1. Specimens of Arabian leopard kept at the Oman Natural History Museum.

Accession No.	Description	Origin
ONHM 135	Complete	Musandam 1981
ONHM 503	Complete	Jabal Samhan 1985
ONHM 1064	Skull	Musandam 1980
ONHM 1065	Skull	Musandam 1980
ONHM 1288	Complete	Bait Barakah Breeding Centre 1989
ONHM 1523	Complete	Bait Barakah Breeding Centre 1990
ONHM 2295	Skull	Dhofar 1994
ONHM 2756	Complete	Bait Barakah Breeding Centre 1997
ONHM 3299	Complete	Jabal Samhan 2002



Fig. 4. Nubian ibex and kid camera-trapped (Photo A. Spalton).

and the Directorate General for Environment in Dhofar. The MRMEWR employ 38 wildlife rangers in Dhofar.

The Office of the Adviser for Conservation of the Environment in the Diwan of Royal Court commenced the work of the Arabian Leopard Survey in 1997. This has comprised field research and studies in Jabal Samhan Nature Reserve and since 2000 in Jabals Qara and Qamar. In 2006 surveys were undertaken with Biosphere Expeditions in the Musandam peninsula.

The Directorate General of Royal Farms & Gardens of Royal Court Affairs is responsible for Oman's only group of captive leopards held at the Bait al Barakah Breeding Centre for Omani Mammals, Muscat.

In 2002 an Arabian Leopard Working Group was established under the chairmanship of the Director General for Nature Conservation of the MRMEWR and members include representatives from the OACE and the Sultan Qaboos University.

Inventory

The Oman Natural History Museum, Ministry of National Heritage and Culture holds nine specimens of Arabian leopard (Table 1).

Seven animals are kept at the Bait Al Barakah Breeding Centre for Omani Mammals, Directorate General of Royal Farms & Gardens, Royal Court Affairs, Muscat (Table 2).

Ongoing work

OACE is continuing the work of the Arabian Leopard Survey as follows:

- *Camera-Trapping* in the Dhofar Mountains. Camera-trap survey work continues across the Dhofar mountains to determine the continuing presence or absence of leopards and to ascertain the degree of fragmentation of the population. This work is being carried out in conjunction with staff of MRMEWR.
- *Investigation of Livestock Killing*. Camera trapping, satellite tracking and molecular scatology are being used to help the MRMEWR to investigate cases of reported livestock killing by wild animals and thus be better equipped to address the issue of compensation.

- *Genetic Studies*. Staff of the Biology Department, College of Science, of the Sultan Qaboos University are developing genetic techniques to identify leopard and other large carnivores (wolf, hyena and caracal) from scats (faeces) collected on the jabal. To date DNA has been successfully isolated from tissue material and scats of captive (Al Ansari *et al.* 2005) and wild leopards (Pers. comm. Al Ansari, January 2006).

- *Satellite GPS Tracking*. Four GPS satellite collars have been recovered from leopards captured in Jabal Samhan and Jabal Qamar. Data is being analysed that will give vital range information for male and female leopards. Collaring will continue in order to further investigate the ecology of the species and especially to investigate interaction of the leopard with people and their livestock.

- *Surveys in Governorate of Musandam*. In January 2006 OACE joined up with Biosphere Expeditions to carry out survey work in Musandam while simultaneously helping to develop responsible tourism (www.biosphere-expeditions.org).

- *Education & Public Awareness Material*. Staff continue to work with local schools and government offices to disseminate information.

- *Documentary Film*. David Willis has been contracted to produce the region's first documentary film about the leopard and the work of the Arabian Leopard Survey. Leopard footage will be obtained from video-camera traps.

Table 2. Animals kept in captivity (in and outside Oman) in December 2006.

Studbook Nr	Sex	Birth date	Sire	Dam	Location	Date	Local ID	Event	Name
8	M	05.05.93	1	3	BC-Oman	05.05.93	M267	Birth	Mohan
10	M	24.02.95	1	3	BC-Oman	24.02.95	M297	Birth	Zeak
12	M	~ 1993	wild	wild	Yemen	~ 1994	UNK	Capture	Nimrod
					Private	~ 1994	UNK	Transfer	
					Sharjah BR	18.05.95	PP001	Loan to	
					BC-Oman	03.05.97	UNK	Loan to	
					Sharjah BR	12.02.98	PP001	Transfer	
					BC-Oman	30.04.02	M350	Loan to	
17	F	21.02.97	1	7	BC-Oman	21.02.97	M342	Birth	Riha
18	F	21.02.97	1	7	BC-Oman	21.02.97	M343	Birth	Badria
3	F	~ 1984	wild	wild	BC-Oman	~ 1985	UNK	Capture	Nesra
					BC-Oman	~ 1985	M112	Transfer	
					Sharjah BR	04.05.97	PP003	Loan to	
6	F	15.05.90	1	3	BC-Oman	15.05.90	M214	Birth	Hesra
					Sharjah BR	11.11.95	PP002	Loan to	

Recommendations

Survey & Research. To continue with current programs (identified above) for survey and research including investigations into livestock killing by large carnivores.

Implementation of Management Plan. To strengthen efforts to implement the management plan for Jabal Samhan Nature Reserve.

Public Education Campaigns. To continue with these in schools and public forums.

Social Survey. In order to understand what the leopard means to the local people of Dhofar it is recommended that a survey be carried out within leopard range areas to determine attitudes and needs of local human communities.

Captive Breeding. Maintain the captive group and encourage new breeding loans with collections outside Oman in order to avoid inbreeding and to broaden the genetic base.

Collaboration with neighbouring range states. To investigate the possibility of surveying areas within Yemen close to the Oman – Yemen border and give assistance, where appropriate, to conservation authorities in Yemen.

Regional Conservation Initiatives. To support efforts to develop a Strategic Plan for the conservation of the species.

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Fig. 5. Education to engage young Omanis in leopard conservation (Photo A. Spalton).

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Appendix A: Distribution records

Reports classified as confirmed (when animal remains have been collected, or animal photographed and clearly recognisable) or unconfirmed (all others). Names after records indicate a personal communication, the location of which is given in notes below.

Musandam

Confirmed reports

- 1976: Young female killed, skull collected, near Limah (N. McNeil¹).
- 1979: Animal shot and recovered in Wadi Maqalayli; (R. Thompson²).
- 1980: Eight leopards killed, some recovered whole, parts of others collected; female at Al Hawshak, male at Qusaydat, unknown sex west of Wadi Jellabat, unknown sex at Al Mintera, male at Al-gema, male west of Wadi Jellabat, male³ at Al Alama and female³ west of Limah (S. Gordon⁴).
- 1981: January, male³ was killed and re-

- covered near Taf al Qarha; (G. Walker⁵). February, adult photographed dead at Khasab (R. H. Daly⁶).
- 1990: February, male shot and photographed, near Khasab (D.M. Fernie⁷).
- 1992: November, male killed in Wadi Zibat on the border of Oman and Ras Al Khaimah. Head recovered to Arabian Leopard Trust (G. Feulner¹²).
- 1997: October, two leopards caught in a leghold trap and then shot, by men from outside Oman, on Omani territory close to the border with RAK (David Insall⁸).

Unconfirmed reports

- 1994: Locals reported single sightings at Bait Shaikh, Khasab, Jabal Jemayaim (D. Insall⁸).
- Other sightings have been documented for the Oman / UAE border (Anon 1995).

Northern Oman

Confirmed reports

- Undated: M.P. Butler obtained an incomplete skin from locals SW of Ibrī (Harrison 1968)
- 1976: Animal of unknown sex was shot and later photographed near Nakhl (Gasperetti et al 1986).

Unconfirmed reports

- 1976: footprints similar to leopard spoor found near Warrawarra in the Wadi Sareen Reserve (Munton 1985).
- 1979: Single leopard seen by a local person in Jabal Alka, to the south of Wadi Sareen (D. Insall⁸).

Dhofar and Central Oman

Confirmed reports

- Presence in the Dhofar mountains noted by Thomas (1932) and Thesiger (1949).
- 1947: Specimen from Jabal Samhan (Harrison 1968).
- 1948/49: Specimen from Dhofar (Harrison 1968).
- 1977: Two specimens Jabal Samhan; one recovered dead (Gasperetti *et al.* 1986) and a skin received by the Oman Flora & Fauna Survey, 1977 (Reade et al. 1980).
- 1985: Four animals (2.2) trapped in Jabal Samhan and taken to the Breeding Centre for Omani Mammals (Usher Smith 1985).
- 1988: Dead animal photographed near Sadh (R. Wood⁹).

- 1994: Skull and other remains of a single animal near Jibjat (A.G. Boulter¹⁰).
- 1995-2000: Photographs of 17 different individual leopards made by camera-trap in Jabal Samhan Nature Reserve (Spalton & Willis 1999, Spalton et al. 2006).
- 2001-2005: Six individuals trapped for fitting with GPS collars in Jabal Samhan Nature Reserve and two in Jabal Qamar (OACE, unpublished data).
- 2001-2005: Photographs of 9-11 different individual leopards made by camera-trap in Jabals Qara and Qamar (OACE, unpublished data).

Unconfirmed reports:

- 1994: Single animal reported in Wadi Mughsayl and one in Wadi Jaroom (Ali Salim Bait Saeed¹¹).
- 1995: Two adults with three young reported between Sadh and Hadbeen (Ali Salim Bait Saeed¹¹). Single leopard seen in Wadi Hanna in 1995, another in Wadi ‘Aynenya (D. Insall⁸).
- 1996: Single animals seen in Wadi Naehez and Wadi Seeq (D. Insall⁸).

Notes on source of information

- Office Adviser Conservation of the Environment (OACE; PS2/6-10/76)
- OACE (C6/45/79)
- also Gasperetti et al 1986
- OACE (C6/56 & 60 /80)
- OACE (C6/64-68/81)
- OACE (with photograph; C6/74/81)
- OACE (with photographs; PS2A/9/90)
- David Insall, pers. comm.
- Richard Wood, pers. comm.
- OACE (PS2/29/94), specimen ONHM 2295
- Ministry of Regional Municipalities, Environment & Water Resources.
- Gary Feulner, pers. comm. February 2003.

Status of the Arabian Leopard in United Arab Emirates

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³ Animal Management Consultancy, PO Box 1022, Umm al Quwain, UAE

Experts estimate the wild population of Arabian leopard (*Panthera pardus nimr*) in the Northern Emirates and Musandam Peninsula to be as low as 5–10; however, the UAE does not have the area capacity to carry a population larger than 10–20 animals. In recent historic times, the caracal is thought to have become an apex predator in areas not used by the Arabian leopard. Its predominance in many wadis may therefore serve as an indicator for declined/extinct leopard populations. Very little is known about the primary and marginal habitats of the Arabian leopard in the UAE, assessment is based on scattered reports and knowledge of leopards from other regions. It is thought that the UAE provides a corridor for leopards moving between the Musandam Peninsula and the Al Hajar Mountains of Oman, although the leopard may be extinct from the Al Hajar Mountains. Accurate data regarding the distribution, ecology and behaviour of the Arabian leopard will enable suitable protected areas to be planned and proposed.

يقدر الخبراء اعداد النمر العربي (بانثرا باردوس نمر) في البرية في الامارات الشمالية وشبه الجزيرة العربية مسندم منخفضة بحيث لا يتجاوز 5-10 نمر ، وتعتبر بيئات النمر العربي في دولة الامارات محدودة المساحة بحيث لا تتحمل أكثر من 10-20 حيوان وذلك حسب طبيعة هذا الحيوان البري والذي يحتاج الى مساحات كبيرة (15 كيلو مربع لكل ذكر بالغ). وفي السنوات الاخيرة بدأ ظهور حيوان الوشق كمفترس رئيسي في البيئات التي كان يعيش فيها النمر العربي حيث تؤخذ هذه الظاهرة كمؤشر على اختفاء او إنقراض النمر العربي من بيئاته الطبيعية، هذا من ناحية ومن ناحية اخرى كان المعلومات عن المواطن الاساسية والنادرة للنمر العربي تعتبر شحيحة ، الى ما توفر عن هذه البيئات في مناطق اخرى. وتعتبر المناطق الواقعة في جبال الحجر لدولة الإمارات مناطق ممر للنمر العربي التي تنتقل من شبه جزيرة مسندم وبقية جبال الحجر في عمان. ومن اجل الحفاظ على النمر العربي فإنه من المهم ايجاد قاعدة معلومات دقيقة عن (توزيع النمر العربي في البرية ونظم البيئية التي لعبت فيها بالاضافة الى سلوكيات هذا الحيوان الخجول، مما سيتيح الفرص لإقتراح وإنشاء مناطق محمية صالحة للنمر العربي.

Status, distribution and development of the Arabian leopard population

Limited literature exists upon which to base an estimate of the historical distribution of the Arabian leopard in the United Arab Emirates (UAE). Reports, kills and sightings of leopard are rare and recorded knowledge is often based on hearsay.

The Arabian leopard was first recorded in the UAE by Thesiger (1949) who reported the presence of a visiting leopard on Jebel Hafit (1 in Fig. 1). Hellyer (1993) also reported leopard on Jebel Hafit with an account of one that was shot and wounded in 1976. Harri-

son (1968) refers to a report from Tyrell of a leopard shot near Masafi (2 in Fig. 1) in 1962 and a leopard sighting is recorded at the Qalidda Pass in Harrison (1971) and Harrison & Bates (1991). Press reports (1993) document a group of three leopards that were killed in a cave in Ras al Kaimah in 1986 (3 in Fig. 1). As leopards do not usually remain in groups it is assumed that this group was a mother with sub-adult cubs. Another leopard was killed in Ras al Khaimah in May 1993 (5 in Fig. 1); this kill was apparently corroborated with photogra-

phic evidence (IUCN/SSC Conservation Breeding Specialist Group CBSG 2000). Spalton *et al.* (2006) report that two leopards were killed in the Musandam in 1997 and Jongbloed (2001) recorded the killing of a female in Ras al Khaimah in 2001 (7 in Fig. 1). Llewellyn-Smith also found signs thought to be leopard in Wadi Zeebat in 2001 (Fig. 2 and 3). According to Spalton *et al.* (2006), the last report of leopard in the adjacent Al Hajar Mountain was in 1976. Oman authorities now consider leopard extinct in this region. Recent

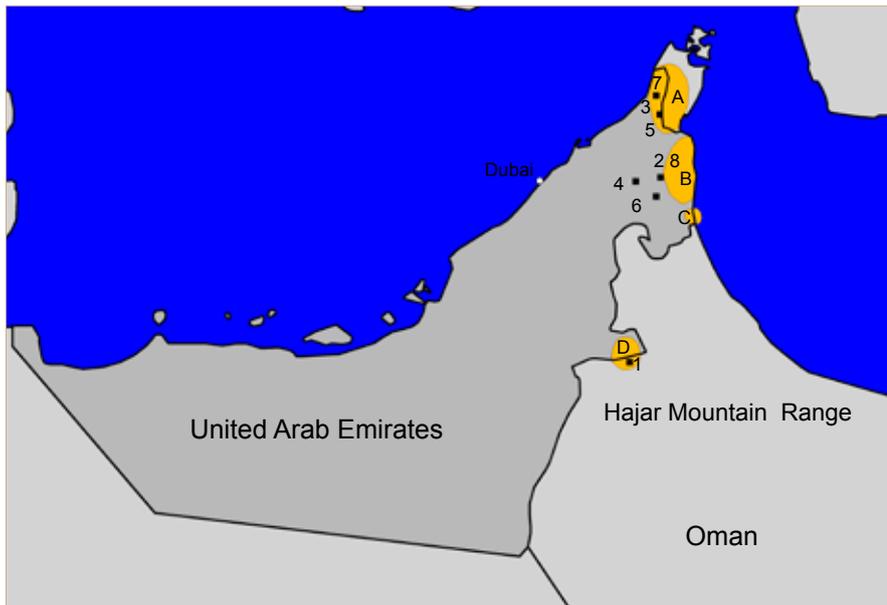


Fig. 1. Information on protected areas and distribution of the Arabian leopard in the United Arab Emirates. Protected areas (yellow): A = Ru'us al Jibal (proposed), B = Al Hajar-Shumayliya Mountains (proposed), C = Mangrove Community at Khor Kalba (proposed), D = Jebel Hafit (declared). Observations (black squares): 1 = Jebel Hafit 1976, 2 = near Masafi 1962, 3 = Ras al Kaimah 1986, 4 = near Manama, 5 = Ras al Kaimah 1992 and 1993, 6 = Wadi Shawka 1995, 7 = Ras al Kaimah 2001, 8 = Wadi Wurayah 2004.

field surveys conducted by Biosphere in 2005 found no evidence of leopard in the Musandam (Spalton *et al.* 2006).

During the course of a field survey in 1995, evidence of leopard sign (tracks in Wadi Shawka) in the UAE was suggested (6 in Fig. 1), however, the authors express doubt about the occurrence of any resident leopards due to the lack of other signs confirming their presence

(Stuart & Stuart 1995). It should also be noted that this wadi is known to support caracals. Caracal and leopard are not often found to inhabit the same home range (A. Spalton, pers. comm.).

Faecal samples collected from Wadi Wurayah were analysed at King Khalid Wildlife Research Centre (KKWRC) in Saudi Arabia and identified as Arabian caracal *Caracal caracal schmitzi* drop-

pings. In recent historic times, the caracal is thought to have become an apex predator in areas not used by the Arabian leopard (A. Spalton, pers. comm.). Its predominance in these wadis may therefore serve as an indicator for declined/extinct leopard populations.

A single footprint was photographed by D. Egan from a shallow rock cave in Wadi Wurayah in 2004 (8 in Fig. 1). The print was found in soft powder-like sand on rock. Size comparisons with prints of Arabian leopard and Arabian caracal made in soft sand at the Breeding Centre for Endangered Arabian Wildlife (BCEAW), Sharjah indicate that it is similar in size to those of the leopard but could also be from a large/male caracal. The print had insect prints over it. There were no other signs (faeces, scrape marks, carcass remains etc.) indicating that the cave was used for any length of time.

During a Conservation and Assessment Management Plan (CAMP) workshop for Arabian Carnivores held in Sharjah in February 2000, experts estimated the wild population in the Northern Emirates and Musandam Peninsula to be as low as 5–10 (CBSG 2000). The home range of Arabian leopards on Jabal Samhan is about 350 km² for males and 250 km² for females (A. Spalton, pers. comm.). With an approximate mountain area of 3,200 km², the UAE does not have the capacity to carry a population larger than 10–20 animals.

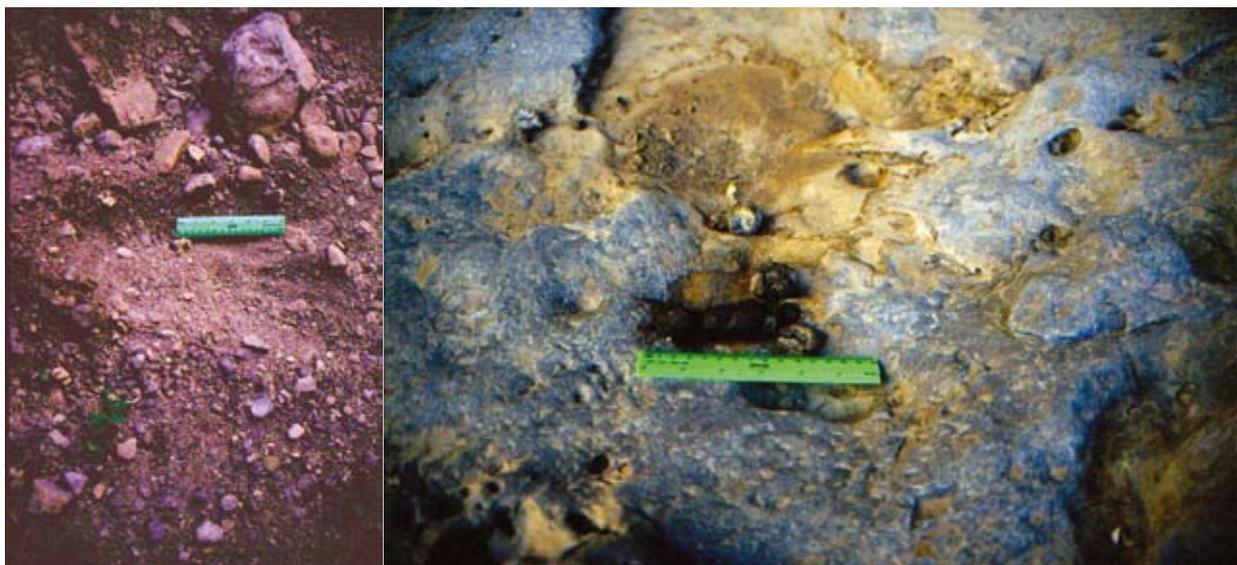


Fig. 2 and 3. Photos taken in Wadi Zeebat in 2001. The signs are thought to be leopard scraping (left) and leopard faeces (right; Photos R. Llewellyn-Smith).

Threats

The general consensus amongst locals and experts is that the population is decreasing at an unsustainable rate. Live animal trade, trade for parts (pelts) and indiscriminate hunting are thought to have the greatest effect on population numbers (CBSG 2000). Direct persecution due to predator-livestock conflicts occurs and local farmers and shepherds are also known to be of the opinion that any predator threatening their livestock will be shot.

Competition with man in early years was restricted by natural factors such as limited perennial water and inability to easily access wadis containing water. Farming was limited to the carrying capacity of the natural environment. Recent years have witnessed a rapid increase in development throughout the UAE as a result of new wealth generated mainly from the discovery of major oil resources. Construction of new roads (Fig. 4) and highways across the country and expansion of the many small villages scattered throughout the mountains has resulted in important habitat fragmentation for many species. Improved availability of resources such as pumped water has led to increased cultivation (Fig. 5) and overexploitation of limited wadi resources. Also of enormous impact to the loss of viable habitat is extensive quarrying of the Shumayliya Mountains (Fig. 6) for the construction of multiple off-shore residential and pleasure islands along the UAE coastline.

Hunting and increased livestock numbers have resulted in a decrease of natural prey species, such as Arabian tahr *Hemitragus jayakari*. During a survey conducted by the BCEAW at perennial water holes of various wadi branches in the Shumayliya Mountains (B in Fig. 1) it was confirmed that Arabian tahr do still occur in the region but in very limited numbers. The survey, which was conducted between June 2000 and January 2002, included camera trapping, behavioural observations and faecal sample collection. During the 18-month period only thirteen photographs of tahr were obtained (Ruddock 2002, Ruddock & Smith 2002). There were five live animal sightings (Ruddock & Smith 2002) one of which was photographed (Fig. 7).



Fig. 4. Construction of roads allows access to remote areas (Photo J. Edmonds).



Fig. 5. Widespread farming now occurs in the mountains (Photo J. Edmonds).

Local residents are known to have limited interest and awareness of the natural history of the UAE. A popular pastime enjoyed by both locals and expatriates in the region is “wadi-” and “dune-bashing”, which requires careful attention. Aside from the impact of noise and disturbance on the habitat, problems such as plant and animal destruction, erosion and pollution have a negative impact on these fragile habitats.

Habitat

Leopards have a wide habitat tolerance but are generally associated with rocky hills and mountainous ranges (Fig. 9 and 10; Skinner & Smithers 1990, Harrison & Bates 1991). They are said to seldom venture onto the open plains (Harrison & Bates 1991) however; an individual trapped in the early 1990’s was in fact caught on the open plains near Manama (4 in Fig. 1). Leopards are believed to be absent from the true desert of the central Arabian peninsula (Harrison & Bates 1991).

The Shumayliya Mountains run from north to south along the east coast of the UAE, covering an approximate area of 3,200km². Scrapings, tracks and kills have all been found in mountain wadis with permanent water (CBSG 2000, R. Llewellyn-Smith, pers. comm. and D. Egan, pers. comm.).

Not enough is known about the habitat of the Arabian leopard to accurately identify primary or marginal habitat in the UAE, assessment is based on scattered reports and knowledge of leopards from other regions. It is thought that the UAE provides a corridor for leopards moving between the Musandam Peninsula and the Al Hajar Mountains of Oman (CBSG 2000). However, it should be noted that the leopard is considered to be absent from the massive Al Hajar Mountain range in northern Oman (Spalton *et al.* 2006) and the existence of a corridor today would therefore be redundant.

Whilst the leopard itself is said to be independent of water and able to obtain



Fig. 6. Destructive impact of quarrying for the construction of multiple off-shore residential and pleasure islands along the UAE coastline. This quarry is situated near Wadi Shawka (Photo J. Edmonds).



Fig. 7 and 8 Evidence of the occurrence of Arabian tahr in the Shumayliyah Mountains of the UAE. The image on the left is the single photograph obtained from a live sighting of tahr in Wadi Wurrayha, photographed by Mike Smith. The image on the right is one of the 13 photographs of tahr obtained by camera traps during the Shumayliya Mountain survey carried out by the BCEAW between June 2000 and January 2002.

moisture requirements from prey (Skinner & Smithers 1990), some prey species occurring in the UAE, such as the tahr, are water dependant. Water could therefore be considered a limiting factor for the occurrence of Arabian leopard.

No suitable protected areas exist in the UAE, Jebel Hafit - Ain al Faydah (D in Fig. 1) near Al Ain has been declared a National Park. The area covers 11,700 ha. Since 2003, intensive effort has been employed to eradicate feral sheep and goats from the Jebel and thereby allow the expansion of a healthy tahr population from the present population in the region (C. Drew, pers. comm.). Hatta Nature Reserve (see map) has been designated a protected area since 2003. This land area covers 16 km². Protection has been proposed for an area of the Ru'us al-Jibal Mountains (A in Fig. 1) that is thought to be visited by leopards (Llewellyn-Smith 2002). The proposal has yet to be accepted.

During their study of the UAE flora and fauna, Chris and Tilde Stuart (1995) suggested the Shumayliya-Hajar moun-

tain region on the east coast of the UAE be included as a protected area (B in Fig. 1). If the UAE does form an important corridor for migrating leopards to move between the Hajar Mountains and the Musandam Peninsula, protection of the Shumayliya-Hajar region would reduce the vulnerability of leopards moving through this north/south corridor and may allow repopulation of the Al Hajar Mountain region.

Prey Species

Although there are no official statistics to refer to, experts have consistently concluded that traditional prey species for the Arabian leopard are in a state of decline (CBSG 2000 and 2001, Environment and Protected Areas Authority 2002, 2003, 2004, 2005 and 2006).

According to a study of the diet of the Arabian leopards, traditional prey species in Oman consist of the Arabian tahr *Hemitragus jayakari*, mountain or Arabian gazelle *Gazella gazella cora*, Ethiopian hedgehog *Paraechinus aethiopicus*, small rodents, reptiles and even

insects (Muir-Wright 1999). Also identified by Muir-Wright (1999) as part of the main constituent of a leopard's diet is the Cape hare *Lepus capensis cheesmani*, which is still present on the plains of the UAE (Drew 2000) and Rock hyrax *Procapra capensis*. Rock hyrax (Fig. 11) is not a traditional prey species in the UAE as they are not endemic. They were however introduced onto the Jebel Hafit and a leopard population existing on or near Jebel Hafit would likely utilize the hyrax as a primary food source.

Skinner & Smithers (1990) record that African leopards prey on whatever is available within their home range. As with other leopard sub species, the Arabian leopard is likely to be an opportunistic hunter and it is therefore possible that the Blanford's fox *Vulpes cana* and White-tailed mongoose *Ichneumia albicauda* would form an occasional part of the diet of the Arabian leopard. There is however, there is no scientific evidence to support this statement.

Domestic animals

There is very little proof that loss of livestock in the UAE is due primarily to the Arabian leopard; although as a result of a lack of other suitable prey within the leopards' range it is not unlikely that livestock is killed. Leopards do have a widespread reputation as a killer of domestic livestock (Roberts 1977, Harrison & Bates 1991).

An informal survey conducted by Moaz Sawaf on behalf of the Arabian Leopard Trust (ALT) during 1993 (Jongbloed 2001) revealed that all farmers in the mountains kept free-ranging goats, the numbers ranging from 50–500. These goats compete with Arabian tahr for grazing ground (Fig. 12). A large portion of the farmers questioned (75%) said that wild predators killed their goats from time to time but whilst everyone questioned had seen caracals, less than half had ever seen a leopard. Many of the farmers said they would refrain from hunting the leopard if compensation for lost goats was paid to them. A later community survey conducted by Moaz Sawaf on behalf of Chris and Tilde Stuart in 1995 revealed similar statistics (Stuart & Stuart 1995).

No compensation system for losses of livestock exists within the UAE. No-



Fig. 9. Mountain habitat of the UAE (Photo J. Edmonds).



Fig. 10. Wadi bed in the Shumayliyah Mountains (Photo J. Edmonds).

teworthy with regard to these surveys is that many locals refer to any large cat or canid as “nimr” raising the question of data authenticity (CBSG 2000, personal observation). Stuart & Stuart (1995) also expressed doubt about validity of data provided in their survey report.

Methods used for animal management by locals vary considerably from tribe to tribe. Many goat herds are free ranging, although in some areas, particularly the larger villages, the herds are sometimes kept in primitive kraals (fenced area). A small number of farmers enclose newborn goats until they are old enough to keep up with the main herd. Research in the Ru’us al Jibal area of Ras al Kaimah revealed that local tribesmen employ “herdsmen” to live in the mountain settlements tending the goatherds (Jongbloed 2001).

Legal Status

- The Arabian leopard is classified as *Critically Endangered* (CR) in the global IUCN Red List.
- Under the CITES (Convention on International Trade in Endangered Species) treaty it has been listed in Appendix 1 since 1975 and is therefore protected from international trade through UAE custom points.
- Federal Law 11, implemented on 26 April 2003, protects all CITES listed species. This law does not apply for species or trade within a country. Implementation of animal trade laws within the UAE is not consistently enforced. There is no federal legislation officially protecting the Arabian leopard within the country.
- Federal Law no. 24 of 1999 Concerning Protection and Development of the Environment has a single article (Article 12) that specifically deals with animals and mentions that owning, hunting, transporting and selling of species referred to in “the list” is forbidden or is subject to licence/permit from the competent authorities. The list of species protected under this law has yet to be compiled.
- The Gulf Cooperation Council (GCC) agreement is an agreement drafted for the preservation of wildlife and the conservation of its natural habitats in the Arab Gulf states of the GCC. The agreement has yet to be signed and implemented; however, once en-



Fig. 12. Goats are competing with tahr for grazing ground (camera trap picture of BCEAW).

forced it would cover many issues of wildlife conservation and protection. There are no CITES laws prohibiting international trade in any of the endemic prey species i.e. gazelle and tahr. The Arabian gazelle was included in Appendix 3 of CITES in April 1976 but was deleted from this category the following year in July.

The only UAE hunting law that exists is the Federal Decree – Law No. 9 for 1983; Regulating the Hunting of Birds and Animals. The law states the following: “This law protects certain species of birds, deer of various kinds, wild cows, hares and Mastigures (spiny-tailed lizards).” Gazelle and tahr could be classified into one of the categories mentioned; however, confirmation has not been possible.

Conflicts and public awareness

The leopard will on occasion prey on domestic livestock (Gasperetti *et al.* 1985). There are no confirmed records of the frequency of such killings in the UAE; however, the leopard or “nimr” is most often blamed for the kill. As mentioned previously, a survey amongst local farmers revealed that less than half the people questioned had ever even seen a leopard, however, nearly all the farmers said that they would not hesitate to kill any predator they encountered. Field notes by R. Llewellyn-Smith in 1999 (Jongbloed 2001), describe the sentiment of two mountain residents as “re-lieved that there were no leopards left,

as they are devils”.

Moaz Sawaf recounted a leopard sighting on June 13, 1996 by a local tribesman in Wadi Zeebat (Jongbloed 2001). As a result of contact with Moaz and the ALT; the tribesman did not shoot the male but rather watched it through binoculars for ten minutes. His parting comment to Moaz was that he would not mention this incident to his friends as they may arrange a hunting party in order to try to shoot the leopard.

During the survey conducted on behalf of Chris and Tilde Stuart by Moaz Sawaf in 1995 it was revealed that only 50 % of the farmers knew of any laws banning hunting. Of the farmers inter-



Fig. 11. Rock hyrax, a potential prey species for leopards in the Jebel Hafit (Photo J. Edmonds).

viewed 44 % did not feel obliged to obey such a law and would hunt as they pleased, 94 % felt it was quite acceptable to kill leopards and 81 % said they would hunt a predator actively whether or not it threatened their herds.

Until their closure in 2001, the ALT was extremely active in promoting conservation within the UAE and maintained the Arabian leopard as their flagship species. The organisation was instrumental in organising fund raising events throughout the eight years that they were active.

A children's story called "Hayat the Arabian leopard" written by Marycke Jongbloed sold 5,000 copies in English. The story was serialized in "Young Times", the children's section of a local newspaper. An Arabic version of the book was printed and distributed at schools in the UAE, sponsored by ERWDA (Environmental Research and Wildlife Development Agency).

A series of postage stamps depicting the four wild cat species of the UAE was issued by the General Postal Authority on October 10, 1994. The leopard has been featured on UAE telephone cards.

The release of an educational video, "Land of the Nimr" during 1997 in both English and Arabic, sponsored by Shell and produced by World Wildlife Production included information about the Arabian leopard and the efforts being made to save it.

The BCEAW, Sharjah has designed and regularly updates an informative web page, focusing on all endemic Arabian wildlife (www.breedingcentres-harjah.com). This is an ongoing educational tool that has been implemented since 1999.

The BCEAW, Sharjah organises an annual Conservation Workshop for the Fauna of Arabia on behalf of the Environment and Protected Areas Authority. These workshops have encouraged co-operation between conservation institutes on the Arabian Peninsula and have also provided international exposure of conservation efforts within the region. Through the workshops, numerous surveys have been initiated and the captive breeding program for Arabian leopard has become a co-operative ex situ conservation aide.

Arabia's Wildlife Centre at the Sharjah Desert Park has a unique public dis-

play of fauna endemic to Arabia. Each display has general information lecterns providing basic details about the animal and its habits. Large species, including the Arabian leopard have audio facilities giving interesting facts in English and Arabic.

People and institutions

The Environment and Protected Areas Authority (EPAA) of the Sharjah Government supports and funds the BCEAW and research work carried out at the centre.

World Wildlife Fund (WWF) operates at a Federal level to address conservation priorities. There are five main priorities that the WWF presently focus on, namely 1) marine environment, 2) species of special concern (for the UAE and globally), 3) freshwater environments, 4) climate changes and 5) toxic and chemical threats.

The Environment Agency - Abu Dhabi (EAD) formerly known as the Environment Research and Wildlife Development Agency (ERWDA) is a government funded organisation based in Abu Dhabi. EAD conducts wildlife research and regional surveys of Abu Dhabi. The agency does not have any direct involvement in leopard projects at this stage.

Dubai Natural History (DNH) group and Emirates Natural History Group (ENHG) are non-government wildlife awareness groups that organise regular field excursions, wildlife awareness lectures and monthly newsletters. The Emirates Environmental Group (EEG), based in Dubai, is actively involved in promoting environmental awareness in and around Dubai. The group focuses on wildlife awareness and practical environmental goals such as recycling waste etc. Student workshops and Interschool environmental competitions are some of the activities also organised and promoted by the EEG.

No universities are actively involved in leopard conservation in the UAE although the American University of Sharjah has recently formed a student conservation group.

Ongoing work and research projects

There is currently no monitoring system specifically targeting the occurrence of Arabian leopard within the UAE. Staff

at the BCEAW, Sharjah conducted an intensive 24-month monitoring project of the Arabian tahr between June 2000 and January 2002. The survey was conducted with the use of camera traps and observers in the field. The monitoring site is located within prime leopard habitat in the Shumayliya Mountains along the east coast of the UAE (see map). As mentioned previously, the survey project only produced 13 photographs of tahr which represents 2.1 % of the total number of photographs taken. All the photographs of tahr were of females and offspring. 1.6 % of the photographs were of Arabian caracal, 2.2 % of the photographs were of Sand partridge, Red fox appeared in 0.3% of the photographs and hedgehogs occurred in 2.8% of the photographs. The vast majority of the photographs (64.7 %) were of feral goats. Surprisingly, with 26.4 % occurrence, Blanford's fox was photographed more commonly than any of the other endemic species.

The Arabian Tahr Conservation Group (ATCG) plans to implement an extensive survey of the UAE in 2006/2007. The presence/absence of leopard is likely to become apparent through this survey.

The BCEAW, in conjunction with Henry Doorly Zoo, Omaha, USA initiated genetic research to determine whether there are in fact two distinct forms of the sub-species *Panthera pardus nimr* within the region. Initial findings indicated that there is no evidence to support species differentiation between northern and southern leopards, however the sample size was extremely small. Further investigation is required with a larger set of samples to substantiate these findings, with particular focus on northern specimens as only 3 samples were available. Further genetic identification is in progress in collaboration with Carlos Fernandes at Cardiff University, UK.

The collection and analysis of morphological data from captive specimens is ongoing at the BCEAW. The data provides an average range of measurements with which to describe the subspecies.

The BCEAW, Sharjah sponsored and supported research into the reproductive physiology of the Arabian leopard which forms the thesis for a PhD at Cambridge University. The aim of

the thesis is threefold 1) to establish the normal reproductive physiology of the Arabian leopard, 2) to address infertility in the captive Arabian leopard in terms of incidence and cause and 3) to assess the potential use of assisted reproductive physiology in captive breeding including semen banking and control of the oestrus cycle for artificial insemination, oocyte retrieval and embryo transfer. Data collection has now been completed and the results compiled (de Haas van Dorsser 2006).

Recommendations

Knowledge of the distribution, population size, biology/ecology and behaviour of the Arabian leopard is still very limited. Further research is essential in order to plan effective conservation approaches. Accurate data regarding the distribution, ecology and behaviour of the Arabian leopard will enable protected areas to be planned and proposed.

Correct management and representation of the captive breeding programme already established will ensure an important genetic "reservoir" that can be used to supplement and improve increasingly threatened wild populations throughout the Arabian Peninsula. Of extreme importance is improved cooperation between the range states of the peninsula to provide the largest possible founder population on which to build the captive genetic pool.

Improved legislation and enforcement protecting the leopard and its prey species from trade (national and international) will ensure both long and short-term conservation strategies are successful.

According to Ogada *et al.* (2003) traditional livestock husbandry practices similar to those used in Kenya can make an important contribution to carnivore conservation. Livestock that is closely herded by day and corralled at night are less likely to be killed by wild predators. Fewer predators would be killed where fewer predators kill livestock (Ogada *et al.* 2003). Implementation of low cost herding practices among local farmers and education regarding the benefits of herding and corraling of livestock would contribute to reducing human-predator conflicts.

Inventory

There are no museum collections known within the UAE.

22 animals are kept in captivity: 20 (12 M, 8 F) at BCEAW, Sharjah, and 2 (1 M, 1 F) at Nakhlee Estate, Dubai.

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History of the Arabian leopard Captive Breeding Programme

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The Arabian leopard (*Panthera pardus nimr*) is highly endangered and captive breeding has therefore become an essential component of conservation for this species. The Captive Breeding Program has been operating in its present form since 1999 although the first Arabian leopards registered in the studbook were caught in 1985. During the 1990's additional institutions within the range states began to acquire leopards and the need for a coordinated breeding program became a priority. The Regional Studbook was first published in its present form in 1999 and has been followed by several Conservation Assessment and Management workshops through which improved regional cooperation has been initiated. A large proportion of the captive population is wild caught, however, only half of these have produced offspring in captivity. To maximise genetic diversity in the captive population, it is essential that the unrepresented founder animals contribute to the breeding program.

النمر العربي معرض لخطر الانقراض بشكل كبير وتعتبر المجموعات المتواجدة في الأسر من المكونات الأساسية لبرنامج الحفاظ على هذا النوع. بدأ برنامج إكثار النمر العربي في الأسر منذ عام 1999م، علماً بأن أول نمر عربي تم تسجيله في كتاب الأنساب للنمر العربي كان في عام 1985. وفي التسعينات بدأت مؤسسات معنية في المنطقة ومثال على ذلك مركز الإكثار الحيوانات المهددة بالانقراض، في الشارقة، بالاهتمام في البدء ببرامج إكثار النمر العربي وأصبحت الحاجة إلى وضع برنامج الإكثار في الأسر بشكل منسق بين مختلف المؤسسات في المنطقة. تم نشر كتاب أنساب هذا الحيوان، النمر العربي بشكله الحالي عام 1999م أعقبته عدة ورش عمل لتقييم برامج الحفاظ على النمر وخطّة إدارة المشاريع الخاصة بذلك (CAMP)، ما أسهم في تنشيط وتكثيف برامج التعاون على المستوى الإقليمي.

Introduction

As extinction rates accelerate, methods for preserving critically endangered species such as the Arabian leopard have to be initiated. One such method is captive breeding, which in the case of the Arabian leopard has thus far proven both a successful and invaluable conservation aide.

Captive breeding programmes ensure the ex situ establishment of healthy "safety net" populations, thereby removing some of the pressure to breed successfully in the wild. Captive breeding programmes also potentially ensure species survival as human expansion continues to threaten and fragment habitats.

Reintroduction is often the ultimate goal of captive breeding programmes. "Reintroduction" is defined as an attempt to establish a viable free-ranging population of a species in an area

which was once part of its historical range but from which it has become extinct (IUCN 1995). The concept of reintroduction of captive-born animals into the wild is, however, constantly under review as successful reintroductions are few and far between. Success rates remain below 50 % despite extensive research into factors influencing success (Tenhumberg *et al.* 2004). The problems faced are immense and may impose considerable biological costs on the populations.

Many experts are of the opinion that the Arabian leopard will not survive in the wild without the reintroduction of animals from captive breeding programmes (IUCN/SSC Conservation Breeding Specialist Group CBSG 2000). It is therefore of utmost urgency that recommendations are initiated and plans discussed for implementation. The pro-

cess for reintroduction is a long one that should be prepared well in advance of any potential releases (U. Breitenmoser, pers. comm.). It is also important that biodiversity conservation is initiated prior to the implementation of reintroduction programmes (IUCN 1995).

The captive breeding programme for Arabian leopard focuses on ensuring a genetically sound population that closely resembles the wild population. Co-operation between regional institutes holding Arabian leopards is essential to ensure that genes from all the wild caught animals are represented within the population. It is also essential that international institutes are included in the captive breeding programme for the Arabian leopard to further expand growth potential within the population.

History of the Captive Population

Although Harrison (1968) records a wild caught male “Tedi” in Tel Aviv Zoo in approximately 1945 and a second wild caught female that died in London Zoo on the 19th of April 1955, a co-ordinated captive breeding programme for the Arabian leopard was not established until 1985. Four leopards, two males and two females, were caught on Jebel Samhan in the Dhofar region of southern Oman and transferred to the Oman Mammal Breeding Centre (OMBC).

The OMBC, situated near Muscat, is the private centre of His Majesty Sultan Qaboos Bin Said. One of the two captured males died from trauma during capture and translocation, the remaining three animals were incorporated into a captive breeding programme. It was not until May 1990 that any of the cubs born were successfully reared by the dam.

In the United Arab Emirates (UAE), captive breeding was first initiated in 1995 with the transfer of a male from the Republic of Yemen and a female from OMBC. The young leopard was rescued from an illegal exhibit in Yemen following months of negotiations between Christian Gross (for the Arabian Leopard Trust) and the Environment Protection Authority (EPA) of Yemen. As experienced in Oman, it took several years before any cubs were successfully mother-reared at the purpose built Breeding Centre for Endangered Arabian Wildlife (BCEAW) in Sharjah. The centre was commissioned by His Highness Dr. Sheikh Sultan bin Mohammed al Qassimi, Ruler of Sharjah and Member of the UAE Supreme Council.

The National Wildlife Research Centre (NWRC) in Ta’if, Saudi Arabia, obtained its first Arabian leopard, a wild caught juvenile male, in 1997. The NWRC forms part of the National Commission for Wildlife Conservation and Development (NCWCD) under the Chairmanship of His Highness Prince Sultan bin Abdulaziz. A second wild caught male was transferred to the NWRC in 1998.

In the year 2000 the Environment and Protected Areas Authority (EPAA) in Sharjah hosted a Conservation Assessment and Management Plan (CAMP) workshop. The workshop paved the way for the authorisation of breeding loan agreements between au-

thorities from Saudi Arabia and Sharjah, which has led to the transfer of several leopards from Ta’if to the UAE.

Building on the relationship initiated by Christian Gross in 1995, cooperation agreements between the EPA, Yemen, and the EPAA, Sharjah, were signed for collaborative conservation and research efforts at the 2001 annual CAMP workshop. One of the projects included in the cooperation agreement was to improve the health status of the animals in the two main zoos in Sana’a and Ta’iz. This project included numerous trips to Yemen, providing veterinary health and husbandry advice and basic medical supplies. Training programmes for the Sana’a Zoo staff at the BCEAW were initiated during 2004. Basing their management techniques on those used at the BCEAW, Sana’a Zoo reported their first ever mother-reared leopard cubs. The cubs born in October 2004 are also the first captive offspring born at Sana’a Zoo to survive beyond their first year.

Ongoing cooperation between Yemen and the EPAA resulted in the rescue of a second wild caught male in 2003 that is now on breeding loan to the BCEAW.

Ta’iz Zoo, Yemen, ceased to participate in the captive breeding programme shortly after agreeing to cooperate with the regional studbook in 2001. Only three of the six wild caught leopards held at Ta’iz Zoo have bred in captivity. It is imperative that the unrepresented wild caught leopards held in this collection and the offspring from those founders that have bred become available to the captive breeding programme to expand the current limited bloodlines.



Fig. 1. Leopard Nesra at the Breeding Centre for Endangered Arabian Wildlife, Sharjah, UAE. She is the oldest leopard recorded in the Arabian leopard Studbook (Photo J. Edmonds).

The Studbook

The Regional Studbook was first compiled and produced in its present form in 1999 when staff from Animal Management Consultancy accepted the task of coordinating the studbook records and advising the captive institutions on behalf of the BCEAW. Coordination and management of the studbook was taken over by Kevin Budd in 2001 and has been administered by Jane Edmonds since 2004. Prior to 1999, the OMBC produced the regional records for the captive breeding programme.

The studbook is a policy that provides a common goal for all captive bree-

Table 1. Number of Arabian leopard in held in various breeding facilities on the Arabian Peninsula. OMBC = Oman Mammal Breeding Centre, BCEAW = Breeding Centre for Endangered Arabian Wildlife, UAE. ADWC = Abu Dhabi Wildlife Centre. Besides the number of animals housed in the respective year, leopards born/died are given in brackets.

Year	OMBC	BCEAW	Ta’if	Sana’a	Ta’iz	ADWC
1999	6 (0/0)	6 (1/0)	2 (0/0)	0	3	
2000	6 (0/0)	9 (2/0)	2 (0/0)	4(0/0)	9 (4/1)	
2001	5 (0/1)	10 (2/0)	3 (0/0)	4 (1/1)	11 (2/0)	
2002	6 (0/0)	13 (4/1)	4 (0/0)	5 (2/1)	11 (unk)	1 (0/0)
2003	6 (0/0)	16 (3/1)	3 (0/0)	4 (0/1)	11 (unk)	1 (0/0)
2004	6 (0/0)	19 (3/0)	3 (0/0)	6 (2/0)	11 (unk)	1 (0/0)
2005	6 (0/0)	22 (2/0)	3 (0/0)	6 (0/0)	11 (unk)	1 (0/0)
2006	5 (0/1)	20 (1/0)	4 (0/0)	4 (0/2)	11 (unk)	

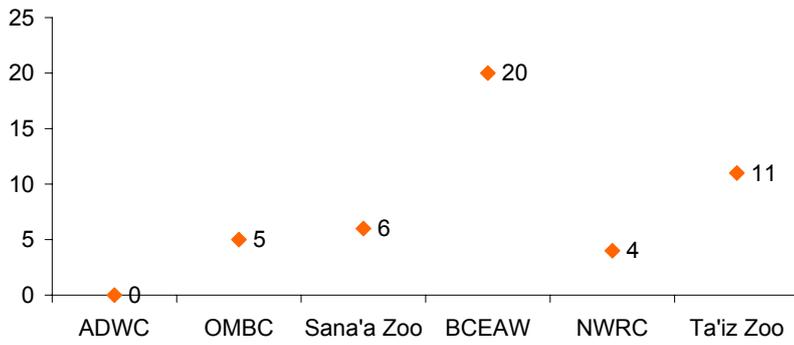


Fig. 2. Distribution of Arabian leopard within the captive population in 2006.

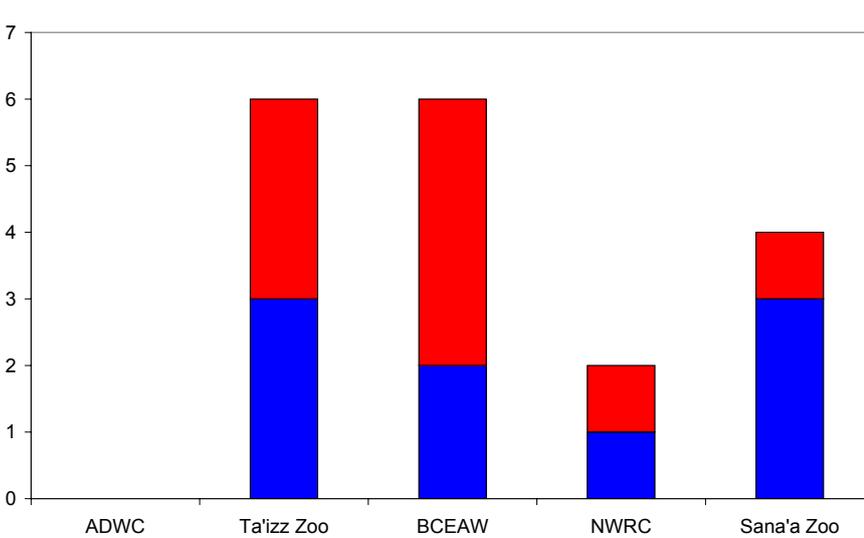


Fig. 3. Distribution of represented (red) and unrepresented (blue) wild caught leopards within the captive population (2006). Unrepresented animals from Abu Dhabi Wildlife Centre and National Wildlife Research Centre were transferred to the Breeding Centre for Endangered Arabian Wildlife at the end of the 2005 breeding season for inclusion in the breeding programme. The first litters from these animals are anticipated during the 2006/2007 breeding season.

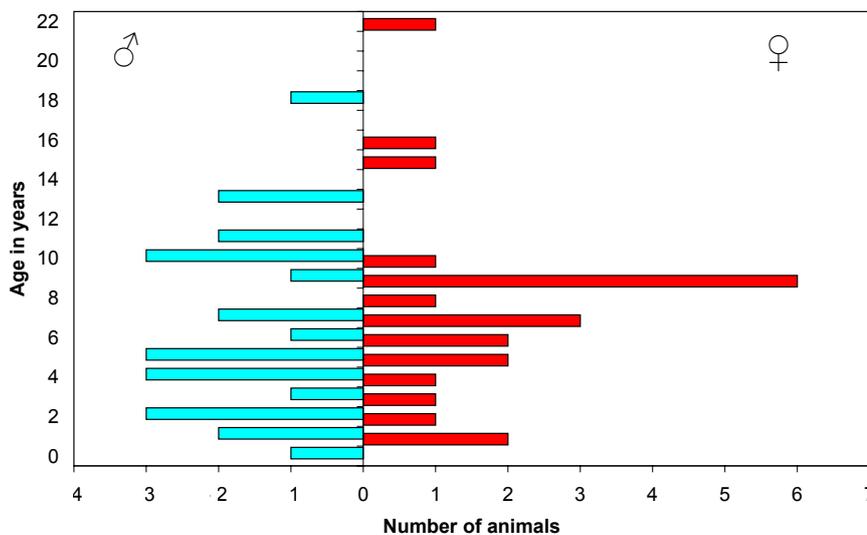


Fig. 4. Age distribution of the captive population 2006.

ding institutes on the Arabian Peninsula and encourages cooperation between institutes and countries. It provides data for animals that are kept and managed in collections within the Arabian Peninsula. No Arabian leopards are yet held in captive breeding programmes outside the Arabian Peninsula.

Studbook coordinators use the studbook publication as a tool to recommend to institutes holding Arabian leopard how best to manage their captive population to maximize total numbers in captivity, maintain genetic diversity and ultimately create or select founder populations for possible reintroduction. Inbreeding and loss of genetic diversity are inevitable in small isolated populations; breeding recommendations are therefore made to ensure that the genetic integrity of the population is maintained. Careful pair selection and management strategies are advised through the studbook. Strategies are aimed at maintaining internationally recommended buffer requirements to be able to support a population crash in the wild.

Current Status of the Captive Population

The current living population consists of 25.23 (48) leopards with six institutions registered in the Regional Studbook (Fig. 2). Historically there are 32.32.4 (68) animals recorded in the studbook. The statistics of the captive population show that there is still a large proportion of the known population that has not bred successfully. Of the current living population, 41.5% (20) are wild caught, only ten of which have reproduced in captivity. To maximize genetic diversity in the captive population, it is critical that unrepresented founder animals contribute to the breeding programme. Captive populations should possess at least 90% of the known genetic diversity of the subspecies to be able to act as a buffer for the remaining wild population. Representation of wild-caught founders is therefore still a high priority for the region, with particular focus on the three founders registered to NWRC, Ta'if, Saudi Arabia. Inclusion of the five (2.3) wild caught leopards at Ta'iz Zoo, Yemen in current breeding efforts is highly desirable but unlikely. In order to further fulfil international genetic diversity criteria, the captive population

will be required to expand to 200 - 250 individuals.

A large proportion of the growth reflected in the captive population during the past five years is as a result of an influx of wild caught animals rather than due to recommended breeding within the population. It is critical that the population growth begin to reflect the genetic diversity already held in captivity rather than depleting a tiny wild population that is not yet buffered by the captive breeding programme.

As can be seen from Figure 4, a large number (64.5 %) of the leopards recorded in the captive breeding programme are within the optimum breeding range of four to twelve years of age. Of the animals within the prime breeding age bracket, fifteen are wild born. There are eleven leopards considered juvenile (3 years and under) and two that are geriatric (over 16 years).

The age at which females become reproductively inactive is not yet known. The oldest known female to reproduce within the captive population was 16.5 years of age. This particular female still displays oestrus behaviour at regular intervals (~21 days). Faecal steroid hormone analysis carried out as part of a PhD study on the reproductive physiology of the Arabian leopard confirmed these observations.

The oldest leopard recorded in the studbook (Stbk # 03) is a wild caught female (currently ~22 years old) who has been in captivity for 21 years. Faecal steroid hormone analysis showed that regular ovarian activity ceased at 18-19 years of age. Nesra produced three litters in captivity, the last of which was born when she was ~11 years of age.

The youngest age at which leopards have thus far reproduced in the captive programme is three years of age for females and four years of age for males. Semen evaluation has shown that normal adult parameters are not attained before three years of age in the male although puberty is evident from two years (de Haas van Dorsser & Strick 2005). The earliest age at which oestrus behaviour has been noted in a female is twenty two months; the youngest age at which a pregnancy has been carried to term is three years. No female younger than four years has reared a litter of cubs; there is thus far no record of a dam successfully rearing



Fig. 5. Female Arabian leopard with cubs in the Breeding Centre for Endangered Arabian Wildlife, Sharjah, UAE (Photo J. Edmonds).

her first litter within the Arabian leopard captive breeding programme. The earliest age at which artificial hormonal stimulation was attempted is three years of age. Artificial insemination attempts have thus far been unsuccessful in the Arabian leopard; no pregnancies were artificially produced during a PhD study conducted at the BCEAW.

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A Framework for the Conservation of the Arabian Leopard

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A Framework for the Conservation of the Arabian Leopard. The Arabian leopard is Critically Endangered according to IUCN Red List criteria. To secure its survival, a strong partnership between the range countries, but also between governmental agencies, non-governmental organisations, and scientists is needed. Steps in the strategic planning for the conservation of the Arabian leopard include (1) compilation of baseline information (status reports), (2) definition of common goals and activities at the range level (conservation strategy), and (3) the definition of tasks and actions for each range country (action plans). The Status Reports published in this issue form the basis for the development of a range-wide Conservation Strategy. The Strategy should be developed in a participative process using a logistic framework approach, with all relevant governmental agencies of the range countries, important non-governmental organisations, and the experts involved. The Strategy should express the common will to save the Arabian leopard and provide guidance for the definition and implementation of conservation action in the countries, which are the management units. Consequently, it will be of outstanding importance that the political authorities in charge of nature conservation in each range country endorse the Conservation Strategy.

بحسب معايير الاتحاد الدولي لصون الطبيعة، يعد النمر العربي في وضع التهديد الحرج. ولضمان بقاءه لابد من قيام شراكة بين الدول التي يعيش فيها، ويجب أن يكون التعاون بين الجهات الحكومية والمنظمات غير الحكومية والعلماء. تتضمن الخطة الإستراتيجية لصون النمر العربي الخطوات الآتية (1) جمع وتصنيف قاعدة معلومات (تقارير الوضع الراهن)، (2) تحديد الأهداف المشتركة والأنشطة على مستوى دول الانتشار (إستراتيجية الصون) و(3) تحديد المهام وخطوات العمل لكل دولة من دول الانتشار (خطط العمل). تمثل تقارير الوضع الراهن، المنشورة في هذا الإصدار، الأساس لتطوير إستراتيجية صون واسعة المدى، ويجب تطوير الإستراتيجية في خطوات مشتركة تستخدم فيها هيكلية منطقية، مع جميع الجهات الحكومية ذات العلاقة في دول الانتشار والمنظمات غير الحكومية المهمة والخبراء المعنيين بالأمر. ويجب أن تعبر الإستراتيجية عن الرغبة المشتركة لإنقاذ النمر العربي وأن تقدم التوجيه لتحديد وانجاز عملية الصون في هذه الدول، والتي تمثل وحدات الإدارة. وبذلك سيكون من المهم أن يوقع على حماية البيئة في كل دولة على إستراتيجية الصون.

1. Introduction

The Arabian leopard (*Panthera pardus nimr*) once roamed throughout the mountains and forests of the Arabian Peninsula, from the Hajjar Mountains of south-east Arabia, mountains of Dhofar, through Hadhramaut to the hills north of Aden north along the mountains of western Yemen and along the Asir and Hijaz ranges to the Jordan Valley and the Negev. During the 20th century, the distribution area and population size decreased at an alarming rate, though largely unnoticed. Although the present distribution range is highly fragmented and was already discontinuous in historic times, there is good evidence that the leopard on the Peninsula including the Negev and Sinai belong to the same subspecies (see Spalton & Al Hikmani 2006). Since 1996, the IUCN/SSC Cat Specialist Group has listed *P. p. nimr* as *Critically Endangered* in the IUCN Red

List, with the justification: "The Leopard population of the Arabian peninsula is estimated to number approximately 100 mature individuals, with a declining trend, and no subpopulation estimated to contain more than 50 mature individuals" (www.redlist.org). The Conservation Workshop for the Fauna of Arabia organised annually by the Environment & Protected Areas Authority (EPAA) of Sharjah has put the Arabian leopard high on its agenda from the very first meeting in 2000. Since then, the Captive Breeding Programme co-ordinated by the Sharjah Breeding Centre for Endangered Arabian Wildlife (BCEAW) has made remarkable progress (Fig. 1; Edmonds *et al.* 2006), securing the survival of the taxon in captivity. The ultimate goal is however the conservation of the Arabian leopard in the wild. To get started on this difficult road, we

first need to compile baseline data. At the 2003 meeting in Sharjah, the Arabian Leopard Working Group decided to review all information available and to publish country-based Status Reports (this issue).

The conclusions from the Reports are not at all reassuring. The distribution range of the Arabian leopard is extremely fragmented. Only a few population nuclei remain, scattered along the rugged mountains and wadis in the south and west of the peninsula. Recent observations are confirmed only for three localities: the very small nuclei in the Negev desert, one of unknown size in Wada'a north of Sana'a, and the largest and best-preserved population in the Dhofar mountains in south Oman, probably stretching into eastern Yemen. But even the largest remnant population in south-west Oman cannot

be considered viable in the long-term, given its small total size and isolation. Several spots in the Al-Hijaz mountains of Saudi Arabia and in Yemen which had known occurrence in the 1980s and early 1990s, but with no recent observations, remain to be surveyed (Al Jumaily *et al.* 2006; Judas *et al.* 2006). An exchange of individuals between the remaining nuclei seems unlikely. The quality of the information available at present does not allow for population estimation; but we believe that the effective population size is clearly below 250 individuals.

Urgent conservation action is required, but is impeded by the fact that so little information on the Arabian leopard is available. Indeed, the only populations studied and monitored in the field are those in Oman (Spalton & Willis 1999) and in the Negev (Ilani 1980; 1990; Perez *et al.* 2006). No systematic research has been done on threats, conflicts and human attitudes, and yet, awareness building, education, and capacity building are imperative. To develop a sensible conservation action plan and to set priorities in such a situation is not easy; everything needs to be done at the same time and with limited understanding, awareness and funding.

Nevertheless, it is necessary to proceed in a careful and well-planned way in an emergency situation. The Status Reports provide baseline information for the next steps in planning, which will be (1) the development of a range-wide conservation strategy for the Arabian leopard, and, building on this general strategy, (2) country-based action plans. In this paper, we outline the requirements for and the steps towards a comprehensive conservation of this charismatic top predator of the Arabian Peninsula.

2. Scenario for the recovery of the Arabian leopard

The first priority is to assure the continued existence of the Arabian leopard as a distinct taxon. This is granted through the captive breeding programme (Edmonds *et al.* 2006). Then, the survival of the remaining wild populations must be secured. The only one with a good prognosis is presently the population in Oman. It is the largest occurrence, its core zone is a protected area and it is mo-



Fig. 1. Arabian leopard in the Breeding Centre for Endangered Arabian Wildlife, Sharjah. The Arabian leopard is one of the smallest and most endangered leopard subspecies worldwide (Photo U. Breitenmoser).

nitored. The fate of all other nuclei is at stake. One small population is nowhere near sufficient to secure the survival of the Arabian leopard in the wild. Genetic impoverishment or catastrophic events could wipe it out. To down-list the Arabian leopard from Critically Endangered to Endangered according to IUCN Red List criteria, the effective population size must be over 250 individuals, that is a total population of about 500 leopards. To regain the status of Vulnerable, the population must increase to an effective size of 2,500 individuals, which will only be possible through a considerable expansion of the presently occupied range. This is impossible for any of the present nuclei. A more realistic scenario is the recovery of several local populations, which then form a meta-population along the mountain chains of the Arabian Peninsula. First, the further decline must be stopped and the remaining nuclei stabilised. This requires improvement of habitat and prey populations and education of local people. Still, the remnant populations will likely not be strong enough to regain lost areas in the near future. Specific measures might be needed, including reintroduction or restocking using the captive population as a source. A meaningful merging of *in situ* and *ex situ* procedures calls for strategic planning.

3. Strategic conservation planning

To secure the survival of the Arabian leopard according to IUCN Red List criteria is one aspect of its conservation. Beyond this, the leopard is the top predator of the regional eco-system, and plays an important role as an umbrella and flagship species (see Simberloff 1998). Such a view implies that the Arabian leopard should be conserved in all suitable habitats of its historic range as an integral part of the eco-system, and that populations must be maintained or restored in all range countries. For effective international co-operation, we need strong partnership and an agreement on long-term goals, hence a conservation strategy endorsed by the national authorities.

The *Partnership* must include (1) national governmental organisations, providing political guidance and responsible for legal aspects (laws on nature conservation, protected areas, etc.) and implementation of conservation actions agreed, (2) non-governmental organisations and interest groups, which can support leopard conservation in many ways, e.g. stakeholder involvement, education, raising awareness and fundraising, and (3) scientific experts, responsible for compiling (biological) baseline information, surveys and monitoring using adequate methods. In this

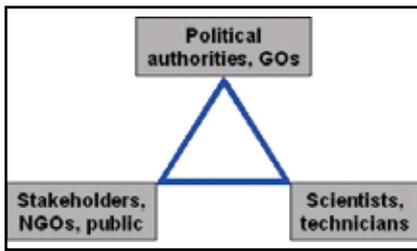


Fig. 2. Triangle of Conservation. In conservation programmes, the institutions at each of the corners play important, but different roles, which need to be coordinated. Governmental organisations are responsible for legislation, law enforcement, management, and education; scientists provide (ecological) baseline knowledge and do the monitoring; non-governmental organisations are often the front-runners of conservation projects, which raise awareness, provide first funding and education.

“triangle of conservation” (Fig. 2), each partner plays a different and important role. The pact does not only include agreement on long-term goals and co-operation, but also mutual consultation, supervision and, whenever needed, constructive criticism.

Partnership agreement, general goals and common activities are settled in a range-wide *Conservation Strategy*. The Strategy is a prevailing document providing guidance for on-the-ground

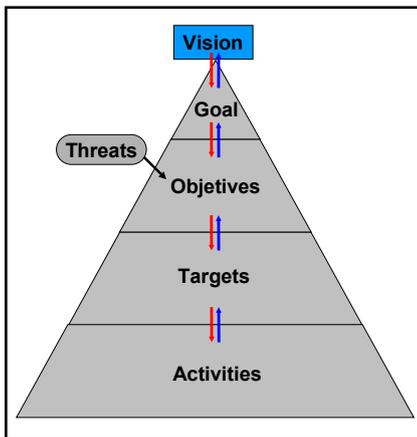


Fig. 4. Logistic framework pyramid for the development of a conservation strategy in a participative process. The group first formulates a common vision and a more concrete goal. The identification of threats and the goal allow defining more concrete objectives, targets, and activities. The pyramid represents also a time scale. The vision describes a long-term perspective, the goal a state to be reached within 10–20 years, and the activities finally actions to be done within the next 1–3 years.



Fig. 3. Arabian Leopard Working Group at the 2006 CAMP meeting in Sharjah, UAE (Photo U. Breitenmoser).

activities. The political authorities of the range countries must endorse the Strategy, so that all implementing agencies can act according to the principles agreed upon in the Strategy. The Strategy is developed in a participative process (Fig. 3) using a logistic framework approach involving all partners of the “triangle”. The LogFrame (Fig. 4) defines goals, objectives, and actions on the (international) range level and for overriding activities such as the captive breeding programme, and it is a binding agreement for the development of more specific action plans.

National Action Plans are tools for the definition and implementation of the target-driven conservation actions according to the long-term goals defined in the Strategy. Countries are the management units under a common jurisdiction, management structure and budgets. Hence specific assignments must be defined and implemented on this level. Action Plans are, like the Strategy, developed in a participative process involving all partners and institutions that will have to implement the plan or will be affected by its implementation, such as local people or interest groups. Compared to the Conservation Strategy, an Action Plan is more specific in regard to places, procedures, actors, and deadlines, and should be regularly revised and adapted.

4. Research, survey and monitoring
Research and monitoring using appro-

ved methods must be an integral part of any conservation programme. On one hand, reliable information is fundamental to development of sound and target-driven conservation activities, and on the other hand, all conservation programmes need careful monitoring allowing for continuous adaptation of procedures and actions. We still have considerable gaps in our basic knowledge regarding biology and ecology of the Arabian leopard and in our understanding of the threats causing its decline. More specific information is e.g. needed in the following domains:

- (1) Distribution and status of leopards in Yemen and Saudi Arabia. The distribution nuclei indicated in these two countries (this issue) are mainly concluded from unconfirmed observations. Sound initial surveys followed by continuous monitoring must have high priority for all potential leopard areas.
- (2) The identification of threats and conflicts are not based on explicit investigations, but rather on general assumptions. To tailor conservation actions specifically for a certain area, understanding the local people’s attitudes towards leopards is important.
- (3) Depletion of wild prey is believed to be a major reason for the decline of the Arabian leopard, but its diet and feeding ecology is not understood. A preliminary study by Muir-Wright 1999 (quoted in Spalton *et al.* 2006)

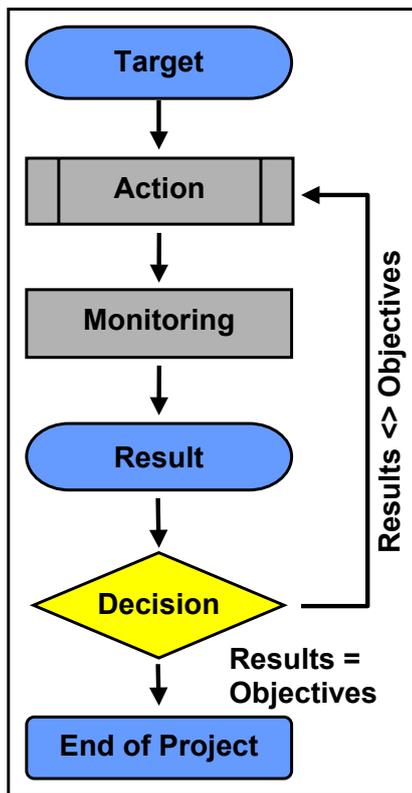


Fig. 5. Flowchart for the monitoring of a conservation project. Monitoring is an important component of any conservation activity, not only to compare the (preliminary) results with the pre-defined target, but also to recognise errors. Most conservation programmes are adaptive processes, needing continuous assessment and adjustment. The monitoring is continued as long as the results do not match the objectives defined at the beginning of the project.

of 74 leopard's scats collected in Jabal Samhan NR found Arabian gazelle (*Gazella gazella*) and Nubian ibex (*Capra nubiana*) to be the most important prey, followed by Cape hare (*Lepus capensis cheesmani*), rock hyrax, birds, Indian crested porcupine (*Hystrix indica*), Ethiopian hedgehog (*Paraechinus aethiopicus*), small rodents and insects. Judas *et al.* (2006) note that in Saudi Arabia gazelles and ibex have become rare, but they assume that the still common hyrax and even sacred baboons (*Papio hamadryas*) could be important alternative prey. Obviously, the exploitation of prey of such diverging size, distribution, and social set-up must have consequences for the leopard's behaviour, distribution, vulnerability to environmental changes, and conflict with livestock husbandry. Understanding the

leopard's feeding ecology is of utmost importance for any recovery plan.

Monitoring is crucial for the control of success and the adaptive management of any conservation programme (Fig. 5). Many different things can be monitored, like size and distribution of the leopard population, dynamics of prey populations, changes in human attitudes, etc. Monitoring is a demanding, time-consuming and expensive task, and a particular challenge in the rugged and remote mountains of the Arabian Peninsula. Well-planned co-operation and co-ordination between countries and agencies can however assist the monitoring through standardisation, calibration and adaptation of methods according to the principles of stratified monitoring (Breitenmoser *et al.* 2006).

Co-operation between countries and institutions and the principle of adaptive processes go along with reporting. Both on national and range-wide level, progress and failures need to be continuously assessed and necessary adaptations identified. On an international level, the annual conservation workshop in Sharjah would offer a perfect forum for the review of the progress in implementing the actions defined in the Conservation Strategy and in the Action Plans, and to discuss necessary changes.

5. Conclusions

The aim of strategic planning in conservation is to implement on-the-ground conservation actions. The development of strategies and plans will not save the Arabian leopard on their own, but actions in the field will. The situation of the Arabian leopard is critical, and we cannot afford to lose time. Nevertheless, jumping into action without sound baseline information and without careful planning and prioritisation of activities may, in the long run, cost a lot of money and time. In conservation, time is one of the most difficult aspects to assess. We most often do not understand the dynamics of the processes well enough to estimate how much time we have left and how much time we will need. We must be prepared to act immediately and to go on for a long time. This requires a very firm commitment from all partners involved, including the political authorities that will have to endorse the Conservation Strategy and hence place

an obligation on their wildlife conservation and management agencies.

Yet, the Arabian leopard as the top predator of the peninsula will serve as a flagship and umbrella species not only in the ecological sense of the term. Partnership agreements, strategic planning, implementation and monitoring could become a model case for many other important co-operative conservation programmes on the Arabian Peninsula.

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