Proceedings of the

16th Annual Conservation Workshop for the Biodiversity of Arabia

Human Wildlife Conflict, Electronic Data Capture, the Conservation of Sea Turtles in the Arabian Region, and Veterinary Management of Wild Herbivores

16th Annual Conservation Workshop for the Biodiversity of Arabia

Human Wildlife Conflict, Electronic Data Capture, the Conservation of Sea Turtles in the Arabian Region, and Veterinary Management of Wild Herbivores

3-6 February 2015

Compiled by Philip Seddon[1], Mike Knight[2], David Mallon[3], Brandon Anthony[4], Jane Budd[5], Gerhard Steenkamp[6] and Sarah May[7]

Organised by
Environment and Protected Areas Authority (EPAA)
Government of Sharjah, United Arab Emirates

[1] Department of Zoology, University of Otago
PO Box 56, Dunedin, New Zealand
Email: philip.seddon@otago.ac.nz

[2] Park Planning and Development, South African National Parks
Nelson Mandela Metropolitan University, Summerstrand Campus
PO Box 7700, Port Elizabeth 6031, South Africa
Email: M.Knight@nmmu.ac.za

[3] Manchester Metropolitan University, UK, &
IUCN/SSC Conservation Planning Sub-Committee
Email: d.mallon@zoo.co.uk

[4] Department of Environmental Sciences and Policy
Nador U. 9., 1051 Budapest, Hungary
Email: anthonyb@ceu.hu

[5] Breeding Centre for Endangered Arabian Wildlife
Email: jane.budd@bceaw.ae

[6] Department of Veterinary Science, University of Pretoria
South Africa
Email: Gerhard.steenkamp@up.ac.za

[7] Environmental Consultant
Email: sarahamay@gmail.com

16th Annual Conservation Workshop for the Biodiversity of Arabia

© Environment and Protected Areas Authority, Sharjah, 2017

Recommended citation: EPAA (2017). *16th Annual Conservation Workshop for the Biodiversity of Arabia*. Environment and Protected Areas Authority, Sharjah, UAE.

Reproduction of this publication for educational, conservation or other non-profit purposes is authorised without prior written permission from the copyright holder provided the source is fully acknowledged. Reproduction of this publication for sale or other commercial purposes is prohibited without prior written permission of the copyright holder.

The designation of geographical entities in this book, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of EPAA or other participating organisations concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. The views expressed in this publication do not necessarily reflect those of EPAA or other participating organisations.

Executive Summary

The Sixteenth Annual International Conservation Workshop for Arabia's Biodiversity (ICWAB) was held at the American University of Sharjah, in conjunction with the Breeding Centre for Endangered Arabian Wildlife (BCEAW) in Sharjah, United Arab Emirates, from the 2nd to the 5th of February 2015. Over 150 participants representing UAE, Qatar, Jordan, Saudi Arabia, Bahrain, Kuwait, Yemen and Oman, as well as from the UK, South Africa, Hungary, Australia, and New Zealand, participated in this forum. The Sharjah workshops are hosted by the Environment and Protected Areas Authority (EPAA) of the Government of Sharjah, under the patronage of His Highness Sheikh Dr Sultan bin Mohammed al Qasimi, Member of the Supreme Council and Ruler of Sharjah.

The 16th Workshop in 2015 had four themes. The protected areas and planning theme looked at the assessment and management of human-wildlife conflict; a species assessment theme conducted a review of the conservation status, threats and management of marine turtles in the Arabian Peninsula region; a veterinary theme looked at the issue of herbivore health care; and a technical theme examined aspects of electronic data capture.

The topic of human-wildlife conflict had been raised as an important regional issue at previous ICWAB workshops, particularly concerns around predation of livestock by native carnivores. In a series of session facilitated by Dr Brandon Anthony of the Central European University, Budapest, Hungary, working groups looked at case studies relevant to the Arabian Peninsula: livestock predation and perceived threats to humans by leopard, wolf, hyena, caracal and jackal; commensalism by Hamadryas baboons; and issues concerning goats in and around protected areas. During three days the working groups looked at: identification of stakeholders; environmental and social risk factors; the perceived and real costs of the conflict; policy and management options; contextual challenges; monitoring and evaluation; and research needs. Stakeholder engagement strategies and social scientist tools need be further developed for the region in taking this subject further.

The species assessment theme covered the status and conservation of the five species of marine turtles (four of them breeding) in the Arabian Peninsula. Topics covered included identification of key nesting and foraging sites, a threat assessment at regional and national levels, research needs, identification of stakeholders, and listing of recent and current turtle conservation projects. A vision and a goal for marine turtle conservation were developed along with a set of objectives to provide a conservation strategy framework for integration into existing initiatives, such as the CMS IOSEA (Indian Ocean and South-east Asia) Memorandum of Understanding.

This year we were honoured to have a panel of experts present to address the veterinary stream: herbivore health care. The panel consisted of Prof Moritz van Vuuren, Drs June Williams and Gerhard Steenkamp (from the University of Pretoria's Veterinary Faculty), Dr Jane Budd (Breeding Centre for Endangered Arabian Wildlife) and Dr Anne-Lise Chaber (Wildlife Consultant LLC). Mr Meyer de Kock

(Tahr working group) and Mr Yassir Al Kharusi (Environment Agency Abu Dhabi) also presented disease status overviews for the Arabian oryx and Arabian tahr.

The focus of the veterinary component was to equip the attendees with a good understanding of what a notifiable disease is, how to recognise common notifiable diseases of herbivores and how the control of these diseases helps a country or region protect not only the production animals so many depend on, but also wildlife. Discussions revolved around the emerging and re-emerging diseases of the Arabian Peninsula. To complement these, lectures and hands-on sessions dealt with the appropriate techniques of post mortem evaluation and sample collection with an emphasis on simple, in-house diagnostic procedures that can be used to make a diagnosis. The practical situation within the UAE was elaborated using case discussions covering cases presented to participants within the previous year. Practical preventative medicine discussions followed in order to give guidelines of how to protect animals from diseases entering a herd. Additional discussions centered on the immobilisation of hoof stock and possible complications such as capture myopathy.

The Workshop included a technical training component facilitated by Ms Chenay Simms of the SANParks Scientific Services, South Africa, comprising a day of hands-on exercises, regional case-studies, and equipment assessments relating to the selection and application of electronic data capture, including smart-phone apps, GPS, remote sensing, and drones.

Contents

Figures

Tables

HUMAN-WILDLIFE CONFLICT

Introduction

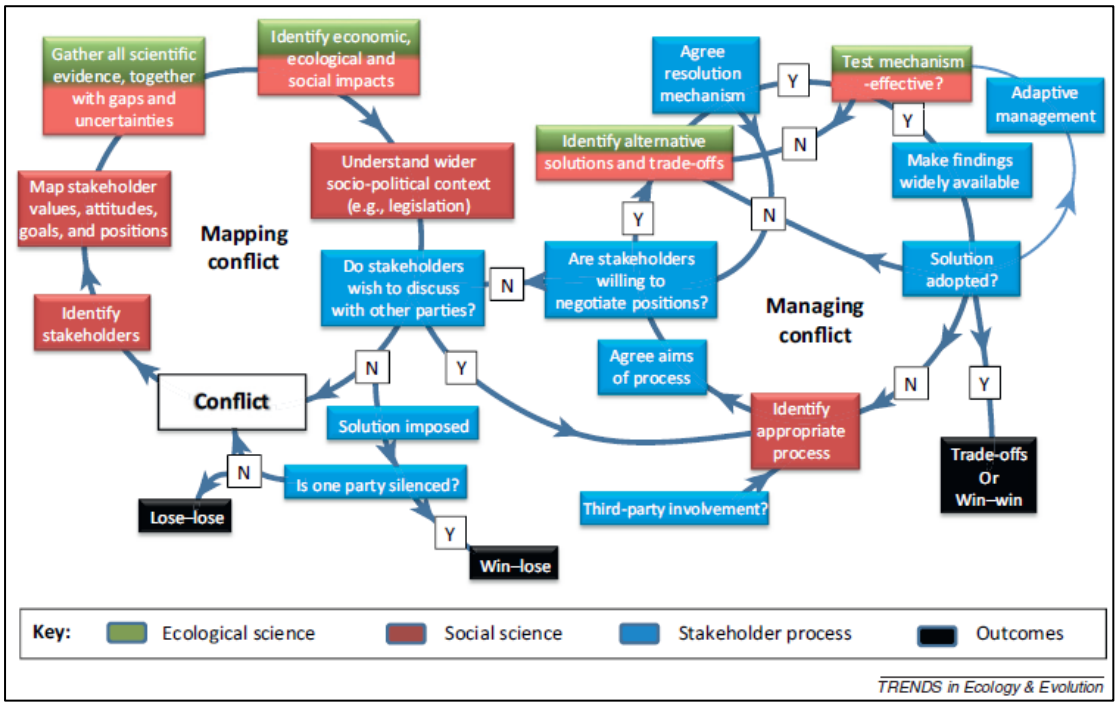
Human-wildlife conflict (HWC) arises from a rivalry or antagonism between humans and wildlife, and/or between people over wildlife and its management. The former typically emerge from territorial proximity between humans and the wildlife, conflict over the same resource or even a direct threat to human wellbeing or safety. The latter typically emerge when disparate values clash in the face of management decisions. Such conflicts have been in existence from time immemorial.

Protected areas are credited with saving a number of wildlife populations from regional or range-wide extinction, and they remain a cornerstone of conservation. They have, in many cases, also faced substantial criticism for undemocratic imposition of a societal goal on local peoples. Thus in the context of protected area establishment and management, HWC has been a recurrent theme identified in numerous discussions in previous Sharjah workshops (e.g. protected areas management, trans-boundary conservation, park planning, species conservation plans).

Conflicts with wildlife arise from the expanding human population, wildlife range expansion, climate change, non- or inadequate responses to conflict, inappropriate legislation, and limited resources, to name a few. Thus, HWC is more than simple competition for space, food, and life. It pits different nature values against one another and demands attention from economic, legal, social, and environmental policy makers (Knight, 2000). Threats from wildlife remain real or perceived, economic or aesthetic, social or political. Perceptions will in turn influence how management or communities respond to threats and will vary depending upon: values; types of wildlife (carnivores, herbivores and their size and impact), peoples, and their location; and perceived or actual control over the situation.

With regard to protected area management and engagement with HWC-type issues, there has been a shift from the emergence of protected areas focused on biocentric type ideas with little to no appreciation of the social aspects, through involving local peoples in a consultative role, to a co-management perspective that includes a closer link between ecological-social-economic contexts. If not addressed quickly and thoroughly HWC can escalate into political clashes (Anthony et. al., 2010) – so much so that HWC has been identified as one of the most prominent challenges faced by wildlife managers. Political clashes, in turn, have sometimes undermined political support for protected areas and wildlife managers, at many levels (Treves, 2009). Human–wildlife conflict impacts species' conservation, jeopardizes human livelihood and safety, and requires increased resources from managers (Baruch-Mordo et. al., 2009). There has been greater realisation by management authorities that in addressing HWC, focusing on both wildlife and human dimensions together is critical, as opposed to treating them separately (Clark et. al., 1996). Redpath et. al., (2013) identified the process to guide effective management of conservation conflicts (Figure 1).

Figure 1. A flowchart to guide effective management of conservation conflicts (Redpath et. al., 2013).



Aim of the Workshop

The aim of this workshop was to highlight the scope and scale of HWC issues associated with protected areas management in the Arabian Peninsula, and how to address these issues by drawing on a number of relevant local examples. It specifically aimed to explore multi-stakeholder complexities involved in preventing and resolving HWC and fostering coexistence between people and wildlife.

Methods and Outputs

The following aspects were addressed through a series of participant engagement exercises.

Five HWC themes/species were selected for discussions:

1. Wolf
2. Leopard
3. Hyaena/caracal/jackal
4. Baboon
5. Goat farming

Elements from these are used to illustrate the different subcomponents of understanding HWC issues in the region.

The details of these outputs are less important than understanding the approaches and methods to collate and assess the information.

Identification of Stakeholders

Objective(s)

1. To provide a clearer understanding of stakeholders and, as a result, provide insights as to how best to engage them. This was done via:

- Identifying relevant stakeholders in conflict;
- Ranking stakeholders according to importance and influence; and
- Assessing what is/isn't known about stakeholder(s).

Details of this can be accessed at:

http://www.ifc.org/wps/wcm/connect/938f1a0048855805beacfe6a6515bb18/IFC_StakeholderEngagement.pdf?MOD=AJPERES. See also Messmer (2000).

Who are stakeholders?

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organisations and groups with special interests, the academic community, or other businesses.

For example, these could include:

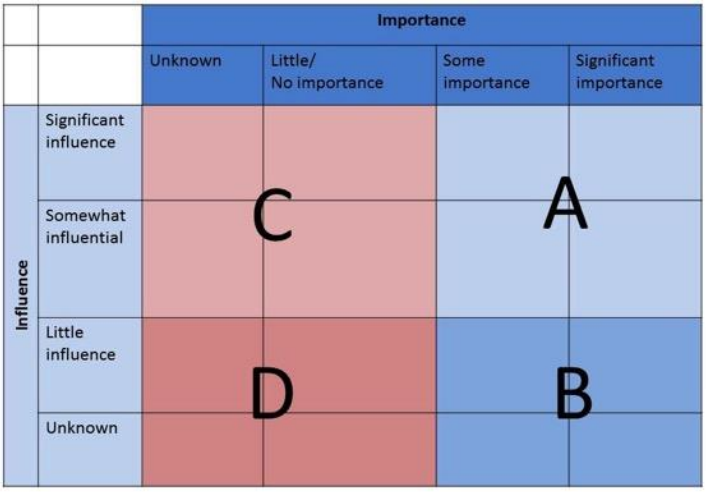
- Immediate neighbours — Public or private property owners.
- Major economic interests — Significant local employers, dominant industries, major local land-owners, unions, general business associations.
- Resource-based industries — Agricultural, ranching, mining companies and business associations.
- Tourism industry — Hotel/motel associations, outfitters, hunting industry, etc.
- Recreational user groups — Hunting and fishing clubs, hikers, equestrians, birdwatchers, recreational vehicle enthusiasts, etc.
- Environmental groups — Environmental advocacy organisations.
- Anti-environmental groups — Organised 'Wise Use' groups.
- Community/Civic/Neighbourhood organisations.
- Government officials and/or agencies — National and regional natural resource agencies, etc.
- Educational institutions — Schools, colleges, PTAs, teachers unions.
- News media — Reporters, editorial board members.

Description

Stakeholder analysis is an essential part of developing a useful Engagement Plan. Deciding how to define stakeholders is important, as it affects who and what counts. A common method of stakeholder

analysis is a Stakeholder Matrix, where stakeholders are plotted against two variables (Figure 2). These variables might be plotting the level of 'stake' in the outcomes of the project against 'resources' of the stakeholder. Another typology is the 'importance' of the stakeholder plotted against their 'influence'. The concept is the same, though the emphasis is slightly different.

Figure 2. A matrix of stakeholder importance and influence.



Box A ('Players'). These are stakeholders appearing to have a high degree of influence on the project, who are also of high importance for its success. This implies that the implementing organisation will need to construct good working relationships with these stakeholders, to ensure an effective coalition of support for the project. Examples might be senior conservation officials and/or livestock farmers associations.	Box B ('Subjects'). These are stakeholders of high importance to the success of the project, but with low influence. This implies that they will require special initiatives if their interests are to be protected. An example may be traditionally marginalised groups, who might be beneficiaries of an intervention, but who have little 'voice' in its development.
Box C ('Context Setters'). These are stakeholders with high influence, who can therefore affect the project outcomes, but whose interests are not necessarily aligned with the overall goals of the project. They might be financial administrators, who can exercise considerable discretion over funding disbursements. These stakeholders may be a source of significant risk, and will need careful monitoring and management.	Box D ('Crowd'). The stakeholders in this box, with low influence on, or importance to, the project objectives, may require limited monitoring or evaluation, but are of low priority.

Method

This entailed:

- Making a list of all stakeholders.
- Categorising the stakeholders as well known, moderately known or not well known.
- Ranking the stakeholders on a scale of one to five, according to one of the criteria on the matrix, such as 'importance of stakeholder'.
- Keeping this ranking for one criteria, plot the stakeholders against the other criteria of the matrix.

To guide this process, the following questions were asked:

- Who will be adversely affected by potential environmental and social impacts in the conflict's area of influence? Are special engagement efforts necessary?
- At which stage of conflict resolution will stakeholders be most affected?
- What are the various interests of stakeholders and what influence might this have on the project?
- Which stakeholders might help to enhance the intervention design or reduce project costs?
- Who strongly supports or opposes the changes that the intervention will bring and why?
- Whose opposition could be detrimental to the success of any intervention?

Output

Wildlife authorities, livestock owners (farmers) and tribal authorities were identified as being the most important and influential with regards to managing the hyaena/caracal/jackal issue (Figure 3). The biological research fraternity were considered to be potentially very important but with limited influence. Stakeholders including the military and agricultural authorities were considered to be of limited importance, yet holding significant influence. Groups such as the Scout Association fell into the 'Crowd' category being insignificant in terms of both importance and influence. Campers were specifically highlighted in this group although they were poorly understood as a stakeholder.

Figure 3. The matrix of important and influential stakeholders associated with hyaena/caracal/jackal issues in the Arabian Peninsula.

Colour codes refer to well known (green), moderately known (yellow), and not well-known (red) stakeholders.

		Importance			
		Unknown	Little/ No importance	Some importance	Significant importance
Influence	Significant influence		Military areas Agricultural authorities	Wildlife authorities	Sheep owners Tribal authorities
	Somewhat influential	Environmental educators	Transport authorities Development planners Mining companies Wildlife traders Poutry owners	Police (Oman, KSA, UAE)	
	Little influence	Campers	Scouts Assoc. Tour operators Photographers		
	Unknown			Researchers	

Environmental and Social Risk Factors

Objective(s)

1. Identify environmental risk factors associated with conflict; and
2. Identify social risk factors associated with conflict

Method

Environmental and social risk factors were tabulated (Figure 4). Environmental risk factors were subdivided into:

1. Environmental characteristics;
2. Land-use management;
3. Human behaviour; and
4. Behaviour and management of conflict species.

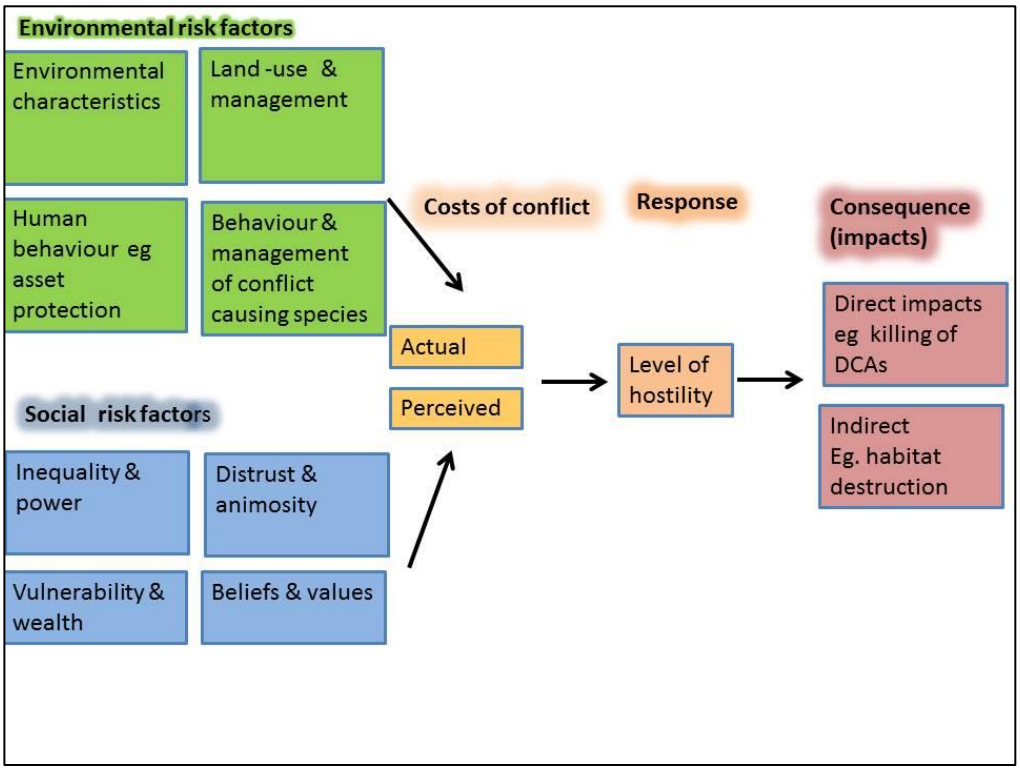
Similarly, social risk factors were subdivided into:

1. Inequality and power;
2. Distrust and animosity;
3. Vulnerability and wealth; and

4. Beliefs and values.

Identified risks were colour-coded as being well, moderately or not well understood.

Figure 4. Framework for following environmental and social risks through costs of conflict, responses, and finally impacts of responses (following Dickman 2010).



Output

The environmental and social risk profiles associated with leopard management in the Arabian Peninsula are listed in Figure 5 and Figure 6. Most factors were considered to be well known while a few such as competition for prey, weak law enforcement, traditional medicine, and the fear of reporting leopards, were considered moderately understood. The potential environmental risk from climate change was poorly understood. Benefit would have been gained by listing possible tolerance levels (e.g. leopards' low tolerance for low prey bases, and farming livelihoods low tolerance for leopards).

Figure 5. Environmental risk profile for leopards in the Arabian Peninsula.

Key: green = well understood, yellow = moderately understood, red = not well understood risks.

A. Environmental risk factors

Environmental characteristics
Lack of prey
Habitat loss
Reduced population size
Fragmented population
Provision of alternative prey (livestock)

Competition for prey (eg hyrax)

Climate change

Land -use & management

Overgrazing
Human settlement expansion

Weak law enforcement
Infrastructure & development

Human behaviour eg asset protection

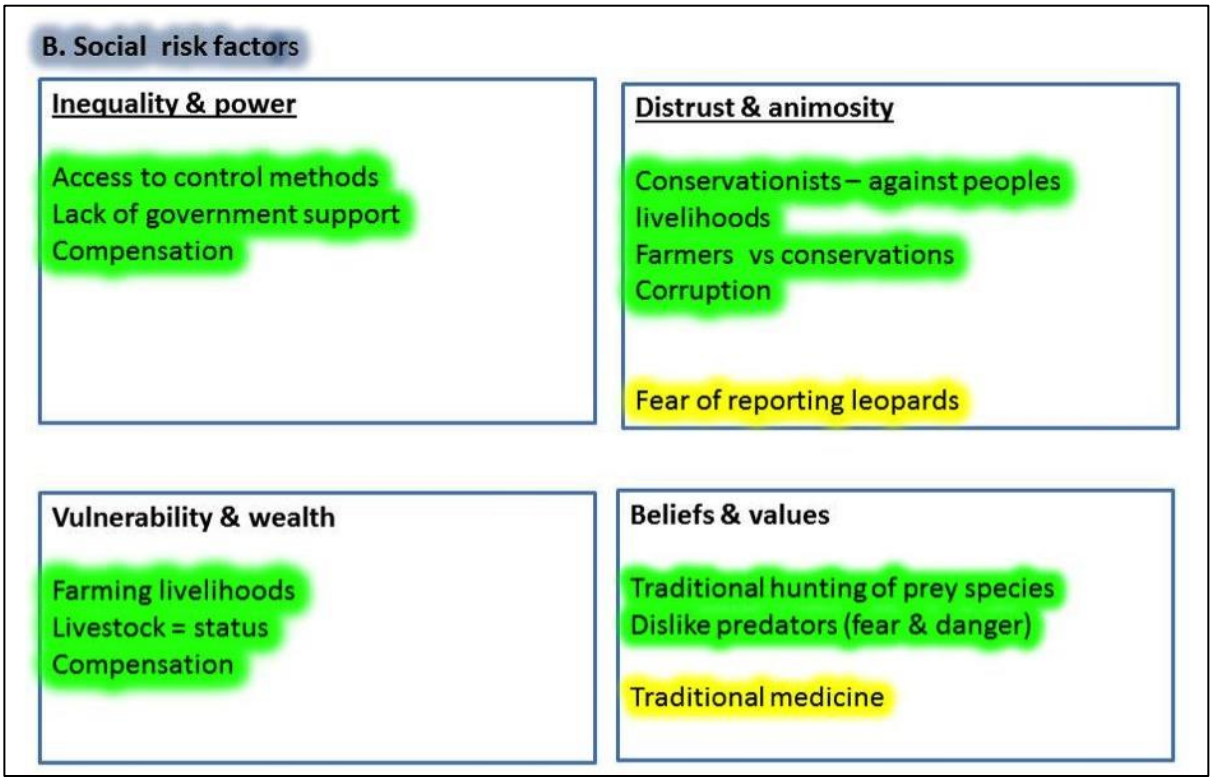
Farming of livestock
Security of livestock
Lack of awareness of environment
Traditional & cultural beliefs/practices
Hunters (traditional, trophy, recreational)

Behaviour & management of conflict causing species

Territoriality & breeding seasons
Flexibility & adaptation
Juvenile dispersal & hunting proficiency
Carnivore behaviour
Individual habitat preferences
Displacement from disturbance
Health issues

Figure 6. Social risk profile for leopards in the Arabian Peninsula.

Key: green = well understood, yellow = moderately understood, red = not well understood risks.



Perceived Risks / Costs : Responses / Consequences

Objective(s)

1. Identify the type and variation in *perceived costs* of conflict.
2. Identify the type and variation in *real costs* of conflict.
3. Identify the direct and indirect *responses and consequences* of conflict by stakeholders.

Perceived Costs

The scale of conflict was categorised (following Inskip and Zimmermann, 2009) as:

- Severe: High frequency of (perceived) livestock depredation, attacks on people, retaliatory killing.
- High: High frequency of (perceived) livestock depredation, low frequency of attacks on people (if any), high levels of retaliatory killing.
- Moderate: Some livestock depredation, no attacks on people, retaliatory killing frequent.
- Low: Infrequent livestock depredation, no risk to humans, some retaliatory killing.
- None: No evidence of species exhibiting conflict behaviours or being a perceived threat to humans or livestock, or of retaliatory killing.
- Data deficient: Very little reliable (especially scientific) information available regarding the species

In addition, attention must be given to the following aspects:

- Actual damage is often lower than the perceived damage, but it is perceived damage that influences public opinion.
- Consider individual verses community costs.
- Consider the influence of shifting baseline syndrome, which refers to changing human perceptions of biological systems due to loss of experience about past conditions.
- Within the anthropological literature, an individual's understanding and perceptions of risk are socially and culturally constructed, and influenced by prior experience. The species and size of animals are important. People's perceptions of risk are influenced by more 'visible' species (i.e. size), the degree to which wildlife are considered to be dangerous, whether species are diurnal or nocturnal, and the degree of control an individual feels they have over wildlife activities. Additionally, people's perceptions of risk are often strongly influenced by rare and extraordinary or extreme events (i.e. 'worst case' scenarios, rather than more frequent, less extreme occurrences).
- Approval of lethal control generally increases with exposure to conflict (e.g. seen in rural area < approaches human < kills pet < kills livestock/guard dog < injures/kills human)

Real Costs

Direct costs to humans are the financial, social and cultural losses suffered as a result of HWC. Direct damage costs can result from predation on biological resources and from economic losses because of destroyed equipment.

Examples include:

- Raiding and destruction of food crops;
- Loss of income from sales of produce from cash crops;
- Damage to water sources and installations;
- Damage to stored produce;
- Loss of livestock;
- Human injury or death; and
- Damage to property (buildings, etc…).

Indirect costs of HWC are generally associated with the physical threat of living with large mammals. This has the effect of restricting people's freedom of movement, for fear of running into such animals, or restricts their access to resources such as water, firewood and grass for thatching. These costs are often not considered when investigating costs (Barua et. al., 2013). Members of local communities that live with high levels of HWC often suffer from a sense of insecurity. This might be due to the anxiety of potential losses that they can suffer or from the worry of physical threat to their lives and property. Indirect damage costs are far more difficult to assess. Other examples of indirect damage costs are the loss of cattle, involving many years of lack of access to careful breeding management.

Losses can generate other costs to household members, including:

- An increased need to guard fields, which creates labour bottlenecks in certain seasons;
- Disruption of schooling because children are needed to guard family fields;
- Increased risk of injury from wildlife; and
- Increased risk of contracting diseases (e.g. malaria) if people are required to guard their fields at night

The **total cost of wildlife to agricultural production** (Ca) can be disaggregated (Emerton, 2001) into:

$$Ca = ach+acv+acl+act+acs$$

where, ach = harvest losses; acv = veterinary costs; acl = value of livestock kills; act = time spent in crop and livestock protection; acs = damage to other farm structures;

For the majority of wildlife areas, the **total opportunity costs of wildlife** (Co) can be disaggregated into:

$$Co = occ+ocl+ocr$$

where, occ = crop income foregone; ocl = livestock income foregone; ocr = wild resource utilisation foregone.

Responses/consequences

These should ideally be categorised based upon a level of hostility (minimal, moderate, high) and temporal and spatial variation.

Responses to direct impacts include: persecution of species, retaliatory killing, and negative attitudes.

Responses to indirect impacts include: habitat destruction; opposition to wildlife sanctuaries close to farms; resistance to the reintroduction of extirpated predators to protected areas.

Method

Following the framework in Figure 4, the direct or indirect impacts were listed, together with their perceived and real costs. These costs were ranked from severe to none as noted as above. In addition, the degree of understanding of each of the impacts was noted highlighting any knowledge gaps.

Output

The direct and indirect risks associated with living close to troops of baboons were assessed (Figure 7). Direct costs focused primarily on infrastructure and crop damages, as well as the possibility of human injury. Indirect costs related to a loss of credibility by conservation agencies, diseases and the opportunity costs associated with addressing the matter. These filtered out into basic human constituents of well-being (Barua et. al., 2013), namely security, livelihood, health and human relations categories. Interestingly, 53% of the impacts were noted for limited information or understanding,

while only 27% (crop damage, food security compromised, credibility of authorities and farmer livelihoods) were considered to be better understood.

Responses to these impacts were in the form of increased persecution of baboons and increased hostility towards conservation organisations.

Figure 7. Direct and indirect impacts identified for baboon troops living in close proximity to urban and agricultural areas in the UAE.

Detailed consequences (H = high, M = moderate and L = low severity of impact with colour codes reflecting state of understanding (well known = green, moderately known = yellow and not well known/understood = red). Consequences of impacts are also listed.

A.
Direct costs:
- Property damage
- Injury/fatalities
- Budget
- Crop damage
- Injury to tourists/ urban dwellers

Indirect costs:
- Transaction costs (good will)
- Opportunity costs
- Health aspects
- Livelihoods affected
- Insecurity (fear)

B. Impacts
Security:
- Personal safety (tourists/ urban dwellers) L/M
- Access to resources (fields) L

Livelihoods:
- Crop damage H
- Food security compromised H
- Housing/infrastructure insecure H

Health:
- Loss of life L
- Stress related issues M
- Infectious diseases disease M/L

Human relations:
- Costs to respond H
- lack of info H
- Loss of trust of conservation authorities M
- Loss of confidence by authorities M
- Opportunity costs
- Health aspects M/L
- Farmers livelihoods affected H
- Psychological fear L

C. Consequence/ responses
Direct :
- Persecution of baboons
- Reallocation of funds
- Baboon guards

Indirect:
- Antagonism towards conservation

Assessment of Policy and Management Options (domestic + international)

Objective(s)

1. Explore and identify relevant and feasible policy and management options to minimise/mitigate conflict.
2. Assess options according to efficiency, costs, and durability.

The success of programs designed to resolve HWC issues remains a dynamic environment. It largely rests on the ability of the decision makers and managers to recognise, embrace, and incorporate differing stakeholder values, attitudes, and beliefs in the policy making process.

Methods

A number of methods are available to assess management options to address HWC issues (Chardonnet et. al., 2010; Dickman, 2010; Linnell et. al., 2012; Morrison, et. al., 2009; Redpath et. al., 2013). Following Chardonnet et. al., (2010) management options were ranked from 1 to 4 (with increasing value) with regard to their efficiency, cost and durability. Further, perceptions were graded as: poor (P), neutral (N), good (G), needs incentive (I), donor dependent (D), institutional/commercial support (S), requires community involvement (C), ethical/conservation reason (E).

Outputs

Table 1 documents the synthesis of management options associated with the potential introduction of wolves into a private reserve in the UAE. These options were compiled into human, livestock, wolves, and environment categories. From an efficiency and durability perspective, finding alternative land for livestock farmers had a high value but high transactional costs. Perceptions were notably complex, requiring or having incentives, commercial/institutional support, community support, and ethical considerations. Finding alternative (as long as it's not additive) forms of income appeared to offer the best option. Perceptions were that this option was good, requiring institutional/commercial support and, of course, community buy-in.

Providing livestock enclosures appeared to offer the best prospects from an efficiency, cost and durability perspective, while encouraging livestock farmers to avoid expected wolf areas appeared to offer the least prospect of success (Table 1). Using guard dogs appeared to also offer reasonable efficiency, low cost and good durability. Notably, it had a wide diversity of perceptions issues.

Maintaining well-managed fencing seemed to provide favourable efficiency, cost and durability options (Table 1). From an environmental perspective, improving habitat for wolves within the reserve appeared to offer good options.

Table 1. Synthesis of management options associated with the potential introduction of wolves into a private reserve in the UAE.

These are ranked from 1 to 4 with increasing value. Perceptions are graded as poor (P), neutral (N), good (G), needs incentive (I), donor dependent (D), institutional/commercial support (S), require community involvement (C), ethical/conservation reason (E).

Management option	Efficiency	Cost	Durability	Perception
Human Mgmt.				
Compensation schemes (animal loss)	1	4	1	NCSC
Compensation schemes (land trade)	4	4	4	GISCE
Alternative source income	3	2	4	GSC
Education & awareness	1	2	4	GSC
Mediation/arbitration	2	1	2	GSC
Penalties (enforcement)	3	3	3	GISCE
Livestock				
Livestock enclosures	4	2	3	GICS
Carcass disposal	2	2	2	GICS
Grazing times	2	2	3	NIC
Guarding (by dogs)	3	2	4	NICEDS
Guarding (by humans)	3	3	3	NIC
Avoid wolf areas	1	2	1	PISC
Wolf				
Improved fence management	3	4	3	GS
Aversive conditioning (Taste, fence avoidance)	2	3	2	GSE
Selective removal of problem animals	3	4	2	NSE
Population control	3	3	2	GSE
Environment				
Buffer zones	3	4	2	GSC
Corridors	3	4	2	GSC
Alternative prey	3	3	2	GSC
Habitat restoration in core areas	3	4	3	GSE

Contextual Challenges

Objective(s)

1. Understand and identify specific contextual challenges associated with the implementation of proposed measures (both domestic and international).

Method

Management options were assessed in terms of their contextual challenges (see Redpath et. al., 2013; Anthony and Szabo, 2011) with regards to:

- Legal (existing legislative framework, commitments, species protection, etc.);
- Ecological (ecology of species, prey cycles, habitat, livestock behaviour, etc.);
- Political (policy dimensions and timeframes, efficiency, communication, etc.);
- Socio-economic (inequality in wealth, influence, rural vs urban interests, etc.); and
- Cultural (hunting traditions, farming traditions, cultural significance of predator/prey species, etc.).

Output

Three management options are illustrated in Table 2. With regard to proposed compensation schemes for expected livestock losses from wolves introduced into a reserve in the UAE, it was felt that there was considerable uncertainty around which agency would be responsible for implementing any compensation scheme. In addition there was considerable uncertainty about potential state funding and that it was open to potential abuse. Communication channels were considered adequate. Other issues such as the lack of current legislation, inability to differentiate signs of wolf killings from those of other carnivores and the need to determine some fair compensation price were considered of intermediate uncertainty. With regard to increasing law enforcement as a management option, it was felt the issue of identifying a responsible department/agency and the right level of fines that would act as a suitable deterrent were major concerns. Aspects such as the need to improve monitoring and address corruption were quite well understood. Other issues such as regulations and penalties, as well as communal property rights were of intermediate concern/understanding level.

Table 2. Contextual challenges of delivering on different management options related to introducing wolves to a private reserve in the UAE.

Key: green = well understood, yellow = moderately understood, red = not well understood risks.

Management option	Legal	Ecological	Political	Economic	Cultural
Human Mgmt. Compensation schemes for animal losses	Lack of relevant legislation	Unsure of signs of wolf killings	Unsure of agency that assesses & pays Need independent assessment process	High costs Determining fair price	Money does not replace value of livestock Disincentives for good husbandry Dependence on state funding Potential abuse Lack of communication
Increased law enforcement	Need legislation Authority to rangers	Prove culpability	Who enforces law Regulations & penalties need to be determined Address corruption VIP expectations High level support required	Improved monitoring required What fines will act as deterrent	Property rights of communities?
Livestock Disposal of carcasses in buffer areas	Legalities unsure	Negative impact on scavenger guild	Will to enforce Monitoring compliance & enforcement	Who pays?	Cultural issues of removing camels?

Monitoring and Evaluation (M&E)

Objective(s)

1. Understand and embrace multi-stakeholder goals in designing M&E programs for HWC resolution strategies.

Within the adaptive management cycle, Monitoring and Evaluation (M&E) are instrumental stages in understanding the effects of management decisions, and informing where and how adjustments are needed for improvement. The evaluative criteria for M&E can originate from theory, analyses of cases, or direct stakeholder elucidation. There are a number of challenges associated with implementing M&E to assess the impacts of conservation programs on local communities. One of these is attribution, i.e. how to determine whether observed impacts are related to the institution, the ecosystem being managed, or other factors. A second challenge concerns assessing relatively intangible impacts, including changes in attitudes and practices, which could be just as important as more tangible impacts in determining the perceived success of a program. A third challenge lies in ensuring that the impacts on different multiple stakeholder groups are being captured.

To meaningfully assess the merits of any wildlife damage mitigation program, one must disentangle its multiple goals. This necessitates the inclusion of relevant stakeholders, whereby broadening involvement in identifying and analysing change is a priority to enrich the data available to underpin all stages of the management decision process, including impacts, interventions, system responses, stakeholder engagement, and public attitudes and preferences.

There are a number of different M&E approaches available including logic models (W.K. Kellogg Foundation, 2004), and participatory monitoring and evaluation (Guijt and Gaventa, 1998).

Method

In developing a standard M&E programme, the following critical steps were followed:

1. Definition and prioritisation of the key questions to be answered. This would depend on a number of factors – the likely end users; objectives, and key issues to be assessed.
2. Definition of the geographical and time limits of the conflict and its impacts. Defining the scope and scale of the impact assessment helps identify the methodology that makes the most effective use of available resources.
3. Identification and prioritisation of key indicators for each question/issue. Important elements are needed to prioritize the issues to be assessed. Appropriate indicators were clearly identified and defined to address negative as well as positive impacts. Attributes of a good indicator are: that it should be a direct and unambiguous measure of change; is relevant (measures objectives of the program); varies across time, space, groups, and is sensitive to change in programs, policy, or projects; is transparent and cannot be manipulated to show achievement where none exists; and is cost-effective to track (Schreckenberg et. al., 2010).
4. Determination of the experimental design – including sampling design and types of research tools to be used. This depends on: the resources (financial, time, skills) available; the level of differentiation required – from individuals to communities to the whole protected area system; the attribution approach – whether the study includes 'control' communities or households; and the level of statistical certainty required.

Output

The conflict between communities and the planned introduction of wolves into a reserve was used as an illustrative example. An ecological and social question was used as an example of developing a M&E process.

The goal was: '*To minimise conflict between wolves and the communities surrounding the reserve*'.

The ecological question posed was: '*How could the creation of buffers around the reserve potentially reduce conflict between wolves and the surrounding community?* While, the social question was: '*How effective would a compensation scheme for livestock losses influence community attitudes to the reserve and its wolves?*

The priority monitoring aspects with regards to the 'reserve management' stakeholder focused on gaining a better information base of the efficiency of the fence to contain wolves, vegetation monitoring and the wolf population itself (Table 3). As an example, breaches of the fence would be monitored by daily fence patrols, which would record the GPS coordinates of any breaches by carnivores and other species. This would be noted in monthly reports, which would in turn feed into the annual report that would allow adaptive management actions to be made based upon accumulated and analysed data.

In assessing the effectiveness of establishing a livestock compensation scheme, three stakeholder groups were identified, namely the reserve, responsible government authority and the local community (

Stakeholder	Reserve management			Local community	
Question	How is the movement of wolves influenced by the distribution and abundance of livestock in the buffer area?				
Priorities for monitoring	Fence	Vegetation	Wolf& preypopulationsizes & distribution	Wildlife sightings	Livestock:what, where, when & how many
Indicators	Number of fence breaches	Recruitment of selected species	No. sightings Distribution of tracked wolves	Population sizes & distribution	Population sizes & distribution
Methodology	Daily patrols	Sample plots – twice/yr	Daily VHF/GPS tracking Virtual barrier alarm Camera traps	Weekly patrols	Weekly patrols
Output	Month report with GPS coords	Annual report	Weekly distribution map	Monthly report	Monthly report
Review	Annual review of monitoring techniques to measure the ability to contain the wolf group. If found wanting,change methodology			Annual review of data	

Table 4). Change in attitudes of the local community over time would be monitored via a questionnaire survey undertaken before wolves are introduced and then intermittently thereafter. This would be recorded in annual reports but importantly discussed with the community in an on-going process to provide continual learning and adaptation.

Table 3. A monitoring and evaluation programme for measuring the importance of buffers in potentially reducing conflict between wolves and the surrounding community.

Component	Stakeholder				
Stakeholder	Reserve management			Local community	
Question	How is the movement of wolves influenced by the distribution and abundance of livestock in the buffer area?				
Priorities for monitoring	Fence	Vegetation	Wolf& preypopulationsizes & distribution	Wildlife sightings	Livestock:what, where, when & how many
Indicators	Number of fence breaches	Recruitment of selected species	No. sightings Distribution of tracked wolves	Population sizes & distribution	Population sizes & distribution
Methodology	Daily patrols	Sample plots – twice/yr	Daily VHF/GPS tracking Virtual barrier alarm Camera traps	Weekly patrols	Weekly patrols
Output	Month report with GPS coords	Annual report	Weekly distribution map	Monthly report	Monthly report
Review	Annual review of monitoring techniques to measure the ability to contain the wolf group. If found			Annual review of data	

	wanting,change methodology	

Table 4. A monitoring and evaluation programme for measuring the effectiveness of a compensation scheme for livestock losses in influencing community attitudes to the reserve and its planned wolves.

Component	Stakeholder		
Stakeholder	Reserve	Govt agency/authority	Local community
Question	How effective will a compensation scheme for livestock losses influence community attitudes to the reserve and its wolves?		
Priorities for monitoring	Distribution and movements of wolves	Scheme payments Mortality of livestock	Impact of a compensation scheme on community attitudes towards wolves.
Indicators	% time outside reserve	% stock losses by wolves	Change in attitude
Methodology	Daily VHF/GPS tracking Virtual barrier alarm Camera traps	Frequency and amount of payments made Frequency of stock losses by wolves and other carnivores	Questionnaire on community attitudes before and after introduction of wolves and compensation scheme
Output	Weekly distribution map	Quarterly reports	Annual report
Review	Annual	Annual	Adjust compensation in light of community feedback. Feedback to community

Research Needs

Objective(s)

1. Identify specific research needs in order to better understand conflict and how it might be addressed.
2. Explore research capacity of stakeholders.

Method

Drawing upon what has been learnt from the process thus far, the research gaps in terms of the legal, ecological, political, economic, and cultural environments were identified. These should also identify who should undertake the research, when and how. These should be prioritised and costed for potential funding.

Output

A number of research gaps and their priority were listed for cultural, economic and political stakeholders (Table 5). Ideally these should be taken to a lower level, allocating potential funding along with responsibility and time lines for delivery.

Table 5. List of identified research gaps for a number of identified stakeholder groups and their priority (high (H), moderate (M), low (L)) associated with the planned introduction of wolves to a reserve in the UAE.

Cultural/economic	Cultural/economic	Economic/political	Political
Local communities	Hobby farmers	Land-use planners	VIPs
Who are they, where are they, and what do they do? H What are their attitudes to wildlife, government agencies and how it varies across area? H What is their economic status and education levels? H What are their herd management practises? M What's the community structure and governance processes? H What are their lifestyle needs and expectations? H How influential are they in local society? H	Who are they? M What are their motives for farming and how economically important is it? H What are their lifestyle needs and expectations? H How influential are they in local society? H	What legislation governs land use planning? H How effectively is land use planning implemented? H What consultative process exists in land use planning? M	Who are the most influential persons in the different tiers of government (community, local, national)? H What are their attitudes to wildlife and community engagement? H

Conclusions

The following points were noted:

- The complexity of HWC issues.
- There are no simple solutions to address such issues.

- There is a need to engage in an open and transparent manner to earn trust from all parties in finding lasting solutions to HWC issues.
- It's accepted that HWC issues remain a dynamic situation requiring constant engagement and alteration to changing circumstances and personalities.

References and Further Reading

Anthony, BP, Scott, P and Antypas, A 2010. Sitting on the fence? Policies and practices in managing human-wildlife conflict in Limpopo Province, South Africa. *Conservation and Society* 8 (3): 225-240.

Anthony, BP and Szabo, A 2011. Protected Areas: Conservation Cornerstones or Paradoxes? Insights from Human-Wildlife Conflicts in Africa and Southeastern Europe. In: *The Importance of Biological Interactions in the Study of Biodiversity* López-Pujol, J (ed), 255-282. Rijeka, Croatia: InTech Publishers.

Barua, M, Bhagwat, SA and Jadhav, S 2013. The hidden dimensions of human-wildlife conflict: Health impacts, opportunity and transaction costs. *Biological Conservation* 157:309-316.

Baruch-Mordo, S, Breck, SW, Wilson, KR and Broderick, J 2009. A Tool Box Half Full: How Social Science can Help Solve Human-Wildlife Conflict. *Human Dimensions of Wildlife* 14 (3): 219-223.

Chardonnet, P, Soto, B, Fritz, H, Crosmary, W, Drouet-Hoguet, N, Mesochina, P, Pellerin, M, Mallon, D, Bakker, L, Boulet, H and Lamarque, F 2010. *Managing the conflicts between people and lion: review and insights from the literature and field experience*. Wildlife Management Working Paper 13. Rome: Food and Agriculture Organisation of the United Nations.

Clark, TW, Curlee, AP and Reading, RP 1996. Crafting effective solutions to the large carnivore conservation problem. *Conservation Biology* 10 (4): 940-948.

Dickman, A.J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* 13 (5): 458-466.

Emerton, L. 2001. The nature of benefits and the benefits of nature: why wildlife conservation has not economically benefitted communities in Africa. In: *African wildlife and livelihoods: the promise and performance of community conservation*, Hulme, D and Murphree, M (eds), 208-226. Cape Town: David Philip Publ.

Guijt, I and Gaventa, J 1998. *Participatory Monitoring and Evaluation: Learning from Change*. No. 12. Brighton, UK: Institute for Development Studies.

Inskip, C and Zimmermann, A 2009. Human-felid conflict: a review of patterns and priorities worldwide. *Oryx* 43 (1): 18-34.

Knight, J (ed) 2000. *Natural enemies: people-wildlife conflicts in anthropological perspective.* New York: Routledge.

Linnell, JDC, Odden, J and Mertens, A 2012. Mitigation methods for conflicts associated with carnivore depredation on livestock. In: *Carnivore Ecology and Conservation: A Handbook of Techniques*, Boitani, L and Powell, RA (eds), 314-332. Oxford: Oxford University Press.

Messmer, TA 2000. The emergence of human-wildlife conflict management: turning challenges into opportunities. *International Biodeterioration and Biodegradation* 45: 97-102.

Morrison, K, Victurine, R and Mishra, C 2009. *Lessons Learned, Opportunities and Innovations in Human Wildlife Conflict Compensation and Insurance Schemes*. Bronx, NY: WCS TransLinks Program.

Redpath, SM, Young, J, Evely, A, Adams, WM, Sutherland, WJ, Whitehouse, A, Amar, A, Lambert, RA, Linnell, JDC, Watt, A and Gutiérrez, RJ 2013. Understanding and managing conservation conflicts. *Trends in Ecology and Evolution* 28 (2): 100-109.

Schreckenberg, K, Camarago, I, Withnall, K, Corrigan, C, Franks, P, Roe, Dilys, S, Lea M and Richardson, V 2010. *Social assessment of conservation initiatives: A review of rapid methodologies.* London: International Institute for Environment and Development.

Treves, A 2009. The human dimensions of conflicts with wildlife around protected areas. In: *Wildlife and Society: The Science of Human Dimensions,* Manfredo, MJ, Vaske, JJ, Brown, PJ, Decker, DJ and Duke, EA (eds), 214-228. Washington DC: Island Press.

WK Kellogg Foundation 2004. *Logic Model Development Guide: Using Logic Models to Bring Together Planning, Evaluation, and Action*. Battle Creek, Michigan: WK Kellogg Foundation.

Spatial Data for Biodiversity Conservation Management

Introduction

The technical component for the 16th Annual International Conservation Workshop for Arabia's Biodiversity (ICWAB) considered the capture of spatial field data in support of conservation research and management. These sessions were facilitated by Ms Chenay Simms of the SANParks Scientific Services, South Africa, and comprised a day of hands-on exercises, regional case studies, and equipment assessments relating to the selection and application of electronic spatial data capture.

The following summary was compiled with reference to, and from presentations by, Chenay Sims, John Pereira (Protected Areas Department, Environment and Protected Areas Authority, Sharjah), Maral Khaled Chreiki (Wadi Wurayah National Park, Fujairah Municipality), and Meyer de Kock (Manager, Al Bustan Zoological Centre).

What is Spatial Data?

Spatial data is more than just maps; it is about the depiction of data in context with co-occurring elements to enable patterns of association and change to be discerned. Any physical element can be described in two ways: with location information (where it is), and attribute information (what it is). The representation of spatial data can take the form of vectors, x/y coordinates to locate points in space, or to join these using lines or polygons. Vectors are used to depict discrete data, such as the location of an animal, or static objects such as buildings. The raster format however, displays continuous data in the form of grid cells (pixels) and is used for elements such as habitat types. Data from many different sources can be combined and displayed together as layers of spatially oriented information.

Why Collect Spatial Data?

Spatial information is a common currency – we are all familiar with locating objects in space and seeing how objects change in status or distribution over time and space and in conjunction with other spatially located quantities. Accurate, reliable spatial data can inform conservation management by enhancing monitoring effectiveness, by tracking change over time or in response to interventions, and for planning future management interventions. Spatial outputs such as maps are also readily deciphered by a wide range of stakeholders, and can thus deliver information far more rapidly and reliably than other forms of communication.

Collecting Spatial Data

There are four data considerations: *quality, standard, source, and metadata*. Data quality is critical since it will determine the reliability and therefore usefulness of any depiction or analysis of spatially oriented data. It might not be possible to detect poor quality data on the basis of final outputs of maps or conclusions based on it, so careful attention to data quality needs to take place from the start.

Quality

Data quality elements include *scale, resolution, accuracy, precision, consistency, completeness, and error tolerance*.

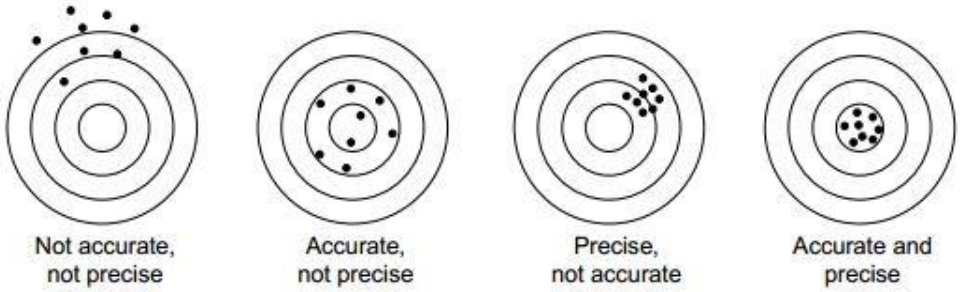
Scale is the relationship between features on a map and features in the real world, for example, 1cm on the map = 100,000 cm in the real world. Features at a large scale show more detail – they more closely represent the real world features. Scale affects the volume and level of detail of data in a database, and can influence both the cost and accuracy of data. Integrating data from different scales can be difficult.

Resolution is the size of the smallest features that can be mapped, and is directly related to scale. As scale decreases, resolution decreases, and feature boundaries must be smoothed, simplified or not shown at all, i.e. zoom out and less detail becomes visible.

Accuracy refers to the proximity of a measurement to the true value of a quantity (Figure 8).

Precision refers to the proximity of several measurements to each other. Precision is independent of accuracy, so you can be very precise but inaccurate (Figure 8).

Figure 8. Concepts of accuracy and precision in spatial data capture.



Logical Consistency relates to whether the data follow rules of logic? For example: is a feature classified as both water and zoned land; do lines intersect when they should not (e.g. power lines); or do polygons not close on themselves?

Completeness considers whether a data layer is complete or lacking in coverage? For example, does a layer on roads leave out some roads, and if so, does it do so systematically or randomly; or does a database of buildings in a city leave out some buildings? Completeness also describes completeness in coding of features.

Error Tolerance cencerns four types of errors:

1. Referential – a labeling error i.e. street name incorrect
2. Topological – a break in what should be a continuous feature, e.g. a break in gas pipeline or road network
3. Relative – inaccurate positioning relative to two features, e.g. a stop sign too close to street centre line.
4. Absolute – the misidentification of the true position of a feature.

Data Standards

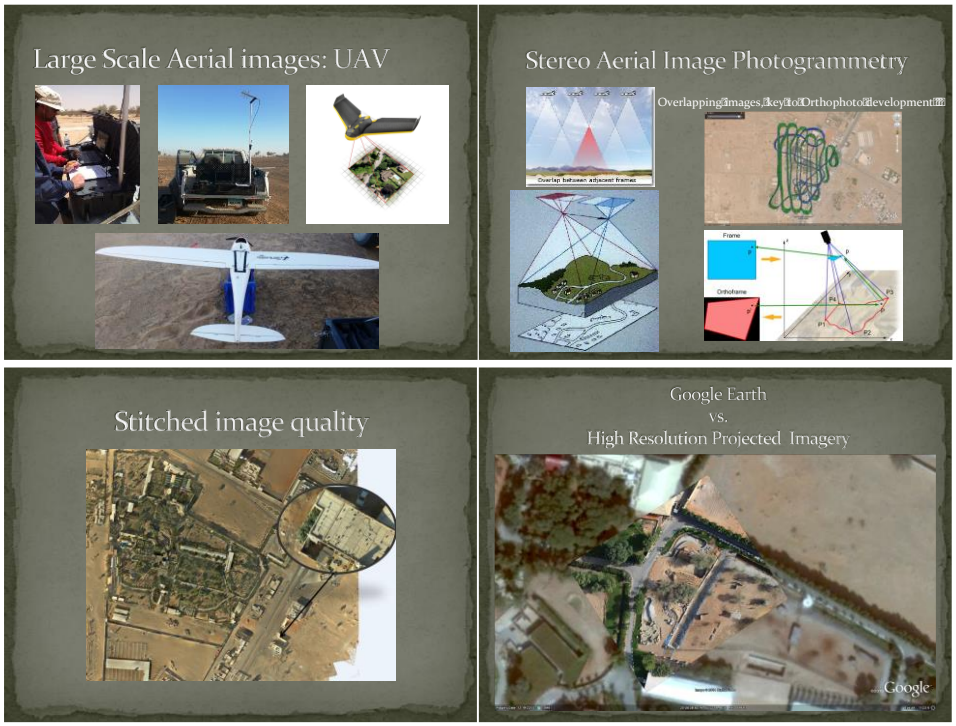
Confidence in results and facilitates the sharing of data. There are five data standards:

1. Data quality standards (i.e. the appropriate map scale, resolution, and projection for source material)
2. Error standards (referential, topological, relative, and absolute)
3. Naming standards (layers, attributes)
4. Documentation standards (minimum amount of metadata required for each dataset)
5. Digital interoperability standards (e.g. DXF, DLG)

Data Sources and Metadata

Sources of data shopuld be reliable, fit for purpose, cost effective, and come with appropriate metadata. For example, remote data used for habitat mapping could come from any of a range of satellite imagery sources. Some, such as Landsat (http://landsat.gsfc.nasa.gov), might be relatively low cost and provide images over large areas, but have low spatial and temporal resolution, whereas others such as Ikonos (www.satimagingcorp.com) could provide high resolution (1-4 m) images using both *multispectral and panchromatic* sensors, but come at high cost. The highest resolution (< 1m) is still obtained from aerial photography, and filters can be used to obtain different spectral images, however individual photos need to be ortho-rectified (production of an orthophoto) and stitched together to provide coverage of large areas. Costs of flying specially equipped aircraft can be high, but with the increased use of private drone aircraft for aerial mapping the associated costs might be expected to decline (Figure 9).

Figure 9. Using an Unmanned Aerial Vehicle (UAV) or drone, for mapping of the Al Bustan Zoological Centre, Sharjah, UAE.



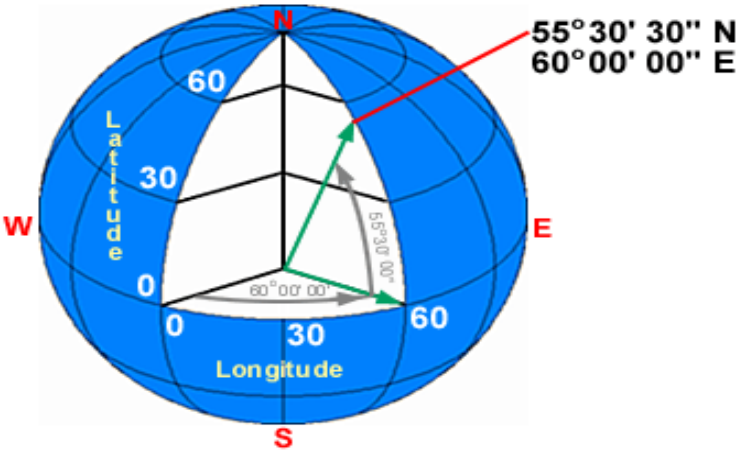
Comparison of satellite imagery and large –scale aerial imagery for area mapping:

Satellite imagery	Large-scale aerial imagery
Some images free	Can be expensive
Reduction in costs in last decade	Cost effective solution for smaller areas
Covers large areas	Need individual images stitched together
Includes multispectral sensors	Can include filters for other spectra
Geo-referenced	Needs to be ortho-rectified
Improved resolution (Ikonos, Quickbird)	Sub-metre resolution

Coordinate Systems

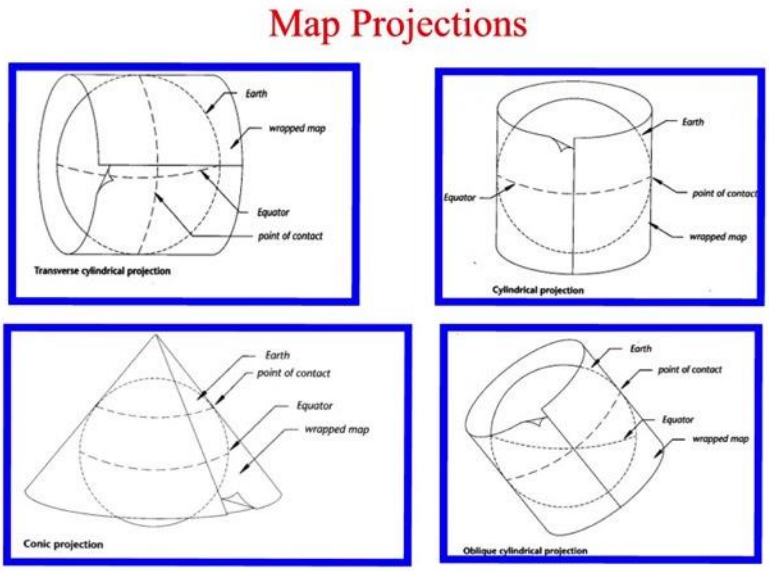
There are two types of coordinate systems: *Geographic Coordinate Systems*, and *Projected Coordinate Systems*. A *Geographic Coordinate System* enables any position on Earth to be described by a set of numbers, most commonly latitude and longitude. Latitude (parallels) is your position north or south of the equator; Latitude and Longitude measures position as angles in Degrees, Minutes and Seconds (DMS) (Figure 10). The term "Datum" and "Geographic Coordinate System" can be used interchangeably. Essentially a Datum provides a "frame of reference for measuring locations on the surface of the earth i.e. lines of latitude and longitude."

Figure 10. Geographic Coordinate System



A **Projected Coordinate System** refers to data that is defined by a flat 2-D surface and can be measured in units of meters and feet. "Map projections" and "Projected Coordinate Systems" can also be used interchangeably (Figure 11). So to establish the position of a geographic location on a map, a map projection is used to convert geodetic coordinates to two-dimensional coordinates on a map; it projects the datum ellipsoidal coordinates and height onto a flat surface of a map. The datum, along with a map projection applied to a grid of reference locations, establishes a *grid system* for plotting locations. A common map projection in current use is the Universal Transverse Mercator (UTM), which maps the surface of the Earth as a cylinder, but other types of projection are possible.

Figure 11. Projected Coordinate Systems/Map Projections



Collecting Spatial Data Using GPS

The *Global Positioning System* (GPS) is a constellation of *Navstar* (Navigation System Using Timing and Ranging) satellites that provide location and time information in all weather conditions, anywhere on or

near the Earth where there is unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system from the 1970s, and the U.S. Department of Defense is required by law to "maintain a Standard Positioning Service (as defined in the federal radio navigation plan and the standard positioning service signal specification) that will be available on a continuous, worldwide basis," and "develop measures to prevent hostile use of GPS and its augmentations without unduly disrupting or degrading civilian uses."

As of early 2015, high-quality, FAA grade, Standard Positioning Service (SPS) GPS receivers provide horizontal accuracy of better than 3.5 meters, although many factors such as receiver quality and atmospheric issues can affect this accuracy.

Factors affecting GPS accuracy include:

1. Ionosphere and troposphere delays

   Can delay the satellite signal.

2. Receiver clock errors

   It is not practical having an atomic clock in each receiver, and the internal clock of the receiver might have some degree of errors.

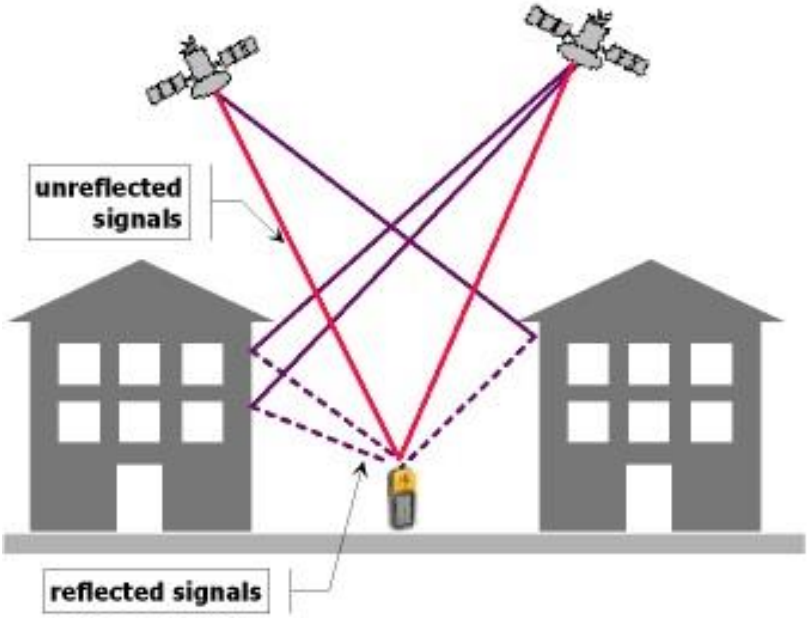
3. Orbital errors

   Inaccuracies of the satellites reported position (EPHEMERIS errors).

4. Signal multi-path

   Occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before they reach the GPS receiver (Figure 12).

Figure 12. Illustration of a Signal Multi-path Delay



5. Number of satellites visible

   The more satellites the receiver can "see" the better the accuracy.

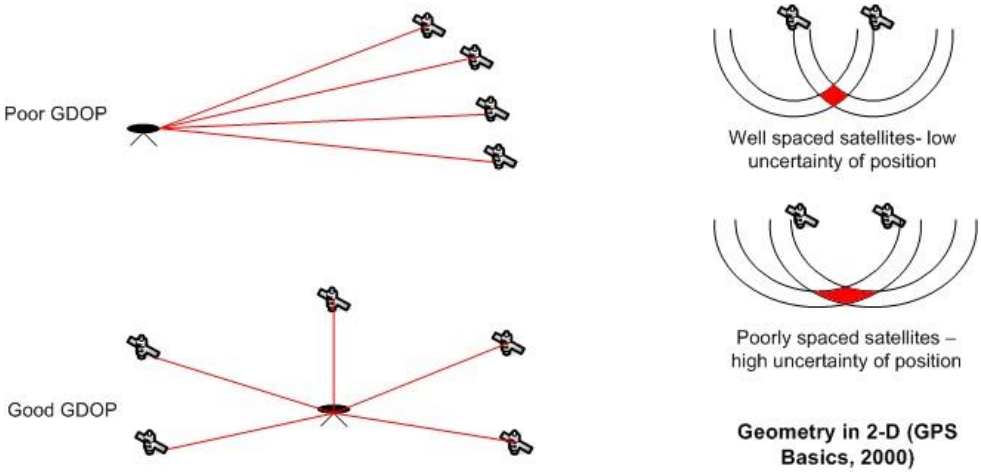
6. Geometric Dilution of Precision (GDOP)

   GDOP indicates the geometric relationship between receiver position and the position of the satellites (Figure 13); there are four GDOP metrics:

- PDOP (position - 3D)
- HDOP (horizontal – Lat Long)
- VDOP (vertical - height)
- TDOP (time)

HDOP is potentially the most valuable for assessing the accuracy and precision of a location estimate and data could be filtered by HDOP, however, under most conditions relatively high HDOP values can be associated with accurate location estimates.

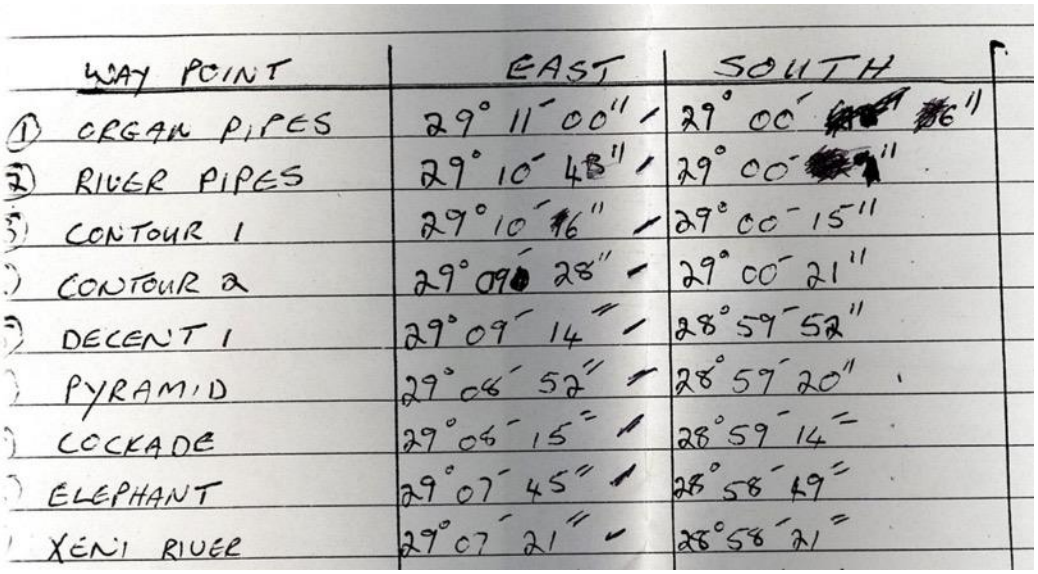
Figure 13: Examples of Geometric Dilution of Precision



7. Human error

   Incorrect input or use of GPS device, i.e. time zone, datum, address etc., or simply unclear recording or transcription of GPS data (Figure 14).

Figure 14. Example of poorly recorded data that increases the likelihood of error.



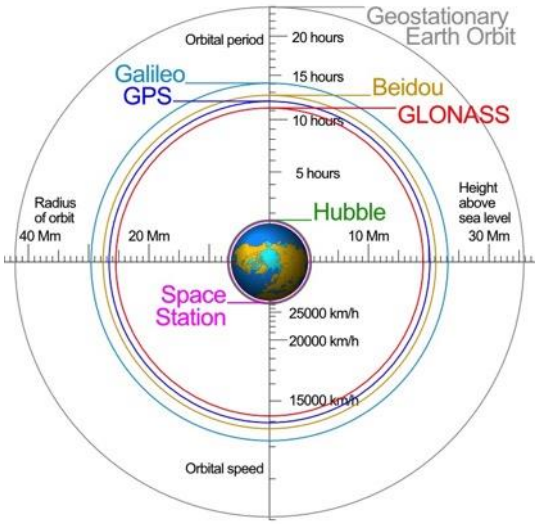
WAY POINT	EAST	SOUTH
1 ORGAN PIPES	29° 11' 00"	29° 00' [illegible] 16"
2 RIVER PIPES	29° 10' 48"	29° 00' [illegible]"
3 CONTOUR 1	29° 10' 16"	29° 00' 15"
4 CONTOUR 2	29° 09' 28"	29° 00' 21"
5 DECENT 1	29° 09' 14"	28° 59' 52"
6 PYRAMID	29° 08' 52"	28° 59' 20"
7 COCKADE	29° 08' 15"	28° 59' 14"
8 ELEPHANT	29° 07' 45"	28° 58' 49"
9 XENI RIVER	29° 07' 21"	28° 58' 21"

Other satellite navigation systems in use or various states of development include (Figure 15):

- GLONASS – Russia's global navigation system. Fully operational worldwide.
- Galileo – a global system being developed by the European Union and other partner countries, planned to be operational by 2014 (and fully deployed by 2019).
- Beidou – People's Republic of China's regional system, limited to Asia and West Pacific.
- COMPASS – People's Republic of China's global system, planned operational by 2020.
- IRNSS – India's regional navigation system, planned to be operational by 2015, covering India and Northern Indian Ocean.

- QZSS – Japanese regional system covering Asia and Oceania.

Figure 15. Orbital information about GNSS and other systems.



ArcGIS mobile suite

www.esri.com

ArcGIS for Windows Mobile provides the capacity of ArcGIS for Windows Mobile devices for use in the field. When used on a GPS-enabled device, it is possible to collect point, line, and polygon features and to edits these using GPS or map sketching. ArcGIS for Windows Mobile is easy for field workers with no GIS-specific training, as field workers select from a list of predefined tasks and there is a simple interface.

ArcGIS for Windows Mobile is fully integrated with the ArcGIS system. GIS data is prepared in ArcMap, then added to your mobile project in the Mobile Project Center application. Once configured to your specifications, the project is deployed onto a mobile device for fieldwork.

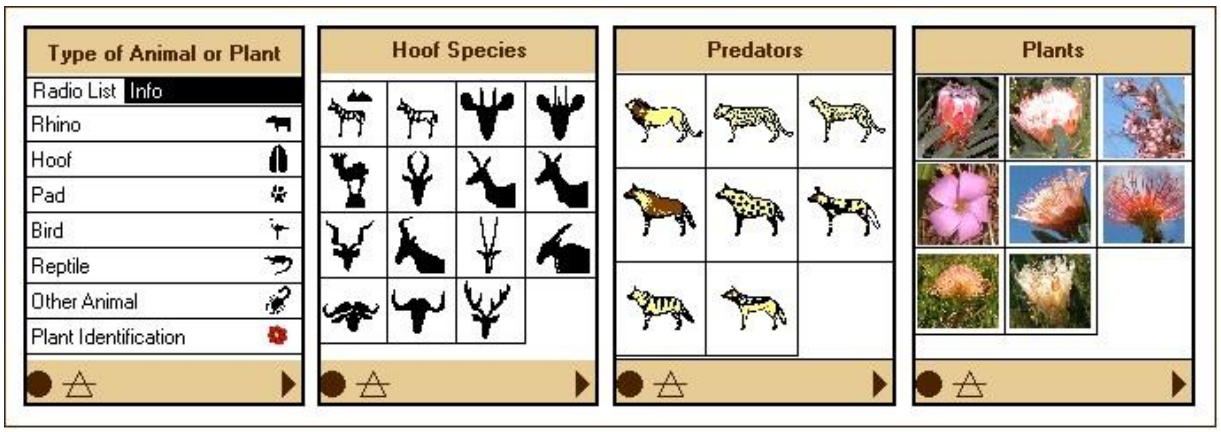
Cybertracker

http://www.cybertracker.org

Cybertracker is freeware, downloadable software for use on a range of hardward devices such as smartphones or handhald computers, to facilitate efficient GPS-referenced field data collection (Figure 16). The program has been designed to allow a user with no GIS or programming skills to design and

edit a spatial database with an icon-driven inteface that enables even illiterate staff to collect spatially oriented observational field data.

Figure 16. Examples of Cybertracker fields.



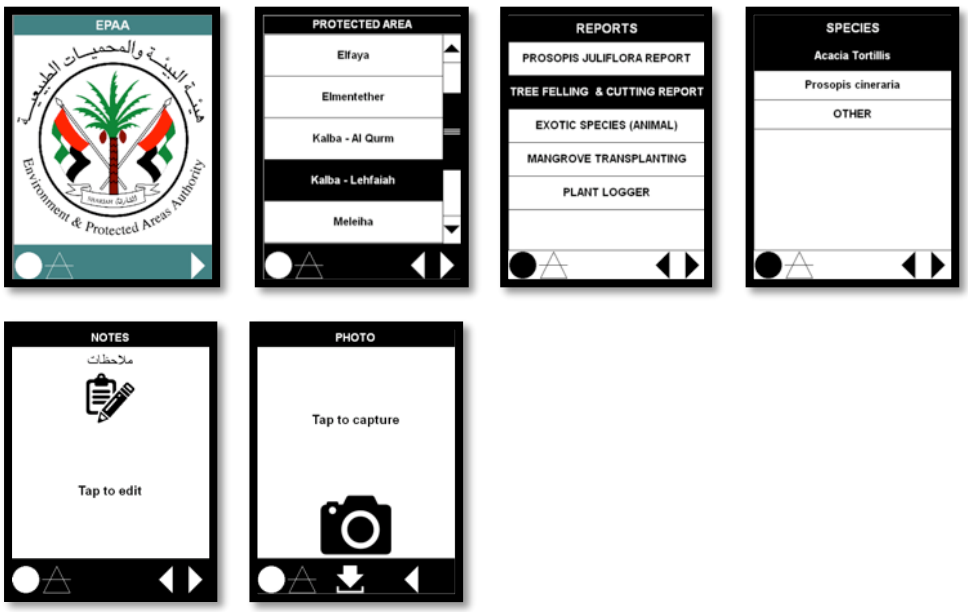
Cybertracker has been used in a large number of applications, including floral and faunal surveys and monitoring, ground-truthing of satellite images, aerial line transect surveys (in conjunction with a laser range finder), and in the production of field guides.

Cybertracker Application Case Study: Sharjah, UAE

Cybertracker is being used for field monitoring of the protected area network administered by the Environment and Protected Areas Authority (EPAA) in Sharjah. It was chosen due to its simple layout and design, and flexibility.

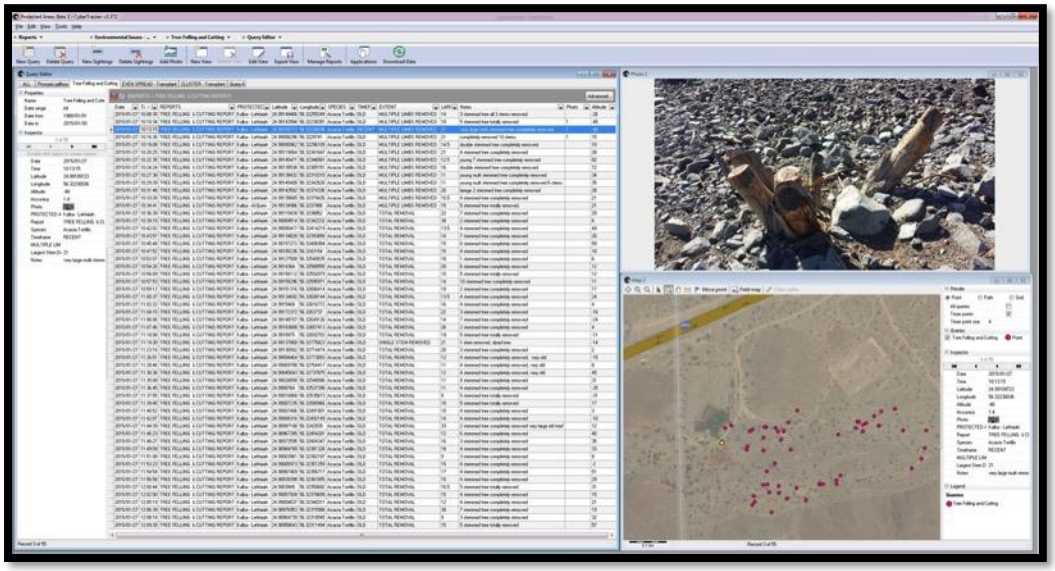
The screen-shots below illustrate the sequence of custom-designed screens for the capture of information on illegal tree cutting in Kalba Protected Area; optional screen enable the free entry of notes and the capture of images (Figure 17).

Figure 17. Examples of screens used to capture information on illegal tree cutting in the Kalba Protected Area.



The captured data automatically populates a structured database (Figure 18) so that data can be viewed in Tables, Maps and Graphs. Map views include Microsoft Virtual Earth, Google Earth, ESRI Shape File map layers or Image maps.

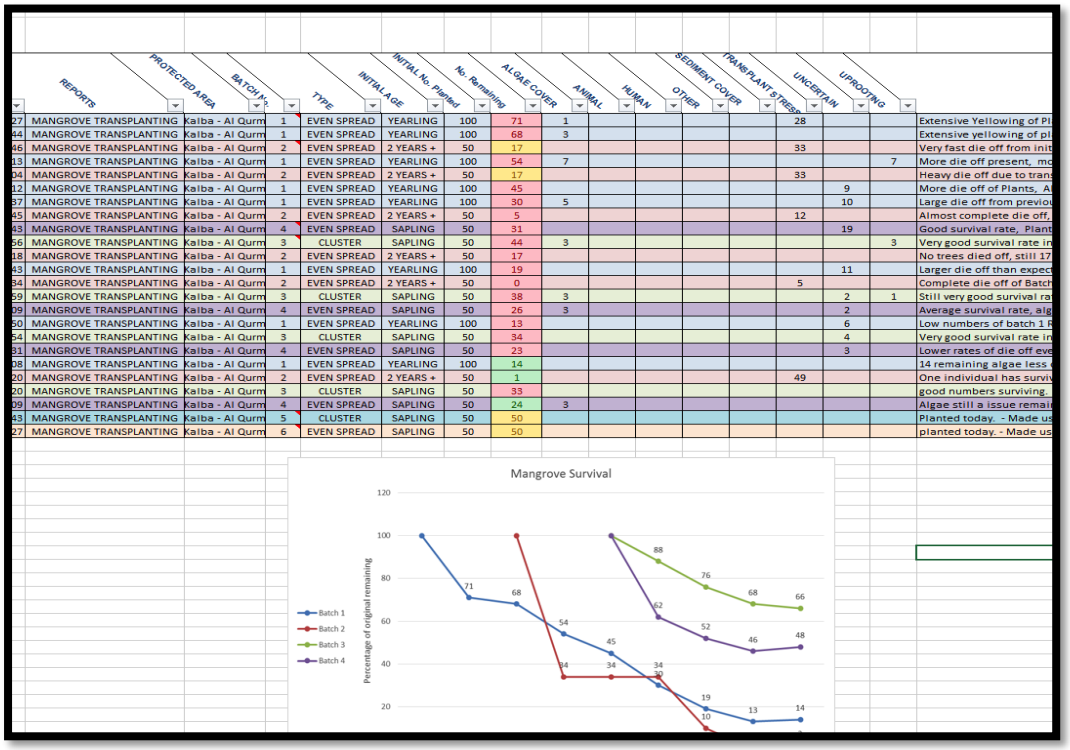
Figure 18. View of Cybertracker database.



The Table view allows you to query your data with easy-to-use filters, and queries can be saved in Reports, which are updated when new data is collected.

Once data has been filtered it can be Exported to Microsoft Excel, Comma Separated Values, XML or HTML formats (Figure 19). The Map View can also be exported as ESRI Shape Files.

Figure 19. Microsoft Excel view of Cybertracker data.



REPORTS	PROTECTED AREA	BATCH No.	TYPE	INITIAL AGE	INITIAL No. Planted	No. Remaining	ALGAE COVER	ANIMAL	HUMAN	OTHER	SEDIMENT COVER	TRANSPLANT STRESS	UNCERTAIN	UPROOTING	
27 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	71	1					28			Extensive Yellowing of Pl
44 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	68	3								Extensive yellowing of pl
46 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	17						33			Very fast die off from init
13 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	54	7							7	More die off present, mo
04 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	17						33			Heavy die off due to trans
12 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	45							9		More die off of Plants, A
37 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	30	5						10		Large die off from previou
45 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	5						12			Almost complete die off,
43 MANGROVE TRANSPLANTING	Kalba - Al Qurm	4	EVEN SPREAD	SAPLING	50	31							19		Good survival rate, Plant
56 MANGROVE TRANSPLANTING	Kalba - Al Qurm	3	CLUSTER	SAPLING	50	44	3							3	Very good survival rate in
18 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	17									No trees died off, still 17
93 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	19							11		Larger die off than expec
34 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	0						5			Complete die off of Batch
59 MANGROVE TRANSPLANTING	Kalba - Al Qurm	3	CLUSTER	SAPLING	50	38	3						2	1	Still very good survival ra
09 MANGROVE TRANSPLANTING	Kalba - Al Qurm	4	EVEN SPREAD	SAPLING	50	26	3						2		Average survival rate, alg
50 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	13							6		Low numbers of batch 1 R
54 MANGROVE TRANSPLANTING	Kalba - Al Qurm	3	CLUSTER	SAPLING	50	34							4		Very good survival rate in
31 MANGROVE TRANSPLANTING	Kalba - Al Qurm	4	EVEN SPREAD	SAPLING	50	23							3		Lower rates of die off eve
08 MANGROVE TRANSPLANTING	Kalba - Al Qurm	1	EVEN SPREAD	YEARLING	100	14									14 remaining algae less
20 MANGROVE TRANSPLANTING	Kalba - Al Qurm	2	EVEN SPREAD	2 YEARS +	50	1						49			One individual has surviv
20 MANGROVE TRANSPLANTING	Kalba - Al Qurm	3	CLUSTER	SAPLING	50	33									good numbers surviving.
09 MANGROVE TRANSPLANTING	Kalba - Al Qurm	4	EVEN SPREAD	SAPLING	50	24	3								Algae still a issue remai
43 MANGROVE TRANSPLANTING	Kalba - Al Qurm	5	CLUSTER	SAPLING	50	50									Planted today. - Made us
27 MANGROVE TRANSPLANTING	Kalba - Al Qurm	6	EVEN SPREAD	SAPLING	50	50									planted today. - Made us

A large number of menu options can be supported to cover the variety of activies within the network of protected areas and to generate a series of applications, for example:

- Animal Report

Menu: Species > Gender > Status > Body Condition > Ear Tag Number > Photo > Notes

- Dead Animal Report

Menu: Species > Cause of Death > Biological Data > Notes > Photo

- Fence Maintenance Report

Menu: Fence Condition > Repair Priority > Photo > Notes

- Protected Area Patrol Report

Menu: Fence Status > Water Supply Status > Game Count > Animal Status > Human Waste > Offroad Driving > Photo > Notes

- *Prosopis juliflora* Report

Menu: Status > Tree Height > Stem Diameter > Distance to Nearest > Flowering > Seeding > Photo > Notes

- Tree Felling & Cutting Report

Menu: Species > Age > Extent > Largest Stem Removed (Diameter) > Total Stems Removed > Photo > Notes

- Exotic Species Report

Menu: Species > Observation type > Photo > Notes

- Mangrove Transplantation Report

Menu: Batch Number > Initial Age > Initial No > Type > Number Remaining > Cause of Death > Photo > Notes

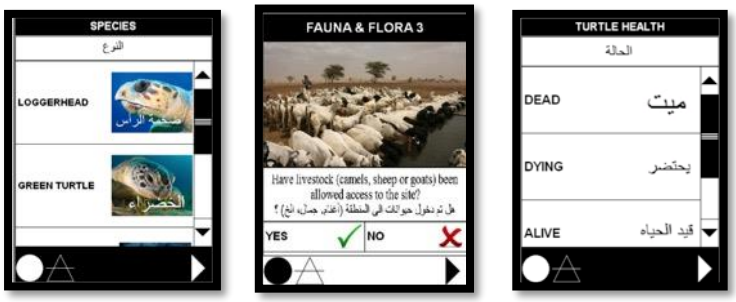
Each menu option is supported by a series of screens (Figure 20).

It is possible then to generate a range of graphs to explore data and distribution patterns, trends, and efficiency of patrols and monitoring.

Although a dedicated Arabic language option is not available, it has been possible to incorporate multi-language screens in conjunction with icons so as to enable accurate data capture by a range of field staff (Figure 21).

Figure 20. Examples of screens that support the menu option of Cybertracker

Figure 21. Example of multilanguage screens.



EPAA staff assessed the pros and cons of Cybertracker:

PRO'S

- Tremendous *versatility*
- *No programming* required
- *Ease of use* on mobile device
- Availability of *inexpensive* mobile devices
- It's *free*
- *Consolidated* platform for multiple reports
- *No expertise required* by device user.
- *Online* community
- Excellent *Time* Saver

CON'S

- Lack of *Arabic* text option
- Occasional *stability* issues
- *Low image processing* ability
- *Apple* unsupported

SMART – Spatial Monitoring and Reporting Tool

http://www.smartconservationsoftware.org

SMART is a comprehensive site-based approach to monitor and evaluate conservation management, including the effectiveness of wildlife law enforcement patrols and site-based conservation activities. First release in 2013, SMART is freely available to the conservation community, enabling access to best practice to help protected area and wildlife managers better plan, evaluate and implement their activities and to promote good governance. SMART comprises a desktop application created on open-source software, training and implementation manuals, web-based training materials, standardised protocols.

The software and associated training material are available in a number of languages and although the initial focus on SMART is on law enforcement, ongoing development is producing a suite of software tools to capture, manage and analyse various kinds of spatial data critical to the effective management and monitoring of conservation areas.

SMART is fully compatible with Cybertracker.

Figure 22. SMART entry screen.

Links and Further Information

- ArcGIS Mobile suite: www.esri.com
- Cybertracker: www.cybertracker.org
- SMART: www.smartconservationsoftware.org

Status and Conservation of Sea Turtles in the Arabian Peninsula

Introduction

The conservation status of breeding sea turtles in the Arabian Peninsula was discussed and reviewed at the workshop.

The turtle workshop consisted of a series of presentations on turtle status and conservation in the region, a discussion and analysis of threats facing turtles in the region, location of main breeding beaches and foraging sites, conservation and rehabilitation. A Vision and outline conservation strategy framework was drafted and research needs were identified and compiled.

The following presentations were given at the workshop:

1. EWS-WWF Marine Turtle Conservation (Marina Antonopolou / Oliver Kerr)
2. CMS Indian Ocean Sea Turtle MoU (Lyle Glowka)
3. Turtles in Khor Kalba (Lisa Hebbelmann)
4. Nesting Turtles on Sir Bu Nair (Lisa Hebbelmann)
5. Dubai Turtle Rehabilitation Project (Kevin Hyland)
6. Welfare Aspects of Turtle Rehabilitation (Peter McKinney)
7. Conservation of Turtles in Yemen (Abdul Karim Nasher and Masa'a Al Jumaily)

Marine turtles in the Arabian Peninsula

The area covered all the seas and coasts around the Arabian Peninsula: the Red Sea, Arabian Gulf, Arabian Sea, Gulf of Aden and Gulf of Oman.

Species summaries

There are seven species of marine turtles globally. Five species occur in the waters of the Arabian Peninsula, and four of them breed in the region. Gasperetti et. al. (1993) and Ross and Bawani (1996) provided summaries of the status of sea turtles in the region. The species and country summaries below are based on these two accounts, updated from more recent publications and with information presented during the 2015 workshop. The latest Red List status (global and regional) was extracted from the IUCN website (www.iucnredlist.org). Table 6 provides a summary of the conservation status of the region's turtle species.

An overview of the species' is available on the website of the CMS Indian Ocean Sea Turtle MoU: http://www.ioseaturtles.org/species_overview.php

Table 6. Status of marine turtles in the Arabian Peninsula

Species	Global Red List status (date)	Regional Red List status (date)	Breeding
Green *Chelonia mydas*	Endangered (2004)	Not assessed	Bahrain, Kuwait, Oman, Saudi Arabia, UAE, Yemen
Hawksbill *Eretmochelys imbricata*	Critically Endangered (2008)	Not assessed	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE, Yemen
Loggerhead *Caretta caretta*	Vulnerable (2015)	Critically Endangered (NW Indian Ocean) (2015)	Oman (Masirah), Yemen (Socotra)
Olive Ridley *Lepidochelys olivacea*	Vulnerable (2008)	Not assessed	Oman (Masirah, Al Hillaniyat islands)
Leatherback *Dermochelys coriacea*	Vulnerable (2013)	Data Deficient (NE Indian Ocean) (2013)	Breeding not confirmed in the region

Green turtle (*Chelonia mydas*)

Global Red list status: Endangered (2004 – needs updating)

This is the most common species of marine turtle in the region, occurring in all sea areas (Figure 23). The largest breeding sites, each harbouring several thousand individuals, are Karan island (Saudi Arabia), Ras al Hadd–Ras al Jinz (Oman) and the coast east of Mukalla (Yemen). There are also several smaller breeding sites. Extensive feeding grounds lie in the seagrass beds of the Gulf and off the coasts of Oman and Yemen. Green turtles are present all year round at the Ras Al Hadd Nature Reserve, Oman, with two distinct nesting seasons: a higher-density nesting season from June to September and lower-density from October to May (Ross and Barwani, 1982).

Figure 23. Green turtle, Khor Kalba (source: Lisa Hebbelmann, EPAA)

Hawksbill (*Eretmochelys imbricata*)

Global Red list status: Critically Endangered (2008)

Hawksbills breed throughout the region in the Gulf, Arabian Sea and Red Sea, though generally in small numbers. Larger aggregations occur on Sir Bu Nair Island (Sharjah, UAE), Masirah Island (Oman) and at Jebel Aziz in Yemen. Other large breeding sites in areas adjoining the Arabian region occur on the northern side of the Gulf in Iran and the western side of the Red Sea in Sudan.

Between 2010 and 2013, 90 post-nesting hawksbill turtles in the Gulf (Oman, Qatar, Iran, UAE) were satellite-tracked as part of a programme to elucidate turtle foraging habitats and post-nesting behaviour (Pilcher et. al., 2014a; EWS, 2015). The results of this study showed that when sea temperatures were higher in June–August, the hawksbills migrated north on average 70 km to deeper and cooler waters and returned to their original feeding grounds in September–October. Turtles undertaking summer migration loops generally moved in a north-easterly direction toward deeper water, returning in a south-westerly direction to shallower foraging grounds.

The study also revealed that hawksbills in the Arabian region might nest up to six times in a season with an average of three nests per turtle. Turtles from Qatar, Iran and the UAE generally migrated south and southwest to waters shared by the UAE and Qatar. A smaller number of turtles migrated northward towards Bahrain, Saudi Arabia and one reached Kuwait. Hawksbill turtles from Oman migrated south towards Masirah Island and to Quwayrah, staying close to the mainland and over the continental shelf (Pilcher et. al., 2014b). Critical migration bottlenecks were identified at the easternmost point of the Arabian Peninsula as turtles from the Daymaniyat Islands migrate southward in the waters between Qatar and Bahrain. Further results showed that the main foraging areas did not coincide with coral reefs and that Gulf hawksbills are among the smallest in the world.

Loggerhead (*Caretta caretta*)

Global Red list status: Vulnerable (2015).

Regional: Critically Endangered (Northwest Indian Ocean).

The main loggerhead breeding sites in the region are on the islands of Masirah (Oman) and Socotra (Yemen). Loggerheads are seen throughout the region but are rather uncommon outside the breeding sites. Recent research shows that a foraging population may be present in the Gulf off the north shore of Qatar and Bahrain (Pilcher et. al., 2015).

The average annual nest counts in the period 2010–2014 at Masirah island was 64,561 nests while about 5,000 nests per year are estimated in other nesting sites in Oman and 50-100 females are estimated to nest annually in Socotra island, Yemen which suggests that Masirah island hosts over 90% of the nests of this subpopulation (Tucker et. al., 2013; Casale, 2015). Based on these figures the annual number of nests for the entire subpopulation is estimated at 70,000 (Casale, 2015). If a conversion factor of 5.5 nests per female per year (Tucker et. al., 2013) is considered, about 13,000 females may nest annually in this subpopulation (Casale, 2015).

Olive Ridley (*Lepidochelys olivacea*)

Global Red list status: Vulnerable (2008)

Small numbers of this species nest on Masirah Island and the Al Hillaniyat islands, Oman. Olive ridleys are occasionally seen elsewhere and may be scarce in the region because they prefer areas of low salinity and mangroves (Ross and Barwani, 1996). In the Gulf there were only 11 confirmed records of olive ridley turtles up to June 2015, and the first breeding record in the Gulf occurred on the Iranian coast in May 2013 in Nayband Marine-Coastal National Park (Tollab et. al., 2015).

Leatherback (*Dermochelys coriacea*)

Global Red list status: Vulnerable (2013).

Northeast Indian Ocean population: Data Deficient

Leatherbacks do not breed in the region but are seen occasionally in the Red Sea, as far north as Jordan, the Arabian Sea and the Gulf (Figure 24). Gasperetti et. al., (1993) reported solitary dead specimens found in Bahrain and Qatar. Ross and Barwani (1995) listed five records in the Arabian Sea off Oman. Al Mohanna and Meakins (2000) reported the first occurrence of the species in Kuwait.

Figure 24. Leatherback turtle, Yemen (source: AK Nasher, Sana'a University).

Country summaries

Bahrain

Small numbers of green and hawksbill turtles have bred on Hawar island off the south coast. No significant breeding takes place now but seagrass beds and coral reefs provide important foraging habitat (Miller and Abdulqader, 2009). Loggerheads also occur and olive ridley turtle was recorded for the first time in Bahrain waters in 2007 (Abdulqader and Miller, 2012).

Abulqader (2010) estimated that on average over 300 turtles were caught in fishing nets every year. Details of turtle mortalities in 2007-2008 were assessed by examining carcasses and asking fishermen to respond to a questionnaire (Abdulqader and Miller, 2012). In total, 142 dead turtles were recorded (115 green, 22 hawksbills, 4 loggerheads, 1 olive ridley) with the evidence indicating that the shrimp trawl fishery was responsible for most of the green and loggerhead turtle deaths; wire fish traps, known as 'gargoor' placed on the sea bed to catch benthic fish species were responsible for the hawksbill and olive ridley turtle mortalities (Abdulqader and Miller, 2012). Most mortality occurred in waters north of the island and east of Fasht (reef) Al Jarim. Some education programmes for fishermen involving appropriate equipment to minimise turtle mortalities has been provided.

Iraq

Iraq contains c. 58 km of coastline at the head of the Gulf and a small coral reef lies offshore. No turtle breeding beaches are known.

Jordan

Jordan has 27 km of coast along the Gulf of Aqaba with coral reefs and seagrass beds. Turtles are seen offshore: hawksbill is the commonest, there are a few records of green turtle and loggerhead is rare. There are no known breeding sites. Sandy beaches are under a lot of pressure from tourism and development. Consumption of turtle meat is very low. Some awareness programmes have been developed and beach clean-up operations carried out (e.g. 2.5 tonnes of plastic were collected from one beach during a major recent operation). (Auspices of Royal Marine Conservation Society of Jordan (JREDS); www.jreds.org).

Kuwait

Kuwait has c. 280 km of shoreline and 10 offshore islands ranging in size from 0.5 to 56 km^2 with sandy shores found along about 20% of the southern coast and on some offshore islands (Meakins and Al Mohanna, 2000). Nesting attempts on the mainland have been observed in the past but recent breeding by green and hawksbill turtles is limited to two offshore islands, Qaruh and Umm al Marddin (Meakins and Al Mohanna, 2004). Nesting habitats have been altered in recent years and beach monitoring and satellite telemetry has indicated that green turtle nesting is now limited to Qaruh, with only 1–5 turtles nesting annually with foraging habitats occuring along the northern shore of Failaka Island (Rees et. al., 2013). Loggerheads have also been observed in Kuwaiti waters. The first record of a leatherback was in March 2000 when one animal was found on a beach in southern Kuwait (Al Mohanna and Meakins, 2000). The coastguard controls access to Qaruh and Umm al Marddin islands. Turtles are sometimes caught in traditional fish traps known as *hadra* that are erected in the intertidal and subtidal zones. As the tide recedes, fish and other marine fauna are directed along a wall, placed perpendicular to the shore, and into an approximately circular enclosure with a funneled mouth (Meakins and Mohanna, 2004), raising concerns for the conservation of this depleted population (Rees et. al., 2013). The Kuwait Turtle Conservation Project ran from 2008 to 2011. The Scientific Centre Kuwait (TSCK) and volunteer teams are involved in turtle monitoring.

Oman

The four main turtle breeding sites are: Ras Al Hadd–Raz Al Jinz in north-east Oman; Masirah island; the Al Hillaniyat islands off the south coast; and Al Dimaniyat islands in the Gulf, north-west of Muscat. Turtles may also nest on the mainland at Bar al Hikman, close to Masirah, and at Duqm to the south-west, but this has not been confirmed.

Ras al Hadd Nature Reserve is situated at the easternmost point of Oman. It covers 120 km^2 and extends from Ras al Hadd for c. 42 km to Ras al Jinz. This site contains the largest green turtle rookery in the region. During the 1990s, at least 15,000 female green turtles nested annually (Mendonça et. al., 2010). An estimated 5000 turtles still breed there, mainly on one beach as Ras al Hadd and two beaches at Ras al Jinz. The red fox *Vulpes vulpes* has been identified as the most important predator of

sea turtle eggs and hatchlings (Mendonça et. al., 2010). The Ras al Jinz Scientific and Visitor Centre serves tourists, who are only allowed onto the northern beach, leaving the southern Beach undisturbed.

Masirah Island is an exceptionally important site, harbouring the main loggerhead breeding site in the Arabian Peninsula, with >90% of the regional breeding population. Olive ridley, green and hawksbills also nest on the island. Each species nests on specific beaches and seasons, with some overlap: hawksbills and olive ridleys nest in winter and spring, whereas loggerhead and green turtles nest in summer and autumn (Rees and Baker, 2006).

The five Al Hillaniyat islands lie off the south coast, 50 km from Hasik; green, hawksbill and olive ridley turtles breed there. Al Dimaniyat consists of nine small islands 18 km off the coast, not far from Muscat, with a combined area of c. 100 ha. Both hawksbills and green turtles breed there. The islands are a nature reserve.

Trawl-nets are widely used in Oman but gill-nets are uncommon. According to the local authorities, incidental mortality of adult green turtles by capture in fishing nets at Ras al Hadd is approximately 37 per year. Mortality rates are especially high in the area, most likely due to the number of fishing vessels operating in the highly productive Arabian Sea, and also because of the intense maritime traffic in this oil-rich region (Mendonça et. al.,2010).

The Environmental Society of Oman (ESO) and the Ministry of Environmental and Climate Affairs (MECA) are engaged in marine turtle conservation.

Qatar

Qatar has approximately 600 km of coastline and several offshore islands. Significant portions the coast are developed or under development. An estimated 100-200 hawksbills breed at three sites: Ras Laffan, Fuwairit and Halul Island (Supreme Council of Environment and Nature Reserves (SCENR), 2006; Pilcher et. al., 2014). Qatar waters also contain important foraging areas, with a resident population of juvenile green turtles and a transient population of juvenile hawksbills; recent research also shows a foraging population of loggerheads off the north coast (Pilcher et. al., 2015).

Fuwairit is situated on the north coast. Up to 100 hawksbills may nest on the beach, which is closed for recreational use during the nesting season to prevent disturbance (Doha Times, April 2015). Ras Laffan Industrial City (RLIC) is situated at the north-eastern end of the country. The city occupies an area of 106 km^2 and hosts a commercial port and two Liquid Natural Gas (LNG) terminals. It has approximately 9 km of beach on the northern coast and 5 km on the east. In 1999–2000, RLIC constructed a 6 km long sand barrier parallel to the northern beach to prevent vehicle access. It also cleared rubbish (timber, plastic, nylon ropes, glass and metal scraps), and set up continuous monitoring to deter egg poaching (Tayab and Quiton, 2003).

Halul Island is situated 80 km north-east of Doha. Breeding has also been reported at Al Khor, on the east coast, south of Ras Laffan (Tayab and Quiton, 2003) but it is not clear whether this site is still used.

Fuwairit is under the protection of the Ministry of the Environment and Qatar University. Qatar Petroleum is responsible for Ras Laffan and Halul, which is also a naval base.

Saudi Arabia

Saudi Arabia has c. 1800 km of coastline along the Red Sea and c. 650 km in the Gulf, as well as several offshore islands. Around 15 breeding beaches are well known. The largest mainland-breeding site in the Saudi sector of the Red Sea is at Ras Baridi, north of Yanbu. Here five breeding beaches are distributed along a distance of about 6 km and harbour c. 600 breeding green turtles. Turtles also breed on the islands of the Al Wajah bank in the northern Red Sea off the coast of Tabuk province. In the southern Red Sea, the Farasan islands archipelago lies about 40 km from Jizan in southwest Saudi Arabia. Green and hawksbill turtles breed on the islands. In the northern part of the Gulf, the islands of Karan and Jana are also important breeding sites. Around 2,000 green turtles breed on Karan and 500 hawksbills on Jana. Extensive research and satellite tracking have been carried out on turtles on the Farasan islands, Ras Baridi, Jana and Karan. The Farasan islands are a protected area and access to Jana and Karan is controlled.

On Farasan and in Jizan there is some medicinal use of turtles, including the tail as an aphrodisiac. Cement dust from a cement factory at Ras Baridi close to the breeding beaches has had a negative effect on turtle hatching success (Pilcher, 1999) and light pollution affects the breeding site. Boat strikes, discharge of untreated sewage and low levels of awareness also affect sea turtles. A Sea Turtle Conservation Project has been ongoing in the Red Sea since 1989 and in the Gulf since 1992, notably on Ras Baridi and the Farasan islands (Red Sea) and Karan and Jana Islands (Gulf). Project work involves metal tagging and satellite tagging, studies of behaviour, physical measurements, egg size and weight, hatching success, and nesting substrate (Al Mansi et. al., 1999).

United Arab Emirates

The UAE has c. 1300 km of coastline, mostly along the Gulf, with a smaller area along the Gulf of Oman, plus many offshore islands. Hawksbills are the most numerous breeding species. The first record of breeding green turtle in UAE came from Sir Bu Nair Island, Sharjah in May 2010 when Emirates Marine Environmental Group discovered two nests of this species (Al Suweidi et. al., 2012). Most breeding beaches are found in the Gulf (i.e. the western part of UAE) in Abu Dhabi, Dubai and Sharjah emirates.

In Abu Dhabi, a survey in 2012 estimated at least 177 hawksbill nests on 14 islands; an aerial census in summer estimated c. 6,412 foraging turtles and a winter survey showed no apparent decline since a similar survey in 2004 (Ministry of Climate Change and the Environment (MoEW), 2012). The breeding season is mid-March to mid-July with a peak in April-May (Al-Ghais, 2009). Breeding sites include: Bu Tinah, a small archipelago situated within the Marawah Marine Biosphere Reserve that it is closed to visitors and patrolled; Arzanah (180 km north-west of Abu Dhabi), and Zirkoh (140 km north-west) which have oil production facilities and are both managed by the Zakum Development Company

(ZADCO); Dina, a military base; Jarnain (privately owned); Saadiyat Island, 500 m off Abu Dhabi, c. 2.5 km^2 in area and which has code of conduct and beach protection; and Sir Bani Yas.

About 35 hawksbills breed in Jebel Ali sanctuary, Dubai. In Sharjah, Sir Bu Nair Island is an important site with 300–350 nesting hawksbills each year. On the east coast, the mangroves at Khor Kalba provide a green turtle foraging site and there is one recent record of breeding. There is another breeding record of green turtle from the east coast at Dibba, in Fujairah emirate. Khor Kalba is a protected area and Sir Bu Nair is controlled by the military. The Environment Agency (EAD) in 2001 established Marawah Marine Biosphere reserve (MMBR) and Al Yasat Marine Protected Area in 2005.

The EAD has conducted monitoring of turtles and dugongs since 1999, as well as ongoing mangrove and coral reef surveys. Socio-economic survey of fishing communities (threats) carried out in 2014. Seagrass monitoring and rehabilitation is planned for 2015 onwards.

EAD and EMEG are monitoring turtles on Sir Bani Yas.

EPAA, EMEG and EWS have been carrying out a project from 2010 on Sir Bu Nair covering nest site mapping, and monitoring hatching success. EPAA initiated a study of green turtle ecology in the Kalba mangroves in 2015.

Dubai Turtle Rehabilitation Project (DTRP) in cooperation with the Jumeirah Beach Hotel began in 2004 and has rescued 562 turtles since 2004 (www.jumeirah.com/turtles). In Abu Dhabi, the Tourist Development and Investment Company (TDIC), EAD and Emirates Palace Hotel are implementing a rehabilitation project.

A research project carried out by EWS-WWF satellite tracked 90 hawksbill turtles (Figure 25 and Figure 26), locating foraging and nesting grounds, migration bottlenecks and collecting information on activity patterns (WEWS-WWF, 2015) (Figure 27). A project stakeholder workshop was held on 24-25 May 2014.

Figure 25. Turtle with satellite transmitter (source: EWS-WWF, UAE)

Figure 26. Turtle monitoring in the region (source: EWS-WWF, UAE)

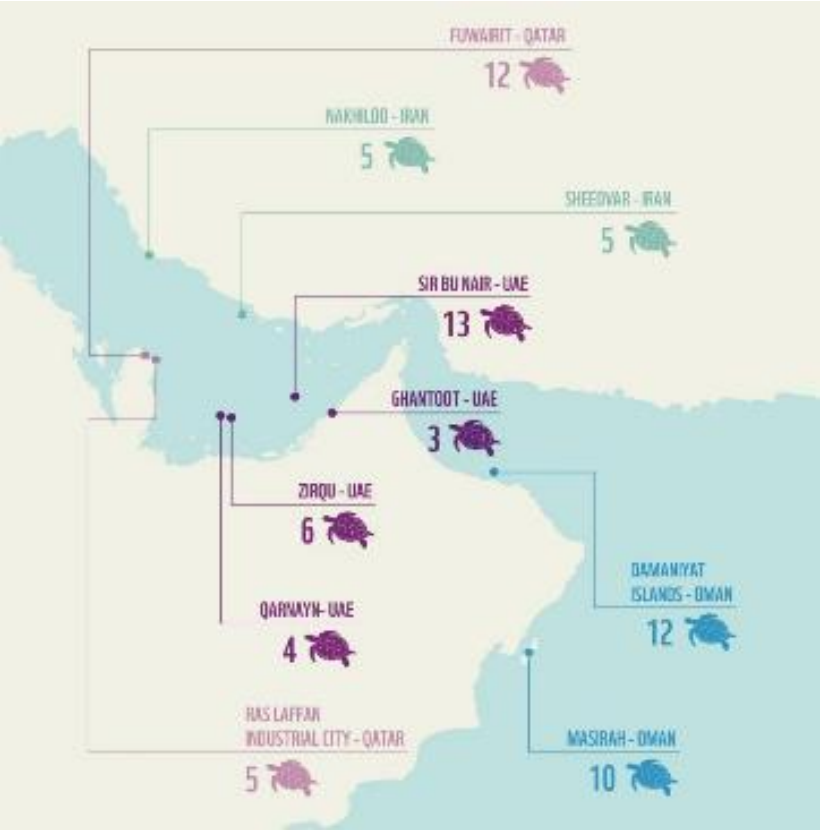
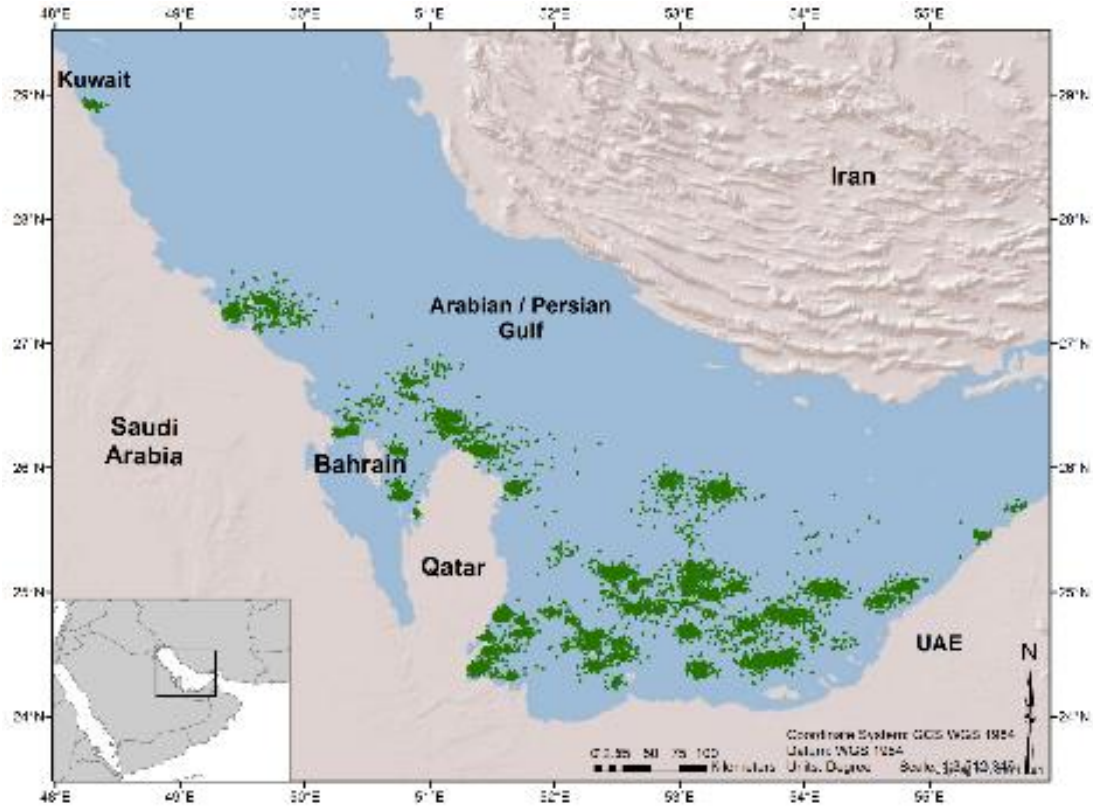


Figure 27. Main foraging grounds for sea turtles in the Arabian Gulf (source: EWS-WWF, UAE)



Yemen

All five species have been recorded in Yemeni waters. Green and hawksbills breed on the south coast and loggerheads on Socotra Island (Figure 28). No breeding sites have yet been found on the Red Sea coast of Yemen, noting that some islands, such as the Hanish Islands in the Red Sea, have not been surveyed for turtles at this time.

Figure 28. Green turtle, Yemen (source: AK Nasher, Sanaa University)

On the south coast, there are three main breeding areas: Ras Imran and Azizi Island near Aden; Ras Sharma-Jethmoun PA (beaches separated by rocky ground) in Hadhramaut governorate; and Al Fatk (3 sites over a distance of 5170 m separated by rocky ground); and Ad-Damar beach (1370 m in length) in Mahra governorate, eastern Yemen. In 2014, 26,406 nests were counted at Jethmoun and 25,536 at Sharma. The length and coordinates of these beaches were calculated from satellite imagery (Groombridge, 2010) (Table 7). Ras Sharma is notionally protected but the regulations are not effectively enforced (Stanton, 2008).

Table 7. Location of sea turtle breeding sites in Hadhramaut, Yemen

Site	Length (km)	Latitude	Longitude
Ras Sharma north	0.43	14°49′31.86″N	50°1′32.81″E
Ras Sharma south	0.33	14°49′16.82″N	50°1′30.10″E
Jethmun	4.4	14°50′22.75″N	50°4′59.14″E

Source: Groombridge (2010)

On Socotra there are Loggerhead nesting beaches at two sites: on the north coast from Ras Gubba along Abalhen beach to Ras Kadama; and in Ras Shu'aib Bay at the western end of the island (Figure 29). Totals counted were 239 in 2006 and 95 in 2012, but the census methods are not rigorous enough to make direct comparisons.

On Socotra, turtle products were formerly used only for medicinal purposes, but some people have also begun to eat the meat (Figure 30). The liver is eaten; the blood and fat are used in traditional medicine and the sexual organs of males as an aphrodisiac. Hawksbill shell is used to make souvenirs. On the mainland, turtle meat is sold in Hadhramaut and is reportedly available at one restaurant in Aden (AK Nasher, pers. comm.)

Figure 29. Location of the principal sea turtle breeding sites in the Arabian Peninsula. Further information is provided in Appendix 2.

1. Farasan islands; 2. Ras Baridi; 3. Al Wajah bank; 4. Karan Is; 5. Jana Is. (Saudi Arabia). 6. Qaruh Is (Kuwait). 7. Ras Laffan; 8. Halul Is. (Qatar); 9. Sir Bani Yas; 10. Arzanah and Zirkoh; 11. Bu Tinah; 12. Saadiyat Is; 13. Sir Bu Nair; 14. Jebel Ali; 15. Dibba; 16. Khor Kalba (United Arab Emirates); 17. Al Dimanayat Is; 18. Ras al Hadd-Ras al Jinz; 19. Masirah Is; 20. Al Hillaniyat Is. (Oman). 21; Al Fatk; 22. Sharma and Jethmun; 23. Ras Imran-Azizi Is; 24. Socotra (Yemen).

Figure 30. Remains of turtles, Yemen (source: AK Nasher, Sana'a University).

The Yemen Sea Turtle Conservation Program is operated by the Yemeni Biological Society and funded by US Fish and Wildlife Service. The program works in collaboration with the Socotra Society for Marine Turtle Conservation (on Socotra), Halfoun Wildlife Protection Society and Friends of Environment Association (Hadhramaut), Ras Imran Society for Sea Turtle Conservation (Ras Imran, Azizi), and Al Fatk Fisheries and Services Society (Al Mahra). The Environment Protection Authority (under the Ministry of Water and Environment) is responsible for monitoring and flipper tags and protected areas. The Ministry of Fisheries operates a Marine Research Centre in Aden.

Threats

Sea turtles of the Arabian Peninsula are threatened directly and indirectly by natural and man-made threats.

Direct threats. To the turtles, their breeding beaches and foraging grounds, such as direct strikes by boats, persecution and exploitation.

Indirect threats. Affect turtle breeding beaches, foraging areas and migration routes.

Natural predation

Ghost crabs and seagulls are among regular predators on hatchlings. In Hadhramaut, Yemen, feral dogs also predate on turtle hatchlings. At Ras al Hadd, Oman, red foxes *Vulpes vulpes* were identified

as the most important predator of sea turtle eggs and hatchlings and these items made up 95% of red fox diet, based on analysis of 20 scats (Mendonça et. al., 2010). During the early hours of the day 1-2 foxes/km^2 were seen digging into turtle nests for eggs. Foxes were also seen feeding on hatchlings and caused additional mortality by chewing off a small piece of a relatively large number of prey (10-20 hatchlings per night, per fox), to store for later consumption. However, the stored food was rarely eaten, as the foxes killed fresh hatchlings each day (Mendonça et. al., 2010). There is little information available on natural predation on adult turtles.

Direct mortality

Turtles and their eggs are killed for food and medicine (blood, fat, sexual organs) throughout the region. These activities are mainly local in scale but in Yemen there is a limited commercial trade in turtle meat in Hadhramaut and one restaurant in Aden is even reported to offer turtle meat. Hawksbill shells are still used to make tortoiseshell for jewelry and ornaments. Fishermen may also directly target turtles.

Boat strikes

It is difficult to assess the impact of collisions with boats but it is likely to be a greater problem at migration bottlenecks in busy shipping lanes. On Karan Island in the northern Gulf, 3-4% of 400 turtles tagged at the nest had a damaged flipper (A Al Mansi, pers. comm.). There are few other studies available.

Incidental mortality

Drowning through entanglement in fishing nets, gill nets, trawl nets, entanglement in abandoned nets lines and other fishing gear. In Bahrain, an estimated 300 turtles were caught annually in shrimp trawl nets, some of which were assumed to have died (Abdulqader, 2009; Abdulqader and Miller, 2012). Turtle mortality has also been recorded in traditional fish traps (*hadra* in Kuwait and *gargoor* in Bahrain).

Habitat destruction and degradation

Coastal development (construction of ports, industrial infrastructure, dredging, sand collection; tourism and residential development, recreational disturbance, tourism, beach driving, and light pollution) may all result in destruction of breeding beaches and disturbance. Clearance of mangroves, damage to seagrass beds and coral reefs negatively affect foraging sites.

Plastic

Ingestion of discarded plastic bags and other debris is widely feared to be a cause of turtle mortality. Sea turtles are especially susceptible because of the downward facing spines in their throats that prevent regurgitation. The plastics therefore become trapped in their stomach. However, evidence from the region to support or to quantify this threat is lacking.

Cold stunning

This is a hypothermic reaction that occurs when sea turtles are exposed to prolonged cold-water temperatures. Initial symptoms include a decreased heart rate, decreased circulation, and lethargy, followed by shock, pneumonia and possibly death. The phenomenon has been recorded in the Atlantic, especially with young turtles, but has not yet been confirmed in the Arabian region.

Climate change

Predicted effects of warmer climatic trends include rising sea levels affecting breeding beaches, increased coral bleaching, and hotter sea temperatures disrupting movement patterns and foraging. Site-specific effects are not yet quantified and research into this topic is urgently needed.

General threats to the marine environment

Several overall threats pose potential problems for sea turtles. The impacts of offshore oil installations are enormous and oil spill emergencies result in substantial pollution. Operational pollution from ships and dumping of ballast water are also among the main causes of chronic pollution in the marine environment. Municipal sewage and industrial effluents from industries such as petroleum refineries, power, desalination and petrochemical plants further contribute to marine pollution. Dredging and reclamation activities are also a permanent feature in many coastal areas with damaging effects. Sedimentation, high salinity, extreme temperatures, and land-based and sea-based pollution are additional issues of concern.

Constraints

Background issues influencing sea turtle conservation include lack of funding and other resources, lack of trained personnel and a wider lack of appreciation of the importance of sea turtles and the marine environment. There is in addition inadequate knowledge of many aspects of turtle status, biology and ecology.

Conservation

The many national level efforts aimed at sea turtle conservation are summarised in the country accounts, above. These are supplemented by international agreements (IOSEA, MOU, CITES, PERSGA, ROPME) and international organisations concerned with turtle conservation.

PERSGA (Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden)

PERSGA is an official regional organisation based in Jeddah, Saudi Arabia that is responsible for the development and implementation of regional programmes for the protection and conservation of the marine environment of the Red Sea and Gulf of Aden. It was formally established in September 1996, with the signing of the Cairo Declaration by all cooperating parties to the Jeddah Convention. In February 1982 the governments in the region signed The Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (the Jeddah Convention) together with a Protocol Concerning Regional Co-operation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency. The main focus of the Convention concerns the prevention, reduction and fight against pollution. The organisation was established in September 1995 under the umbrella of the Arab League. A Council composed of the Ministers responsible for the environment from each Member State governs PERSGA. The PERSGA Secretariat manages day-today matters. PERSGA produces a quarterly newsletter *Al Sambouk* (Email: persga@persga.org).

Regional Organisation for the Protection of the Marine Environment (ROPME)

The ROPME Sea Area covers eight Gulf states (Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) that have adopted the Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, otherwise known as the Kuwait Convention. ROPME was established in 1979 and later became the secretariat for the Kuwait Convention and Action Plan. Projects range from coastal area management, fisheries, public health, sea-based pollution, biodiversity, oceanography, marine emergencies, GIS and remote sensing to environmental awareness and capacity building. A Regional Marine Emergency Mutual Aid Centre (MEMAC) was established in 1982 in Bahrain to assist in combating pollution by oil and other harmful substances and to co-ordinate and facilitates information exchange, technological co-operation and training (www.ropme.com).

Convention on the Conservation of Migratory Species of Wild Animals (CMS) IOSEA Marine Turtle MOU

The Convention on Conservation of Migratory Species of Wild Animals (CMS; also known as the Bonn Convention) is an environmental treaty under the aegis of the United Nations Environment Programme (UNEP) that provides a global platform for the conservation and sustainable use of migratory animals and their habitats. Besides establishing obligations for each State joining the Convention, CMS

promotes concerted action among the Range States of many of these species. CMS acts as a framework Convention and develops agreements that range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding that can be adapted to the requirements of particular regions.

The Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA Marine Turtle MOU)

The IOSEA Marine Turtle MOU and its associated Conservation and Management Plan (CMP) were developed over a series of intergovernmental sessions and became effective on 1 September 2001. A secretariat was established in April 2003 to coordinate activities under the MOU. For implementation, the MOU area is divided into four sub-regions: South-East Asia (plus Australia, China, Japan, Republic of Korea and United States), Northern Indian Ocean, Northwestern Indian Ocean, and Western Indian Ocean. The objectives of the CMP are listed in Appendix 3.

The ultimate aim of the IOSEA MOU is to maintain and recover marine turtle populations by promoting cooperation among Governments and other organisations. The agreement seeks to ensure that consumptive or non-consumptive use of turtles for the benefit of human beings is sustainable well into the future.

The IOSEA Secretariat has developed an online Projects Database, Satellite Tracking Meta-database, Bibliography Resource and the forthcoming International Flipper Tag Recovery Database which are at the disposal of anyone interested. Current projects include the development a Network of Sites of Importance for Marine Turtles. The IOSEA website (http://www.ioseaturtles.org/) also contains summaries of the status of the species of marine turtles occurring in the region.

The IOSEA MoU's Conservation and Management Plan contains 24 programmes and 105 specific activities focused on reducing threats, conserving critical habitat, exchanging scientific data, increasing public awareness and participation, promoting regional cooperation, and seeking resources for implementation. See Appendix 1.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES is an international environmental agreement between governments. Its aim is to ensure that international trade in wild animals and plants does not threaten their survival. Most countries in the world are signatories to CITES. All marine turtles are included in CITES Appendix I, which prohibits international trade in specimens of these species, except for non-commercial purposes, for instance scientific research. In such exceptional cases, trade may take place provided it is authorised (www.cites.org).

IUCN/SSC Marine Turtle Specialist Group

The IUCN SSC Marine Turtle Specialist Group (MTSG) is part of the Species Survival Commission (SSC) of IUCN, the International Union for Conservation of Nature. Comprised of more than 230 expert members in over 80 countries, the MTSG is the global authority on marine turtle research and conservation and is responsible for making Red List assessments and publishes the *Marine Turtle Newsletter* (www.iucn-mtsg.org).

Salahif

Salahif (one of the Arabic words for 'turtle') is an internet-based network dedicated to the conservation of sea turtles in the Arabian Gulf, Red Sea and western Indian Ocean (www.salahif.org).

Regional conservation strategy for sea turtles

Vision

Safe and self-sustaining sea turtle populations and their habitats thrive throughout the region and are valued by communities.

Goals

1. Understand and protect important feeding and nesting habitats of sea turtles in the region to provide the appropriate assessment of conservation needs.

2. Promote awareness of harmony between sea turtles and human beings.

Objectives and actions

Objective 1. Reduce direct mortality

1.1. Identify the main causes of mortality (bycatch, persecution, consumption) in each country.

1.2. Promote the use of fishing gear modification (TEDS, circle hooks) among governments and fishing communities.

1.3. Establish the extent of illegal trade (motives, economic incentives, consumers).

1.4. Monitor the impact of natural predation on eggs and hatchlings.

1.5. Map the overlap between fishing activities and turtle foraging areas (mortality hotspots).

1.6. Establish the seasonality of mortality vs fishing effort.

1.7. Record all mortality on national and central databases.

1.8. Assess the impacts of pollution on sea turtles.

Objective 2. Protect key breeding and foraging habitats

2.1. Map and monitor all breeding sites and important foraging grounds.

2.2. Implement protection programs at all key breeding beaches, including beach closures at critical times.

2.3. Produce maps of areas critical to turtles for each country and integrate these into coastal development proposals.

Objective 3. Increase awareness of sea turtle conservation

3.1. Highlight the importance of turtle conservation to governments and decision-makers.

3.2. Produce publicity materials and develop campaigns aimed at the fishing community. (see Figure 31)

3.3. Provide articles press releases to the media, including social media.

3.4. Include sea turtle conservation in the official school curriculum.

Figure 31. Raising awareness of the importance of protecting sea turtles with local communities, Yemen (source: AK Nasher, Sana'a University)

Objective 4. Improve understanding of sea turtles in the region

4.1. Initiate a coordinated regional census of breeding turtles using a standard methodology.

4.2. Conduct a programme of research covering:

Population

- Trends
- Population structure and demography
- Genetics
- Dispersal and migration

Habitat

- Migration and movement sites
- Habitat restoration (sea grass, mangroves, coral reefs)

Ecology

- Diet
- Feeding behaviour
- Physical characteristics, temperature and sex ratios
- Mating
- Inter and intraspecific competition
- Niche separation

Conservation impact

- Measure success and failure of programmes and activities

Socio-economic

- Public attitudes to sea turtle conservation
- Fishermen's attitudes to sea turtle conservation

Climate change

- Sea surface temperatures
- Sand temperatures
- Coral bleaching
- Water quality and turbidity
- Salinity and PH

Objective 5. Enhance the rehabilitation network

5.1. Maintain existing rehabilitation programmes and expand where needed

5.2. Develop a regional stranding protocol

5.3. Develop regional guidelines on handling, husbandry, veterinary care and release

Objective 6. Maximise the regional platform for sea turtle conservation

6.1. Develop common methodologies for collecting and storing data

6.2. Strengthen the database and sharing of information

6.3. Establish regional collaborative programs for sea turtle research and conservation

6.4. Coordinate conservation activities and reporting with the IOSEA MOU and CMP

References

Abdulqader, EAA 2010. Turtle captures in shrimp trawl nets in Bahrain. *Aquatic Ecosystem Health and Management* 13: 1-11.

Abdulqader, EAA and Miller, J 2012. Marine turtle mortalities in Bahrain territorial waters. *Chelonian Conservation and Biology* 11: 133-138. doi: http://dx.doi.org/10.2744/CCB-0826.1

Al-Ghais, SM 2009. Nesting of Hawksbill Turtles, *Eretmochelys imbricata*, on the islands of the Arabian Gulf. *Zoology in the Middle East* 48: 43-48.

Al Mansi, AMA, Khushain, OA, Al-Marghani, MMH 1999. On the effect of substrate on nesting success of Green Turtle, *Chelonia mydas*, in the Arabian Gulf. *Zoology in the Middle East* 19: 5-11.

Al Mohanna, SY and Meakins, RH 2000. First record of the leatherback turtle (*Dermochelys coriacea*) from Kuwait. *Zoology in the Middle East* 21: 27-29.

Al Mohanna, SY, Al Zaidan, ASY and George, P 2014. Green turtle (*Chelonia mydas*) of the north-west Arabian Gulf, Kuwait: the need for conservation. *Aquatic Conservation: Marine, Freshwater Ecosystems* 24: 166-178.

Al Suweidi, AS, Wilson, KDP, Healy, T and Vanneyre, L 2012. First contemporary record of green turtle (*Chelonia mydas*) nesting in the United Arab Emirates. *Marine Turtle Newsletter* 133: 16-17.

Casale, P 2015. *Caretta caretta (North West Indian Ocean subpopulation)*. The IUCN Red List of Threatened Species 2015: e.T84127873A84127992.

EWS-WWF 2015. Marine turtle conservation project Final Report. EWS-WWF, Abu Dhabi, UAE.

Gasperetti, J, Stimson, AF, Miller, JD, Ross, JP and Gasperetti, PR 1993. Turtles of Arabia. *Fauna of Saudi Arabia* 13: 170-367.

Groombridge, B 2010. Using Google Earth to Confirm Marine Turtle Nesting: Pakistan and Yemen. *Marine Turtle Newsletter* 129: 17-19.

Meakins, R. and Al Mohanna, SY 2000. Sea turtles in Kuwait after the Gulf War. *Marine Turtle Newsletter* 88: 7-8.

Miller, J and Abdulqader, EA 2009. Marine reptiles. In: *The Marine Atlas of Bahrain*. Manama: Bahrain Center for Study and Research, Loughland, RA and Zainal, A (eds).

Mendonça, VM, Al Saady, S, Kiyumi, AA and Erzini, K 2010. Interactions between Green Turtles (*Chelonia mydas*) and foxes (*Vulpes vulpes arabica*, *V. rueppellii sabaea*, and *V. cana*) on turtle nesting grounds in the northwestern Indian Ocean: Impacts of the fox community on the behavior of nesting sea turtles at the Ras Al Hadd Turtle Reserve, Oman. *Zoological Studies* 49(4): 437-452.

MoEW 2012. *Wildlife and Marine Conservation Eefforts in the United Arab Emirates*. Abu Dhabi, Ministry of Environment and Water. 101 pp.

Pilcher, NJ 1999. Cement dust pollution as a cause of sea turtle hatchling mortality at Ras Baridi, Saudi Arabia. *Marine Pollution Bulletin* 38: 966-969.

Pilcher, NJ, Perry, L, Antonopoulou, M, Abdel-Moati, MA, Al Abdessalaam, TZ, Albeldawi, M, Al Ansi, M, Al-Mohannadi, SF, Baldwin, R, Chikhi, A, Das, HS, Hamza, S, Kerr, OJ, Al Kiyumi, A, Mobaraki, A, Al Suwaidi, HS, Al Suweidi, AS, Sawaf, M, Tourenq, C, Williams, J and Willson, A 2014a. Short-term behavioural responses to thermal stress by hawksbill turtles in the Arabian region. *Journal of Experimental Marine Biology and Ecology* 457: 190-198.

Pilcher, NJ, Antonopoulou, M, Perry, L, Abdel-Moati, MA, Al Abdessalaam, TZ, Albeldawi, M, Al Ansi, M, Al-Mohannadi, SF, Al Zahlawi, N, Baldwin, R, Chikhi, A, Das, HS, Hamza, S. Kerr, OJ, Al Kiyumi, A, Mobaraki, A, Al Suwaidi, HS, Al Suweidi, AS, Sawaf, M, Tourenq, C, Williams, J and Willson, A 2014b. Identification of Important Sea Turtle Areas (ITAs) for hawksbill turtles in the Arabian Region. *Journal of Experimental Marine Biology and Ecology* 460: 89-99.

Pilcher, NJ, Al-Maslamani, I, Williams, J, Gasang, R, Chikhi, A 2015. Population structure of marine turtles in coastal waters of Qatar. *Endangered Species Research* 28: 163-174.

Rees, AF and Baker, SL 2006. Hawksbill and Olive Ridley nesting on Masirah Island, Sultanate of Oman: an update. *Marine Turtle Newsletter* 113: 2-5.

Rees, AF, Hafez, AA, Lloyd, JR, Papathansopoulou, N and Godley, BJ(2013. Green turtles, *Chelonia mydas,* in Kuwait: nesting and movements. *Chelonian Conservation and Biology* 12(1): 157-163.

Ross, JP and Barwani, MA 1995. Review of sea turtles in the Arabian area. Pp. 373-383. In: *Biology and Conservation of Sea Turtles,* Bjorndahl, KA (ed). Washington, DC, Smithsonian Institute Press.

Stanton, DB 2008. Ras Sharma is unprotected. *Wildlife Middle East News* 3(2): 7

Tayab, MR and Quiton, P 2003. Marine Turtle Conservation Initiatives at Ras Laffan Industrial City, Qatar (Arabian Gulf). *Marine Turtle Newsletter* 99: 14-15.

Tollab, MA, Dakhteh, MH, Zaferani, GG, Hesni, MA, Ahmadi, F, Langari, MS, Alavian, Z and Rezaie-Atagholipour, M 2015. The Olive Ridley Turtle, *Lepidochelys olivacea*, in the Persian Gulf: A review of the observations, including the first nesting of the species in the area. *Chelonian Conservation and Biology* 14(2): 192-196. doi: http://dx.doi.org/10.2744/CCB-1148.1

Tucker, AD, Baldwin, R, Willson, A, Al-Kiyumi, A, Schroeder, B, Possardt, . and Witherington, B (2013). Preliminary estimates for loggerhead clutch frequency from Masirah, Oman derived from satellite tracking. In: *Proceedings of the 33rd Annual Symposium on Sea Turtle Biology and Conservation*, Tucker, T, Belskis, L, Panagopoulou, A, Rees, Frick, M, Williams, K, Leroux, R and Stewart, K (eds),. NOAA Tech. Mem NMFS-SEFSC-645: 243.

Wallace, BP, DiMatteo, AD, Bolten, AB, Chaloupka, MY, Hutchinson, BJ, Abreu-Grobois, FA, Mortimer, JA, Seminoff, JA, Amorocho, D, Bjorndal, KA, Bourjea, J, Bowen, BW, Briseño-Dueñas, R, Casale, P, Choudhury, BC, Costa, A, Dutton, PH, Fallabrino, A, Finkbeiner, EM, Girard, A, Girondot, M, Hamann, M, Hurley, BJ, López-Mendilaharsu, M, Marcovaldi, MA, Musick, JA, Nel, R, Pilcher, NJ, Troëng, S, Witherington, B and Mast, RB 2011. Global conservation priorities for marine turtles. *PLoS ONE* 6(9): e24510. doi:10.1371/journal.pone.0024510.

Wallace, BP, DiMatteo, AD, Hurley, BJ, Finkbeiner, EM, Bolten, AB, Chaloupka, MY, Hutchinson, BJ, Abreu-Grobois, FA, Amorocho, D, Bjorndal, KA, Bourjea, J, Bowen, BW, Briseño-Dueñas, R, Casale, P, Choudhury, BC, Costa, A, Dutton, PH, Fallabrino, A, Girard, A, Girondot, M, Godfrey, MH, Hamann, M, López-Mendilaharsu, M, Marcovaldi, MA, Mortimer, J.A, Musick, JA, Nel, R, Pilcher, NJ, Seminoff, JA, Troëng, S, Witherington, B and Mast, RB 2010. Regional Management Units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. *PLoS ONE* 5(12): e15465. doi/10.1371/journal.pone.0015465.

Appendix 1. Status and Conservation of Sea Turtles in the Arabian Peninsula workshop: CMS IOSEA Conservation Management Plan Objectives and Sub-regional Plan

Objectives

1. Reduce mortality
2. Protect habitats
3. Improve understanding
4. Increase awareness
5. Regional/International cooperation
6. Promote implementation

IOSEA sub-regional plan

How do we manage to promote implementation?

1. Integrate with existing programs (IOSEA, ROPME, PERSGA etc.)
2. Identify coordinator/steering committee/coordinating agency
3. E.g. getting an existing organisation to coordinate (like IOSEA)
4. Promote regional cooperation
5. Exchange experience/good practice programs
6. Ensure adequate capacity
7. Logistics
8. Personnel
9. Training
10. Publish
11. Develop MOU
12. Obtain funding
13. Private sector (oil/gas, tourism, industry etc.)
14. Philanthropy
15. Multi-lateral donors (world bank, GEF
16. Government agencies – regional (EDA, APAA etc.)
17. Foundations
18. MAVA
19. MBZ – Sheikh Mohammed bin Zayed Species Fund (for small projects)
20. INGOs – international NGO
21. WWF
22. International governments

23. USFWS
24. Embassies
25. Universities and research institutions
26. KACST, KISR

Appendix 2. Main sea turtle breeding sites in the Arabian Peninsula

Site	Species	Number	Status
Bahrain			
Hawar Island		?	Protected area
Kuwait			
Qarouh Island	Hawksbill	?	
	Green	?	
Umm al Marddin Island	Hawksbill	?	
	Green	?	
Oman			
Al Dimaniyat Islands	Hawksbill	?	Nature reserve
	Green	?	
Ras Al Hadd-Ras Al Janz	Green	c. 5,000	
Masirah Island	Hawksbill	?	
	Green	?	
	Olive Ridley	?	
	Loggerhead	30,000 in 1996	
Al Hillaniyat islands	Hawksbill	?	
	Green	?	
	Olive Ridley	?	
Duqm			Breeding unconfirmed
Qatar			
Fuwairit	Hawksbill	100-200	
Ras Laffan	Hawksbill		
Halul	Hawksbill		
Saudi Arabia			
Farasan Islands	Hawksbill	?	Protected Area
	Green	?	
Ras Baridi	Green	c. 600	
Jana island	Hawksbill	c. 500	
Karan Island	Green	c. 2,000	

Site	Species	Number	Status
Al Wajah Bank		?	About 20 scattered sites
UAE			
Arzanah (Abu Dhabi)	Hawksbill	20	Petroleum company
Jarnain Island	Hawksbill	50	Private
Zirkoh Island	Hawksbill	70	Petroleum company
Dina Island	Hawksbill	40	Military base
Bu Tinah	Hawksbill	40	Marine Biosphere Reserve
Sir Bani Yas	Hawksbill	46	
Saadiyat Island	Hawksbill	?	Tourist development
Jebel Ali Sanctuary (Dubai)	Hawksbill	35	PA
Sir Bu Nair (Sharjah)	Hawksbill	300-350	Under military control
	Green	2	
Khor Kalba (Sharjah)	Green	1	PA
Dibba (Fujairah)	Green	1	
Yemen			
Ras Imran/Azizi Island	?	?	
Sharma	Green, Hawksbill	25,536 (2014)	
Jethmoun	Green, Hawksbill	26,406 (2014)	
Dargham	Green, Hawksbill	479 (2014)	
Al Fatk	Green, Hawksbill		
Ad-Damar beach	Green, Hawksbill		
Socotra	Loggerhead	239 (2006), (2012)	

Herbivore Health Care

Introduction

A panel of experts was present during the veterinary workshop to address a number of issues important to herbivore health care. The panel of lecturers consisted of Prof Moritz van Vuuren, Drs June Williams and Gerhard Steenkamp (from the University of Pretoria's Veterinary Faculty), Dr Jane Budd (Breeding Centre for Endangered Arabian Wildlife) and Dr Anne-Lise Chaber (Wildlife Consultant LLC). Mr Meyer de Kock (Tahr working group) and Mr Yassir Al Kharusi (Environment Agency Abu Dhabi) also presented disease status overviews for the Arabian oryx and Arabian tahr.

The focus of this workshop was to equip the attendees with a good understanding of:

1. What a notifiable disease is;
2. How to recognise common notifiable diseases of herbivores; and
3. How the control of these diseases helps a country or region protect not only the production animals so many depend on, but also the spill over at the wildlife human interface.

Controlled diseases, programmes and legislation

The Office International des Epizooties (World Organisation for Animal Health) (OIE) was established in 1924 with the objective of fostering cooperation among member countries to improve control of serious transboundary animal diseases, specifically Rinderpest. Until 2005 the focus on transboundary diseases was emphasised by the composition and definition of List A, which consisted of transboundary diseases defined as 'those epidemic diseases which are highly contagious or transmissible and have the potential for very rapid spread, irrespective of international borders, causing serious socio-economic and possibly public health consequences' and required immediate notification to the OIE. List B consisted of diseases considered important at the national rather than international level and not requiring immediate notification.

During the last decades of the 20th century various disease events occurred that revealed a need to change the approach in order to include a wider spectrum of diseases among those requiring immediate notification to the world body. In particular, the emergence of Bovine Spongiform Encephalopathy (BSE, 'mad cow disease'), which did not fit the definition in terms of being highly contagious or transmissible, yet had serious socio-economic and public health consequences and the potential for transboundary spread, influenced the change from the former Lists A and B to a single list of diseases. These diseases should be reported twice annually to the OIE by all countries where they occur, with immediate notification restricted to occurrence or recurrence in countries where they are not endemically present.

In summary, animal diseases should be controlled for the following reasons:

1. It constrains livestock production and food security;
2. It can have serious trade implications; and
3. It can be a human health threat.

It is important to understand the international nomenclature of controlled diseases and an abbreviated definitions list follows:

Notifiable disease (high impact diseases)

1. High impact diseases are diseases that can have a significant negative effect on the lives of humans and animals;
2. They must be reported by member countries to the OIE;
3. In the international context these diseases are referred to as notifiable or listed diseases. The list of notifiable diseases is regularly revised by experts and updates approved at the annual General Assembly, based on formal adoption by governments (Article 5); and
4. The list of notifiable diseases includes >100 terrestrial and aquatic animal diseases.

Controlled animal disease

A controlled animal disease is a disease controlled by a given country (State) because the disease:

1. Is difficult to control by individuals /farmers/NGOs;
2. Can pose a public health risk for humans;
3. Is highly contagious and can thus spread rapidly;
4. Is a threat to the agricultural industry;
5. Needs extensive financial and human resources to control it; and
6. Is important for trade or export reasons (e.g. surveillance should be done to prove freedom of disease).

Emerging diseases (infections)

Emerging diseases are those that are newly[1] appearing in a population (Morens et. al., 2004).

Re-emerging diseases (infections)

Re-emerging diseases are those that have previously occurred in a population but are now increasing in incidence, host range or distribution (Morens et. al., 2004)

[1] New diseases are not necessarily infections; multi-cellular parasites, toxic agents or other biologically active substances that animals may encounter in the environment may also cause them.

During the discussions it was quite clear from the participants of the various countries that there is no consistency in disease reporting in the Middle East region: the general opinion amongst participants was that there is no clear, structured reporting system, supporting the findings of Shimshony et. al. (2006).

The most recent list of notifiable disease of the UAE was made available to participants to be used as a guideline. This was published in October 2013 and is presented in Table 8.

Table 8. Notifiable diseases for the UAE – as published October 2013

Disease	Causative Organism
African Horse Sickness	Orbivirus
Dourine	Trypanosoma (Trypanozoon) equiperdum
Glanders	Burkholderia mallei
Equine Encephalomyelitis	Alphavirus
Equine Viral Arteritis	Arterivirus
Equine Infectious Anaemia	Lentivirus
Contagious Equine Metritis	Taylorella equigenitalis
Equine Influenza	*Influenza A virus* subtypes H7N7 (formerly equi -1) and H3N8 (formerly equi-2)
Equine Rhinopneumonitis	Equid herpesvirus-1 and-4 (EHV-1 and EHV-4)
Japanese Encephalitis	Flavivirus
Surra	Trypanosoma evansi
West Nile Fever	Flavivirus
Vesicular Stomatitis	Vesiculovirus
Leptospirosis	Leptospira sp.
Johne's Disease (Paratuberculosis)	Mycobacterium avium ssp. paratuberculosis
Rabies	Lyssavirus
Anthrax	Bacillis anthracis
Foot and Mouth Disease	Aphthovirus
Lumpy Skin Disease	Ortho- or Capripoxvirus
Blue Tongue	Orbivirus
Bovine Spongiform Encephalopathy	Prions
Contagious Pleuropneumonia	*Mycoplasma mycoides* ssp. *mycoides* small collony type (SC)

Rinderpest	Morbillivirus
Pestes de Petits Ruminants	Morbillivirus
Rift Valley Fever	Phlebovirus
Brucellosis	Brucella spp.
Sheep and Goat Pox	Capripox viruses
Tuberculosis	Mycobacterium spp.
Scrapie	Prions
Screwworm	Cochliomyia hominivorax (Blow Flies)
Newcastle Disease	Avian paramyxovirus type 1 APMV-1
Avian Influenza	Avian Influenza virus
Infectious Laryngotracheitis	Gallid Herpesvirus 1 an alphaherpesvirus
Fowl Cholera	Pasteurella multocida ssp.
Fowl Typhoid	Salmonella enterica ssp. enterica serovar Gallinarum biovar pullorum (Salmonella pullorum)
Leishmaniasis in canines	Leishmania spp.
Q-Fever	Coxiella burnetii
Camel Pox	Orthopoxvirus

Further to this document, attendees were also introduced to the OIE World Animal Health Information System (WAHIS), which is a tremendous resource and can be accessed at http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/diseasehome

It is accepted that veterinary services in individual countries do not control notifiable diseases in the same manner as controlled diseases for the following reasons:

- Some diseases can be managed by individual farmers but may be threatening to emerge or re-emerge.
- Veterinary Services therefore wants to keep a finger on the pulse of these diseases in the event that state control may become necessary.
- Some contagious or vector-borne diseases may represent a significant threat if it is given a chance to spread – emerging and re-emerging diseases.

The implementation of a regional, national or provincial control program in order to control an outbreak of controlled diseases is imperative. Some general principles for such a program would include:

- The land on which the controlled disease occurs is placed under quarantine – thus restricting movement of animals and spreading of disease.
- Confirm diagnosis – to make sure that the outbreak is due to the suspected disease.

- Determine origin of the disease – to apply control at origin.
- Determine possible spread of disease – to apply control measures at destination.
- Announcement of the disease to the local community – farmers can take necessary steps to prevent spread to their land.
- Declare a controlled area – to apply control measures in specified area.
- Cordons and roadblocks – to prevent spread, control movement of animals and 'sometimes humans' (e.g. foot and mouth disease) as well as e.g. cloven-hoofed products (FMD), deter illegal movement.
- Apply treatment – control disease, prevent spread of disease, prevent severe losses of stock (e.g. vaccination, dipping etc.).
- Disinfection – to kill organism.
- Regular inspection in infected area – to determine spread as soon as possible.
- Lifting of quarantine – normal movement of stock allowed.

The drivers of emerging and re-emerging diseases (ERIs)

New infectious diseases of humans and animals are on the increase globally for a number of direct and indirect reasons. Obvious/direct/true drivers include illegal trade in animals or animal products. Less direct/indirect drivers' includes climate change and rural development policies, e.g. poverty relief.

There is not always a clear differentiation between true drivers of ERIs and situations that contribute indirectly to their occurrence. However, it is accepted that most ERIs are anthropogenic and the following six factors are important:

1. Human demographics and behavior.
2. Technology and industry.
3. Economic development and land use

4. International travel and commerce
5. Breakdown of public health measures
6. Microbial adaptation and change

Urbanisation of the world's population increases the exposure of humans and animals at the human/animal (wildlife or production animals) interface as this leads to intensified farming practices, particularly pigs and poultry, in response to the demand for protein as a food source – the so called 'urban agriculture'.

These intensified farming practices within urban areas leads to frequent occurrences of local epidemics of New Castle Disease (NCD) and African Swine Fever in Africa; and NCD, Avian Influenza and Classical Swine Fever in Asia. The large amount of waste products generated by these farming operations also increases the amount of 'infective material' present.

Currently, *large-scale human migration* is one of the big drivers behind the bush-meat trade, which is estimated at US$1 billion annually (2013 Jane Goodal Institute). Bush-meat as a vector for introducing ERIs into destination countries cannot be overemphasised (Chaber et. al., 2010).

Rural development plans, including damming of water and irrigation of farms, may also lead to increased abundance of vectors such as mosquitos, which in turn can introduce ERIs to an area. The re-emergence of Rift Valley Fever on the African continent is testament to that. Together with climate change, suitable habitat can be inadvertently created for the *Culicoides* midges – the vectors for Bluetongue Virus.

Rural development policies should be well thought through, including assessing the cost to the environment, before they are agreed to and implemented. Unintended consequences such as atmospheric or ground water pollution from mining activities or agricultural waste can have detrimental consequences for the inhabitants of these waterways (e.g. the pansteatitis (Yellow Fat Disease) deaths of Nile crocodiles in the Olifants river gorge in South Africa as a result of accumulated toxins released into the river from nearby mining activity).

Trade in live animals poses the greatest risk for introducing ERIs into a new area. This may also be true if animals are exported to countries where the diseases do not occur but suitable vectors do.

The Smallenburg virus that has been identified in 2011, a member of the family *Bunyaviridae*, serves as a warning of how well viruses adapt and change to new conditions. Similarly, the rapid replication of viruses (as in the case of Human Immunodeficiency Virus) is a warning of how quickly viruses can spread throughout a population. It stands to reason that preventing the incidence of ERIs in a region/country is better than eradication, which may be very costly and/or ineffective.

Biosecurity

Biosecurity serves as a first line of defense against the importation of an ERI into a region/country/province/farm. The benefits of biosecurity should never be overlooked and at a farm level it:

- Protects your neighbours and the countryside.
- Keeps new diseases out.
- Reduces the spread of disease.
- Keeps more animals healthy.
- Cuts costs of disease prevention and treatment.
- Improves farm efficiency.

There are 3 main components to biosecurity:

1. The *conceptual component* of biosecurity. The risk of infection determines the extent to which procedures relating to biosecurity will be implemented (risk management). Assessing the risk will necessitate consideration of factors such as prevalence of infection; frequency of clinical outbreaks of disease; herd or flock immunity; population density; presence of reservoir populations (vectors); and the movement of animals, their products and people into and within an area.

   The conceptual component of biosecurity entails the use of conceptual skills such as situation analysis, planning, problem solving, risk management and decision-making.

2. *Structural components* of biosecurity (e.g. buildings, fences and natural barriers)
3. Farm layout – keep farm access routes, parking areas, yards, feeding and storage areas clean and tidy.
4. Security fencing – prevent contact with neighbour's livestock (e.g. maintain fences).
5. Design of stables, parlours, farrowing pens, poultry houses – keep isolation buildings as near as possible to the farm entrance and separate from other livestock buildings by at least 3 metres.
6. Provide shower facilities.
7. Water supply – fence off streams and rivers; supply clean, fresh water in troughs.
8. *Procedural component*. The extent to which biosecurity is implemented (risk management) in a production system is limited by motivation of management, availability of funds, personal and physical resources.

Assessing the Disease Risk Posed by Visitors

Although diseases are most commonly introduced into a herd by the addition of animals, there is a risk of disease introduction by people traveling between groups of animals. This risk may vary considerably and is influenced by the specific disease agent, the extent of the animal contact, the time elapsed since the last animal contact, and the preventive measures used.

Low-risk visitors include those from urban areas or those who have had no livestock contact. Although these visitors present very little risk of introducing disease to the farm, some precautions can be taken, including:

- Asking visitors to wear freshly laundered outerwear and clean footwear. You may wish to provide them with disposable plastic boots (or clean rubber boots which remain at the farm) and coveralls as an added precaution. This not only reduces the disease risk for your animals but also helps prevent guests from contaminating their clothing with germs from your farm.
- Not relying heavily on disinfectant-filled boot baths. Research has shown the use of boot baths to be an unreliable method of routine disinfection, unless boots are thoroughly scrubbed before immersion and adequate contact time in the disinfectant is permitted usually at least five-minutes contact time is required.
- Not allowing visitors to enter pens, walk through feed alleys, or touch animals unless necessary.
- Not allowing visitors to bring food articles with them onto the farm.
- Providing a plastic bag for collection of disposable boots and asking guests to wash their hands (and boots, if worn) before leaving.

Moderate risk visitors include those people who routinely visit farms, but who have little or no actual contact with animals. Salesmen, feed and fuel delivery drivers, and maintenance workers are examples of this group. They should be expected to observe the same precautions as stated earlier and in addition:

- They should wear clean coveralls and boots if there is any contact with feed, animals, soil, or manure.
- Any sampling equipment should be properly cleaned and disinfected between uses.
- Dirty boots should be cleaned and disinfected, and coveralls should be removed and placed in a clean plastic bag or container before re-entering the vehicle.

High-risk visitors are those people who come into direct contact with livestock in their work and would include: inseminators; processing crews; veterinarians; livestock haulers; and livestock-owning neighbours. These people typically have direct contact with animals and their bodily discharges. In addition to the precautions listed earlier, other recommendations include:

- Vehicles should be clean and free of visible manure on the tires and wheel wells and should be kept away from animal areas and driveways used by the farm's own vehicles. In an emergency disease situation, e.g. the presence of foot-and-mouth disease (FMD), restrictions on access to the farm should be in place and disinfection of vehicles should be considered even if not mandated. Vehicle interiors should be clean and easily cleanable. Livestock trucks and trailers should be clean and dry, and preferably disinfected, before arrival on the farm.

- Visitors should arrive with clean clothing, boots, and equipment. Equipment and instruments that have direct animal contact (dehorners, castration equipment, halters, etc.) should be cleaned and disinfected (or sterilised) after use and maintained in such a way that they do not become re-contaminated.
- Disposable sleeves/gloves, other disposable clothing, or clothing that can be disinfected should be worn whenever there is the possibility of direct contact with bodily discharges or animal tissues.
- Before leaving the farm, dirty equipment and footwear must be cleaned and disinfected with an appropriate chemical agent. Soiled coveralls should be removed before re-entering the vehicle. Potentially contaminated hands and forearms should be washed with soap and water.
- Farm employees who have livestock at their own home should be required to report to work personally clean and in clean clothes that have not been exposed to their own livestock. They could provide their own clean coveralls and disinfected boots, or it may be easier to supply employees with outerwear and boots that are left at the farm when the employee returns home.

Surveillance

An important aspect of biosecurity is the continual surveillance of a population/farm/country or region for the presence or absence of specific diseases. At its core, "surveillance is aimed at demonstrating the absence of disease/infection, determining the occurrence or distribution of disease/infection, while also detecting as early as possible exotic or emerging diseases " (Martin et. al., 2013).

The responsibility for disease surveillance generally rests with the veterinary regulatory authorities of a given country and can be done in several ways:

1. Passive surveillance

   Usually done by veterinarians, animal health technicians or livestock/wildlife owners through reporting animal diseases mandated through regional or national reporting requirements, legislation or requests

   The downside of passive surveillance is *under-reporting*, as a result of too few state veterinarians, a lack of motivation and a lack of skills.

2. Active surveillance

   The users of the data are actively involved in generating the data. The users of the information design the activity.

   Both the nature and the quality of the data are adequate to meet the users' surveillance requirements.

In general, surveillance is only one component of the process to assess risk in a population/farm/country or region. General guidelines of the process that should be followed once a risk has been assessed (surveillance done) include:

- General surveillance (routine or passive surveillance)

- Targeted surveillance (active or risk-based surveillance)
- Sampling
- Diagnostics
- Reporting and response
- Risk communication

Once this process has finished and if a risk has been identified, it needs to be reported. What is reported depends on the disease as well as the country where it occurs. It could be notifiable disease on a country level, regional level or globally. The following flow diagram (Figure 32) is an example of how reporting on a country level in South Africa would work.

Figure 32. Information flow in the reporting of a notifiable disease in South Africa

Farmer /Owner

⇓

Private or State Veterinarian

⇓

State Veterinarian

⇓

Provincial Director of Veterinary Services

⇓

National Director of Veterinary Services

⇓

Information Collated (database), Interpreted and Compiled

⇓

Reports sent Nationally and Internationally

Local reporting within the country is important for a variety of reasons:

- Governments usually take the lead in control (by means of animal diseases legislation) and disease investigations.
- Spread prevention (vaccination, movement control, etc.).
- Eradication of diseases where possible.
- Protection of surrounding livestock.

The only time there is deviation from this reporting flow diagram is in a case of emergency. This would arise when there is:

- An outbreak or suspected outbreak or an ERI.
- Any new or previously eradicated disease.
- Abnormal outbreaks of high impact diseases (in a South African context), e.g. AHS, anthrax, Newcastle disease.

In the event of the aforementioned emergency, reporting is directly to the National Director of Veterinary Services, which will then assess and report to local and state veterinarians as well as the local or national media.

Once this process has been completed it is the responsibility of a country's National Veterinary Services to report on behalf of the whole country to:

1. OIE
2. Regional organisations
3. International trade partners
4. Provincial veterinary services and state veterinarians
5. National media

International disease reporting is governed by the OIE and is necessary for the following reasons:

- Member countries of the OIE are obliged to report certain diseases to this organisation (Article 4, OIE Organic Statutes).
- Lead to the implementation of the World Animal Health Information System (WAHIS). The WAHIS allows all Members to be on line electronically with a server located in OIE headquarters.
- To maintain international credibility for trade in animals and animal products.
- To identify areas free of diseases (possible free zones for exports).

As the reporting of notifiable diseases may have important consequences for a farm/country/region every effort should be made to make the correct diagnosis before reporting commences. Collection of the correct specimens/samples ante mortem as well as post mortem is essential. Once the samples have been collected the correct transport or fixation medium should be used in order to assure an optimal sample arriving at the laboratory.

The latter was identified by attendees at the workshop as problematic in the region as there are few laboratories that can give the required diagnostic support to veterinarians. Consequently, veterinarians need to send samples to foreign countries for diagnosis which can be expensive as well as cumbersome trying to obtain all the necessary permits to ship potentially contagious material internationally.

To this end, several lectures and interactive practical demonstrations focused on the systematic post mortem analysis of a dead herbivore as well as the various samples that can be collected.

In order to detect the causative agent in viral infections, the following diagnostic approaches can be used:

1. Microscopic techniques

- Antigen detection – fluorescent antibody tests e.g. Rabies.
- Histopathological investigation – looking for inclusion bodies, evaluating tissue pathology patterns and inflammatory response patterns or the lack thereof etc.
- Electron microscopy – visualising the actual virus.

2. Viral isolation

- Diseases of unknown aetiology.
    - Focus on untreated, acutely ill animals.
    - Try to include 10% of the animals in the group where practical.
    - Focus on animals that died very recently.
    - Collect from the edge of lesions.
    - Choose tissues associated with the clinical signs.
    - Collect samples aseptically.
    - Put individual samples in separate containers.
    - Virus sample transportation.
        - Main function is to prevent desiccation.
        - Selection of specialised transport media depends on the suspected organism.
        - Conventional transport media.
            - Eagle's MEM, 10% foetal calf serum, antibiotics.
            - Normal saline.
            - Ringer Lactate.
        - Transport medium for Bovine Respiratory Syncytial Virus (BRSV).
            - 45% sucrose, 10% horse serum, 75µg/ml gentamicin, 30µg/ml fungizone.
- Diseases caused by viruses with multiple serotypes.
- Diseases with similar clinical signs.
- Controlled diseases.
- Exotic diseases.
- Virus sample transportation.

3. Serological investigation - detection of antibodies in serum, but in practice antibodies can be detected in various body fluids such as:

- Cerebrospinal fluid.
- Effusions/ascitic fluid.
- Saliva.
- Milk.

- Mucus secretions.

In addition, blood can be collected, ideally during the viraemic phase, and stored in the following tubes for diagnostic evaluations:

- Brick-red top tubes (no preservatives).
    - Serology.
    - Viral isolation.
- Green top tubes (heparin).
    - Viral isolation.
    - PCR.
    - Bacterial isolation.
- Purple top tubes (EDTA).
    - Bacterial isolation.
    - PCR.

4. Molecular virological techniques

- Polymerase Chain Reaction (PCR).
    - It targets a single fragment of DNA, typically 100 to several thousand base-pairs long.
    - Amplifies the fragment by repetitive cycles of DNA synthesis.
    - It must be evaluated against the epidemiology of the disease, e.g. distribution, hosts/reservoirs (possible persistent infection) and transmission.
    - Does a positive PCR result in an animal with clinical signs or lesions necessarily prove a cause-effect relationship?
    - The rapidity and sensitivity of PCR make the technique attractive.

Serologically testing a single sample of an animal is very restrictive. Since antibodies in the serum may only show exposure it needs to be evaluated in conjunction with all clinical parameters of the animal. Clinicians should keep in mind which antibody is tested for (IgG or IgM) as this may be indicative of how long the animal has been exposed to the pathogen. Furthermore, paired samples take a few days/weeks apart should be tested to see if seroconversion takes place. The latter is important in the pathogenesis of many virus infections and is not possible to diagnose on single samples.

The presence of notifiable diseases identified in wild hoof stock of the Arabian Peninsula was highlighted during recent surveys. For each disease the species affected as well as the samples taken and how it was confirmed is listed in

Table 9.

Table 9. Summary of the notifiable diseases discussed during the Workshop.

Disease	Samples	Tests

Tuberculosis	Exudates, discharges lymph node biopsies lungs, other tissues exhibiting granulomas or abscesses Fresh for culture or PCR Fixed for histopathology	Tuberculin skin test In vitro gamma interferon assay Histopathology Culture PCR STAT-PACK ELISA Fluorescent polarisation assay
Q Fever		
Brucella [2*,#,+,**]	Foetal stomach content Metacarpal fluid	Rose Bengal Test ELISA Culture/Isolation
Contagious Caprine Pleuropneumonia CCPP		
FMD – Foot and mouth disease	Heart muscle Pieces of freshly ruptured epithelium using scissors and put in a buffer Probang/Sputum cup in buffer	
Lumpy skin disease		Virus isolation PCR Serology Immunohistochemistry
MCF – Malignant catarrhal fever		Polymerase chain reaction Histopathological examination Serology Virus isolation

[2] Mohammed MA, Shigidy MT & Al Juboori AY 2013. Sero-Prevalence and Epidemiology of Brucellosis in Camels, Sheep and Goats in Abu Dhabi Emirate. *International Journal of Animal and Veterinary Advances* 5(2): 82-86.

Mollah MWA & McKinney PA 2002. Brucellosis and suspected paratuberculosis in a Nubian Ibex (*Capra ibex nubiana*) - a case report In: *Proc. World Ass. of Wildlife Veterinarians*, Wildlife Sessions at the 27th World Veterinary Congress, Tunisia, 19-21.

+ Worsley B, Goodwin S, Jahans K & Atallah C 1996. First Report of a Strain of *Brucella melitensis* that was Widely Sensitive to Brucellaphages Isolated in the United Arab Emirates. *Clinical Infectious Diseases*.22: 190-1

** Al-Awadhi FAM, Al-Shehhi HAM & Nowotny N 2004. Human Brucellosis in the United Arab Emirates. 2nd GCC Medical Students Conference Faculty of Medicine & Health Sciences, United Arab Emirates University.

In order to protect certain populations against ERIs, vaccination protocols have been developed using vaccines developed for use in domestic species. The protocol of the Breeding Centre for Endangered Arabian Wildlife is outlined in Table 10.

Table 10. Vaccination protocol followed at the Breeding Centre for Endangered Arabian Wildlife. This protocol is regularly reviewed and reassessed for relevance with regard to known disease outbreaks and new information released through research/publications.

Species	Disease	Interval	Vaccine	Comments
Arabian oryx Arabian mountain gazelle Sand gazelle Nubian ibex Arabian tahr	Foot and mouth disease (FMD)	Annual	Locally available vaccines, Merieux is reliable but not readily available in the region.	Vaccine interval should be bi-annual however extreme environmental temperatures in the region mean that handling events are confined to the cooler winter months.
	Pests des Petits Ruminants (PPR)	Every 1-3 years	Locally available brands	Vaccination interval in domestic animals is reported as every 3 years, efficacy in exotic ruminants is unknown.
	Chlostridia/Pasteurella	Annual	Multivalent, up to 8 strains available	Important to boost annually. Administer at the start of the cool season before risk of infection is high
	Sheep/goat Pox	Annual		Not currently used at BCEAW but of value to consider in high risk areas that have close or possible contact with sheep/goats

Primary Health Care

An ounce of prevention is worth a pound of cure. Primary health care comprises those management practices undertaken on a daily basis to maintain health and production, and includes observation, examination and reporting/recording findings. Today, antibiotic resistance is prevalent and becoming more so, thus preventing bacterial infection is essential. This is particularly true in non-domestic animals that hide disease well (disease is often already advanced when noticed) and require general anaesthesia for clinical examination.

Primary health care requires a holistic approach to health care, encompassing health and welfare; nutrition; hygiene; vaccination; and parasite management.

1. Health and welfare

It is well known that stress results in immune suppressing corticosteroids circulating in the system. Chronic suppression of the immune system results in weakened/compromised ability of the body to respond appropriately to disease and infection. Ensuring optimum health and welfare standards in any type of animal collection will therefore assist in reducing disease states due to stress related immunosuppression. There are five basic needs that all living beings require and that are our duty of care to provide, namely:

- Access to a suitable diet and fresh water;
- Provision of a suitable environment offering shelter and safety;
- Conditions that allow the ability to exhibit normal behaviours; and
- Protection from pain, suffering, injury and disease and freedom from fear and distress.

It is important to know the needs and natural behaviours of each species to be able to provide targeted enrichment that encourages the expression of natural behaviours. Enrichment has multiples or functions, with many beneficial outcomes that reduce stress in general by reducing stereotypies, increasing foraging times, reducing aggression and improving behavioural diversity.

2. Nutrition

Optimum nutrition is essential to good health. It is important to understand the natural feeding ecology of each species to be able to meet their nutritional needs. Poor diet leads to ill thrift, disease and poor breeding performance. However, duplicating the natural diet in a captive situation can be challenging due to lack of ingredient supply, paucity of species-specific knowledge etc. Captive diets for hoof stock commonly lack fibre/roughage that is essential in these browsing/grazing species. Pelleted feeds are convenient and usually meet the predicted nutritional requirements but they do not meet rumination requirements, as they are low in fibre and higher in start than natural forage/browse. Providing appropriate plant fibre in the diet of a ruminant results in improved GI tract health, dietary diversity and encourages foraging behaviours.

3. Good Hygiene

Good hygiene prevents the spread of disease through regular waste removal, and includes disinfection of feeding/cleaning utensils and areas, sensible food management (fresh), and sensible use of disinfectants.

4. Vaccination

Vaccination is a centuries old technique that builds on the ability of the body to develop resistance to some pathogens following exposure to that pathogen. Vaccination is a durable and cost effective method of combatting contagious bacterial and viral infections by reducing the severity of clinical

disease resulting from infection, and reducing the amount of pathogen shed into the environment. Vaccination has the potential to confer herd immunity to a pathogen and even eliminate a pathogen if transmission is sufficiently reduced. Vaccination should be approached with care in wildlife species as the vaccines are developed for domestic species and may therefore have variable responses in wild species. The duration and/or efficacy of the vaccine may be reduced but equally, vaccines may cause disease in susceptible species if not judiciously used.

Generally, the use of killed or inactivated vaccines is advocated in wildlife species to avoid causing disease due to residual virulence in the vaccine or negatively suppressing the immune system. The vaccination event should be scheduled with care to confer adequate protection over the period of highest risk. However the use of killed or inactivated vaccines can result in shorter duration immune responses in the animals and lower efficacy in preventing viral entry. Vaccination should only be administered to healthy animals, with consideration to maternal antibody interference. During viral disease outbreaks, all susceptible animals should be vaccinated regardless of the date of their last vaccine. Common diseases that are vaccinated against in the region include foot and Mouth Disease (FMD), Pestes des Petits Ruminants (PPR), Contagious Caprine Pleuropneumonia (CCPP), Sheep and Goat Pox and Clostridia/Pasteurella strains.

Endo and ectoparasites were briefly discussed, with particular focus on the importance of preventative and management protocols to reduce the impact of disease and stress caused by these organisms. Awareness of the importance of regular faecal screening was discussed. Parasite management is closely linked with good animal management practices. Careful consideration of factors such as stocking density, stress factors, nutrition, hygiene (and waste removal) and zoonoses will all assist in reducing the harmful effects of parasites.

Chemical Immobilisation

The basic principles of chemical immobilisation in hoof stock was presented and actively discussed by participants. Hoof stock are one of the main groups of animals classically associated with capture and translocation. Historically, safe anaesthesia in this group has been one of the veterinarians' most difficult challenges.

The general principles of anaesthesia apply, whatever the species. It is important to note: there are no safe anaesthetics; only safe anaesthetists and their teams. Safe anaesthesia is all about preventing problems. Most anaesthetic complications can be avoided with careful preparation, assessment and planning and doing the basics well.

In hoof stock, there are several anatomical considerations to remember when planning anaesthesia:

1. The larynx is deep and difficult to visualise;
2. Excessive laryngeal stimulation can stimulate regurgitation; and
3. Some species (bovidae in particular) have a flat diaphragm, which results in decreased ventilator efficiency.

Position during anaesthesia is important. The animal should always be placed in sternal recumbency with the head and neck extended.

4. Drugs increase the risk of regurgitation, which must be monitored closely as the drugs also block the ability to swallow the regurgitus as it comes up. Suffocation or iatrogenic pneumonia may result.

Planning is essential to avoid complications during immobilisation. Each case is different and should be evaluated individually for appropriateness of anaesthesia, with consideration of the current general health of the animal and seasonal/environmental conditions. It is important to collect all the relevant data (age, sex, weight, health history) before commencing with the immobilisation.

Preparing for human safety is also essential. Look after your team! Recognise and reduce the risk of injury, anticipate complications and prepare to be able to respond appropriately in the event of an emergency. Have treatment and emergency response plans in place and communicate those plans with your team so that everyone is aware of their role and appropriate response.

In preparing an immobilisation event, preparation and consideration of the animal's environment is as important as preparing the work area and equipment you plan to use.

- Ensure the environment is calm, quiet and stress free. Most non-domestic hoof stock require remote delivery of the immobilisation drugs; consider whether it is appropriate to separate the individual from the group or whether the animal would become more stressed on its own and away from the herd and therefore negatively impact on the efficacy of the immobilisation drugs administered.
- Ensure the induction environment is safe for the animal as it becomes recumbent and consider having only essential staff present for the event.
- Consider where the work will be carried out and what hazards may be present in that environment.
- Identify emergency exits where appropriate.
- If working outdoors, consider the weather and suitable protection for the animal with regard to temperature regulation, emergency support, safe recovery etc.

Injection techniques and remote drug delivery systems were discussed. Whatever method is used to administer the drugs, work quickly, calmly and accurately. Minimise stress and pain to the animal. Get to know your immobilisation system inside-out, trust the equipment and know its limitations. Be aware of the hazards of darting – wrong dart type, inaccurate placement, ricochets, the distance animals travel before induction, and environmental hazards.

Choosing the immobilisation drug combination is important. Know the drug function and how it works. Stick with familiar and well-tried protocols. Always remember that all species are different and respond differently.

Characteristics of an ideal immobilisation drug are:

- Stable.

- Rapid absorption.
- Rapid onset of action giving sufficient immobilisation.
- Calm safe induction and recovery.
- Adequate duration of effect.
- Wide margin of safety.
- Minimum cardiorespiratory suppression.
- Reliable antidote available.
- Rapid elimination from the body.
- Should not cause tissue irritation.
- Minimum possible risk to personnel.

The first assessment after induction is essential:

1. Is the animal safely immobilised?
2. Is the animal's position good?
3. Initial physiological assessment (A-B-C) – is the animal receiving adequate oxygenation?
4. Rectal temperature – assess hyperthermia/hypothermia.

Constant and vigilant monitoring during anaesthesia (breathing, pulse, mucous membrane colour, capillary refill time, temperature, muscle tone, oxygen saturation) is essential to constantly assess the animal's well-being and the depth of anaesthesia. Problems are much easier to correct if detected early. Few serious emergencies are sudden in onset; monitoring vital signs is the key to avoiding anaesthetic-related deaths. Prevention is always better than cure and the best way to handle anaesthetic emergencies is to predict the next problem and be ready before it happens. Place an intravenous catheter to ensure prompt administration of emergency drugs is possible.

Remember that sudden arousals are relatively common, plan ahead for such events. Use eye covers and earplugs to reduce external stimuli.

Recovery from anaesthesia is not safer than any other phase. Pay attention to position (sternal, open airway), conditions (alone, quiet, dimly lit, free from physical hazards, prevent hyper or hypothermia), and monitoring and reversal agents.

Various anaesthetic emergency situations were described and discussed among the participants using case examples.

Capture myopathy and other handling side effects were discussed following the chemical immobilisation overview to highlight the importance of careful handling of hoof stock during capture events and the consequences of inappropriate handling. It is our duty of care to minimise stress and injury during handling. Capture related mortality rates higher than 1-2% is unacceptable.

Stress is the body's reaction to abnormal states that disturb the normal physiological equilibrium. Stress can result in capture myopathy (aka muscular dystrophy, white muscle disease, capture disease) which

is a disease complex most commonly associated with capture/handling/pursuit/restraint and transportation of wild species. It is a complex multifactorial metabolic disease that occurs when an animal cannot cool itself (hyperthermia). Prevention is the only treatment for this condition, once it starts it is always ultimately fatal. Predisposing factors influencing the incidence of capture myopathy include species (more skittish is more prone), environment (extreme temperatures, humidity, extreme terrain) other concurrent disease, signalment (age, pregnancy etc), nutrition, drugs.

The disease complex is classified into various syndromes, all of which may present in conjunction with another syndrome, namely:

1. Capture shock syndrome occurs during immobilisation and often results in death 1-6 hours after capture.
2. Ataxic myoglobinuric syndrome is the most common form that presents within a few hours to days post capture.
3. Ruptured muscle syndrome presents 1-2 days post capture. Delayed peracute syndrome is the most rare form.

There is a wide margin of onset of clinical signs/death, it is important to always include capture myopathy as a differential diagnosis in collapsed hoof stock or wader birds that have been captured within the past few weeks.

Treatment is generally considered ineffective but principle aims should include pain relief (ethical and prognostic), benzodiazepines for muscle relaxation, B and C vitamins, fluid therapy and correction of metabolic acidosis.

As discussed, prevention is better than cure. It is important to understand the behaviour and physiology of individual species. Recognising the environmental limitations, use of experienced personnel and using recognised and refined capture techniques to ensure minimum possible handling during capture events will help to reduce the incidence of capture myopathies. Ensuring immobilisation drugs are effective and have safe, rapid induction and recovery are also important, as is the use of tranquilisers to reduce stress where indicated. Consider capturing family or herd groups where appropriate.

Be aware of complications that can be avoided and plan to avoid those complications!

Post Mortem Examination and Sampling Techniques

This section will be produced as a published booklet separately to this report.

References

Chaber A, Alebone-Webb S, Lignereux Y, Cunningham AA & Rowcliffe JM 2010. The scale of illegal meat importation from Africa to Europe via Paris. *Conservation letters – a journal of the Society for Conservation Biology* 3(5), 317 – 321

Morens DM, Folkers GK, & Fauci AS 2004. The challenge of emerging and re-emerging infectious diseases. *Nature* 430, 242-249

Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL & Daszak P 2008. Global trends in emerging infectious diseases. *Nature* 451, 990-993

Shimshony A & Economides P 2006. Disease prevention and preparedness for animal health emergencies in the Middle East. *Rev. Sci. Tech.* 25(1): 253-269.

Participant List

Bahrain

Dr Mohamed Ali Abdelrahim Saad
Al Areen Wildlife Park
malisaad@yahoo.com

Hungary

Dr Brandon Anthony
Central European University
brandonbacsi@gmail.com

Jordan

Ehab Eid
The Royal Marine Conservation Society of Jordan
eha_jo@yahoo.com

Dr Zain Shaheen
Al Ma'wa for Nature & Wildlife
newhope.jordan@gmail.com

Ibrahim Al-Khader
Birdlife International
Ibrahim.khader@birdlife.org

Ala'a Abdoh
The Royal Society for the Conservation of Nature
alaa.abdo@rscn.org.jo

Kuwait

Salah Behbehani
The Scientific Centre, Kuwait
salah@tsck.org.kw

New Zealand

Prof. Philip Seddon
University of Otago
philip.seddon@otago.ac.nz

Oman

Abdullah Ghasib Al Harsusi
Office for Conservation of the Environment, Diwan of the Royal Court

Ali Abdullah Al-Raisi
Office for Conservation of the Environment, Diwan of the Royal Court
aaaraisi@diwan.gov.om

Azzan Alkalbani
National Field Research Centre for Environmental Conservation
al-kalbani@hotmail.com

Hadi Al Hikmani
Office for Conservation of the Environment, Diwan of the Royal Court
hadidofar@gmail.com

Hamad Al Wahebi
Ministry of Environment and Climate Affairs
hnk_alwhabi@hotmail.com

Hussein Al Qasmi
National Field Research Centre for Environmental Conservation
hussein_hope@hotmail.com

Khaled Al Rasbi
Oman Mammal Breeding Centre
tayamooo@hotmail.com

Khalifa Hamad Al Jahwari
Office for Conservation of the Environment, Diwan of the Royal Court
kjahwari@gmail.com

Dr MansoorAl Jahdhami
Office for Conservation of the Environment, Diwan of the Royal Court
mhjahdhami@gmail.com

Mohammed Al Saadi
Ministry of Environment and Climate Affairs

Saeed Hamed Al Rashdi
Office for Conservation of the Environment,
Diwan of the Royal Court
s-alrashdi@outlook.com

Salem Bait Bilal
Ministry of Environment and Climate Affairs
salim_196@hotmail.com

Steve Ross
Oman Earthwatch Programme
Steve.Ross@bristol.ac.uk

Sultan Mohammed Al-Bulushi
Office for Conservation of the Environment,
Diwan of the Royal Court
gajooor@gmail.com

Younis Alkaabi
Ministry of Environment and Climate Affairs
alkaabi221@hotmail.com

Qatar

Dr Abdi Arif
Al Wabra Wildlife Preservation
aarif@alwabra.com

Dr Sarah May
Qatar Museum of Nature and Science
smay@qma.org.qa

Saudi Arabia

Dr Abdul Kader Shaikh Omar
King Abdulaziz Univeristy
ak_shaikh90@yahoo.com

Dr Abdulhadi Aloufi Tabuk University
Aloufi@ut.edu.sa

Abdulhadi Al Otaibi
Taif University
vip101010@hotmail.com

Abdulla Al Tlasat
Saudi Wildlife Authority
A_altlassy@hotmail.com

Dr Ahmed Al-Mansi
Saudi Wildlife Authority
mansi911@hotmail.com

Ahmed Boug
Saudi Wildlife Authority, National Wildlife
Research Centre
bouga@nwrc-sa.org

Aishah Abdallah
IUCN Commission for Education and
Communication
othman.aishah@gmail.com

Ali Al Assaf
Saudi Wildlife Authority
aliassaf2006@yahoo.com

Ali Salim Alfaqih
Taif University
asasf1990@gmail.com

Hany Tatwany
Saudi Wildlife Authority
hany.tatwany@gmail.com

Dr Mohammed Shobrak
Taif University
mshobrak@gmail.com

Dr. Naif Al Hannoush
Saudi Wildlife Authority

Othman Llewellyn
Saudi Wildlife Authority
othman.aishah@gmail.com

South Africa

Chenay Simms
South African National Parks
Chenay.Simms@sanparks.org

Dr Gerhard Steenkamp
University of Pretoria
Gerhard.Steenkamp@up.ac.za

Dr June Williams
University of Pretoria
june.williams@up.ac.za

Dr Mike Knight
South African National Parks
M.Knight@nmmu.ac.za

Prof. Moritz van Vuuren
University of Pretoria
Moritz.VanVuuren@up.ac.za

United Arab Emirates

Aakansha Virwani
American University of Sharjah
g00046484@aus.edu

Ahmed Al Ali
Environment & Protected Areas Authority
ahmedalali@epaashj.ae

Ahmed Al Hashmi
Ministry of Environment and Water
aealhashmi@moew.gov.ae

Dr Anne-Lise Chaber
Wildlife Consultant and Veterinary Services
alchaber@hotmail.com

Anniek Boshoven
anniekboshoven@hotmail.com

Ahmed Hamad Al Shehhi
Public Works & Service Department -
Government of Ras Al Khaimah
aalshehhi@pwsd.rak.ae

Ahmed Abdullah
Sharjah Municipaltiy
dr-ahmed-dahab@hotmail.com

Dr Akram Eisa Darwish
International Fund for Animal Welfare
adarwich@ifaw.org

Alex Cloke
EWS-WWF
acloke@ewswwf.ae

Ali Saqer Al Suwaidi
Emirates Marine Environment Group
info@emeg.ae

Amin Al Masri
Sharjah Municipaltiy
drmas1976@gmail.com

Amna Al Dhaheri
Al Ain Zoo
amna.h.aldhaheri@alainzoo.ae

Ana Perez De Vargas
Al Ain Zoo
ana.perez@alainzoo.ae

Dr Arshad Toosy
Al Ain Zoo
Arshad.Toosy@alainzoo.ae

Asma Al Suwaidi
Environment & Protected Areas Authority

Dr Bakhtiyor
Mardonov Ecologist

Balazs Buzas
Al Mayya Breeding Centre
almayyabc@gmail.com

Barbara Arca
Al Aseefa Falcons

Dr Carlos Rojo-Solis
Environment Agency - Abu Dhabi

Christiana Hebel
German Veterinary Clinic
christiana_hebel@yahoo.com

Dr Coner Kilgallon
Dubai Falcon Hospital

Cornelie van der Feen
Wildlife Consultant
cvanderfeen@gmail.com

Cristian Segura
Modern Veterinary Clinic
cristian.segura.cortijes@gmail.com

Csaba Geczy
Mohamed Bin Zayed Al Nahyan Private Office
Csaba.Geczy@mbzo.ae

Declan O'Donovan
Wadi Al Safa Wildlife Centre
declan@shp.ae

Dina Haleem
Emirates Marine Environment Group

Elsa Cardenas
Al Wasl Veterinary Clinic
elsa_card@hotmail.com

Fadi Yaghmour
American University of Sharjah
fadiyaghmour90@gmail.com

Faisal Al Hammadi
Environment & Protected Areas Authority

Fathi Ibrahim
Sharjah Municipaltiy

Fatima Ahmed
Environment & Protected Areas Authority
fatimaahmed22@outlook.com

Fatima Al Zaabi
Environment & Protected Areas Authority

Dr Fatin Samara
American University of Sharjah
fsamara@aus.edu

Ghada
Emirates Marine Environment Group

Grant Furniss
Management of Nature Conservation
grantfurniss@gmail.com

Greg Simkins
Dubai Desert Conservation Reserve
greg.simkins@emirates.com

Dr Guilio Russo
Nad al Sheba Veterinary Hospital

Haemish Melville
Office of His Highness Sheikh Mohammed Bin Zayed Al Nahayan
Haemish.Melville@mbzo.ae

H.E. Hana Shaheen Al Suwaidi
Department of Heritage and Cultural Affairs

Hassan Zain Al Sharif
Dubai Municipality Environment Department

Hayat Al Ali
Environment & Protected Areas Authority

Hessa Al Shamsi
Breeding Centre for Endangered Arabian Wildlife
hs.alshamsi@hotmail.com

Hiba AlShehhi
Ministry of Environment and Water
hodarwish@moew.gov.ae

Hind Al Ameri
Environment Agency - Abu Dhabi
hind.alameri@ead.ae

Hollis Stewart
Lehab Conservation
stewartvet@gmail.com

Ida Tillisch
EWS-WWF
itillisch@ewswwf.ae

Jackie Strick
Breeding Centre for Endangered Arabian

Wildlife
jackie.strick@bceaw.ae

Jacky Judas
EWS-WWF
jackyjudas@gmail.com

Dr Jane Budd
Breeding Centre for Endangered Arabian Wildlife
jane.budd@bceaw.ae

Jeruel Aguhob
Dubai Municipality Environment Department
jcaguhob@dm.gov.ae

John Pereira
Environment & Protected Areas Authority
oppisand@gmail.com

Dr Judit Nagy
Wildlife Veterinarian
virgoncka@gmail.com

Dr Johan Forsman
Al Aseefa Falcons

Dr Kathrine Whitehouse-Tedd
Breeding Centre for Endangered Arabian Wildlife
katherine.whitehousetedd@bceaw.ae

Kevin Budd
Breeding Centre for Endangered Arabian Wildlife
kevin.budd@bceaw.ae

Kevin Hyland
Wildlife Protection Office
kevinwpo@emirates.net.ae

Khaled Ali Hussain
Hamriyah Municipality

Khuloud Al Hindasi
Ministry of Environment and Water
kaalhindassi@moew.gov.ae

Larry McGillewie
Nakhli Wildlife
larry.mcgillewie@gmail.com

Lisa Banfield
Al Ain Zoo
lisa.banfield@alainzoo.ae

Lisa Burns
Al Bustan Zoological Centre
kate@albustanzoo.ae

Lisa Hebbelmann
Environment & Protected Areas Authority
lisahebbelmann@gmail.com

Lordes Lavilla
Modern Veterinary Clinic
lourdes.lavilla@gmail.com

Dr Louis Lignereux
Environment Agency - Abu Dhabi
louis.lignereux@ead.ae

Dr Lucia Pappalardo
American University of Sharjah
lpappalardo@aus.edu

Lyle Glowka
UNEP/CMS Office - Abu Dhabi
LGlowka@cms.int

Maha Al Juwaied
Environment & Protected Areas Authority
m.aljuwaied@outlook.com

Maitha Al Hameli
Environment Agency - Abu Dhabi
maitha.alhameli@ead.ae

Maral Khaled Shuriqi
EWS-WWF
mchreiki@ewswwf.ae

Mariam Bu Shehab
Environment & Protected Areas Authority

Marina Antonopoulou
EWS-WWF
mantonopoulou@ewswwf.ae

Mark Craig
Al Ain Zoo
mark.craig@alainzoo.ae

Marta Munoz Baquero
Dubai Aquarium & Underwater Zoo
Mbaquero@emaar.ae

Meyer de Kock
Al Bustan Zoological Centre
meyer@albustanzoo.ae

Mohamed Eltayeb
Dubai Municipality
mohamedeltayeb@hotmail.com

Mohammed Ali Hashim
Dubai Municipality Environment Department
mahussain@dm.gov.ae

Mustafa Khamis
American University of Sharjah
mkhamis@aus.edu

Dr Nazrul Pathan
Management for Nature Conservation
dr_pathan@hotmail.com

Ndira Pluma
EWS-WWF
nayrapluma@gmail.com

Nele Koedooder
Breeding Centre for Endangered Arabian Wildlife
nele.koedooder@bceaw.ae

Oliver John Kerr
EWS-WWF
okerr@ewswwf.ae

Oliver Combreau
EWS-WWF
ocombreau@ewswwf.ae

Dr Omer Abdel Muttalib
Khor Fakkan Municipality

Patricia Cabrera
EWS-WWF
pcabrera@ewswwf.ae

Paul Vercammen
Breeding Centre for Endangered Arabian Wildlife
bceaw@bceaw.ae

Peter Arras
Management of Nature Conservation
peterarras@arcor.de

Dr Peter McKinney
Al Wasl Veterinary Clinic
birdvetmckinney@gmail.com

Peter Roosenschoon
Dubai Desert Conservation Reserve
peter.ddcr@emirates.com

Priscilla van Andel
Wildlife Photographer
info@priscillava.com

Rawan Basher
American University of Sharjah
rawanhadeethi@gmail.com

Reza Khan
Dubai Municipality Parks & Horticulture Dept.
MAKHAN@dm.gov.ae

Rhiene van Onselen
Breeding Centre for Endangered Arabian Wildlife
rheinie.v.onselen@bceaw.ae

Riaan Mulder Nakhli Wildlife
drriaandubai@gmail.com

Saif Al Awaini
Hamriyah Municipality

Sami ullah Majeed
Wadi Wurrayah National Park
samimajeed@gmail.com

Sandra Knuteson
American University of Sharjah
sknuteson@aus.edu

Sean O'Sullivan
Al Ain Zoo
sean.osullivan@alainzoo.ae

Shaban Abdul Hakeem
Hamriyah Municipality
shabanhakim@yahoo.com

Sharif Mohammed Ali
Dibba Al Hisn Municipaltiy
human222000@gmail.com

Stephen Bell
Dubai Desert Conservation Reserve
stephen.bell@emirates.com

Dr Susannah Philip
Breeding Centre for Endangered Arabian Wildlife
susannah.philip@bceaw.ae

Swamiti Kakembo
Wadi Wurrayah National Park
kakemboswamit@gmail.com

Tanya Sadler
Breeding Centre for Endangered Arabian Wildlife
tanya.sadler@bceaw.ae

Dr Valentina Caliendo
Al Wasl Veterinary Clinic
valentina@awvetclinic.ae

Yanni Smith
Emirates Marine Environment Group

Yassir Hamdan Al Kharusi
Environment Agency - Abu Dhabi
yalkharusi@ead.ae

United Kingdom

Dr David Mallon
IUCN/SSC Antelope Specialist Group
d.mallon@zoo.co.uk

Yemen

Dr Abdul Karim Nasher
Sana'a University
Karimnasher@yahoo.com

Dr Ali Al Najjar
Sana'a Zoo
ali.alnajjar@alsana'azoo.ae

Dr Masa'a Mahdi Al Jumaily
Sana'a University
dr.masaa@hotmail.com

Omer Baeshen
Environment Protection Authority
rubatbaeshen@yahoo.com

Dr Mohammed Sadeg Al-Awar
Sana'a Zoo
momed.sadeg@gmail.com