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The status of the Saiga antelope in the Ustiurt region of western Kazakhstan

By

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A report submitted in partial fulfillment of the requirements
for the M.Sc. Environmental Technology
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DECLARATION OF OWN WORK

I declare that this thesis "The status of the Saiga antelope in the Ustiurt region of western Kazakhstan" is entirely my own work and that where any material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgements given.

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ABSTRACT

The Saiga antelope (*Saiga tatarica tatarica)* has experienced spectacular declines in all four of its Central Asian populations in recent decades. Anthropogenic factors are considered to be the root cause, with poaching considered to be the primary factor. This activity is fuelled by the demand for meat for local sustenance and the relatively high income that can be gained by selling the horns, possessed only by the males, to the Chinese market for traditional medicine.

An expedition went to the remote Ustiurt population in western Kazakhstan during May 2004 to investigate the status of the antelope at a particularly vulnerable time in its life cycle, when the majority of the population historically migrates into a restricted range to form aggregations in which the females give birth in a mass calving event. Anecdotal evidence from other Saiga populations suggests that at low densities this behaviour changes, with females choosing to give birth away from the shelter of an aggregation. This study set out to gather evidence to ascertain whether this was the case in Ustiurt and to establish whether the calves, were comparable in vital statistics to those sampled in 1998, time when the population size was large and healthy.

Results indicated that the majority of Saiga were not aggregating and were instead forming dispersed groups over a large area and hence at a very low density. An extremely low ratio of males to females and calves to females was observed and this is believed to be interrelated, the biased sex ratio resulting in few pregnancies, with many barren females. The root cause of this observation for the low proportion of males and associated low fecundity is likely to be from selective hunting of the males for their horns. The species is in grave danger of reproductive collapse unless urgent conservation action is taken.

Direct disturbance by the expedition may have been a driving factor in certain observations of behaviour and the benefits of intrusive research should in future be weighed against the costs of disrupting an already endangered population.

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List of acronyms

CBD	Convention on Biological Diversity
CMS	Convention on Migratory Species
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
GDP	Gross Domestic Product
GIS	Geographical Information System
GPS	Geographical Positioning System
IoZ	Institute of Zoology (Almaty – Kazakhstan)
IUCN	International Union for the Conservation of Nature (World Conservation Union)
MoU	Memorandum of Understanding
SD	Standard Deviation
SE	Standard Error
USSR	Union of Soviet Socialist Republics

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INTRODUCTION

The Saiga antelope is a nomadic herd-forming ungulate found in the steppe, semi-desert and desert of ex-Soviet Central Asia. It is about the size of a domestic goat and has a distinctive protuberant nose in which the apertures of the tubular nostrils are directed downward. During the summer its coat is a sandy colour with a white belly whilst in the winter it develops a heavy, creamy coloured coat. Only the males possess ringed, lyrate horns which are amber-coloured, and set wide apart on the head.

Figure 1.1: A group of Saiga feeding in typical steppe habitat during spring 2003. Two young males (with horns) can be seen in the left hand side of the photograph, with females to the right. (copyright J.-F. Lagrot, reproduced with kind permission).

The Saiga belongs to the order Artiodactyla and the family Bovidae. There is some debate as to the subfamily but consensus seems to be with Antilpopinae (Bekenov *et al*. 1998). There are two sub-species: *Saiga tatarica mongolica* in Mongolia and *Saiga tatarica tatarica* in Russia (Kalmykia) and Kazakhstan, with seasonal migrations that include Uzbekistan and Turkmenistan. The former is morphologically distinct from *Saiga tatarica tatarica*, with a smaller head and smaller horns (Lushchekina *et al*. 1999). This study concentrates on the Ustiurt population in western Kazakhstan and henceforth "Saiga" will be taken to be referring to the *Saiga tatarica tatarica* sub-species unless stated otherwise.

Since the collapse of the Union of Soviet Socialist Republics (USSR) in 1991, Saiga populations have declined by more than 90% (Milner-Gulland *et al*. 2001), leading the World Conservation Union (IUCN), to classify the species as Critically Endangered in its 2002 Red List. Saiga were also included in Appendix 2 of the Convention on Migratory Species (CMS) in 2002 and have been listed in appendix 2 of the Convention for International Trade in Endangered Species (CITES) since 1995, upgraded from Near-Threatened to Critically Endangered in 2002.

Poaching, illegal trade in horns and other products, uncontrolled hunting, habitat destruction and fragmentation preventing natural dispersion and migration are thought to have contributed to recent declines in the Saiga. The collapse of the rural economy and the lack of alternative livelihood options following the break-up of the USSR are likely to be important contributing factors. The resulting economic hardship and impoverishment of local communities is thought to be driving the illegal hunting of Saiga. The antelope are economically valuable for their meat and hide, but especially for their horns, which are used in Chinese traditional medicine *(*Milner-Gulland *et al*. 2001). In 2000 a kilogram of Saiga horn was valued at $100 on the black market in Russia (Robinson & Milner-Gulland, 2003). Before the opening of the Russian-Chinese border in 1991 lead to the creation of a lucrative black market for Saiga horn, the market focus had been on Saiga meat (Sokolov & Zhirnov 1998).

Saiga numbers have dropped spectacularly in recent years throughout their range and especially in the Ustiurt region. Figure 1.2 illustrates the decline from 1980 to present, the current Ustiurt population size being around six per cent that which it was a decade ago for example *(*Milner-Gulland *et al*. 2001. Milner-Gulland. Unpublished data). The observed decline appears to be accompanied by a decrease in birth rates and an increase in the number of barren females (Milner-Gulland *et al*. 2003). This suggests that the population is undergoing a reproductive collapse, which could seriously inhibit the species ability to recover, especially in the face of continuing hunting pressures.

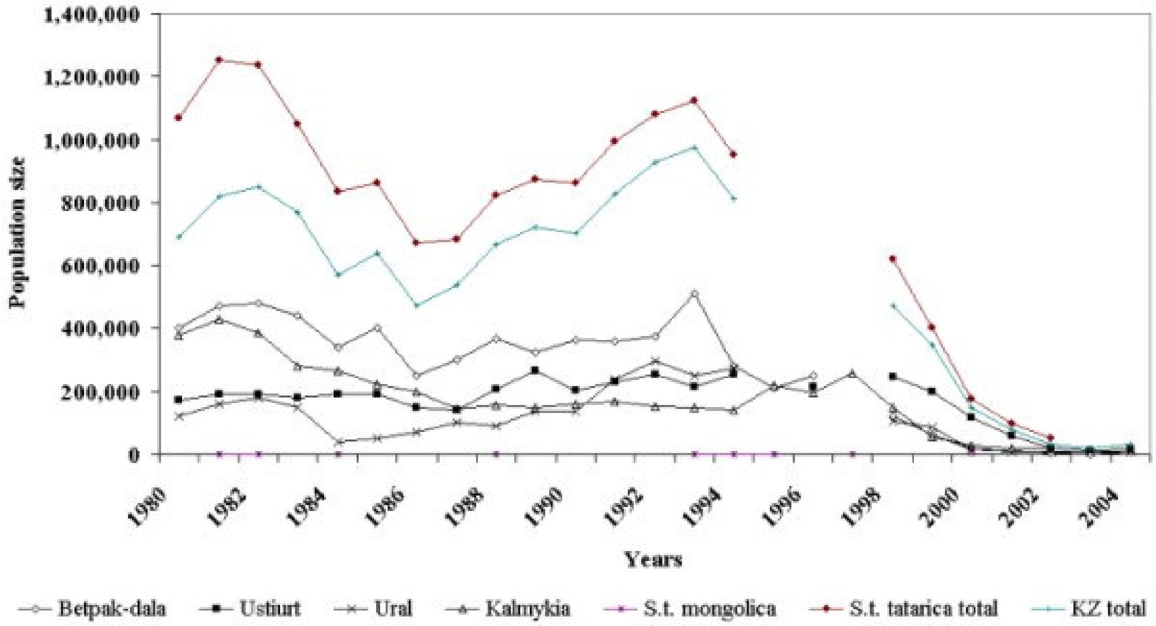

Figure 1.2: The trend of decline in numbers for the Saiga antelope since 1980 until the present day. (1980 – 2000 data from Milner-Gulland *et al* 2001 in Oryx, post 2000 from unpublished data, Institute of Zoology, Almaty, Kazakhstan. Iu. A Grachev, pers comm. 2004.).

This reproductive collapse of the species is thought to be driven by an extremely biased sex ratio, with the lack of sufficient males being directly responsible for the decline in fecundity observed (Milner-Gulland *et al* 2003). Selective poaching of adult males driven by the demand for Saiga horn has most probably resulted in this devastating situation.

The overall aim of this thesis is to examine the ecology and behaviour of the Saiga antelope, during the spring calving event in May 2004 in the Ustiurt region in western Kazakhstan. This region is home to what is currently the largest population of Saiga antelope, although this was not the case historically. Saiga traditionally form large aggregations of up to tens of thousands of animals to give birth during a mass calving event, taking place within a relatively short period. The time of birth varies between years and regions but is generally in the first or second ten day period in May (Bekenov *et al.* 1998).

Anecdotal reports from aerial surveys over the Betpak-dala region in central Kazakhstan indicate that the Saiga population there have failed to form the large birthing aggregations since 1997, with females increasingly being observed to give birth without the protection that this affords (Iu. A Grachev, pers comm. 2004). In recent years this has been observed in Kalmykia too, which has a population comparable in size, if not range, to that of Ustiurt (A. Kuhl, pers comm. 2004). The Ustiurt population, which is more remote and historically less disturbed, has not been observed behaving in this manner to date but then again has not been surveyed from the ground during the calving time since 2001.

In order to establish the current situation of the population in Ustiurt the following questions will be addressed:

1) What is the current status of the adult Saiga population at calving time?

- Are the Saiga forming aggregations?
- Is there a consistency in the herd sizes observed throughout the expedition?
- Is there noticeable sexual segregation?
- Is there a noticeable bias in sex ratios?
- Is human disturbance or predation having a discernable negative impact?

2) What is the current status of the Saiga calves born in May 2004?

- Is mass calving taking place on both spatial and temporal levels?
- Is there any circumstantial evidence for reduced fecundity?
- Is there a significant difference between the number of single calves and twins?
- Do the vital statistics match with the central tendency seen in 1998?

2. BACKGROUND TO THE SAIGA ANTELOPE *(Saiga tatarica tatarica)*

2.1. Saiga antelope populations, ecology and geography

The Saiga antelope require an even terrain with watering places and open pasture with low-growing vegetation. The Saiga antelope is an ecologically important herbivore of these rangelands, they are known to eat more than 80 species of plant and lichen in Kazakhstan. The staples of its diet are grasses (*Elymus, Poa, Eremomyrium* and *Festuca sulcata*); Chenopodiacea spp. (especially *Salsola, Kochia* and *Nanophyton erinaceum*); Compositae spp. (*especially Artemisia spp*.) and legumes (*Astragalus* and *Medicago*). Other plants are eaten less frequently and in smaller quantities. In their nomadic periods, Saiga only eat a part of the grass crop and cause insignificant damage to the pasture (Bekenov *et al* 1998).

The Saiga has a discrete yearly cycle, with the rutting occurring in a short period during December and the mass calving event taking place throughout May, with the vast majority of females giving birth within short space of time. Throughout the rut the males fight for control of 'harem' herds with the strongest males driving others away and males of about equal strength will fight fiercely for females. These herds consist of 50 or fewer animals and once the rut is over, the harem herds join together to form larger groups. Recently anecdotal evidence from Kalmykia suggests that whereas traditionally males choose their harem and defend it, dominant females have been observed aggressively excluding sub-dominant females from the males and as a result forming harems around the males, membership being determined by the females (Milner-Gulland *et al* 2003). However, currently it is unknown if this behaviour is wide-spread, nor exactly how it takes place and crucially, why it might occur.

During the spring the Saiga concentrate in the calving areas, forming dispersed groups which have in the past numbered tens of thousands. There are very few smaller groups of females or single animals outside these large congregations which may make up more than two thirds of the total population. The main Saiga calving region in Ustiurt historically covers an area of 300 km from north to south and 300 km from east to west (Bekenov *et al* 1998). The population density at this time of year historically ranges from 5 – 600 animals per km^2, (usually 15 - 400). The males stay with the females during calving and migrate with the rest of the group, although there is some sexual segregation that has been observed in the past, with groups of males moving ahead of the group in the return to the summer pastures. (Iu. A Grachev, pers comm. 2004). In summer, the Saiga gradually disperse, with large groups of animals splitting up into separate herds during migration, or in some years once they have reached their summer range. In autumn, Saiga form larger herds for the start of their mass migration to the winter rangelands.

Saiga perceive humans and vehicles to be a threat and it is almost impossible to get close without them fleeing, reaching speeds of up to 80kph. Whilst Saiga are running, they often make so-called ‘observational’ jumps, the function of which is not entirely clear. These jumps are apparently an instinctive reaction to a perceived threat, and have some sort of signalling function. The direction in which the animals run is not influenced by the direction of the wind or the position of the sun, but depends on the behaviour of the others in the herd (Bekenov *et al* 1998. Personal observation. 2004).

2.2. Historical range area

The historical range of the species used to be extensive, fossilized remains from the latter part of the tertiary having been identified from many parts of Western Europe, including Britain. Up to a century ago its range extended as far east as Poland and as far west as mid Mongolia. (Milner-Gulland 1991). Today however, *Saiga tatarica tatarica* are only found in four distinct populations, as shown in Figure 3.1. Three of these are in Kazakhstan and the fourth is in Kalmykia, Russia. The populations in Kazakhstan are located in; Betpak-dala in the centre of the country, Ural in the north west and Ustiurt in the south west, bordering Uzbekistan. A survey of 14,000 marked Saiga calves between 1986 and 1993 showed that these three separate populations did not mix during this period and are unlikely to at present with their decreased population sizes (Bekenov *et al*. 1998). Using data from 2000, which was the last instance of full population counts for all regions, the populations in Kazakhstan made up more than 85 per cent of total numbers. It must be stressed that the ranges illustrated are historical and may not represent the present day range of the populations which are so greatly reduced in size.

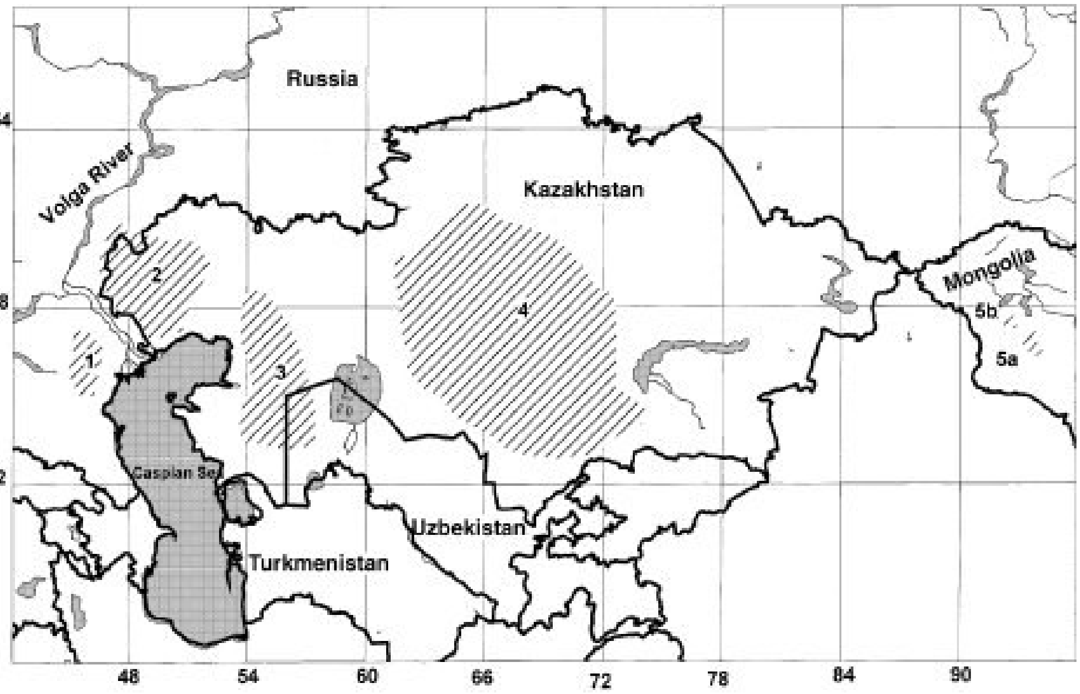

Figure 2.1: The approximate current ranges of the four *Saiga tatarica tatarica* populations and the Mongolian sub-species *Saiga tatarica mongolica* are illustrated with country borders, and latitude and longitude. 1) Kalmykia (Russia), 2) Ural (Kazakhstan), 3) Ustiurt (Kazakhstan, but migrates to Uzbekistan), 4) Betpak-dala (Kazakhstan), 5a) Shargyn Gobi population (Mongolia), 5b) Mankhan population (Mongolia). Reproduced from Milner-Gulland *et al*. 2001 with kind permission.

2.3. Seasonal migrations

Saiga migrate during the spring and autumn between their winter and summer ranges, prompted by the need for new pastures and by the presence of deep snow. The general direction of the spring migration is north to north-west, and of the autumn migration south to south-east. This is illustrated in figure 3.2. The timing, routes, distance and speed of these migrations may differ between years depending on biotic and abiotic factors such as climatic conditions or the degree of disturbance encountered. The overall area of the summer range in Kazakhstan is in the region of 300,000 – 350,000km^2 and that of the winter range is 49,000 – 105,000 km^2. The position of spring calving sites varies from year to year because it is related to the distance travelled by Saiga moving north from their winter range. The Saiga winter ranges are in the deserts south of latitude 48^o The summer ranges are located in semi-desert regions, at a latitude of around 48-49^o.

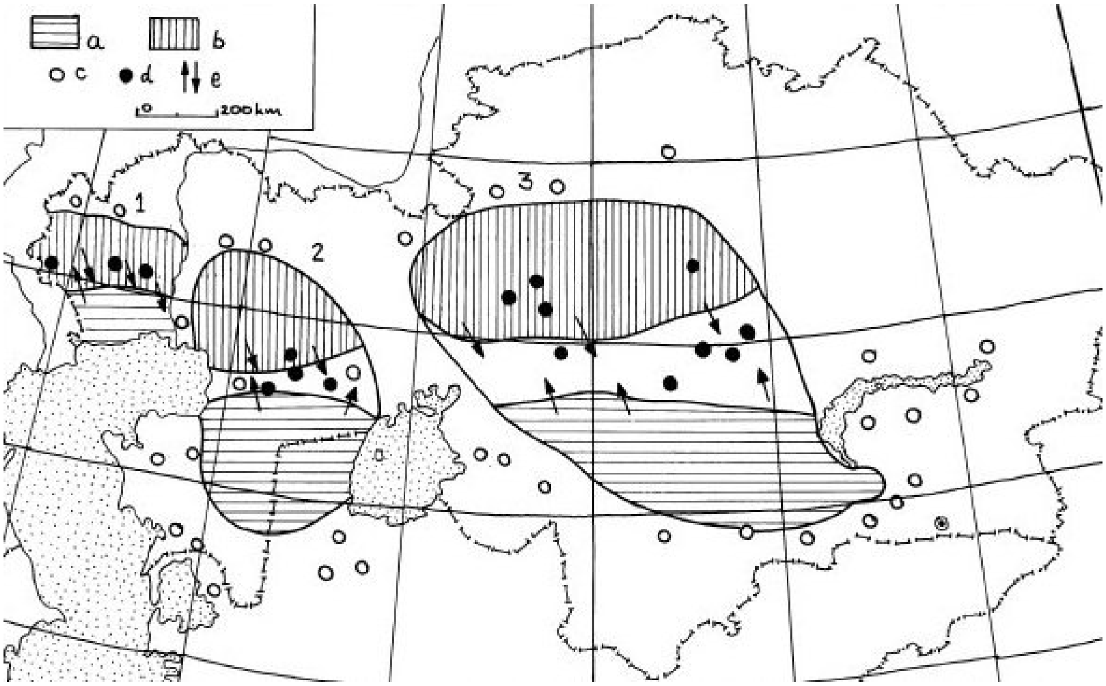

Figure 2.2: Approximate ranges of the three present-day Saiga populations in Kazakhstan. 1, Ural population; 2, Ustiurt population; 3, Betpak-dala population. (a) winter ranges; (b) summer ranges; (c) Occasional sightings; (d) Usual birth areas; (e) Migration routes. (Taken from Bekenov *et al* 1998).

Saigas generally migrate at a rate of 5–20 km per day, although this may increase if weather conditions are adverse or if water is scarce. Females with young calves migrate at a rate of 10–15 km per day. The Betpak-dala population covers 600–1,200 km each way during migration, the Ustiurt population covers 300–600 km and the Ural population 200–300km. (Bekenov *et al*. 1998).

2.4. Reproduction

Saiga are an enormously fecund species that have an exceptionally high rate of reproduction and recruitment. Females are sexually mature at 8 months of age and up to 95 per cent produce offspring in their first year, mostly giving birth to single calves. Twins are common though generally in older animals. Females can breed until around 10 years of age, Triplets also occur, although this is not common. (Bannikov *et al* 1961). Normally, male Saiga are sexually mature at 19 months old, (Lundervold. 2001), although as with females this depends on the climatic conditions and availability of food when they were developing.

Saiga antelopes gather in large concentrations at calving time, choosing different locations every year but within predictable regions. The first Saiga calves are born in late April and the last in early June. However the mass calving, like mass mating, takes place within a short time period of around 5–8 days (Fadeev & Sludskii. 1982) and the timing of peak births varies between years and regions. Calving is timed to coincide with the most favourable period in the year, when the daily temperature is growing warmer, fresh vegetation is starting to grow and there are more abundant watering places. (Bekenov *et al* 1998). The concentration of Saiga during the mass calving event has further biological significance. In giving birth in such a restricted space of time, the risk of predation to each calf during this vulnerable period is minimised (Milner-Gulland. 2001). This predator swamping mechanism does however have to trade off with the increased risk of density dependent neonatal mortality due to factors such as disease and parasites. A similar trade off is made in timing the birthing window to catch the spring flush of greenery whilst running the risk of a late spell of bad weather bringing frosts and cold rain, which increases mortality among new born calves.

Climate is the main limiting factor, affecting both mortality and fecundity. In Ustiurt, both the number of breeding females and the average number of embryos per female were noticeably lower after a severe winter in 1990/91. In 1992, when conditions were favourable, the fertility rate in the Ustiurt population was unusually high. Lower than average fertility was also seen in the Betpak-dala population following a severe winter in 1993/94. Summer droughts may also affect fecundity (Lundervold. 2001). This means that in years with a favourable climate and hence survival rate, the population size can increase rapidly. A population increase of up to 60 per cent in a single year has been recorded. The high recruitment rate is also encouraged by the high percentage of breeding females in the population (Fadeev & Sludskii, 1982).

The new-born Saiga calves are effectively helpless for the first few days of their lives, lying motionless in open spaces and not reacting when approached by humans. At 3–5 days old however, they are already easily able to outrun a human unless encountered under cold or wet conditions. They begin to follow their mothers at 4–5 days old, though they are still left behind if the females flee from a perceived threat. At 7–10 days old they are almost always found next to their mothers and are able to keep up with the pace if the herd runs (Bekenov *et al*. 1998).

Generally, the sex ratio in calves is close to 1:1. Fadeev & Sludskii (1982) noticed that in years when the Saiga population was at its peak (1972 and 1974) the sex ratio of embryos was in favour of males, and when it was at its lowest (1976 – 1978) was in favour of females. However on analysis of data from 1983 – 1997, the slight fluctuations observed in the sex ratio had no clear link with climatic conditions or population size (Bekenov *et al*. 1998).

New born male calves weigh 3.5–4.5 kg, 3.9 kg on average. They grow rapidly in the first period of intensive suckling. Subsequently, until the end of the first year, growth and weight gain are slower. From 1 to 1.5 years, (the onset of sexual maturity), more intensive growth occurs, but with insignificant weight gain. Male body size and weight continue to increase until the age of about 3.5 years, and the horns continue to grow until the age of 1.5 years. New born females weigh 3.1–4.2 kg, 3.6 kg on average, and subsequently females grow at more or less the same rate as males, but are slightly smaller than males of the same age (Bekenov *et al* 1998).

2.5. Population limitations

Abiotic factors

A variety of factors limit population growth in Saiga antelope. Episodes of high mortality have been observed due to extreme climatic conditions. During particularly harsh winters known as “dzhuts”, which occur approximately once every 10–12 years, Saiga may become severely malnourished or starve to death when the snow cover is deep. Males are especially vulnerable as they are often weakened by the rut and may make up to 80 per cent of the fatalities. In the winter of 1971 - 72 it was estimated that 400,000 Saiga died in the southern part of Betpak-dala (Fadeev & Sludskii, 1982). Summer droughts occur about 3 years in 10 (Milner-Gulland. 1994b) and may also cause high mortality, predominantly affecting females and calves.

Biotic factors

In the 1980–1990s biotic factors played an important role in limiting Saiga populations. In the spring of 1981 over 70 000 animals died from pasteurellosis in an area of 1300 km^2 between the Turgai and Ulyshilanshik rivers in the Turgai province (Fadeev & Sludskii, 1982). Ninety-nine per cent of the animals that died were females and calves. Large numbers of Saiga also died in 1984 and 1988 (estimated number of deaths in May 1988 was 270,000); pasteurellosis was also thought to be the cause. Although other diseases affect Saiga, (e.g. necrobacteriosis, brucellosis) the only other disease to significantly affecting numbers is foot-and-mouth disease.

The main predatory threat to the Saiga comes from wolves, especially at the time of calving. On one occasion a Wolf was observed devouring five Saiga calves in an hour, on another, six calves (Fadeev & Sludskii, 1982). Wolves mainly prey on sick or wounded animals or those in unfavourable situations (heavy snow, crossing rivers, in thickets of reeds, etc.), so their impact on Saiga populations should not be regarded as wholly negative. The claim that predators do not severely limit population growth is supported by the fact that Saiga numbers in Kazakhstan increased in the 1940–1950s, when Wolf numbers were high. (Bekenov et al 1998). Other predators and scavengers include; Foxes *Vulpes vulpes* and *Vulpes corsac*, Steppe Eagles *Aquila rapax*, Imperial Eagles *A. heliaca*, and Golden Eagles *A. chrysaetos*. These occasionally prey on Saiga calves but do not cause significant damage to the population. Another predatory threat comes from feral dogs or dogs owned by shepherds.

2.6 Saiga management

Saiga were heavily hunted in the throughout the 18^{th} and 19^{th} century but were still numerous and widespread. It was not until the second half of the latter century that hunting caused numbers of Saiga to decrease in all populations, continuing into the early 20^{th} century when the species was on the verge of extinction and a hunting ban introduced. Saiga numbers subsequently recovered, animals reappearing in rangeland they had previously inhabited during the 1930's. It is clear that they are vulnerable to over hunting but do have the capacity to recover their numbers quickly.

Commercial hunting of Saiga has been licensed since 1954, the same year that annual aerial counts of Saiga populations began. It was carried out by specialist state run organisations known as '*promkhozes'* until the late 1980's. Historically the promkhozes not only hunted the Saiga but also were involved in protecting them outside of the hunting season. Reporting population numbers and locations, ensuring they remained undisturbed during the spring calving, apprehending any poachers encountered and culling wolves during the winter, for which they received a premium from the government. Recommendations on the number of animals that should be culled from each population were made annually by the Institute of Zoology (IoZ), based on the spring aerial census, analyses of sex and age structure, estimates of fertility, mortality and population growth and evaluation of natural limiting factors (Lundervold. 2001).

In 1998 control of the hunting inspectorate was transferred to '*Okhotzooprom*', who have exclusive rights over the hunting and commercial exploitation of the Saiga. The following year the IoZ recommended a hunting ban in based on a low population estimate for all three populations, which was implemented by the Ministry of Ecology and Natural Resources. Although this ban has been lifted between 1998 and the present day, it is currently in force once more in 2004.

2.7 Poaching

The most significant impact on Saiga numbers has been anthropogenic, with poaching being the most serious threat but habitat fragmentation, agriculture, livestock and disturbance also being significant. Being a migratory animal whose range covers areas of up to 400,000 km^2, the Saiga is a difficult animal to adequately protect from poaching due to the logistical problems of monitoring such vast regions. During Soviet times there was the a functional hunting inspection organisation which afforded some degree of protection but most importantly the majority of rural people living within range areas were employed and any poaching of the Saiga was for meat, the horns being worthless with the Chinese border closed to trade and just being left in the steppe to rot (Iu. A Grachev, pers comm. 2004. Personnel observation 2004).

When the Chinese border reopened in 1988 the poaching of Saiga intensified as a result of the high demand for the horns. The post Soviet economic decline in Kazakhstan during the early 1990s was accompanied by a substantial increase in rural unemployment and lack of alternative livelihood options, forcing many to turn to poaching (Lundervold. 2001). Saiga were now being shot all year round for their horns, with high season being spring and autumn, followed by summer, whereas previously they had been targeted mainly in autumn and winter for their meat. Organised groups of poachers now pursue the animals during daylight hours, in paired teams using 2 – 4 motorcycles, with one person driving and the other shooting. The reduced funding to the hunting inspection bodies meant they are unable to adequately control the situation. Currently approximately 150km^2 of the Ustiurt region is patrolled by eight Okhotzooprom rangers working in paired shifts. They have four 4x4 vehicles between them, with two of these patrolling one month in the field and then taking one month off whilst the other team takes over the patrol (Okhotzooprom ranger Nicolai, pers comm. 2004). A major concern about selective poaching for the horns is that the proportion of adult males in the population may become very small, which can affect the population dynamics of the species (Milner Gulland, 2003).

2.8 Current conservation efforts

A workshop in Elista, Kalmykia in spring 2003, supported by CMS, CITES and IUCN brought all *Saiga tatarica tatarica* range states together: Russia, Kazakhstan, Uzbekistan and Turkmenistan. However, despite this increasing international awareness, only limited significant direct action in the form of research into the factors driving the Saiga decline or direct conservation has taken place. More recently a workshop held in Almaty, Kazakhstan during April 2004 developed a Memorandum of Understanding (MoU) concerning the conservation, restoration and sustainable use of the Saiga antelope. This is in accordance with the Convention on Biological Diversity (CBD), which has recognised migratory species such as the Saiga to be unique and globally important components of biodiversity under the CMS. This non-binding administrative agreement is specifically between; the ministry of natural resources and environmental protection of the republic of Kazakhstan, the ministry of agriculture of the Russian federation, the ministry of nature protection of Turkmenistan, and the state committee for nature protection of the republic of Uzbekistan. These range states were requested to make arrangements for their country's ambassador to

Germany to sign the MoU in Berlin on the 23rd June 2004 at an event to celebrate the 25th anniversary of the CMS. (Mullner-Helmbrecht, correspondence. May 2004). However this was not accomplished and hence the MoU remains ineffective, and will remain so until at least three of the range states have signed it. There is currently a meeting planned under the auspices of CITES for October / November 2004, where the signing of the MoU will be high on the agenda.

3. BACKGROUND TO THE REPUBLIC OF KAZAKHSTAN

3.1 Geography and climate

The Republic of Kazakhstan is located in Central Asia and shares borders with Russia in the north and west, Turkmenistan, Uzbekistan and Kyrgyzstan in the south and China in the east, as illustrated in figure 3.1. To the west lies the Caspian Sea, separating it from the Caucasus. Kazakhstan is the ninth biggest country in the world, a land locked state covering 2,717,300 million square kilometres (1,049,150 square miles) - roughly the size of Western Europe.

Figure 3.1: The Republic of Kazakhstan's geographical location in the world.

Lowlands make up one-third of Kazakhstan's huge expanse, hilly plateaus and plains account for nearly half, and low mountainous regions about one-fifth. The climate is sharply continental and hot summers alternate with equally extreme winters, especially in the plains and valleys. Temperatures fluctuate widely, with great variations between sub-regions. Average January temperatures in northern and central regions range from -19° to -16° C; in the south, temperatures are milder, ranging from -5° to -1.4° C. Average July temperatures in the north reach 20° C, but in the south they rise to around 29° C. Temperature extremes of -45° C and 45° C have been recorded. Light precipitation, ranging from 200 to 300 millimetres falls annually in the northern and central regions to 400 or 500 millimetres in the southern mountain valleys (Encyclopaedia Britannica. 2004).

The country has inherited two major ecological catastrophes; in addition to the problems of the rapidly disappearing Aral Sea there are the problems resulting from widespread radioactive contamination of the soil, food products, and water sources around the nuclear testing site in the Semey province in the East of the country. The Aral Sea suffers not just from the shrinking associated with diversion of its main source for irrigation but also with pollution and salinization. Its waters are contaminated with pesticides, especially DDT, and with chemical fertilizer fed into it by various rivers; the contraction of the Aral Sea has left a toxic dust in the newly formed salt flats, leading to respiratory disorders and other health problems. In addition, Lake Balkash is seriously polluted, and the water level in the Caspian Sea is rising, covering old oil well-heads from the Soviet period and thus contaminating the lake. There are also many thousands of acres of steppe that have been turned into barren wasteland, as a result of over-intensive cultivation and excessive use of pesticides and fertilisers.

3.2 History and people

The country came into being as an entity in 1929 when it was officially proclaimed the Kazakh Soviet Socialist Republic. The word “Kazakh” comes from the Turkic and means free and independent. However this freedom was not realised until 1991 when the collapse of the Soviet Union ended 70 years of communist rule and a previous 150 years of Tsarist rule (CIC 2003). Kazakhstan became an independent nation-state for the first time on the 16th December 1991 and is the largest independent state after Russia, to emerge from the former Soviet Union. Politically and economically Kazakhstan is currently seen as the most liberal of the five Central Asian states and is the region’s pacesetter.

Kazakhstan has a diverse mixture of ethnicities and religious groups; this mosaic is partly explained by the fact that from Tsarist times onwards, Kazakhstan was regarded as an empty part of the world that could be used for agriculture and social experiments, often involving the re-settlement of large numbers of people. According to the 2002 figures, the present population of 14.8 million is comprised of more than 100 ethnic groups, including

Kazakhs, Russians, Ukrainians, Uzbeks, Germans, Uigur and others. The breakdown of relative proportions is given in figure 3.2 (CIC. 2003).

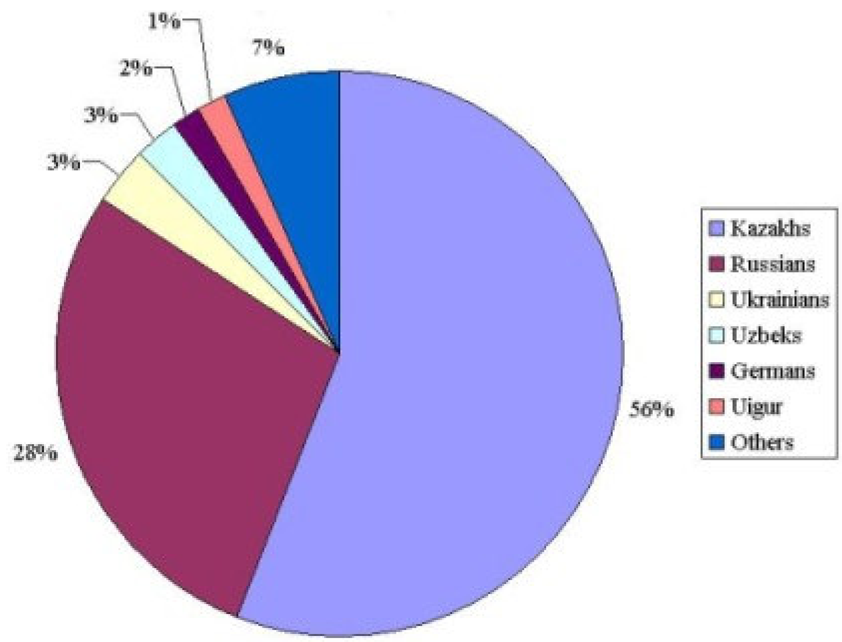

Figure 3.2: Kazakhstan's ethnic diversity in a population of 14.8 million. (Taken from the Caspian Information Centre, 2002 data).

Until the 19th century Kazakhstan's economy was predominantly based on livestock rearing and minor trade. During the Stalin era the impact of forced collectivisation of agriculture was brutal in its consequences for Kazakhstan as for any other part of the USSR. During the 1920's and early 1930's, more than a million people, nomadic Kazakhs as well as Russian kulaks, died as a result of the disastrous programme of collectivisation of Kazakh land.

Under Nikita Khrushchev's "Virgin Lands" campaign in between 1954-1962, mass immigration continued. During this time at least two million people, mostly from European parts of the USSR, were settled on land that was supposedly unused or abandoned. In fact much of that land had been left fallow by Kazakh herders who worked the land and knew how to prevent its being over exploited. Although this new wave of immigration disturbed the traditional methods of Kazakh herders it did gave the country a major boost, with the transformation of vast arid lands into agricultural areas and turning the region a major grain producer. Kazakhstan was the largest grain exporter to other parts of the Soviet Union, and also exported about 300,000 tons of meat every year to other republics (Lundervold. 2001).

As a result of several waves of immigration, the Kazakhs who had accounted for 90 per cent of the population at the end of the 19th century represented only 30 per cent by 1960. They once again became the majority in the 1990's, as a result of emigration, mostly back to Russia (CIC 2003).

The collapse of the Soviet Union in 1991 was followed by massive changes to the economy which in turn brought about increasing unemployment and poverty as demand for Kazakhstan's traditional heavy industry products collapsed. In the period 1990-94, industrial output fell by more than 60 per cent. Having been effectively removed from the rouble zone, Kazakhstan introduced its own independent currency, the tenge. In November 1993 the tenge was introduced at 5 tenge to the US dollar, but within a year its value had dropped sharply and inflation rocketed, peaking at an annual rate of around 3,000 per cent in 1993. As a result hyperinflation and high unemployment soon began to create economic chaos and there were large-scale internal migrations as people sought to escape poverty. By 1995-97 however, recovery began to occur as a result of a programme of economic reform and privatisation. In 1996, for the first time since the dissolution of the USSR, production stopped falling and began to grow. In 1998 the capital was moved from Almaty, in the remote south-east, to Akmola (formerly Tselinograd) in the centre of the country, which was then imaginatively renamed Astana (meaning 'the capital' in the Kazakh language). Buoyed by high energy prices and robust regional demand for exports, GDP rose in 2000 when an increase of 9.8 per cent was recorded. This trend has continued since and estimates for GDP growth for 2003 are set at around 8.6 per cent (CIC 2003).

3.3 Current economic and political situation

Kazakhstan has had better success in its transition from command to market economy than most of the former Soviet republics because of extensive privatisation programs, economic strategies and the fact that the republic possesses a wealth of natural resources. However the economic situation for the majority of the population in Kazakhstan has consistently worsened since independence, especially for those in rural areas due to a lack of alternative livelihood options. In 2003 the proportion of people living below the poverty line was 28 per cent. This compares to 42 per cent in 2000 and the government's stated objective is to lower the proportion to less than 20 per cent by 2006 (CIC. 2003).

The Kazakh president Nursultan Nazarbayev, who was elected in 1990, grasped the fact that in order for the country to realise its mineral wealth, it would be necessary to open up to foreign investment. This has been accomplished most successfully in the oil and gas industries where over $13 billion has been received in investment since Independence. Although still a minor oil exporter at present, Kazakhstan is expected to be one of the world's top five producers within the next decade. In 2003 the petroleum sector accounted for 25 per cent of the country's GDP, and about one half of the country's export earnings. Despite being a net importer of gas, there are substantial proven natural gas reserves of 65 million cubic feet. This places Kazakhstan in the top 20 countries in the world. Present trends suggest that the country will soon be a significant net gas exporter as production doubled in 2000, rose by a further 16 per cent in 2001 and exceeded this figure in 2002. In addition, Kazakhstan possesses huge reserves of a large number of other minerals. These include a quarter of the world's uranium resources, much of it high quality, and a third of the world's reserves of chromium and manganese (CIC. 2003). Importantly Kazakhstan has not shown signs of following the pattern of explosive growth followed by equally dramatic decline familiar in oil rich states in Africa and elsewhere. Economic growth has been consistent, averaging almost ten per cent over the past five years and this looks set to continue. Inflation has been curbed and is currently running at around six percent. While the economy remains sensitive to major changes in the price of oil and gas, its rich reserves of other mineral resources provide for a huge export potential, and therefore will limit over-dependency.

3.4 The Ustiurt region

The Ustiurt region in is situated within both Kazakhstan and Uzbekistan at a latitude south of 48°. It is located between the Aral Sea and the Amu Darya (river) delta in the east and the Mangyshlak plateau and the Kara-Bogaz-Gol (an inlet of the Caspian Sea) in the west. The geographical location of the region is identified in figure 3.3. The region has an area of about 200,000 square km and an average elevation of about 150 m, rising to a maximum of

365 m in the southwest. At its edges it is deeply dissected and ends in high escarpments ("chinks") that plunge steeply to the Aral Sea and the surrounding plain. This topography is illustrated in figure 3.4 but is not typical of the region on the whole.

Figure 3.3: Map showing the location of the Ustiurt region of western Kazakhstan. The region is encircled in red next to the Aral Sea.

Figure 3.4: A westerly view of the chinks on the Ustiurt plateau during May 2004.

The majority of Ustiurt is a typical Turanian desert with a combination of clay, stony and salt plains. The soils associated with the region have evolved under semi-arid and arid conditions. They are characterised by a low organic matter content (<1%) and a high level of calcium, often associated with gypsum. These grey-brown soils are composed of particles of varying sizes, are frequently saline, have unfavourable water-physical and physio-mechanical properties, poor structural characteristics and often a high level of compaction. (Gintzburger, 2003). The area is dominated by rarefied semi-shrub communities formed by the perennial saltworts and sagebrushes. Species that prevail on clay soils of the region include *Anabasis salsa*, *Salsola orientalis*, and sagebrushes such as *Artemisia terrae albae, A. turanica,* and *A. gurganica* to the west. The plant communities from *Salsola arbusculae formis* and *Nanophyton erinaceum* are typical in stony soils. Typical for sandy soils are psammophitic semi-shrubs such as *Ceratoides papposa, Artemisia terrae albae*, *A. santolina*, and *A. songarica*, and shrubs such as *Calligonum aphyllum, Ephedra lomatolepis,* and psammophitic grasses (Bekenov *et al* 1998). The vegetation varies relatively minimally with the exception of that which is found in association with water bodies and salt pans. The landscape is flat and barren with the exception of the plateau's chinks. The typical landscape is illustrated in figure 3.5.

Figure 3.5: A typical landscape on the Ustiurt plateau. The photograph was taken during May 2004.

The region has an extreme continental climate with considerable diurnal and seasonal fluctuations in temperature and humidity. The average temperature over the year is 4–5 °C, reaching a maximum temperature of + 40 °C in the summer and a minimum of –25 to –40 °C during the winter months. The average annual precipitation is 100–250 mm, about 25 per cent of which falls in winter. Snow cover remains for 30–50 days in Ustiurt and is typically 4–15 cm deep, but does not lie evenly due to strong winds and uneven terrain, so that some areas remain free of snow throughout the winter. Summers are dry and there are droughts several times a decade. The growing season is characterized by excessive heat and insufficient moisture which affects the productivity of the plants.

4. METHODOLOGY

The methodology used in this study will be described in a logical order beginning with the essential information about the expedition which made the research possible. Next will be listed what observations were to be recorded for the climate, Saiga herds and Saiga calves. Finally the method of data capture will be described, focussing in on the use of CyberTracker as a pilot scheme for collecting spatial and temporal information about the Saiga in Kazakhstan.

4.1 Expedition details

Since the Saiga antelopes have historically gathered in large numbers in May to give birth within a short space of time, the timing of the expedition was crucial. The expedition departed Almaty on Thursday 6th May 2004; this was later than originally planned due to bureaucratic complications in gaining official permission to do research in the region. This was a cause for concern since the historical dates of mass calving in Ustiurt over the period 60's – 70's were in the first 10 days of May and in the 80's -90's during the second 10 days of May (Fadeev & Sludskii. (1982); Bekenov *et al*. (1998)). However there was no guarantee that this still occurs given the greatly reduced population size.

The expedition team was composed of two Imperial College students (the author included), two scientists from the IoZ in Almaty along with their driver and five employees of Okhotzooprom to act as drivers, and in their official capacity as state inspectors. A French film crew from Marathon Productions also accompanied the expedition in order to complete a film to raise awareness of the problem of the Saiga antelope's declining numbers. Initially there were three vehicles, a large ex-military vehicle (Gaz 66) which carried the supplies and two 4x4 vehicles driven by the Okhotzooprom personnel. A further 4x4 vehicle joined us on the 9th May with the scientists from the IoZ. These vehicles are illustrated in figure 4.1. Sporadically rangers employed by Okhotzooprom also accompanied the expedition.

During the 10th and 11th of May the expedition made its way through Ustiurt to the region that it was believed the calving would take place, occasionally seeing herds of Saiga. This region was identified from observations of herds congregating in early May from aerial surveys (Iu. A Grachev, pers comm. 2004) and from historical data. The rangers from Okhotzooprom were consulted about the expected whereabouts of the Saiga herds but they were not well informed, since they had not received wages for two months and hence had not been out on patrol. The experience of the scientists from the Institute of Zoology and advice from local people was invaluable at this stage in navigating to the areas that had on previous year's hosted aggregations.

Figure 4.1: The expedition vehicles. This photograph was taken from the camera crew's vehicle hence it is not included here.

After two days of searching from two different base camps (camp one E 58.01.092. N 47.12.362, camp two E 57.09.928. N 47.00.141) it was decided that a permanent base camp would be established at a location known as "taccau" (E 57.47.500. N 46.14.050), which was on the plateau where there had been numerous herds sighted during the previous day's patrol. Daily patrols then commenced around the plateau between approximately 08:00 – 21:00.

The large Gaz 66 accompanied the patrol on the 10th, 11th, 13th and 26th.during our approach and exit to the plateau, and during base camp relocations. Otherwise vehicular disturbance was kept to a minimum with normally no more than two vehicles on patrol, the other vehicle being the French film crew.

4.2 Daily climactic observations

Daily weather conditions were recorded as follows:

- Minimum and maximum temperature and humidity was recorded once a day using a digital min-max thermometer. Where possible this was placed in a position which is both sheltered and shaded, and reset at a time of intermediate temperature.

Overall daily weather conditions were recorded using the following categories:

- Precipitation type, duration of precipitation (all day, half day, less than half day).
- Weather type (sun, sun with significant amount of cloud cover, overcast).
- Wind direction and approximate wind strength (no wind felt, intermediate, strong)

4.3 Saiga herd observations

Saiga antelopes were observed during either 4x4 patrols or walking transects, both prior to and after the mass calving event. The aim was to collect spatial, temporal and if possible behavioural data about the herds. This methodology facilitated the location of the calves whilst collecting data on the adult population. Search effort per day in approximate kilometres covered and the method used for observation was recorded per day. The approximate distance and orientation from which each herd is observed at was also recorded.

Where possible the following information was recorded for each herd sighted:

- Date
- Time
- GPS location
- Estimated total herd size (including minimum and maximum estimate)
- Distance from which the herd is being observed from
- Orientation of the herd in relation to the observer's position.
- Number of males (including generation)
- Number of females (including pregnant and non-pregnant)

- Number of calves
- Approximate age of individuals
- Signs of human disturbance such as poaching, vehicle presence or livestock
- Signs of predators or scavengers.

Where possible males were classified into three age groups by the length and colour of horns as well as their proportions in the herds: sub adult (2003 generation), adult (2002 generation) and prime adult (2001 generation and older). Male Saiga can be reliably aged by the size and shape of their horns up until the age of 18 months. After 18 months only a rough estimate can be given. Young males' horns are shorter and straighter, with black tips; the older the animal gets the more lyrate the horns become and the tips become less black (Lundervold. 2001, Iu. A Grachev, pers comm. 2004). When large distance or poor visibility does not permit the classification of males into three age groups, only the total number of males was recorded.

If it was feasible from close range to distinguish pregnant from non-pregnant females the relevant numbers of pregnant and non-pregnant adult females was recorded. Animals too far away to allow identification of pregnancy status would be excluded from the ratio analysis, but recorded in the overall herd size. Disturbance of herds was attempted at all times to be kept to a minimum, in order to observe natural behaviour.

4.4 Saiga calf observations

The method for locating Saiga calves was one traditionally used by IoZ scientists; this involved patrolling the region in the 4x4 vehicle, stopping frequently to scan the countryside with binoculars for Saiga herds. The herds always flee from the disturbance caused by the vehicle but if females have a young calf in the area they will not run far but instead demonstrate behaviour such as running to and fro instead of directly away, presumably to divert attention from their young. They will also constantly stop to look back at where their calves are hidden. Once it was established that there were likely to be calves in the area the search began on foot.

Saiga calves remain alone during the majority of the daytime, being fed by their mothers only in the morning and early evening. Therefore they can relatively easily be approached by humans in the first two days after birth, and thus their spatial distribution can be recorded. From two days after birth it becomes progressively more difficult to catch Saiga calves unless it is cold and / or wet as they become able to outrun humans, so as a result measurements such as length, weight, sex and age were not taken for every calf encountered.

After initial vehicular observations of the location and spread of the birth aggregation, a transect route with the aim to cross the area of highest concentration of calves was selected. The position of the daily transect route was crucial to ensure representative data collection. Transects were terminated when the number of calves encountered over the last two kilometres was zero. When possible the transect routes were cross shaped with a transect perpendicular to the first crossing the estimated centre of the aggregation, in order to gauge the overall spatial extent of the aggregation.

The transect routes were determined using a GPS unit. A compass direction was selected and then a point projected forward from the current position. A distance of 25m was kept between each person walking the transect route wherever possible.

Transects were walked at times when the mothers were most likely to be absent, i.e. during the middle of the day, in order to minimise disturbance. Whenever a calf/dead adult/placenta was encountered, the team stopped temporarily to gather the measurements listed below. To ensure that calves were caught unaware, when a live calf was spotted this was communicated to others by raising an arm instead of calling out and possibly disturbing it and any neighbouring calves.

For calf observations the following was recorded:

- Time and date during which the calves were encountered.
- Number of calves, presence or absence of a twin.
- GPS position of live and dead calves (the likely cause of mortality was recorded if possible)

- Weight of calves in grams.
- Length of calves in millimetres (nose to rump).
- Approximate age classification of calves using the guidelines in table 4.1 below. (Developed by M. Lundervold. (2001) in consultation with Saiga specialists from the IoZ)

Age	Calf condition
<6 hours	Calf still wet with placental fluid.
12 hours	Dry, but with dried placental fluid on it coat and its navel wet.
24 hours	Dry, with only some areas of dried placental fluid, and its navel almost dry.
48 hours	Dry with dry navel, still slightly unsteady on its legs.
72 hours	Not at all unsteady on its legs, only caught because it was cold

Table 4.1: Saiga calf approximate age classification.

- Vegetation type in a 2m radius around the bedding.
- Distance & orientation to nearest neighbour if one is present.
- Time and date during which placentas were encountered.
- Number of placentas, presence of more than one at a single location.
- GPS position of placentas
- Approximate age of placentas using the guidelines in table 4.2.
- Signs of human disturbance such as poaching, vehicle presence or livestock
- Signs of predators or scavengers.

Age	Placenta condition
Fresh	Placenta still wet, not dried up.
Medium	Placenta partly dried up, not completely dehydrated.
Old	Placenta completely dehydrated, possibly partly decayed.

Table 4.2. Placenta approximate age classification

The involvement of the IoZ Saiga specialists with their experience in handling Saiga calves ensured that calf distress was short-lived. Walking when possible rather than driving transects also minimised disturbance to calves and females. The base camps were intended to be set well away from the aggregations in order to minimise impact of the expedition's presence. Previous studies suggest that these techniques have negligible effects on calf survival (Grachev & Bekenov. 1993).

During calving transect fieldwork, a rough classification of different steppe vegetation community types was established (with local expertise and literature). The different vegetation types that were associated with calves bedding sites were identified, using key indicator species. These were photographed for reference and are described in appendix 3. All were characterised by the presence of a high percentage of bare ground in the immediate surrounding area. Unless stated otherwise the identification of these plants was taken from Gintzburger *et al*. (2003).

4.5 Data capture using CyberTracker

Since there were numerous observers on the 2004 Ustiurt expedition, recording the same fundamental information, it was an ideal opportunity to trial the use of a CyberTracker field computer in Saiga research. As the data would still be captured by other members of the expedition via traditional methods of paper and pencil, should there be a problem with the technology in the field.

Figure 4.2: On the left hand side is the author using the CyberTracker handheld computer in Kazakhstan and in Saiga research for the first time.

CyberTracker software is freely available to download from the internet as “greenware” – free software that benefits conservation. A database is then customised on a computer in a two stage process. Firstly with the data manager, the individual database items (e.g. Saiga calf) are defined for which unique properties are assigned to (e.g. Saiga calf sex). The next stage uses the screen writer which allows the user to develop a screen sequence for specific data gathering. The interface is designed with a series of screens that follow a logical sequential order and then loop back to the start in order to enter new observations, or making smaller loops back to enter observations that are very similar. A process of progressive refinement narrows down to specific information. Screens may be text-based or combine text and icons, however, icons are quicker to scroll through since they are easier to recognise than text. Screen types include check lists, multiple choice, number screens and notes screens. Once the database has been customised to satisfaction it is loaded onto a handheld computer, in this case a Visor Handspring deluxe which runs the Palm operating system, and is powered by two AAA batteries. The database is transferred via a USB HotSync cradle which enables refinements to be uploaded to the handheld & data collected to be downloaded for analysis to the computer. The GPS unit used was a Magellan GPS Companion which is a 12-channel global positioning system receiver that attaches to the Handspring Visor handheld through an expansion port.

5. RESULTS

5.1. Data management and analysis

The data were analysed with Microsoft Excel 2000™ and SPSS for Windows version 12.0. Hard copy maps were scanned using a HP flat bed scanner and edited using Microsoft Paint™, and Lead technologies' GIMP version 2.0.3. The INTAS GIS map (09/07/2002) was used in conjunction with CyberTracker 2.7.5.0 and ArcView GIS 3.2 for Windows software to analyse the GPS information.

5.2. Climactic results

The weather conditions observed in Ustiurt during the period in between the 10^{th}–26^{th} May 2004 were generally stable, with sunshine and patchy cloud prevailing for around 80 per cent of the time. Precipitation occurred only once in the form of a heavy storm on the 21^{st} May. The maximum recorded daily temperature was 33.7 degrees centigrade (mean=28.2^{c}, range=11.8^{c}) and the minimum 6.9 degrees centigrade (mean=11.6^{c}, range=11.7^{c}). This is illustrated below in figure 5.1.

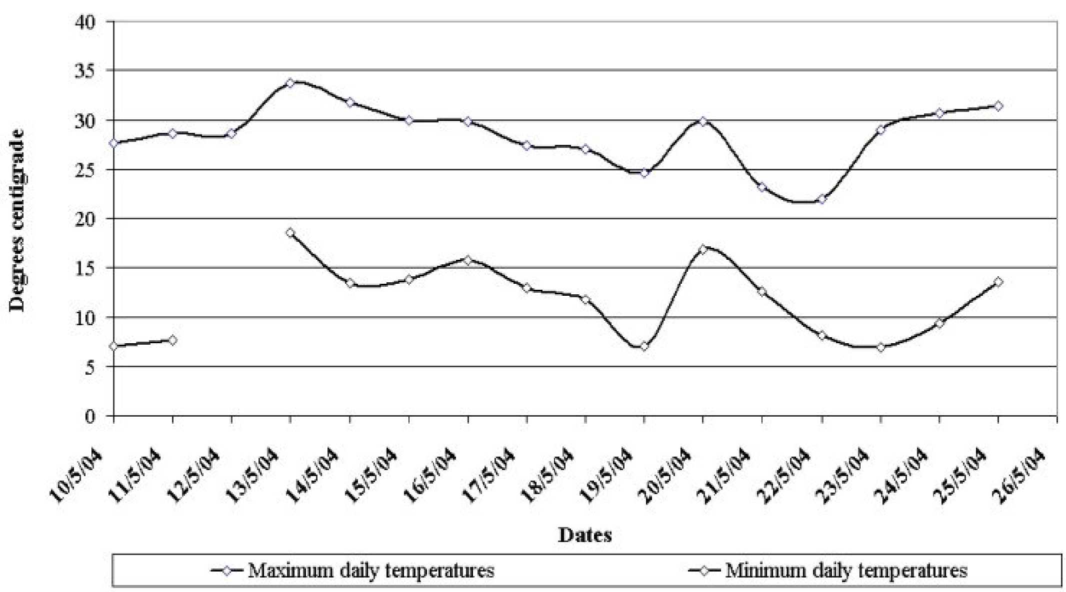

Figure 5.1. Maximum and minimum daily temperatures for the duration of the expedition in May 2004.

The maximum recorded daily humidity was 89 per cent (mean=64.1 per cent, range=45 per cent) and this was at the time of a storm episode on the 21st May. This can be seen on figure 5.2 which shows a great increase in humidity on the day of the event and the following day. There is a corresponding drop in temperature which is likely to have as a consequence. The minimum recorded daily humidity was 19 per cent (mean=25.8 per cent, range=17 per cent), which corresponds broadly to the period of maximum daily temperatures.

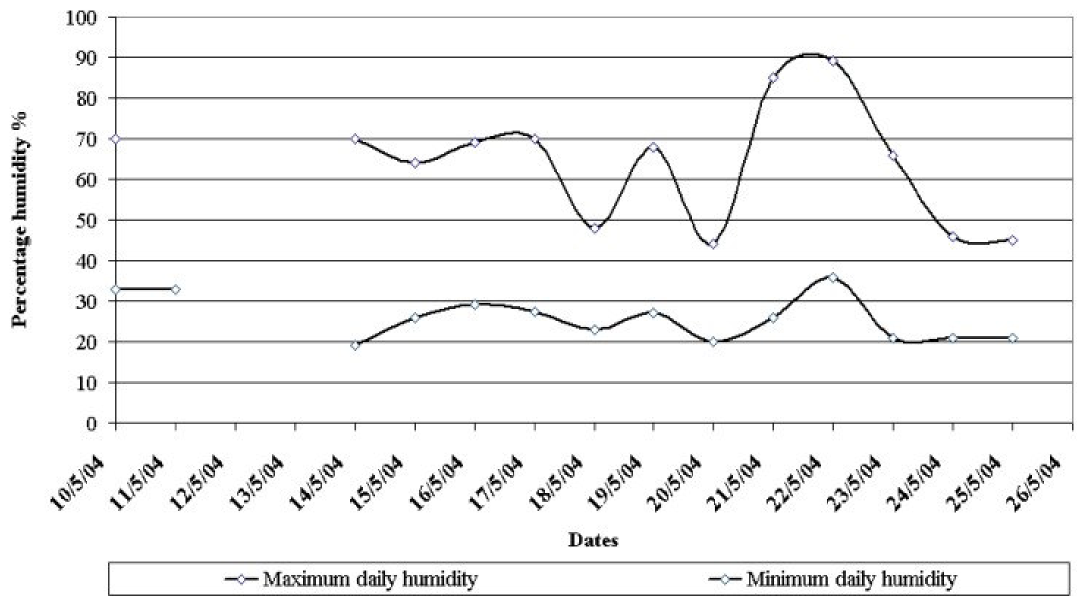

Figure 5.2. Maximum and minimum daily humidity for the duration of the expedition in May 2004.

The other observations which were recorded for climactic conditions throughout the period were for wind direction and relative strength. There was not a discernable dominant prevailing direction identified as for the fourteen days that the information was recorded, the prevailing direction was from seven of the eight compass points used (i.e. north, north east, east etc). The relative wind strength was more consistent however, being intermediate to strong on every day.

5.3 Ecological results – Herd

These results will be taken in a structured order, the analysis of certain results being essential to move onto subsequent investigations. Initially the general findings will be examined followed by a more in depth analysis of the herd proportions, temporal and spatial elements, followed by an estimation of the true number of Saiga on the Ustiurt plateau. The assessment of disturbance and predation will then conclude this section.

The first Saiga antelope herd was sighted on the 10^{th} May at latitude 47.54, longitude 58.13. In total there were 838 sightings of Saiga herds in between the 10^{th}–26^{th} May 2004. The maximum number of animals in a herd throughout this period was estimated to be around 400 but it was much more common to see much smaller sized herds. In total it is estimated that 8530 individuals were observed (minimum=7,425, maximum=9,943, range = 2,518), this is not to be taken as an estimate of the total population as there was no doubt individuals counted more than once since the patrol routes covered similar areas on a daily basis and the Saiga were concentrated in this region. The majority of herds (70 per cent) were seen at distances of over 500 metres and it was most common to estimate that the herd was observed from over a kilometre away.

The observations recorded in Ustiurt have yielded a number of interesting results; the daily observations are listed in table 5.1 below. This illustrates the total numbers seen and the breakdown into numbers of males, females, calves and adult Saiga for which the sex was indistinguishable due to distance, dust or the mirage effect which obscured sightings at a distance of over approximately 500 metres from 11:00–16:00 on hot days. Almost 60 per cent of the total numbers of Saiga observed were unconfirmed as to their gender. The "assumed female" column is therefore the sum of confirmed female and unconfirmed sex Saiga, since they were more than likely female. This will be clarified in greater detail in the following section. For the same reason non pregnant & pregnant females were merged with the confirmed females as it was so rarely possible to distinguish the status of females. This also applies to the males; it was not possible to distinguish the estimated generations for the vast majority of the time, only twenty one of the total number could be identified as being from the 2003 generation and one from the 2002 generation. In the few occasions where calf numbers were indistinguishable in the latter stages of the expedition for the reasons listed above, an estimate was made based on the observation of adult numbers and relative proportions seen in herds where numbers of calves could be accurately judged.

Date	Kms	Number of observations	Males	Confirmed females	Unconfirmed sex	Assumed female	Calves	*Totals*
10/05/2004	200	8	1	253	285	538	0	***539***
11/05/2004	43	10	5	30	139	169	0	***174***
12/05/2004	385	29	45	90	340	430	0	***475***
13/05/2004	194	36	20	17	547	564	0	***584***
14/05/2004	306	26	85	104	581	685	1	***771***
15/07/1900	121	42	2	199	67	266	2	***270***
16/05/2004	221	37	29	325	134	459	4	***492***
17/05/2004	193	47	0	152	20	172	2	***174***
18/05/2004	173	83	0	40	364	404	9	***413***
19/05/2004	222	72	2	68	220	288	10	***300***
20/05/2004	76	41	3	323	454	777	63	***843***
21/05/2004	154	58	5	163	116	279	55	***339***
22/05/2004	230	30	0	40	101	141	5	***146***
23/05/2004	235	95	7	209	289	498	39	***544***
24/05/2004	148	116	0	266	82	348	71	***419***
25/05/2004	150	74	1	210	858	1068	227	***1296***
26/05/2004	200	34	3	368	273	641	107	***751***
Totals	***3251***	***838***	***208***	***2854***	***4873***	***7727***	***595***	***8530***

Table 5.1: This illustrates the daily count of Saiga from 10th – 26th May. The total is broken down in those confirmed to be male, female and calves. Further break down is between those not confirmed to be either male or female.

The same data is charted in figure 5.3 to graphically illustrate the numbers seen on a daily basis over the seventeen days of the expedition. This highlights the fact that although there is an overall trend to increasing numbers of Saiga being sighted throughout the period, it is not a clear pattern. The highest numbers of animals sighted was on the 25th May, with an estimated 1,296 Saiga observed. The day when the fewest animals were seen was the 22nd May with only an estimated 146 seen. An explanation for the inconsistency in the number of animals seen per day is that the patrol routes differed on a daily basis, covering areas with higher or lower concentrations of Saiga. Also effort was occasionally directed towards alternative objectives, such as walking transects searching for calves and hence fewer herds were observed as a result.

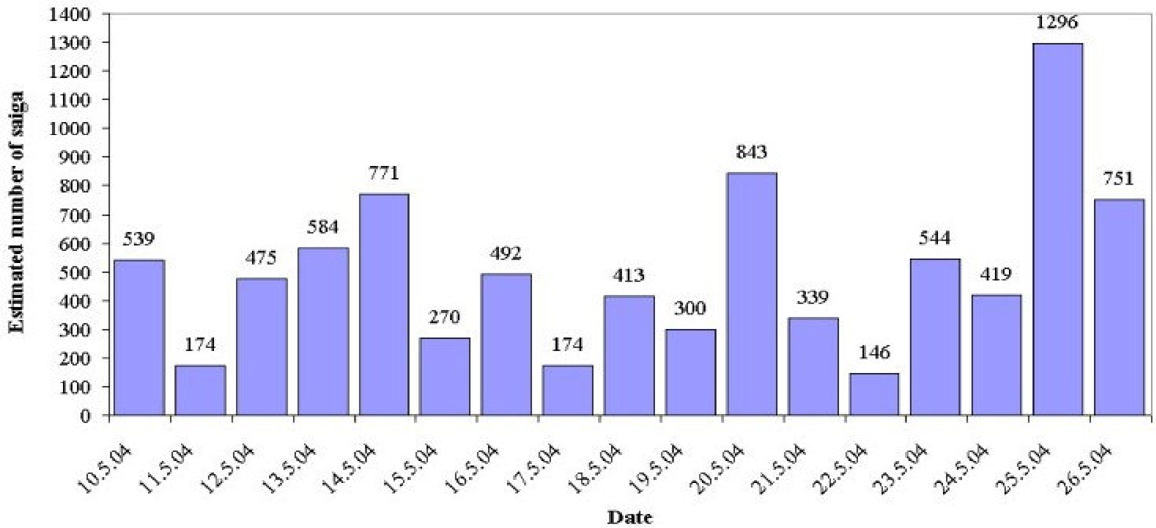

Figure 5.3: The total estimated number of Saiga seen in herds observed on a daily basis throughout the expedition.

5.3.1 Proportions and segregation

Females were expected to be found in larger group sizes than males during spring, as they are gathered in calving groups at this time of year and this was found to be the case. Although males did occasionally form a part of these groups, they were very much the minority. Figure 5.4a graphically illustrates this fact by comparing the proportions of confirmed males, confirmed females, unconfirmed sex and calves. This highlights for how many Saiga observed, sex was undeterminable, for the reasons mentioned in section 5.3.

All of the Saiga for which gender was indistinguishable were adults, strictly speaking it is likely that the vast majority of these animals were indeed females but to make a judgement about how many were possibly male it is necessary to look at what was known about the proportions where sex could be determined. If the proportions of confirmed females and confirmed males to each other are taken (93 per cent and 7 per cent respectively) and the unconfirmed sex number of 4873 reallocated accordingly (4532 to the females and 341 to the males) this then adjusts the figures to 7386 females and 549 males. The overall proportions are now 87 per cent females, 7 per cent calves and 6 per cent males, as illustrated in figure 5.4b. This brings the ratio of observed females to observed males to 13.45:1 and observed females to observed calves to 1:12.41

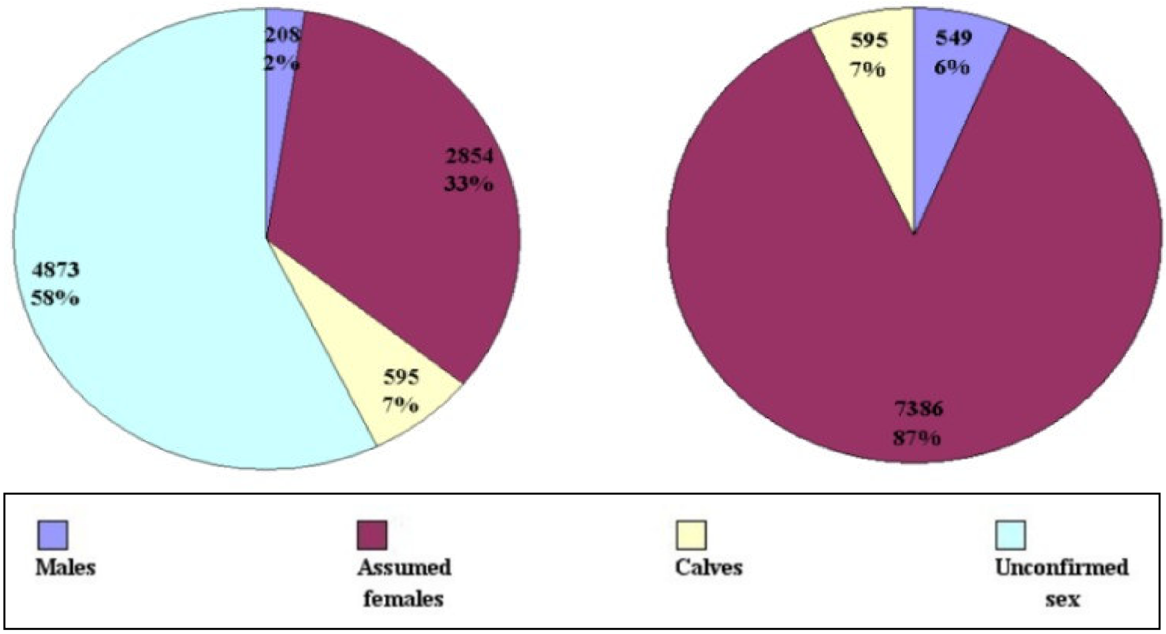

Figure 5.4: a). The chart on the left illustrates the proportions of confirmed males, confirmed females, unconfirmed sex Saiga and calves. b).The chart on the right illustrates the allocation of the unconfirmed sex proportion to the males and females.

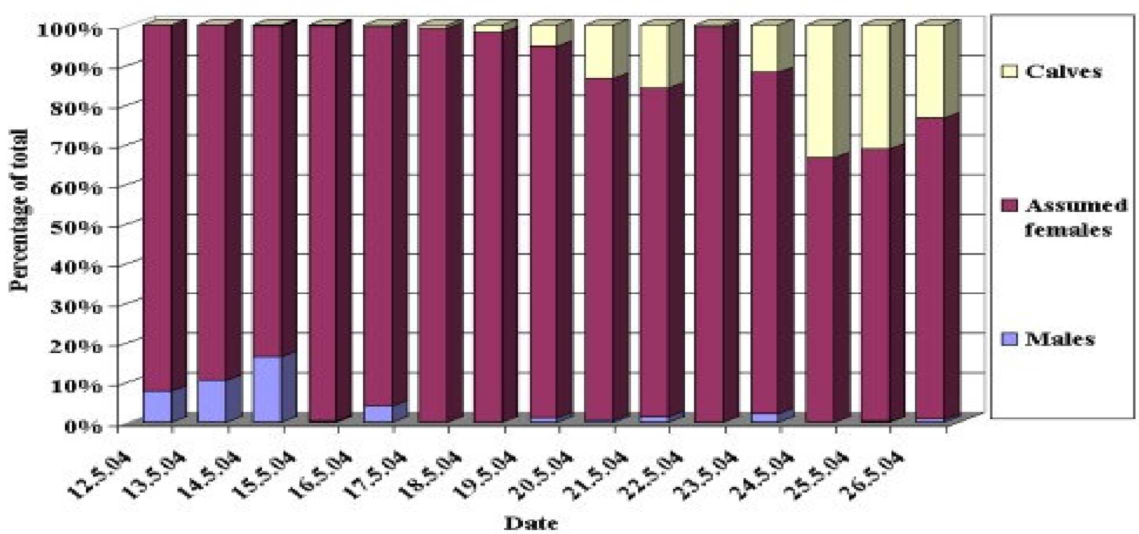

Figure 5.5: Chart illustrating the proportions of males, assumed females and calves observed during May 2004.

As noted in the introduction, Saiga are known to exhibit some degree of sexual segregation during calving, with the males often being in herds on their own, away from the aggregations. By looking at the proportions of males, females and calves observed throughout the period that the patrols focussed on the plateau itself, which is the 12th–26th May, as illustrated in figure 5.5 (which uses unadjusted data and assumes that all unconfirmed sex Saiga are female), there is certainly circumstantial evidence for this occurring. Males making a maximum 17 per cent contribution to the daily percentage of observed herds during the initial days of observation. However once the calves start to appear in any numbers (they are a percentage of the herd from the 14th but too insignificant a presence to register), the number of males observed decreases considerably. There may be alternatives reasons for this observation however, which will be discussed later.

The number of males seen daily throughout the expedition, not just on the plateau, is illustrated in figure 5.6. Relatively high numbers were seen on the 12th–14th and 16th, in comparison to the other days and these were days of particularly intense travelling, with the highest number of kilometres covered on patrol. They were also some of the first days the expedition spent on the plateau and so it is possible that what figure 5.6 actually represents is the males choosing to make a local migration to an area where they were not being constantly disturbed.

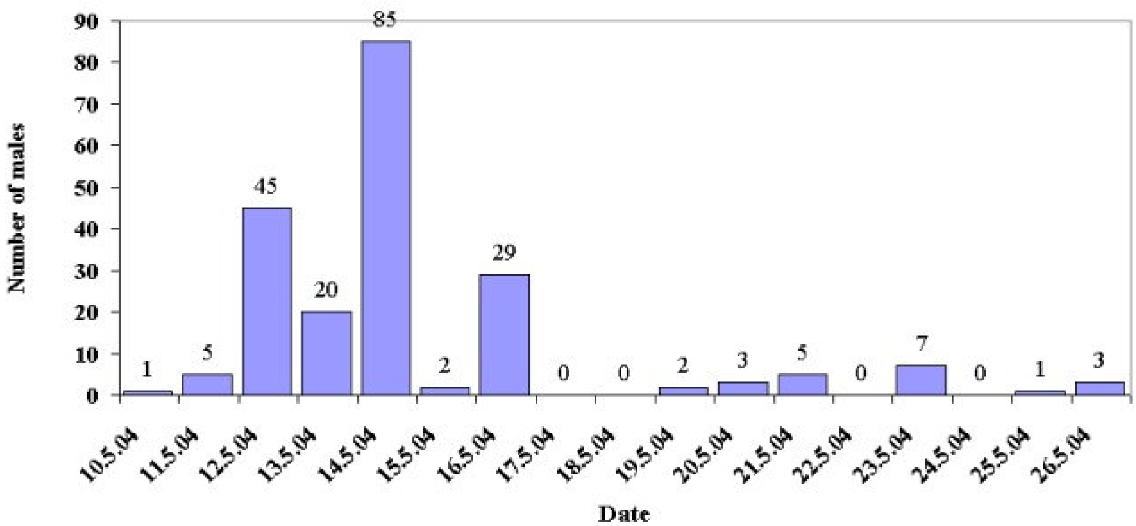

Figure 5.6: The frequency distribution of male Saiga observed throughout the expedition.

5.3.2 Analysis of herd spatial and temporal activity

The daily results as shown in table 5.1 are detailed but not very suitable for direct comparison in order to look at herd dynamics over the duration of the expedition. Any attempt to group days into periods for ease of analysis is going to rather arbitrary but also quite necessary. Several assumptions have been made in an attempt to explain the rationale behind choosing the following dates to group days into 3 five day time periods during the expedition, these being in between 12th–16th May (period one), 17th–21st May (period two), and 22nd–26th May (period three). The reason for not using data from the 10th and 11th of May is that they were days spent travelling throughout Ustiurt searching for signs of Saiga aggregations and then establishing different base camps. So there was no systematic patrolling, which took place to a greater extent after these dates. Also the regions travelled through then were subsequently not revisited and hence comparison is inappropriate. Another justification for the somewhat subjective selection of dates is that a pattern emerges when the proportions of Saiga males, assumed females and calves are examined over time. As figure 5.5 illustrated there is a marked difference in the proportions of males over time, which broadly corresponds to an increase in calf numbers.

Saiga	**Period one 12th-16th May**	**Period two 17th-21st May**	**Period three 22nd-26th May**	**Totals**
Daily observations	170	301	349	***820***
Kilometres covered	1227	818	963	***3008***
Males	181	10	11	***202***
Confirmed females	735	743	1093	***2571***
Unconfirmed sex	1669	1177	1603	***4449***
(Assumed female)	(2377)	(1920)	(2696)	***(6993)***
Calves	7	139	449	***595***
Totals	***2592***	***2069***	***3156***	***7817***

Table 5.2: Herd observations reduced for comparison to three periods. 12th – 16th, 17th – 21st, 22nd – 26th May 2004. Totals do not include the assumed females shown in brackets, since they are the sum of the confirmed females and unconfirmed sex.

Around the time that the calves are being born the proportion of males decreases substantially. This makes a natural division defined by the reduction in numbers of males and calves making a greater contribution to herd sizes, it also allows the periods to be divided equally into five days each. Table 5.2 illustrates the breakdown of herd observations into the three periods, using the same data as for table 5.1.

What becomes immediately apparent is the greater proportion of males in period one in comparison to periods two and three, and the greater proportion of calves in period three compared to periods one and two. The first result concerning the males was noted and discussed in the previous section and the second result being expected, since the calves are at this stage well developed and often visible, running with the herds. The numbers of Saiga assumed to be female are relatively similar with a range of 776. There is an error margin with these figures of 341 since this is the number of the unconfirmed sex estimated to be male as calculated in the previous section, however it is neither possible nor practical to accurately allocate this to either period.

The number of observations of herds shows considerable difference between the periods, as do the total number of animals observed. The greatest number of observations does yield the highest total in period three, however period one with less than half the number of observations has only around 22 per cent less animals observed. Period two also has significantly more observations than period one but much fewer animals observed in total. So there is clearly a difference in herd sizes throughout these three periods in order for this to occur and these have been tabulated in table 5.3. There is only a weak relationship between the numbers of kilometres covered on patrol and both the number of observations and the total number of Saiga sighted (appendix 3).

Number of Saiga estimated to be in herd	**Period one frequency 12 – 16th May**	**Period two frequency 17th – 21st May**	**Period three frequency 22nd – 26th May**
1 – 5	101	244	272
6 – 20	30	44	48
21 - 50	27	9	17
51 - 150	12	2	9
151 - 300	0	1	2
> 300	0	1	1
Total	**170**	**301**	**349**

Table 5.3: The frequency of herd sizes observed throughout the three periods in May 2004.

Saiga herd sizes have been divided into six groups according to the frequency at which they were observed. For all periods the greatest numbers of observations were for the smallest herd size, with the largest herds receiving the fewest number of observations. In other words throughout the expedition it was consistent to see herds with small numbers of individuals and least common to see larger herds. There is variation however between periods in terms of the frequency of encountering herds of different size and a Chi squared test has found this to be significant (df=6, X^2=49.309), the results of which are listed in appendix 4.

Period one results show a mean herd size of 15.247 (range=149, SD=25.744) which illustrates that whilst smaller herds were the most frequently encountered there were also some substantial sized herds which increased this number. Period two has a mean herd size of 6.873 (range=399, SD=29.863) which is due to the greater occurrence of smaller herds and period three has a mean of 9.042 (range=374, SD=30.145) since although smaller herd sizes predominate as with period two, there are also more larger herds which serve to increase the mean value.

These results are most descriptive when viewed together as frequency distributions as illustrated in figure 5.7. Viewing the results in this way shows the difference in herd sizes seen throughout the three periods and illustrates in particular the variance in frequency of herd sizes observed, with the least variance in period one and the greatest in period three.

There is prevalence for observed herds to be small in size with numbers in the region of 1-5 being most commonly seen in all periods. Another pattern with small herds of <20 animals is that the number observed increases throughout the three periods, peaking in the final period where these sized herds make up over 90 per cent of the total observations. Period one shows much less smaller herds than the later periods, around 70 per cent less observations.

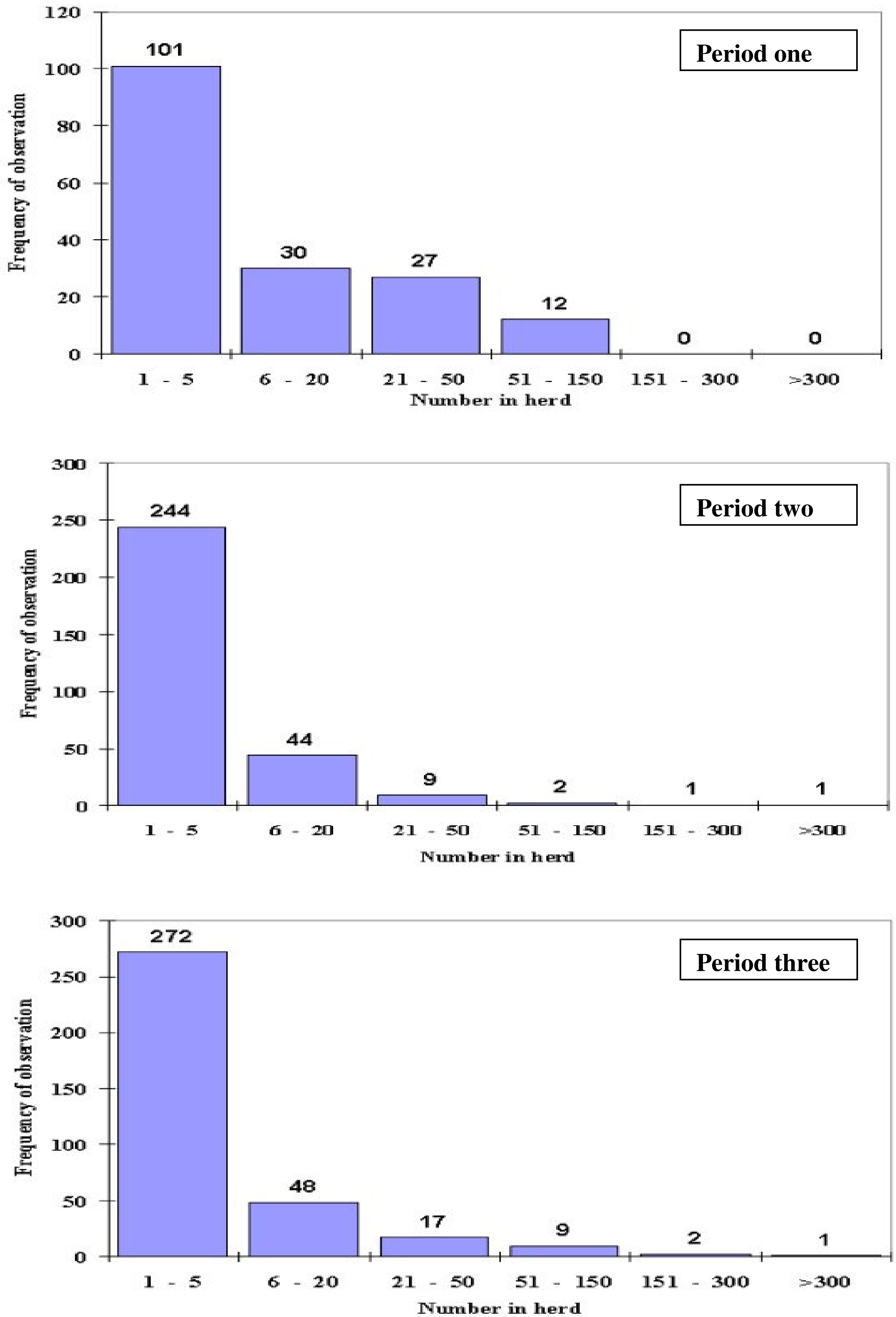

Figure 5.7: The frequency distribution of herd sizes observed for the three periods. This graphically illustrates the information shown in table 5.3.

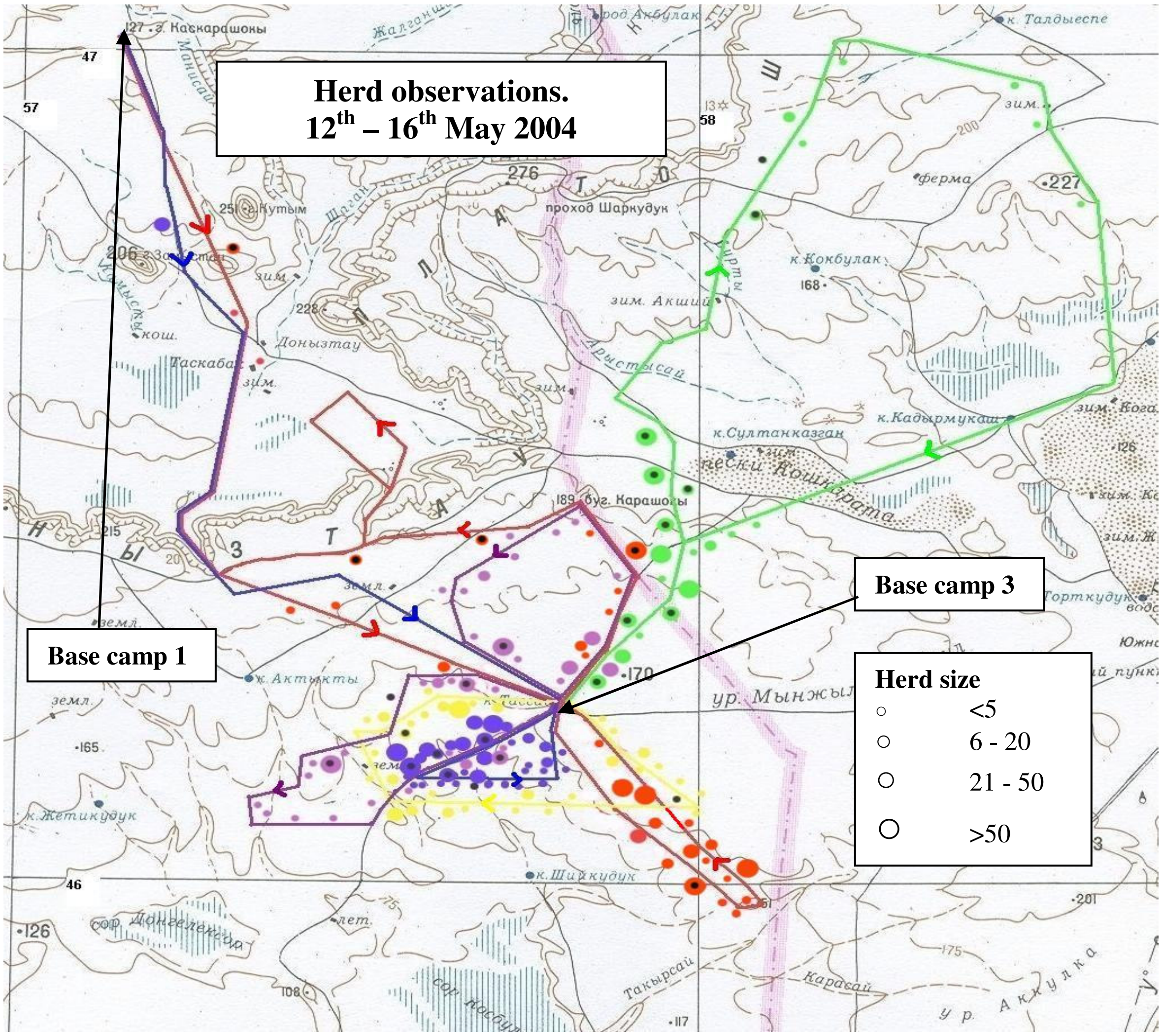

Figure 5.8: Geographical map illustrating the routes covered during period one, the spatial location of the herds and their relative sizes. Routes are drawn in solid lines with their colours relating to the dates: **12th May, 13th May, 14th May, 15th May, and 16th May**. Herd sizes are represented by correspondingly coloured dots, their relative size indicating the number observed in each herd. Herds in which males were sighted are identified with a black dot in the centre. The legend for this geographic map can be found in appendix 8.

Period one's observations show a trend for larger herds to be sighted (but not the largest herds in total estimated numbers) when compared to the two later periods, for which the greater number of observations are for herds sized in between 1–20. Figure 5.8 illustrates the routes covered in between the 12th–16th of May, the direction of travel shown by the arrows bisecting the route, along with a schematic spatial representation of the relative herd sizes encountered on a daily basis. This period was the most extensive in terms of kilometres covered and area surveyed but has the lowest density. The most noticeable features apart from this are the overall relative scarcity of sightings and the high number of males seen, as indicated with the black dots.

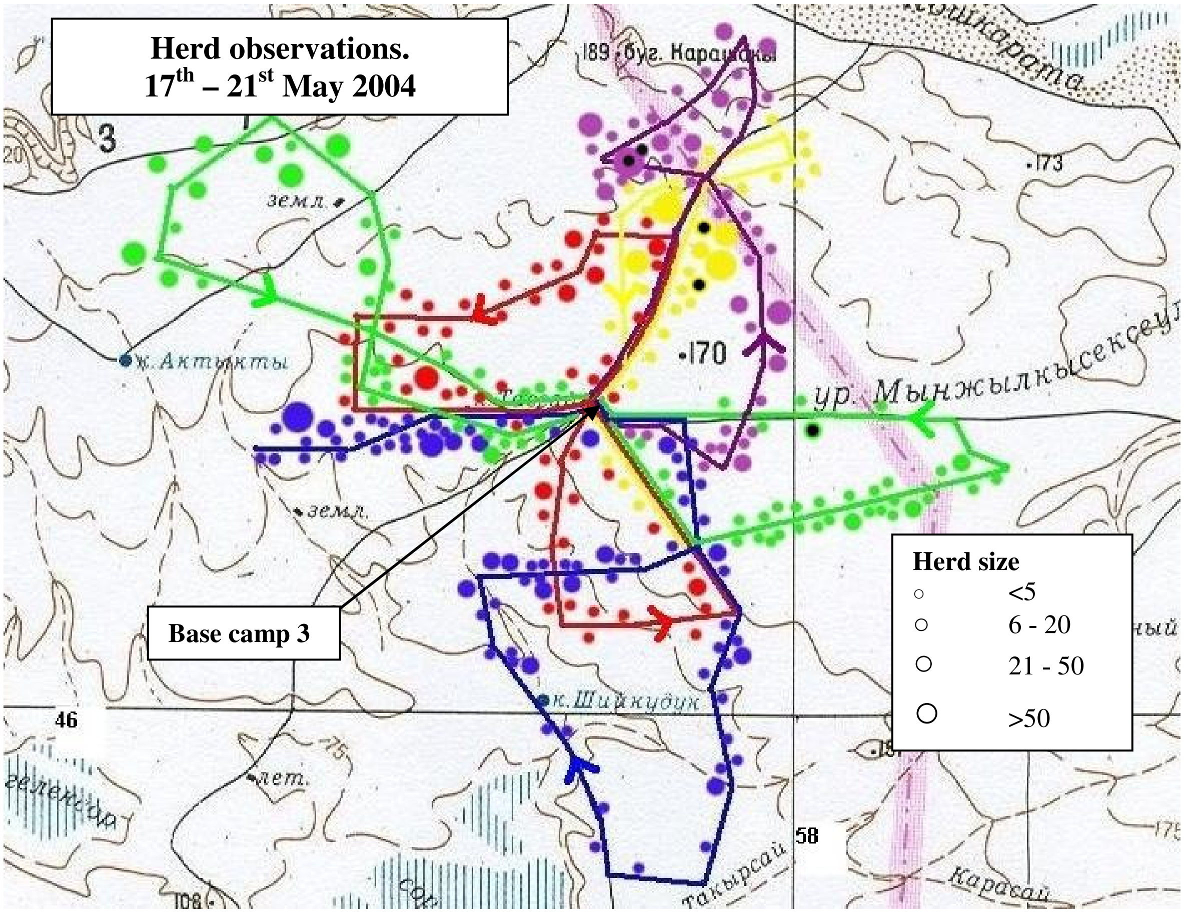

Figure 5.9: Geographical map illustrating the routes covered during period two, the spatial location of the herds and their relative sizes. Routes are drawn in solid lines with their colours relating to the dates: **17th May, 18th May, 19th May, 20th May, and 21st May.** Herd sizes are represented by correspondingly coloured dots, their relative size indicating the number observed in each herd. Herds in which males were sighted are identified with a black dot in the centre. The legend for this geographic map can be found in appendix 8.

Figure 5.9 illustrates the same information for the 17th–21st of May but in a more confined area as the least distance was covered during the patrols during this period. In all cases the routes expand out from a central point, which is base camp three. The most obvious features on this map are the increased density resulting from the higher proportion of smaller herds and scarcity of both the medium to large herds and males as seen in the previous period.

The final period of the 22nd-26th of May is shown in figure 5.10 below, where the density and frequency of herd observations is at its maximum with very many observations of small herds but also more of the largest herds which were not observed to the same degree in the previous period.

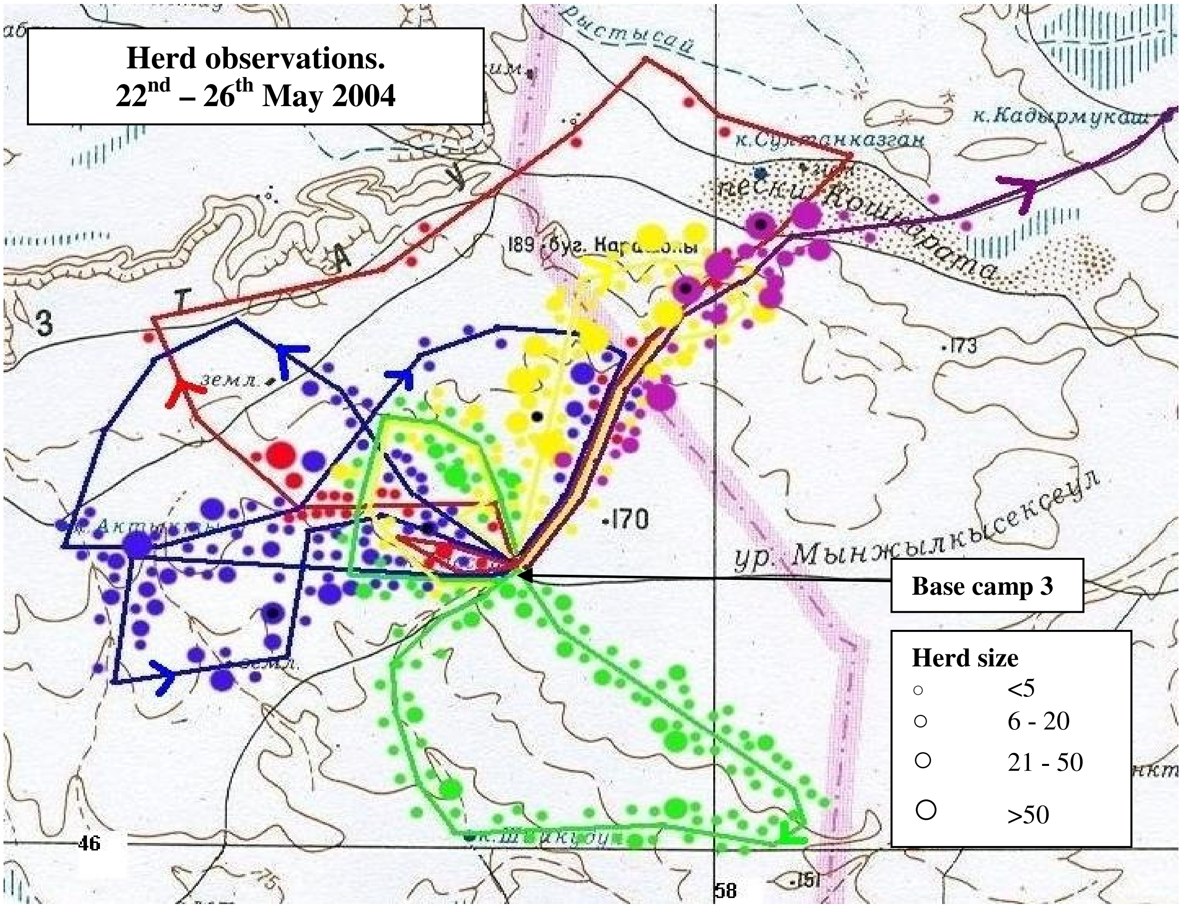

Figure 5.10: Geographical map illustrating the routes covered during period three, the spatial location of the herds and their relative sizes. Routes are drawn in solid lines with their colours relating to the dates: **22nd May, 23rd May, 24th May, 25th May, and 26th May**. Herd sizes are represented by correspondingly coloured dots, their relative size indicating the number observed in each herd. Herds in which males were sighted are identified with a black dot in the centre. The legend for this geographic map can be found in appendix 8.

All maps were produced using CyberTracker software, from GPS coordinates obtained in the field. For illustrative purposes all three maps have been magnified and hence are not to scale, instead they should be viewed as schematic. Since the GPS was taken at the point of observation, either in a vehicle or on foot and not at the point at which the herd had been situated there is some slight discrepancy in the exact position of the herd's spatial location, although this has been corrected where possible using the information on distance and orientation of sighting. Where is was not possible to get the GPS coordinates for a variety of reason the positioning of the herd has been accomplished using other information such as kilometres covered, time and neighbouring observations. Overall though the maps do give a good visual overview of herd sizes spatial and temporal dynamics over the three periods.

5.3.3 Estimation of true numbers

As noted earlier, the number of observed Saiga was not taken to be a census of true numbers of animals. An estimation of the true number of Saiga on the Ustiurt plateau in between the 12th-26th May is in the region of 3500 (3484). This figure is derived from the calculation of the estimated number of Saiga (not including males or calves) seen per kilometre squared on a daily basis (mean=5.74/km^2, range=12.41/km^2, SE=1.074), multiplied by the total area of the plateau upon which Saiga were observed (480km^2). A precautionary approach to estimating the true number of males precludes the use of the reallocated estimated total and instead the only the number of confirmed males are used. Since confirmed sightings of males were so rare and in diverse locations their contribution to herd sizes were removed from this equation, as were the calves since they were constantly developing and joining the herds, it was unlikely in either case there was significant double counting, which was the case with the females. These daily total estimates of numbers in the region were thus analysed and the mean of 2681 taken as the total number of females (SE=465.698). The confirmed males (208) and calves (595) estimates were then added to this. The resulting ratio of true numbers of males to females is approximately 1:13 (12.889) and calves to females 1:4.5. The relative true proportions are illustrated in figure 5.11.

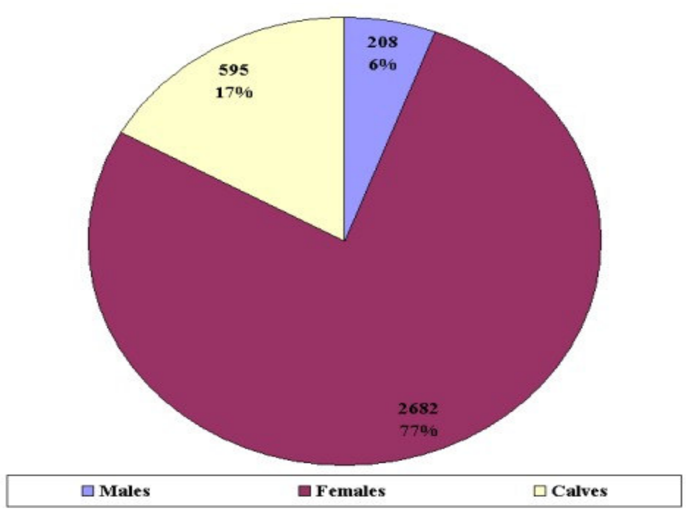

Figure 5.11: The estimated true proportions of Saiga believed to be on the Ustiurt plateau in between the 12th-26th May 2004.

5.3.4 Disturbance and predation

The number of kilometres covered during the daily patrols (table 5.1), and therefore the expedition's direct disturbance to the Saiga, varied according to the routes taken, difficulty of terrain negotiation and time spent driving. Regression analysis comparing the daily kilometres travelled to the numbers of Saiga herds seen, appears to show a negative correlation, which is to say that more kilometres travelled did not equate to more Saiga being observed. This is illustrated in figure 5.12. It is likely that this is the result of the Saiga being disturbed by the increased presence on days where the patrols travelled extensively in search of the herds and them making local migrations away from the region.

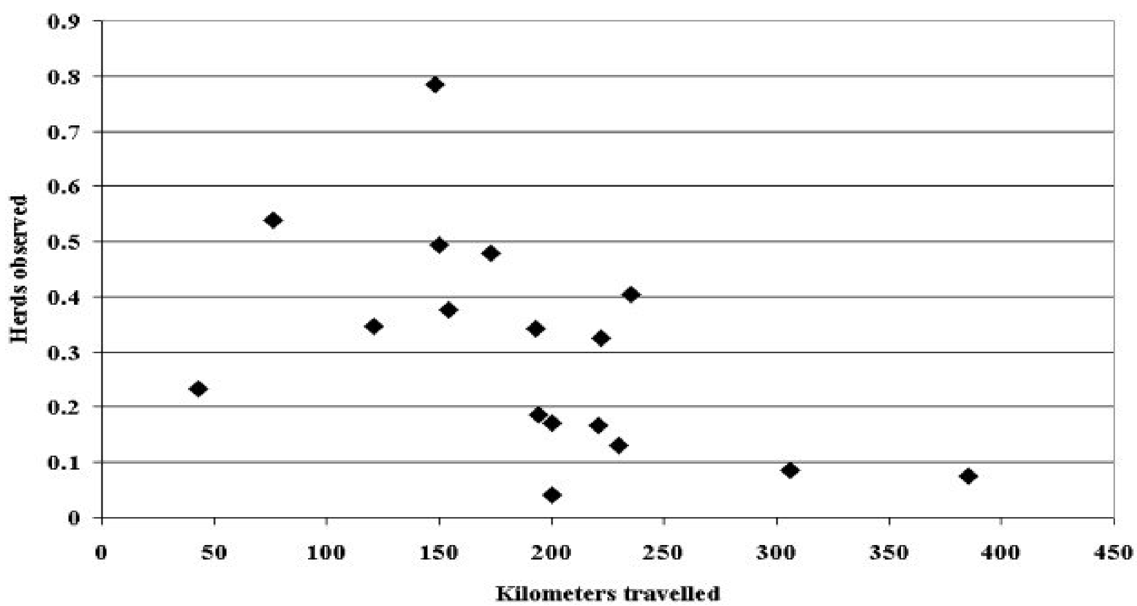

Figure 5.12: Regression of the number of kilometres travelled against the number of herds observed.

Further analysis of the number of Saiga herds seen per kilometre travelled, plotted against a disturbance index of the number of vehicles patrolling the area indicates that there is not a very strong relationship between the two (R^2=0.103). The meaning of this is that the number of animals seen is not dependent upon the number of vehicles on patrol and hence volume of disturbance. This was an observation witnessed in the field as it did not appear to matter if there were fewer vehicles, the Saiga would be as disturbed with one vehicle as they would be with four, the result would be that the would flee immediately. This is illustrated in figure 5.13.

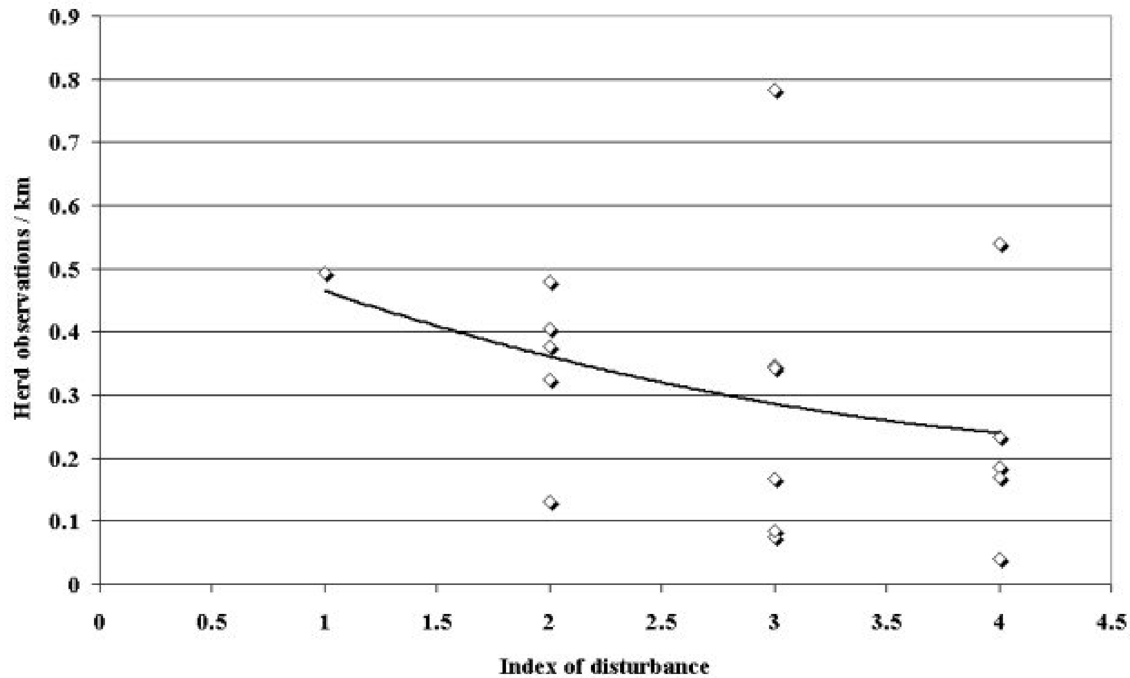

Figure 5.13: The regression of observation per kilometre of herds against a disturbance index relating to the frequency of human disturbance observed within the Ustiurt region through out the expedition (R2 = 0.103).

The spatial locations of disturbance is illustrated in figure 5.14 for vehicles other than the expedition's, motorcycle tracks, evidence for poaching activity and livestock. The area within the white rectangle is where the majority of Saiga were observed whilst on the plateau and the area within which all calves were sighted. The frequency of vehicular sightings was relatively high around the base camp three since there were several wells at that location and it was commonly used as a site to replenish supplies and rest. Since there were several roads running through the area it was unavoidable that the Saiga would encounter vehicles in this region. Motorcycles are commonly used by poachers hunting Saiga; tracks were seen with more frequency during the early stages of the expedition, to the north of the region and in the vicinity of a farm but no motorcycles were actually seen being driven. Evidence for poaching was found in the form of male Saiga skulls with the horns sawn off; these were found dispersed throughout the region. None were freshly killed and all were estimated to have been weathered for at least over a year. Livestock was sighted sporadically, being mostly Bactrian camels, Gissara and Karakul sheep, horses and cattle. The only concentration being seen around a farm (situated on the right hand side in figure 5.14). It was unlikely that there would have been any close contact between the Saiga and these animals, since very few Saiga were seen in that region.

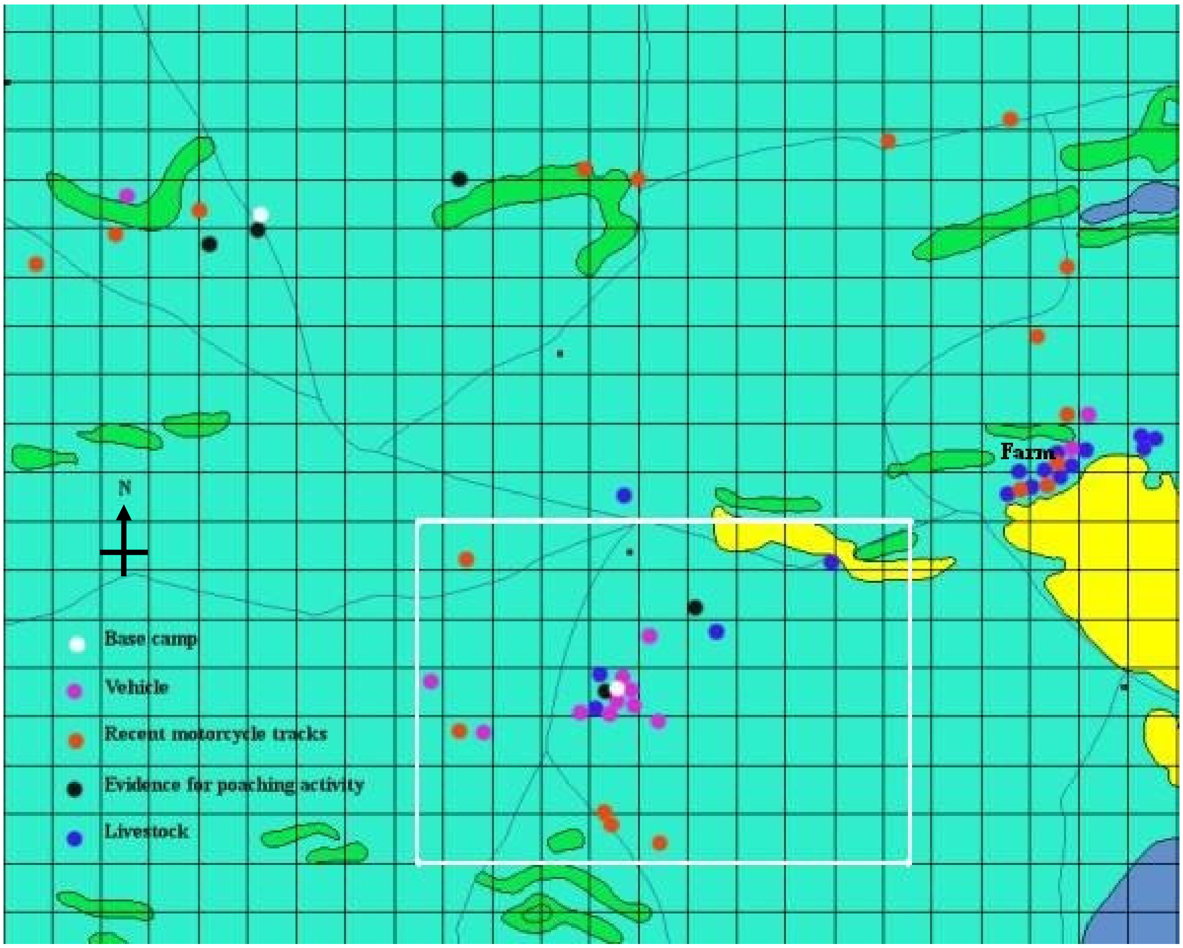

Figure 5.14: The spatial distribution of evidence for human disturbance observed in between the 10th-26th May 2004. The grid squares represent $10km^2$. The legend for this map can be found in appendix 9.

Surprisingly little evidence was found for predation on the Saiga population during the spring calving, a time when they are particularly vulnerable. This was unexpected, especially since there have been reports of increased wolf numbers in recent years since the management regime has collapsed. The most numerous predators seen were the large birds of prey, in total 119 were sighted. Of this number 50 per cent were unidentified species of eagle, 35 per cent positively identified as being Steppe eagles and the remainder were species of vulture. The two species of fox, *Vulpes vulpes* and *Vulpes corsac* were also commonly encountered, especially at dusk. The presence of fresh spoor or faeces was noted and the spatial location recorded for these observations as well as for direct sightings. Of the 39 foxes identified the majority were *V. corsac* (65%), which are the smaller of the two species and the least capable of doing harm to any Saiga except for very young calves. Of the steppe wolves, none were actually seen during the daily patrols and the only evidence for their continued presence in the region was found as spoor (figure 5.15).

Figure 5.15: Fresh spoor of two adult wolves, found near to a body of water on 15/05/2004. The coin for scale is a 50 tenge piece. This is approximately the same size as a twenty pence sterling coin, around 20mm in diameter.

Ten separate wolf tracks were identified from around the region, 60 per cent of these being associated with proximity to water bodies. The remainder were found in association with Saiga tracks but only on one occasion could it be ascertained that the predators were actually pursuing the antelope. In this case the spoor was intermingled in such a way that it was apparent that both the Saiga and the wolf in question were running fast and at the same time.

Figure 5.16 illustrates the spatial distribution of all the observations of predators throughout the period. The white rectangle on this map indicates where the majority of the Saiga and all of the calves were seen.

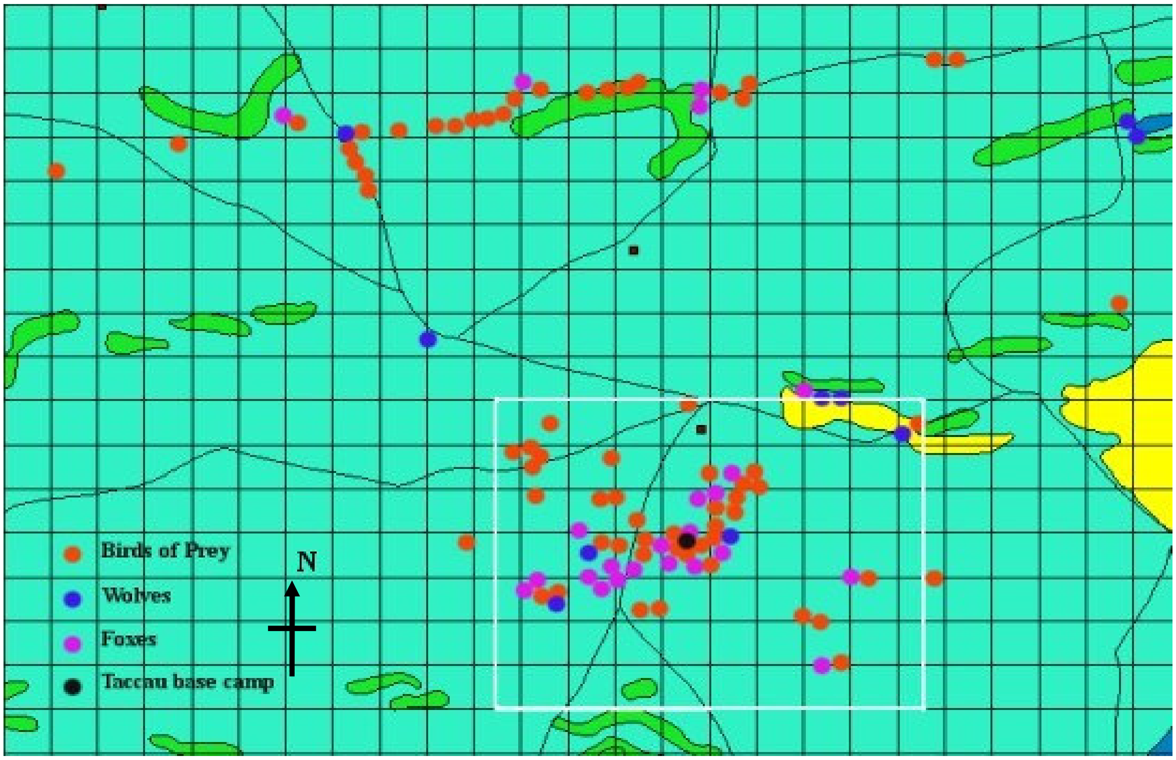

Figure 5.16: The spatial distribution of evidence for potential Saiga predators observed in between the 10th-26th May 2004. The grid squares represent 10km^2. The legend for this map can be found in appendix 9.

5.4 Ecological results - Saiga calves

These results will be taken in a logical order, the sequential analysis of some findings being essential to move onto subsequent results. Initially the general findings will be examined followed by more in depth analysis of the temporal and spatial elements. Next the inference of results of the incidence of observations of single calves and twin pairs will be illustrated. A comparison with the calf data collected in 1998 will complete this section.

In between the 14th – 26th May 2004 a total of 153 observations yielded an estimated 595 calves. This was the minimum sighted as it was often impossible to get an accurate count once the calves joined the herds and were seen from the distance. Whilst running in amongst the herd they are often obscured by the adults, vegetation and dust. The total number of calves observed on a daily basis throughout the expedition is illustrated graphically in figure 5.17 below. As expected there is a trend for increasing frequency of sightings over time as the calves develop and join the herds, once they are able to run away from danger and no longer need to employ their camouflaged hiding defence.

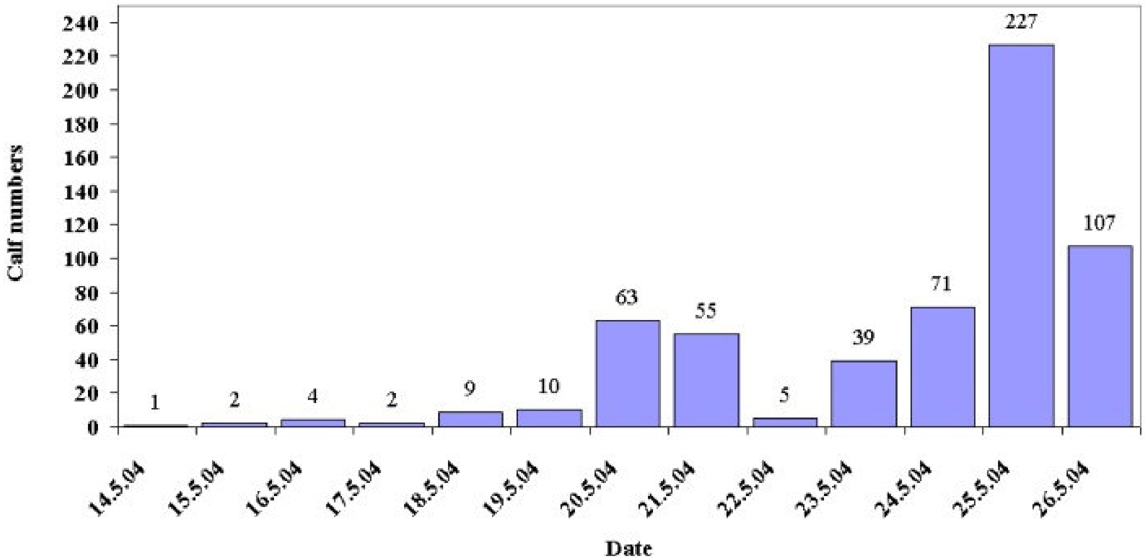

Figure 5.17: The frequency distribution of Saiga calves observed throughout the expedition.

It was expected that a large number of samples could be collected in just a few days, while the calves are situated at high density in a small area (Lundervold. 2001). Instead a total of only 13 live Saiga calves were captured. No dead calves were encountered and only one placenta was located. A further 52 calves were sighted and capture was attempted between 18^{th}–24^{th} but was unsuccessful since all but one was estimated to be at least over three days old and therefore easily able to outrun a human. This small sample size was unexpected and was the result of the calves being so widely distributed over an area of approximately $300km^2$ at very low density. Each capture was extremely costly in terms of man hours and kilometres covered. The measurements taken from the calves are listed in table 5.4.

The mean weight for the 2004 calves was 3,396 grams, (range=3,100-4,600, SD=980.116). Overall the mean weight for the males (3,657 grams, range=3,100–4,600, SD=578.380) was greater than that for females (3,575 grams, range=3,150–4,500, SD=518.411), though not considerably so. This is to be expected, since a greater proportion of the captured males were older and hence had more time to develop and put on weight. Males too are known to be born heavier than females (an average of 3,900 grams compared to an average of 3,600 grams, (Bekenov *et al* (1998)) and are thought to grow faster in early life. Male calves are generally found to be heavier at a given length than female calves, according to a multivariate regression performed on the Ustiurt and Betpak-dala population in 1998

(Lundervold. 2001). A similar trend was found with the 2004 calves, regression analysis was used to assess the correlation between weight and length of males and females as illustrated in figure 5.18. This showed a positive correlation as expected. The larger the calf, the heavier it is, and male calves are generally heavier at a given length than female calves, however the small sample size involved makes this result inconclusive.

Calf	Date captured	Age	Sex	Length mms	Weight grams	Twin / Singleton	Vegetation type
1	14th May	24	Male	510	3150	Singleton	Unknown
2	15th May	12	Male	610	3550	Singleton	Type one
3	16th May	24	Female	570	3450	Twin	Type two
4	16th May	24	Male	570	3150	Twin	Type two
5	16th May	48	Female	585	3200	Twin	Type three
6	16th May	48	Male	570	3100	Twin	Type three
7	17th May	48	Female	560	3150	Twin	Type three
8	17th May	48	Female	570	3300	Twin	Type three
9	18th May	24	Female	600	3850	Singleton	Type three
10	18th May	72	Male	630	4100	Twin	Type one
11	19th May	72	Male	600	3950	Twin	Type one
12	19th May	72	Female	660	4500	Twin	Type one
13	20th May	72	Male	660	4600	Singleton	Type two

Table 5.4: Table illustrating the measurements and observations taken from the 2004 captured calves.

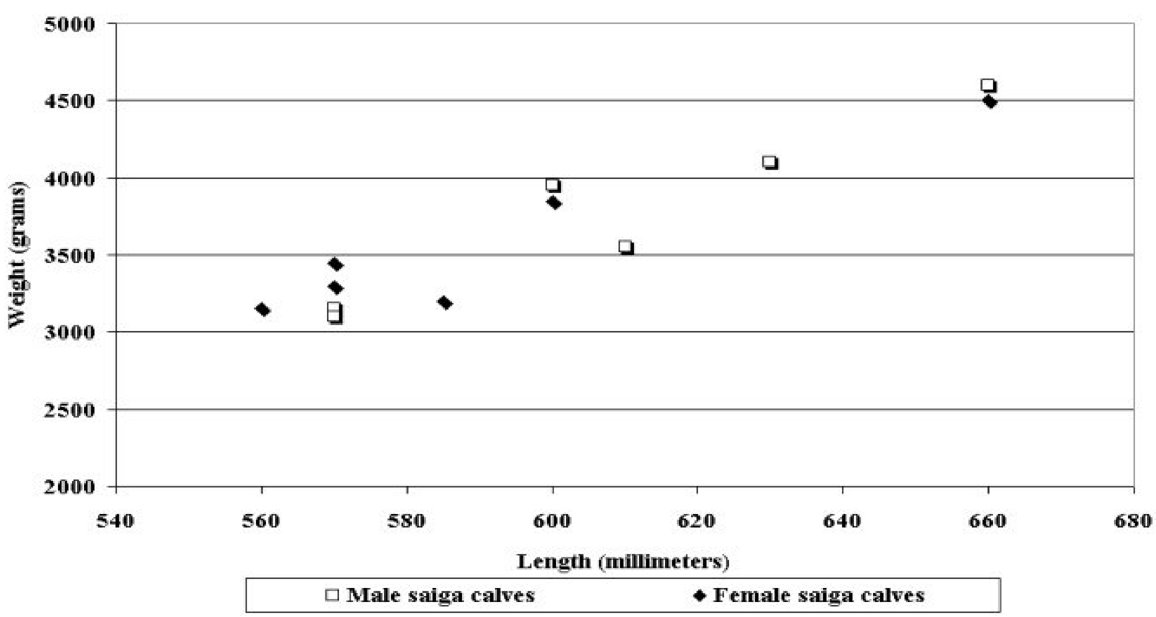

Figure 5.18: The correlation between length and weight in male and females Saiga calves sampled during May 2004.

Although listed in table 5.4, the length measurement for calf number one is not taken into account in this section as it was captured late at night and its measurements were taken alone and in the dark by a colleague on the expedition. It is highly probably that there was some error, given the difficulty in handling the animal alone and the unusually small measurement will otherwise skew the subsequent analysis. Its weight however falls into the expected range and was therefore included in the previous results. The mean length for the 2004 calves was 599 millimetres (range=560–660mm, SD=35.170). Overall the mean length for the males (606.6mm, range=570–660mm, SD=35.023) was greater than that for females (590.8mm, range=570–660mm, SD=36.662) but once more not by a great margin. This is to be expected, considering the difference in weight between the sexes and the correlation between the two variables.

5.4.1 Temporal estimation for calf birth dates

In order to assess whether the calving had occurred during the time period expected from previous year's data (Lundervold. 2001, Bekenov *et al*. 1998). It was firstly necessary to consider when the timing of peak mass calving was occurring. After estimating the age of the 13 captured calves and 52 relatively close sightings it was possible to chart the approximate dates upon which they were born. This is illustrated in figure 5.19.

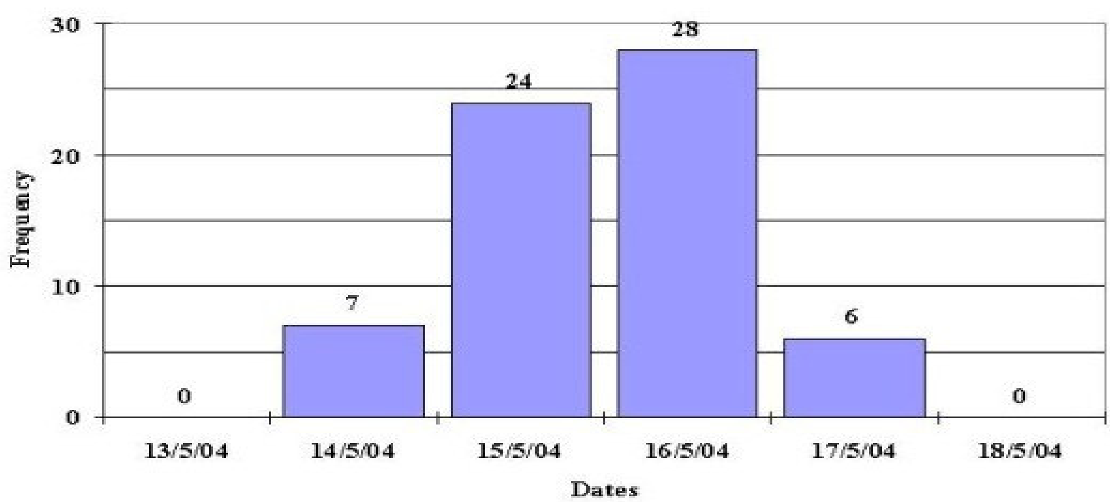

Figure 5.19: The frequency distribution of the estimated dates of birth for calves in May 2004 from direct observations of captured calves and inferred from the behaviour of calves observed from close range but not captured.

However since the sample size of calves for which age could be directly estimated is not large, it is necessary to look at the behaviour of both the calves and herd in order to extrapolate when the peak calving time occurred and to see if this is consistent with the expected timing, the second ten day period of May (Fadeev & Sludskii, 1982). Although this is crude and does make some certain assumptions it should provide a more accurate indication of timing when used in conjunction with data from the captured calves. To do this a time line has been constructed with observations of behaviour and known facts about the calves in their first ten days of life. These facts are listed below in table 5.5 and are taken from Bekenov *et al* (1998) and communication with Saiga specialists from the IoZ.

Approximate age	Behaviour
< 24 hours	Hide motionless. No attempt to run away.
< 48 hours	Hiding but being able to run. Still unsteady.
< 72 hours	Able to run, not at all unsteady on legs.
3 – 4 days	Running, making observational jumps.
4 – 5 days	Following mothers but still left behind when running.
7 – 10 days	Always running with females.
2 – 3 weeks	Forming nursery herds.

Table 5.5: Calf behaviour correlated to approximate age.

On the 11th May the first female was sighted behaving as if her calf was new born and in the vicinity. The female did not run far, she constantly stopped to look back at where it was presumed her offspring were hidden, and was running backwards and forwards trying to divert attention from them (Lundervold. 2001.). This behaviour was again observed on the 12th and 13th. Furthermore a female with a bloodied rump was seen on the 12th, she was running in an erratic manner that suggested she had recently giving birth. The first calf was captured on the 14th and its age estimated to be 24 hours, since it was captured at 23.30 it is likely that it was born on that day. Two calves were sighted on the 15th, the first captured and estimated to have been born that day and the second already able to run away from a human which indicates it was likely to have been born around the 12th or 13th, however since there had been high minimum and maximum temperatures and good weather conditions over the past few days it is possible that it was younger but well developed. Two pairs of twins were captured the following day and their date of birth was likely to have been the 14th and 15th since they were about 24 and 48 hours old respectively. Another pair was captured on the 17th that were approximately 48 hours old, so again the date of birth may have been the 15th. The numbers of calves sighted increased significantly from the 18th with nine sighted that were able to run away, probably having been born around the 15th. A single placenta was identified on this day which was mostly desiccated and believed to be around three days old, from the 15th also. One of the two calves captured was believed to be only 24 hours old however. The 19th saw ten sighted which ran away easily and two were captured but only through a great deal of effort. These two were much heavier and larger than those previously measured and there age was likely to have been at least 3 days old, so their date of birth was the 16th give or take a day. On the 20th what was thought to be a small aggregation was located, spread over about a $6km^2$ area, close to base camp three. The last calf, number thirteen was captured here, again through concerted effort. The others were running, making observational jumps and not attempting to hide after they had run sufficient distance to feel safe. These were likely to have been born in between the 15th–16th. One dead female was found in the immediate vicinity of the calving ground, she was approximately 18 months–2 years of age. A field autopsy established that she had been dead for around 5 hours and had given birth to twins 2 / 3 days before. No cause of death could be established. Calves were seen to be with females in herds on the 21st but were left behind when the herd took flight, these were likely to be 5–6 days old and so born around the 14th–16th although the accuracy of these assessments declines as the calves get older and are observed from greater distance. From the 23rd to the end of the expedition on the 26th all calves observed were running with the herd and not being left behind when running, the only assessment from this is that they are likely to be at least 7–10 days old. It now became almost impossible to numbers seen given the distance, dust and movement. One single female was identified as behaving in a similar way to that observed on the 11th–13th, running around, not away and looking. It was possible that she gave birth much later than the majority or had a calf that was weak or injured. There were no nursery herds seen at all.

This assessment of behaviour adds some important information to the data gathered from direct observation of estimated calf age, in the latter it was estimated that peak birth probably occurred around the 15th–16th May. This was because during the walking transects on the 20th and 21st through the small aggregation, a great many calves were seen and their age guessed at around 5 days. From this behavioural study it can be extrapolated that the calving probably started around the 11th, with relatively few calves being born in the next few days. The increase in calves sighted on the 18th possibly signifies that the peak of the mass calving had begun around the 14th–16th and lasted until 17th–18th, give or take a day either way. This corresponds broadly with the data gathered on birth dates from 1998, with high numbers of calves being captured between 14th and 21st of May. It is also consistent with Fadeev & Sludskii (1982) and Bekenov *et al* (1998), in that the temporal positioning of mass calving in Ustiurt is in the second ten day period in May.

5.4.2 Spatial distribution of Saiga calves

In order to assess whether mass calving was taking place within a concentrated area the GPS coordinates of all calves observed (captured and nor captured) were mapped onto a GIS map using the CyberTracker software. The results are illustrated on figure 5.20. In this map the positions of calves identified to be singletons or twins are identified with different coloured dots respectively. Calves that were not distinguishable in this way are identified with a white dot of varying size depending upon the number seen. These latter calves were often those observed later in the expedition when they were running with herds and so not readily identifiable with a particular female. The overall area in which calves were sighted was approximately 300km^2, each grid square measuring 10km^2 and thirty squares being populated with calves. There is a loose spatial clustering in at least two main areas with many calves being observed alone, however this over a much greater range than that reported in literature, with Fadeev & Sludskii (1982) estimating a relatively even distribution with an average density of five to seven calves per hectare, compared to an approximate two calves per square kilometre. No discernable pattern can be seen in this distribution with both single calves and twin pairs dispersed throughout the region. It must be stressed that although the dots depicting calf location are illustrative and not to scale, they are within 10km^2 grid squares and appear to be much closer to neighbouring calves than is actually the case. If they were scaled down to represent distance from the nearest neighbour they would be indistinguishable. In the majority of cases each calf observation is at least a kilometre distant to the next nearest sighting, the only exception being the calves observed within the small aggregation to the north.

It has been suggested that a female may influence her calf's spatial location by deciding whether to give birth within an aggregation or solitarily (Milner-Gulland. 2001). In this case it would appear that the majority made the decision to give birth outside the shelter of a concentrated group, although this may be the representation of Saiga aggregating at greatly reduced population levels and density. If the population size is not adequately large enough, aggregating to give birth in close spatial proximity potentially becomes an unsuccessful strategy in predator defence. Alternatively it may be that disturbance led to the disruption of normal aggregating behaviour, since base camp three was centred in the middle of the calving ground, a fact not recognised until post expedition analysis and both the calves and adults would therefore have been subjected to the vehicles moving through the region on a daily basis.

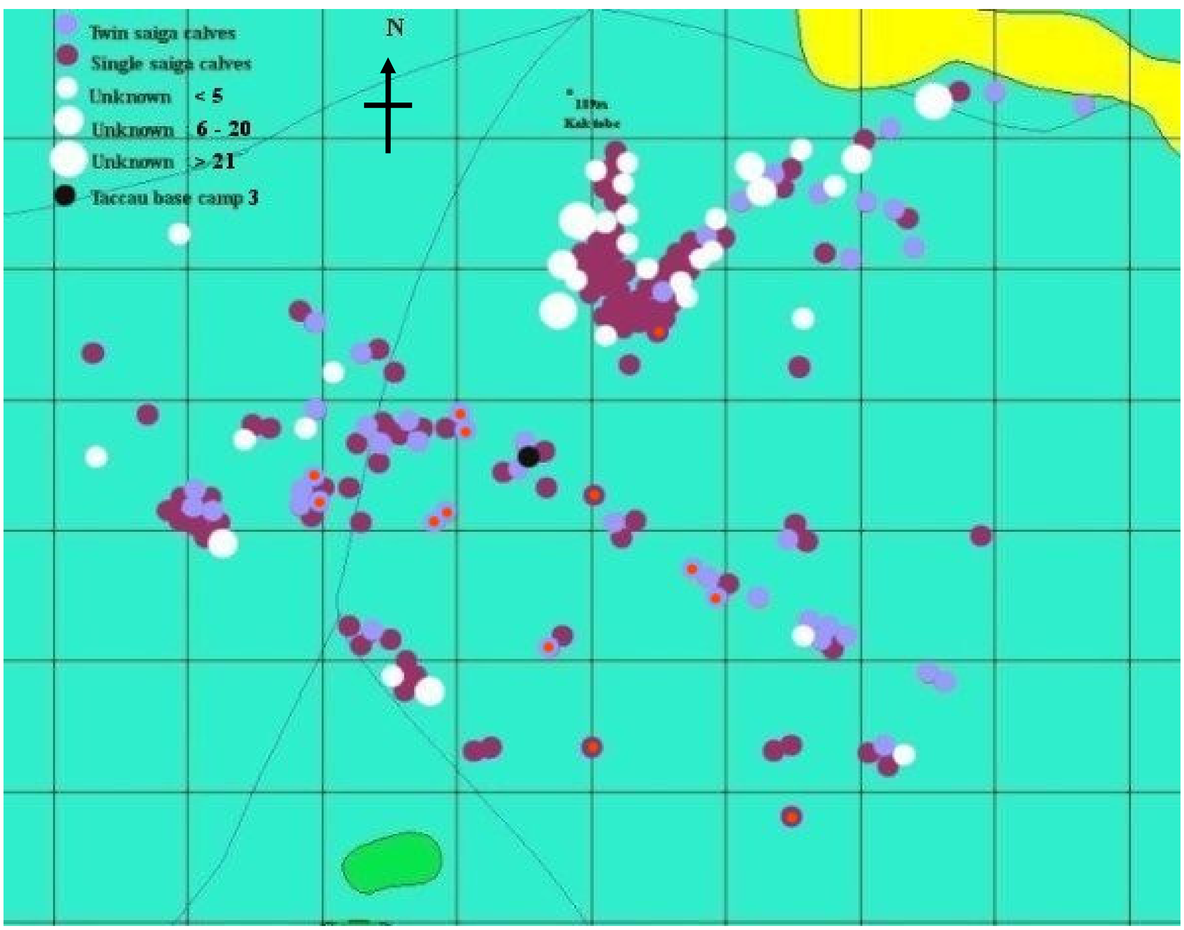

Figure 5.20: Map produced with CyberTracker GIS software to illustrate the spatial locations of the Saiga

calves in between 14th – 26th May 2004. Calves which were captured are indicated with a red dot. Only those calves sighted and identified with GPS coordinates are shown. For reference, the taccau base camp 3 and kok tobe elevation (189m) are shown for identification and comparison with the geographical map which can be found in appendix 8.

5.4.3 Ratios and proportions

The overall ratio of calves to Saiga which were positively confirmed to be female (595 calves to 2,857 females) is 1:4.8. This is extremely low already in a species which is ordinarily so fecund, with first year females normally giving birth to single calves and older dams producing twins. However this does not take into account the other 4,870 Saiga which were not 100 per cent confirmed to be female because of either distance, mirage or dust. These are more than likely the vast majority females, with some 2003 generation males which are difficult to distinguish apart, making up a small proportion. So if these animals are included in the ratio it increases to 1:12.9, that is to say that there is one calf observed for every 13 (assumed) females. In section 5.3.2 it was established that by using the known proportions of confirmed males to confirmed females the unconfirmed sex numbers could be reallocated (93 percent to females, 7 per cent to the males) and a more accurate estimate of males and females made. With this new estimated number of females at 7,386, the ratio of calves to females is still extremely low at 1:12.4. However this ratio is assuming that all females were sighted only once, sampling without replacement, and this was extremely unlikely to be the case. In section 5.3.3, the expected total number of Saiga on the plateau, where all of the calves were observed, was calculated and the number of females was estimated to be around 2,682. Since the calves were seen later in the expedition, their numbers constantly being swelled as they developed and were able to run with the herds. There was clearly less likely to be double counting of the calves than with the females, the estimated number of calves is more likely to be in the region of the observed estimated total of 595 which makes the proportion of calves to females 0.221, a ratio of 1 calf for every 4.5 females.

Figure 5.21 illustrates the relative numbers of single calves and twin pairs observed from the 14th – 26th May. Although an estimated 595 calves were sighted between these dates, it was not possible on every occasion to identify the sibling status of every calf and instead only 133 could be positively confirmed to be either a single calf or twin pair.

With a few exceptions at the beginning of the calving period, there is an overall trend for more single calves (or an equal number) to be identified than twin pairs; only 35 per cent of all calves for which sibling status could be identified were found to be twins. For this to be the case later in the spring, when the calves are running with the herds and it is difficult to distinguish whether they are twins or not, this observation would be understandable. However this trend appears to assert itself early on and with an animal such as the Saiga that so commonly gives birth to twins when over one year of age, this result is unexpected.

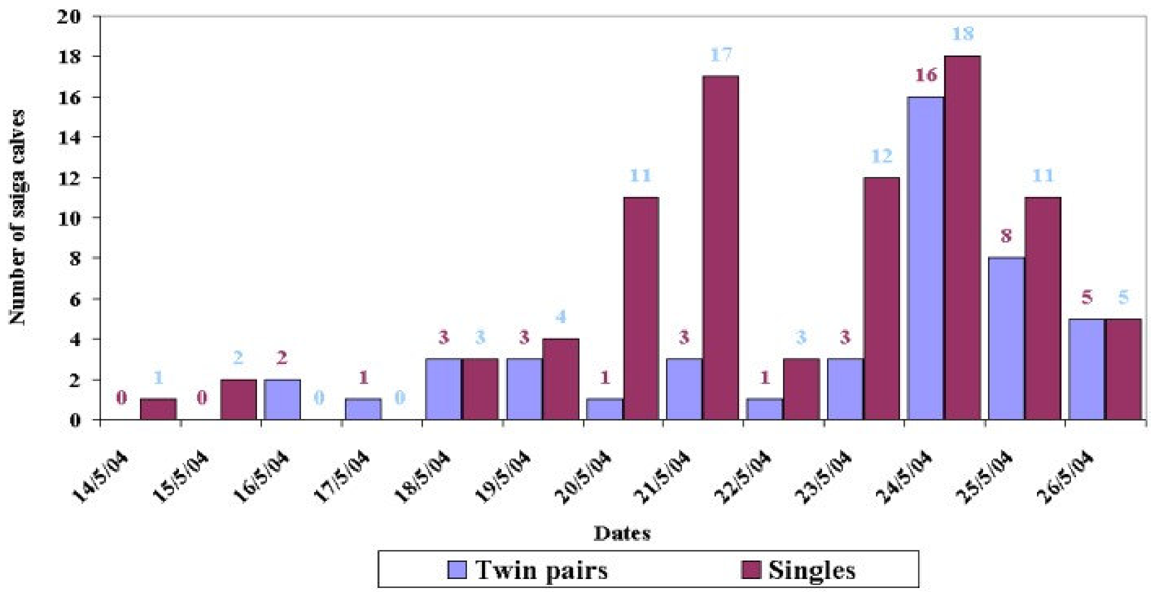

Figure 5.21: The frequency distribution of single calves and twin pairs observed.

Using the Chi squared test, this result was found to be significant (df=2, X^2=7.737). The X^2 test and results can be found in appendix 6.

5.4.4 Calf association with vegetation types.

Three vegetation communities were identified as being associated with calf bedding sites during the period 15th–24th of May, when calves were captured or where it was possible to get close enough to pinpoint the location at which the calf had been laying. Only 44 calves were identified in this way, which makes the sample size rather small and any results are likely to be non-significant, especially with the lack of any control. The indicator species used to classify these communities into Type 1–3 are listed in table 5.6, these species are described in appendix 3. All plant species are those know to be consumed by Saiga (Bekenov *et al* 1998, Iu. A Grachev, pers comm.).

Vegetation type	Indicator plant species
Type 1	*Anabasis salsa, Artemesia terre albae*
Type 2	*Artemesia terre albae, Eremopyrum orientale, Ceratocarpus arenius*
Type 3	*Rheum tataricum, Artemesia terre albae, Salsola arbuscula*

Table 5.6: Indicator plant species which comprised vegetation communities with which Saiga calves were found in association with.

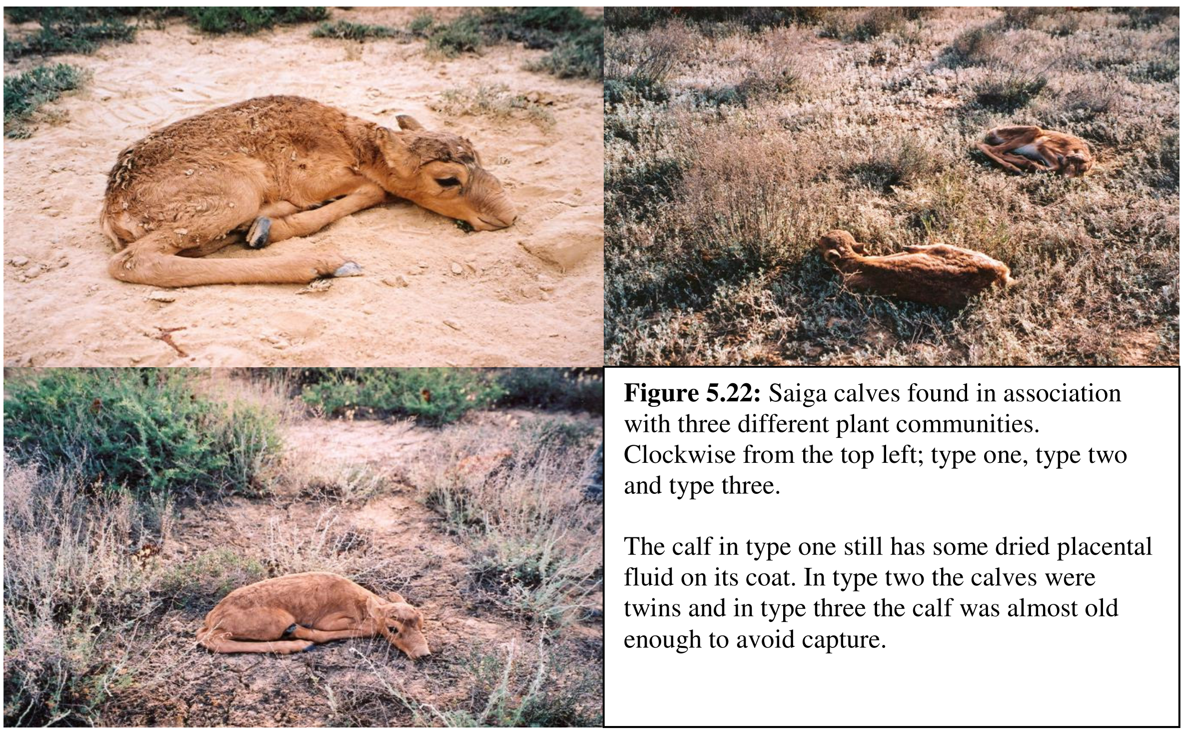

Figure 5.22: Saiga calves found in association with three different plant communities. Clockwise from the top left; type one, type two and type three.

The calf in type one still has some dried placental fluid on its coat. In type two the calves were twins and in type three the calf was almost old enough to avoid capture.

The frequency for which calves were identified with a particular plant community is illustrated in figure 5.23. There were approximately three times as many calves found in association with type 2 than in type 1 and in type 3. However other elements need to be considered before this can be considered to be a significant result. Firstly around 80 per cent of the total number found in association with vegetation type 2 were sighted over a two day period, in a localised area on walking transect where a small aggregation had been located. This was the only vegetation type in the area, so the calves were not preferentially choosing type 2 over others in the immediate area.

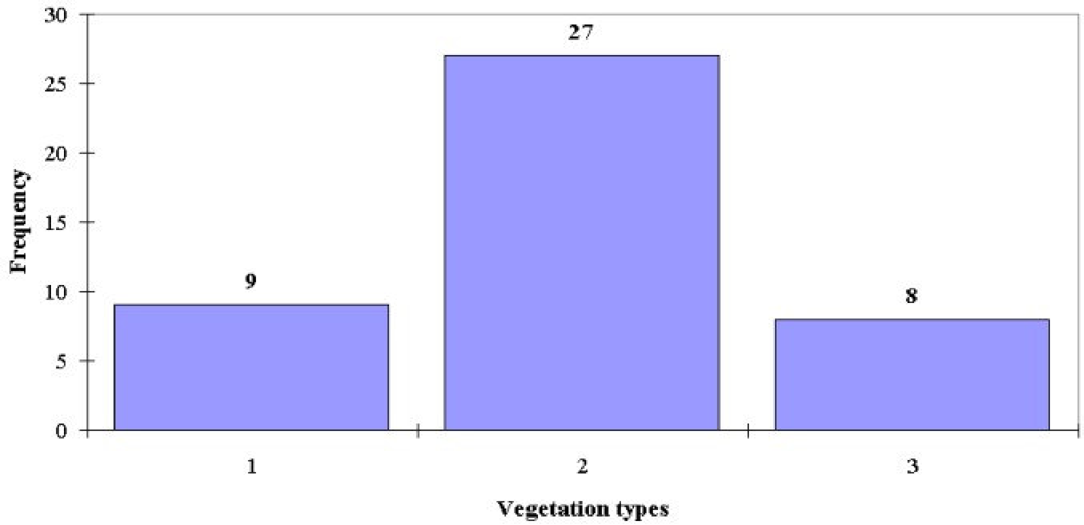

Figure 5.23: The frequency distribution of Saiga calves being found in association with particular vegetation types.

The other calves in vegetation types 1 and 3 had been found individually over a greatly dispersed area, over the ten day period, where there was a variety of vegetation types other than the ones identified. 70 per cent of these were also younger than the calves sighted in the small aggregation. Calves were found within type 1 throughout the period with no particularly discernable pattern, whereas the majority of calves found in type 3 were young, <48 hours, although older calves were also seen in this vegetation type towards the end.

5.4.5 Comparison with 1998 Saiga calf data

A previous expedition to Ustiurt in 1998 (INTAS project 95-29) recorded the length, weight, sex and age at capture of 611 Saiga calves in between the 13th – 21st May. More calves were sampled but not all four variables were recorded. This acts as a useful dataset for comparative purposes. The comparison is of particular interest because in 1998 the Ustiurt population was large and healthy with large aggregations of animals forming, since then however the population has experienced a rapid decline and currently stands at 6 per cent of the 1998 levels. This is illustrated in figure 5.24; the actual yearly populations are listed in appendix 7.

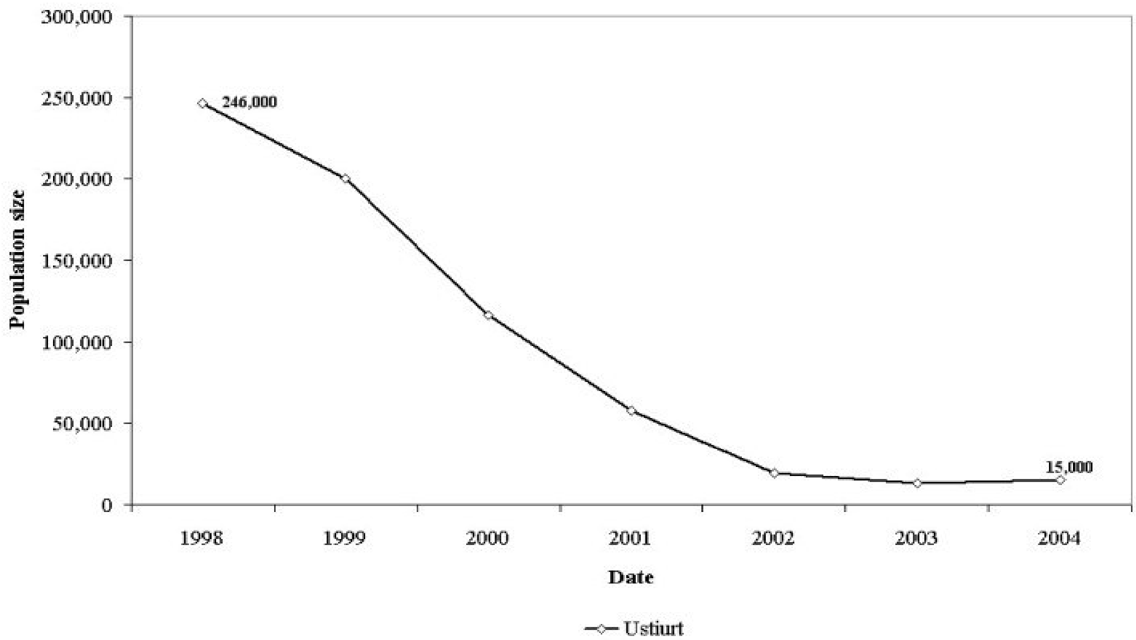

Figure 5.24: This graph charts the dramatic decline of the Ustiurt Saiga population since 1998 to 2004.

In contrast to 1998, where over 600 calves were sampled, only 13 calves were captured in the same region during the 2004 expedition. In order to facilitate meaningful statistical comparison between these different populations with distinctly dissimilar sample sizes it was necessary to use a bootstrapping technique, employing the random re-sampling (with replacement) of the 1998 dataset to reduce bias (Effron, B. Gong, G. 1983). A vital assumption underlying this procedure is that the dataset to which re-sampling is applied is itself an unbiased sample. The 1998 dataset was re-sampled in this manner 1000 times; in each instance extracting 13 data points individually for calf weight and length. In this way a large number of samples were generated from which a mean measure of comparison can be estimated. From this cyber population was then extracted a further sample of 1000 which was used for contrast.

The results of this technique are illustrated in figure 5.25, the columns representing the frequency distribution of the bootstrapped population's Saiga calf weight, the frequency being read from the Y axis on the left. There is a strong central tendency around the mean of 3,303grams (range=2,750 grams, SD=406.859) which is consistent with the 1998 data but not with Bekenov et al (1998) which states that *newborn* calves are expected to have a average weight of 3,750 grams (males=3,900 grams, range=3,500–4,500 grams, females=3,600 grams, range=3,100-4,200 grams).

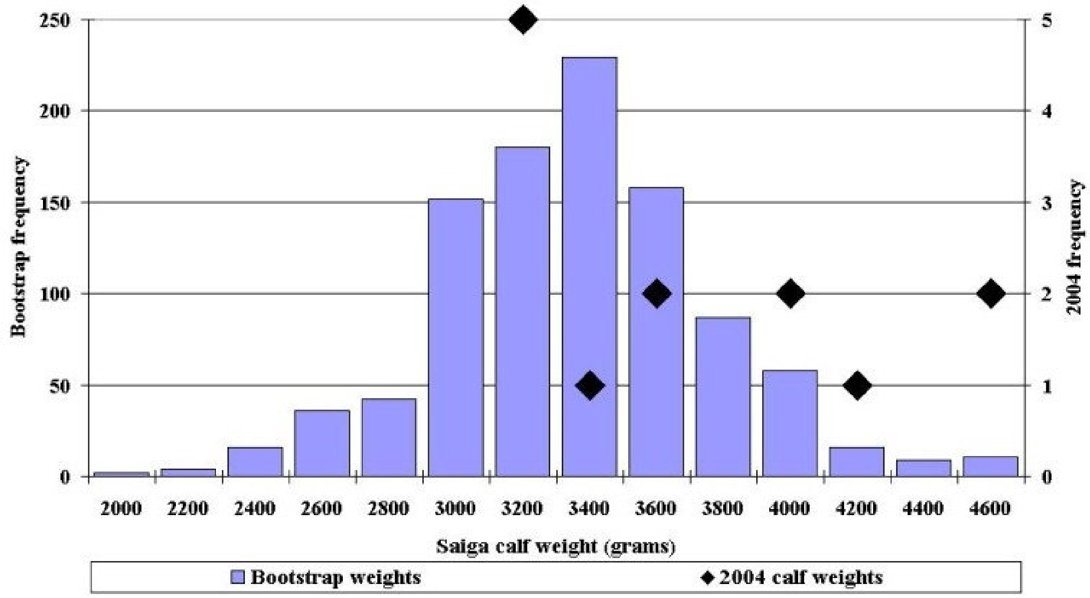

Figure 5.25: The frequency distribution of Saiga calf weights from 2004 compared with the bootstrapped population.

The 2004 calf weights are represented as black diamond shapes and the frequency is on the Y axis on the right. These have a greater mean weight of 3,619 grams (range=1,500 grams, SD=530.148) with the majority of the data points falling within the central cluster of the bootstrapped population. The slight trend for heavier calves can be explained by the fact that there was a bias towards older and hence heavier calves being captured and weighed compared to younger calves. There is nothing to suggest that the 2004 population has deviated significantly from what was observed in 1998.

The results from the analysis of the bootstrap population Saiga calf length are illustrated in figure 5.26. The columns represent the frequency distribution of the bootstrapped population's Saiga calf length, the frequency being read from the Y axis on the left. There is a strong central tendency around the mean of 618.84 millimetres (range=66.153mm, SD=9.226). The 2004 calves are represented as black diamond shapes and the frequency is on the Y axis on the right. They have a lower mean length than of 591.923 millimetres (range=150mm, SD=41710) which again is broadly consistent with the 1998 bootstrapped population, the majority falling under expected values. As mentioned in section 5.4 the first calf captured appeared to be measured abnormally small and was not included in that analysis as it skewed the result. This outlier can be seen far to the left in figure 5.27 and although it appeared not to fit with 2004 data it does register with the bootstrapped population as an observed length in 1998. What is unusual about these results is that although the 2004 calves show a trend to be heavier than the bootstrap sample, they conversely appear to show a tendency to be shorter in length. It is likely that this is down to measurement error, differences in technique when measuring nose to base of tail.

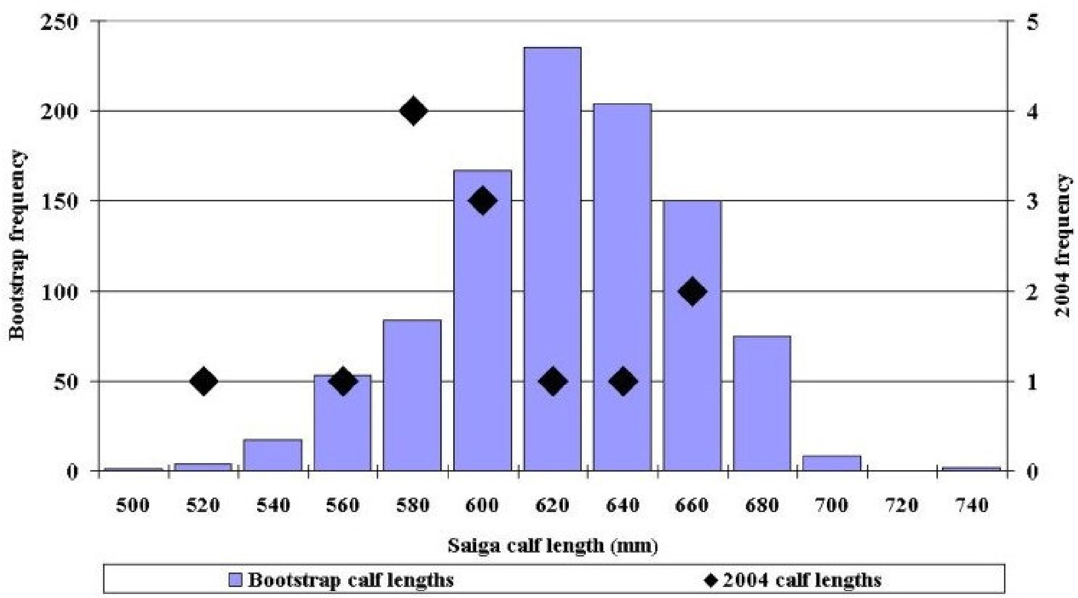

Figure 5.26: The frequency distribution of Saiga calf lengths from 2004 compared with the bootstrapped population taken from 1998 data.

Figure 5.27 illustrates the results of a regression of the calf weights and lengths for 1998 and 2004. The latter results fit within those of 1998 well, although their spread is around the bottom of the plots indicating again that they are generally not as large as the 1998 calves but showing a tendency to be heavier. It is interesting to note that the majority of calves sampled in 1998 were females and as such are not as large or heavy as males of the same age, this would affect the distribution and may be the reason for the 2004 data not aligning as well as expected. The R^2 value of 0.79 for 2004, for length predicting weight is better than for 1998 (0.34) but this is likely to be due to the disparity in sample sizes.

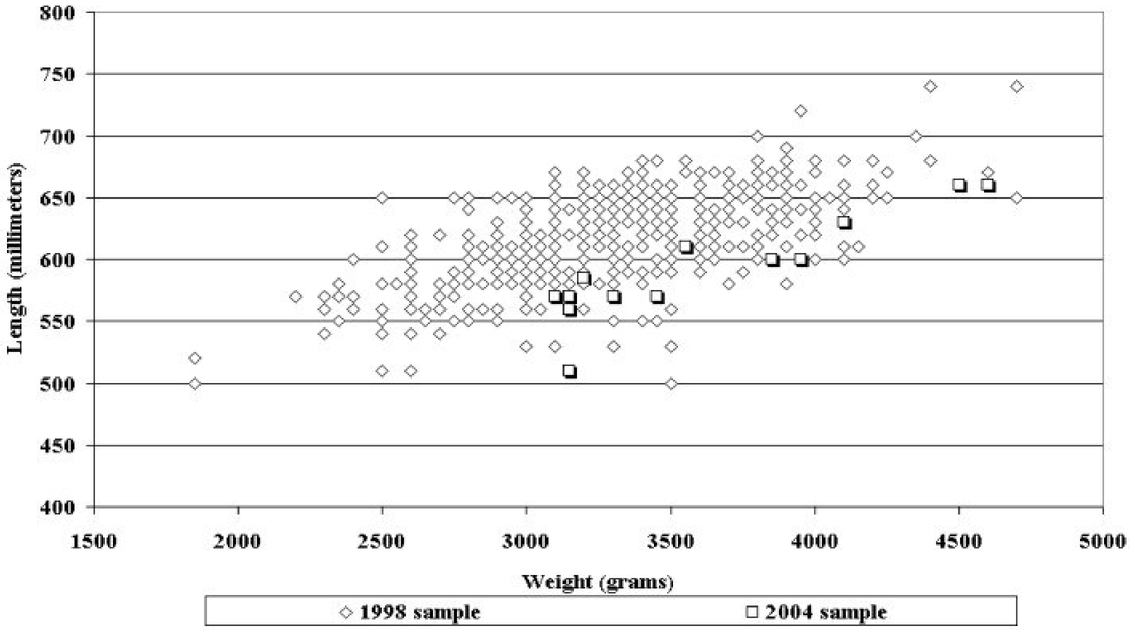

Figure 5.27: The correlation between the weight and length of Saiga calves sampled in 1998 and 2004 (r2 = 0.34 and 0.79 respectively).

The mean age of captured Saiga calves in 1998 was 25.6 hours (range=6–72 hours, SD=13.4). In 2004 the mean age of captured calves was 45.2 hours (range=12–72 hours, SD=21.99). In 1998 the number of calves caught aged 48-72 hours old was much less than calves aged 24 hours because they are increasingly more difficult to catch as they grow older (Lundervold. 2001). In 2004 however, the number of calves caught aged over 48-72 hours old was greater than those aged 24 hours or under. There is a rational explanation for this without having to look for underlying causes. Since calves were widely distributed over a large area and are not easy to locate whilst they were following their hiding strategy in the first few days of life, the majority were sighted and subsequently captured as they where attempting to run away, being almost old enough to outrun a human. Since the sample size was so small, a great deal of effort was made trying to increase the number of calves captured. This had the effect of securing measurements from proportionally older calves than in sampled in 1998 when they were much more abundant and the extra effort was not required.

Sex ratios of Saiga calves

In 1998 the majority of calves sampled were females, whereas in 2004 the majority were males. However comparatively however this is non-significant since the sample size was so dramatically different, 13 in 2004 and 611 in 1998. The bootstrapping method was also attempted for calf gender but since the 1998 sample showed a strong bias towards females and there are only two variables the results were predictably skewed, being consistently in favour of a female dominated sample. Saiga calves are generally found to have an approximate 1:1 sex ratio (Fadeev & Sludskii, 1982) which is consistent with the 2004 results.

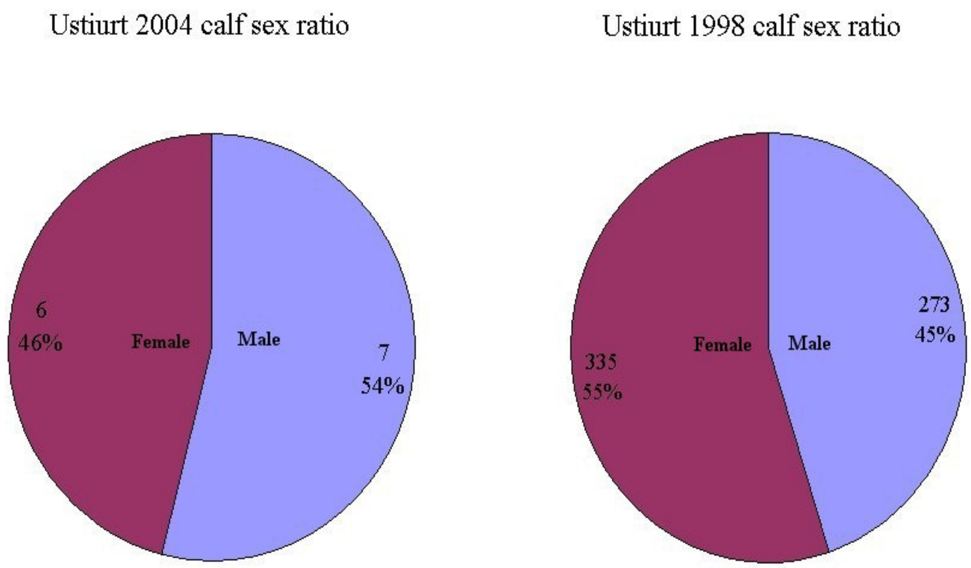

Figure 5.28: Comparison between the sex ratios of calves captured in 2004 and 1998.

6. DISCUSSION

In this section the results will be first be summarised and the implications of these results for the future of the Ustiurt population of Saiga will be considered. Certain aims and objectives were raised in the introduction and these will be met as a subsequent consequence. Next the constraints on sampling methods, possible bias and errors will be examined. An assessment of the usefulness of CyberTracker in Saiga research will follow this and the section will conclude with policy recommendations for further conservation and management.

6.1 Results summary

Climactic discussion:

The environmental measurements of temperature and humidity, taken for the duration of the expedition are within normal parameters for that time of year in the Ustiurt region. Since the minimum temperatures recorded preclude the formation of frost on the ground and the maximum temperatures were not intolerable, the only adverse circumstances which may have affected the Saiga and calves in particular, was the storm event which brought with it the substantial precipitation, lower temperatures and increased humidity for several days. However this period was at least three days past the peak calving period and it is unlikely to have had much of a negative impact, certainly no fatalities were recorded. As a result of the expedition at times having no fixed base, travelling during the beginning and end of the period it was not possible to obtain the full data set. This has resulted in some missing information about the daily conditions but it is believed that the number of observations obtained were sufficient reflect the normality of the results.

Ecological discussion – Herd

An estimated total 8530 Saiga were observed during the seventeen days of observations on the May 2004 expedition with a range of 1150 between daily totals. This was only the number sighted and was not taken to be a population count. Gender could not be positively identified for 57 per cent of the Saiga seen and so using the proportions observed in confirmed males and females (3 per cent and 97 per cent respectively) this number was reallocated accordingly. Females made up the vast majority of sightings with the proportions being an estimated 87 percent females, 6 per cent males and 7 percent calves. Given the variety of factors listed earlier in the results section it was not possible to gain a meaningful number of observations of pregnant to non-pregnant females to estimate a ratio and neither was it possible to distinguish the age of a sufficient number of males to establish what range of generations were represented, only that none of those identified were believed to be older than the 2002 generation.

Considering that the true number of Saiga on the Ustiurt plateau is estimated to be around 3500 and that the IoZ aerial census from April 2004 has estimated the Ustiurt population to be in the region of 15,000 Saiga, it appears that either the majority of Saiga were aggregating elsewhere, the estimate from the expedition is flawed and too low or that the aerial estimate is too generous. However since vehicular population estimates are notoriously inaccurate this can not be viewed as conclusive. Three female Saiga were identified approximately 200 kilometres east from base camp three on the final day of the expedition, this location was around 30 kilometres from the Aral Sea. This may be a further indication that that not all of the Ustiurt population was concentrated on the plateau and it is possible that there were other aggregations of Saiga elsewhere within the region, this tentative suggestion is backed up by the presence of three suspected poachers seen within 20 kilometres of these Saiga. If they were indeed poachers then it would be expected that they would be operating within an area that had a relatively high concentration of Saiga, in order to make their efforts worthwhile.

This presence of males observed in herds changed over the period of the expedition with males being more abundant at the beginning and then decreasing in their overall numbers and frequency of sightings over time. Whether this was due to sexual segregation during the calving time or whether it was due to males making local migrations away from the source of disturbance on the plateau is unclear. Both interpretations have some degree of evidence to back them up, the segregation argument being supported by the presence of males being higher before the time of estimated peak calving and decreasing thereafter as calves began to make a contribution to the herd's composition. Also the fact that only young males were positively identified may indicate that older, more mature males were segregated further away from the calving grounds. Of course the absence of older males may also be taken to mean that there are very few if any older males. However, since age could only be determined for only a small proportion of the males (10 per cent) this remains unproven. The frequency of sightings males was highest in the initial days of patrolling the plateau, when the region was intensively searched in terms of time driving and kilometres covered, the vast majority of males (90 per cent) being sighted in period one. It is conceivable that these observations are not a representation of segregation behaviour but instead local migrations in reaction to presence of the expedition vehicles, as males are more likely to have experienced previous disturbance from poaching pressure for their horns than the pregnant females, who would also be unable to leave the area as they would have given birth or be close to giving birth. It is likely that the observations reflected a measure of both these effects.

Taking the numbers of males (208) to females (2682) from the estimated true population on the plateau during the expedition, the proportion of males is 0.077. This is the precautionary proportion given the risk of over estimating the number of males in the population. To take the total number of males estimated to have been observed throughout the expedition, from the reallocation of the Saiga for which gender could not be assigned (548), the proportion rises to 0.204. The proportion of adult males normally seen in unselectively hunted populations is 0.20–0.25, so this may be an indication that the reallocation was incorrect and those unconfirmed Saiga were in fact female, since it is unlikely that the Ustiurt population would have such a healthy proportion of males when it is know that there are the target of poaching activity and there are so few calves. Thus it is likely that the former calculation is more appropriate. It has been inferred that the threshold proportion of adult males for reproductive collapse lies below 0.025 (Milner-Gulland *et al* 2003), so whilst the proportions are extremely low and there is absolutely no call for complacency, it appears that at least the population has not reached this critical point just yet.

Using three time periods partly determined by the change in relative proportions of males and calves observed in herds to analyse spatial and temporal herd activity, it was found to be significant that there was a change in herd sizes observed throughout the periods. There was also an increase in overall numbers of Saiga sighted between the periods, which was not related to the numbers of kilometres covered during the patrols. This is partially explained by the presence of calves increasing the amount of in the later periods but this does not fully clarify the situation. The vast majority of herd sightings were for smaller herds with in between 1–20 Saiga and of these around 40 per cent were single animals (34 per cent in period one, 45 per cent in period two and 38 per cent in period three); nearly all of these were female. There are two significant trends throughout the three periods; the first was for the smaller herds sized 1–5 to increase dramatically over time, especially between the first two periods where sightings more than doubled. Herds sized 6–20 also increased in the same way, though the not to the same scale. Secondly the largest sized herds composed of more than 151 became more frequently observed in the last two periods, not having been sighted at all in the first period. The medium sized herds of 21–150 individuals were observed more frequently during the first and last periods but decreasing significantly in the middle period. This perhaps helps to explain the increased observations of smaller herds and largest herds in this period, since the beginning of the period 17th–21st falls within the peak mass calving time, hence the increase in single females or small groups sighted, the end of the period falls in with the time where it was common to see large herds with many calves able to run with the adults.

According to Fadeev and Sludskii (1982), May is the month which has historically seen large herds (>500) making up the highest proportion of sightings, with the lowest proportion of herd sightings being those with few animals (<50). Obviously with a reduced population these specific numbers may not be expected, however the trend for large herds making up a high proportion would be. However in May 2004 the exact opposite has been observed. It is unclear without data from previous year's observations of herd sizes in May, whether the changes in herd sizes is normal behaviour or whether the disturbance of expedition and other vehicles caused the herds to fragment over time. Certainly medium to large herds were seen to diminish in their frequency of sighting and conversely a trend for smaller herds was observed over time. In the field Saiga were seen to react to the expedition vehicles and run away over the horizon every time, with the herds often splitting up and sometimes running in different directions. This lends credence to the idea that disturbance was a major factor in contributing to the average herd size decreasing over the period that the expedition vehicles were travelling through the region in which the Saiga were concentrated. However Bekenov *et al* (1998) notes that "…in May, during and after calving, Saiga do not form herds: females disperse over the entire area occupied by the group and stay with their calves", which also gives credibility to the idea that what was observed was in fact normal behavior for Saiga at this time in the year and that the antelope had arrived on the plateau in herds, then dispersed as females gave birth, only to gather in larger herds once the calves were able to keep pace with the adults. Clearly there is a conflict between what is reported between these two papers and what was observed on the plateau in May 2004 since herds were commonly observed as well as the many dispersed females. One possible explanation for this behavior is that pregnant females dispersed in order to give birth to their calves but non pregnant females would not need to separate from herds. This may be related to why so many herds were seen predominantly composed of females and why so few calves were observed, simply that there was a greater proportion of females who were not pregnant; this is further backed up by the extremely low numbers of males which were observed. As mentioned earlier and suggested in Milner-Gulland (2003) it is possible that these observations are the result of low fecundity altering behavior, caused by the biased sex ratio which is resulting from the selective hunting of males for their horns.

Fortunately for the Saiga no direct evidence of predation upon either adults or calves was observed, though that is not to say it was not occurring in areas not identified or during the nighttime. Whilst there were numerous large birds of prey and foxes sighted it is likely that since the Saiga migrates through the region they are not a staple part of these predators diet. The absence of many wolf sighting was obviously advantageous for the calves especially, although through personal communication with the rangers there are still many wolves in the region, which are shot on sight. Three dead adult Saiga were found throughout the expedition, the first on the 17th May, being only skins and bones was unidentifiable in terms of sex or cause of mortality. The second was within a small aggregation within which many calves had been seen. It was a female who had recently given birth, estimated to have been dead for less than 12 hours. A field autopsy was conducted but no cause of death could be found, only that the female had twin uteruses. This animal was consumed by birds of prey, within 24 hours. The third and final corpse was a 2003 generation male who was thought to have died some time around the end of April 2004. Again no cause of death could be identified due to the condition of the corpse, however since the head still retained one of the horns, poaching (for horns) could be ruled out.

The human disturbance on the plateau, apart from that caused by the expedition was not particularly intense given the number of observations and area over which the Saiga were distributed. However the Saiga had chosen to concentrate and give birth in an area where there are some of the main transport routes used to cross Ustiurt and hence they would have had a high amount of contact with vehicles. Had the Saiga chosen an alternative calving ground the amount of disturbance would have been greatly reduced. Since Saiga run from the sight and sound of vehicles, and many of those observed were large trucks which could be seen and heard from a great distance, it is likely that every vehicle observed caused disturbance during its journey. The livestock presence was minimal and mostly centered around the one farm encountered; Ustiurt has anyway, always been virtually devoid of livestock (Lundervold. 2001). There was no sign that there could have been any competition for food and the only threat posed to the Saiga would have been disease transmitted from the domestic grazers. Motorcycles are the preferred mode of transport for poachers since they are able to negotiate the terrain at speeds necessary to chase the Saiga. Whilst many motorcycle tracks were seen no machines were seen pursuing the Saiga. Most of the tracks were estimated to have been left before the expedition reached the region it is likely that the presence of armed Okhotzooprom representatives in addition to the rangers precluded poaching activity during the period that the expedition was in Ustiurt. The only evidence for poaching was the frequent observations of old skulls, except for one encounter with three suspected poachers with two motorbikes, one broken down. However no weapons or Saiga products were found when the men were searched by the rangers and they were located far from the plateau so their intentions could not be ascertained. Personal communication with villagers from Chelkar, located to the North of the Ustiurt region confirmed that poaching was an ongoing activity in the region.

A major cause of disturbance on the plateau was the presence of the expedition itself, since at times there were up to five vehicles driving in convoy through the steppe, which is not the major issue as Saiga will as readily run from one vehicle as five. It was often the case that several vehicles were driving in different directions; the expedition scientists, Okhotzooprom rangers and the French film crew, each leaving a trail of disturbance in its wake. The expedition to examine the population at this time was necessary for research purposes but, to make a banal misuse of Heisenberg's uncertainty principle, taking it to mean that the very act of observing a phenomenon inevitably alters that phenomenon in some way, the expedition's very presence in Ustiurt probably distorted what it was there to observe.

Ecological discussion – Calves:

The most striking result obtained from the 2004 expedition in relation to calves is the lack of overall observed numbers. Since the majority of the Saiga observed on the plateau were female it was expected that there would be many more calves, especially since the species is able to conceive in it's first year of life and mature females so commonly produce twins. The issue of reduced fecundity was raised earlier in the discussion relating the low proportions of males to females, to further address this question from the results from the calf data it is necessary to look at two issues. Firstly what is the observed ratio of calves to females and secondly whether there is a significant difference between the number of twins and singletons, since more mature females are most likely to produce twins and younger animals to produce singletons. Section 5.4.3 addressed the former question, initially using the ratio of total estimated calves to total estimated females on the plateau as calculated in section 5.3.3 to produce 1:12.4. This ratio was subsequently adjusted for the estimated true number of female and calves calculated to be on the plateau to give a more realistic 1:4.5, although this is still an alarmingly low ratio, especially when faced with the fact that in between 1986-1996 the mean number of embryos per female sampled was 0.9 for immature females (<1 year old) and 1.7 for mature females (Bekenov *et al*. 1998). The higher frequency of observation for single calves compared to twin pairs is also a cause for concern and may be due may be due to several factors. As mentioned earlier more mature females are more likely to produce twins, so it is possible that this result reflects an age structured population where there are more young females as a result of the older females having been poached for their meat, since the older the Saiga the more contact it is likely to have had with poachers and a higher probability of being shot. There are other factors to consider however and Coulson *et al* (2000) have demonstrated density dependent reduction in fecundity of the Saiga through an increase in the number of singletons and a decrease in the proportion of twins born. This may be related to the female's poor body condition at conception, caused by forage limitation in the autumn or maybe due to stress caused by continual harassment through disturbance or poaching pressures.

Saiga calves were observed widely dispersed throughout an area of approximately 300km^2, at an approximate density of 2/km^2. Since the observed calves were so widely scattered it appears that the majority of calves had been born away from the shelter of an aggregation. Only one area was identified as having probably been the site of an aggregation, which had a concentration of many calves of a very similar age within an area of approximately 6km^2 but since they were at least 3-4 days old and able to run away, it is uncertain whether they were all born in the area or whether they had gathered there out of choice for the vegetation type or they were there in the form of a scattered nursery herd. The spatial analysis of twins and single calves reveals no clear pattern, the concentration of single calves in one area is likely to be an artefact of the sampling process and because the calves were old enough to move independently of any twin they might have, therefore making them appear as single calves. The peak timing of mass calving was estimated to be in between the 14th – 18th May, which is consistent with literature (Bekenov *et al* 1998). The average age of the captured calves was around two days, which is a result of the time taken to locate the calves whilst they were being born and hence more old calves were sampled. Only one placenta was located, which was not unusual given the scattered distribution of the calves over such a large area. It is also likely that many of these would have been consumed whilst still fresh since there was a high proportion of scavengers such as foxes and birds of prey in the region.

The biological results from the sample of calves obtained in May 2004 correlate broadly with the bootstrapped results from the 1998 expedition, although there is a tendency for the former sample to shorter in length at a given weight. Whether this is a true result is unknown since the two sample sizes are so dissimilar and there may be a degree of measurement error. There are some discrepancies when comparing both the 2004 (3,619.230 grams) and 1998 (3,302.859 grams) mean weights to existing literature such as Bekenov *et al* (1998) (3,750 grams) as the mean weight for *newborn* calves as quoted in this paper is actually higher than the 2004 mean weight for calves estimated to be aged between *6 - 72 hours*. This could be construed to mean that there has been quite a drastic decrease in average newborn weight since this data was collected and reported by Fadeev and Sludskii (1982) or alternatively that this mean weight is the sum of some or all of the Saiga populations and the Saiga calves in Ustiurt are normally below the average weight. This is borne out to some extent by Lundervold (2001) who states that the calves born in

Betpak-dala were significantly heavier than those born in Ustiurt, although these results were confounded by the fact that the mean age of calves sampled from Betpak-dala was greater than in Ustiurt in this study. A study by Bannikov *et al* (1961) reported a mean birth weight of 3,200 grams (males=3,300, range=2,000–4,400, females=3,100, range=1,900–4,400). This fits the 2004 results better than that reported by Fadeev and Sludskii (1982) but further meaningful analysis cannot be taken with the small sample size obtained in 2004 and lack of newborn calf data, to judge whether there has been a significant decrease in mean weight at birth. If this is a true effect then a possible reason for this could be as a result of continual disturbance by poachers throughout the year, causing stress in the females which might result in a lower mean birth weight of calves. Another might be climactic factors causing a loss of condition in the females and this subsequently impacting on their offspring.

All vegetation types which were found in association with calf bedding sites were composed of species known to be consumed by Saiga. A possible interpretation of the results is that the younger calves were found near to where they had been born and hence the surrounding vegetation type was the mother’s choice. It may be coincidence that vegetation type 3 afforded more cover than the others, with the relatively large *Salsola arbuscula* species, and was associated with the majority of calves (55%) sighted and estimated to be under 2 days old. The mother’s imperative being presumed to be finding vegetation that would shelter the calves from possible predators and provide shade. A further interpretation for the vast majority of older calves being found in association with vegetation type 2 could be that they were sufficiently developed to be able to outpace predators and would not need the larger vegetation that would impede their escape and obscure their vision. The plants found in this vegetation are also likely to be more palatable to the calves since they have none of the woody stems found in the other two types. This is of course all conjecture since, as previously stated there is no control and the sample size is very small. What can be stated with a reasonable degree of confidence is that calves were only found in association with the three vegetation types identified rather than others that were available.

The sex ratio of calves identified was in favour of males, which is the opposite of that found in 1998, however the difference in 2004 was only by one calf and the sample size is so small that the result is inconclusive. This is more consistent with literature however which reports the sex ratio to generally be 1:1 (Bekenov *et al*. 1998)

6.2 Aims and objectives met

The questions that were asked in this study were:

1) What is the current state of the adult Saiga population at calving time?

- Are the Saiga forming aggregations?

Only one small aggregation was positively identified in 2004, this was composed of around 400 adults in an area approximately 6km^2. Several other areas may have hosted small aggregations since calves were located in greater concentrations there than elsewhere. However, the vast majority of females appeared to give birth away from other adults. According to Bekenov *et al* (1998) the Saiga concentrate in large numbers in the calving areas and are mostly females. The majority of Saiga observed in May 2004 were females and they were loosely concentrated but in numbers greatly reduced from what is quoted in this paper and over a much larger area. It is also likely that the majority of the population was not represented since the number of Saiga observed in the 480km^2 of the Ustiurt plateau surveyed was estimated to be around 3,500, which is just under a quarter of the total 2004 population of 15,000 as estimated from the April 2004 aerial survey. In Ustiurt in 1987 a concentration of 80,000 Saiga was observed in an area of 400km^2, an average of 200 animals per km^2. In 1990, 150,000 animals were recorded in the same place and in 1993; 80–100,000 Saiga were seen there. Expressed as proportions these represented approximately a half – two thirds of the total populations, much greater than observed for 2004. This highlights the need for further up to date research on the Saiga, given that their current population levels preclude comparison with literature that is not relevant to Saiga at their reduced numbers.

- Is there consistency in the herd sizes observed throughout the expedition?

There is no consistency for herd sizes to remain constant throughout the expedition. There is consistency however for smaller sized herds to increase in the frequency of their observation, along with the largest herds, throughout the period of the expedition, with both peaking in the final period when calves were running with the herd. Whether this represents a reaction to disturbance or is natural behaviour can not be determined.

- Is there noticeable sexual segregation?

There appears to be a change in the proportions of males in herds over the period of the expedition, with this decreasing around the time that the calves are being born. However whether this is natural behaviour or whether it was due to disturbance prompting the males to make local migrations to avoid contact with humans and vehicles is unclear.

- Is there a noticeable bias in sex ratios?

There is an extremely strong bias observed which increases over the period of the expedition, towards males making a very low contribution towards the herd's composition. As noted previously the increase in this observation may be due to several factors and may not represent the true overall male to female ratio. However given the low number of calves sighted when compared to numbers of females, it is likely that there were correspondingly low numbers of pregnancies which would have resulted from a low proportion of males to females around the rutting season.

- Is human disturbance or predation having a discernable negative impact?

No evidence for direct predation was observed during the expedition, merely scavenging behaviour. Human disturbance was affecting the Saiga, most notably with vehicles driving through the region in which the animals were distributed, since every Saiga within range would react to the sight or sound of any vehicle and run over the horizon in any direction, meaning that the same animals may be disturbed many times by the same vehicle if they do not run in a direction which is directly away from the route taken by that vehicles through the steppe. What the overall effect of this disturbance was is hard to quantify but it is likely that it contributed to the fragmentation of the herds and dispersal of the Saiga throughout the region.

2) What is the current state of the calves found in comparison to 1998?

- Is mass calving taking place on both spatial and temporal levels?

There was a mass calving event on the Ustiurt during the second ten day period of May 2004, peaking around the 14th – 18th May which is consistent with literature. This took place throughout an area of around 300km^2, with calves scattered throughout in a more dispersed manner than considered normal, due to the low number of pregnant females and the wide distribution of the animals. Calving was occurring at a time when both minimum and maximum temperatures were high, fresh greenery was growing and water bodies were available in the region.

- Is there any evidence for reduced fecundity?

Direct evidence exists for reduced fecundity, that being the extremely low numbers of calves observed when compared to the high numbers of females observed, which were of breeding age but were presumed to not be pregnant since they were without calves even up to a week past the peak calving period, when the calves, had they existed, would have been running with the herd. Circumstantial evidence such as the lower incidence of twins compared to single calves further corroborates this. Further direct evidence would have to come from accurate knowledge of the percentage of adult and juvenile females in the population, and estimated mean number of embryos per female, which was not possible on the 2004 expedition. Although it is conjecture given the lack of evidence it is proposed that this reduced fecundity is a result of the extremely low proportion of males in the population and the expected high proportion of these to be young and potentially lacking the virility that more mature males would possess.

- Is there a significant difference between the number of single calves and twins?

Almost twice as many single calves were identified compared to confirmed twin pairs, although whether this was due to an age structured population favouring juvenile females which more commonly produce single calves or whether it was due to environmental or anthropogenic factors in undetermined.

- Do the vital statistics match with the central tendency seen in 1998?

The dates of the calving event correspond to that recorded on the 1998 expedition. Although the weights and lengths recorded during 2004 broadly fit with data from 1998 and the sex ratio shows a difference, the dissimilar sample sizes of calves measured makes this inconclusive. All that can be said for certain is that given the small sample size the results indicate that the 2004 calves do not show significant deviation from that observed during 1998.

6.3 Constraints on sampling methods, possible bias and errors

Patrolling effort was not constant throughout the expedition due to a variety of factors. Firstly it was not possible to drive transects due to the difficult terrain and so there was a biased selection of the areas sampled. The majority of routes were along roads or tracks and these are not random samples of topography, tending to go along the grain of the countryside rather than across it. By nature they are transport routes for vehicles and hence are regions avoided by Saiga which are shy of such disturbance. Therefore there is an element of "road count" bias to the herd results. Kilometres travelled and time spent on daily patrols was not consistent due to the relative difficulty of driving in certain areas compared to others. Also since the Saiga were not appearing in large enough herds to make it appear that an aggregation had been found the patrol routes could not be planned and the same areas were often sampled both on the same day and on consecutive days. Other factors such as searching for calves in an attempt to increase the sample size disrupted the daily patrols, for example when a female Saiga was spotted behaving in a way that suggested her calf was nearby the vehicles would stop and a search commence on foot. This would happen to varying degrees throughout the expedition. Other factors affecting the continuity of effort were; vehicle breakdowns, which occurred frequently, problems with navigation and the agenda of the French film crew which was occasionally at odds to the scientific research agenda. A mirage effect occurred occasionally between the hours of maximum temperature, making accurate observations of herd sizes impossible and so the patrol was halted in these circumstances.

The expedition to Ustiurt was delayed by several days due to bureaucratic issues. This had the impact of arriving on the plateau during the second ten day period of May and searching for an aggregation whilst calving was taking place. Timing is a major factor when sampling the calves, since the majority are born during the mass calving event. Also the probability of capture decreases greatly after they are older than two days as they are easily able to out run a human and hence measurements can not be taken. In fact many calves were not caught because they ran away. A very short time period was available for sampling, and since only a small number had been captured it was therefore deemed important to sample as many calves as possible, i.e. all the ones caught, thus random sampling was not attempted. Also in an attempt to increase the sample size, inappropriate effort was made in capturing some of the older calves, which would not have been attempted in 1998 when younger calves were more abundant and easy to capture. Therefore some sampling error was introduced. An unknown number would have not been found anyway, despite searches of areas where the female's behaviour indicated that a calf might be hidden because of their camouflage and ability to hide. These biases are unavoidable, and impossible to quantify.

6.4 Assessment of the usefulness of CyberTracker in Saiga research

The CyberTracker hand held computer and GPS companion has proved to be a very useful tool in Saiga antelope research. There are some exceptionally useful elements to using this method of data collection but also some major drawbacks, these will be discussed below as advantages and disadvantages.

A major advantage in using CyberTracker is that data entry is quick and easy, large quantities of data can be captured at a high level of detail. The icon touch screen interface also enables significantly faster data collection than traditional written methods. Each observation is linked to GPS coordinates and can be viewed on a GIS map after synchronising with a laptop whilst still in the field. In this way spatial and temporal information can be analysed and research can be modified immediately as a result of observed trends such as large concentrations of Saiga sighted in specific areas, which are likely to represent calving aggregations. Once on the computer the data is extracted using a simple query system which allows the user to display observations for any selected period on a map. The user may query any level of detail corresponding to the information gathered in the field (e.g. herd observations from the 22nd May or predators observed throughout the expedition). A query session can be saved as a project, so that in future the user only needs to open an existing project and select the required date range to view the data. The data is also displayed in tables. Tables can sort data chronologically, alphabetically or numerically for a chosen field and then can be exported for advanced analysis (e.g. to Excel) with minimal effort.

There are disadvantages associated with using CyberTracker, some of which would doubtless by resolved with increased frequency of use. Initially setting up the database and screen sequence is relatively time consuming and the on-line instructions are often not very clear, accompanied with the difficulty with programming in all permutations of the conceivable variables. In a one off project this almost counters the subsequent ease of data extraction in terms of time saved. However taking a long term approach to using the tool in the future this is only an initial drawback. More serious issues arise with the reliability of the hand held computer / CyberTracker program which does exhibit some instability, whether arising from the hardware or software is unknown. On three separate occasions over seventeen days the unit crashed with a fatal error message, resulting in losing several days data irretrievably. This highlights the suitability of trialling the CyberTracker as a data collection tool when there were other observers to provide hard copy back up. This may have happened for various reasons including incompatibility and conflict with other programs installed on the unit or possibly as a result of being used within vehicles that were constantly subjected to off road conditions and in an extremely dusty environment. Although there is a back up module option with the device and this was used rigorously after the first system crash, there are still doubts as to reliability. Another issue arose with power supplies as there were limited batteries brought from the UK and it transpired that locally produced batteries had a life of only a few hours and even less for the GPS companion, which drained them even more rapidly. This resulted in powering down and removing the GPS after every observation to preserve the power levels as much as possible but at the cost of exposing circuitry to the elements on a frequent basis. Another problem which may have been a CyberTracker issue or a computer problem was the inability to synchronise and send data between the two; this also resulted in some lost data. The final issue may also not be directly attributable to CyberTracker but there were frequent problems obtaining a signal with which to get the GPS coordinates, this may also have been related to being inside a particular make of vehicle or due to the remoteness of the region.

In summary, CyberTracker has the potential to be an excellent tool for use in Saiga management and conservation. The program can be modified and tailored for all kinds of uses and if used by patrolling rangers to collect spatial and temporal information relating to the herds observed and poaching activity throughout the year, it could prove to be a tremendous aid in assessing the population's health and to swiftly identify any trends which need addressing. However it does have limitations and requires some level of technical knowledge to fully utilise. An infrastructure must also be established in order to link the field observers with scientists and decision makers. Whilst the hand held computer and GPS unit is relatively cheap and the software free, the additional costs of reliable laptops may be prohibitive at a time when there is not a great deal of funding for Saiga research. It was also viewed with scepticism by members of the IoZ and Okhotzooprom who have often for decades used tried and trusted traditional methods and on the 2004 expedition were not keen to use even a GPS device to navigate.

6.5 Policy recommendations for future management and conservation

Increased protection throughout their range, especially during the vulnerable stages of their lifecycle, as well as improved law enforcement is required to halt the current decline of the Saiga in general. In the past, Saiga management was well-funded, and the rural economy was strong with livelihood options other than poaching Saiga. These conditions are prerequisite for an increasing and healthy Saiga population. Recommendations thus include:

- Accurate data on Saiga numbers are needed to continue evaluating the situation, therefore continuing adequate funding for complete aerial surveys is critical. International agreements over airspace is also crucial since the Saiga migrate between bordering countries and more precise estimation of population size cannot be made whilst part of the population is not in Kazakhstan, as was the case in 2004 when part of the Ustiurt population was believed to still be in Uzbekistan when the surveys were undertaken.

- Improved research into the dynamics of the reduced populations is necessary in order to establish the size and areas of the present ranges and where the current migratory routes are. Since the majority of literature concerning the Saiga relates to populations much greater than seen at present, there is a need for up to date research in order to make accurate and meaningful analysis of observations. Despite the stress caused to Saiga by physical or chemical restraint, it is necessary to radio tag a small proportion of the population in order to gather vital information of spatial and temporal behaviour.

- Restrict access to the Saiga calving areas for the duration of the calving period. This could be achieved establishing temporary mobile nature reserves, the location depending on where the Saiga concentrate each year. Since the majority of the population should be within one area, the Okhotzooprom rangers would not need to patrol such a wide ranging region and instead could concentrate on the main access routes to prevent disturbance. Also since the calving takes place over such a short timescale the shift patterns could be temporarily changed so that all rangers are involved. Since the presence of the rangers may in itself cause disturbance the benefits of their activities would have to be weighed against the cost of potentially disturbing the Saiga.

- Involve the local rural population in Saiga conservation in the short term and the sustainable use of Saiga in the long term. Turning the local people and poachers into gamekeepers and allow a certain quota of animals to be taken each year. There will then be a vested interest in protecting the Saiga from poachers coming from other areas. There would need to be established a market for the meat and horns for commercial sale that is competitive with anything on offer through the black market, this need could be met by Okhotzooprom. This also has the benefit of aiding another long term goal; that of improving the rural economy by creating jobs for young people and offering alternative lifestyle options other than poaching.

- Integrated socio-economic schemes should be examined as a way to link Saiga conservation to the rural development agenda. Although community based conservation schemes or ecotourism may be appropriate in places such as Kalmykia where the Saiga have a restricted range compared to Ustiurt, it is more likely that schemes such as controlled trophy hunting may be successful in reducing the need to poach Saiga by facilitating the influx of cash into communities.

- The role of captive breeding centres should be examined as a way of enhancing wild populations, especially for reintroducing males into wild populations in order to redress the unequal sex ratios seen at present. This should be in accordance with the IUCN reintroduction guidelines. The other benefits to this would be to increase the knowledge base about Saiga ecology, to provide a protected genetic pool and to determine the feasibility of commercial farming of Saiga to benefit local rural communities.

- Most importantly the Memorandum of Understanding needs to be signed and ratified by all Saiga range states and the Action Plan concerning Conservation, Restoration and Sustainable Use of the Saiga Antelope needs to be implemented as fast and thoroughly as possible. This will have the result of achieving the main objectives of; restoring populations of Saiga antelope and their range and habitats to ecologically and biologically appropriate levels throughout its range, and to enhance trans-boundary and international cooperation for conservation and sustainable use of Saiga.

7. CONCLUSION

In this study, I have conducted fieldwork to gather data on the ecology of the Saiga antelope in the Ustiurt region, with a particular emphasis on spatial and temporal dynamics at spring calving. It has been found that the dramatic decline of the Ustiurt Saiga antelope population coupled with the prevalence of poaching & disturbance at critical times in their life cycle, has led to a disruption in their ecology.

Approximately a quarter of the Ustiurt population was estimated to have been observed on the plateau during the expedition in May 2004; these animals were loosely concentrated over an area of around 480km^2 and were mostly females. Mass calving took place at a time consistent with historical temporal data, during the second ten day period of May; however the majority of calves were born away from the shelter of an aggregation, which in the past has been a tactic used to maximise the survival of the calves in the face of predatory threats. The number of calves observed in proportion to females was extremely low which is highly unusual in this species which is normally so fecund and routinely produces twins. The low incidence of calves is attributed to the reproductive collapse of the species due to the distorted sex ratio of males to females which has resulted in a drastic decline in the number of pregnancies. This is believed to be as a result of the selective poaching of the males for their horns. Very few males were observed throughout the expedition and those for which age could be estimated were all 2002 generation or younger. For females too, circumstantial evidence exists for an age structured population, with many more single calves being observed than twins, single calves being most commonly produced by immature females and twins by more mature females.

The vital statistics of the Saiga calves studied produced results which were generally consistent when compared to the results obtained on the 1998 expedition, a time when the population was large and healthy. However some of the results do not concur with certain definitive literature concerning Saiga and this requires further investigate in order to establish if there is a true effect or whether it is the result of the small sample size or an issue specific to the Ustiurt population

The socio-political changes in Kazakhstan since the break up of the Soviet Union have had dramatic effects on the country's economy, with rapid and direct consequences for Saiga conservation. Whilst the economy is now recovering on the whole this has yet to filter down to rural communities who remain reliant on the Saiga for meat and horn for sustenance and income.

Despite the Ustiurt populations being estimated to have increased for the first time in a decade, from aerial surveys, in these present circumstances the Saiga are very much at risk from a variety biotic and abiotic factors, an outbreak of any major disease, bad winter (dzhut) or summer drought could prove disastrous for the population.

Whilst the expedition was vital in order to assess the status of the Ustiurt population of Saiga during the calving period, it also disrupted natural behaviour at a time when the antelope were particularly vulnerable. The disturbance caused potentially influenced the observations made and may have adversely affected the population, although this is impossible to quantify. However the benefits of future intrusive research should be weighed carefully against the cost to this already beleaguered population.

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APPENDICES

Appendix 1: Transcript of BBC World Service article broadcast in April 2004 subsequent to an interview with the Central Asian correspondent 20/04/2004.

(CUE: Wildlife conservation groups working in Central Asia say the Saiga antelope, which once roamed the steppe in vast herds, is facing extinction as a result of poaching. The Saiga is one of the main large animal species inhabiting the grasslands and deserts of Kazakhstan, but it's now critically endangered. As Ian MacWilliam reports from Almaty, Western conservation groups and the Kazakh government are backing a campaign to prevent the Saiga from being wiped out:)

IM: For the nomadic Kazakh people, the Saiga antelope was once emblematic of the vast grasslands of their native country. With its straight, sharp horns and its odd humped nose, the animal figures prominently in traditional art and folklore. But the great herds of Saiga which migrated across the steppe as recently as thirty years ago are no more. The animals were protected by the Soviet government. But when the Soviet Union collapsed and the collective farms died, most rural Kazakhs were plunged into poverty. People began hunting the Saiga for meat and for the males' horns, which are sold for use in traditional Chinese medicine. The antelope population plummeted, from about a million animals in 1990, to less than 50,000 today. Where once the Saiga roamed all the territory between Ukraine and China, the surviving population is now divided into four groups, in remote areas of Kazakhstan and the Russian Caucasus. Poaching for the valuable horns has decimated the male population in particular, severely reducing the rate at which herds can reproduce. The British government's Darwin Initiative, the American Wildlife Conservation Society and the European Union are financing a project to try to save the Saiga. It's hoped that reviving depleted livestock herds, or encouraging such activities as camel breeding will provide an alternative source of income for rural people and help to reduce poaching. /// In addition the project is training wildlife rangers and promoting greater awareness of the Saiga's impending fate among people in Kazakhstan and southern Russia.

Ian MacWilliam, BBC News, Almaty.

Date	Max temp	Min temp	Max humidity	Min humidity
10th May	27.6	7	70%	33%
11th May	28.6	7.6	Unknown	33%
12th May	28.6	Unknown	Unknown	Unknown
13th May	33.7	18.6	Unknown	Unknown
14th May	31.7	13.4	70%	19%
15th May	30	13.8	64%	26%
16th May	29.8	15.7	69%	29%
17th May	27.4	13	70%	27.4%
18th May	27	11.7	48%	23%
19th May	246	7	68%	27%
20th May	29	16.8	44%	20%
21st May	23.1	12.6	85%	26%
22nd May	21.9	8.1	89%	36%
23rd May	29	6.9	66%	21%
24th May	30.7	9.3	46%	21%
25th May	31.4	13.6	45%	21%
26th May	Data unavailable as the expedition was exiting Ustiurt			

Appendix 2: Daily maximum and minimum temperature and humidity recorded during the expedition.

Appendix 3: Descriptions and illustrations of key indicator plant species which were used to identify vegetation types found in association with Saiga calves.

Rheum tataricum

Family: Polygonaceae.

Description and morphology: Perennial, ephemeroid large herb (height 25-60cm). Robust with a woody base & large leaves (up to 100cm wide) which lie flat on the ground.

Reproduction: Sexual. Flowering occurs between April-May. Fruit maturation occurs between May – June.

Grazing importance: Excellent fodder plant; large succulent leaves & young inflorescences are well grazed. Fresh leaves are rich in sugar (up to 6%).

Habitat: Meso-xerophyte, occurs in patches on sandy soils, grey brown soils & also sierozem. Often found in association with *Artemesia, Haloxylon* and *Salsola* plant communities.

Distribution: Middle & Central Asia.

Artemesia terre albae

Family: Asteraceae (formerly Compositae)

Description and morphology: Perennial, low shrub (height 30-50cm). Life span of 7 - 25 years. Stem is slender and lignified with short, strong branches at the base. Leaf surface is densely covered with silky hairs giving the leaves a silky appearance. Growth of above ground organs from end of February to beginning of June. Distinctive herbal aroma.

Reproduction: Sexual and vegetative. Flowering occurs between September-October. Fruit maturation occurs between October – November.

Grazing importance: One of the best grazing plants on the steppe. Both drought and frost resistant.

Habitat: Meso-xerophyte. Most abundant on sand, stony or grey brown soils. Endemic of the Central Asian dessert.

Eremopyrum orientale

Family: Poaceae

Description and morphology: Annual, small ephemeral grass (height 10–30cm). Winter – spring development, starts growing around the middle of January; in a warm year it may start as early as autumn.

Reproduction: Sexual. Flowering occurs between April – May. Fruit maturation occurs from May to the beginning of June.

Grazing importance: Inflorescence is especially grazed in the winter – spring. Nutritional value is high.

Habitat: Psammophyte.

Ceratocarpus arenius

Family: Chenopodiceae.

Description and morphology: Annual, almost spherical plant (height 5 – 30cm). Greyish green rigid leaves with spiny tips.

Reproduction: Flowering occurs between May-June. Fruit maturation occurs between July – August.

Grazing importance: Provides better grazing early spring, in autumn it provides good grazing after wet weather. It is rejected in summer due to its spines.

Habitat: Xerophyte.

Salsola arbuscula

Family: Chenopodiceae.

Description and morphology: Perennial shrub (height 50-120cm). Life span of 7 – 12 years. The stem is branched and woody. The leaves fleshy, rectilinear and deciduous.

Reproduction: Sexual. Flowering occurs from the end of May – September. Fruit maturation occurs between September – October.

Grazing importance: Considered a good summer – autumn forage.

Habitat: Xerophyte. Grows on fixed or compacted sandy soils; scattered over considerable areas. Specific distribution includes the Ustiurt, Aral & Caspian region. Also spread throughout Middle Asia, south-eastern Russia, Iran, Afghanistan, China & Mongolia.

Anabasis salsa

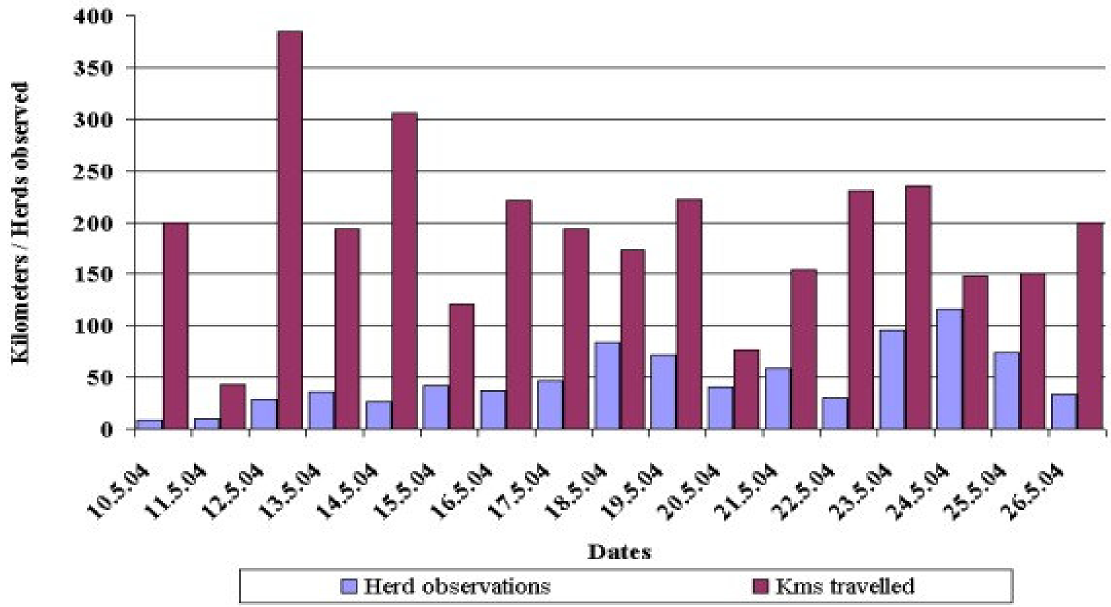
Family: Chenopodiceae.

Description and morphology: Small succulent shrub (height 10 – 60cm), almost spherical with strong woody branches at the base. Leaves are fleshy and slightly pointed at the tip.

Reproduction: Sexual and vegetative. Flowering occurs around May – June. Fruit maturation occurs around August – September.

Grazing importance: Well grazed from autumn until spring but later in spring it is poorly consumed

Habitat: Xerophyte. Grows on fixed or compacted sandy soils.



Appendix 4: The graph compares the kilometres covered on daily patrols to the number of herd observations made each day.

OBS	12th-16th	17th-21st	22nd-26th	TOTAL
HERD 1-5	101	244	272	617
HERD 6-20	30	44	48	122
HERD 21-50	27	9	17	53
HERD 51-400	12	4	12	28
	170	301	349	820
EXP	**10th-16th**	**17th-21st**	**22nd-26th**	
HERD 1-5	127.9146	226.4841	262.6012	
HERD 6-20	25.29268	44.78293	51.92439	
HERD 21-50	10.9878	19.45488	22.55732	
HERD 51-400	5.804878	10.27805	11.91707	
OBS-EXP	**10th-16th**	**17th-21st**	**22nd-26th**	
HERD 1-5	-26.9146	17.51585	9.39878	
HERD 6-20	4.707317	-0.78293	-3.92439	
HERD 21-50	16.0122	-10.4549	-5.557317	
HERD 51-400	6.195122	-6.27805	0.082927	
(O-E)2/E	**10th-16th**	**17th-21st**	**22nd-26th**	
HERD 1-5	5.663133	1.354643	0.336392	
HERD 6-20	0.876097	0.013688	0.296601	
HERD 21-50	23.33409	5.618358	1.369124	
HERD 51-400	6.611601	3.834764	0.000577	
			Chi sq	**49.30907**
			df	**6**

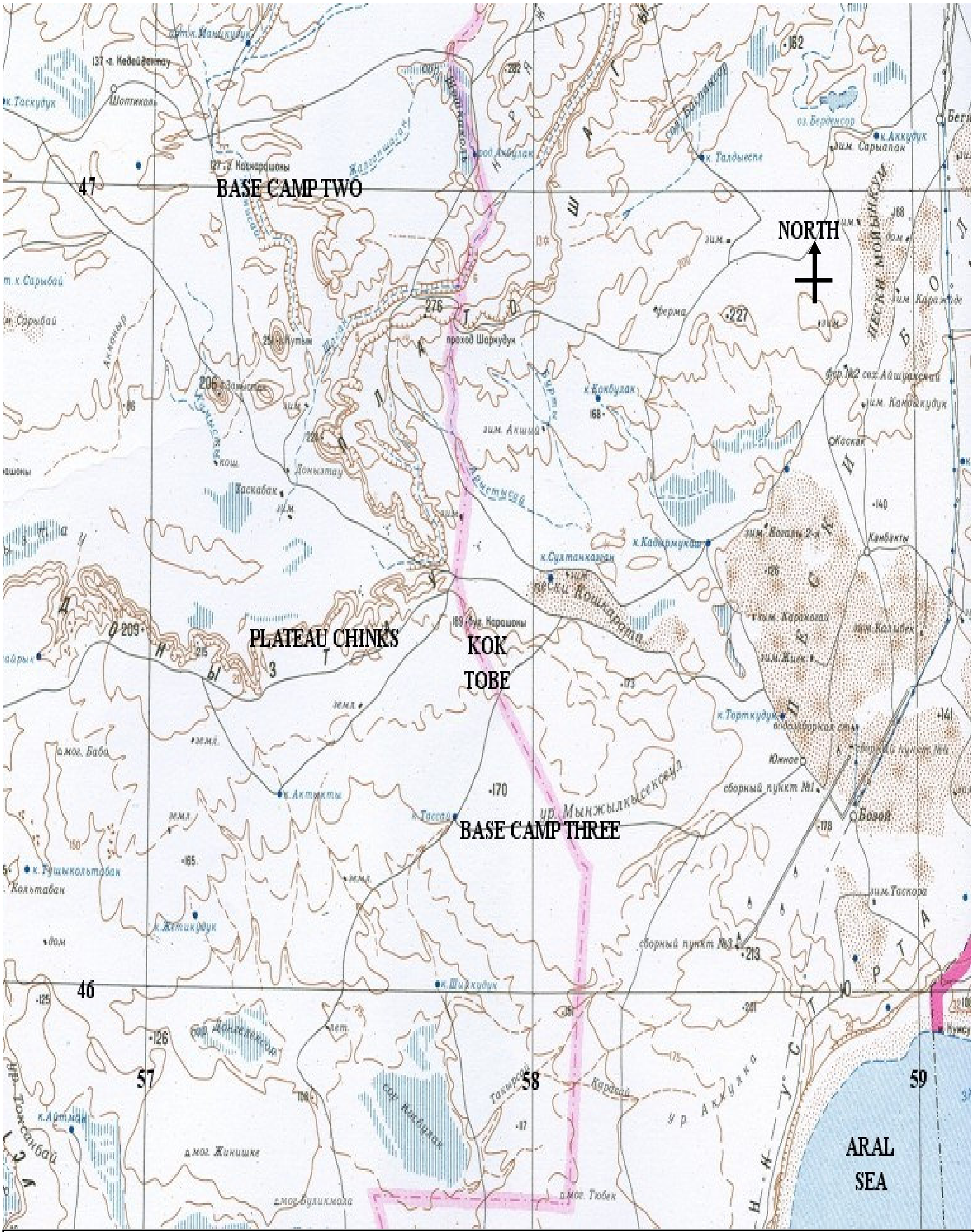
Appendix 5: Chi squared test to test the significance of variation in herd size during the periods 12^{th} – 16^{th}, 17^{th} – 21^{st} and 22^{nd} – 26^{th} May 2004.

OBS	14-18/05/2004	19-22/05/2004	23-26/05/2004	TOTAL
TWIN (pairs)	6	8	32	46
SINGLE	6	35	45	86
TOTAL	12	43	77	132
EXP	**14-18/05/2004**	**19-22/05/2004**	**23-26/05/2004**	
TWIN (pairs)	4.181	14.984	26.833	
SINGLE	7.818	28.015	50.166	
OBS-EXP	**14-18/05/2004**	**19-22/05/2004**	**23-26/05/2004**	
TWIN (pairs)	1.818	-6.984	5.166	
SINGLE	-1.818	6.984	-5.166	
(O-E)2/E	**14-18/05/2004**	**19-22/05/2004**	**23-26/05/2004**	
TWIN (pairs)	0.790	3.255	0.994	
SINGLE	0.422	1.741	0.532	
			CHI sq	**7.737**
			df	**2**

Appendix 6: Chi squared test to test the significance of the frequency for observations of twin and single Saiga calves.

Year	Betpak-dala	Ustiurt	Ural	KZ total
1998	**120,000**	246,000	*104,000*	470,000
1999	***64,000***	**200,000**	84,000	348,000
2000	*15,000*	116,000	17,500	148,500
2001	***12,000***	58,000	*9,500*	79,500
2002	4,000	19,100	*6,900*	30,000
2003	1,800	12,800	6,500	21,100
2004	6,900	15,000	8,800	30,700

Appendix 7: Saiga populations of Kazakhstan from 1998–2004. **Bold**=extrapolated from 50% counts, i.e. doubled. *Italics*=vehicle surveys, the remainder are aerial counts.



Appendix 8: Geographical map used in figures XXX. The legend is given below.

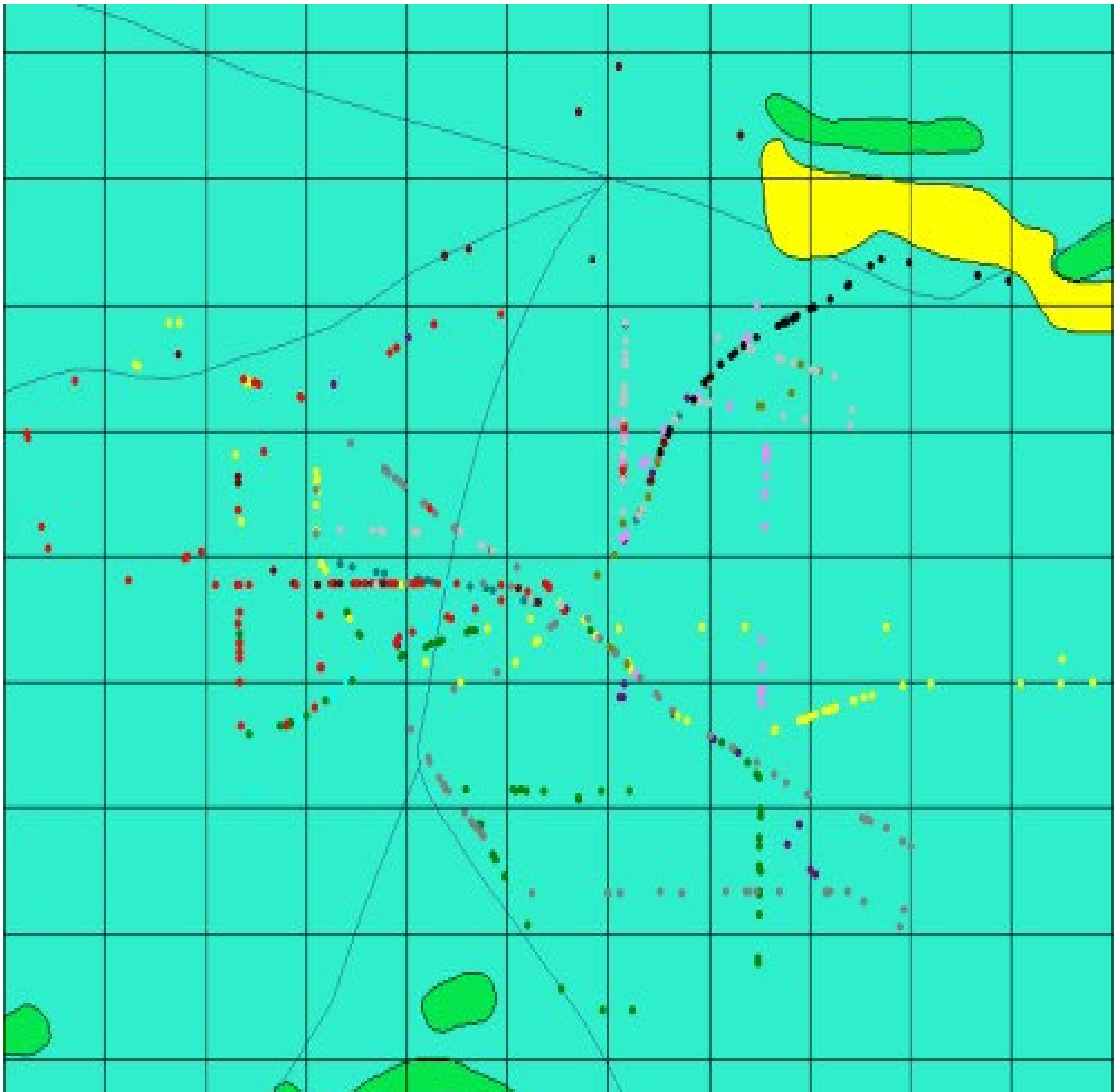
Road

Water body

Sandy desert

Contours (chink)

Altitude 168 •



Appendix 9: GIS map used in for determining spatial distribution in section 5.3.2. The overall extent of Saiga herds observed on the plateau in between the 12th – 26th May 2004. The map was produced using CyberTracker software and was taken from INTAS GIS map 09/07/2002. Each herd observation is linked to GPS coordinates as illustrated by the dots, the different colours represent individual days. Each grid square represents $10km^2$. The legend is given below.

Road | Water body | Vegetation

Altitude | Sandy desert