Report on fieldwork to study the status and distribution of breeding sooty falcons (*Falco concolor*) on the northern islands of Oman – 2010

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Front cover: Near fledging sooty falcon from Fahal Island fitted with a satellite-received transmitter, numbered metal ring and microchip ring.

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Executive summary

- The sooty falcon is a medium-sized falcon that breeds in the Middle East and north-eastern Africa and winters along the south-eastern coast of Africa and on Madagascar.

- The sooty falcon's conservation status is "Near-threatened", and the islands in the Gulf of Oman may hold up to 10% of the global breeding population.

- Since the late 1970's there has likely been a decline of about 15% in the number of pairs holding territories on the islands in the Gulf of Oman, and human disturbance is implicated in the decline

- In 2010 we conducted a survey of sooty falcons on the Daymaniyat Islands (Nature Reserve) and Fahal Island. This added to data collected in 2007-2009. Sultan Qaboos University (SQU) faculty and students and Ministry of Environment and Climate Affairs (MECA) staff participated in the survey.

- Mean clutch size of 2.75 and mean brood size of 2.18 were recorded on the Daymaniyat Islands.

- The number of productive sooty falcon nests on Fahal Island in 2010 appeared to be similar to previous years, but the inaccessibility of some nests meant that we were unable to determine this precisely. Mean clutch size was 2.2 on Fahal and mean brood size was 2.04.

- Disturbance appears to affect occupancy or nesting territories and productivity of sooty falcons in Oman and elsewhere. In 2010 we recorded unauthorized camping on the Daymaniyat Islands and circumstantial evidence of nest disturbance there. We saw no evidence of disturbance on Fahal Island.

- A total of 14 adult sooty falcons were trapped and ringed with alphanumeric and microchip rings or retrapped (physically or electronically). Four birds that were trapped were ringed by us as nestlings.

- 58 nestling sooty falcons were ringed with alphanumeric and microchip rings.

- Feather, serum and egg samples were collected for environmental pollutant analyses by faculty at the Department of Biology, SQU.

- DNA samples have been taken from most falcons that we have handled. DNA has been extracted by faculty at SQU Department of Biology and is awaiting further analyses. DNA samples collected by us have been included in a study of the evolutionary relationships of species in the genus *Falco.*

- Data on sooty falcons were used by an SQU student for his final year project. There are training and research opportunities within this study that could benefit other students from SQU, MECA staff and other Omani institutions interested in conservation and wildlife research.

- Two nestling sooty falcons reared on Fahal Island were fitted with 9.5 g solar powered satellite received transmitters. This work is being done with the support of Microwave Telemetry and the University of Ulm.

- Satellite transmittered nestlings fledged in early October started migrating in early November and by mid December one was located at inland sites in central Africa and the other was located in Madagascar.

- The Daymaniyat and Fahal Islands are globally important breeding grounds for the sooty falcon. We recommend that an annual monitoring and research programme is established for the falcons on these islands.

- We recommend that the coastal areas near Muscat, for which baseline data from 1978 exist, are surveyed.

- We recommend that the coast and islands of Musandam are surveyed, as almost nothing is known about the breeding sooty falcon population there, and potentially it could be globally significant.

- The sooty falcon presents many opportunities for training of Omanis. We recommend that Omani institutions become more involved in the study with the aim of assuming full responsibility for monitoring and research in the future. A plan to ensure the efficient transfer of skills should be developed.

Introduction

This study and the sooty falcon (*Falco concolor*) have been described by McGrady et al 2008). The sooty falcon breeds in the Middle East and winters on Madagascar. It breeds either singly or in aggregations in the late summer (June – October), feeding its offspring on migrating birds and insects in autumn. It can breed singly or in colonies that comprise > 150 breeding pairs. Oman is considered a stronghold for this species and Fahal Island is one of the largest known aggregations of breeders in the world.

Where it has been studied the sooty falcon population seems to be in decline (Shah et al 2008, Kavanagh & King 2008, McGrady et al 2008), and recently its status has been changed from "Least Concern" to "Near-threatened" by BirdLife International (2008), which estimated the global population at 10,000 – 19,999 individuals.

A baseline population study of sooty falcon numbers and productivity suggests that they have suffered a decline of about 15% in Oman (McGrady et al 2008), which is in line with declines noted in Bahrain (Kavanaugh & King 2008). Our lack of knowledge about the sooty falcon's ecology, its status and its distribution in both its breeding and wintering ranges currently undermines our ability to conserve it (Jennings & Sadler 2006).

This report details work carried out in 2010, including surveys, ringing and biological sampling activities and satellite tagging and tracking.

Objectives

The aims of the 2010 field work were:

- to build on previous field work to establish an ongoing monitoring program for sooty falcons on the islands in the Gulf of Oman;
- to gather more information on occupancy, productivity and population demography;
- to provide more training opportunities to SQU students and MECA staff;
- to provide information useful to the MECA as the ministry responsible for managing the Daymaniyat Islands Nature Reserve;
- to collect biological samples to support contaminant and DNA analyses at SQU and the University of California; and
- to fit two juvenile falcons with satellite-received transmitters and track them.

Study area and methods

We surveyed Fahal Island and the Daymaniyat Islands Nature Researve for sooty falcons in 2010. The islands and the methods we used to survey and monitor sooty falcons are described in McGrady et al (2008).

Two near-fledging sooty falcons were fitted with 9.5 g solar powered satellite-received transmitters (PTTs; Microwave Telemetry, Columbia, MD, USA) fitted as backpacks. Birds were tracked via the 6-satellite Argos Doppler system, a non-GPS system that assigns a nominal accuracy or "location class" (LC) to each location estimate (LC-3, LC-2, LC-1, LC-0, LC-A, LC-B). The most precise (best quality) locations (LC-3) have a nominal accuracy of <150 m, but it is generally accepted that data from animals tracked by the Argos system are best applied to large-scale movements; overall accuracy is about 1-5 km for LC-1, 2, 3 and A. Because of weight constraints, GPS transmitters could not be used. Transmitters were programmed to transmit for 10 hrs then turn off for 48hrs.

We collected blood, egg and feather samples for future contaminant and genetic analyses.

Timetable and Personnel

Surveys were made during two trips: 18 August - 1 September to coincide with the egg period, and 22 September - 4 October during the nestling period. Surveys were undertaken by M. McGrady (MM), M. Gschweng (MG), W.A. Al-Fazari (WA) and S. Sayabi (SS). The surveys benefited greatly from the professionalism of the officers and sailors of the Royal Yachts (Royal Court Affairs), who provided boat transport and important help in field work on the islands. At various times employees of the Ministry of the Environment and Climate Affairs, the Office of the Advisor on Conservation and the Environment, the Diwan of the Royal Court, SQU, the Environment Society of Oman and local environmental consultants joined and helped with the survey.

Results

Occupancy and productivity - Daymaniyat Islands Nature Reserve

Sooty falcons were observed on all islands except 1 and 8. Table 1 compares the distribution of territorial pairs across the islands in different years. There were an additional 6 areas where at least a single bird was seen. WA visited D4 in June and July and noted that some territories were occupied by pairs then, but were not occupied during the survey period.

Clutch size varied from 1-4 (mean = 2.75, n = 12). One nest on D-4 failed completely between egg and nestling stage, three on D-4 and one on D-5. Mean productivity per territorial pair was 0.88 (n = 12). Mean brood size for productive nests (nests that had eggs) was 1.9 (n =12); mean brood size for successful nests (nests that produced chicks)

was 2.18 (n=11). See Tables 2 and 3. Twenty-four chicks were ringed with metal alphanumeric (British Trust for Ornithology) rings and PIT (microchip) rings. Blood-feather samples were taken from all chicks.

Table 1. Numbers of occupied territories on the Daymaniyat Islands in 2010.

Island	**2007**	**2008**	**2009***	**2010***
D-1	0	0	0	0
D-2	2	1	1	1
D-3	4	3	2	1
D-4	6	6	3	2
D-5	5	5	6	5
D-6	1	1	0	1
D-7	6	5	3	3
D-8	1	0	1	0
D-9	15	13	8	11
Totals	40	34	24	27

Notes: *, Because fewer pairs on the Daymaniyat Islands laid eggs in 2009 and 2010, pairs may not have been as tied to their nesting sites and so numbers of pairs may have been underestimated. Single birds were noted in some known home ranges.

Table 2. Sooty falcon productivity (SE) on the Daymaniyat Islands.

	1978	**2007**	**2008**	**2009**	**2010**
Territorial pairs	44	40	34	24	27
Nesting pairs	-	28	27	21	16
Clutches recorded	21	28	25	18	12
Clutch sizes recorded	21	21	21	18	12
Eggs recorded	60	69	62	41	33
Mean clutch size	2.86 (0.10)	3.1 (0.15)	2.95 (0.19)	2.41 (0.24)	2.75 (0.07)
Broods recorded	12	17	16	11	11
Chicks recorded	33	42	36	21	24
Chicks/nesting pair	-	1.5	1.44	0.89	1.5
Mean brood size	2.75 (0.21)	2.47 (0.17)	2.25 (0.17)	1.47 (0.31)	2.18 (0.09)

Table 3. Clutch size and productivity of sooty falcons nesting on the Daymaniyat Islands, 2007-2009.

Island	2007			2008			2009			2010		
	Clutches	**Successful clutches***	**Nestlings/ fledglings**	**Clutches**	**Successful clutches***	**Nestlings/ fledglings**	**Clutches**	**Successful clutches***	**Nestlings/ fledglings**	**Clutches**	**Successful clutches***	**Nestlings/ fledglings**
1	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	3	1	0	0	1	1	>2	1	1	2
3	3	1	3	3	1	3	2	N/A	N/A	1	0	0
4	5	1	2	4	1	2	3	0	0	1	1	0
5	4	4	10	4**	4**	9	>4	>4	>7	6	4	9
6	1	0	0	1	1	1	0	0	0	1	1	3
7	4	1	1	3	1	2	3	N/A	N/A	0	N/A	N/A
8	0	0	0	0	0	0	1	N/A	N/A	0	0	0
9	10	9 (10^)	23	9	8	19	8	≥6	≥12	≥10	≥7	≥12
Totals	28	17(18^)	42	25	16	36	>22	>11	>21	>20	≥14	≥26

Notes: *, successful clutches produced≥1 nestlings/fledglings; ^, signs at the nest site indicated that chicks might have fledged prior to our visit; **, at one site a pair was clearly breeding and behaviour indicated incubation in August and the presence of chicks in September but the site was inaccessible so success was not quantified. This site is excluded from the totals presented in the table.

Occupancy and productivity - Fahal Island

We identified 44 territorial pairs of falcons on Fahal Island. Fahal is difficult to survey because many nesting places are on inaccessible cliffs that can only be observed from a boat. Because sooty falcons nest in holes and crevasses, the location of a nest in an inaccessible location can usually only be determined when the adults arrive at or leave from the nest, or if large chicks can be seen. For this reason, the number of nests identified is probably below the actual value.

Clutch size varied between one and three eggs; mean clutch size was 2.22 (n = 9). Mean brood size for productive nests was 2.23 (n = 15); mean brood size for successful nests was 2.26 (n = 15). See Table 4.

Table 4. Sooty falcon productivity (SE) on Fahal Island in various study years.

	1978	**2007**	**2008**	**2009**	**2010**
Clutches recorded	13	-	24	32	42
Clutch sizes recorded	13	-	15	8	9
Eggs recorded	30	-	41	23	20
Mean clutch size	2.31 (0.17)	-	2.73 (0.18)	2.87 (0.21)	2.22 (0.07)
Broods recorded	10	9	19	30	15
Chicks recorded	24	24	48	60*	42*
Mean brood size	2.4 (0.16)	2.67 (0.17)	2.53 (0.16)	2.04 (0.16)	2.26 (0.05)

Note: *, this is a minimum number of chicks produced on Fahal in 2009 because chick counts at some sites could only be made from a distance because nests were inaccessible.

Trapping and ringing of adults

A total of 27 breeding adults have been trapped since 2007, some more than once. In 2010, 14 adult sooty falcons were trapped, either physically or electronically using the microchip reader. Eleven of those birds had been ringed by us in previous years. Four

breeding birds that were captured had been ringed by us as nestlings (2 in 2007 and 2 in 2008) and had returned to Oman to breed. Two of these were reared on Fahal and returned to breed on Fahal, one was reared on D-4 and bred on D-5, and one that was reared on the Daymaniyats returned to breed on Fahal.

Ringing of chicks

Fifty-eight chicks were ringed in 2010; in total 238 nestlings/fledglings have been ringed during 2007-2010. As mentioned above, some are returning to breed in Oman. The numbers of adults and chicks ringed each year and on each island are provided in Table 5.

Table 5. Summary of sooty falcon ringing 2007-2009.

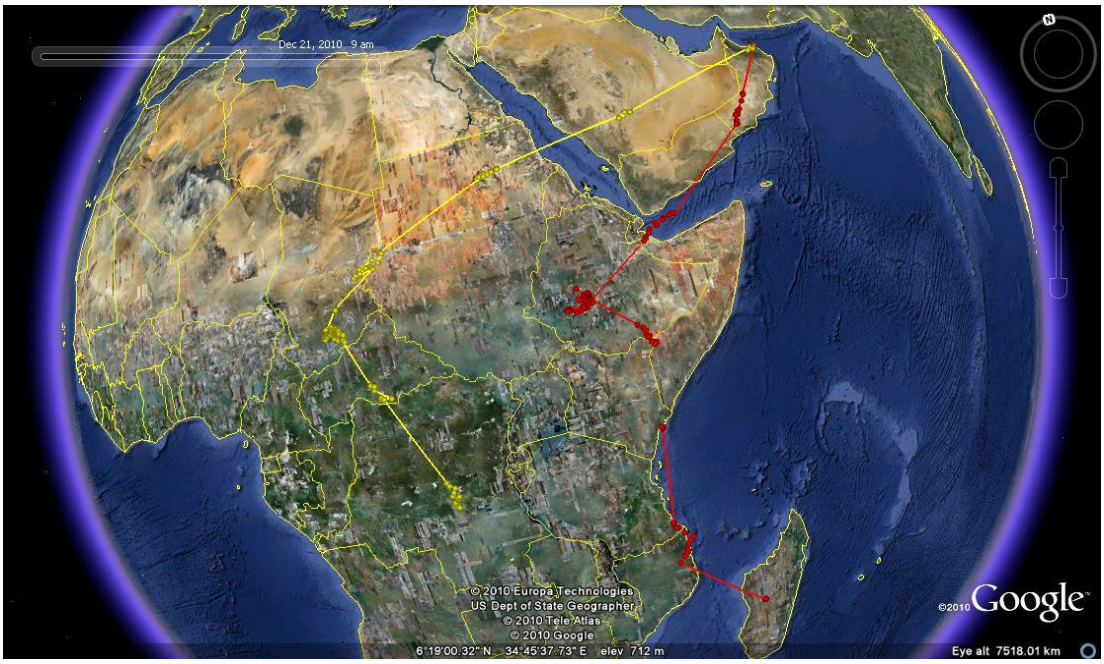
	2007	**2008**		**2009**		**2010**	
Island	**Nestlings ringed**	**Nestlings ringed**	**Adults ringed**	**Nestlings ringed**	**Adults ringed (retrapped)**	**Nestlings ringed**	**Adults ringed (retrapped)**
Daymaniyat 1	0	0	0	0	0	0	0
Daymaniyat 2	0	0	1	0	0	3	0
Daymaniyat 3	3	3	1	0	0	0	0
Daymaniyat 4	2	2	3	0	(1)	0	0
Daymaniyat 5	10	9	3	7	2(2)	8	(4)
Daymaniyat 6	0	1	1	0	0	3	0
Daymaniyat 7	1	2	1	0	0	0	0
Daymaniyat 8	0	0	0	0	0	0	0
Daymaniyat 9	22	19	2	12	0	10	(1)
Suwaydi islands	1	0	0	0	0	0	0
Fahal island	23	45	3	18	6(1)	34	2(7)
Totals	62	81	15	37	8(4)	58	2(12)

Satellite tagging and tracking

Two near-fledging falcons from Fahal Island were fitted with PTTs: Falcon ringed with BTO ring number EX11544 was fitted with PTT ID number 945598 on 2 October and falcon ringed with EX11534 was fitted with PTT ID number 94599 on 3 October. Data collection is ongoing. Details of migration are being posted regularly by us at http://sootyfalconoman.blogspot.com/

In the days following fitting of the tags, location estimates were intermittent, probably because the birds were not fully capable of flight and were sheltering in places where views of satellites were poor. Transmissions suggest that the birds fledged around 10 October. They spent about a month flying in the vicinity of their nest, and then started to migrate in early November.

EX 11534 migrated south across the central desert of Oman, and crossed the sea to the Horn of Africa (south of Djibouti) on the 7th of November. It then proceeded to the Ethiopian Highlands SW of Addis Ababa and stayed there until about 13 December when it continued its southward migration. On 14 December it was located inland near the Kenya-Somalia border, and by 18 December it had reached Madagascar, where it has remained until now 3 January 2011.



After leaving its natal area EX11544 flew across Saudi Arabia, crossing the Red Sea around 5 November. It was located in Sudan (about 400 km north of Khartoum) in early November, then moved SW into Chad. By mid November it was in Central African

Republic and by 10 December was located in central Democratic Republic of Congo. It has not been heard from since 12 December and so we fear that either the bird has died or the transmitter has malfunctioned.

Discussion and Conclusions

As in 2009 field work was constrained by the time available due to other commitments, the timing of the Holy Month of Ramadan, and a smaller field team than in 2007-2008. It seems to be most effective to have two teams of two people undertaking the survey, trapping of adults and marking of nestlings. Securing funding for our time in the future will ensure that this fieldwork does not fall victim to prioritization of time and resources. Ultimately, the benefits that come with establishing a long-term study will be best realized by developing in-country expertise through training of Omanis working for government, the university or local NGOs.

Having collected four years of data we now have a better idea of the range in variation in annual productivity data. We do not know the reasons for the variation, but it is probably linked to the availability of food throughout the time falcons are in Oman, and maybe conditions on the wintering grounds. Food supply can affect the breeding performance of raptors by reducing the proportion of breeders that lay eggs, the size of clutches, the size of broods and the proportion of nestlings that fledge (Newton 1979).

Many studies of small falcons and other raptors link food supply and breeding success (e.g. Village 1990), and our data point to this link existing in sooty falcons. Annual variation in breeding statistics is more pronounced on the Daymaniyat Islands, which are farther from the mainland than Fahal Island. It may be that sooty falcons on Fahal Island are able to commute to the mainland to hunt over the mainland (near Muscat) where potential prey is present in the gardens and parks. Also, although we did not collect data on prey availability, we noted that in 2007, the most productive year so far, a locust swarm provided additional food for sooty falcons prior to egg laying. A comprehensive multi-year study of prey availability and diet could illuminate the relationship between productivity and food and be the basis for a post-graduate degree. A simple diet study

could be done by a student and may not require actual field work by that student if prey remains collection is done by a field team. This may facilitate the study being undertaken by a female. There are many more female Biology students than male at SQU.

Disturbance may have played a part in the low numbers of successful pairs. McGrady et al (2008) called attention to a potential disturbance effect by noting that the islands most accessible and attractive to people landing were where the greatest declines were seen. As in 2009, no fledglings were produced on D1 or D4 in 2010. D1 supported a single pair of breeding falcons in 1978 (Walter 1979). The location of this site is near a place where people land and camp illegally. When we visited D1 in August there was a party of >10 people camping there and the camp seemed to have been occupied for a number of days. D4 can support 5-6 home ranges, and these seem to be occupied in every year. In 2010 only a single pair hatched chicks on D4, at a location about 30 m from the ranger's accommodation. These nestlings disappeared sometime between 15 September and 24 September. Disappearance coincided with a change in work schedule by rangers due to Ramadan. The timing of disappearance, the lack of potential natural predators, and the accessibility of the nest site suggests to us that birds were removed from the nest by people during that time, and highlights the role the presence of rangers can play in deterring disturbance.

We speculated that reduced apparent occupancy in 2009 (relative to 2007 and 2008) was the product of lower food availability (McGrady et al 2009), and evidence gathered in 2010 seems to support this notion. During visits to D4 in June and July 2010 WA recorded occupancy of sites by sooty falcons where we later (August and September) recorded no falcons. This suggests to us that home ranges may be occupied early in the breeding season, but if birds fail to lay eggs or abandon the breeding attempt they may no longer remain in the home range, and so measures of occupancy made in August and September may be made too late to give an accurate picture of occupancy rates. Although occupancy data would be useful because it would more closely approximate the total breeding population on the islands, they would be best collected during the early breeding season (June) before breeders that are unsuccessful become more nomadic.

Also, as mentioned by McGrady et al (2009) methodologies would have to be developed for islands (e.g. Fahal) that are more difficult to survey.

We think that the lower number of breeding birds and lower breeding success in 2009 and 2010 on the Daymaniyats probably fall within the "normal" annual variation of these statistics. As discussed above, we think the main driver for this is the availability of food, with human disturbance playing some unquantified role. The data in 2010 do not argue against the main conclusion of McGrady et al (2008): that the population of breeding sooty falcons on the islands of the Gulf of Oman has declined (perhaps 15%) since 1978, though it remains globally important (Gaucher et al 1995).

Perhaps the most interesting "findings" in 2009 were related to ringed birds. In 2010 we captured as breeders falcons that were ringed by us as nestlings. The relatively high number (4) of these in relation to the overall number of falcons ringed as nestlings could point to: the global population being relatively small, the islands in Oman as being an important source of future breeders, the islands being an important breeding place, fidelity of breeders to their natal sites. These possible causes for the high number of breeders marked as nestlings by us are not mutually exclusive. High overwinter mortality of adults is not currently implicated because we are also capturing breeding adults year after year.

Mark-recapture studies, as their name implies, use the marking of animals and their recapture to understand the population structure and dynamics. Mark-recapture studies can provide data critical to conservation including information on annual mortality rates, recruitment of new breeders and overall longevity. For this reason and because we now have a large number of marked individuals, this aspect of further study should be a focus. It provides not only the opportunity to collect data important to understanding the status of sooty falcons globally and in Oman, but is a training opportunity for students and employees of government and NGOs involved with wildlife.

In June 2009, Natural Research teamed with the Environment Society of Oman (ESO) to win an award from the Ford Foundation. That award paid for equipment that reads the microchip rings on birds. In 2010 we were able to identify two birds using this method rather than physically capturing them. In the future as a larger percentage of breeding birds is marked with microchip rings trapping efficiency should increase and therefore data useful to population modelling will be collected at a higher rate. In this way we will be able to "capture" birds electronically, thereby reducing disturbance on falcons and increasing the number of falcons we can trap. Because mark-recapture studies benefit from having large number of animals marked, we have provided microchip rings to colleagues studying sooty falcons in the Red Sea. In this way we will be able to electronically capture any marked birds from the Red Sea that come to nest on the islands in the Gulf of Oman. In winning the award one benefit of close partnership with Omani institutions has been demonstrated. Additionally, these microchip readers can also log data and so studies of nest site attendance by adult sooty falcons could be undertaken. Such a study might lend itself to be done by a student at SQU.

Fitting PTTs to sooty falcons is an exciting new aspect of the study. If birds and transmitters survive we will collect data important in understanding the movements and ecology of sooty falcons in the years prior to becoming breeders. Because at the time of writing this report we are still following these birds and only one bird has reached its presumed wintering area in Madagascar, it is premature to discuss in depth their movements. From what we have seen they have not followed the path used by an adult sooty falcon that nested in Abu Dhabi and was followed to its wintering area in 2008, rather they have moved through inland areas of Africa. It may be that the movements and migratory pace of these birds are at least partially affected by food availability along the way, especially availability of insects including termites.

Information on movement of sooty falcons and locations of their wintering areas is important to their conservation, and provides data that could be useful when designing ways to make more accurate population estimates by surveying during winter.

The blog is visited regularly by people in Oman, Europe and North America. This promotes sooty falcon conservation and raises global awareness of Oman and its wildlife. Our aim is to maintain the blog site so as to keep people informed about the birds' movements. The blog could possibly be used as an educational resource by Omani institutions.

As data accrues from the tracking that aspect of the study will become somewhat self contained, while providing context for what we see on the breeding grounds in Oman (especially if the tagged birds come to breed in Oman). It is likely that the tracking itself will produce a peer-reviewed paper, however the sample size is very low and arriving at a more robust understanding of pre-breeding ecology, and migration ecology would require that more birds are marked with PTTs.

DNA has been extracted by Dr. Aliya Al Ansari of the Biology Department of SQU. We are currently seeking collaboration from laboratories that have experience in analysing falcon DNA. The provision of samples to the University of California for their studies is seen as a first step in this process.

Although shade seems to be important in nest site selection in Oman, information from Egypt suggests that in some places sooty falcons nest successfully in direct sunlight (I. Moldovan pers. comm.). Natural Research has 10 data loggers that could record nest site temperature throughout the breeding season. We brought these to Oman in 2009, but because of time constraints were unable to deploy them. A study of nest site microclimate and attendance by adults would be a good post-graduate study topic for an SQU student. Because field work could be minimal, such a study might lend itself to being done by a female.

Suggestions for the future

Many of the suggestions made in earlier years remain in force.

- The Daymaniyat Islands Nature Reserve and Fahal Island are nationally and internationally important breeding sites for sooty falcons. Therefore, monitoring of the breeding population and productivity in conjunction with a ringing and recapture programme should be conducted annually.

- Training of the MECA rangers would allow them to become involved in the monitoring programme, and make them more effective in protecting the Daymaniyat Islands.

- Blood, feather and egg samples should be routinely collected and a comprehensive study of contaminants conducted. Feather and egg sampling protocols could be taught to rangers

- Genetic studies to understand the population structure at both local and regional levels should be conducted.

- Given that the numbers of falcons on the Suwaydi Islands are relatively low and most sites seem to be in inaccessible locations, we think that monitoring of the Suwaydi Islands need not be conducted annually. However, given their close proximity to the mainland we suggest that simple surveys of these islands are conducted every two-three years.

- A survey of the coast, perhaps as far as Ras al Da'oud, should be undertaken, as should a survey of Musandam (probably in early October when chicks are large and seas are calmer after the main monsoon season).

- In terms of their conservation, it is important to know more about their migration and winter ecology and the ecology of young birds before they become breeders. Further studies are therefore required. These could be undertaken using satellite tracking technology (expensive but relatively accurate) or light recording data loggers, so called "geolocators" (cheap but relatively inaccurate).

- It is important that human disturbance is controlled and that ground predators are not brought to the islands. If Indian Crows (*Corvus splendens*) move onto the islands, these should be shot.

- Breeding sooty falcons aggregate at high densities on islands off the north coast of Oman where they can be studied intensively with relative ease. This offers a unique opportunity to provide training and conservation/ecology education to university students, MECA biologists and rangers, researchers and conservationists from other government agencies and industry and the wider general public in Oman. An integrated research and training programme should be developed.

- The occurrence of sooty falcons in Oman is attractive to tourists. There is potential added value to tourists who visit the waters around the islands for

diving, and an educational opportunity to teach visitors more about Oman's natural resources.

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