Proceedings of the

15th Annual Conservation Workshop for the Biodiversity of Arabia

Wildlife Reintroductions, Small Mammal Survey Techniques and Captive Carnivore Care

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Wildlife Reintroductions, Small Mammal Survey Techniques and Captive Carnivore Care

3-6 February 2014

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Executive Summary

The Fifteenth Annual Conservation Workshop for the Biodiversity of Arabia was held at the Breeding Centre for Endangered Arabian Wildlife (BCEAW) in Sharjah, UAE, from the 3-6 February 2014.

This year's workshop included three themes: wildlife reintroductions, small mammal survey techniques, and a new veterinary strand that focused on captive carnivore care.

The overarching theme of Wildlife Reintroductions was a natural follow-on from the previous year's workshop theme: Species Conservation Planning. The recently completed and fully revised *IUCN Guidelines for Reintroduction and Other Conservation Translocations* was introduced at the workshop and delegates practiced applying the guidelines, including project definitions, goal setting, feasibility and risk assessment, release site selection, release strategies, post-release monitoring programme design, to five regionally important species: the Nubian ibex, Arabian wolf, Arabian tahr, wonder gecko and Arabian oryx.

The technical component of the workshop was in direct response to one of the recommendations from 13th Conservation Workshop for the Biodiversity of Arabia in 2012 where training in small mammal survey techniques was identified as a regionally important topic requiring attention. Further, it was recognised that small mammals are ideal focal species for attempts to understand the biogeography of the region due to their size, ubiquitous distribution and relative ease in surveying. This theme focused on a variety of interconnected topics related to the study of small mammals, including: capture and handling; preparation of specimens; identification; and biodiversity and ecological surveys.

This was the first year to have a veterinarian theme as part of the workshop. This component was included in response to the realisation that there are an increasing number of wild and exotic animals in captivity and in the care of veterinarians. Some of these animals will be used in reintroduction programmes: building closer ties and relationships between veterinarians and other wildlife professionals will be important in any reintroduction attempts. In addition, it exposes veterinarians to the 'bigger picture' of wildlife conservation and helps wildlife professionals to understand the contribution of veterinarians to wildlife conservation.

Captive carnivores were the focus for this theme as carnivores present unique challenges in the field of veterinary science and captive care. Future workshops will address other taxa and their associated challenges.

The captive carnivore theme covered relevant legislation, the composition and application of F10 disinfectant; facility planning; biosecurity, nutrition; primary healthcare; medical husbandry training; behavioural enrichment; dental health care; pathogens and other diseases; and pain control and anaesthesia. A practical session on remote injection techniques was included.

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Planning for Wildlife Reintroductions and Other Conservation Translocations

Introduction

The 15th Annual Conservation Workshop addressed the overarching theme of Wildlife Reintroductions, introducing the recently completed and fully revised *IUCN Guidelines for Reintroduction and Other Conservation Translocations,* and applying the process of reintroduction planning to selected species of regional importance. Regionally there has been significant activity around the transport and release of wildlife to establish new populations, and reintroduction practitioners in the Arabian Peninsula have been early adopters of IUCN reintroduction guidelines. Many projects in Arabia have been examples of best practice, but there is always room to enhance translocation planning in order to improve project success. The arrival in 2013 of the fully revised IUCN Reintroduction Guidelines marked an advance in translocation planning. The 15th Annual Conservation Workshop in Sharjah provided a timely opportunity to present the new guidelines to participants and to apply them to some regionally relevant case study species.

A brief history of conservation translocations

The first conservation translocations in the world took place over 120 years ago. In New Zealand during the 1880s, large numbers of flightless birds, kakapo (*Strigops habroptilus*) and kiwi (*Apteryx australis*), were moved to an offshore island by the naturalist Richard Henry, marking the first attempt to protect New Zealand's native species from the impacts of exotic mammalian predators (Hill and Hill 1987). About the same time, on the other side of the world, the Tobasco sauce manufacturer, Edward (Ned) McIlhenny, translocated captive-bred snowy egrets (*Egretta thula*) from declining populations along the southern US Gulf Coast to into Bird City, a private bird refuge McIlhenny established in 1895 on Avery Island, Louisiana (Furmansky 2009).

Reintroduction really only came of age in 1907 when 15 American bison (*Bison bison*) were sent from Bronx Zoo and released into the Wichita Mountains Wildlife Preserve in Oklahoma (reviewed in Beck 2001). This was an initiative of the American Bison Society (ABS) in response to population declines from over 40 million to only ~1,000 animals by 1884.

In the decades following the successes of bison reintroductions in the US there were few reintroduction attempts, but several high profile success stories in the 1960s to 1980s helped raise the profile of reintroduction as a population restoration tool. These included projects on Golden Lion tamarin (*Leontopithecus rosalia*) in Brazil (Kleiman and Mallison 1998), Black-footed ferret (*Mustela nigripes*) in the USA (Dobson and Lyles 2000), Peregrine falcon (*Falco peregrinus*) in North America (Cade and Burnham 2003) and Arabian oryx (*Oryx leucoryx*) in Oman (Stanley Price 1989).

In contrast to these well-planned, well-monitored and well-documented reintroduction successes, there were many poorly planned releases of animals into unsuitable areas where their inevitable failure to establish a population was undocumented. The lack of post-release monitoring makes it impossible to learn anything from these undocumented failures.

The lack of documentation may reflect the fact that many reintroductions were viewed as pure management exercises, involving manipulations to achieve management objectives without attempting to learn about how the systems under management work (McNab 1983). Pure management manipulations typically lack adequate monitoring: without post-release monitoring nothing can be learned about what variables were important in a successful translocation, and even less knowledge is gained from undocumented failures.

By the 2000s there had been a marked increase in the number of species that had been translocated in population restoration project globally (Figure 1), and an explosion in the number of reintroduction-related publications (Figure 2), the latter driven by the improved generation of data from post-release monitoring of an increasing number of projects. This growing source of information about reintroduction outcomes was being used in reviews seeking general principles of translocation success (e.g. Fisher and Lindenmayer 2000).

Today there is a recognised discipline of Reintroduction Biology encompassing the science around all forms of conservation translocation (Ewen et. al., 2012). Improved translocation procedures, detailed post-release monitoring, and the framing of releases as explicit experimental tests of prediction is generating a growing literature that informs reintroduction attempts for a broadening range of species globally (Seddon et. al., 2014).

Figure 1. Increasing numbers of animal species that have been translocated in population restoration projects; numbers are minimums only (after Seddon et. al., 2005).

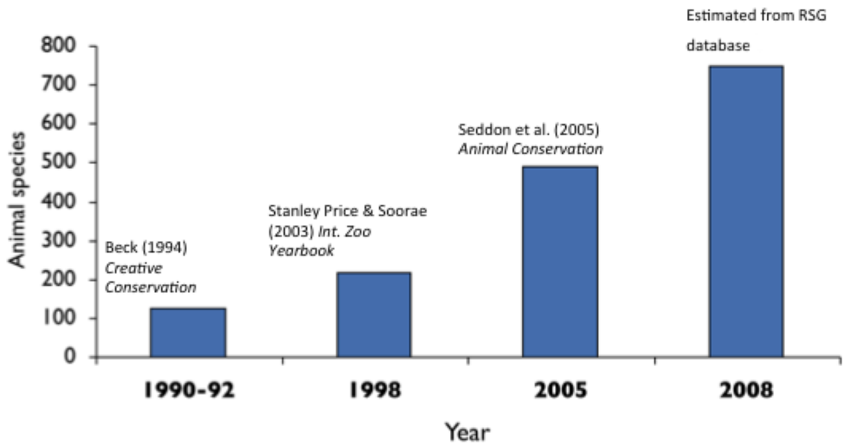
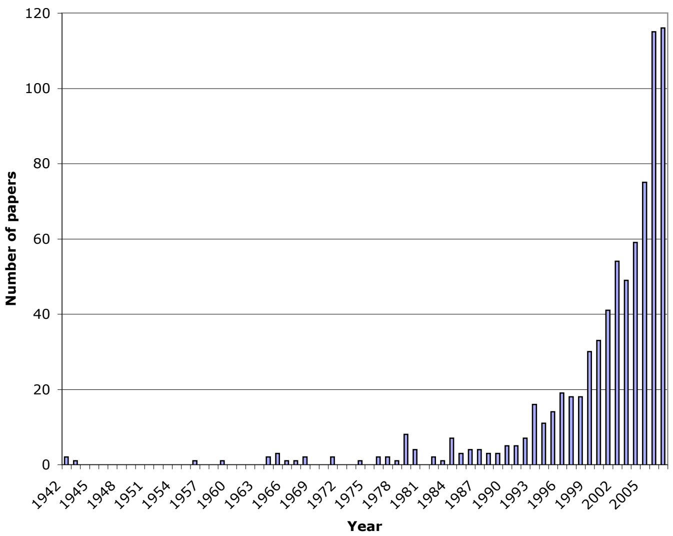


Figure 2. Increasing numbers of publications relating to wildlife reintroductions worldwide (Seddon et. al., 2007).



Role of the IUCN Reintroduction Specialist Group

In the early years, many reintroduction projects were not only viewed purely as management manipulations, but were doomed to failure due to poor planning, inappropriate founder animals, low founder population sizes, and a lack of resources. Post-release monitoring was negligible so that causes or timing of failures were unknown, as were the processes by which reintroduced populations may have become established.

It was largely in response to rising numbers of ill-conceived reintroduction attempts that Dr Mark Stanley Price, the architect of the Arabian oryx reintroduction to Oman (Stanley Price 1989), formed the IUCN/SSC Reintroduction Specialist Group (RSG) (Figure 3) in 1988 with the aim of promoting responsible reintroductions (Stanley Price and Soorae 2003). After 2000, Dr Fred Launay (Environment

Agency - Abu Dhabi (EAD), United Arab Emirates) took over as Chair of the RSG, and in 2013 passed this role on to Dr Axel Moehrenschlagar (Head of the Center for Conservation and Research, Calgary Zoological Society, Canada). The RSG's first strategic planning output was the Reintroduction Guidelines (IUCN 1998). By 2006 the RSG consisted of a volunteer network of over 300 practitioners and maintained a database of nearly 700 reintroduction projects. The 1998 Reintroduction Guidelines were designed to encourage reintroduction practitioners to consider the various aspects of proposed projects, including biological, social, legislative and economic variables. They recognized that any reintroduction project is more than just a manipulation of a wildlife population, and success requires the support of stakeholders and a long-term commitment of resources. The 1998 Guidelines were informed by the first examinations of translocation outcomes (Griffith et. al., 1989; Wolf et. al., 1996, 1998), and in turn influenced a number of taxon specific guidelines.

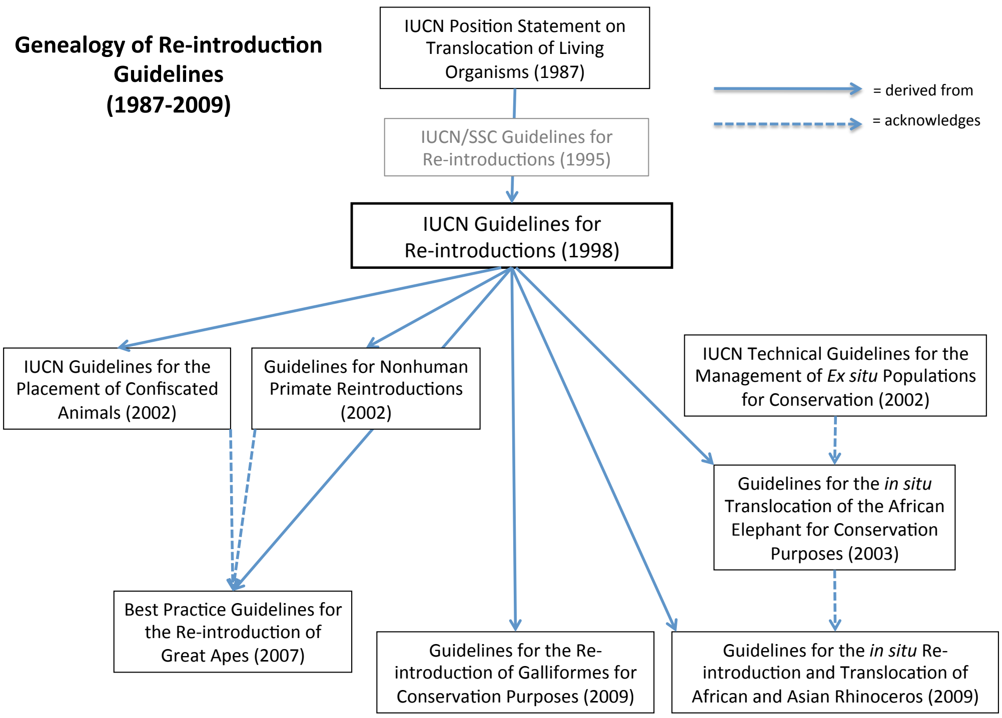
2013 Reintroduction Guidelines

Although the 1998 Reintroduction Guidelines provided a basic framework for reintroduction planning, by 2010 it was evident they were not sufficiently comprehensive. A task force was formed under the auspices of the SSC, and because the new guidelines needed to deal with translocations outside the indigenous range, the task force core membership was drawn from both the RSG and the Invasive Species Specialist groups. The fully revised and much more comprehensive Guidelines became official IUCN policy in 2013 (Figure 4), and includes detailed policies on conservation introductions, the movement and release of an organism outside its indigenous range (IUCN 2013). The 2013 IUCN Guidelines place great emphasis on feasibility and risk analysis being an essential component of any conservation translocation. Given the uncertainties involved in moving species outside their ranges, assisted colonization is inherently more risky than "traditional" translocations such as reintroductions. Where protection from threats in the indigenous range is unfeasible, and where appropriate habitat can be identified elsewhere, application of carefully planned assisted colonization might be appropriate (Hoegh-Guldberg et. al., 2008).

Figure 3. Logo of the IUCN/SSC Reintroduction Specialist Group.

RSG

Figure 4. Genealogy and influence of the 1998 Reintroduction Guidelines.



The Conservation Translocation Spectrum

The 2013 Guidelines recognize a spectrum of conservation translocation options (Figure 5). The following definitions are taken directly from Section 2 of the 2013 Reintroduction Guidelines and should be read in conjunction with Figure 5. Bolded terms are defined at first use.

Translocation is the human-mediated movement of living organisms from one area, with release in another. Translocation is therefore the overarching term. Translocations may move living organisms from the wild or from captive origins.

Translocations can be accidental (e.g. stowaways) or intentional. Intentional translocations can address a variety of motivations, including reducing population size for welfare, political, commercial or recreational interests, or for the purpose of conservation.

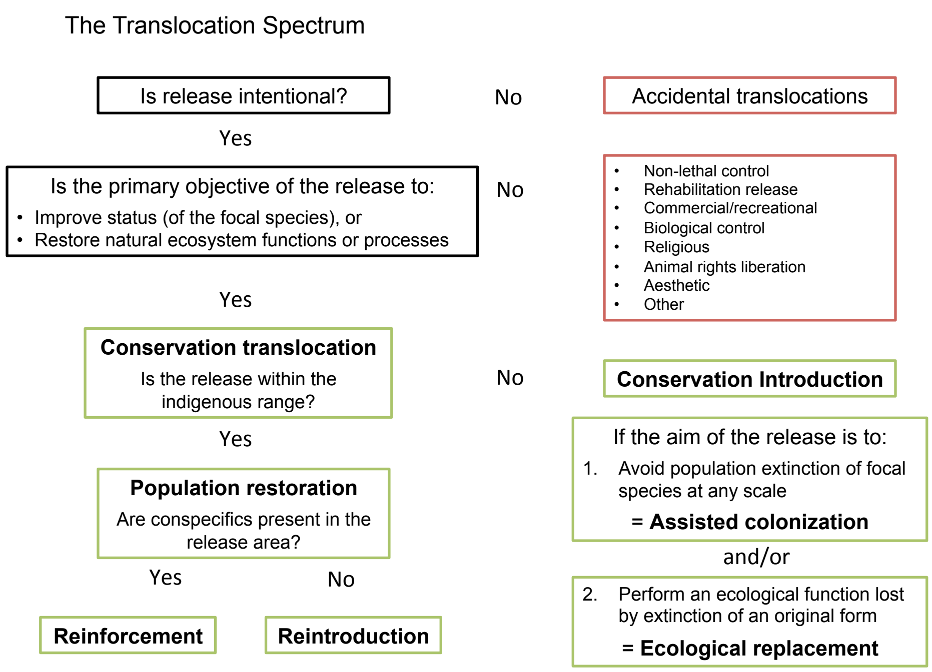
Conservation translocation is the intentional movement and release of a living organism where the primary objective is a conservation benefit: this will usually comprise improving the conservation status of the focal species locally or globally, and/or restoring natural ecosystem functions or processes.

A translocation involves releasing organisms. Release here specifically excludes the act of placing organisms into conditions that, for management purposes, differ significantly from those experienced by these organisms in their natural habitats.

Conservation translocations can entail releases either within or outside the species' indigenous range.

The **indigenous range** of a species is the known or inferred distribution generated from historical (written or verbal) records, or physical evidence of the species' occurrence. Where direct evidence is inadequate to confirm previous occupancy, the existence of suitable habitat within ecologically appropriate proximity to proven range may be taken as adequate evidence of previous occupation.

Figure 5. The Translocation Spectrum (after Seddon 2010 and Seddon et. al., 2012).



Population restoration is any conservation translocation to within a species indigenous range and comprises two activities: reintroduction and reinforcement.

Reinforcement is the intentional movement and release of an organism into an existing population of conspecifics. Reinforcement aims to enhance population viability, for instance by increasing population size, increasing genetic diversity, or increasing the representation of specific demographic groups or stages.

Reintroduction is the intentional movement and release of an organism inside its indigenous range from which it has disappeared. Reintroduction aims to re-establish a viable population of the focal species within its indigenous range.

Conservation introduction is the intentional movement and release of an organism outside its indigenous range. Two types of conservation introduction are recognized: assisted colonization and ecological replacement.

Assisted colonisation is the intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal species. This is carried out primarily where protection from current or likely future threats in current range is deemed less feasible than at alternative sites. The term includes a wide spectrum of operations, from those involving the movement of organisms into areas that are both far from current range and separated by non-habitat areas, to those involving small range extensions into contiguous areas.

Ecological replacement is the intentional movement and release of an organism outside its indigenous range to perform a specific ecological function. This is used to re-establish an ecological function lost through extinction, and will often involve the most suitable existing sub-species, or a close relative of the extinct species within the same genus.

Aims of the Workshop

The aim of this part of the workshop was to apply the 2013 IUCN Reintroduction Guidelines to planning for the conservation translocation of a range of regionally important species. It was not necessary that actual projects were involved as this was considered a demonstration of the ways in which the guidelines could be applied using hypothetical examples. For this reason outputs from the case study working groups are not reproduced here, but the process by which the different components of the Guidelines were applied is set out in detail below.

Case study working groups

As usual, during the Workshop, delegates had the opportunity to share their own regionally relevant experiences and approaches: working groups used selected examples to apply aspects of the new Reintroduction Guidelines, including project definitions, goal setting, feasibility and risk assessment, release site selection, release strategies, post-release monitoring programme design. Delegates were asked to bring along information relating to ongoing or proposed translocations in their area.

In the first session delegates were asked to identify five suitable case study species that fulfilled the following criteria: regional species; range of taxa (mammals, birds, reptiles); have a particular release site in mind for a given species; have a possible, planned, preliminary or even hypothetical translocation in mind; and have good knowledge of species ecology, status and distribution.

Five case study species and projects were selected as a basis for working groups:

1.	Nubian Ibex Reinforcement	Jordan/Saudi Arabia
2.	Arabian Wolf Reintroduction	United Arab Emirates (UAE)
3.	Arabian Tahr Reinforcement	UAE
4.	Wonder Gecko Assisted Colonisation	UAE
5.	Arabian Oryx Reintroduction	Yemen

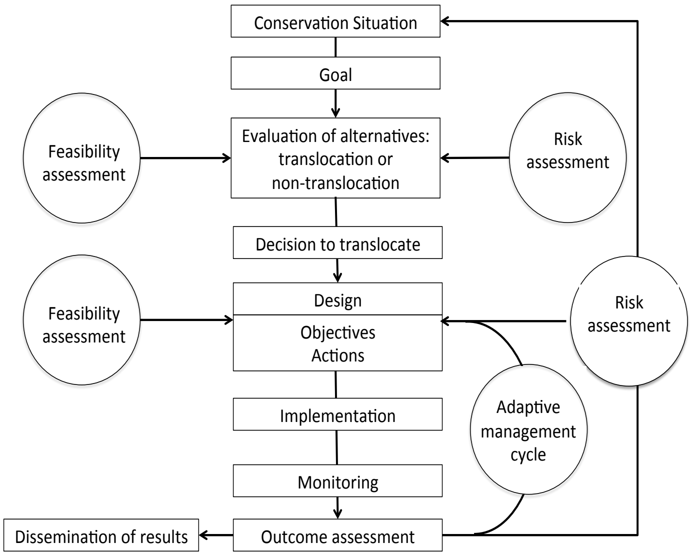
Conservation Translocation Cycle

The Conservation Translocation Cycle (Figure 6) sets out a framework for planning that indicates the key components to be addressed at different stages in the project planning cycle. This formed the basis of the workshop structure and process.

Groups proceeded from a real conservation situation and started by framing a Goal statement for a proposed or hypothetical conservation translocation of each case study species. Initial Feasibility and

Risk was then assessed and **Non-translocation alternatives** to achieve the same goal were considered. Whatever the outcome of these assessments it was assumed, for the purposes of the planning exercise, that a **Decision to translocate** was made, so that groups could proceed to consider the **Design** and **Monitoring** for each project.

Figure 6. The Conservation Translocation Cycle (after IUCN 2013, p34).



Conservation Translocation Goal Statements

A **Goal** is a statement of the intended result of the conservation translocation.

It should articulate the intended conservation benefit, and will often be expressed in terms of the desired size and number of populations that will achieve the required conservation benefit either locally or globally, all within an overall time frame.

Source: IUCN Guidelines (2013) Section 4.1

Process

The examples below were used as a guide by the case study working groups to frame translocation goal statements for their focal species.

Bad Example

To develop a successful project to reintroduce (the species) back to the wild.

Good Examples

Black Stilt (Kaki), New Zealand

To improve the status of kaki from critically endangered by increasing the wild population to >250 breeding individuals, with a mean annual recruitment rate exceeding mean annual adult mortality rate.

African wild dog, South Africa

To create a viable population of wild dogs to supplement the one in Kruger National Park, through establishment of a “managed metapopulation” with a minimum 9 packs of wild dogs over a 10-year period.

Eastern-barred bandicoot, Victoria, Australia

To minimise the probability of eastern barred bandicoot by establishing at least two self-sustaining populations which total a minimum of 2,500 individuals.

Brown bear, Central Alps, Italy

To avoid extinction of brown bear by the re-establishment of a minimum viable population of 40-60 bears in the central Alps in 20-40 years.

Greater One-horned Rhino, Assam, India

To expand the range of rhino into suitable habitats within Assam through wild-to-wild translocation to increase the rhino population to ~3,000 individuals in Assam by 2020.

Conservation Translocation Feasibility and Risk Assessment

Primary planning focus is on the desired performance of the focal species after release, in terms of population performance, or ecological roles. Translocation design is subject to constraints and opportunities, so the broad feasibility of translocation must first be assessed. Any translocation bears a risk it will fail and/or cause unintended damage, so the full range of hazards must first be assessed. Any proposed translocation has high cost and considerable risk, so alternative solutions should be considered also. Conclusions from feasibility and risk assessments should determine whether a translocation should proceed or not.

Feasibility Assessment

Translocation design will be subject to opportunities and constraints; the broad feasibility of translocation must first be assessed.

Source: IUCN Guidelines (2013) Section 5

Process

Case study groups worked through each feasibility component, addressing specific issues and questions for each, and make a determination of the feasibility of each and of the proposed translocation overall. Some components required only a Yes/No answer; others required a short written explanation.

Detailed information concerning each of the feasibility components was taken from the following sections of the 2013 IUCN Guidelines:

1. Basic biological knowledge — Source: IUCN (2013) Section 5.1.1
2. Habitat — Source: IUCN (2013) Section 5.1.2
3. Founders — Source: IUCN (2013) Section 5.1.4
4. Disease and parasites — Source: IUCN (2013) Section 5.1.6
5. Social feasibility — Source: IUCN (2013) Section 5.2
6. Regulatory compliance — Source: IUCN (2013) Section 5.3
7. Resource availability — Source: IUCN (2013) Section 5.4

1. Basic biological knowledge

Working groups were asked to collate information on the biology and ecology of wild populations, including: reproduction; mating systems; social structure and behavior; parental care; diet and growth; biotic and abiotic habitat requirements; seasonality; dispersal; and interspecific relationships (including feeding, predation and disease).

2. Habitat

Matching habitat suitability and availability to the needs of the species is central to feasibility and design. Working groups undertook to complete the following:

- Characterise the habitat requirements of the species.
- Characterise the ecological role of the species.

- Determine the indigenous range of the species.
- Determine the current distribution of the species.
- Assess the status of habitat in the indigenous range.
- Is there sufficient area of suitable habitat for releases?
- Determine the cause(s) of declines or local extinctions.
- Assess future threats, and address the question: Can/have past and potential future threats be addressed?

3. Founders

- Is there a source of founders: from wild or captive populations?
- Will available founders have adequate genetic diversity?
- Will available founders be suited genetically to the release area?
- Can sufficient founders be obtained without impact on the source?

4. Disease and parasites

- What are the known diseases of the species?
- What are the known parasites of the species?
- Is it feasible to screen for disease and treat founder animals?

5. Social feasibility

- What human communities are in or around the likely release area?
- What is the relationship between local communities and the focal species?
- What are the possible impacts, positive and negative, of proposed releases on local communities?
- What mechanisms/bodies are in place to engage with local communities?

6. Regulatory compliance

- What type of movement is required: international, cross-border, outside indigenous range, national, regional?
- What are the relevant international, national, or regional/sub-regional regulations?
- Which organization/body/authority will manage the proposed releases?
- What other regulatory groups would need to be involved?
- Will the proposed translocation be able to meet regulatory requirements?

7. Resource availability

- What is the likelihood of sufficient funding and other resourcing being available and from where?

Risk Assessment

Risk is the probability of an identified factor occurring + the severity of its impact. The range of possible risks comprises a “risk landscape”. Risk assessment may be quantitative or qualitative. Lack of data does not indicate absence of risk.

Seven risk factors were considered:

1 Risk to source populations

- What is the possible impact of removal of individuals for a translocation?

2 Ecological risk

- What is the impact of release animals on other species or ecosystem functions?

3 Disease risk

- What is the risk spread disease/contract disease after release?

4 Associated invasion risk

- What is the risk of the accidental release of invasive species?

5 Gene escape risk

- What is the risk of genetic mixing with extant populations?

6 Socio-economic risk

- What is the risk of direct, harmful impacts on people and income?

7 Financial risk

- What are the risks of discontinuation of support/funding?

Process

Case study groups were asked to identify the full range of possible risks and estimate two scores, impact and probability.

Impact (severity) score

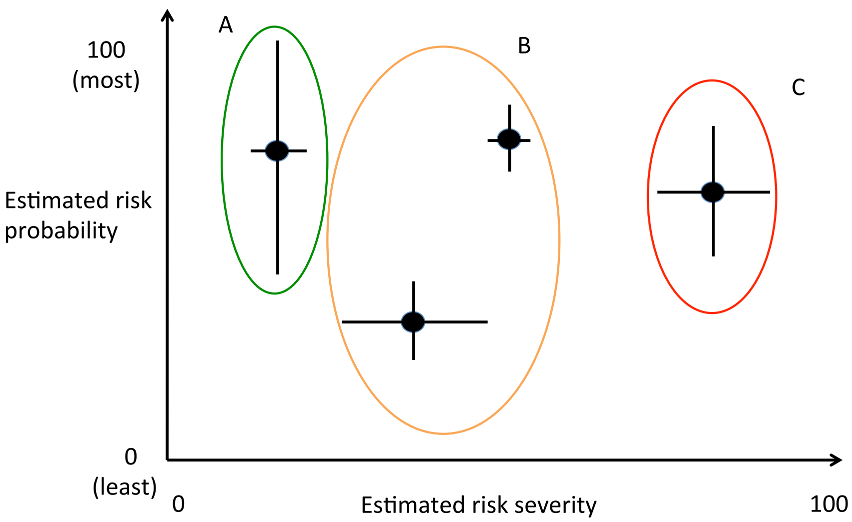
For each risk factor groups discussed and assigned a likely severity of impact using a relative scale of 0-100, where: 0 = no measurable impact, and 100 = catastrophic impact, then discussed and agreed on upper and lower levels to account for uncertainty.

Probability score

For each risk factor groups discussed and assigned an estimated probability of occurrence using the scale of 0-100, where: 0 = no chance, and 100 = will always occur, then discussed and agreed on upper and lower levels to account for uncertainty, e.g. 0, range 0-30.

Groups then plotted **severity** (along x-axis) against **probability** (y axis) for each factor (Figure 7), and discussed each factor, adjusting these in relation to the others. They then categorised all factors into three groups based on their possible impact: A = least risk; B = moderate but acceptable risk; C = major risk (Figure 7). Groups decided whether any factors in Category C warrant a decision to abandon plans for the translocation.

Figure 7. Hypothetical conservation translocation risk landscape.



Conservation Translocation Non-translocation Alternatives Assessment

Any proposed translocation must be justified through comparison with alternative solutions to achieve the same conservation benefit.

Source: IUCN Guidelines (2013) Annex 3.3

Process

Case study working groups were asked to consider the costs and benefits of translocation and non-translocation options. First, each group listed all non-translocation alternatives to achieve the desired conservation benefit. For each alternative, groups estimated the relative **cost** on a scale 0-100, where: 0 = no cost, and 100 = maximum cost.

Next, for each alternative, groups estimated the **likelihood** that this option alone would achieve the desired conservation benefit, on a scale 0-100, where: 0 = no chance of success, and 100 = will succeed under any conditions.

For the translocation option groups also estimated the relative costs and the likelihood of success.

Groups plotted relative cost (along bottom, x-axis) against probability of success (y axis) for each option, translocation and non-translocation on the same graph (e.g. Figure 8), then discussed each factor and adjust in relation to the others in order to answer the following question:

Compared with the non-translocation alternatives, is translocation a viable option?

The non-translocation alternatives that were considered are:

1 Area-based solutions

- Increase habitat availability through restoration, connectivity, or protection

2 Species-based solutions

- Improve the viability of existing populations, e.g. predator control, supplementary food

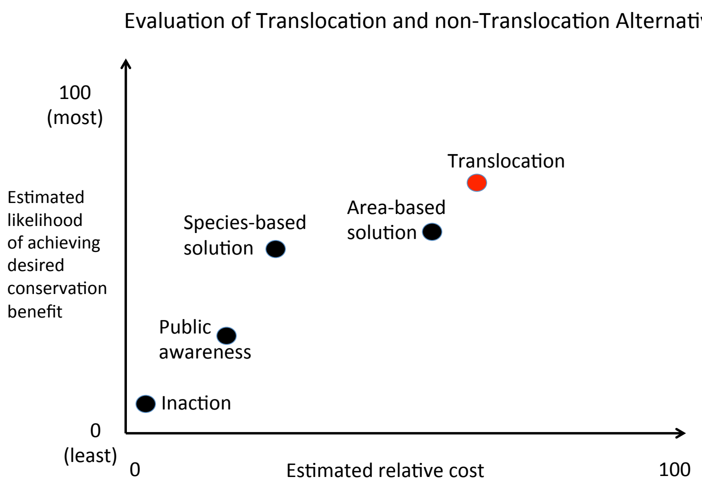
3 Social/indirect solutions

- Change in legislation, public education, financial incentives or compensation

4 Doing nothing

- Taking no action might have lower risks of extinction compared to alternatives

Figure 8. Hypothetical example of an evaluation of translocation and non-translocation alternatives.



Conservation Translocation Release Site Selection

Source: IUCN Guidelines (2013) Section 7.1

Process

Considering the information used in the earlier Feasibility Assessment, the groups identified a suitable **release site** within a wider **release area**, located these on a map, and provided a rationale for their selection taking into account: habitat suitability and species biology; size; protection status; mitigation of possible future threats; and ease of access for release and monitoring.

A **release site** is the specific point of release.

A release site should meet all the practical needs for effective release with the least stress; enable the release animals to exploit the surrounding release area; and be suitable for media and public awareness needs.

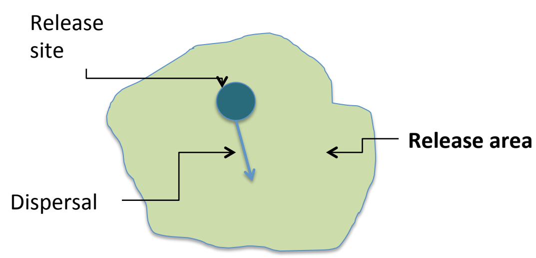
A **release area** is the wider area around the release site into which the released animals are expected to disperse and settle.

A release area should meet all the species' biotic and abiotic requirements: be appropriate habitat for the life stage released and all life stages of the species; be adequate for all seasonal habitat needs; and be large enough to meet the required conservation benefit.

We can consider a release site that sits inside a reintroduction area presumably selected because it is inside the historic range and it has suitable habitat.

Ideally founders disperse from the release site and move into reintroduction area (Figure 9).

Figure 9. Conservation translocation release site (dot) and release area (green shape).
The arrow indicates dispersal from the release site into the release area.



Typically a few animals will move very small distances, most will move intermediate distances, and there is a long tailed distribution (Figure 10) of so-called Long Distance Dispersers.

Figure 10. Distribution of typical dispersal away from a release site.

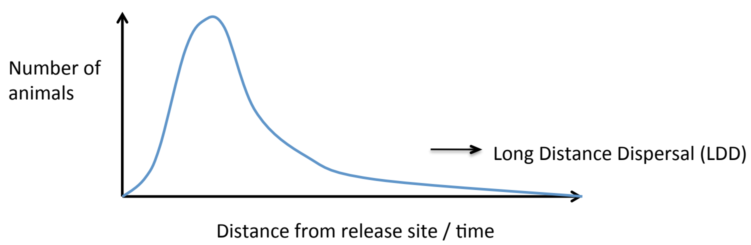
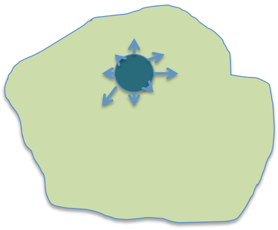


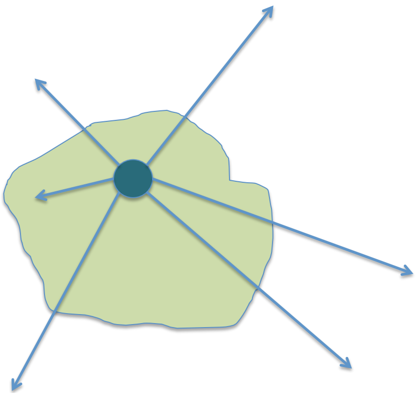
Figure 11. Illustration of extreme clumping at a release site (see Figure 10 for symbols).



Founders and offspring may all remain close to the release site (Figure 11). With this comes increased density and higher mortality risks due to disease and social competition. Therefore, some movement away from release site is necessary – but how much will depend on the site and the species.

Causes of extreme clumping include social aggregation, focal supplementary food/water, and innate fear response of naïve animals.

Figure 12. Illustration of extreme dispersal from a release site.



If all or most animals move away from the reintroduction site (Figure 12) the population will never establish and mortality may be high. This might mean animals move away from selected suitable habitat, habitat management (e.g. predator control), and supplementary care. It might also take animals out of range of post-release monitoring; therefore it would not be known if they were dead or alive elsewhere. Extreme dispersal might be facilitated in highly connected landscapes. Loss of a large proportion of founders may necessitate follow-up translocations to reinforce a reduced local population. This may have negative public relations consequences.

Causes of extreme dispersal include social competition; translocation stress/disorientation; homing behavior; lack of resources in release area; and habitat selection mismatch.

Ultimately some animals may move out of reintroduction site and settle in suitable habitat elsewhere (Figure 13). Natural recolonisation avoids the need for further translocations. Barriers could prevent natural recolonisation to dispersal (Figure 13). The short-term aim is to keep founders in the focal area. Too much dispersal will result in a low founder population, whereas too little dispersal leads to clumping and reduced fitness. Dispersal will be influenced by perceived habitat quality and might be driven by selection of outside areas in highly connected landscapers; a mismatch between selection cues and habitat quality; selection of poor quality area (ecological traps); and avoidance of suitable areas (perceptual traps) (Figure 13).

Conservation Translocation Release Strategy

Source: IUCN Guidelines (2013) Section 7.2

The life stage and season of release should be optimised with respect to the species' natural dispersal age or season, considering whether dispersal after release is to be encouraged or discouraged. The age/size, sex composition and social relationships of founders may be optimised for establishment and the population growth rate stated in the objectives. Translocation success increases with the numbers of individuals released, but this needs to be balanced against impacts on source populations. Releases, either simultaneously or sequentially, at multiple sites may serve to spread out the released animals. Minimising stress during capture, handling, transport and pre-release management will enhance post-release performance. Various management interventions and support before and after release can enhance performance.

A release strategy will relate directly to a specific management objective, which in turn will be dictated by the overall goal of the project. Ideally there will be integration of goals, release strategy and post-release monitoring, possibly within an adaptive management framework (Figure 14).

Figure 13. Illustration of natural recolonisation of suitable areas, barriers to dispersal, attraction to ecological traps, and avoidance of perceptual traps.

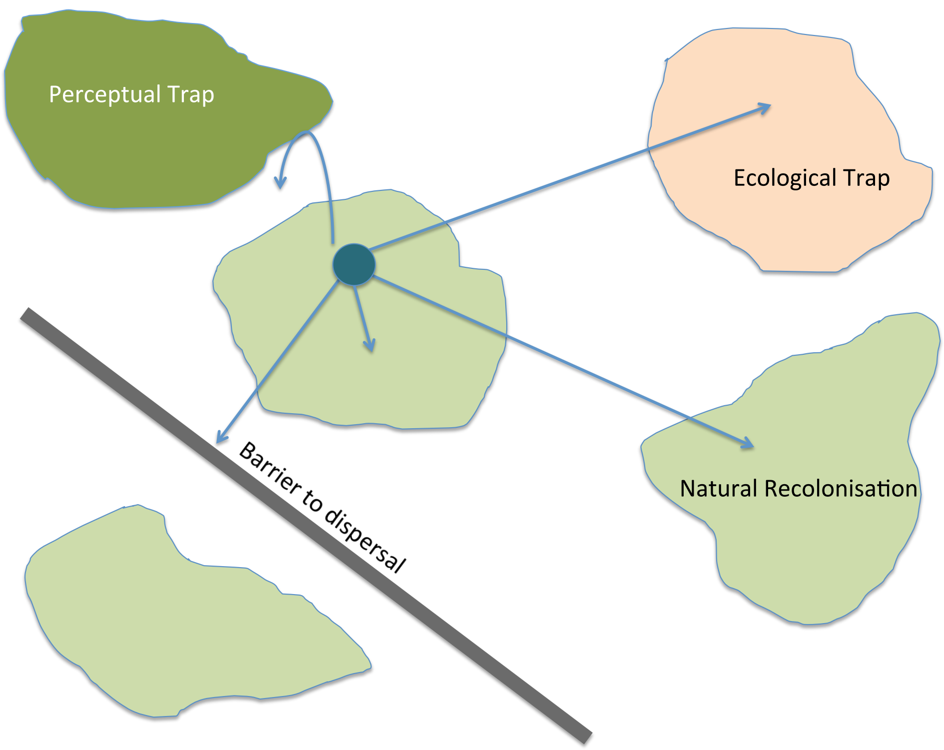
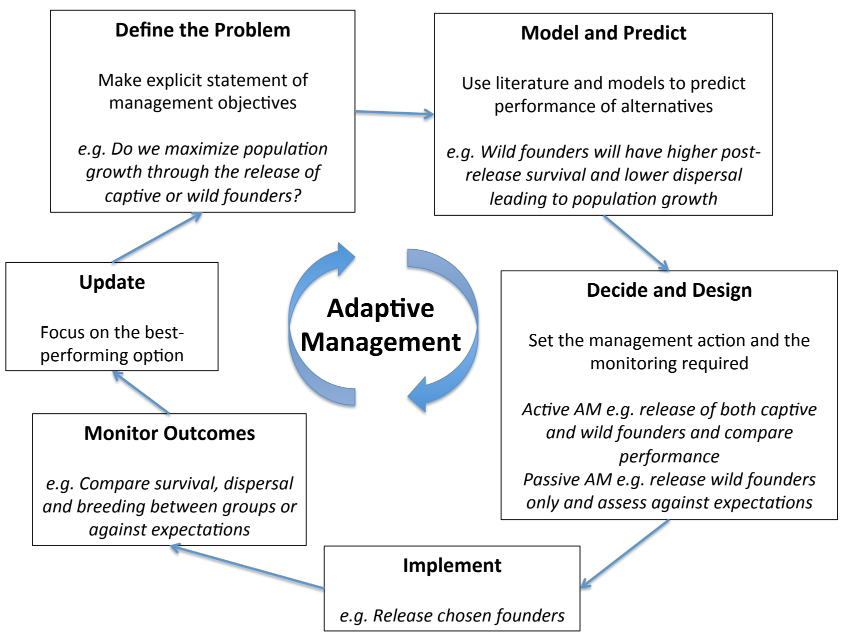


Figure 14. An example of an Adaptive Management cycle.



Process

Working groups were asked to design a release strategy for each case study species, adopting either a Passive or/and Active Adaptive Management strategy for at least one aspect of the release.

Example: Will the re-established population grow more rapidly with the release of wild-caught founder animals, or captive-bred founders?

Passive Adaptive Management = release what you think best and assess that assumption.

Example: Wild-caught founders will be better than captive bred founders, so release only wild-caught animals and assess their survival and breeding.

Active Adaptive Management = conduct release of both options and compare performance.

Example: Release both wild-caught and captive bred animals and assess whether wild-caught animals really have higher survival and breeding rates.

Groups considered the following aspects, as appropriate, for each release strategy:

1. Where will animals come from: captive or wild?
2. What age/life stage will be released?
3. What number of animal will be released?
4. How will animals be caught?
5. How will animals be transported?
6. How will animals be released: soft or hard release?

Post-release Monitoring

Source: IUCN Guidelines (2013) Section 8

Monitoring is essential to measure the performance of released animals. The type, intensity and duration of monitoring will be determined by the specific information that is needed to evaluate outcomes.

Four types of monitoring were considered:

1 Demographic monitoring

Typically "vital rates" of survival, reproduction and dispersal are key parameters to measure, and/or population size.

2 Ecological monitoring

Used to record ecological changes associated with the translocation; where restoration of an ecological function is the primary goal then 'ecological monitoring' should seek to detect a return of this function.

3 Genetic monitoring

Tissues samples can be used to assess changes in genetic diversity.

4 Disease/health monitoring

Identifying causes of death can be critical in assessing progress.

The type of data to be collected will determine the necessary type of animal marking, e.g. cohort marking, individual tags, radio/GPS tracking.

Process

Working groups were asked to design a monitoring plan for their translocated species, taking into account the Passive or Adaptive Management strategy adopted in their release strategy.

Groups considered the following:

1 How will animals be marked?

Individual or cohort?; temporary or permanent?; visible or hidden (transponders)?; radio tags or GPS tags?

2 How will animals be observed and/or recaptured?

Visual observation of free-ranging animals by eye or camera crap; observation of animal sign (footprints etc); live capture in trap, net, snare, leg hold …etc.

3 What specific data is required and how will this be obtained?

For example: survival rates through mark-recapture analysis?

4 How frequently will monitoring take place?

Daily, weekly, monthly annually?

5 For how long will monitoring take place?

This could be expressed as a time period, e.g. 1 year, or the time required to obtain certain information, or to make an evaluation of a change).

Groups also considered behavioural, genetic, health and socio-economic monitoring.

On-going Management

Source: IUCN Guidelines (2013) Annex 8

Information from monitoring allows adjustment of ongoing management. Decisions about management adjustment or change should be based current understanding of the population's dynamics and impacts. Long-term management of re-established populations may be necessary for persistence.

Exit Strategies

Source: IUCN Guidelines (2013) Section 4.3

Not all translocations go according to plan and there may be a point where investing further resources is not justified. A decision to discontinue will be based on the result of monitoring and the assessment of progress towards the Goal. If undesired or unacceptable effects have occurred all free-ranging animals may need to be removed (caught/killed). An Exit Strategy needs to be part of translocation planning.

Information Dissemination

Source: IUCN Guidelines (2013) Section 9

Regular reporting should start in the planning stages. This serves to: create awareness and gain support; meet statutory requirements; contribute to the body of knowledge.

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Useful Websites

IUCN/SSC Reintroduction Specialist Group website	http://www.iucnsscrsg.org
Avian Translocation database	http://www.lpzoo.org/conservation-science/projects/avian-reintroduction-and-translocation-database
Oceania (Australia and New Zealand) Section of the RSG	http://rsg-oceania.squarespace.com
IUCN/SSC Conservation Breeding Specialist Group	http://www.cbsg.org
IUCN/SSC Invasive Species Specialist Group	http://www.issg.org
Center for Conservation and Research	http://www.calgaryzoo.com/about-us/centre-conservation-research

Small Mammal Survey Techniques

Introduction

Continuing the theme set at the 13th Annual Conservation Workshop (Seddon et. al., 2012) of including a technical-focused component, small mammal survey techniques were identified as a regionally important topic requiring attention. Given ‘small mammals’ size, largely ubiquitous distribution in the Arabian Peninsula, and ease in working on, they are ideal focal species for attempts to understand the biogeography of the region.

This section deals with a variety of different, but connected, topics related to the study of small mammals. The information presented here has been drawn from diverse sources including published papers, books and the personal experience of Ara Monadjem studying small mammals in Africa. The most important references have been cited in the relevant sections of text (see below).

Aims of the Workshop

This was to train the delegates in how to set up small mammal surveys, the do’s and don’ts associated with handling animals, and what can be achieved through such surveys. In addition, it was hoped to stimulate coordinated regional surveys of small mammals to broaden our understanding of species diversity, distribution and change in response to shifting environmental circumstances.

Discussion groups deliberated how to get greater coordination with regards small mammal studies and collections in the Arabian Peninsula.

What are Small Mammals?

The term “small mammal” does not refer to a taxonomic unit and therefore there are no clear boundaries defining this group. In fact, small mammals have been defined in numerous different ways by different authors. One popular definition is any mammal weighing less than 5 kg. Another definition is less defined and refers to any mammal smaller than, e.g., a fox. Depending on one’s objectives, such definitions may be fine but they fail to clearly define the group (for example, what if the male weighs 5.3 kg and the female 4.5 kg?). For the purposes of biodiversity surveys, a more useful definition would be to define small mammals along taxonomic lines. For example, many mammalogists consider the following orders to constitute small mammals: rodents, bats and “insectivores”. This definition will be used here.

Rodents

The order Rodentia constitutes the largest group of mammals with over 2,200 species recognized to date (approximately 40% of all mammals). New species are continuing to be described and the final figure may well exceed 3,000 within the next decade or two. This group includes the familiar rats and mice, but also includes squirrels, procupines, canerats, gundis, hamsters, anomalurids, dormice, springhares, gerboas and many other less known groups. A total of 49 species of rodents are recorded in “The Mammals of Arabia” (Harrison and Bates, 1991), although undoubtedly this figure has since increased by the discovery of new populations within Arabia and the description of new species. Rodents are perhaps the most important group of wild mammals from a human perspective because of their economic, ecological and health impacts. For example, some of the most virulent diseases are spread by rodents, such as plaque and Lassa fever (Lalis et. al., 2012). Many species are recognized as major crop pests, affecting pre- and post-harvest losses, and under certain conditions these losses may be up to 100%, but more typically around 10-20%. Numerically, rodents constitute the largest populations of any terrestrial vertebrate and as a result are the main prey of many carnivores including mammals, birds and reptiles. Hence, rodents play an important role in the food chain.

Bats

Bats (order: Chiroptera) are the second most diverse group of mammals with > 1,100 species recorded to date. Harrison and Bates (1991) record 48 species for the Arabian Peninsula but several new species have been described from the region (e.g. Benda et al., 2009, 2011), taking the total to well over 50 species. Due to their nocturnal behaviour and powers of flight, bats are more difficult to study and hence have received less attention than rodents. However, like rodents, bats impact humans directly by carrying diseases such as the dreaded Ebola fever (Groseth et. al., 2007; Towner et. al., 2008), or may be beneficial by being the primary predator of crop pests, pollinating tropical and subtropical trees and distributing fruits (Jones et. al., 2009). For example, Boyles et. al., (2011) estimated that bats save farmers more than US$3.7 billion/year in North America alone through the control of pest insects. The role of bats has certainly been underestimated in the past.

"Insectivores"

This group of mammals was previously placed in the order Insectivora and included shrews, hedgehogs, moles, golden moles, elephant shrews (sengis) and various other small insect-eating mammals. However, recent molecular studies have clearly shown that this group is not natural and that these small mammals were lumped together based only on convergent morphological features. In fact, elephant shrews and golden moles are more closely related to elephants and hyraxes than they are to shrews and moles! Within the context of Arabia, the only "insectivores" present are shrews and hedgehogs which are currently placed in the order Soricomorpha but will be referred to as insectivores for the rest of this section (due to familiarity with this term). In general, insectivores are far less diverse than either rodents or bats, and are typically encountered less frequently as well. Their ecological roles and impacts on humans are less clearly understood. Hence, increased effort in studying this group is suggested.

The remainder of this section on small mammals has been divided into six topics:

1. Capture and handling;
2. Preparation of specimens;
3. Identification;
4. Biodiversity surveys; and
5. Ecological surveys.

Capture and Handling

Before commencing this topic, it is important to bear in mind that small mammals carry a variety of zoonoses - diseases that can be transmitted between species, inclusive of humans. In fact, some of the worse diseases known to humans are carried or spread by small mammals, including plague, Ebola and Lassa fever, and rabies (to mention just a few). Rabies has a 100% mortality rate, with Ebola close behind (mortalities for this disease range between 50-90%). Therefore care needs to be taken when handling small mammals. This is not the appropriate forum to discuss the health risks, therefore medical advice should be sought if there is any doubt. However, one (simple) precaution that should be mandatory for all small mammal biologists is rabies vaccination, which can be obtained from most hospitals or clinics. Remember that follow up boosters are required (and may be given every 2-4 years depending on the titer levels of the researcher). Note that transmission of diseases may not only be through a bite, but also through coming in contact with saliva, urine, faeces or blood. Hence wearing latex gloves is also recommended. Thicker gloves may be required when working with bats which can easily bite through the latex gloves. Normal standard hygiene practices such as washing of hands after handling small mammals is highly advised.

Standard capture techniques for small mammals include the use of a variety of specialized equipment, but some may be captured by hand (such as bats in a hibernating roost; note that hibernating roosts should not be visited unless an exceptional reason is forthcoming because such disturbance could result in significant impacts, including mass mortality of the bats). The aim of this section is not to provide an exhaustive list of capture techniques; instead it is to familiarize the reader with the most commonly used techniques, including those that are most likely to be successful in the Arabian Peninsula.

Terrestrial small mammals

Rodents, especially the smaller rats and mice, are most commonly captured in one of two ways: live-traps or break-back (kill) traps. There are numerous live-traps available on the market, but the fold-up Sherman traps are probably the most widely used (Figure 15).

Kill traps (Figure 16), as the name suggests, capture the animal by killing it. It is generally preferable to capture the animal alive, however some species are “trap shy” and do not enter Sherman (or other live) traps. For such small mammals, the kill trap may be the only option available to the researcher. For biodiversity surveys, where specimens should be collected (see Biodiversity Surveys section), the use of kill traps might be appropriate. Kill traps are also useful for diet analysis of stomach contents (the stomach contents of live-trapped animals invariably are filled with whatever bait was used to lure them into the trap).

Figure 15. Example of a live trap.

Figure 16. Example of a Victor (kill) trap used for capturing terrestrial small mammals.

The use of appropriate bait is critical. Inappropriate bait may result in poor captures or no captures at all. The right bait will vary geographically and from habitat to habitat. Furthermore, different species have different dietary preferences. However, the combination of rolled oats and peanut butter (oats, sunflower oil and raisins can also be used, especially for vegetarian species) usually works well in many savanna and desert regions of the world. It may be worthwhile trying different baits in a preliminary study so as to be sure of the efficacy of the bait that is finally selected for the study.

Insectivores, unlike rodents, rarely enter live-traps and are best captured using a pit-fall trap. The easiest way to set up such a trap is to dig a normal bucket into the ground, ensuring that the lip of the bucket does not protrude above the surface. Shrews, in particular, are easily captured in such bucket pit-fall traps, especially if a drift fence connects two or more buckets (typically 10 buckets connected by drift fences give good results in many habitats) (Figure 17).

Figure 17. Bucket pit-fall traps connected by drift fence.

The buckets do not need to be baited and the shrews typically fall in accidentally. Occasionally juvenile rodents are also captured in these pitfall traps, but rarely are adult rodents captured in this way.

Volant (flying) small mammals

Small mammals that fly (typically bats, but also some rodents such as anomalures and flying squirrels) can be captured with the use of mist nets, and bats can also be captured in harp traps. Mist nets are effective for many species of bats, but it is important to purchase special bat nets. Avian (bird) mist nets are usually coarser (due to thicker strands) which are easily detected by the bats through echolocation. As a result, bird nets are efficient at catching only non-echolocating bats (such as fruit bats in the family Pteropodidae). Even with the use of special bat mists, however, many bat species have the capability to detect and avoid them. Hence, it is always preferable to survey bats using both mist nets and harp traps (Figure 18 and 19). Both the mist net and harp trap catch the bats alive. A mist net should be checked regularly (5-20 min intervals), both for the sake of the captured bat and the net (bats have sharp teeth!). In contrast, a harp trap can be set and left overnight, although it is good practice to check the harp trap several times between sunset and midnight before leaving it till dawn. Mist nets should be taken down as soon as the trapping session is over and should never be left overnight.

Capture rates for bats are generally low, especially if nets and harp traps are placed randomly. However, if the capture site is carefully selected (by determining possible flight paths or placing nets near drinking/feeding sites or roosts, etc) capture rates can be greatly increased. Capturing bats in the roost (using a hand net) is also a commonly used and effective technique.

Figure 18. Mist net.

Mist net erected between metal or wooden poles and held tight by guy ropes. A mist net needs to be attended to continuously whilst it is erect.

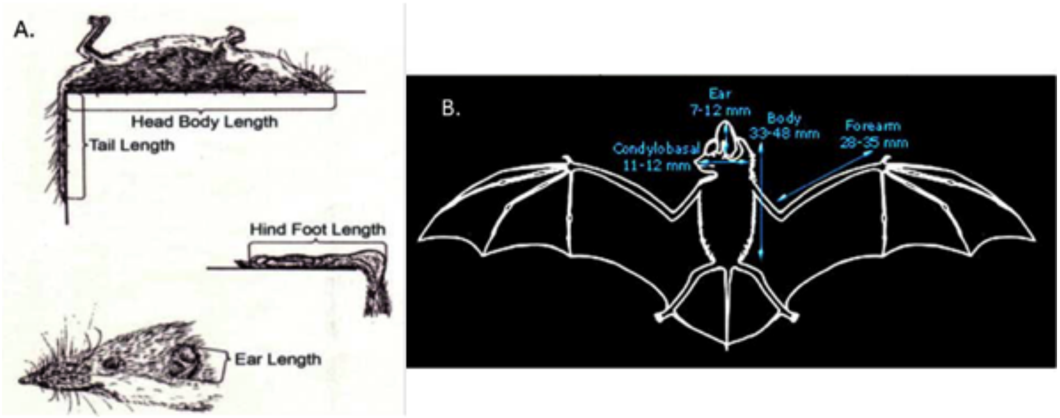
Figure 19. Harp trap.

Harp trap set in a natural pathway used by foraging bats within a forest; the bats can be seen as black dots in the white collecting bag. A harp trap can be left overnight without any damage to the trap or to the captured bat.

Handling of small mammals

Once an animal has been captured, it will usually need to be handled (at the very least to determine sex and age, and to measure the animal before releasing it). If the animal is alive, handling will stress it and might compromise health and survival after release. It is therefore critical to try to reduce this stress as much as possible by handling the animal gently (to prevent internal injuries) and to “process” it as quickly as possible. Do not take unnecessary measurements if they are unlikely ever to be used. Rather take a few standard measurements, unless you have special reasons to take more. For terrestrial small mammals, mass and hindfoot length are useful measurements (Figure 20). If possible also take body length (tip of snout to anus) and tail length (anus to tip of tail), but these measurements require two people. For bats, take mass and forearm length (Figure 20). It is also good practice to photograph your study animals, especially when you are starting out your study and you are not always 100% sure of species identification.

Figure 20. Standard measurements for small mammals.



Adapted from Hoffmann et al 2010; http://www.bio.bris.ac.uk/research/bats/britishbats/batpages.

Remember that small mammals feel pain in a similar way to humans: do not inflict unnecessary pain and suffering. There is no reason to cause physical pain if the animal is handled carefully. Another way to reduce suffering is to check your traps regularly. Traps are typically set and baited in the late afternoon and checked early in the morning. In hot climates (as in much of Arabia), ensure that you have checked all your traps before the sun has become too hot (start checking at first light before sunrise). In cold climates, such as on top of mountains, place cotton wool inside the trap for the animal to curl up in.

Even when the animal needs to be sacrificed, ensure that the animal is killed humanely, and preferably kill it as soon as possible. If the animal needs to be kept alive for a few hours (e.g. for behavioural observations), make sure that it has a comfortable cage with water and food provided.

Live rodents are typically held by the scruff of the neck. Make sure you have a tight grip otherwise the rodent may be able to turn around and bite your finger. The skin here is tough in most rodents however in some species (such as the tropical African genus *Lophuromys*) it tears easily and such species cannot be held in this way. Bats and shrews can be held by the scruff of the neck, but because they are predators and have sharp teeth it is advisable to rather handle them with a strong (thick) glove into which they can bite without harming you.

Once you have processed your animal, release it gently. Do not throw a rodent onto the ground; rather release it by placing it gently on the ground. Similarly, do not throw a bat into the air; instead allow the bat to decide when to fly off.

Preparation of Specimens

Occasionally specimens are needed as vouchers (to provide direct evidence that a particular species occurs at a particular locality) or for verification of species identity (see section on Identification). These specimens need to be killed. Chloroform has been a standard method for killing small mammals for decades, but is now considered unethical. Perhaps the most humane method for killing the smaller small mammals (around 5-25 g) is by cervical dislocation, which is a fancy way of saying “breaking the neck”.

Thoracic compression is also used for rodents, although it takes longer (and therefore might be more painful for the animal) than cervical dislocation. Euthanasia by the appropriate drug is also ethically acceptable. If you are unsure of which method to use, first speak to a trained veterinarian who should be able to advise you.

Identification

Small mammals are notoriously difficult to identify. Not only is this group incredibly diverse, new species are continuously being described. For example, within a 12 month period, six new species of bats were described by the same researchers in tropical Africa (Taylor et. al., 2012; Monadjem et. al., 2013a, b). Even experts rarely are willing to give definitive identifications without careful examination of a specimen (which usually includes examination of the skull and teeth; something not yet possible on a living animal). Some species of small mammals are morphologically indistinguishable, but are genetically highly divergent to the extent that they cannot interbreed. These species can only be identified with certainty using karyological or molecular techniques. Hence, tissue samples should always be collected when sacrificing a specimen. All tissue within an animal has the same DNA so it should not make a difference where the tissue comes from, but a small piece of muscle is generally recommended. In bats, the pectoral muscles (that power the wings) are easily sampled in a specimen. In rodents and insectivores, muscles from around the forearm or chest are also fine. If the animal is being released alive, then tissue sampling must have minimal impact. In bats, a small piece of the wing membrane can be taken with a biopsy punch; ensuring that no veins or arteries are punctured in the process. In rodents and insectivores, the very tip of the tail can be snipped off (the tail is often damaged or broken off in older individuals anyway). It is vitally important that all tissue samples are collected off the fresh specimen (i.e. before it has been placed in formalin) and put into separate vials of 96% ethanol, and labelled accurately. The specimen can then be placed in formalin to be fixed or skinned and stuffed before it is sent to an appropriate institution.

It is highly advisable to deposit all your specimens in internationally recognized public institutions such as national museums. In this way, the curator of the mammals section of the museum can verify your identifications, and the specimens will be available to any researcher who would like to examine them in the future. Small mammals in museum collections are typically either as “dry” (i.e. stuffed skins) or “wet” (i.e. in formalin/alcohol) specimens (Figure 21). It is good practice to communicate with the museum before you start your survey work since the museum may provide useful practical information regarding the collection of specimens.

Figure 21. Examples of specimen preservation.

Dry specimen of skin (left), and skull (middle). Wet specimens are typically either in formalin or ethanol and kept in bottles (right).

Biodiversity Surveys

Biodiversity surveys function to provide basic and baseline information on the presence of plant and animal species at a specific location. Such surveys may be organized by an institution (such as a museum) or an individual researcher. However, increasingly biodiversity surveys are becoming an integral component of Environmental Impact Assessments (EIAs) and are often funded by the private sector. Finally, governments (and large global conservation NGOs) may commission such surveys particularly in poorly known areas suspected to have high biodiversity value. Small mammals are often a specific target for such biodiversity surveys, or they may fall under the broad remit of “mammals”.

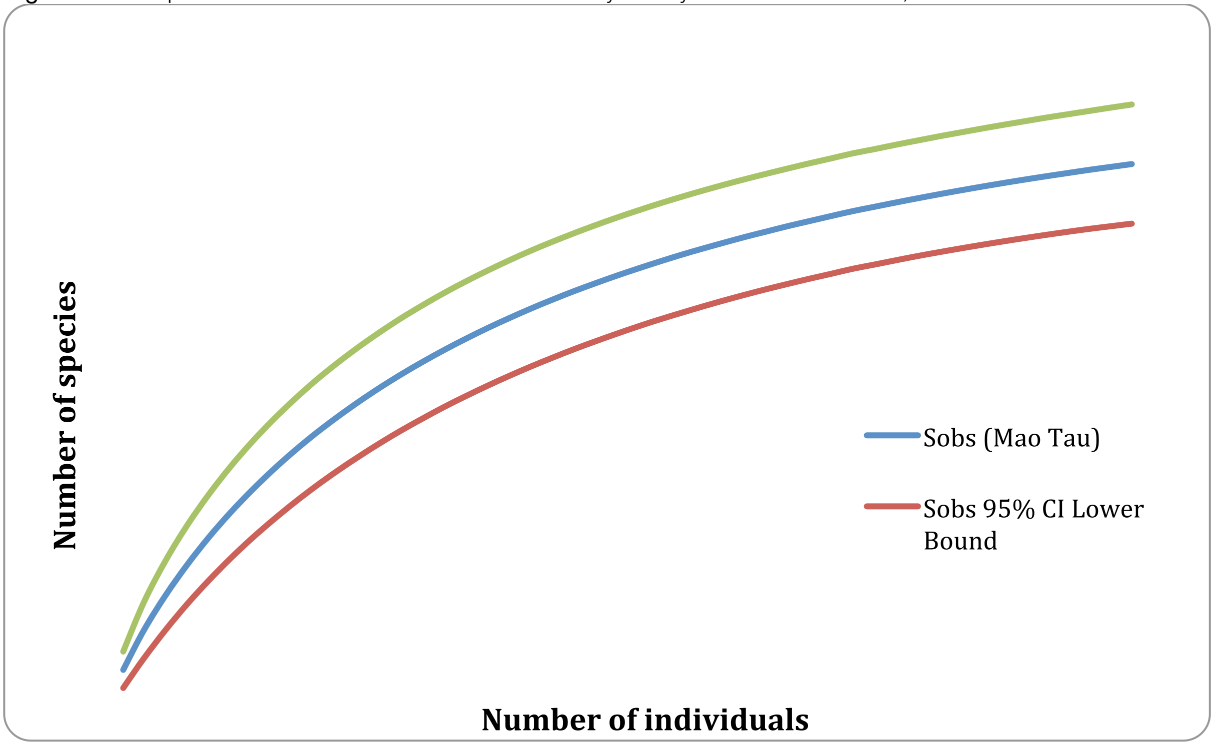
The goals of such surveys are typically to find out what species occur in the study site, and perhaps habitat requirements and threats facing their populations might be secondary goals. Therefore, the aim is more about finding out what is there, rather than ecological details such as population dynamics, etc. Hence your survey design should be geared towards this. For example, when trapping using live- or kill-traps, set them out in trap lines (as opposed to grids; see Ecological Surveys). Basically, put your traps in a single line (usually with 20-50 traps per line) 5-10 m apart and crossing through as many habitats as possible. For example, if there is a swamp at your site, set your traps to cross through the swamp and into the grassland or woodland on the other side. This maximizes your chances of trapping different species. Use both types of traps at each trap location so that you also capture trap shy species.

Make sure that you have all the necessary equipment with you before you travel. Essential equipment will include all your traps (see Capture and Handling), a dissecting kit (which should at least include sharp scissors, scalpels, and a biopsy punch), 96% (or stronger) ethanol, formalin, collecting jars/bottles (to place specimens in), vials (for tissue samples), cloth holding bags (for live animals before they are processed), labels (each specimen must have a label attached with at least a specimen number, the date and location on it), scales for weighing, calipers and ruler for measuring, camera (for photographing specimens and habitats), field guides and keys to identification. The best guide currently available for Arabian mammals is the book “The Mammals of Arabia” by Harrison and Bates (1991), but it is somewhat out of date and does not include recent additions or descriptions of new species. However, it is still an excellent starting point for any work on Arabian mammals.

A question that is often asked regarding biodiversity surveys is whether the survey was complete. This is an incredibly important question. How do we know whether a survey was effective in recording all (or most) of the species present in an area? Without known the “level of completeness”, the value of a survey is brought into question. There is no easy answer to this question. However, there is a simple statistical tool that can assist us to shed light on this; it is called a species accumulation curve (Figure 22). When a survey starts (e.g. on the first day), all the species captured will be new to the study. On the second day, there may be some repeat captures of species recorded on the first day, along with other species new to the study. After a certain amount of time (i.e. effort), the number of new species being added to the list starts to diminish until eventually all the species have been captured. This is what the species accumulation curve shows. Based on these data, it is possible to estimate the “true” species richness at a site. A useful program that allows such analyses is EstimateS (http://viceroy.eeb.uconn.edu/estimates/) can be downloaded freely from the internet.

Another useful tool for biodiversity surveys is the IUCN Red Data List website (www.iucnredlist.org). This site provides the latest IUCN global assessments for most vertebrates (including all mammals and birds), as well as many invertebrates and plants. Knowing that you have threatened species present in your site may provide additional justification for protecting the site, or at least mitigating for those threatened species.

Figure 22. A species accumulation curve for a biodiversity survey of bats at Mt Nimba, West Africa.



The central (blue) line shows the accumulation curve (based on the Mao Tau method), the lines above and below it are the 95% confidence intervals. The slope of the curve is slowly flattening off but the asymptote has not yet been reached and therefore we can conclude that not all the bat species of this site were captured during this study (and furthermore, we can predict exactly how many species were overlooked).

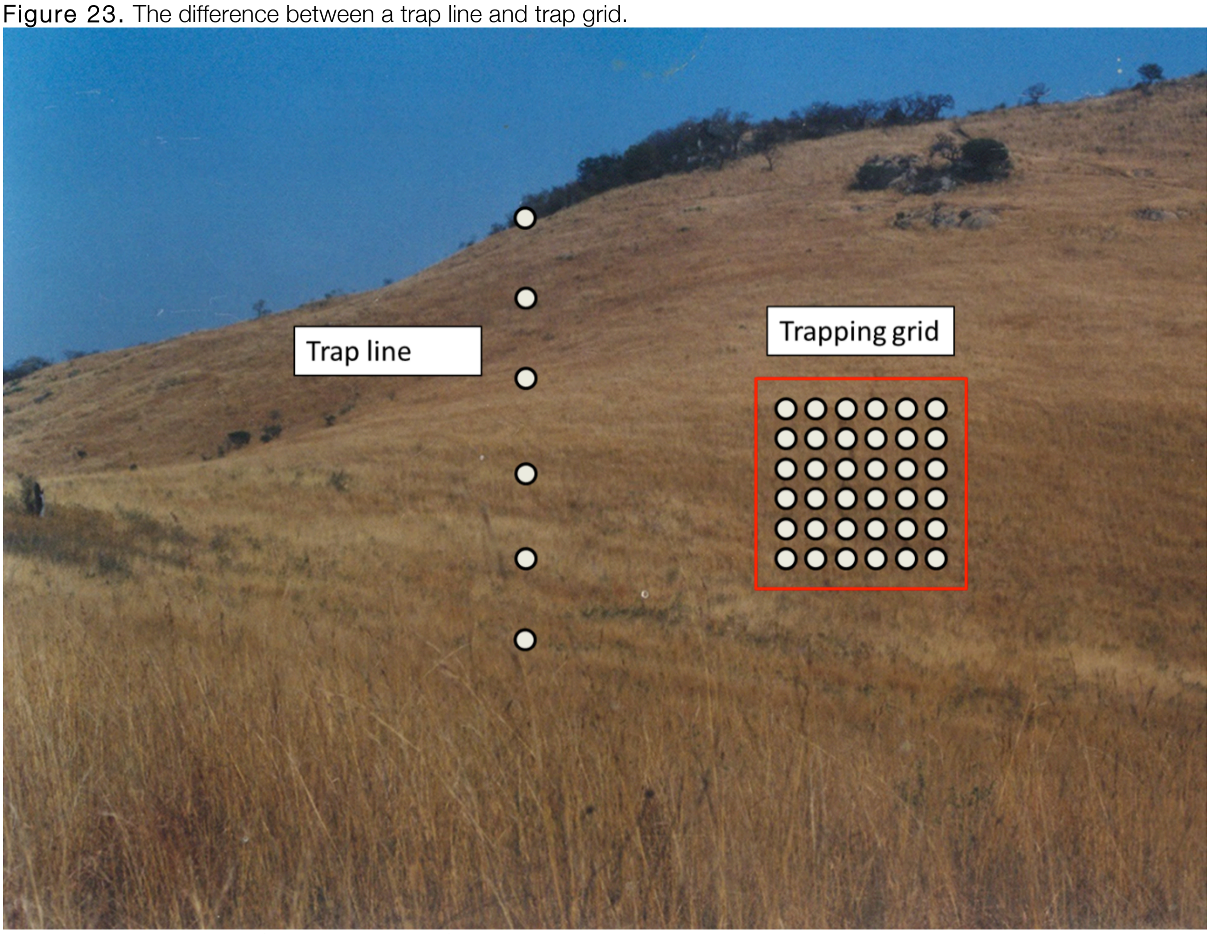
Ecological Surveys

Biodiversity surveys are useful for determining which species are present at a particular site. By combining data from multiple surveys, it is possible to plot the distribution of species across a larger geographic area (such as the Arabian Peninsula). Such maps are critical for effective conservation planning.

However, sometimes more detailed ecological information might be needed. In such situations, we need to employ other techniques. The field of ecological methods is enormous and new techniques are being introduced every year. The purpose of this next section is not to provide a summary of all the available techniques. Rather, it is to introduce the reader to some of the new (or relatively new) techniques that are being used on small mammals.

Before we discuss these new techniques it is worthwhile comparing trapping methods for biodiversity surveys (trap lines) with those commonly used in ecological studies (trap grids). As mentioned earlier, trap lines are very effective at capturing a greater diversity of different species, but they are of limited use in providing other types of ecological information such as population estimates. However, placing traps in a grid (Figure 23) allows such analyses.

Figure 23. The difference between a trap line and trap grid.



A trap line consists of traps (shown in white dots) set out in a straight line: a trap grid is when traps are set out in a square formation. Trap lines cover more habitat (for the same number of traps), but grids allow the estimation of population size and other ecological analyses.

The five techniques that will be discussed here are:

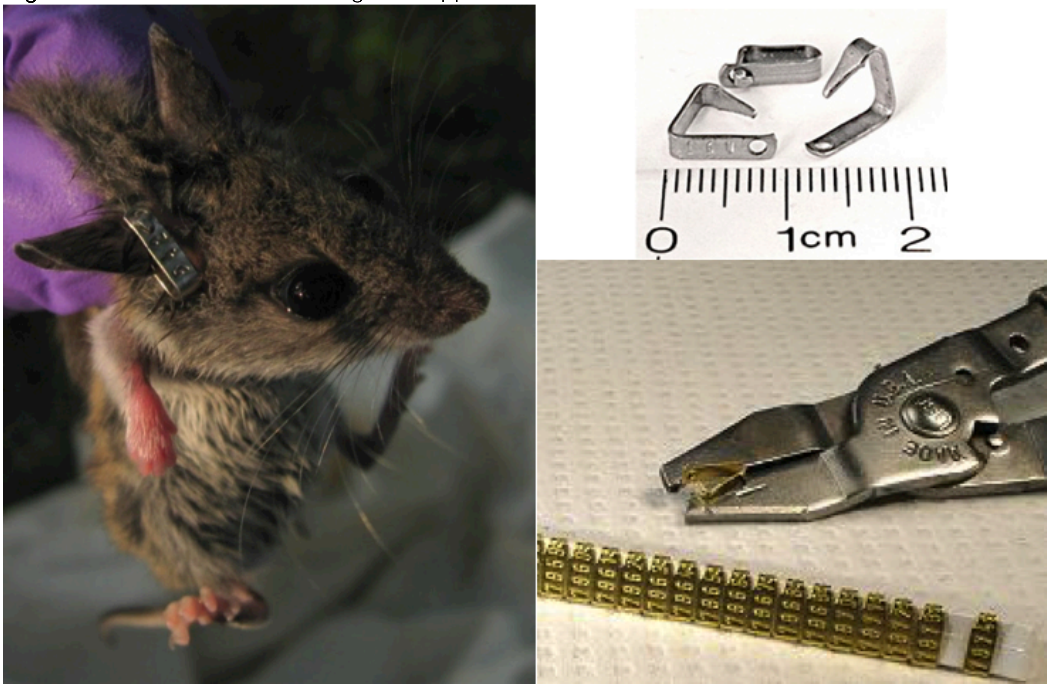
1. Tagging;
2. Molecular analysis of diet;
3. Acoustic surveys (bats);
4. Fluorescent tracking; and
5. Rhodamine B.

There are numerous other relevant techniques that will not be covered here. Perhaps the most useful of these are: radio-tracking which was covered in detail in the Proceedings of the 14th Annual Conservation Workshop for the Biodiversity of Arabia (Seddon et. al., 2013); camera trapping which was covered in detail in the Proceedings of the 13th Annual Conservation Workshop for the Biodiversity of Arabia (Seddon et. al., 2012); spot-light surveys; hair trapping; and spoor tunnels/tracking tiles.

Tagging

Tagging of small mammals is not a novel technique, but is included here because it is so commonly used and is critical to most ecological studies and analyses. For certain ecological analyses, it is essential to be able to identify and separate individual small mammals from each other. This is only possible if the animals carry some unique marking (such as stripes on a zebra) or they are given such a mark. Rodents and insectivores were, in the past, marked by toe-clipping. This technique is currently considered unethical and should not be used to mark terrestrial small mammals. An alternative, ethically acceptable, method is ear tagging. Metal ear tags, with unique numbers engraved on them, are punched through the ear using a special applicator (Figure 24).

Figure 24. Small mammal ear tags and applicators.



A rat with an ear tag (left). The ear tags (right, above) and the ear tag applicator (right, bottom).

Figure 25. A bat with a band on its right forearm.

Bats can be fitted with specially designed and manufactured bat bands that are fitted over the forearm (Figure 25). These bands also have a unique number engraved on them. It is important to note that these are not the same as bird rings (or bands). A bird ring fitted over the forearm of a bat will cut through the wing membrane and cause injury. Bat bands are specifically designed to avoid this. Use only proper bat bands on bats.

Uniquely identified individuals can be used in a variety of different ecological studies including the estimation of survival, population dynamics and individual movements.

Molecular analysis of diet

Diet studies have been conducted on small mammals for decades. The traditional method was stomach content analysis, which involves sacrificing the animal and then examining its stomach contents under a microscope. Faecal pellet analysis, by comparison, is non-destructive and can be conducted without harming (or even capturing) the animal. Both these methods suffer from the problem of not being able to identify digested (or partly digested) remains. Hence, many dietary studies of small mammals only refer to very broad food categories such as “insects”, “herbage” or “seeds”. Some studies have managed to go further and identify insects down to order level (e.g. beetles, flies and moths).

Figure 26. Collection of bat faeces for dietary analysis.

Bat faeces (the dark spots on the white board on the left of the photograph) were collected beneath a large roost of free-tailed bats by placing out a white board covered with cling-film. Individual pellets were then collected and stored in a vial with dehydrating salts (being done by the person in the photograph).

To overcome this problem, and identify prey remains down to species level, one can take advantage of molecular techniques that are becoming cheaper and quicker by the year. The molecular analysis of diet in small mammals was only very recently development (Clare et. al., 2009; Bohmann et. al., 2011), but is now becoming routine. It still requires the use of a highly specialized laboratory with skilled technicians and expensive reagents. However, these obstacles can usually be overcome by partnering with an appropriate institution (many European and North American universities and laboratories are eager to collaborate with researchers from species-rich but under-surveyed African and Asian environments).

As far as the field-work is concerned, all that needs to be done is to collect uncontaminated (i.e. not touched by human tissue) faecal material and place them in vials (Figure 26). Reagents added to the faecal material will depend on the molecular technique to be employed. Some techniques only require that you add dehydrating salts to the vial and seal it, and send it off to the laboratory for analysis.

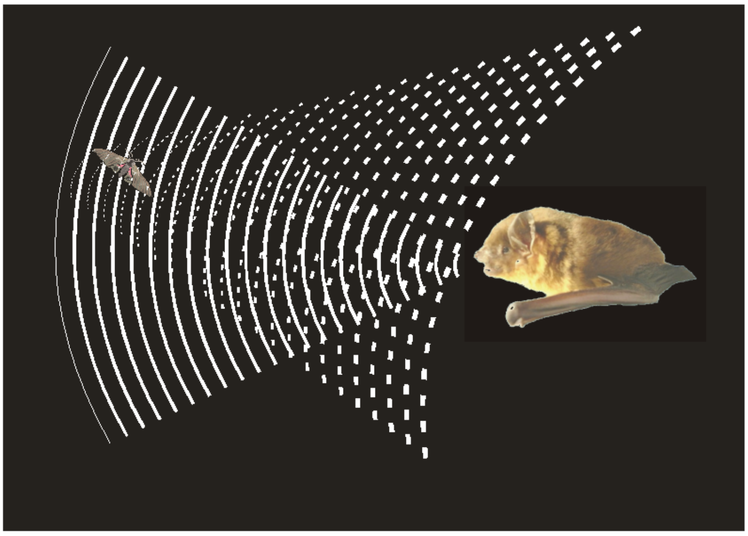
Acoustic surveys and bat detectors

Most bats navigate using sonar; referred to as "echolocation". This allows the bat to perceive its environment through its ears rather than its eyes (Figure 27). Echolocation calls tend to be species specific. By recording these echolocation calls using bat detectors, it is possible to identify species present in an area without having to capture them. However, due to significant variation within species and overlap between species this is not as easy as it sounds. In areas or habitats that support fewer bat species (such as temperate or desert zones) it may be possible to conduct relatively comprehensive acoustic surveys. The two essential items are: 1) a suitable bat detector such as Anabat (a discussion of the pros and cons of the various bat detectors will not be attempted here); and 2) a complete echolocation call library of the bats present (or expected) in the region. A recent review of echolocation in bats, with a focus on African bats is provided in Monadjem et. al., (2010).

A bat detector, such as Anabat (Figure 28), is designed to recognize and record echolocation calls of bats, which are typically at frequencies well above the audible range in humans (ca. 18 kHz is the highest that humans can hear).

The calls recorded by bat detectors can be graphically presented as sonograms or spectrograms (Figure 29). Different species often have different sonograms, hence allowing species identification through acoustic monitoring.

Figure 27. Bats use echolocation to perceive their environment.

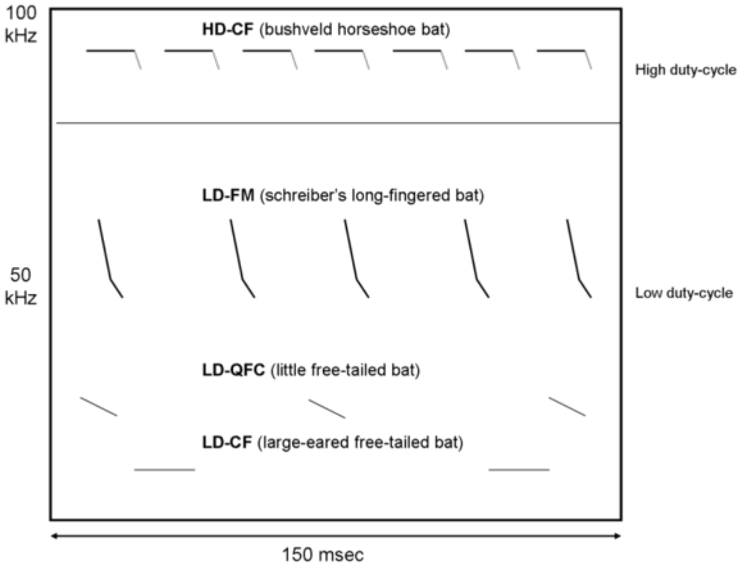


A sound is emitted from the bat that bounces off any obstruction (such as prey or vegetation) in its path. The returning echo is received by the ears and analysed by the brain to create a "picture" of its environment (much in the same way that we see with our yes, bats "see" with their ears). Not all bats are capable of echolocation, such as most fruit bats (Family Pteropodidae).

Figure 28. The SD II Anabat bat detector.

The SD II Anabat bat detector is a "frequency division" device that is popular with bat ecologists wishing to survey bat activity. It can also be used to conduct acoustic surveys, but this is only possible in regions where a complete bat call library is available (to be used as a reference to compare the recorded calls against and hence allowing identification of the calls).

Figure 29. Sonogram.



Calls recorded by bat detectors can be viewed as sonograms (or alternatively called spectrograms). This is a special kind of graph that showing frequency of the call on the vertical axis and time on the horizontal axis. The calls of 4 different species of bats are shown in the above sonogram, illustrating the distinctness of each species.

The situation throughout most of the Arabian Peninsula is probably similar to that of Sub-Saharan Africa where acoustic surveys are realistically possible at only a handful of localities, mostly due to the lack of comprehensive call libraries (which are essential as a comparative reference resource). Hence, at this stage, the focus in the Arabian Peninsula should probably be towards developing local call libraries.

Fluorescent tracking

Fluorescent powders can be purchased commercially and then used to dust a captured animal that will then glow in the dark (but which is only visible under UV light) (Figure 30). The powder tends to drop off the animal as it moves about, also illuminating the path that the animal has moved on. This is a useful technique for following animals that are too small to be fitted with radio-transmitters or the resources are not available for radio-tracking. Alternatively, it is very useful for tracking the exact path moved by an animal (as opposed to getting fixes that may be many minutes or hours apart when radio-tracking). But a constraint of this method is that the dust usually falls off within the first night (or day) of release, so an animal cannot be followed for long. It has been successfully used to quantify the microhabitat use of certain species such as the African pygmy mouse (*Mus minutoides*) (Long et. al., 2013).

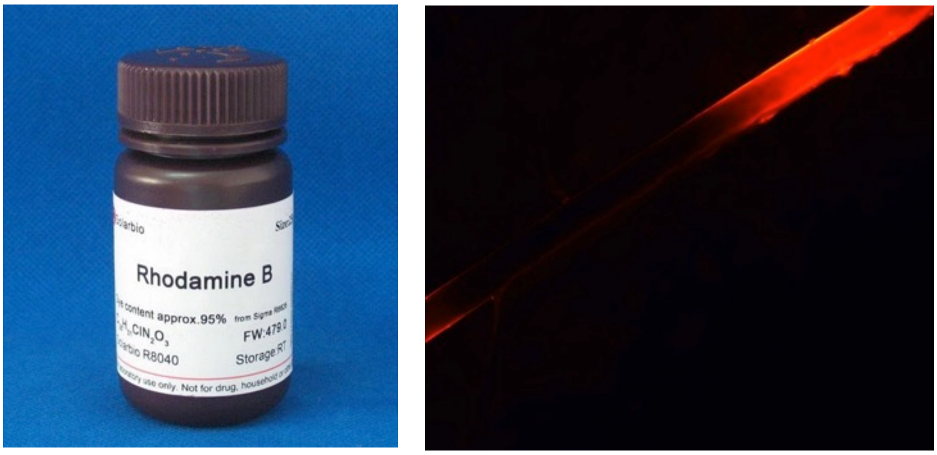
Figure 30. Fluorescent powders.

Fluorescent powders can be purchased commercially and need UV light in order to be detected in the dark (left). The tracks of a mouse (right) that had been dusted as seen through UV light.

Rhodamine B biomarker

Rhodamine B is a non-toxic dye that has been used as biomarker. It can be fed to an animal (without having to capture it) and then used to identify that animal if it is trapped in the future. Rhodamine B can be purchased commercially (Figure 31) and mixed with foods normally used as bait (such as rolled oats and peanut butter). It can then be left out at a specific location where rodents are predicted to be visiting (such as a storeroom). Trapping at different distances from this storeroom about 5-7 days after placing of the Rhodamine B bait may result in the capture of some of the rodents that visited the storeroom. By plucking two whiskers from each animal (which can then be released unharmed), it is possible to detect whether the animal had ingested Rhodamine B (and therefore, whether it had entered the storeroom) by examining the whiskers under a fluorescent microscope. Rhodamine B was successfully used to characterize the interaction between alien invasive rats (*Rattus* spp.) and indigenous mice (*Mastomys* spp.) with respect to homes in rural Swaziland, without having to capture mice within homes (Monadjem et. al., 2011).

Figure 31. Rhodamine B.



Rhodamine B can be purchased commercially (left). Once it has been ingested by an animal, Rhodamine B, which is completely non-toxic, will work its way into the hair of the animal where it can be viewed using a fluorescent microscope (right).

Small Mammals in the Arabian Peninsula

Distribution maps (particularly of threatened species) play a key role in the development of conservation action plans and the identification of protected area networks. However, in order for such maps to be useful, they need to accurately portray the actual distribution of the species considered in the analysis. At the end of the day, the better surveyed a region is, the more accurate will be the maps that are derived from those surveys.

The status of mammals in the Arabian Peninsula was last reviewed by Harrison and Bates (1991). In this book, the authors present distribution maps for each species. However, the authors themselves admit that their maps are incomplete and called for further surveys. Almost a quarter of a century has passed since the publication of that book, and several new species have been described since then. Also, some species may have contracted or expanded their range (perhaps due to climate change). As a result, it may be worth considering the development of a small mammal survey for the Arabian Peninsula. Perhaps the survey should not be restricted to just small mammals, and should include all mammals? This purpose of this section is to highlight some of the challenges associated with conducting such a survey, and to provide some initial guidance and pointers. Recommendations from the workshop are noted as bullets in the sections below.

1 Set the objectives

Clearly define what the objectives of such a survey are to be at the outset. This will largely answer many of the other considerations listed below and will be an essential requirement in any funding application.

- Suggested an initial focus on small carnivores as a priority although ideally all small mammals should be covered.
- Aim to collate the information for a full Red List assessment of the small mammals in 2-3 years.
- Collate all information per site to update the Harrison and Bates, 1991 publication/distribution maps.

2 Identify the survey area

The first consideration would be to define the geographical scope of the study. What exactly is meant by the “Arabian Peninsula”? This is important because it focuses attention on the study at hand, and prevents wasting energy and resources. However, by defining the boundaries of your geographical area, you are not restricting yourself to that area; the boundaries can be shifted in the future as needs be.

- Need a standard recording grid for the Arabian Peninsula such as that used by the Arabian Breeding Bird Atlas (ABBA).

3 Who drives this process?

Will it be by a committee (which has the advantage of transparency, but the disadvantage of bureaucratic inertia)? Or an institution or an individual? Projects driven by committed and credible individuals are often the most successful ones.

- The need for an institutional base for this regional information was identified as a priority.
- Dr. Eitimad Hashim Abdel Rahman Ahmed, Department of Biology, Hail University, Kingdom of Saudi Arabia (Mobile: +966 564127766; Email: e.hashim2006@gmail.com) volunteered to start a small mammal network – see http://networkarabianmammals.blogspot.com/. The objective was to understand who was working on small mammals in the region, what they were doing, share any interesting information, upcoming events, and any comments.

4 Select species/groups to survey

Is it to be a subset of mammals (e.g. rodents, small carnivores) or all mammals? If a subset, then what specific groups are being included?

- Suggested an initial focus on small carnivores as a priority worth investigating.

5 Methods to use

Will the survey methods be standardized and all participants will be expected to conform to these? Or will you allow different individuals/institutions to survey with independent methods, but simply coordinate the locations that will be surveyed (to avoid duplicating effort)? Allowing for researchers to act independently usually is more acceptable and may result in better buy-in.

- Use a standard recording grid for the Arabian Peninsula. Suggested use the Arabian Breeding Bird Atlas (ABBA) that uses half-degree grid squares (i.e. about 1, 142 squares).
- Through a combination of presence only information and species distribution modeling (using the MAXTENT software) one would be able to identify gaps for focused surveys. Area selection would be further stratified using the AEGEDI habitat map overlay for the Arabian Peninsula.
- As a start it was suggested that all working on mammals or who have knowledge of their distribution and status should be called together at one of the Sharjah meetings to get the process running of collating the information. As a start it may be worth-while to commence with an updated checklist and map for the different species building on the Harrison and Bates, 1991.

6 Data storage

For effective and efficient use of the data, it will need to be entered into a central database. Where will this database be housed? Who will be responsible for its upkeep and maintenance? How will different researchers and organizations access this database (either to enter data or retrieve data)?

- Building on the initiative already started by Dr. Eitimad Ahmed, identify a potential site or sites for storage of such information. This database should ideally start small and simple format (Excel) and grow progressively as required.
- Suggested this could be linked via the planned Sharjah website.

7 Storage and curation of specimens

Where will the voucher specimens be deposited? Choose an institution (preferably a museum or museums) that is within the Arabian Peninsula and that is interested to collaborate on this project. These specimens will form the source of the distribution maps that are eventually produced, and therefore must be accessible to all researchers (both for verification of identifications and for comparative material).

- This should logically flow from knowledge of whose studying small mammals and where specimens are stored. Developing the network first, then an assessment of what's in the collections and their state can be done and shared.

8 Collaborator's list

Compile a list of interested collaborators. Who within and beyond the Arabian Peninsula is interested in contributing to this project? Make this group as inclusive as possible; some people on the list may never contribute anything but it is better to have them included as one never knows what will happen in the future. Some people may take several years to find funding or enthusiasm!

- See comments made in Section 3 above.

9 Advisors

It might be worth having one or more independent advisors that are not directly involved in the day-to-day workings of the project, but that have the experience to provide advice and guidance on broader issues.

10 Publish the results

It is critically important to publish the information, ideally in a peer reviewed journal, as it facilitates the distribution of the information, enhances the status of the project and the region in the international scientific community.

- As part of the small mammal network – recent papers could be shared.

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Captive Carnivore Care

Introduction

This was the first year where a veterinary theme was added to the usual biodiversity themes presented annually. The reason for this is the increasing number of wild and exotic animals in the care of veterinarians with different needs to the regular animal populations serviced by them. We decided to focus on carnivores as these present some unique challenges in the field of veterinary science and captive care, with a view to expanding the themes to cover all taxa and their associated challenges.

Secondly we feel it is important that there must be a closer working relationship between veterinarians and other wildlife professionals. This closer working relationship is needed not only to expose veterinarians to the bigger picture of conservation, but also to help the other wildlife professionals to understand the value a veterinarian may add to such a team.

It is our hope that there may well be several interactive sessions in the future to strengthen this relationship.

This workshop was mainly conducted through formal lectures. There was one session that was more interactive in the lecture room and lastly a remote injection practical was held where everyone had the opportunity to use a variety of tele-injection systems.

Overview of Legal Regulations

Since the majority of these predators are exotic to the region, we asked the Ministry of Environment and Water (MOEW) to give us an overview of the laws and regulations governing the keeping of carnivores, especially large carnivores in captivity.

We were shown that the UAE has several laws and ministerial resolutions on a Federal level in place to deal with animal and wildlife matters. These are:

A Legislation dealing with import and export of animals

Federal Law no. 6/1979 and its amendments concerning veterinary Quarantine.

Ministerial resolution no. 460/2001 concerning the by –law of Veterinary Quarantine of GCC Countries.

Several Ministerial resolutions regulate the import and export on Live animals and animals products.

B Legislations regulate Animal Health

Federal Law no. 10/2002 concerning practicing the Veterinary medicine Profession

Federal Law no. 8/2013 concerning the protection of Animal diseases

Ministerial resolution no. 170/2003 concerning the By –law of practicing the Veterinary medicine Profession

Several Ministerial resolutions regulate the import and export on Live animals and animals products

C Legislations regulate Animal welfare

Federal Law no. 16/2007 concerning Animal Welfare

Ministerial resolution no. 384/2008 concerning the By –law of Animal Welfare

Several Ministerial resolutions regulate the Animal Welfare

D Legislations regulate Wild life

Federal Law no. 11/2002 concerning the regulation and monitoring of international trade for endangered species.

Ministerial council resolution no. 22/2003 concerning the By –law of Federal Law no. 11/2002 concerning the regulation and monitoring of international trade for endangered species.

Federal Law no. 24/1999 concerning Environment protection and development and its amendment.

Ministerial resolution No. 346/2012 concerning the importation of wild animals and its amendment.

Several Ministerial resolutions and instructions regulate the import and export on Live animals and animals products.

From the meeting there was a feeling that most of these laws/ministerial resolutions were not visible in everyday practice and that the implementation of them may not be as effective as they could be.

Some discussion took place regarding similar laws in the rest of the region, however very little information is available. We would propose that a specific meeting in future should be convened with stakeholders of the region participating in a discussion to ultimately bring fruition to the mission of the MOEW:

We strive towards integrated management For Environment Ecosystem and Natural resources to realize Green Economy for the present and future generations

The Composition and Application of F10 Disinfectant

This talk focused on the need for biosecurity and specifically all the factors that make F10 (new age quaternary ammonium compound) a valuable partner for any practice/facility.

Facility Planning

The main principles of planning a facility were dealt with. These are not restricted to the facility/cage where the animal will be kept, but the entire facility. During this planning the flow of traffic in and out of the facility should be considered as well as the flow of people within the facility. Enrichment within the displays was touched on as this is a very important aspect of modern facilities.

Perimeter fences/walls were emphasized as a secure barrier to protect these collections from free ranging animals.

Biosecurity

Following on from the F10 talk, practical implementation of biosecurity measures within facilities were discussed. A variety of products to disinfect cages, utensils, vehicles etc was discussed. Hand washing and hand sanitisation as an important measure to control human to animal transmission of diseases and *vice versa* was emphasized.

Nutrition (including enrichment)

Wild and exotic carnivores have unique nutritional requirements that are often poorly understood by both veterinarians and the general public. Nutritional needs in various exotic carnivore groups were discussed, and some of the more common metabolic derangements due to nutritional deficiencies were highlighted.

The importance of enrichment in the lives of captive housed wild animals is well known yet poorly implemented. Enrichment techniques using diet as the enrichment source were explained and easy to use examples were presented to the delegates to implement in their collections.

Primary Healthcare

Captive populations are at risk of infectious diseases and parasites. This can be due to intensification and/or the close proximity to domestic animals and humans.

Carnivores like lions especially are at risk of contracting canine distemper virus and the difficulty in finding an appropriate vaccination protocol was discussed. These complications re-iterated the need for appropriate biosecurity measures to be in place at facilities as well as enforced.

Medical Husbandry Training

This is a growing science within zoological collections around the world. Medical husbandry training is a great tool in enrichment programs and also provides safer, stress-free alternatives to common veterinary diagnostic procedures in the management of wildlife diseases. The ability to interact with animals in a stress free manner, without customary immobilization, during sample collection reduces the risk of losses due to anesthesia, saves time and expense and reduces stress to both animal and the veterinary team. Successful medical training also provides improved diagnostic ability in patients that are poor anaesthetic risk or that require ongoing monitoring. Not to be overlooked are the positive benefits gained in accurately administering medications in a trained and accessible animal.

Behavioural Enrichment (including stress and welfare)

As with medical husbandry training, the importance of behavioural enrichment in the health and well being of all animals housed in captivity and the field has become an integral part of managing captive collections of all species. This talk focused specifically on enrichment on carnivore species and compared the positive impact that enrichment has with some of the negative consequences that are encountered where inadequate enrichment is offered. In addition to introducing the science behind enrichment research, practical methods of recognizing stress indicators in the animals were discussed along with simple and inexpensive techniques that can be implemented in any collection. The presentations were re-enforced with a practical session giving participants an opportunity to implement and discuss some the concepts covered.

Dental Health Care

Captive predators do suffer from dental disease. These are mainly tooth fractures and as these conditions are painful should be addressed when seen. Apart from dental disease some other oral disorders like periodontitis and oral tumours were also discussed.

Viral and Bacterial Diseases

Various viral and bacterial diseases can be devastating for any captive collections. Discussions around them took place and especially in cheetahs, feline infectious peritonitis seems to be of concern in the region. This disease is caused by a coronavirus and it is very difficult to diagnose the condition, with confidence, without a post mortem.

Biosecurity measures and quarantine of new animals into a facility was emphasized.

Fungi and Parasites of Captive Carnivores

Very little is known of the viruses and parasites that affect carnivores in the region. Some common fungi and parasites were discussed but the need for an epidemiological study to determine these species for the region was emphasized.

Metabolic Diseases

This presentation examined metabolic diseases due to nutritional deficiencies in more detail and explained the pathological processes occurring in various metabolic diseases as well as basic treatment approaches.

Neoplasia

Wild animals like domestic animals suffer from a variety of neoplasia. The presentation was based on published information on tumours in captive carnivores. Very little information is available regionally and discussions took place on how to diagnose tumours and which samples to take. A concern was expressed that the support from the laboratories are not as reliable as what it could be throughout the region.

Pain Control

Analgesia in carnivores needs to look at a more balanced approach, incorporating not only the systemic but also local routes. Drugs available differ within the region and this may impact on animal welfare when specific drugs are not available. Standardised regulations regarding the use of for instance opioids should be drafted within the region, but it also appears as if within the Emirates the availability of these drugs is differently regulated.

The veterinary fraternity should approach the regulatory bodies and clearly discuss the need for these kinds of drugs and work with government to incorporate a reliable and safe record keeping mechanism.

Anaesthesia in Captive Carnivores

A very practical approach to anaesthetizing wild and captive carnivores was presented. The audience was shown that the final induction of anaesthesia can be as safe as the planning that went into the procedure if well considered. The type of cage and structures within the cage should be properly evaluated and all risk factors assessed before an animal is actually anaesthetized.

Specific drug combinations were not discussed at great length, however as for analgesia, it was obvious that drug availability in the region is varied. In order to safely immobilize/anaesthetise animals recommended drug combinations and doses should be adhered to.

Practical Session – Remote Injection Techniques

As an introduction to this session, participants were shown the basic safety measures when dealing with powered tele-injection systems. The types of dart systems was explained and they were given the opportunity to, under guidance prepare darts with water. These darts were then used to remotely inject carcass legs that were provided for the purpose.

For many participants this was the first time they had this kind of exposure and training and all enjoyed the opportunity.

Conclusion

This was the first workshop of its kind in the region and all participants found value in it. Although the lectures were quite formal, there was ample time for discussions and even though the language (English) was sometimes a barrier it did not deter from the discussions.

The interactive sessions and practical session on the last day did attract many comments and views from participants, and through its interactive nature people walked away with experiences that they were comfortable to go and implement in their own spheres of operation.

Appreciation was expressed to the Sharjah government for taking the lead on this and the hope that in future these lectures would continue.

Areas identified for further discussions and hopefully future action:

- Understanding all the specific laws and regulations (decrees) present within the region dealing with the capture, care, movement and welfare of wild animals.
- Understanding the jurisdiction of the various governments, agencies and municipalities in implementing and enforcing these laws.
- Epidemiology of diseases and their vectors in the region.
- A limiting factor to obtain the epidemiological data is access to appropriate diagnostic laboratories within, if not throughout the region.
- Access to drugs needed for the capture and care of wild animals that are not freely available within the region.

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