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Conservation introduction of the Arabian Tahr to Sir Bani Yas Island, Abu Dhabi Emirate, UAE: challenges and lessons learnt

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Abstract
The Arabian tahr (*Arabitragus jayakari*) is a mountain ungulate endemic to the Arabian Peninsula and found only along the Hajar Mountain range that extends between the United Arab Emirates (UAE) and the Sultanate of Oman. In the UAE, the Arabian tahr was known to be present in two locations, namely Wadi Wurayah in Fujairah Emirate and Jebel Hafeet in Abu Dhabi Emirate, but no sightings have been recorded from Wadi Wurayah since 2013. A conservation introduction project was initiated to create a population of semi-wild Arabian tahr that would be better suited for reintroduction into their historic range. The population on Sir Bani Yas Island in the Arabian Gulf in Abu Dhabi Emirate has generated many challenges and lessons learnt as an individual were lost to predation and another to injury. The lessons learnt were that a released population should be sufficiently large to cope with losses; as losses in small populations can be catastrophic. The management of this project via a multi-disciplinary committee comprising all stakeholders has been very effective in resolving issues and making urgent and important decisions. This "half-way house" conservation introduction (placement of species outside their historic range for conservation purposes) project can be useful for creating semi-wild populations for release and also have an important educational awareness component.

Introduction

The rugged mountains of the Hajar Mountain range (N23.85°, E056.68°) that spans between the United Arab Emirates (UAE) and the Sultanate of Oman are inhabited by a unique species of ungulate that is related to the wild goat, known as the Arabian tahr (*Arabitragus jayakari*). The Arabian tahr is one of three species which were, until recently, classified in a single genus, Hemitragus. The other two species are the Himalayan tahr (*Hemitragus jemlahicus*) and Nilgiri tahr (*Nilgiritragus hylocrius*). Genetic analysis split the tahr into three genera with the Arabian tahr now classified as Arabitragus (Ropiquet and Hassanin 2005). This species of tahr only occurs in UAE and Oman. In the UAE, the tahr is found in two places, Wadi Wurayah (N25.392813°, E056.269532°) in Fujairah Emirate and Jebel Hafeet (N24.061924°, E055.771868°) in Abu Dhabi Emirate (Al Zaabi and Soorae 2015). However, there have been no recent sightings in Wadi Wurayah National Park in Fujairah Emirate, which is approximately 224 km^2, including a 92 km^2 buffer zone, despite intensive camera trapping since 2013 (Maral Chreiki, *personal communication*). Using camera traps, the Terrestrial and Marine Biodiversity Sector (TMBS) team of the Environment Agency, Abu Dhabi, was able to capture initial images of Arabian tahr on Jebel Hafeet (Al Zaabi and Soorae 2015). The last confirmed sighting of the Arabian tahr on Jebel Hafeet was in 2004 by the Arabian tahr Conservation Group, Sharjah (ATCG). In the Sultanate of Oman, the Arabian tahr occurs along the Hajar Mountain range in the north of the country.

The Arabian tahr is listed as endangered in the IUCN Red List (IUCN 2016), but not listed on the CITES appendix as it is not threatened by unregulated international trade. The Sultanate of Oman mentions this species in the Convention on Biological Diversity (CBD) and is in the process of protecting it (CBD Oman 2016). The UAE mentions the protection of important habitat in the country such as Jebel Hafeet where the Arabian tahr occur (CBD UAE 2016). Conservation plans for this species were suggested as early as the mid 1970's (Harrison 1976, Harrison and Gallagher 1974) and a range of conservation efforts and awareness programmes have been carried out to date (Wood 1992, Robinson 2005).

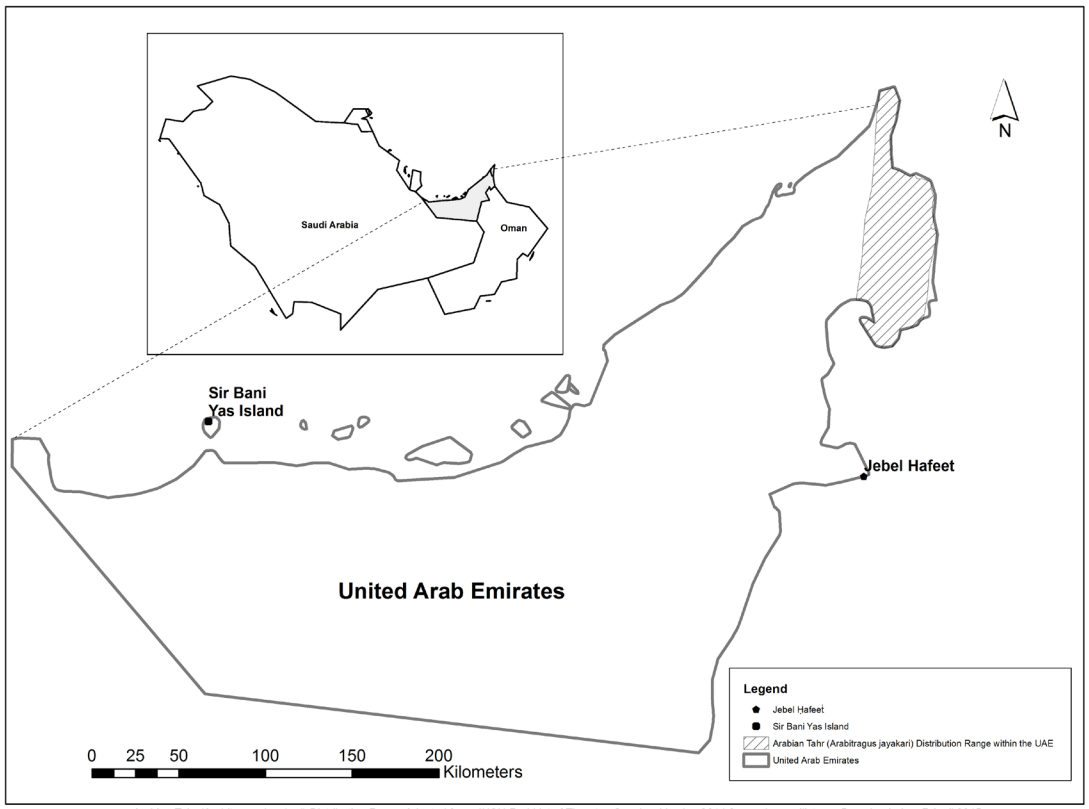

Figure 1. Arabian tahr historic range and release site on Sir Bani Yas Island

A plan was developed to create a "half-way house" population, that would be raised as a semi-wild population to produce individuals suitable for re-introduction into their historic range. The chosen site was the Sir Bani Yas Island (SBYI, N24.31751°, E052.60470°) in the Arabian Gulf, Abu Dhabi Emirate (see Figure 1). This plan was considered a conservation introduction, as per the IUCN Guidelines for Re-introductions and other Conservation Translocations (IUCN 2013) which refers to the intentional movement and release of an organism outside its indigenous range for conservation purposes. Conservation introductions are an increasingly common strategy in species restoration efforts when no suitable area occurs in the species historic range. For example, the Philippine crocodile (*Crocodylus mindorensis*) was moved outside its historic range to increase the wild population (Manalo et al. 2016). A sub-population of Tasmanian devils (*Sarcophilus harrisii*) were moved to islands offshore from Tasmania that were free of the devil facial tumour disease to establish a disease-free population (Wise et al. 2016). Similarly, the current move to SBYI represented a move to an enclosure on an offshore island, which also houses other introduced species including predators; chances of species becoming feral are limited.

Intervention: Conservation Introduction Planning

A feasibility workshop conducted in June 2014 on SBYI looked at the three main criteria for developing a conservation introduction plan: a) habitat availability/suitability; b) species biology; and c) social and political concerns associated with the plan. Following these criteria the main issues and concerns with this conservation introduction and whether it would constitute a feasible project were considered.

Multi-disciplinary Committee

A technical multi-disciplinary committee was created comprising representatives from: government agencies (Environment Agency, Abu Dhabi, EAD); a Tourism Development and Investment Company (TDIC); Barari Forest Management (BFM); a wildlife and conservation service provider that manages SBYI's flora and fauna; and a non-commerical zoological institution i.e. Al Bustan Zoological Centre (ABZC). This committee came to the conclusion that a conservation introduction (IUCN 2013) should be initiated to create a population of tahr on SBYI, in the Arabian Gulf, Abu Dhabi Emirate. This committee established a platform to unite various conservation organisations involved in the conservation introduction of Arabian tahr, including those interested in genetic improvement and breeding exchanges. The committee also acted to oversee and evalute the project, devise future strategic planning and write the necessary documentation to support these actions. All decisions, permissions and evaluations related to the introduction fell within the scope of this committee.

Objectives

The objective of this release was to create a population that would persist in semi-natural surroundings and act as a source population for future releases within the historic range. This "half-way house" would aim to breed individuals better suited to a wild existence and provide an adaptive learning environment for previously fully captive individuals to acquire skill-sets needed for survival in a semi-wild and free-living environment. A five-stage strategy was formulated and adopted: stage 1, breed the species *ex-situ* from selected captive animals sent to SBYI to undergo a dedicated re-wilding programme, involving a transition towards the provision of conditions required for populations to be self-

sufficient in the wild (Price 2011); stage 2, initial orientation stage provided animals time to recover after transfer to SYBI in a small camp; stage 3 and 4, animals were released into an 11 hectare (ha) camp simulating the natural environment, providing opportunities to learn new skills required to survive in the wild; and finally stage 5, release animals into camp (55 ha) where they should adapt to natural conditions (searching for food, water and shelter). Animals which reached stage 5 would be available for re-introduction to their historical range following current IUCN guidelines (IUCN 2013).

Additional outcomes of this release project was the development of protocols for the conservation introduction of the Arabian tahr into semi-wild conditions, which would provide useful lessons for future initiatives. Finally, it was hoped public awareness would be stimulated for a flagship species as a tourist attraction on SBYI, which is a key eco-tourism destination, and awareness of a lesser-known species such as the Arabian tahr would be achieved.

Habitat Availability/Suitability

Site Selection

SBYI was chosen because it is a large island with high wildlife diversity, including many species that are involved in conservation and tourism services. The site also has an existing wildlife-related infrastructure with a large team of wildlife biologists and botanists whose experience and skills would be useful for this project. Another reason for choosing SBYI was to include the Arabian tahr into a programme of public education and awareness, as it is an exceptional species.

Pre-Release

The SBYI release site had steep concave scarps and mid-slopes on the mountainous central northern portion, surrounded by moderately undulating valleys. The mountainous central dome was largely ecologically undisturbed. There were isolated patches of irrigated tree plantations such as umbrella thorn (*Vachellia tortilis*), ghaf (*Prosopis cineraria*), toothbrush tree (*Salvadora persica*), Christ's thorn (*Ziziphus spina-christi*), date palm (*Phoenix dactylifera*) and mesquite (*Prosopis juliflora*). Grasses and shrubs recorded included perennial grasses such as drop seed grass (*Sporobolus spicatus*) and blue-seed grass (*Tricholaena tenerrifae*). Other plant species recorded were purslane-leaved aizoon (*Aizoon canariense*), dill (*Anethum graveolens*), Arabian primrose (*Arnebia hispidissima*), turnsole (*Heliotropium bacciferum*), sweet-clover (*Melilotus indicus*), frog-fruit (*Phyla nodiflora*), Madras leaf-flower (*Phyllanthus maderaspatensis*), shore-line purslane (*Sesuvium portulacastrum*), black night-shade (*Solanum nigrum*) and yellow fruit night-shade (*Solanum xanthocarpum*). In this area rainfall is low and sporadic and the infiltration rate of the sandy soil high, resulting in little or no natural drinking water for animals. Once individuals were released into the larger 55-ha camp, an artificial water supply system would need to be designed to replicate water sources present in the wild of the historic range.

Surveys of potential sites were carried out on SBYI via an aerial survey and ground truthing. Aerial photographs with a pixel resolution of 2.8 cm were taken with a Sony NEX 5 mounted on an Unmanned Aerial Vehicle (UAV) and flown at an altitude of 80 m above ground level. A digital terrain model at 20 cm resolution was then developed through photogrammetry according to Leon et al. (2015). Terrain modeling was then performed on GIS software to determine macro- and micro-topography. It was necessary for the site to meet the species' requirements of shelter and protection: defined as broken slopes, steep escarpment or rocky outcrops with a minimum size of 0.3 km^2 per family group, with natural vegetation for shelter and shade, have safe drinking water and natural browse (the latter could be artificially supplied) (Robinson 2005). It was also important the site meet the objectives of the tourism focus of the company that manages the island as a resort.

Potential sites were narrowed down to three, based on the following four factors: 1) natural resources including cover, availability of water and food, topography (aspect and slope); 2) physical requirements of the animals including available infrastructure, potential human conflict, pollution and ease of access; 3) ecological factors such as animal behaviour, health concerns and protection against predators; and 4) social and management factors such as availability of development funds and support for the release process. All three sites were then placed on matrix table to determine the most suitable site using weighted linear, spatial multi-criteria decision analysis (Drobne 2009). Subsequently, a suitable site was chosen. An ecological study and interpretation of the aerial photos confirmed little natural vegetation. There were however, three local plantations of *Salvadora persica*, *Vachellia tortilis* and *Ziziphus spina-christi*. The site had easy access for maintenance of infrastructure and for tourists, was large enough to allow for expansion in the future, and was sufficiently remote to prevent conflict with humans and was fenced.

Post-Release

The chosen release site was 66 ha and divided into two sections. The larger 55 ha section would allow animals to roam freely once they had adapted to conditions on the island; hereafter referred to as the Release Camp. The second 11 ha section had a 2.5 m fence which extended underground by 20 cm and functioned as an introductory area for acclimation, supported by a quarantine area in the north-eastern corner consisting of four introductory pens, each containing a water basin, shade, boulders and trees, as well as, pellet and grass feeders.

Selection process

Obtaining suitable individuals for this conservation introduction was challenging as captive Arabian tahr are not currently listed in studbook, so most information was retrieved from ZIMS (Zoological Information Management Systems), representing records of current members of Species360. The captive Arabian tahr population comprised 91 animals in seven institutions (Species360 2017). Captive-bred individuals were acquired from Al Bustan Zoological Centre (ABZC), Sharjah Emirate, UAE, which has a successful track record in breeding this species and their institutional conservation goals aligned with the conservation introduction. ABZC coordinated and led the selection process for individuals considered best suited to the conservation introduction, considering their demographic, genetic and health status. Arabian tahr live in small family groups of between three and five animals with one adult male (Robinson 2005); though wild sightings and camera traps have observed one to three individuals (Al Zaabi and Soorae 2015). Literature suggests a minimum area of 33 ha per free-roaming male; which was used a when delimiting the area required for relocation relative to the number of animals selected.

Social learning of new environmental adaptive skills, required in the released individuals that are being translocated from an intensively-managed zoo environment to a semi-wild introduction area, may increase the success of the introduction process. According to Coussi-Korbel and Fragaszy (1995) more extensive and more frequent behavioral coordination in time and space will be achieved among groups exhibiting an egalitarian or tolerant style of social dynamics. Therefore, the social structure of the introduced herd was manipulated to achieve better environmental adaptive learning, thereby increasing the success rate of the conservation introduction. The different approaches in re-introduction research include a range of activities which have been studied to improve the outcomes for the release of

captive-bred animals; for example, simulation modeling can assist in increasing the success of re-introduced populations (Seddon 2007). The evaluation of re-introduction projects and sharing of results, whether positive or negative, are essential in building a reference framework for similar future projects to increase the success of re-introduction projects.

The animals bred at ABZC and sent to SBYI for the conservation introduction comprised: a) one adult female born in 2011 with two generations of known parentage who had previously bred twice at ABZC; b) one juvenile female born in 2014 to the adult female a) with three generations of known parentage; and c) one juvenile male born in 2014 and unrelated to the females, with one generation of known parentage. The juvenile's mother died from trauma when he was 15 days old and he was hand-reared by ABZC staff. As all animals were born in captivity they were naïve to the natural environment. The initial founder population of three individuals was considered small but efforts would be made in the future to increase the population (and subsequent genetic diversity).

Veterinary screening and animal transportation

Veterinary protocols for this conservation introduction were strictly enforced and follow a three step process: 1) pre-translocation testing; 2) vaccination; and 3) translocation to the island.

Pre-translocation testing

Between BFM and ABZC, the Arabian tahr were tested for diseases commonly associated with this genus (*Arabitragus*) that are high profile and prevalent within the region (Table 1). In addition, bacteriology of faeces for Salmonella, Campylobacter and Yersinia and Parasites were conducted including biochemistry and haematology analysis.

Vaccinations

To ensure the animals being imported onto SBYI were not naïve to diseases on the island, they were vaccinated for Pasteurella, Clostridium, PPR, lumpy skin disease (LSD) and FMD. All vaccines were given after pre-translocation testing and after the reading of the intra-dermal skin testing for TB.

Table 1. Disease tests undertaken on the Arabian tahr (OIE, 2014)

Disease name	Pathogen	Diagnostic Test Type
Foot and Mouth Disease (FMD)	Genus *Aphthovirus*	Antigen ELISA
Rift Valley Fever (RVF)	Genus *Phlebovirus*	Antigen ELISA
Brucellosis	*Brucella abortus* and *Brucella melitensis*	Rose Bengal Test (RBT) and ELISA
Peste des petits ruminants (PPR)	Genus *Morbillivirus*	Competitive ELISA
Coxiellosis or Query (Q) fever	*Coxiella burnetii*	ELISA
Blue tongue	Genus *Orbivirus*	Competitive ELISA
Contagious Caprine Pleuropneumonia (CCPP)	*Mycoplasma capricolum* subspecies *capripneumoniae*	Complement fixation test (CFT) and Competitive ELISA
Tuberculosis (TB)	*Mycobacterium bovis*	Delayed hypersensitivity test
Para tuberculosis or Johne's disease	*Mycobacterium avium* subspecies *paratuberculosis*	Complement fixation test (CFT) and ELISA

Translocation to the island

Selected animals were subsequently transported to quarantine for 30 days; separated from the main herd and at least 500 m from other zoological livestock and 1 km from domestic livestock. After the quarantine period, the animals were transported to SBYI in standard IATA transport boxes (IATA 2016). Upon arrival animals were moved to the conditioning pens in the management camp. The quarantine area was 66 m x 54 m and consisted of four introductory pens measuring 43 m x 66 m. The animals were kept in these pens to let them acclimatise to the island environment under strict monitoring for two weeks. Then the gates of the conditioning pens were opened to allow the animals to freely explore the management camp.

Monitoring daily every 30 mins during the morning and evening included the animals' feed consumption, health status, behaviour, habitat use, social interactions and movement. A known amount of feed was offered to the animals and remaining feed was collected and weighed the next day to calculate the amount of feed consumed. The tahr were fed 3.5% of their body weight daily, consisting of 30% concentrated pellets and 70% alfalfa. Browse, which in nature is the only source of food, was also offered *ad lib*. Different plants naturally occurring in the wild were experimentally offered to assess their preferences to browse. Behaviour, social interaction, movement and habitat use was observed daily from a vantage point without interrupting the animals. These data were collected using four camera traps (Reconex PC800 Hyperfire Professional IR), and direct observations were made for 30 minutes in the morning and 30 minutes in the evening and all data were transferred to standard data sheets. These data will be used to create guidelines on the aforementioned parameters for future releases of these species.

Socio-economic and Political concerns

This project has been highlighted in various local newspapers both in the Arabic and English press, such as the The National (http://www.thenational.ae/uae), Khaleej Times (http://www.khaleejtimes.com/) and Al Bayan (www.albayan.ae/). The project was also highlighted on social media, such as Yahoo Maktoob (https://en-maktoob.yahoo.com/). Information on the project has also been presented at various conferences and workshops such as the 2nd Annual Arabian Zoo and Aquarium Conference held in Al Ain in 2014. Visitors can view the Arabian tahr in their natural habitat without disturbing from a vantage point and show

Table 2. Chronology of significant events of the Arabian tahr release onto Sir Bani Yas (Pop = population)

Date	Individual	Significant event	Pop.
26 September 2014	Adult female Juvenile female Juvenile male	Arabian tahr released into the pen on Sir Bani Yas Island (11 ha camp)	3
14 November 2014	Juvenile male	Fatal attack by striped hyena	2
15 December 2015	Adult male	Additional male released into group to bolster the population	3
4 January 2016	Adult female	Fatal leg injury despite treatment	2
30 June 2016	Birth recorded	Evidence of successful mating	3
Current population as of 20 October 2016			3

deep interest in knowing the background, conservation efforts and importance of the project towards the re-introduction of species back into their historic range. The fact that the species is endemic to UAE and the Sultanate of Oman also adds a sense of traditional attachment of the local community towards this species and project. Many guests have shown interest in entering the management camp and closely interacting with the animals; a request that had to be turned down at the current stage of the project but will be incorporated once the population at SBYI is at a more sustainable level and has adapted well to the habitat on the island.

Discussion

The chronology of significant events that have impacted upon the SBYI Arabian tahr conservation introduction project is summarised in Table 2. After the initial release of two females and one male in September 2014 into the 11 ha camp, there was a mortality event due to predation by a striped hyaena (*Hyaena hyaena*), from a population of introduced carnivores that were free-roaming on SBYI (2 individuals) but were re-captured and returned to enclosures after this incident. The hyaena breached the double perimeter fence and attacked the naïve Arabian tahr in November 2014 who showed no flight response to this predator, likely attributed to its captive existence. This risk factor had been under-estimated but provided a valuable lesson that even in a semi-wild enclosure the danger from predators is real and the captive Arabian tahr needed to quickly learn survival skills on predator avoidance. The remaining tahr are now exhibiting anti-predator behaviour and it is hoped that this nucleus will 'teach' this behaviour to new additions and that "safe predator exposure" can be arranged to ensure the Arabian tahr learn predator avoidance skills.

After supplementing the group with an adult male Arabian tahr in December 2015, there was another mortality event in January 2016 when an adult female was involved in an unfortunate accident that resulted in injury and subsequent death while under treatment. The most current significant event has been the mating between the supplemented male Arabian tahr in December 2015 and resident female that resulted in a new born kid in June 2016. The current population on Sir Bani Yas Island therefore stands at three individuals.

Generally, small populations are less stable when compared to larger populations. Currently there have been two tahr lost, one to predation by a hyaena and the other due to a leg injury which led to further complications and its untimely demise. This means the project has faced a significant mortality rate and there is an urgent need to supplement the population with more individuals and establish a stable breeding herd to increase the population and ultimately produce Arabian tahr suitably adapted for release into their historic range. The release should have aimed to place more individuals in the release area to buffer the effects of unforeseen mortality events. The initial release was based on the assumption of 33 ha per adult male (Robinson 2005) and in phase 1 there was only 11 ha available. The useable habitat for the Arabian tahr should be taken into consideration (Paton and Matthiopoulos 2015), as this species prefers rocky mountainous habitat over sandy plains it is important to ensure during site selection that most of the site comprises preferred habitat. Also, in future attempts, such introductions should attempt to stock the minimum number of founder animals as mentioned by Wood (1992).

The Arabian tahr committee was seen as a positive management factor in this project as it was able to convene at short notice and was instrumental in making important decisions as and when required. Despite staff turnover, new replacements were provided, to ensure the committee successfully carried out its mandate.

As a way forward, we propose that the lessons learnt from this half-way house approach be fed into future tahr re-introductions into their historical range. There also needs to be a critical review of all processes, such as enclosure size, minimum population size, predator avoidance, diet manipulation from captive to wild, social learning in naïve individuals and non-invasive monitoring of individuals during all stages of the project. Half-way houses could additionally be used as "soft release" pens within the historical range of the species. Finally, we advocate ensuring full collaboration and cooperation with local, national and regional partners.

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