An Evaluation of Potential Monitoring Strategies for Saiga Antelopes on the Ustyurt Plateau.

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CONTENTS

LIST OF ACRONYMS

CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
FFI	Fauna and Flora International
GEF	Global Evaluation Facility
IUCN	International Union for the Conservation of Nature
SCA	Saiga Conservation Alliance

ABSTRACT

Ecological monitoring is becoming an increasingly popular tool used by conservation managers. However, with this increasing need for monitoring in projects there are few examples within the literature of processes, or frameworks, that can used to help identify, and evaluate, the most appropriate monitoring method for their situation. Using the case study of the critically endangered saiga antelope in Uzbekistan, this study aimed to start to address this problem.

Little is known about the saiga's migration into Uzbekistan during the winter months and so monitoring data is needed to map their distribution. However, typically, there are limited funds and resources available to capture this information.

One of the aims of this study was to identify, and assess, different potential monitoring methods in order to identify the most cost effective, and sustainable, monitoring method for saiga populations in Uzbekistan. This was done through the application of a framework.

The framework was developed by researching case studies for other saiga populations and dryland ungulates. This data was combined with information gathered from interviews with local people, monitoring experts and stakeholders. Using the information gathered, potential monitoring methods were then evaluated against feasibility, costs and the accuracy of the monitoring data collected.

This study identified many problems that conservation managers can face and suggested ways that these can be overcome. It is the first step in developing a framework that managers can use to identify and evaluate potential monitoring methods for all saiga and ultimately highlights the need for studies like this to be done for other species.

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1 INTRODUCTION

1.1 Introduction to this Study

Ecological monitoring can be an effective tool for conservationists as it can be used for developing conservation strategies and assessing their effectiveness (Young et al, 2010). Many techniques have been developed over the years and are still being developed to monitor species, especially for large terrestrial mammals. Information about these techniques is provided in many various forms (Norton-Griffiths 1978; Sutherland, 2006; Singh & Milner, 2011) which can result in conservation managers being left confused which is the best option for their situation.

The appropriate level of precision, statistical significance and power of data is often advocated for the selection of an appropriate census and/or monitoring method for wildlife (Joseph et al. 2006; Gaidet-Drapier et al, 2006). However, there is often a trade-off to achieve these high levels of power and precision as it may reduce resources and funds in other areas of conservation. When funds are limited, trying to achieve these statistical levels may even make a monitoring programme unfeasible. However, managers need to be careful as environmental management decisions can be prone to expensive mistakes if they do not take into consideration the accuracy of their monitoring data (Field et al, 2004).

Choosing the right method can result in big dividends in terms of the precision achieved for a given cost (Sutherland, 2006). Methods that can provide robust information at low-cost are particularly valuable (Jones, 2011).

If the cost effectiveness and accuracy is not considered in a monitoring programme, it runs the risk of not achieving its goals (Walsh and White, 1999) and possibly having a negative effect on the project.

An example of this situation can be seen with the critically endangered saiga antelope in Uzbekistan.

The saiga antelope is listed under CITES Appendix II and is classified as critically endangered by the IUCN Red List. It has been placed in this classification after experiencing one of the fastest declines in population of any mammal species in recent times (Bykova & Milner-Gulland, 2010).

The Ustyurt saiga population is currently experiencing some of the most intense poaching pressure and disturbance in its lifetime. The Ustyurt population size is approximately 6,100 (Bykona, 2011) and declining rapidly, making it the highest priority saiga population for conservation action (CMS, 2010). The CMS has identified that obtaining baseline information about the seasonal distribution and numbers of saiga as one of the highest priorities in their saiga conservation action plan for the Ustyurt population (CMS, 2010).

There is an existing protected area in Uzbekistan for the saiga but the number of saigas that currently live in this protected area, and during what time of year, is unknown (CMS, 2010). In addition, their migration into Uzbekistan is one of the least known components of the population's life history (CMS, 2010). Without information about the population's status and distribution it will be difficult to effectively design or extend any protected areas and manage their protection. Monitoring on the Ustyurt population in Uzbekistan has been limited up until now as there are many challenges to setting up a monitoring programme for this population, including low funds and resources.

Although it is important to evaluate the cost effectiveness of different monitoring methods for a project, there is currently no easy way for managers to do this without spending a substantial amount of money on pilot studies. This study aimed to develop an effective method and framework that was used to evaluate potential monitoring methods for saiga antelope in Uzbekistan before any money or time is invested in a monitoring program. The framework evaluated potential monitoring methods in terms of the trade-offs between accuracy, cost and feasibility, in order to propose the most cost effective monitoring programme.

This study discussed the reasons for monitoring and what factors need to be considered when selecting a monitoring programme. This was followed by a detailed description about the Ustyurt saiga population and what current monitoring techniques are used for other saiga populations. It then described proposed methods to collect and analysis data and evaluate these using a framework developed in this study. Finally the most cost effective and sustainable monitoring programme will be recommended and planned out.

1.2 Aims and Objectives

The aim of this study is to design a framework to evaluate options for a cost effective and sustainable monitoring strategy for saiga populations in Uzbekistan.

To achieve this aim this study will address the following objectives.

i. Elucidate the objectives for monitoring from different stakeholders.
ii. Identify appropriate monitoring methods for saiga antelopes as a species.
iii. Establish set up and running costs for implementing each of these monitoring methods and evaluating their cost effectiveness.
iv. Identify criteria to evaluate local factors that may influence the success of the monitoring.
v. Identify potential surveyors and evaluate their attitudes and ability to successfully monitor the saiga antelope.
vi. Recommend the most cost effective and sustainable monitoring method and design a cost effective monitoring plan.

2 BACKGROUND TO RESEARCH

2.1 Background to Monitoring

2.1.1 Why Do We Need To Monitor?

Monitoring provides scientists with data to measure any changes in a species' status (Spellerberg, 2005), information to evaluate the effectiveness of conservation interventions (Singh & Milner-Gulland, 2011) and to guide the decisions of those responsible for managing the environment (Field et al, 2004).

When making decisions on how best to protect endangered species there is not much room for error and so accurate data concerning the status of the species is essential to guiding management decision. (Abrams, 2002; Ogutu et al. 2006) write that the accurate detection of reliable population trends is of critical importance for the effective management and conservation of threatened species. An example of this is the evidence captured around population trends which guides scientists when assigning a species under the IUCN Red List system (Mallon & Kingswood, 2001).

As humans are putting increasingly widespread pressure on the environment the information obtained from ecological monitoring is becoming increasingly important. We cannot ever expect to effectively reduce global biodiversity loss, unless biodiversity trends, and the human impact on these trends, can be measured (Collen et al. 2009). International policy makers increasingly require reliable and robust information when making and evaluating international policies for the environment. An example of this is in the Convention on Biological Diversity (CBD) which has selected indicators to measure member states success on reducing biodiversity loss (CBD, n.d.).

There are several main reasons why ecological monitoring data may be required

i. *To measure success against stated objectives*

   Monitoring data is required to evaluate and verify if a project's objective has been achieved or not. An example of this was the CBD's 2010 biodiversity indicators example above (CBD, n.d.).

ii. *Monitoring for enforcement*

Monitoring may be used to ensure compliance with any laws and therefore protect the species i.e. ensure that illegal poaching is not happening. Hilborn et al (2007) showed that the number of buffalos, rhinos and elephants were influenced by the level of anti-poacher patrols in the Serengeti.

iii. *To engage the public*

Involving local people in monitoring can be used to engage support towards monitoring and raise awareness about the management of local species. Poulsen and Luanglath (2005) found that participatory monitoring by local people around Xe Pian National Park in Laos had the additional benefit of building trust and even strong friendships between staff and villagers, and also increased awareness of conservation issues in surrounding villages.

iv. *To help inform management decisions*

Information derived from monitoring can help make decisions about a species' status and how best to protect it i.e. what area would be best for a protected area to be set up for a certain species. Thirgood et al (2004) studied migratory wildebeest on the Serengeti to identify how long they spent in the current protected areas to decide whether the boundaries needed to be reconsidered.

Monitoring may just be one of the ways of achieving a conservation objective. Alternative options such as a total ban or unmonitored exploitation may also be able to achieve the objective (Hockley et al. 2005). When choosing whether a monitoring program is needed managers need to balance up the economic and ecological costs and benefits of either monitoring or not (Table 2.1).

	Management Option	
Costs	No Monitoring	Monitoring
Economic	All funding is dedicated to conservation work.	Resources spread across monitoring and conservation work.
	May reduce future funding from external sources as no measurement of the status of the species or the success of any conservation work.	More funding may be generated as a result of monitoring results.
Ecological	Conservation work has no direction or measurement of success.	Conservation work has direction and is able to measure when management is working or not.

Table 2.1 Economic and ecological costs associated when deciding whether to monitor or not. It is assumed that protection is ongoing and shares its budget with monitoring.

Although the need for monitoring information is increasingly required, conservationists still need to consider carefully what they are trying to achieve through a monitoring programme. It is essential to ensure it is designed to meet this objective and that is it not diverting scarce and valuable resources away from conservation or other priorities unnecessarily (Sheil, 2001).

2.1.2 Robustness of Monitoring Data

Decisions about a species status and management will be guided by the results of a monitoring program, so it is essential to understand how reliable and robust the data is.

It is often not possible to monitor a whole population so instead a sample of that population is monitored using methods that allow inferences about the whole population to be made (Milner-Gulland & Rowcliffe, 2007). The reliability of the data and what conclusions can be made from it depends on both accuracy and precision of how the data is collected and what techniques are used to analysis it.

Accuracy is how close the estimate is to its true value, for example how close the population count is to the actual population and how small the bias of the estimate is (Sutherland, 2006). Whereas precision is about how similar repeated estimates are to each other and how much variability there is in the data (Sutherland, 2006).

2.1.2.1 Bias

Bias occurs when the sample units that are selected are not representative. For example, the use of convenience sampling rather than selecting units randomly (Milner-Gulland & Rowcliffe, 2007; Singh & Milner-Gulland, 2011) such as placing transects only along roads (Harris, 1996). It can also occur when poor practical techniques are used and they fail to meet the assumptions required in a sampling system for example you are unable to count everything within the strip transect.

Stratification can be used if a species tends to be found in clusters or shows preference for some areas or habitats, to ensure that a more representative sample is taken (Norton-Griffiths, 1978; McConville et al. 2009). It is then important to randomly select units within the different levels of stratification to ensure they are representative and not biased (Norton-Griffiths, 1978).

When counting animals in an area, some may be missed i.e. not detected. Detectability is the estimate for the probability that if an animal is present in the area, that it will be counted (Royle & Nichols, 2003). This can vary over space and time. There are many factors that can affect detectability including the species, terrain, climate, time of the survey, using different surveyors etc (Thompson, 2004). Not correcting for detectability can result in biased results (Thompson, 2004).

Bias can also be introduced into the monitoring by many means including the equipment or methodology being used or observer bias (Norton-Griffiths, 2010). Observer bias can occur when an observer consistently under/over counts herd sizes (fig. 2.1).

Figure 2.1 Photo showing a herd of 100 saiga. At these distances it can be quite difficult for an observer to accurately count the saiga and often they can under/over estimate their counts. Photo taken by Helen O'Neill in June 2008

If too much bias is allowed in a sample then it becomes unrepresentative and inaccurate (Sutherland, 2006). It is important to try to identify and minimise, any sources of bias in a monitoring scheme. If too much bias occurs then erroneous conclusions could be made about a species and its status.

2.1.2.2 Precision

In any population sampling there will always be a degree of error (Milner-Gulland & Rowcliffe, 2007). A common assumption when sampling a population is that if you study 25% of an area then it will contain 25% of the population. This would only be true if animals were evenly distributed across the whole area (Norton-Griffiths, 1978) but unfortunately this is not the case and each species is distributed differently. Some may occur in groups and some may be very clumped with vast areas that are unoccupied (Norton-Griffiths, 1978). Therefore, if a different area was sampled a totally different result would be obtained, no matter how accurately the survey was carried out. This is results in sampling error (Norton-Griffiths, 1978).

If there is a lot of variation in the group sizes and distribution of the groups in your sample then the range of alternative estimates is large. This means it has low precision and will have large confidence limits i.e. the upper and lower range where the real estimate may lie within. It is possible to be imprecise and also be biased and also imprecise and unbiased (Fig. 2.2).

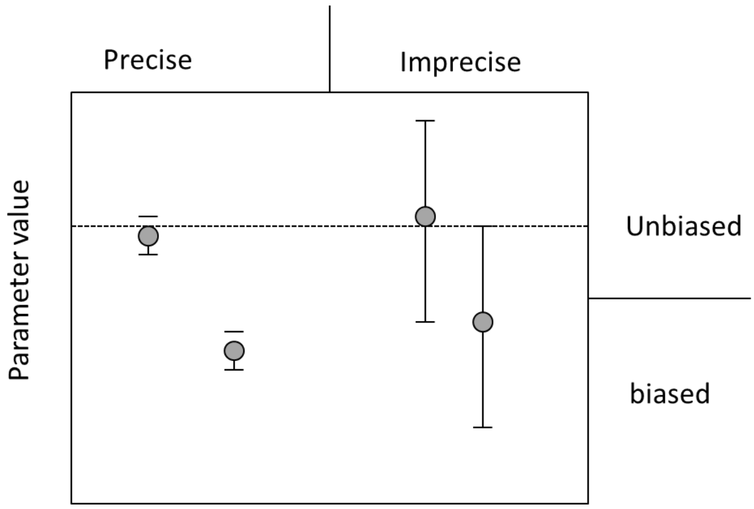

Figure 2.1 Shows the four options that can occur for precision and bias when making estimations. To have high accuracy an estimate needs to be both unbiased and precise. (Milner-Gulland & Rowcliffe, 2007)

The level of precision will affect the system's ability to detect changes in a population (O'Neill, 2008). A lack of precision can obscure results and even make them so noisy that no trends, such as a significant population decline, can be detected (Milner-Gulland & Rowcliffe, 2007). Monitoring results that are too imprecise would therefore be of little or no use to decision makers and a waste of resources (Legg & Nagy, 2005). Unfortunately this is not always considered before starting a monitoring programme and currently millions of dollars are being wasted on monitoring programmes that have no realistic chance of detecting changes in the species they are monitoring (Field et al. 2007).

For monitoring information to be useful, and have limited risk of errors occurring, data needs to be highly precise. However, higher precision requires more investment in time and money (Sutherland, 2006). This is often a problem for many projects with a finite budget as they can't afford the financial cost necessary to achieve the required level of precision for their data (Sutherland, 2006). There will always be a trade-off between how much investment can be put into monitoring and how precise the results will be (Ogutu et al, 2006). Getting this balance correct at the start is essential.

2.1.2.3 Power

Statistical power is the ability of the study to detect a change in the system (Field et al, 2007) and will have low variability (Carlson & Schmiegelow, 2002). A low-power monitoring program will have little chance of detecting all but catastrophic trends, thereby providing an illusion of stability and preventing remedial action required to conserve biodiversity (Fairweather 1991). A monitoring system can have such a low power that even data collected after several repeated visits would only be able to detect drops in the population of around substantial magnitude (Fig.2.3).

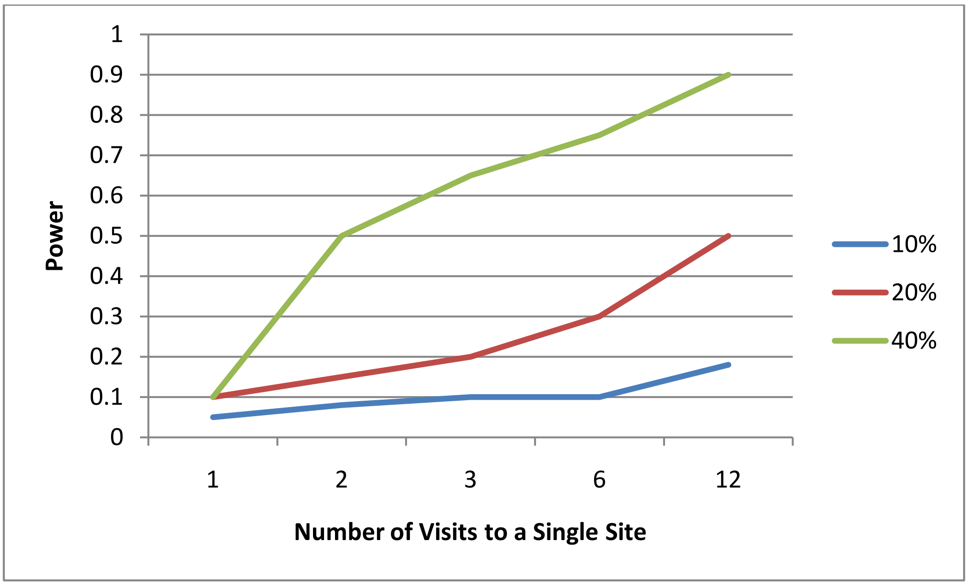

Figure 2.3 Shows the power to detect different declines in a populations .The monitoring system in this example has such a low power to detect changes, that even after sampling one site 12 times, only a 40% drop in the population would be detected.

One of the main reasons monitoring programs can fail is that the sampling design is not capable of detecting the right level of change (Field et al, 2007).

The power of a study can be increased by increasing the sample size. (Milner-Gulland & Rowcliffe, 2007).

A power analysis identifies how much investment is needed to detect a certain amount of change. Some methods that are relatively low cost are inherent to too much bias and so may give less valuable information than data from carefully designed field surveys (Jones 2011). However as a result of the low human capacity and financial resources available for conservation in developing countries, they cannot always stretch to monitoring methods that produce internationally comparable results and are successful in western countries (Danielsen et al. 2000). Instead some low-cost monitoring programs can still provide useful information for guidance with management decisions even if these are not recognised internationally (Danielsen et al. 2000).

2.1.3 Choosing a Monitoring Strategy

Clear objectives for what the monitoring information is to achieve needs to be agreed upon the onset of a project to ensure it will meet these objectives. Otherwise data maybe collected successfully but it does not provide useful information to decision makers.

Once the overall objective of monitoring has been agreed upon, it is important to be clear what data will provide this information. Monitoring data can be collected in various forms, for example population size, relative species abundance, distribution i.e. the proportion of an area that the species occupies and even human activities for example local attitudes and hunting activities (Milner-Gulland & Rowcliffe, 2007).

Which monitoring method is best to collect the data depends on a range of attributes such as how widespread and abundant the species is to begin with, how difficult it is to detect, and the level of resources available to implement the monitoring (Joseph et al, 2006).

Norton-Griffths (1978) breaks this down even further to the following list of key attributes that should be considered:

i. *Capacity*

   This includes what technical capacity is available to carry out the monitoring i.e. is it scientists or unskilled people and how many people are available.

ii. *Resources*

This involves what budget is available to fund the monitoring and what resources are available i.e. camera traps, well equipped cars, binoculars.

iii. *Timeline*

Is the monitoring a ‘one off’ census or does it need to be sustainable and ongoing.

iv. *The size of the study area*

Is the study area only a few hundred hectares or is it several thousand? This can influence if a monitoring can be done on foot or needs to be an aerial survey.

v. *The nature of the vegetation*

Is the study area open plain, wooded grasslands, thick bush or closed canopy forest? This will determine how easy it will be to see a species.

vi. *The nature of the terrain*

Is it flat and accessible? Does it have good roads or is it inaccessible or have no road systems? This may mean that some places cannot be reached by foot or car.

vii. *The species being monitored*

How detectable are they? Are they quite elusive or run away from humans? Is the population very low or high? The detection probability of a species will determine which survey methods are more suitable.

viii. *Regulations*

Are there any local laws or regulations that affect how you carry out the survey?

In reality, when working in the field, the ideal method for carrying out a monitoring programme may be compromised due to local factors and constraints. For example, aerial surveys for saiga antelope in Kazakhstan are determined by the availability of aircraft, by the weather and when the saiga are easily visible (Singh & Milner-Gulland, 2011). These local factors are what make each monitoring project unique and need to be considered when selecting a survey method. The same monitoring method may not be appropriate for the same species if many of the local factors are too different.

2.1.4 Monitoring Approaches

There are various monitoring approaches that can be used each with their own advantages and disadvantages (Table 2.2). These approaches need to be assessed when selecting which one is suitable in a monitoring programme.

	Summary		
Monitoring Approaches	Description	Advantages	Disadvantages
Plotless sampling	* Study of immobile species such as plants. It relies on measuring the distance to the nearest neighbour	*Simple to implement	* Only suitable for immobile species
Plot sampling or strip transects	* A fixed area that is searched for the species. All species found within the area are counted.[2]	* Simple to implement * No model error * Methods of analyses are simple and well defined	* Assumes all animals are seen, which for many populations is difficult to ensure and so populations may be underestimated. [1] *Sightings located outside the strip are ignored which can be wasteful for scarce species [1]
Distance sampling	* All sightings of a species are recorded. The distance of an observation is measured from the line or point to calculate detectability of that species [1] * Has several assumptions that need to be fulfilled. i) All animals are seen along the line with certainty; ii) Objects do not move before measurement is taken iii) Measurements are precise	* Takes into consideration detection probabilities of a species and so allows for animals to be missed [1] * Can be carried out for large and small open habitats [1] * Methods of analyses are well defined	* Requires several major assumptions to be met which are not always possible [3] * More complex to analyse * Need large data set to achieve high levels of precision which is difficult to achieve if the species is rare. The recommended sample size of 40 sightings[3]

Mark-recapture	* Individuals in a population are captured, marked and then released back into the population. Animals are then caught again and the proportion of individuals that are marked is used to calculate abundance [4]	* Good for animals that are difficult to see in the wild [4] * Detectability can be calculated	* Invasive to animals * Need to capture and mark a substantial proportion of the population * Assumption that the population is constant and closed. [2]
Absence/ Presence	* Individuals are recorded if they are present or not present in fixed locations. * Is used to estimate the proportion of occupancy over a number of sites to be used as a proxy for abundance.	* Simpler to implement than other approaches * Useful for species rarely seen and hard to catch [2]	* Is quite a crude index for abundance – population is likely to decline substantially well before the population is recorded as absent [2]. * Assumes all animals are seen which for many populations is difficult to ensure and so underestimates a population i.e. detection probability not calculated [2].
Presence only	* Individuals are only recorded when they are seen	* Simple to implement * Can easily be collected in conjunction with a surveyors other activities	* Provides no information about areas visited and not seen and get results in biased results [5] * Requires a substantial amount of data to get decent precision

Table 2.2 Advantages and Disadvantages of different monitoring approaches.

1. (Buckland et al, 2001) 2. (Milner-Gulland & Rowcliffe, 2007) 3. (Sutherland, 2006) 4(Williams et al, 2002). 5. (Singh et al. 2009)

2.1.4.1 Participatory Monitoring

Participatory monitoring is when local people are involved in monitoring (Danielsen et al, 2008). It is becoming more popular around the world as it combines a way of engaging local people while collecting ecological data in an inexpensive way (Danielsen et al. 2008). As conservation projects often have restricted budgets, hiring local people to do basic monitoring can be seen as a much more attractive and cost efficient way to collect monitoring data rather than hiring expensive outside experts and carrying out more traditional monitoring practices (Sheil, 2001). It may also be that there is no feasible alternative to community based monitoring (Danielsen et al. 2005). There is always a balance between financial sustainability of a monitoring program and how scientifically robust the data collected will be (Yoccoz et al, 2001). There have been few studies where locally based monitoring is compared with professional more established techniques for cost effectiveness and power of the data collected. However when Rist et al. (2008) compared locally based methods to collect catch-effort data with professional methods they found that the locally based methods were sufficiently accurate, precise and cost-effective.

Most examples of successful participatory monitoring schemes have been when the local community members involved in the monitoring are users of the resource themselves (Danielsen et al. 2007). A successful case study of this is in Namibia where legislation was passed giving rights to communities on communal land (Stuart-Hill et al. 2005). The communities were then able to prioritise what should be monitored and organised local community rangers to carry out the monitoring supported by external technicians if needed. This system was successfully implemented in many communities and has been replicated in other areas. This is not always the case however as (Hockley et al. 2005) carried out research on crayfish harvesting in Madagascar into how much harvesters were willing to contribute towards the monitoring of the crayfish. They concluded that local communities willingness to be involved was relatively low and was affected by how much they relied on the resource and will often require outside support. The recommendations from their research was that the best conditions for a community based monitoring scheme to be successful is when harvesting involves a small group of people and frequent returns to the same site. There are also few examples where participatory monitoring has been used for migratory species (Whitebread, 2008).

Although participatory monitoring can be a useful and cost effective monitoring tool it will only be successful in the right situation.

2.2 Background to Saigas in Uzbekistan

2.2.1 Current Situation for the Saiga

The saiga antelope is a critically endangered migratory ungulate that lives in semiarid deserts (Bekenov et al, 1998). It is about the size of a domestic goat, has a sandy colour coat for the summer months and grows a thicker creamy coloured coat for the winter months and only the males have horns (Bekenov et al, 1998). Their most striking feature is a protuberant nose which hangs down over its mouth (fig. 2.4). The females are fecund at around 7 months old and aggregate together to give birth usually within one week (Bekenov et al, 1998, usually at the start of May often having twins making them a highly reproductive species (Bekenov et al, 1998).

Figure 2.4 Photo of a male saiga. Photo by Paul Johnson naturepl.com

Saiga are migratory and are currently found in five distinct populations distributed across Kalmykia in Russia, Kazakhstan, Uzbekistan and Mongolia and sometimes in Turkmenistan (Fig 2.5) (Bekenov et al, 1998). They migrate in separate large herds, which can range anywhere up to 500 saigas in one herd. Their migration occurs in a number of waves with large intervals of kilometres between groups (Bekenov et al. 1998).

Figure 2.5 The approximate range area of each of the saiga populations (Milner-Gulland et al. 2001)

1.Kalmykia 2.Ural 3.Ustyurt 4.Betpak-dala 5. Mongolia inc. 5a. Shargyn Gobi population 5b Mankhan population

Historically it is believed that their range was far more extensive (Bekenov et al, 1998) but their distribution and population has fluctuated due to several factors; hunting, land being used for agriculture and climatic conditions (Bekenov et al, 1998). During the management of the Soviet Union, between 1930 and 1990, all hunting was regulated and saiga populations were increasingly becoming more stable (Bekenov et al., 1998). Unfortunately, following the collapse of the Soviet Union, the trade in saiga horn increased dramatically. The population has decreased by 95% in only 20 years (Bykova & Milner-Gulland, 2010). The main threat to the saiga is illegal hunting for meat and their horns to be used in traditional Chinese Medicine (Bykova & Milner-Gulland, 2011) plus demographic factors (CMS, 2010).

The saiga antelope is now listed under CITES Appendix II (Bekenov et al, 1998) and is classified as critically endangered by the IUCN Red List, after experiencing one of the fastest declines in population of any mammal species in recent times (Bykova & Milner-Gulland, 2010). The CMS has a 5 year goal to stabilise the saiga population with an action plan of how this will be achieved (CMS, 2010).

2.2.2 The Ustyurt Saiga

2.2.2.1 The Ustyurt Plateau in Uzbekistan

The Ustyurt is a vast and remote area making it very difficult to police and protect the saiga effectively. There is a very low human population comprising of 4 villages Jaslyk, Bostan, Karakalpakstan and Kublia-Usturt (Fig. 2.6). The villages have been built along the railway and grew out of the gas compressor stations being built just on the edges of Jaslyk and Karakalpakstan. The only inhabitants in the area are a prison, semi-nomadic shepherds, border guards whom patrol the Northern border with Kazakhstan and foreign oil and gas workers based on the plateau. The Ustyurt plateau is situated in the region of Karakalpakstan, is one of the two poorest regions of Uzbekistan (Richardson & Richardson, 2010).

Figure 2.6 Map of the Ustyurt plateau in Uzbekistan displaying the border with Kazakhstan, the railway line and the villages (Sairam Tourism, n.d.)

2.2.2.2 Status of the Ustyurt Saiga Population

The latest estimates for the Ustyurt population size is approximately 6,100 (Bykona, 2011) and is declining rapidly (Bykova & Milner-Gulland, 2010) as it is experiencing some of the most intense poaching pressure and disturbance of any of the saiga populations (CMS, 2010). The saiga are regarded as a keystone species of the Ustyurt steppe. It is therefore essential to conserve this species in order to protect the wider steppe ecosystem and the many threatened species it supports (Bykova & Milner-Gulland E.J. 2010). The dramatic decline in numbers and its importance to the wider ecosystem has made this population one of the highest priority populations for conservation action (CMS, 2010).

The Ustyurt population's migration from Kazakhstan into Uzbekistan usually lasts around 3-4 months starting around August with the saiga reaching Uzbekistan around October/November. It is believed that the saiga begin to migrate due to the change in climate (Bekenov et al, 1998) though little is known about this migration (CMS, 2010).

In 1991 one million hectares on the Ustyurt plateau was put aside for the Saigachy reserve, a protected area, intended to protect the Ustyurt saiga population's breeding grounds. However there has been no staff or funding to enforce the protection of this critically endangered species (Bykova, n.d.) and is considered a 'paper park'. There are current plans to upgrade the Saigachy reserve and plans to turn this into an effective protected area are underway.

2.2.3 Current Saiga Monitoring Methods

There are several monitoring programmes currently used for saiga populations in some of the range states, each with their own advantages and problems (Table 2.3).

Method		
Description	**Advantages**	**Disadvantages**
Aerial Strip Surveys	* Comprehensive data has been collected for 40 years in Kazakhstan * Accurate population estimates have been collected in Mongolia * Covered large areas in Uzbekistan quickly	* Biased detectability was not being fully addressed in Kazakhstan although this has improved (Norton-Griffiths & McConville, 2007). * The population estimates in Mongolia have low precision (Norton-Griffith, 2010) * In Uzbekistan this has not provided any useful data
Ground vehicle surveys using presence only	* Substantial data collected in Kazakhstan & Kalmykia	* There are concerns about reliability of the data collected (O'Neill, 2008)
Ground vehicle surveys using distance sampling	* Showed potential to produce unbiased results in Mongolia * Was both practical and flexible with the terrain and the species in Mongolia	* There were discrepancies between the census results from the aerial census in Mongolia. (Norton-Griffiths, 2007)
Participatory monitoring	* Engaged the local people in Kazakhstan & Kalmykia	* Accuracy isn't known (Whitebread, 2008)
Satellite Radio collaring	* This allows the saiga's migration into Uzbekistan to be tracked.	* No results have been released yet due to early technical problems (Bykova & Milner-Gulland, 2010).

Table 2.3 Advantages and problems for methods that are currently being used to monitor saiga populations.

Kazakhstan has been doing regular aerial strip surveys on all three of their saiga populations for the last 40 years and this has provided some the most comprehensive monitoring data available on saiga's today. A technical evaluation was carried out in 2007 of the methodology used and the results identified issues of biased detectability that were not being addressed (Norton-Griffiths & McConville, 2007). Additionally aerial survey methods in Kazakhstan were shown not have the power to detect short-term, relatively small-scale trends (McConville et al. 2009). This means that the data cannot be used to detect short term changes in the saiga population size, but can still be useful in the long term. Reviews of the Kazakhstan saiga aerial census by Frederik (2010) and Zuffer (2009) found that many of the recommendations that Norton-Griffiths & McConville (2007) had made in their technical evaluation had been implemented. Therefore the robustness of the monitoring data now being collected in Kazakhstan has increased. Efforts to improve the methodology are still being made but this is only being carried out in the Betpak-dala population.

Ground-vehicular surveys are another method used in Kazakhstan and in Russia (Singh & Milner-Gulland, 2011). O'Neill (2008) investigated how robust the data being collected by anti-poaching Rangers doing ground vehicle surveys in Kalmykia and concluded that there were concerns with the reliability of using presence only data. O'Neill (2008) also ran a pilot trial to evaluate using distance sampling techniques and found that the saiga are extremely wary of humans and moved evasively before they were detected. There was a lot of error and variability in the Ranger's estimates which meant that two assumptions of distance sampling could not be met and resulted in a humped detection function with too much bias and error.

In Mongolia aerial surveys and ground vehicle surveys have both been used. Norton-Griffith (2010) evaluated the aerial survey and found it to be accurate but the precision was low due to the low densities of the saiga and their highly clumped distribution. Distance sampling in ground vehicles has also been carried out. Reports have indicated that the data collected is useful for monitoring the saiga population trends and assessing effectiveness of conservation efforts (Young et al, 2010). There are however discrepancies between the censuses results from the aerial census, estimated at 8000 saiga antelope in 2010 and the ground census, estimated 3,000 saiga antelope between 2007 to 2009 (Norton-Griffiths, 2010). The data collected from saiga monitoring in Mongolia from 2006 to 2010 demonstrated the variation in estimates that can result from different monitoring methods and therefore the uncertainty when interpreting the results (Table 2.4). It is essential to ensure that the resulting population estimates are accurate, as a population decrease can be interpreted as a major catastrophe in the population itself when in fact it is just errors in the sampling methods.

	Data		
Monitoring Method	Year	Abundance	95% CI
Ground survey using distance sampling	2006	4,938	2,762-8,828
Ground survey using distance sampling method 1 analysis	2007	7,221	4,380-11,903
Ground survey using distance sampling analysed by method 2 analysis	2007	3,471	2083- 4859
Ground survey using distance sampling analysed by method 3 analysis	2007	3,533	2147 - 4919
Aerial Survey using strip surveys	2010	8,016	4809 - 11,222

Table 2.4 Saiga Monitoring results from ground surveys in 2006 to 2007 and an aerial surveys in 2010 in Mongolia (Young et al, 2010; Norton-Griffths, 2007; Norton-Griffiths, 2010). When the aerial survey is carried out the population estimate has more than doubled since 2007 but it is unclear if this is a real recovery or if the difference is down to the method employed. In 2007 the same data set was extrapolated using 3 different techniques and resulted in the above variation in the population.

Participatory monitoring by local people has also been set up in Russia, Uzbekistan and Kazakhstan. An early evaluation of participatory monitoring in Kalmykia showed that it was successful in engaging the local people who took part (Whitebread, 2008) but studies are limited that evaluate the accuracy of the survey data.

Each of these monitoring programmes has been implemented for different reasons and each come with its own strengths and difficulties. Which survey type is most suitable depends on local factors and the level of resources available to implement the monitoring (Joseph et al. 2006).

3 METHODS

3.1 Approach

To identify suitable monitoring methods the approach taken was to first identify all available monitoring methods in the literature. Once this research was compiled it was cross-referenced with expert advice to produce a final list of potential monitoring methods that could be used for saiga antelope. As there were so few examples of similar studies research was also done to identify evaluation criteria which were then assembled into a framework. Information about the study area, local attitudes, resources and costs was collected from various sources including personal experiences from travelling to the study area. This information was then used to evaluate each of the monitoring methods in the framework. Adopting this approach meant that the monitoring methods were evaluated using realistic scenarios and the results could be used as a solution to the monitoring problem initially raised.

3.2 Information Gathering

3.2.1 Monitoring Methods

Monitoring methods were identified from the literature review and discussions with experts. This provided a vast amount of initial information especially as there has been a number of monitoring programmes already conducted for saiga population.

3.2.2 Objectives

Any organisations or persons who had long term involvement with saiga conservation in Uzbekistan were identified as stakeholders. These included Gosbiokontrol, the SCA (Saiga Conservation Alliance), CMS (Convention on Migratory Species), FFI (Fauna and Flora International) and the Uzbekistan Institute of Zoology. Representatives from each of these organisations, except the CMS, were interviewed to identify their conservation objectives and how best monitoring could achieve this. The CMS publish the agreed targets and objectives from the member states on their website. These targets and objectives were then incorporated into the final list of objectives for this study.

3.2.3 Local Information

All local information was collected in Uzbekistan from either face-to-face interviews (see Appendix A) or personal experience.

In Tashkent interviews were with employees of the Institute of Zoology and Gosbiokontrol. In Nukus interviews were with employees from Gosbiokontrol in the Karakalpakstan region. These interviews helped gather information on background, feasibility and the objectives of monitoring.

Informal interviews were carried out with local people in Jaslyk, Karakalpakstan, Kubla-Usturt and with shepherds living north east of Bostan. These interviews were to gather anecdotal information about local attitudes towards the saiga and monitoring, information on local factors and local capacity. Interviews with previous or current participatory monitors were carried out to obtain information about the current monitoring methodology being used and attitudes of the monitors.

All interviews were done using a translator. One disadvantage of this was that on several occasions a lot of conversation would happen between the translator and the interviewee, with only a small amount of it being translated back. This improved when working with one translator over several interviews but several translators were used throughout the research period and so it took time to develop each relationship. This could be improved next time by only working with one translator and/or running through the interview questions prior to each interview and explaining the expectations from the translator.

3.2.4 Selecting People

Experts were identified in the literature review and through recommendations if they had substantial knowledge in a particular monitoring method, knowledge in working with ungulates or experience working in the region.

Employees from Gosbiokontrol and the Institute of Zoology were interviewed as they are stakeholders in protecting the saiga. Employees were selected to interview based on their availability and experience with monitoring the saiga.

Local people in the villages on the Ustyurt who were interviewed were recommended to the study through their co-operation with other research interviews being carried out at the same time. As there are so few Participatory Monitors, all were interviewed if they agreed to an interview (see Appendix A).

Shepherds were selected by travelling 11km north of Bostan on the main road and then either approaching all the shepherd's homes that could be seen from the road or approaching those shepherds that had been recommended.

Three groups of surveyors were identified, as they had their own transport and were believed to spend time in the areas where the saiga migrate to in the winter. These groups included border guards, gas employees and protection Rangers. Unfortunately it was not possible to interview any of the Rangers or gas employees due to their availability or where they were located, but it was possible to meet with the head of the border guards. However, he did not want to divulge much information as the details about the border guard's day-to-day activities are sensitive and could potentially be dangerous if given to the wrong people. As a result he wasn't able to answer the majority of questions. Due to these restrictions it was not possible to fully evaluate these three groups and many assumptions had to be made. To reduce the number of assumptions on future projects it would be useful if these three groups of surveyors could be fully evaluated. In addition to interviewing them it would also be beneficial to spend time with the Rangers to learn about their day-today activities. Contact should be made with the head of security in Tashkent to confirm, and identity everyone's intentions, before any further contact is made with the border guards. This would aim to provide confirmation and trust before any interviews are arranged. It would also be beneficial to organise an expedition specifically aimed at meeting and interviewing the gas employees.

3.2.5 Gathering Cost Data

Local cost information was based on interviews with experienced local people and personal experiences from living in the country.

It was possible to gather information about travel, food and living costs through personal experience. Several of the cost estimates for items varied slightly when interviewing different people but not vastly. There was however a vast difference between black market prices and official prices as it is very common for people to purchase items off the black market. There is also a culture to barter for prices and while this isn't as strong as in other countries it did mean that many costs did have to be estimated, resulting in there being no real fixed cost. Finally there was a range in wages that are paid to people within some of the surveyor groups. In all these situations the higher official cost estimate was used but this did mean alternative cost estimates could be made if the lower cost estimate and black market prices were used.

It also became clear that some items, particularly electronics, were actually cheaper if purchased outside of the country. If an item could be purchased for less outside of the country, this lower cost estimate would be used.

For some of the aerial survey costs there was no cost information for these items in Uzbekistan, the cost was assumed to be close to, or near, the cost of the item in Kazakhstan.

As costs were estimated in several currencies, all were converted to US dollars using http://www.xe.com. At the time of the study the exchange rates were the following:

$1 US Dollar: £0.61385 British pounds: €0.70170 Euro: UZS 738 Uzbek SOM

3.3 Evaluations

3.3.1 Evaluating Monitoring Methods

The evaluation criteria, applied to the monitoring methods framework, was identified through the literature review and expert interviews.

Each of the potential monitoring methods were then qualitatively evaluated and given a rating based on how the criteria would affect this methods feasibility (Table 3.1).

Star Rating	Description
*	The method was clearly not suitable. For example it would be too dangerous due to the extreme weather.
**	There were problems, concerns or questions with the method that would not automatically make it unsuitable. For example due to the size of the study area the medium would have some problems.
***	The method was suitable or very suitable. For example all resources were already available.

Table 3.1 Descriptions of how the ratings were awarded

If any method was awarded one star in any category it was considered unsuitable overall. The only exception to this rule was the current flying regulations for aerial surveys which meant that aeroplanes have to take off from Nukus and cannot land on the Ustyurt. As these regulations are quite recent and may change in the future aerial surveys were still regarded as a potential method.

3.3.2 Evaluating Surveyors

The list of potential surveyors was identified through the interviews. Criteria and questions evaluating the priorities and background to the monitoring project were identified in the literature review primarily from (Danielsen et al. 2008). The potential surveyors were then qualitatively evaluated against each of the criteria (Table 3.2).

Star Rating	Description
*	The criterion was a weakness of the surveyor group. For example there was a high risk that they may poach while working as a surveyor.
**	The criterion was neither a strength or a weakness of the surveyor but was acceptable. For example if they would collect reasonably robust data.
***	The criterion was a strength of the surveyor. For example if they had a very positive attitude towards the project.

Table 3.2 Descriptions of how the ratings were awarded

If a surveyor group was awarded one star for any criteria they were considered an unsuitable surveyor. The only exception to this was when out of country scientists were awarded one star when enhancing local capacity. The justification for this decision was that it was not a strength for any of the surveyor groups and also was not considered to be a main objective of the monitoring program.

3.3.3 Cost Scenarios

The remaining suitable monitoring approaches and surveyors from the two evaluation frameworks produced seven scenarios. These scenarios were used to evaluate all the variables in the monitoring methods but as they were based on the real life situations some combinations would not occur. In every scenario the best case situation was used. For example, it was assumed that weather conditions did not stop any of the surveys and only reliable vehicles that did not break down during the survey were selected. Finally, observers did not suffer from fatigue and the assumptions of each methodology were all met.

The amount of distance that could be monitored each day was calculated using: -

$$\text{Distance of Transect } (Km) = (\text{Speed} * \text{Time}) - \text{TravelTime}$$

Equation 3.1

Where *Speed,* measured in Kmph, is the speed that each vehicle could travel during the winter. *Time*, measured in Hours, is the number of hours spent working, fixed at 6 hours. Finally, *TravelTime*, measured in Hours, was the amount of time taken to travel to and from the start of the transects.

The width of these transects was estimated using examples from case studies using the same monitoring method. When using distance sampling with saiga by ground vehicles Young et al (2010) found the detection of saiga over 1km has a detectability of less than 0.2. Therefore, although distance sampling considers everything that can be seen, 1km either side of the line was considered to be width of area that could be accurately monitored. Norton-Griffiths (2007) recommended 1km each side of the aeroplane to be the strip width for aerial surveys for saiga. Ellis & Bernard (2005) found 4m to be the optimum transect width when counting Kudu faecal pellets.

The cost information gathered was entered into MS Project for each scenario (see Appendix B). These were broken down into start-up costs, initial cost per survey and cost per day. *Start-up Costs* included all the costs that would be incurred before the monitoring method, used in the scenario, could start. *Initial Cost Per Survey* included all the costs that would be incurred for each survey before any monitoring began. *Cost per Day* included all the costs which would be incurred per day of monitoring (See Appendix C).

A monitoring budget of \$30,000 was selected to evaluate each scenario as this is the budget that the SCA were awarded by the Whitley Foundation in 2011. The area surveyed for \$30,000 was calculated using the following equation:

$$\text{Area surveyed for \$30,000} = \Big(\big(\text{\$30,000} - (\text{Start-up costs} + \text{Initial cost per survey})\big) \,/\, \text{Cost per day}\Big)\ \text{Area surveyed in one day}$$

Equation 3.2

In scenario Toylocal_4, the start-up costs came to *\$152,301.78* if the cost of purchasing two Toyota Land Rovers was included. As the total monitoring budget was \$30,000 this would disqualify this scenario from the evaluation. It was therefore assumed for the purposes of the evaluation that a separate budget would be used to purchase the two Toyota Land Rovers and so this costs was left out of the start-up costs.

3.3.4 Accuracy of the Monitoring Data

There are many potential causes of bias that will result in errors in a monitoring method (Norton-Griffiths, 2007) and these will ultimately affect the accuracy of the results.

It was not possible to include all potential sources of error that can occur in a monitoring programme in each of the scenarios (Table 3.3). Many of these errors can be reduced or avoided by ensuring good practice is followed during the monitoring period for example ensuring the speed of the car is consistent. However errors arising from the bias caused by detectability and observer counts will vary when using different monitoring methods and for this reason these two errors were estimated and included in the simulation.

Error Type	Description	Addressed in the framework?
Bias due to Detectability	This occurs when counting animals in an area and some are not detected. This will vary for every situation.	Yes
Process (sampling error)	This occurs when sampling units of the population are not representative and can occur as a result of spatial or other characteristics.	No
Bias due to non randomised units	This can occur when sampling locations have been chosen due to convenience such as roads. This causes error due to the resulting bias.	Yes
Bias in observer counts	This can occur due to bias of the observer when counting different group sizes or the distance from the species	Yes
Observer error	This includes counting error but also errors can be caused at different times due to fatigue and using different equipment	No
Model error	Failure to meet the assumptions of the analysis will result in model error	No
Uncontrolled errors due to unequal effort	This can be caused by changing equipment, observers, height or speed of the vehicles and results in operational errors.	Yes

Table 3.3 Errors and bias that can occur in a monitoring program. All the errors that were addressed in this study have been indicated.

It is not possible to accurately calculate detectability or counting error without doing an evaluation in the field. Therefore for the purposes of this study detectability and counting error were estimated using values from similar situations identified in the literature review.

3.3.5 Estimating Counting Error

In an evaluation carried out by O'Neill (2008) the mean percentage difference of Ranger counts for saiga herds to the real herd size was between 20.07% and 25.22%. It was assumed that the anti-plague scientists would have a similar counting error to the Rangers and so an average counting error of 22.5% was selected. As counting error reduces with experience it was assumed that the internal scientists would have a lower counting error as they had previous experience of monitoring the saiga. External scientists would then have the lowest counting error as they would be the most experienced at using the monitoring methods. Also, in the case of scenario Toylocal_4, the counting error would reduce as the view of the surveyors would not be obstructed by the windows freezing up as they are heated in a Toyota Land Rover. 5% was selected as the iterative value that the counting error would reduce by.

Fredrick (2010) stated that even experienced observers in aerial surveys tend to over/underestimate by 20-30%. The average of these two values, 25%, was therefore used as the counting error for aerial surveys.

The number of individuals within a herd are not counted when using the presence/absence method, instead the number of sample units that the saiga occupy are counted (Royle and Nichols, 2003). It is therefore assumed that if the herd is detected there is no counting error.

3.3.6 Estimating Detectability

Detectability was assumed to be 100% for any of the scenarios using distance sampling. This was because distance sampling calculates detectability (Buckland et al. 2001) and therefore would be corrected for when the estimate is extrapolated.

The detection rate of saiga in Mongolia using vehicle surveys (Young et al, 2010) was 22% so this was used as the detection rate for all vehicle surveys of saiga.

In an investigation for potentially using distance sampling O'Neill (2008) found that the saiga were skittish and moved evasively before they were detected. This was supported by everyone who was interviewed, and had spent time looking for saiga by car or motorbike, as they all agreed that the time to detect the saiga was not long before they ran away. Additionally in an interview with an antelope specialist, he advised that saiga pellets should be easier to detect than saiga themselves (Mallon. per.comm. August 2011). For these reasons it was assumed that saiga faecal pellets would have a higher detectability than when counting saiga and for the purposes of this study the 22% detectability for saiga was doubled to 44% detectability for faecal pellets.

There were no detectability estimations for saiga aerial surveys in the literature. In the evaluation of the aerial survey on the Betapak Dala population, saiga's observed in front of the aircraft was detected 50% of the time. Also observations within 200m of the plane and over 800m of the plane were around 50% less than other observations (Frederik 2010). In the absence of any estimated detectability of saiga while doing aerial surveys, 50% detectability was used for the purposes of this study.

To see the effects of these errors as they were based on estimates, the simulation was rerun with 100% detectability in one version and 0% counting error in another version.

3.3.7 Simulating the Accuracy of each Monitoring Method

As the cost effectiveness of each scenario is linked to the accuracy of its monitoring data, an assessment was done to estimate the level of accuracy of each monitoring methods' data. As there was no monitoring data that could be used to compare the accuracy of each method, a simulation using test data, was produced to do a basic comparison of the accuracy of each method. The simulation calculated the range of population estimates and bias for each monitoring method. The data was considered more accurate the narrower the range of population estimates i.e. higher precision and the lower the estimation bias. The ranges and bias for each method were then compared to identify the monitoring method that would produce the most accurate estimates.

3.3.7.1 The Simulation Process

5000 values representing test data for herd size with a lognormal distribution were generated in R2.13.1 (Fig 3.1) using the following code.

```
#Generate Data using rlnorm function
vi<-rlnorm(5000,0.6,0.6)

#Write results out to csv file
write.table(vi,file="results.csv",sep=" ",row.names=FALSE,col.names=FALSE)
```

This distribution was chosen as a good representation of the herd sizes as the majority of species abundance data follow a log normal distribution (Limpert et al. 2001; Slocomb et al. 1977). This distribution represents species abundance as there cannot be a negative value, the mean value is low but the variance is high (Limpert et al. 2001).

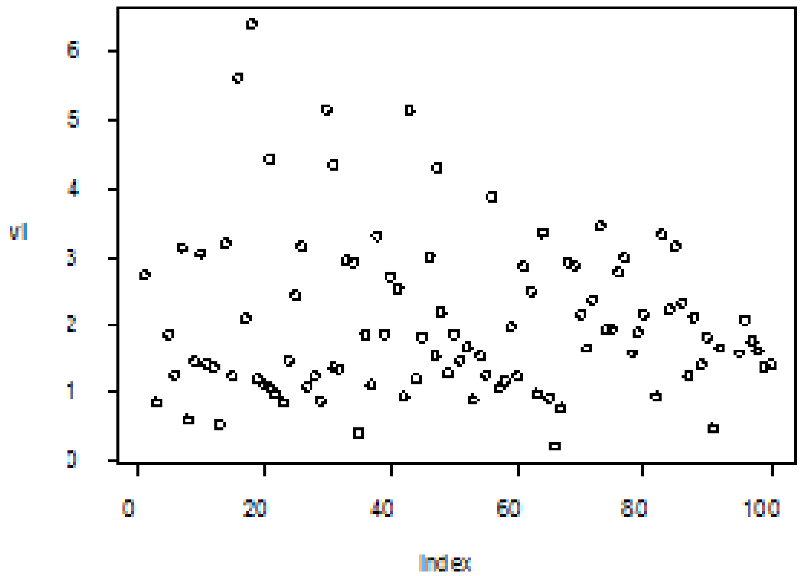

Figure 3.1 Data with a log normal distribution generated using R2.13.1 used to represent herd size test data.

The data was then loaded into a simulation program written in VBA within Microsoft Excel 2007.

The simulation took all 5000 herd size records in batches of 100. Each record within a batch was multiplied by the detectability to account for the different detection rates of different methods. The records were then multiplied by the counting error of the surveyor using each method (Table 3.4). This was done to account for the problems caused by detectability and counting error when using different monitoring methods.

Step	Activity
1	Estimate detectability and counting error.
2	Using the results from Equation 1 calculate the percentage of area monitored for each scenario when the total area of the Ustyurt is 20,000 km2 (Olson, 2011).
3	Using the percentage of area monitored from Step 2, select the number of records within the batch of 100 and sum up their total value. This is done for both the upper and lower counting error records.
4	Multiply this summed total to extrapolate it to 100%. This results in an upper and a lower population estimate.
5	Calculate the estimate bias.

Table 3.4 Process used on each batch to calculate the upper and lower population estimate and bias ranges

The estimate bias is calculated for each of the lower and upper population estimates using the following equation:

Estimation Bias = (Difference from true value / Population size) 100

Equation 3.3

This process was repeated 50 times for each scenario. Once there were 50 lower and upper estimates these were ordered from highest to lowest. The 5% most extreme results were ignored and the highest and lowest remaining values were taken as the range for the population estimates and bias for that scenario.

The results of the cost analysis and simulation data were then used to identify the most cost effective and accurate scenario. The results and lessons learned from this were then used to design the most cost effective monitoring program for a budget of $30,000.

In the monitoring plan the area was stratified into two strata based on data from previous distribution maps (see Appendix D). The start position for each transect line was calculated by using the grid system for latitude and longitude in each strata. Two coordinates from the grid system, that fell within these strata, were then randomly generating using the RANDBETWEEN() function in Excel. Once the transect line reached a natural boundary, such as the sea or the border, a new co-ordinate was generated in Excel to select where the next transect should begin.

4 A REVIEW OF POTENTIAL MONITORING TECHNIQUES

4.1 Potential Monitoring Mediums

Singh & Milner-Gulland (2011) classified monitoring methods for Ungulates into four categories; Aerial, Ground-Vehicle, Ground-Walked and Ground-Other.

Aerial

Aerial surveys are recommended for covering large areas quickly for mammals that are relatively sparse or range over large spatial areas (Sutherlands, 2006). Reliable and consistent results can be obtained as long as certain steps are taken (Norton-Griffths, 1978). Aerial surveys have been used in the Serengeti National Park for Wildebeest (Norton-Griffths, 1978) and have been successfully carried out for saiga antelope in Kazakhstan and Mongolia for the last 40 years (Frederik, 2010; Zuffer 2009; Norton-Griffiths & McConville, 2007).

Aerial surveys can be done by light aircraft, Microlights, or aircraft using thermal infrared technology (Kissell et al, 2004).

Ground vehicle

Monitoring using bicycles was used very successfully to monitor large mammals in Zambezi Valley in Zimbabwe (Gaidet et al, 2003). Car patrols are currently being used to monitor for saiga in Kazakhstan, Russian and Mongolia (O'Neill, 2008; Norton-Griffths, 2007; Singh & Milner-Gulland, 2011).

This can involve either carrying out surveys using line transects, quadrats or point counts. Line transect counts involve a surveyor travelling along a line transect and calculating the distance that any observed species is from the line. Quadrats would be similar and involve a surveyor travelling within a quadrat or a strip and counting everything within the strip. Point counts involve an observer remaining at random fixed points for a fixed time and recording in a circle around the point any objects that they see and measuring the distance from the object to themselves (Sutherland, 2006). On the Ustyurt plateau in Uzbekistan, ground vehicles can be broken down into four types of transportation; Car; Motorbike; Horse/Camel; Bicycle.

Ground Walk

Walking transects were used to monitor Tibetan wild ass, Tibetan gazelle, and Tibetan antelope in Yenigugou (Harris, 1996). Similar to ground vehicle methods, surveys can be done by using line transects, point counts or quadrats.

Ground Other

Camera traps were used to estimate tiger population sizes and density in different parts of India (Karanth & Nichols, 2008) and are good for rare and cryptic species. They can provide data on population abundance, densities and demography (Karanth & Nichols, 2008).

Camera trapping uses fixed cameras triggered by infra-red to capture images of animals passing the camera.

GPS collars were used successfully to monitor the migration of Moose in Scandinavia (Bunnefeld et al, 2010) and were used on the Betpak-dala saiga population in 2009/2010 to identify saiga wintering locations, calving regions and migration routes (Salemgareev et al, 2010).

This technique involves placing GPS collars on a number of animals in a population of interest and recording the GPS co-ordinates sent from the collars on a regular basis.

4.1.1 Historic and Current Monitoring

In the 1990s state monitoring groups carried out aerial and ground surveys on the Ustyurt saiga population in Uzbekistan. These monitoring expeditions took place in May as the saiga used to give birth on the Uzbek side of the Ustyurt (Azipjanov & Yonekorov, per.comm. June 2011). These expeditions were also done as it was necessary to prove the saiga, which were then a game species, were born in Uzbekistan. This information would then ensure that the numbers being harvested were sustainable. The saiga's migration into Uzbekistan now starts approximately around October (Bekenov et al, 1998) and so current surveys face additional challenges compared to the surveys in the 1990's. These new challenges include dealing with the extreme winter climate and cold temperatures, monitoring a population with drastically lower numbers and as the birthing grounds are no longer believed to be in Uzbekistan the saiga are not stationary for a period.

Recent monitoring in Uzbekistan has been limited. Baseline information on the number of saiga found on the Uzbek side of the plateau has been limited to indirect observation of tracks in snow along a few roadways (Olson, 2011). There is also currently no co-ordinated monitoring strategy between Kazakhstan and Uzbekistan (Singh & Milner-Gulland, 2011).

Participatory monitoring has been established since 2007 by several local hunters and ex-hunters. Unfortunately, this activity has not provided scientific data which could be used in management decisions but it has contributed to anecdotal information on saiga distribution, numbers and behaviour. Recently several monitors have stopped being involved in participatory monitoring. A conversation with a researcher currently studying the illegal hunting of saiga said that there is concern that this may be as a result of recent arrests of a poacher and growing mistrust among the monitors (Phillipson, per.comm. July 2011). There are also not many people who travel out to the areas where the saiga migrate to, especially in the winter and there is a concern raised by several people including the saiga programme manager from FFI that the people who are travelling out to these areas are doing so to poach (Karletter, per.comm. 12th May 2011). As a result it is becoming very difficult to find suitable people to be involved in participatory monitoring.

An aerial survey was done by Committee for Forestry and Hunting of Kazakhstan in 2010 on the Ustyurt population (Bykova & Milner-Gulland, 2011) but there are no plans to continue with this. Additionally aerial surveys have been carried out by Gosbiokontrol for the last 5 years but with minimal results (Peregontsev & Mitropolsky, 2008). The lead in the aerial expeditions explained that they had faced many problems due to the weather, which once delayed a survey for 2 weeks leaving the team still to pay for the hire of the plane and resources. Additionally there are regulations that state that they can only take off and land in Nukus (Mitropolskiy per.comm. June 2011). Only 11 saiga were seen in 2008 and none were seen in 2009 (Peregontsev & Mitropolsky, 2008).

Since 2009 a 3 year project has been running to study the seasonal distribution and movement patterns of saiga by using satellite collars (Bykova & Milner-Gulland, 2010). The results of this are still to be released.

Finally in 2011 a pilot study using distance sampling in ground vehicles was attempted but eventually cancelled due to several problems. It was hampered by problems with the vehicles performance and then breaking down, inferior equipment and a lack of preparation for the extreme winter weather conditions (Olson, 2011). This survey highlighted a number of recommendations that would need to be implemented if any further ground vehicle surveys are to be carried out.

4.2 Monitoring Mediums and Approaches

Each monitoring medium has its own strengths and weaknesses which makes them more suitable for different situations. The suitability of each of the mediums is affected by the sampling method. The sampling method is made up of two aspects, firstly, what is being observed i.e. individuals of a species or pellets/tracks of a species. Secondly, the analysis used to calculate the counts i.e. using distance sampling or total counts. The assumptions of each of these approaches will be affected by which monitoring medium is being used.

Each monitoring medium, is considered to be (1) Suitable (2) Possible Concerns (3) Unsuitable, when using the selected sampling method for saiga (Table 4.1).

	Monitoring Medium									
Sampling Method	Ariel surveys (Light aircraft)	Aerial survey (Infrared)	Aerial survey (Micro light)	Ground Vehicle (Car)	Ground vehicle (Motorbike)	Ground vehicle Horse/camel	Ground vehicle (Bicycle)	Ground (Walk)	Ground other (Camera Traps)	Ground other (Satellite Collaring)
Presence/absence for saiga signs e.g. pellets or tracks	X	X	X	?	?	O	O	O	X	X
Presence/absence of saiga	O	O	O	O	O	O	O	O	O	O
Strip plots (total count)for saiga signs e.g. pellets or tracks	X	X	X	?	?	O	O	O	X	X
Strip plots (total count) for saiga	O	O	O	O	O	O	O	O	X	X
Distance sampling using saiga signs e.g. pellets or tracks	X	X	X	?	?	?	O	O	X	X
Distance sampling using saiga	?	X	X	O	O	?	O	O	X	X

Table 4.1 Indicates which surveying medium is suitable against the sampling method.

Key: X Not Suitable ? Possible concerns O Suitable

Although many of these monitoring methods are potentially suitable for saiga, when they are applied specifically to the saiga in Ustyurt case study they are unsuitable (Table 4.2).

Unsuitable Monitoring Method	**Explanation**
Thermal Infrared	Surveys using thermal infrared imagery are usually carried out at night time. After a conversation with aerial survey expert he highlighted that this would be very difficult using an Antonov 2 plane plus, due to the extreme weather conditions, when surveys would take place it would be considered too dangerous (Norton-Griffiths. per.comm. May 2011).
Micro light planes	They would be far too dangerous to fly even during the day due to the extreme weather conditions (Norton-Griffiths. per.comm. May 2011).
Camera traps	Saiga do not have clear unique markings to identify them which camera traps are more suited to. The equipment is expensive and would need a lot of cameras to cover a vast area. It would require trained field assistants to monitor, change and collect the camera film which would be difficult due to the remoteness of the area. There is also the risk of theft and damage (Silver et al, 2004).
Satellite collaring	This is already being carried out by Tottori University and ACBK for this population and has experience several technical problems (Bykova & Milner-Gulland, 2010).
Aerial surveys counting tracks or pellets	It would be impossible to see these from the air

Table 4.2 Unsuitable monitoring mediums that were dismissed in this study and the reasons why they were dismissed

There are several monitoring methods that are possible but may not be the most feasible given the circumstances (Table 4.3). As there are more suitable monitoring methods available these monitoring methods will not be evaluated any further.

Monitoring Methods with possible concerns	Explanation
Aerial surveys using distance sampling	Mike Norton-Griffiths raised concerns about distance sampling being carried out in an aerial survey due to the difficulty in calculating the perpendicular angle from the transect which would invalidate one of the main assumptions of distance sampling (Norton-Griffiths. per.comm. May 2011).
Horse or camel surveys using distance sampling	A monitoring expert raised concerns about the bias introduced by variations in speed when travelling on a horse/camel and so might not be suitable for distance sampling (Singh. Per.comm. May 2011) though it is noted as a suitable medium by Buckland et al. (2001).
Counting tracks	The snow cover has to be around 10-15 cm for tracks to be visible and so would not always be possible to use if less snow fall. Could also introduce bias when calculating distribution as the saiga migration and locations they migrate to may be affected by the amount of snow cover.

Table 4.3 Monitoring methods that are possible but would have had concerns

The remaining methods provided the list of monitoring methods, suitable for saiga antelope on the Uysturt, that were then evaluated in the framework developed in this study.

5 RESULTS

5.1 Monitoring Objectives

There is not one clear monitoring objective shared amongst the stakeholders interviewed in this study or within the conservation action plan. There was also a wide range of what data should be collected (Table 5.1). For example, monitoring experts from Gobiokontrol wanted information for Uzbekistan's endangered species 'Red Data Book' and data that would help Gosbiokontrol to protect the saiga better (Azipjanov, Mitropolskiy & Yonekorov, per.comm. June 2011). The monitoring data that they required included; the abundance and distribution of saiga that spend the winter in Uzbekistan, data on whether saiga are giving birth in Uzbekistan and the status of the saiga habitat. An experienced monitoring expert from Gosbiokontrol wanted distribution data to provide information to the Rangers as to what areas they should focus their efforts (Chernopoer, per.comm. June 2011). The saiga programme manager from FFI required population trends as this would be used as a success indicator to report to donors and to inform management decisions about their other saiga conservation work (Karletter, per.comm. 12th May 2011). All the saiga experts from the SCA that were interviewed agreed that the monitoring objective should be to have distribution data to guide plans for the new designation of the Saigachy reserve (Milner-Gulland, Bykova & Mallon, pers.comm. May 2011). An experienced saiga monitor from the Institute of Zoology felt that it might not be worth monitoring this saiga population in Uzbekistan due to the difficulties involved. Instead they should use the data from Kazakhstan's aerial survey (Esipov, pers.comm. June 2011)

The CMS identifies the overall objective is to increase or halt the decline of saiga populations. They have compiled an action plan (CMS, 2010) to allow range states to achieve this, which includes a variety of monitoring data that should be collected. This includes distribution data on the saigas' range and habitat should be used to make recommendations for protected areas for them. Information should be collected to aid management decisions on population abundance, their demographic parameters, information on trends of sex ratio, survival, reproductive success and age structure. Also, information on saiga diseases to inform mitigation, control and action in the event of a disease outbreak or mass mortality episode

Monitoring Objective	Information Required	Stakeholder/s
Provide Data for 'Red Book' protection for the Saiga	* Abundance data * Distribution Data *Identify lambing grounds *Habitat Data	Gosbiokontrol
Focus areas for the ranger to protect	* Distribution Data	Gosbiokontrol
To guide management decisions	* Population trends	FFI and CMS
To guide management decisions	* Trends in sex ratio, survival, reproductive success and age structure * saiga diseases	CMS
Measure success and report status	* Population trends	FFI
Re-design the Saigachy reserve	* Distribution data	SCA and CMS

Table 5.1 List of all the conservation objectives with what monitoring information would be useful to achieve this identified by each of the stakeholder in this study.

Distribution data and abundance data were the most frequently required data by all the stakeholders. It would not be feasible to collect abundance data without co-ordinating with the monitoring programmes in Kazakhstan. Therefore, the distribution data, used to re-design the Saigachy reserve, would be the most useful and feasible. As a secondary objective this data could also have a positive relationship with overall abundance and so could also be used as a success indicator, thus making it the most useful objective for a current monitoring program.

All of the monitoring approaches proposed in identified in section 4.2 would provide information to map saiga distribution and so would be able to meet this objective successfully.

5.2 Potential Monitoring Methods

5.2.1 Evaluation of Monitoring Mediums Using Local Factors

Using the list of monitoring methods identified in section 4.2 each of the transport mediums were further defined based on what vehicles are available the Ustyurt Plateau (Table 5.2). These mediums were then evaluated against their feasibility dealing with local factors (Table 5.3).

Transport Medium	Descriptions
Aerial Light Aircraft	3 Antonov-2 planes are owned by the state and available to be hired for surveys from Nukus. The youngest plane is from 1956.
Car	UAZ jeeps using Benzene can be hired in Nukus.
Motorbike	Bikes are owned by local people in all the villages on the Ustyurt, these are Ural 650cc or 750cc bikes which run on Benzene.
Bicycle	These will be locally owned and come in a variety of basic models.
Horse/Camel	Camels are used for livestock and are owned by the local villages or shepherds. These are not used for transportation. Horses are sometimes ridden by the Shepherds but there are not many horses within the villages.
Walk	This would involve travelling out using a car or motorbike to the start of each transect and then walking along the transect.

Table 5.2 Descriptions of available transport that can be found on the Ustyurt Plateau

	Factors					
Medium	Resources	Size of Study Area	Vegetation and Terrain	Species	Regulations	Climate
Ariel surveys	Aircraft is available although they have poor visibility plus they are very old. Large investment required to purchase equipment. **Rating:** **	The Ustyurt is a vast area and ideal for plane surveys **Rating:** ***	The Ustyurt is open and flat with small shrubs suitable for seeing the saiga **Rating:** ***	Saiga occur in small numbers, in small groups and are scattered over vast areas. They are fast moving making it difficult to see them. They are comparably small animals to be surveyed from the air and the time to detect them is rather short **Rating:** **	Flying regulation height should be 900m which is too high for an aerial survey. Restrictions for distance to the Kazakhstan border not allowed to land on the Ustyurt to refuel Regulations state that they are not allowed to land on the Ustyurt even to refuel **Rating:** *	Extreme cold weather conditions during the survey can delay or even cancel surveys It can also reduce visibility through the windows **Rating:** **
Ground Vehicle (Car)	Vehicles are available to carry out patrols although are often unreliable. Adequate monitoring equipment would need to be purchased but these are relatively inexpensive **Rating:** **	Due to the vast area ground surveys would take a long time to cover the whole area **Rating:** **	Open, flat and without any major obstacles (except low woody shrub patches) Easily accessible by car **Rating:** ***	Migratory species that occurs in small numbers, in small groups scattered over vast areas Highly nervous with the noise of the vehicle and flee before vehicle is approx 1km away so the time to detect them is short **Rating:** **	There are no regulations that would restrict car patrols **Rating:** ***	Current vehicles severely affected by the extreme cold weather. Windows freeze and observers moral can be affected Diesel freezes in the extreme winter cold **Rating:** **

Ground vehicle (motorbike)	Motorbikes are owned by people in local villages but limits who can be involved in monitoring Additional monitoring equipment would be needed. **Rating:** **	Due to the vast area ground surveys would take a long time to cover the whole area **Rating:** **	Open, flat and without any major obstacles (except low woody shrub patches) Easily accessible by motorbike **Rating:** ***	Migratory species that occurs in small numbers and in small groups scattered over vast areas Hunted using motorbikes so the noise of the vehicle makes them flee as far away as 1km so the time to detect them is short **Rating:** **	There are no regulations that would restrict motorbike patrols **Rating:** ***	Current monitors did not report any problems with the vehicles due to the weather **Rating:** ***
Ground (Bicycle)	Some Bicycles are owned by people in local villages but limits who can be involved in monitoring Adequate monitoring equipment would need to be purchased but these are relatively inexpensive **Rating:** **	Due to the vast area bicycle surveys would not be suitable to cover distances far from the villages **Rating:** *	Open, flat and without any major obstacles (except low woody shrub patches) Easily accessible by bicycle **Rating:** ***	As the bicycle would not make any noise would be suitable for monitoring a skittish species like the saiga **Rating:** ***	There are no regulations that would restrict bicycle patrols **Rating:** ***	The extreme cold would make it too difficult and dangerous for any bicycle patrols **Rating:** *

Ground (horse/ camel)	Only a few Camels and horses are owned by people in local villages and by shepherds and limits who can be involved in monitoring. Adequate monitoring equipment would need to be purchased but these are relatively inexpensive **Rating:** **	Due to the vast area animal surveys would not be suitable to cover distances far from the villages and water supplies would need to be carried. **Rating:** *	Open, flat and without any major obstacles (except low woody shrub patches) Easily accessible by horses/camels **Rating:** ***	As a camel/horse would not make any noise it would be possible to get closer to the saiga. **Rating:** ***	There are no regulations that would restrict camel/horse patrols **Rating:** ***	The extreme cold would make it too difficult and dangerous for any horse/camel patrols **Rating:** *
Ground (walk)	Vehicles are available although most are unreliable. Would require an enormous amount of man power. Adequate monitoring equipment would need to be purchased but these are relatively inexpensive **Rating:** *	Due to the vast area it would take a lot of resource to survey walking transects **Rating:** *	Open, flat and without any major obstacles (except low woody shrub patches) Easily accessible for walking transects **Rating:** ***	Migratory species that occurs in small numbers and in small groups scattered over vast areas so require monitoring over a large areas far away from the local villages. As walking transects would not make any noise it would be suitable for monitoring a skittish species like the saiga though concerns about the noise from the vehicle when travelling to a transect **Rating:** **	There are no regulations that would restrict walking patrols **Rating:** ***	Similar problems that would be experienced by patrols using a car or a motorbike with the addition of the length of time surveyors would be able to spend on the transects due to the extreme cold weather **Rating:** *

Table 5.3 Framework to evaluate of monitoring mediums feasibility against local factors in Uzbekistan

Key: * Not Suitable ** Possibly suitable with concerns or changes required * Suitable**

Bicycle, horse/camel and walking surveys all scored ‘suitable’ for the terrain, species and there are no regulations that would inhibit them, however, there are some issues with resource availability and the species when walking as a car would be used to travel to transects. Across the remaining factors all three mediums scored ‘unsuitable’. Primarily this was due to the size of the area and the extreme cold weather conditions. These factors meant that these options are too dangerous to consider any further.

Aerial surveys scored ‘suitable’ for the size of the study area and the terrain. There are issues with the resources as equipment would need to be purchased. There are also problems monitoring this species and the climate but as several aerial surveys have been done in the last few years it will be considered as still possible to use this medium. Current regulations meant that aerial surveys are ‘unsuitable’ but as these have only been brought in over the last few years. This medium will only be considered as suitable for future monitoring if these regulations change.

Both the car and motorbike scored ‘suitable’ for the terrain and there are no regulations that would affect them. They both scored possible but with concerns for all the remaining factors. Both of these mediums will be considered as suitable monitoring mediums for this study but the concerns would need to be addressed.

The results of this evaluation show that the main monitoring mediums that could be used are predominately ground vehicle based (Table 5.3). The extreme weather conditions meant that many of the mediums are not safe and along with the vastness and remoteness of the area these factors disqualified several options.

5.2.2 Evaluation of Surveyors

Danielson et al. (2008) developed questions that managers could use to identify potential surveyors. The results of the information identified through these questions are the following issues:-

More robust data is required than is currently available but the level of precision is closely related to the budget available. The NGO’s involved with saiga conservation do not have budgets for monitoring long term.

There are scientists available both in and outside the country that could be involved in monitoring. There are a limited number of local people who could potentially volunteer as there are barriers for any potential volunteers. They need their own transportation and they need to travel out in harsh, often considered dangerous, weather conditions. Volunteering however is part of the local culture as volunteer Community Rangers used to help Gosbiokontrol with hunting control. There is a very limited team of Rangers that only consists of two patrol cars and their main role is protection.

There is no legal income directly from saiga as a natural resource to any of the local people. Conservation charities do fund local embroidery groups which would be lost without the presence of the saiga but recent research by a social scientist investigating the benefits of the embroidery work has showed that this brings in minimal income for a small part of the community (Damerell, per.comm. August 2011).

The information that was collected was used to identify potential surveyors (Table 5.4) and contributed to evaluating them in the framework.

Surveyor	Detail
Out of country scientists	Professional scientists not from Uzbekistan and hired specifically for their skills and expertise in monitoring on a temporary contract basis.
In country scientists	Employees from the Institute of Zoology or Gosbiokontrol who live in Uzbekistan but not on the Ustyurt. They have a Zoological background and experience of monitoring but they would need additional training for certain monitoring approaches.
Rangers	The Monak Usyurt Rangers who report to Goskompriroda in Karakalpakia. Their current responsibilities entail wildlife protection for all species including the saiga. They currently have two cars and limited teams of Rangers and no current experience of monitoring. If they took part in any monitoring they would require training and a payment for any additional tasks. They would not be able to change their current day to day activity or locations that they travel to.
Local people	These are people from the local villages with no scientific background or monitoring training. They must have their own transport and would need training for any type of monitoring program. They would be given

	payments for any monitoring data collected but this is not their main source of income.
Gas employees	Employees of the local gas companies who are maintaining the pipeline and mining. They would have no scientific knowledge and would require training for any type of monitoring. Most sources suggest that these employees are not local people but external contractors brought into the country/region. They would require a payment for additional task of monitoring and would not be able to change their current day to day activity or locations that they travel to.
Border guards	Guards who patrol the Northern border between Kazakhstan and Uzbekistan. They would have no scientific knowledge and would require training for any type of monitoring and a payment for additional task of monitoring. They would not be able to change their current day to day activity or locations that they travel to.
Anti-plague service	They work under the Ministry of Health in the Kungrad district. They currently manage and trap rodents that carry the plague. They have a zoological background and currently go out on scientific expeditions on the Ustyurt and live in Jaslyk. They mostly work in the summer months and are available in the winter.

Table 5.4 Definitions of all potential surveyors identified in the study

Danielsen et al. (2008) developed criteria to evaluate the strengths and weaknesses of potential surveyors against goals and criteria of monitoring program. These have been expanded upon to evaluate each of the potential surveyors (Table 5.5).

	Criteria						
Surveyor	**Potential for enhancing local capacity**	**Cost to the project**	**Sustainability**	**Robustness**	**Technical Capacity**	**Current Support/attitude**	**Risk of poaching**
Out of country scientists	Would not enhance local capacity Rating: *	Financial cost is very high Rating: **	Scientists hired and employed for each survey and require constant funding Rating: **	Would expect a high level of accuracy and precision due to training and experience Rating: ***	Scientists with high level of technical expertise are used Rating: ***	No personal involvement or commitment Would expect high level of professionalism Rating: ***	Negligible risk of poaching Rating: ***
In-country scientists	Does have potential to enhance capacity within the country but not locally Rating: **	Financial costs reasonably high Rating: **	Provide long term commitment and expertise Ongoing funding required to continue monitoring long term Rating: **	Scientific background but with current techniques would not be considered suitable for international decision makers. With some training would expect a high level of accuracy and precision Rating: **	Good level of scientific and monitoring background. Additional training required Rating: **	Very positive attitude and strong support to meet monitoring objectives Rating: ***	Negligible risk of poaching Rating: ***
Rangers	This could enhance local capacity but is limited Rating: **	Financial costs are relatively low Rating: ***	There is currently no commitment but would have the potential to be long term and sustainable. Rating: **	Would have to be opportunistic sightings and therefore the results are unlikely to be of high standards for scientific monitoring. Training may improve this. Rating: *	Unsuitable for complex monitoring methodologies Rating: *	Initial conversations seemed positive Rating: **	Negligible risk of poaching Rating: ***
Local villagers	This could enhance local capacity but is limited Rating: **	Financial costs are very low Rating: ***	Financially this system is sustainable long term There are issues around the numbers of people available and several people recently who are discontinuing to monitoring Rating: **	Would have to be opportunistic and therefore the results are unlikely to be of high standards for scientific monitoring. Training may improve this. Rating: *	Unsuitable for complex monitoring methodologies Rating: *	There is mixed support and motivations from current monitors Ratings: *	There is a high risk of poaching Rating: *

Gas and Oil employees	This would not enhance the local capacity Rating: *	Financial costs are relatively low Rating: ***	There is currently no commitment from these companies Little is known about their operations so sustainability is an unknown Rating: *	Would have to be opportunistic and therefore the results are unlikely to be of high standards for scientific monitoring. Training may improve this. Rating: *	Unsuitable for complex monitoring methodologies Rating: *	Unclear at present if they would support this work Rating: *	The risk to poaching is unknown Rating: **
Border guards	This would enhance local capacity but is limited Rating: **	Financial costs are relatively low Rating: ***	There is currently no commitment but would have the potential to be long term and sustainable. Rating: **	Would have to be opportunistic and therefore the results are unlikely to be of high standards for scientific monitoring. Training may improve this. Rating: *	Unsuitable for complex monitoring methodologies Rating: *	Unclear at present if they would support this work Rating: *	The risk to poaching is unknown Rating: **
Anti plague scientists	This would enhance local capacity but is limited. **Rating: ** **	Financial costs would be reasonably high only **Rating: ** **	Potential for long term by commitment of these people Ongoing funding is required to continue monitoring long term **Rating: ** **	Due to scientific background with training would expect there to be low bias and a reasonable level of accuracy and precision **Rating: ** **	Good level of scientific and monitoring background but would need additional training **Rating: ** **	Have shown strong support to monitoring program **Rating: *** **	The risk to poaching is unknown **Rating: ** **

Table 5.5 Evaluation framework applied to the surveyors

Key: * Weakness ** Acceptable with changes required * Strength**

It was not possible to interview any Rangers, Gas employees and Border guards so several assumptions have had to be made about their suitability. A weakness of using these surveyors is that they would not be able to collect very robust data and would have low technical capacity. There would be limited capacity building if any of these groups were used as the border guards and the gas employees do not have any links to the saiga and are not from the local area themselves. Two strengths for all three groups are that they would potentially only require a small budget and would be sustainable in the long term if they agreed to being involved. The likelihood of poaching is unknown for the Gas employees and Border guards but it would be assumed there is no risk for the Rangers. As this monitoring program does require more robust data than is currently being collected it would dismiss each group as the sole surveying group.

Local villagers scored as 'acceptable' to build capacity as they live and have ownership in the local area. However, this would only be a small part of the local community as there are barriers in place restricting who could be involved. As the saiga do not bring an income for the majority of the community there is not a strong incentive to be involved in monitoring. A strength for this group is that they would not be a high cost to the project which would also make the monitoring program sustainable long term. Unfortunately this is not as strong an option as it may seem as there are so few volunteers available. The level of robustness of the data that would be collected is a weakness for this group, as well as their technical capacity, their level of support and their high risk of poaching. Some individual villagers may be suitable for monitoring. As a group local villagers are suitable surveyors for a monitoring program.

Capacity building was a weakness for the out of country scientists but as this is not a priority of the program then this group is still considered suitable. They would be a reasonably high cost to the project and it would be difficult to keep a monitoring program running long term without substantial investment. The robustness of their data, their technical capacity, their attitude and risk to poaching were all strengths for this group. This group is considered as potentially suitable surveyor but may not be suitable if the cost implications are too high.

In-country scientists and the anti-plague scientists both scored 'acceptable' or 'strength' against all of the criteria. It was possible to enhance capacity within the country by involving these groups, they would collect robust data and should be quite sustainable. They have very positive attitude towards the program and no risk to poaching. Both groups would be considered the most suitable surveyors for this monitoring project with some initial investment and training.

5.3 Scenarios to Evaluate Monitoring Methods

5.3.1 Cost Scenarios for the Potential Monitoring Methods

The resulting potential monitoring mediums from section 5.1 are, 'aerial light aircraft', 'car' and 'motorbike'. The resulting potential surveyors are, 'out of country scientists', 'in-country-scientists' and anti-plague scientists'. Seven scenarios have been written using these variables and taking into consideration the real life situations. Several assumptions had to be made for each of these scenarios (Table 5.6).

Scenario	Description
Aerlocal_1	Aerial surveys, using total count surveys, with 2km wide strips counting saiga with in-country scientists. The planes are kept in Nukus and are only allowed to take off and land here. Training is required to improve the methodology. Regulations have changed to allow the aeroplane to fly at 200 m elevation and near the border.
Carexternal_2	Ground vehicle car surveys, using distance sampling counting saiga with 2 British out of country scientists and using local cars. Each car carries an extra 60L of fuel.
Carlocal_3	Ground vehicle car surveys, using distance sampling counting saiga with 2 in-country scientists and using local cars. Training is required from an out of country trainer. Each car carries an extra 60L of fuel.
Toylocal_4	Ground vehicle car surveys, using distance sampling counting saiga using 2 in- country scientists. Two new Toyota Land Rovers are purchased but the cost of purchasing these are not within this monitoring budget. Training is required from out of country trainer. Carry an extra 60L of fuel
Motorpellet_5	Ground vehicle motorbike surveys by anti-plague scientists, using total count surveys of faecal pellets with 2 m wide strip on either side of the surveyor. Training is required from internal scientists.
Motorpresense_6	Ground vehicle motorbike surveys by anti-plague scientists, using

	presence/absence approach counting saiga. Training is required from internal scientists.
Motordistance_7	Ground vehicle surveys by anti- plague scientists, using distance sampling counting saiga. Training is required from out of country trainer.

Table 5.6 Scenarios that were used to test each of the variables and evaluate the cost effectiveness and robustness of the monitoring methods

5.3.2 Results of Cost Analysis

The results show what area would be surveyed for a budget of $30,000 in the first year and then 'on-going' when there would no longer be start-up costs to consider (Table 7).

	Cost Results					
Scenarios	Start up costs	Initial cost per survey	Cost per day	Area surveyed in one day km	Area surveyed for $30,000 1st year	Area surveyed for $30,000 ongoing
Aerlocal_1	$ 7,949.96	$ 1,211.73	$ 4,025.58	600 km^2	3,000 km^2	4,200 km^2
Carexternal_2	$864.98	$ 3871.24	$661	180 km^2	6,120 km^2	6,300 km^2
Carlocal_3	$14,094.34	$ 609.24	$ 402.31	180 km^2	6,120 km^2	11,700 km^2
Toylocal_4	$14,461.78	$ 610.92	$ 260	280 km^2	12, 880 km^2	25, 180 km^2
Motorpellet_5	$ 6901.25	$0	$ 183	1.32 km^2	166.32 km^2	1,815 km^2
Motorpresense_6	$ 6901.25	$0	$ 183	840 km^2	105.840 km^2	136,920 km^2
Motordistance_7	$ 12,303.22	$0	$ 183	840 km^2	80,640 km^2	136,920 km^2

Table 5.7 Shows the breakdown of survey costs and area monitored for each scenario

The results show that there were two variables that had the biggest impact on the size of area covered. The first variable was the cost of the surveyor as this was biggest contributor to the cost per day. As a result, this variable had a large effect on how many days could be spent monitoring and thus size of the overall area that could be monitored. Even though start-up costs for scenario Motordistance_7 and Toylocal_4 were some of the highest, they both still resulted in over 50% of the Ustyurt being monitored.

The second variable was the 'object' that was to be monitored i.e. pellets or saiga. Motoroellet_5 was the only scenario to count pellets. This required substantially narrower strips to be surveyed and the surveyor had to travel at lower speeds. This therefore decreased what area could be monitored per day drastically.

The cost of fuel per km did not have as strong a correlation on the cost effectiveness as initially expected. This was because the amount of distance per day that could be travelled was dictated by the weather and day light. Therefore, there was not a large amount of fuel used each day.

Scenario Motorpresense_6 and Motordistance_7 would cover 100% of the study area (Fig 5.1). This is due to the low daily cost of the anti-plague scientists and motorbikes and the fact that there were three bikes completing transects. Toylocal_4 also covers over 60% of the area as the Toyota Land Cruiser would allow the surveyors to travel further each day in the winter than the UAZ local cars and therefore monitor a larger area. The limitation of the motorbikes is that they cannot carry a lot of equipment with them for example large tents, heaters etc. Also due to the amount of fuel that they can carry they would need to return back each day and refuel. This means that each day they would need to spend time and fuel driving to the start of the next transect.

Motorpellet_5 was the only scenario counting pellets instead of saiga. As none of these scientists were a threat to poaching, it was not seen as a priority to keep the surveyors away from the saiga. The surveyor would have to travel much slower in order to be able to see any pellets and would travel along much narrower transects. Counting pellets therefore meant that the area that could be monitored per day was drastically reduced and would only be recommended if it was not possible to count saiga. Scenarios Carexternal_2 and

Carlocal_3 were both restricted by the amount of distance that can be covered each day in the winter due to the vehicles ability to cope in the winter conditions.

Although it would have been expected that an aerial survey would cover a vast amount of area per day, as so much time and fuel was spent getting to and from the start of the transects it vastly reduced the area that was able to be monitored each day.

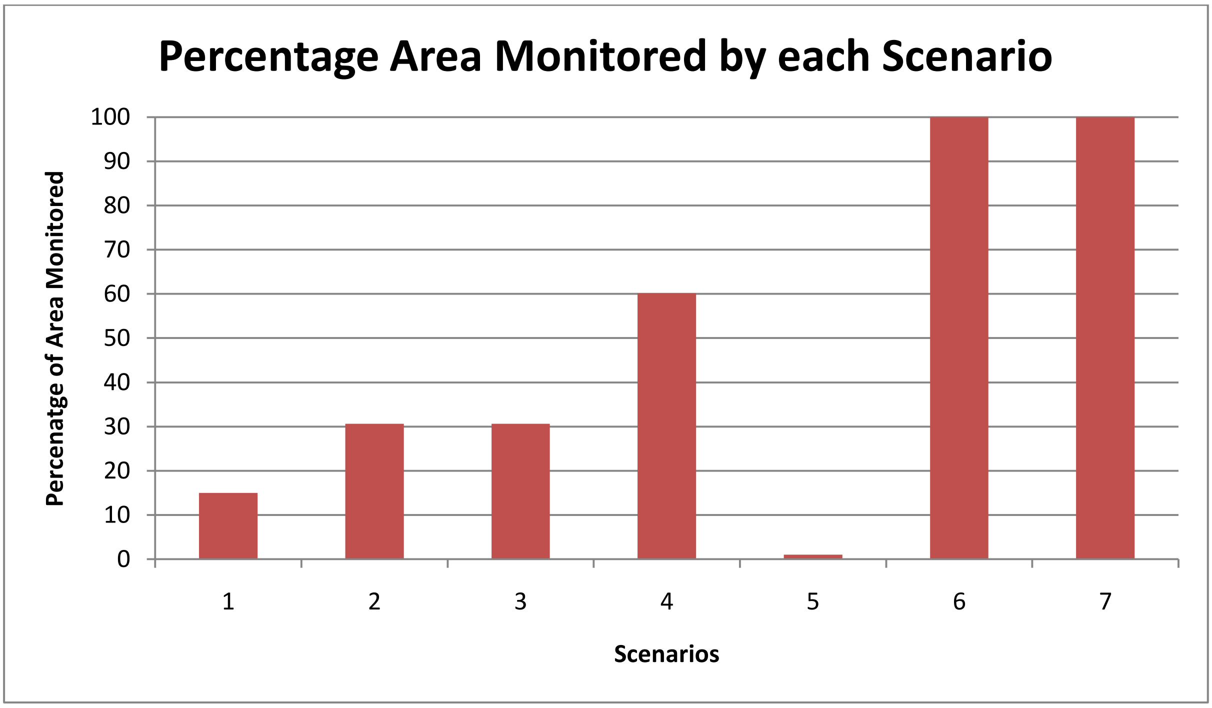

Figure 5.1 Graph showing the percentage area of the Ustyurt Plateau that can be monitored for each scenario for a monitoring budget of $30,000

5.3.3 Results of Simulation Analysis

The simulation resulted in a range of population estimates and estimate bias for each scenario (Table 5.8). The monitoring budget used in the simulation was $30,000 and the actual population size in the simulation was 11,587.

	Variables			Results			
Scenarios	Detectability	Counting Error	% of Area Surveyed	Mean population estimate	Range of population estimates	Mean bias of estimates	Range of bias
Aerlocal_1	50 %	25%	15%	2601	1,792 – 3,863	-77.57	-84.54 to -66.95
Carexternal_2	100%	12.5 %	30%	11,600	8,788 – 15,265	0.05	-21.31 to 29.52
Carlocal_3	100%	17.5 %	30%	11,996	8,445 – 16,976	3.44	-23.12 to 40.72
Toylocal_4	100%	12.5 %	64%	11,721	9,257 – 15,586	1.15	-15.65 to 25.07
Motorpellet_5	44%	22.5%	6.9 %	5289	3156 – 9268	-54.43	-73.05 to -21.28
Motorpresense_6	22%	0%	100%	2,549	2,338 – 2,778	-77.99	-78.04 to -77.96
Motordistance_7	100 %	22.5 %	100%	11,588	8,882 – 15,061	0.01	-19.95 to 19.93

Table 5.8 Shows the resulting upper and lower population estimates and the range of bias in the estimates for each scenarios when run through the simulation

Scenario Motordistance_7 and Toylocal_4 come out with the highest precision and with the least bias (Fig 5.2). Bias was low for these scenarios as detectability was accounted for in distance sampling and they had high precision as a large proportion of the total population was sampled in these scenarios. Although the counting error was the lowest for scenario Carexternal_2, as less samples were taken, the precision of their results was less than scenarios that had higher counting error.

Scenario Motorpresense_6 had the highest precision as individuals were not counted but herds marked as either present or absent so therefore had no counting error. It also sampled 100% of the area.

Scenario Carlocal_3 had quite low precision as less samples were able to be taken and the counting error was quite high compared to other scenarios. This was due to the inexperience of the surveyors using distance sampling and restricted view from the UAZ windows which would often freeze up in the winter. The counting error on would improve over time as the surveyors became more experienced at this technique.

Scenario Aerlocal_1, Motorpellet_5 and Motorpresense_6 all have a strong bias error due to detectability not being accounted for in the sampling technique. All of these could be improved if the results were adjusted in the analysis to account for detectability.

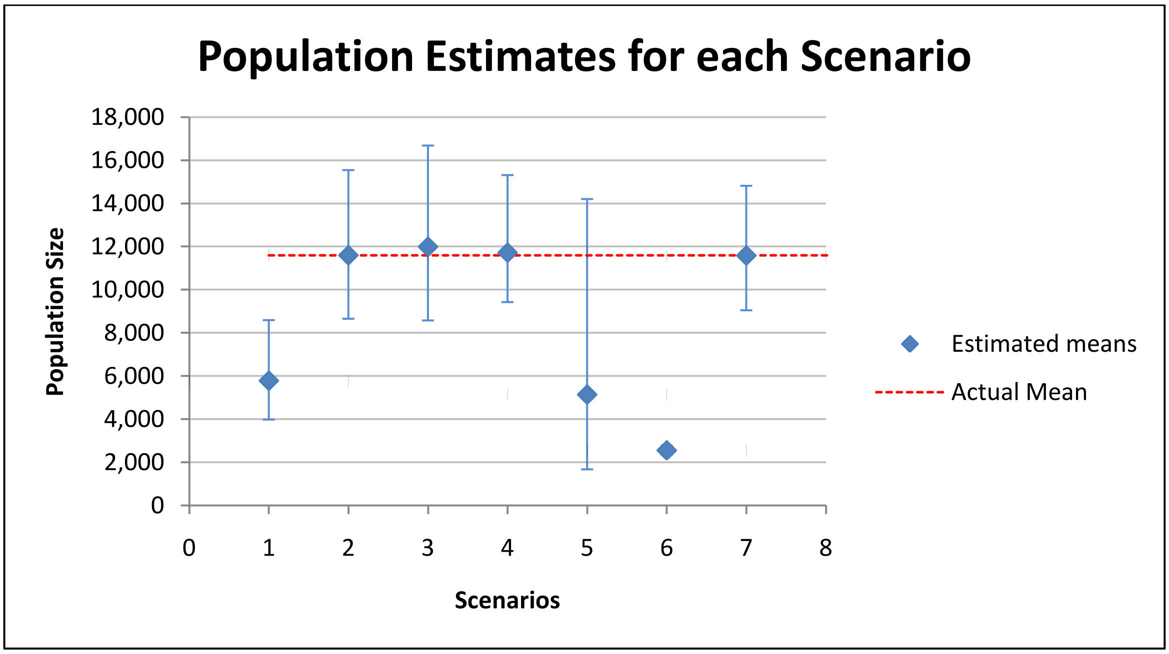

Figure 5.2 Graph shows the range of population estimates for each scenario when run through the simulation

5.3.3.1 Simulation Results with Variables Changed

To test the effect of the variable ‘detectability’, it was adjusted to be 100% for all the scenarios and the simulation rerun. This resulted in no bias occurring in any of the estimates (Fig 5.3) however, the population ranges of for Aerlocal_1 and Motorpellet_5 have increased and in case the case of Motorpellet_5, quite substantially. This increase is due to other variables, such as area monitored, having a larger effect when the population estimates are higher. If detectability was accounted for equally in every monitoring method then Scenario Motorpresense_6 would produce the most accurate results.

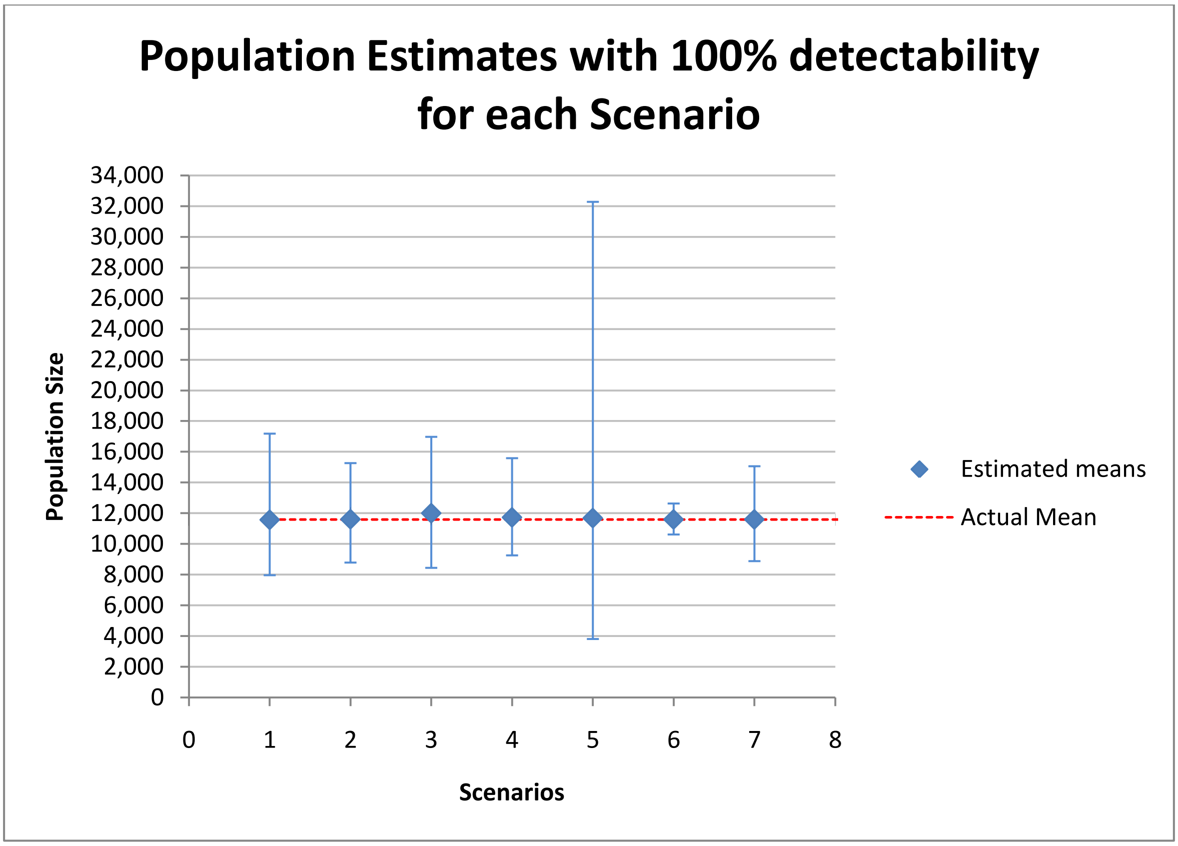

Figure 5.3 Shows the range of population estimates from the simulation when detectability was 100% for all the scenarios

To test the effect of the variable ‘counting error’ this was changed to zero for all scenarios and the simulation rerun. This resulted in all the estimates having slightly narrower ranges (Fig 5.4) and did not affect which scenario was the most accurate.

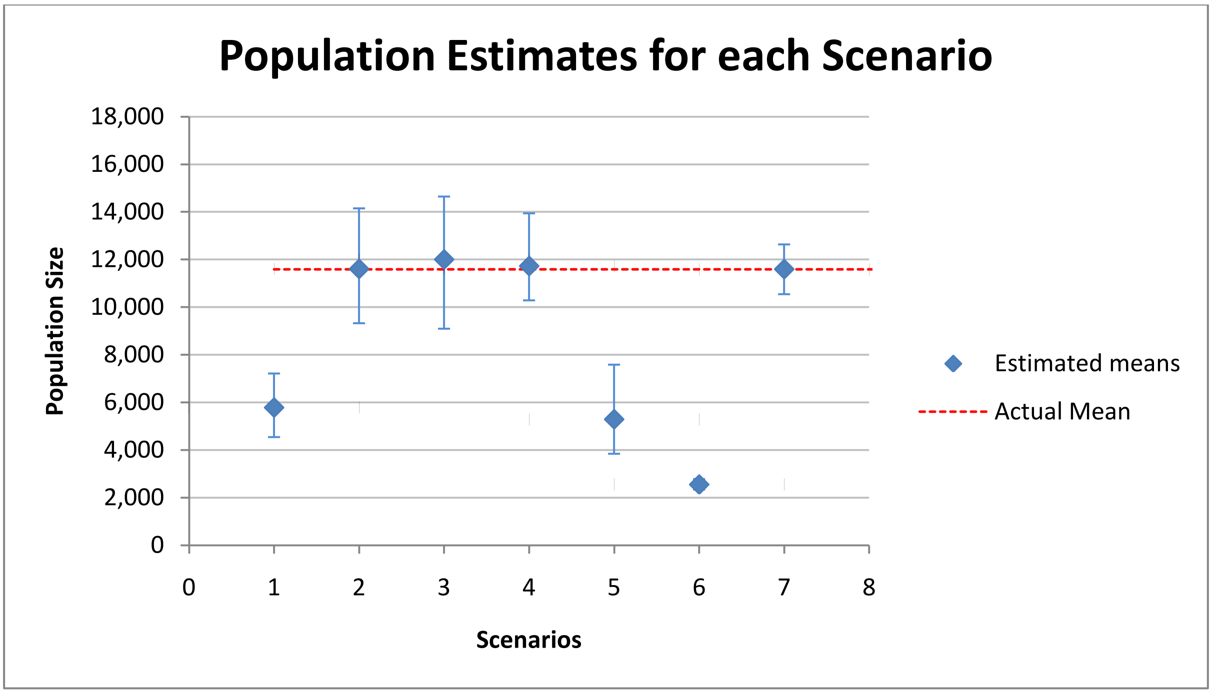

Figure 5.4 Shows the range of population estimates from the simulation when counting error was 0% for all the scenarios

5.3.4 Summary of Findings

The results of this study show that the most cost effective and accurate monitoring method was used in Scenario Motordistance_7. However this scenario was not vastly more cost effective and accurate than all the other scenarios.

Using the lessons learned from these evaluations, a suitable monitoring method can be adapted to a given situation if necessary. The general lessons learned from the results are:-

(i) The monitoring approach, in this study, does not have an effect on the costs but it does have an effect on the accuracy of the data. As distance sampling is the only monitoring approach out of the three that considers detectability, it would therefore provide the most accurate results and be the recommended sampling technique. Alternatively using the presence/absence approach would also be suitable but taking detectability would need to be accounted for in the analysis.

(ii) Motorbikes were the most cost effective medium as they are owned by the anti-plague scientists and so there was no purchase or hire cost for them. Alternatively the Toyota Land Rovers, once they were purchased, would result in cost effective monitoring programs.

(iii) Far greater precision can be achieved counting saiga rather than faecal pellets as the area sampled is far greater.

(iv) The wages of the surveyor greatly influenced the overall cost effectiveness of the monitoring program as this was biggest contributor to the cost per day for the majority of the monitoring methods.

5.3.5 Recommended Monitoring Plan

Scenario Motordistance_7 could cover a total area of 80,640 km^2, which is approximately 4 times the area of the Ustyurt (Olson, 2011). However, it is not necessary to monitor the entire area of the Ustyurt Plateau with equal effort. There is existing distribution data that has been collected by participatory monitors, indicating that the majority of the saiga herds are distributed in the north east of the Ustyurt (see Appendix D). The transects therefore can be stratified so that the majority of effort is focused on the areas where the saiga are believed to be.

To have a high level of precision, the same transects will be surveyed more than once. For this reason the monitoring plan recommends that one survey should complete 27 transects over 9 days and repeat this in November, December, January and February at the same period each month (Table 5.9).

Start up costs	Cost per day	Area of the Usyurt surveyed	Number of days per survey	Cost per survey	Number of repeat surveys	Total cost of monitoring
$ 12,303.22	$ 183	7,560 km^2	9	$1,647	4	$18,891.22

Table 5.9 Details for monitoring plan to be used in Uzbekistan

Training

Training is required for 6 of the anti-plague scientists. This requires an expert in distance sampling to be hired and travel to Nukus. The anti-plague scientists will be taught the theory of distance sampling and will have practical training in line transect surveys and calculating the distances of the saiga from the line on the Ustyurt. This training should take place before the first survey is to begin.

Budget

The budget for the monitoring plan is $18,891.22 (5.5)

ID	Task Name	Cost
262	**Monitoring plan**	**$18,891.22**
263	**Set up costs**	**$12,303.22**
264	**Training**	**$7,307.83**
265	**Trainers travel to and from Tashkent**	**$1,686.21**
266	Flight for trainer from Heathrow to Tashkent	$732.55
267	Hotel in Tashkent	$100.00
268	Travel insurance	$0.00
269	Living expenses in Tashkent	$20.00
270	Visa of British trainer	$331.92
271	Registration and telex	$89.74
272	Taxi to and from Tashkent airport * 4 journeys	$12.00
273	Trainer's wage	$400.00
274	**Trainer's travel to Nukus**	**$781.62**
275	Return flight from Tashkent to Urgench	$171.62
276	Taxi from Urgench Airport Nukus & return	$100.00
277	Hotel in Nukus * 2 return journey	$70.00
278	Living expenses during travel * 2 days	$40.00
279	Trainer's wages	$400.00
280	**Training**	**$4,840.00**
281	**4 days in Nukus**	**$2,720.00**
282	Wages for trainer	$800.00
283	Translator	$80.00
284	Wages for 6 * anti plague scientists	$300.00
285	Hotel in Nukus	$980.00
286	Living expenses in Nukus	$560.00
287	**5 days in the field**	**$2,120.00**
288	Wages for trainer	$1,000.00
289	Translator	$100.00
290	Wages for 6 * anti plague scientists	$375.00
291	Food	$280.00
292	Travel from Nukus to Jasliq	$200.00
293	Petrol in the field	$165.00
294	**Equipment purchase**	**$4,995.39**
295	Clothing * 6	$2,520.00
296	Bionoculars or spotting scopes * 3	$1,401.18
297	GPS * 3	$1,074.21
298	In the field per diem for 6 monitors	**$6,588.00**
299	Food * 6 people	$1,512.00
300	6 * pest control scientist's wages	$2,700.00
301	Petrol for one day * 3 bikes	$2,376.00

Figure 5.5 Budget for each item to complete scenario Motordistance_7 in the monitoring plan

Equipment List

The following equipment will need to be purchased before the surveys should begin.

i. Suitable warm clothing for all of the anti-plague people.
ii. 3 distance measuring binoculars or spotting scopes.
iii. 3 handheld GPS devices

Transects

The transects should be divided into two stata with the focus of the effort being North East of the main road. All the transects are separated by 6 km. The starting point for each row of transect was selected randomly. As the surveyors need to travel to and from the transects each day and fuel is a problem, long line transects were not used. Instead, each transect to be carried out by each surveyor per day has the surveyor travelling north and then travelling south, so that their end position is near to the starting position (Fig 5.6). Co-ordinates for each transect has been recorded but these may be adapted in the field if some are inaccessible (Appendix E).

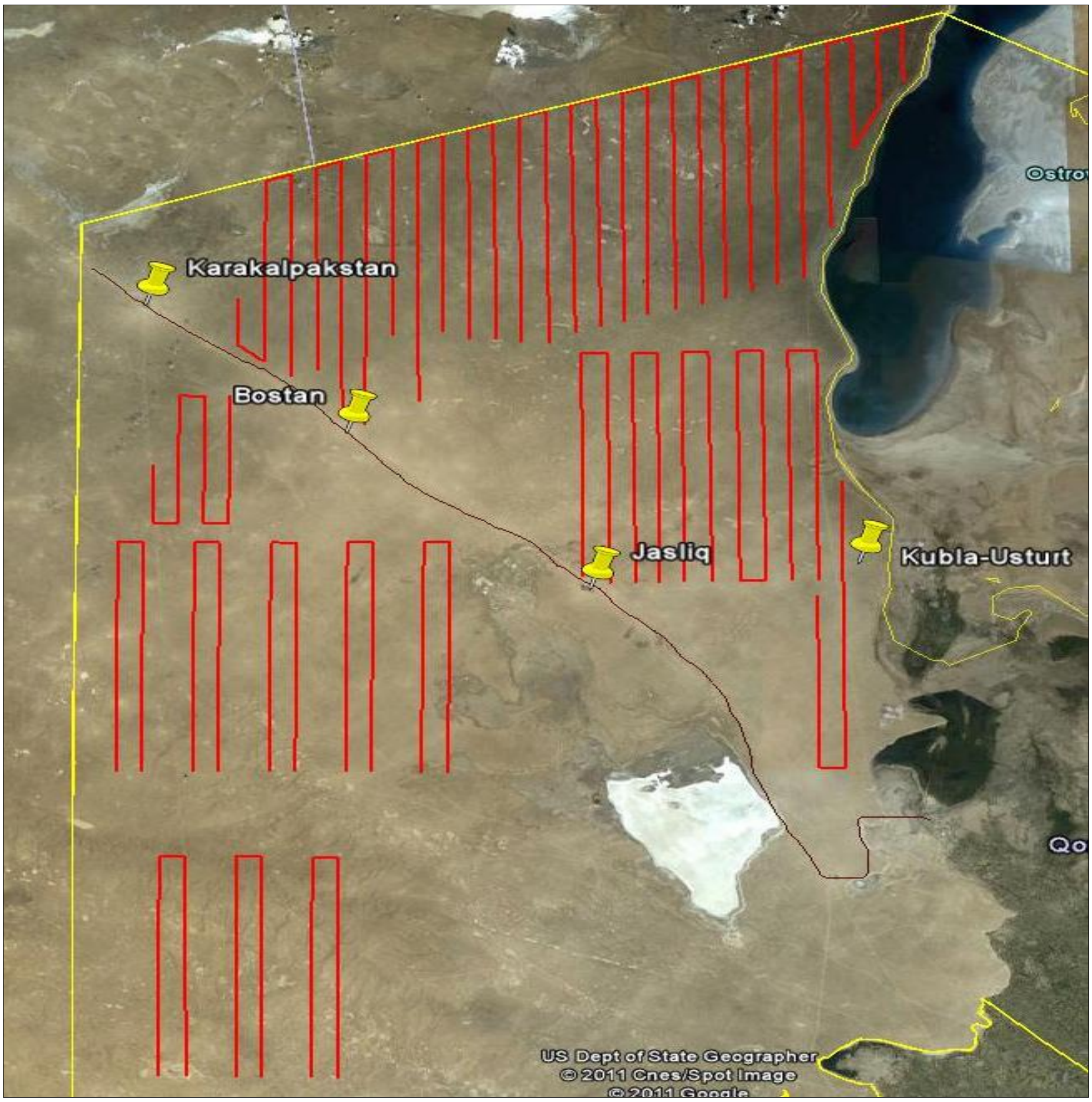

Figure 5.6 Map of the 27 transects to be completed by the 3 anti-plague scientists during each survey period

Next steps

A pilot study needs to be set up to evaluate if distance sampling is the most suitable monitoring approach and should be carried out as part of a training expedition. The pilot study would need to estimate detectability and if encounter rates are enough to establish the recommended sample size of 40 sightings. If distance sampling is not suited then the sampling technique that should be used is presence/absence with consideration for the bias caused by detectability.

The pilot study would also be used to evaluate the recommended transects locations and adjust these if any of the areas are inaccessible.

In order to improve the efficiency of the monitoring program, the locations of the transects should be re-evaluated annually. Singh et al (2009) used habitat suitability modelling to predict the best areas to sample for the rare and elusive Tibetan Argali. Each year's survey data was added to a habitat suitability model to build up a better model of their distribution. This was then used to improve the accuracy of where to focus their surveying effort and further stratify the transects. This approach should be used for this monitoring program. Current distribution data (see Appendix D) was used to stratify the area into two strata for the initial transects. The monitoring data from each year should be collated to produce a habitat suitability model for the saiga to inform how the area should be further stratified in the next survey. Over time this will reduce the effort required to monitor the saiga effectively.

6 DISCUSSION

6.1 Lessons Learned

6.1.1 Conservation Objective

Identifying the objective of a monitoring programme is not always straightforward, especially when, as this study experienced, there are several stakeholders involved. A wide variety of objectives and monitoring information were identified, and the link between what information should be collected and how this would be used to meet a conservation objective was not always clear. Sometimes monitoring information was identified as fulfilling several objectives or, in some cases, the monitoring objective seemed to be a secondary thought once it had been decided that monitoring data was needed. Managers need to be careful that a monitoring programme is implemented to meet a clear conservation objective and not just to have as much information about a situation as possible. It is important to have a common goal whereby all parties involved share and agree a clear objective (Thompson, 2004). To overcome the problem in this, and in any conservation project, it is essential that all the stakeholders involved sit down to discuss and agree the conservation objectives together. Only once these have been agreed, should the stakeholders decide if monitoring is the most effective tool to meet any of these objectives, and if so, what would be the most useful, and feasible monitoring information that should be collected. Monitoring can divert scarce resources from other conservation work (Sheil, 2001) and should only be implemented if it is the best solution to meet the agreed conservation objectives. In this study although there were several objectives identified, they are not all as feasible as each other. In 2006, the range saiga States signed a Memorandum of Understanding (MOU) under the CMS. Target 7 of the MOU was to enhance and expand protected areas for saiga conservation (CMS, 2010). Redesigning the Saigachy reserve would work towards this conservation objective. Distribution data would be the most feasible monitoring data that could be collected and would be the most useful method to achieve this objective. It was also the monitoring data that was identified by the majority of the stakeholders as a priority.

With this in mind, collecting distribution data would be the best way to achieve this objective. It would also be the most recommended objective to measure from a monitoring programme as currently it is the most feasible monitoring information that could be collected.

6.1.2 Co-ordination of Roles, Responsibilities and Resources

All the stakeholders need to be co-ordinated and in agreement how to implement a monitoring programme. It is important that all resources are used as efficiently as possible. Three separate monitoring programmes were identified in this study and were organised independently from each other and by different organisations. An aerial survey was carried out by Gosbiokontrol, vehicle distance sampling was organised by FFI and participatory monitoring was managed by SCA. If the monitoring resources of any groups involved were pooled into one monitoring programme it would help improve the success of any monitoring strategy and require less resources.

6.1.3 Bias in the Data

It can often be assumed that the accuracy of the data will improve if more samples are taken. This will not be the case if the data is biased in some way (McConville et al. 2009). It is more important to have low bias than to have high precision (Milner-Gulland & Rowcliffe (2007) as bias will affect how close the estimate is to the true value. If there is too much bias the sample is unrepresentative and inaccurate (Sutherland, 2006). In this study when the bias caused by detectability was not accounted for in some of the methods its effect was dramatic on the accuracy of the population estimates. In some cases the range of estimates that they produced did not include the actual population size. In an initial study done by O'Neill (2008) on the potential for using distance sampling with Rangers using saiga in Kalmykia, she found that there was too much error and bias in the results. This made the monitoring method unsuitable to collect accurate data. If a manager was making decisions based on biased population estimates, there would be a high risk of expensive mistakes being made. For example, if the population estimates for a game species indicated that the population had increased dramatically, the decision may be taken to allow more animals to be hunted than the population can recover from. It is essential that managers calculate the probability of detection and have an understanding of any other bias that may occur so that these can be reduced and taken into consideration when analysing the results. The accuracy of the aerial survey data collected in the Betpak-dala population in Kazakhstan was improved after recommendations made from the evaluation by Norton-Griffiths & McConville (2007) evaluation were implemented to reduce and quantify any bias that they identified (Frederik, 2010). It is also important for managers to regularly calculate detectability and other forms of bias as these will change with changing weather conditions, equipment and even changes in the species dynamics.

6.1.4 Sustainability of the Monitoring Programme

Unfortunately most monitoring projects don't have long term funding, especially if this is being funded by NGO's who have to apply for short term funding grants. Additionally state monitoring agencies are often not equipped to sample vast areas and therefore are unable to undertake regular monitoring long term (Singh & Milner-Gulland, 2011).

This may result in options that are better for short term monitoring being proposed or certain methods not being considered as there is no guarantee that the monitoring programme will be funded long term. In this study none of the NGOs involved had a confirmed monitoring budget for more than one or two years and Gosbiokontrol's monitoring budget seemed to be re-evaluated each year.

For monitoring programmes to be sustainable, it is important to consider how the monitoring programme will be funded long term. Ideally they should be designed to be cost effective and affordable without long term funding from NGO's and with the involvement and commitment of local or state organisations. If this is achieved a monitoring programme will be continued after funding from the NGO's has stopped and monitoring data will be collected long term. This is even more important if the monitoring programme is only able to achieve low statistical power in the short term as can often occur in poor countries (Sutherland, 2006). Achieving enough power to detect changes is essential for monitoring data to be useful. If a monitoring programme is only able to achieve low statistical power, then collecting monitoring data over a long period of time is way to increase its power. The aerial survey data in Kazakhstan has been collected for 40 years which has increased its power to detect changes (although the bias in the data has affected its overall accuracy). In this study more work should be done with collaboratively with Gosbiokontrol to establish a long term monitoring strategy that will be sustainable long term.

6.1.5 Impacts of Local Factors

This study identified a wide range of monitoring methods available to managers. It can sometimes be difficult to ascertain if a monitoring method is suitable as it may not be obvious when first investigating a situation. Aerial surveys have been used to monitor saigas quite successfully in Mongolia and Kazakhstan (Frederik, 2010; Zuffer, 2009). This approach was also used in the 1990s in Uzbekistan and it was assumed by many of the people interviewed that aerial surveys were still the most suitable monitoring method to cover such a large area. The results in this study showed that because of recent regulations in the area, whereby planes were not to take off and land on the Ustyurt, too much of the flight was spent getting to and from the area rather than monitoring. This meant that only a small area could be monitored each day and therefore was not a cost effective option. In addition to this, the other aerial surveys were carried out in the spring whereas currently the majority of the saiga only migrate into Uzbekistan during the winter months. Therefore the aerial surveys would be drastically compromised due to the extreme winter conditions in Uzbekistan unlike any of the other aerial survey examples. If a monitoring programme needs to be set up for another saiga population, it may have different objectives and local factors affecting its feasibility. As a result the local factors should be re-evaluated.

As local factors can drastically affect the feasibility of a monitoring method, it is important for managers to not make assumptions on the feasibility of a monitoring methods based on its success with similar species or in similar terrains.

6.1.6 Collecting Information

There is little existing information easily accessible on monitoring costs for other monitoring programs (Van Hensberg and White 1995). This study showed that it took a substantial amount of time and resources in order to be able to collect information on costs, local factors, resources and attitudes, all of which were needed to evaluate and compare different monitoring methods. In countries like Uzbekistan information like this is often difficult to come across quickly and easily. Prices, maps and general information can often not be found online and has to be obtained from investigating many sources. The phone and e-mail were not suitable to interview people or request information as people didn't have access to these mediums or were not as comfortable using them. Information is more likely to have to be obtained through face to face conversations when working in less developed countries. In addition information on other case studies and monitoring methods is largely obtained from books and scientific journals which are expensive and not available to most conservation managers. With this in mind it would be almost impossible for most conservation managers in poor countries to dedicate the amount of time and resources required to collect all the information required to accurately evaluate different monitoring methods.

To overcome this, more information about projects needs to be shared among all conservationists. Details about budgets and lessons learned, especially where things went wrong in projects and how these were overcome should be included in reports that are accessible. Data that is collected should also be made available to other conservation organisations. This may reduce the amount of information that needs to be collected as it has already been sourced by another organisation or examples of how other organisations managed to overcome this problem may help. Over time, there would be few situations where there is no pre-existing information already collected, therefore reducing the workload for individual projects when starting a new project.

6.1.7 Evaluation Framework in this Study

Single monitoring methods are sometimes evaluated by bringing in a consultant. For example Mike Norton-Griffiths evaluated the aerial survey in Kazakhstan (Norton-Griffiths & McConville, 2007; Norton-Griffths, 2010). However there are very few examples of case studies where the cost effectiveness of several potential monitoring methods are evaluated. Gaidet-Drapier et al (2006) attempted to do this but his study required detailed fieldwork in order to compare and evaluate the cost effectiveness of several monitoring methods. Joseph et al (2006) was able to compare the cost effectiveness of two monitoring methods but he used the substantial monitoring data that had already been collected in order to do this comparison. Managers need a way to select the most suitable monitoring method for their situation and then if required, a consultant can be brought in to do a detailed evaluation of the proposed method.

The evaluation framework used in this study could be used by managers to evaluate monitoring methods for other saiga populations or even other dryland ungulates. The framework identifies assumptions that need to be addressed when planning a monitoring programme. It recommends what cost information should be collected and how to categorise these costs. It also recommends the types of monitoring mediums that should be considered for dryland ungulates, categorises local factors and makes recommendations how to identify potential surveyors. The framework is the first step to being able to compare cost and feasibility for several monitoring methods for dryland ungulates. It is able to identify the range of potential outcomes for a monitoring program when different approaches are taken and therefore the need to accurately evaluate them.

6.2 Limitations and Recommendations for Future Research

It is inevitable to have some limitations in all studies but it is important to recognize these as they will be useful in identifying and recommending areas for future research.

It is important to develop effective methods to map the distribution of rare species (Singh et al, 2009) otherwise sampling error can occur as the units that are sampled are not representative of the population (Milner-Gulland & Rowcliffe, 2007). The saiga are known to have a highly clumped distribution (Norton-Griffiths, 2010) and the monitoring data currently collected shows that the saiga are distributed heavily in one area of the Ustyurt (see appendix D). In this study, due to time constraints, the spatial distribution of the saiga population was not incorporated into the simulation. It was however considered when designing the recommended monitoring plan. As described in the next steps and using the technique recommended in (Singh et al. 2009) the spatial distribution of the saiga will be mapped out iteratively using on-going monitoring data. Future research could introduce the spatial structure and distribution obtained from this monitoring data and incorporate this into the evaluation process. This would then allow recommendations to be made about the most cost-effective monitoring method and how it should be managed.

There are different strengths and weakness for each monitoring approach and some approaches are more feasible for different surveyors to carry out. For example presence only data is simple for most surveyors to collect (Singh et al, 2009) but distance sampling requires the surveyor to be able to accurately measure the perpendicular distance from the species to the transect and this can be too difficult for some surveyors as O'Neill (2008) found in her investigation. This study was able to identify potential surveyors but with further time and resources it would be useful if a method was developed that could further evaluate potential surveyors ability to carry out the assumptions in different monitoring approaches. This would enable the monitoring approach to be evaluated by both its accuracy and feasibility.

In some situations several monitoring methods have been used to collect data. For example in Kazakhstan there has been ranger vehicle based monitoring, participatory monitoring and aerial surveys for saiga (Chilton, 2011). It can be difficult to combine these different monitoring datasets (Singh & Milner-Gulland, 2011) but there are an increasing number of examples where this has been done (Oba et al., 2008; Rist et al. 2010). This study was able to develop a framework that evaluated independent monitoring methods. With further time it would be useful to further develop the framework so that combinations of several monitoring methods could be evaluated. For instance the local people, rangers, gas employees and border guards were not suitable as the sole surveyors in this study. If the framework was further developed then combinations of participatory monitoring from these surveyors along with another method could be evaluated to calculate which combination would be the most cost effective.

Some methods that are used to extrapolate the results can be quite complex and can result in differing population estimates, even using the same monitoring data set. Zuffer (2009) showed using the population counts from the Betapak saiga population that when using an alternative extrapolation approach to the standard extrapolation approach that was being used, the population estimate was 18% higher. With more time, research could be done to incorporate different extrapolation methods into the framework and developing a way that these can be included in the evaluation process. This would then provide managers with a way to evaluate the entire process of a monitoring program from collecting monitoring data to extrapolating the results.

Finally, the need to evaluate monitoring methods does not apply only to working with dryland ungulates. Many conservation implementers in poor countries need a way to decide which monitoring method is the most cost effective. It is vital that managers working in poor countries with low resources are given the tools and means to be able to choose the most appropriate monitoring method for their situation

If time allowed, further research could be done into developing the framework so that it could be used for similar species. Although this framework was designed for saiga antelope, its criteria was developed using case studies on monitoring large terrestrial mammals. Therefore, research could be done to see how adaptable the framework is for other terrestrial mammals and adapt the criteria and scenarios to incorporate a wider range of mammals.

Although this framework would not be suitable to be used for totally different species or species that are not terrestrial e.g. flora or marine, the fundamental process that was taken to identify the framework could be used to develop new frameworks for species that have different monitoring requirements.

6.3 Conclusion

This study has highlighted the difficulties managers face when considering setting up a monitoring programme. It has also identified the substantial amount of information that is required before most monitoring methods can be reasonably evaluated. Projects that are starting from scratch and have little, or no, access to information about other studies will find collecting this information a strain on their resources and time. This study has shown that there are a wide range of local factors, for example climate or local laws, that can affect the success of a monitoring programme which could be overlooked if sufficient time is not spent identifying them. Monitoring surveyors also has a large impact on the sustainability and accuracy of a monitoring program. Resources and time are often tight and managers need a simple way to help them through the process of selecting a cost effective monitoring method. This study has shown that there are feasible options for a cost effective and sustainable monitoring program to be introduced in Uzbekistan for saiga and it would be able to successfully provide useful information to meet its conservation objective.

As monitoring becomes higher on the agendas of governments and funders and a requirement in many conservation projects, it will become increasingly vital for managers to have a way of evaluation monitoring methods. The framework developed in this study is the first step to providing managers the ability to carry out this process. However more needs to be done to develop frameworks that can be used for other species and requiring less investment of time and resources for conservation managers.

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APPENDICES

Appendix A

People Interviewed During This Study:

Gosbiokontrol is the Uzbekistan's state nature committee and is responsible for managing the protection of the Saiga as well as managing all other species within Uzbekistan.

(i) Leuzad Azipjanov interviewed on the 6th of June. He is currently involved in monitoring all game species. He was involved in Saiga monitoring in 1991.
(ii) Maxim Mitropolskiy interviewed on the 6th of June led the aerial surveys in Uzbekistan for several species.
(iii) Efennaly Yonekorov interviewed on the 6th of June. He used to issue licences for Saiga hunting when it was legal.
(iv) Eugeny Chernopoer was interviewed on the 20th of June. He is the current co-ordintor of the GEF project. Worked previously in a monitoring group which included Saiga monitoring.

The SCA is a charity for Saiga conservation across all the regions.

(i) E.J Milner-Gulland is a chair of the Trustees and the steering committee. She is also a Professor in Conservation Science at Imperial College and has worked in Saiga conservation and research for over 20 years.
(ii) Elena Bykova is the executive secretary or the trustee and steering committee in Uzbekustan. She is also a trained zoologist and works for the Institute of Zoology. She also manages the participatory monitors.
(iii) David Mallon is on the board of Trustees and is also an antelope specialist.

Uzbekistan Institute of Zoology is the Uzbek academy of science.

(i) Alexander Esipov was interviewed on the 6th of June and throughout the field work. He is a zoologist and has many years of monitoring experience on the Usyurt including monitoring Saiga. Alexander provided a lot of cost and feasibility information.

(ii) Dima Golovtsov had been involved in aerial survey training in Kazakhstan, vehicle based distance sampling in Uzbekistan and managing the participatory monitors in Uzbekistan.

FFI is a conservation NGO and is

(i) Maria Karlstetter interviewed on the 12th of May. She is the programme manager for FFI's Euroasia programme.

Participatory monitors

(i) Uralbay was interviewed on the 15th of June in Jaslyk and had previously been a participatory monitor for 4 years.
(ii) Kurmangazy was interviewed on the 16th of June in Jaslyk and had previously been a participatory monitor for 4 years.
(iii) Vladamir was interviewed on the 19th of June in Karakalpakstan and was currently a monitor and had been for 4 years.
(iv) Unnamed was interviewed on the 26 th of June in Kubla Usturt

Local People

(i) Unnamed elderly local in Jaslyk was interviewed on the 15th of June as he was eager talk about how important that Saiga are.
(ii) Antanazaar was interviewed on the 16th of June in Jaslyk. He was a driver for the gas company dismantling pipelines and was interested in becoming a participatory monitor.

Shepherds

Four Shepherd families were visited on the 19th of June 11km north of Bostan. All families originated from Kungrad and only spent time on the steppe between March and November. None of the families had seen any Saiga in the last 3 years.

Experts

(i) Mike Norton is a wildlife expert for counting large animals in Africa and has been evolved in evaluating the aerial survey in Mongolia and Kazakhstan.

(ii) Navinder Singh is a monitoring expert and has done extensive research on rare central Asia ungulates in remote and understudied regions.

(iii) David Mallon as already mentioned is an antelope specialist

(iv) Peter Damerell carried out social surveys in Uzbekistan concerning the saiga awareness campaign

(v) Adam Phillipson carried out social surveys in Uzbekistan to investigate the illegal saiga meat and horn trade.

Appendix B

Two cost scenarios produced in MS Project showing the breakdown of costs for an aerial and a ground based survey.

ID	Task Name	Cost
1	**Scenario: Aerlocal_1**	**$13,205.11**
2	**Set up costs**	**$7,967.80**
3	**Training in Nukus**	**$2,918.00**
4	**Travel to Nukus**	**$1,367.00**
5	Flight of trainer from Heathrow to Tashkent	$732.55
6	Travel insurance	$0.00
7	Living expenses in Tashkent for trainer	$40.00
8	Hotel in Tashkent * 2 nights	$100.00
9	Visa of British trainer	$165.96
10	Registration and telex	$44.87
11	Taxi to and from Tashkent airport * 4 journeys	$12.00
12	Return flight from Tashkent to Urgench	$171.62
13	Taxi from Urgench Airport Nukus & return	$100.00
14	**Training**	**$1,551.00**
15	Hotel in Nukus	$105.00
16	Living expenses in Nukus for trainer	$60.00
17	Wages for trainer	$600.00
18	Translator	$60.00
19	Wages for monitors/observers during training	$726.00
20	**Equipment purchase**	**$5,049.80**
21	GPS for observers * 2	$996.52
22	Photographic equipment	$3,558.56
23	Callibration kit - Fishing rod, markers & measuring tape	$284.72
24	Recording equipment (datasheets, pencils, erasers, sharpners and tape r	$210.00
25	Maps	$0.00
26	First aid	$0.00
27	**Running costs of surveys**	**$5,237.31**
28	**One off cost per survey**	**$1,211.73**
29	Mounting system for camera	$71.21
30	Passenger insurance	$1,140.52
31	**Per diem costs**	**$4,025.58**
32	Aerial survey	$3,600.00
33	Wages for monitors	$200.00
34	Wages for observers	$42.70
35	GPS for pilot	$28.48
36	2* Taxi for monitors and observers to and from airport	$12.00
37	Laser altimeter,mounting system, computer and cables	$70.98
38	Intercom	$28.70
39	Ground assistants * 2	$42.72

ID	Task Name	Cost
41	**Scenario: Carexternal_2**	**$5,398.53**
42	**Set up costs**	**$864.98**
43	Tent	$749.99
44	Propane heater	$114.99
45	Clothing	$0.00
46	GPS	$0.00
47	Bionoculars	$0.00
48	**Running costs of surveys**	**$4,532.24**
49	**One off costs per survey**	**$3,871.24**
50	**Travel to the field**	**$3,871.24**
51	**Travel to Tashkent**	**$2,338.76**
52	Flight of scientists from Heathrow to Tashkent	$1,465.10
53	Travel insurance	$0.00
54	Living expenses in Tashkent	$40.00
55	Flat in Tashkent	$400.00
56	Visa of British trainer	$331.92
57	Registration and telex	$89.74
58	Taxi to and from Tashkent airport * 4 journeys	$12.00
59	**Travel to Nukus**	**$663.24**
60	Return flight from Tashkent to Urgench	$343.24
61	Taxi from Urgench Airport Nukus & return	$100.00
62	Hotel in Nukus	$140.00
63	Living expenses in Nukus	$80.00
64	**Travel to Jasliq**	**$869.24**
65	Food	$40.00
66	2 * Monitor wages	$400.00
67	2 * Driver and car hire	$200.00
68	Petrol to drive from Nukus to Jasliq and return	$229.24
69	**In the field per diem**	**$661.00**
70	Car hire UAZ and drivers	$200.00
71	Food	$28.00
72	2 * Monitor wages	$400.00
73	Petrol for 150 km	$33.00
74	**Cost per km**	**$1.31**
75	Benzene in the field per litre	$1.09
76	Benzene in the field per km	$0.22

Appendix C

Shows the cost breakdowns for each scenario to calculate the area monitored per day and for a $30,000 budget. The breakdown is shown across the two tables.

	Start up costs	Initial costs per survey	Cost per day	Maximum distance available in one day	Distance travelled to and from base to transects	Width of transects monitored	km of transect surveyed
Aerlocal_1	$ 7,949.96	$ 1,211.73	$ 4,025.58	900 km	600 km	2 km	300 km
Carexternal_2	$864.98	$ 3871.24	$661	150 km	50 km	2 km	90 km
Carlocal_3	$14,094.34	$ 609.24	$ 402.31	150 km	50 km	2 km	90 km
Toylocal_4	$14,461.78	$ 610.92	$ 260	200 km	50 km	2 km	140 km
Motorpellet_5	$ 6,901.25	$0	$ 183	600 km	150 km	0.004 km	330 km
Motorpresense_6	$ 6,901.25	$0	$ 183	600 km	150 km	2 km	420 km
Motordistance_7	$ 12,303.22	$0	$ 183	600 km	150 km	2km	420km

	Km^2 surveyed in one day	Days surveyed for $30,000	Area surveyed for $30,000 1st year	Days available in 2nd year	Area surveyed for $30,000 year 2
Aerlocal_1	600 km^2	5	3,000 km2	7	4200 km^2
Carexternal_2	180 km^2	38 - (4 days for refuelling)	6120 km2	39 -4 for refuelling	6,300 km^2
Carlocal_3	180 km^2	38 - (9 days for refuelling)	5220 km2	73 -(8 days refuelling)	11,700 km^2
Toylocal_4	280 km^2	57 - (11 days for refuelling)	12, 880 km2	113 - (22 refuelling)	25,180 km^2
Motorpellet_5	1.32 km^2	126 (refuel everyday)	166.32 km2	163	215 .16 km^2
Motorpresense_6	840 km^2	126 (refuel everyday)	105,840 km2	163	136,920 km^2
Motordistance_7	840 km^2	96 (refuel every day)	80,640 km2	163	136,920 km^2

Appendix D

Map produced by Elena Bykova using participatory monitoring data showing saiga distribution map for 2007-2008.

Appendix E

Transects Co-ordinates for the Monitoring Plan

Strata one: North East of the road

	Southern		Northern		
Transects	**Longitude**	**Latitude**	**Longitude**	**Latitude**	**Km**
T 1.0	56 ^{o} 28.000E	44 39.2000N	56 ^{o} 28.000E	44 47.000N	15
T 1.1	56 33.000E	44 36.400 E	56°33'1.43"E	45° 7'23.41"N	57
T1.2	56°37'58.31"E	44°33'58.90"N	56°37'31.52"E	45° 8'31.55"N	64
T 2.0	56°42'2.76"E	44°35'4.06"N	56°42'9.59"E	45° 9'30.32"N	64
T 2.1	56°47'4.84"E	44°27'34.03"N	56°46'33.95"E	45°10'38.40"N	80
T 3.0	56°51'20.29"E	44°25'42.92"N	56°51'5.84"E	45°11'53.21"N	85
T 3.1	56°55'56.25"E	44°41'35.74"N	56°55'55.68"E	45°12'55.22"N	59
T 4.0	57° 0'43.92"E	44°30'11.75"N	57° 0'11.65"E	45°13'56.39"N	82
T 4.1	57° 4'58.99"E	44°41'26.90"N	57° 4'54.90"E	45°15'0.14"N	62
T 5.0	57° 9'37.74"E	44°41'28.08"N	57° 9'35.09"E	45°16'13.43"N	66
T 5.1	57°14'1.79"E	44°41'37.04"N	57°13'55.84"E	45°16'55.43"N	68
T 6.0	57°28'27.03"E	44°41'16.20"N	57°28'5.07"E	45°19'57.39"N	68
T 6.1	57°32'50.64"E	44°41'52.70"N	57°31'56.36"E	45°20'34.35"N	70
T 7.0	57°36'57.20"E	44°43'19.03"N	57°36'58.94"E	45°21'10.98"N	71
T 7.1	57°41'38.94"E	44°43'55.05"N	57°41'45.21"E	45°23'2.82"N	73
T 8.0	57°46'39.12"E	44°45'8.14"N	57°45'37.59"E	45°23'39.67"N	72
T 8.1	57°51'21.52"E	44°45'31.23"N	57°51'17.56"E	45°24'28.50"N	72
T 9.0	57°56'4.89"E	44°46'56.62"N	57°55'10.76"E	45°25'17.64"N	72
T9.1	57°59'55.12"E	44°47'44.81"N	57°59'40.29"E	45°26'19.04"N	72
T10.0	58° 4'58.07"E	44°48'57.03"N	58° 5'5.28"E	45°27'57.91"N	72
T 10.1	58° 9'25.63"E	44°49'31.92"N	58° 9'35.28"E	45°28'21.57"N	72
T 11.0	58°13'51.06"E	44°59'54.35"N	58°14'10.65"E	45°29'43.02"N	60
T 11.1	58°18'39.92"E	45°30'31.03"N	58°18'51.11"E	45°12'59.12"N	35

T11.2	58°23'43.83"E	45°18'58.90"N	58°23'47.56"E	45°32'21.82"N	24
T11.3	58°28'17.42"E	45°32'20.14"N	58°28'37.77"E	45°23'32.26"N	20
T12.0	57°29'54.42"E	43°59'47.85"N	57°29'30.83"E	44°37'3.48"N	70
T12.1	57°34'36.33"E	43°58'57.63"N	57°34'2.32"E	44°37'18.18"N	70
T13.0	57°38'22.18"E	43°58'44.53"N	57°38'42.54"E	44°37'4.65"N	70
T13.1	57°43'0.40"E	43°59'8.49"N	57°43'5.17"E	44°37'3.48"N	70
T14.0	57°47'55.86"E	43°59'19.53"N	57°47'27.79"E	44°37'2.15"N	70
T14.1	57°51'58.79"E	43°58'53.01"N	57°51'50.70"E	44°37'25.58"N	70
T15.0	57°56'53.94"E	43°58'38.56"N	57°57'6.05"E	44°37'36.02"N	70
T15.1	58° 1'15.01"E	43°59'14.26"N	58° 1'11.07"E	44°37'21.82"N	70
T16.0	58° 6'45.15"E	43°58'45.68"N	58° 5'34.35"E	44°37'32.28"N	70
T16.1	58°10'31.20"E	43°58'30.60"N	58°10'50.15"E	44°37'17.19"N	70
T17.0	58°10'11.37"E	43°55'34.64"N	58°10'7.49"E	43°27'1.26"N	55
T17.1	58°14'50.71"E	44°15'23.45"N	58°14'10.70"E	43°27'23.99"N	90

Strata two: South of the road

	Southern		**Northern**		
Transects	**Longitude**	**Latitude**	**Longitude**	**Latitude**	**Km**
T 18.0	56°13'44.08"E	44°17'57.38"N	56°13'57.27"E	44° 8'21.56"N	18
T 18.1	56°18'4.54"E	44°29'28.58"N	56°18'3.82"E	44° 9'30.60"N	40
T18.2	56°22'44.52"E	44°29'53.32"N	56°22'42.95"E	44° 9'11.25"N	40
T18.3	56°27'21.07"E	44° 9'35.99"N	56°27'26.63"E	44°28'48.97"N	40
T19.0	56° 7'43.65"E	43°25'25.96"N	56° 6'41.47"E	44° 4'21.71"N	45
T19.1	56°11'37.65"E	43°26'44.05"N	56°12'53.58"E	44° 5'16.48"N	45
T20.0	56°20'35.50"E	43°26'29.24"N	56°21'20.74"E	44° 5'48.44"N	45
T20.1	56°25'3.76"E	43°26'33.60"N	56°25'51.83"E	44° 5'28.01"N	45
T21.0	56°34'32.84"E	43°27'6.42"N	56°34'19.29"E	44° 5'10.45"N	45

T21.1	56°39'0.74"E	43°27'10.10"N	56°39'23.27"E	44° 5'14.16"N	45
T22.0	56°47'56.68"E	43°26'52.53"N	56°48'23.37"E	44° 5'20.18"N	45
T22.1	56°52'23.58"E	43°27'44.48"N	56°53'27.01"E	44° 5'23.25"N	45
T23.0	57° 1'19.17"E	43°27'0.94"N	57° 1'53.02"E	44° 5'3.50"N	45
T23.1	57° 6'19.56"E	43°27'27.63"N	57° 6'55.61"E	44° 5'54.24"N	45
T24.0	56°15'56.36"E	42°35'23.55"N	56°14'45.14"E	43°11'16.62"N	45
T24.1	56°19'50.41"E	42°34'38.01"N	56°20'18.46"E	43°12'36.22"N	45
T25.0	56°28'43.09"E	42°35'12.77"N	56°27'34.82"E	43°11'30.02"N	45
T25.1	56°32'36.18"E	42°35'16.82"N	56°33'41.32"E	43°12'49.44"N	45
T26.0	56°42'2.09"E	42°35'26.48"N	56°41'29.95"E	43°12'7.29"N	45
T26.1	56°47'2.12"E	42°34'41.29"N	56°47'4.21"E	43°11'47.24"N	45

Transects are numbered 1.0, 1.1 etc are to indicate that these will all be done in one day, by one team of surveyors.