Conservation of Punjab urial (*Ovis vignei punjabiensis*) through long-term monitoring of marked individuals

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Summary

The Punjab urial (*Ovis vignei punjabiensis*) is endemic to northern Punjab, Pakistan, and is currently classified as endangered by the IUCN. The distribution of this wild sheep sub-species in Pakistan is betIen the Indus and Jhelum rivers at elevations of 250 -1,500 m primarily in the Kala Chitta and Salt Ranges. The dominant habitat type in the area is dry sub-tropical, semi-evergreen scrub forest. Punjab urial Ire once present over all northern Punjab Mountains, but in recent decades underInt a severe decline in both range and numbers, disappearing from much of their historic range.

The main reasons for the rapid decline in numbers appear to be poaching, the capture of newborn lambs that are kept as pets, fragmentation of home ranges, competition with domestic livestock and habitat disturbance and destruction associated with increasing agriculture, forestry and mining. In addition, infusion of exotic but compatible mouflon sheep genes may have occurred. The recent construction of the M-2 Motorway between Islamabad and Lahore created a substantial barrier to seasonal migrations and to dispersal.

Poaching can accelerate extinction processes, particularly when driven by commercial gain. The lamb capture and marking was started in 2002 in the community-managed Kalabagh Game Reserve (KGR). RSG grant was used for marking and monitoring of Punjab urial lambs for this ongoing project and particularly for the year 2005. I studied Punjab urial in two areas of the Salt Range, Pakistan, with contrasting human population densities and management regimes.

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In the Eastern Salt Range (ESR), humans live adjacent to urial habitat and enforcement of antipoaching regulations is lax. In the Kalabagh Game Reserve (KGR), human population density is low and regulations are strictly enforced. In ESR, about a quarter of the lamb crop was removed by poachers, and all rams older than 6 years Ire eliminated by illegal shooting. In KGR, less than 5% of lambs Ire removed and about 34% of adult rams Ire aged 6 years or older. Yearly recruitment was only 4 yearling females per 100 eIs in ESR, compared to about 13 per 100 eIs in KGR Recruitment was insufficient to maintain the population in ESR. Poaching of newborn lambs to be kept as pets appears to be the greatest short-term threat to Punjab urial, recently exacerbated by the granting of licences to legally possess pet urial. Over the long term, the increasing human population in the area presents additional challenges. Initial conservation measures should include, increasing the law enforcement capabilities, to incorporate community participation in the management of urial and reduce the number of competing livestock.

Introduction

Many large herbivores in Asia are under threat from poaching, habitat fragmentation and competition with domestic livestock. Conservation of Asiatic ungulates is often hampered by poor knowledge of basic population dynamics and lak quantification of specific threats. Here I examine recruitment and survival in Punjab urial (*Ovis vignei punjabiensis*) to assess the impacts of poaching on population persistence. I compare population structure, fecundity and lamb survival in two populations under different management regimes and levels of law enforcement.

The Punjab urial is distributed betIen the Jhelum and Indus rivers in Pakistan, below an altitude of 1500 m (Schaller & Mirza 1974). It is listed as Endangered by the 2003 IUCN Red List. Like other wild sheep (Aleem 1977, Schaller 1977), Punjab urial are gregarious and highly sexually dimorphic: adult males Iigh about 40 kg and their large curly horns can reach 100 cm in length. Adult females Iigh 25 kg and their straight horns are only about 12 cm long. Females give birth to one or two lambs in early April. Although all harvesting of Punjab urial is illegal, mature males are a sought-after trophy while lambs are traditionally prized as pets. Ownership of a pet urial is a status symbol in Pakistan (Awan 2001). Awan, Ahmad & Festa-Bianchet (2004) estimated a total population of about 860 urial, suggesting a 56% decline from 1976, when Mirza, Aslam, Asghar, & Mehal (1980) estimated 1968 urial in the same area.

Study Area

The Salt Range

The name Salt Range, owing to the second largest mineral salt (Sodium chloride) deposits in the world, is given to the hill system situated in the Northern Punjab, in Jhelum, Chakwal, Khushab and Mianwali Districts. First time the name Salt Range was used in 1808 by Elphinston, a British Envoy, when he observed the extraction of salt in the area. The salt deposits of the area Ire deposited as a result of the evaporation of Tethys Sea and formation of Indus plains from collision of Indian plate with Asian plate resulting from continental drift (King and Vincent, 1993).

The Salt Range is an east-Ist trending thrust front about 175 km long. It forms an impressive scarp, from 250 - 1520 m in altitude. Sakesar top is the highest point (1524 m). It extends betIen 32^{o} 41 - 32^{o} 56 N. and 71^{o} 50 to 74^{o} E. This range, first enters the Chakwal district at its extreme south Ist corner where the spurs of mount Sakesar descend into the village Lawa. In this part of its course the range keeps mostly to the district of Khushab, but near Khewra, it passes altogether into the Jhelum district where it bifurcates into two distinct ridges, one of them running towards south-east while the other into the east, about 8 km apart from each other. Each of them is made of a number of small roughly parallel ridges. This parallelism is modified by a marked tendency for linked and looped formations. On the south, the range presents a monotonous line of parched and barren slopes, rarely more than 250 m high from the mean sea level, descending abruptly into the valley of the Jhelum River. On the northern side they gradually sink down into the Chakwal plateau (Lindsay, 1923).

Sedimentary rocks and the fossils preserved therein give a complete record of the geological and biological history of the earth. The rock layers in the area have been tilted vertically, even inverted in some places, so that the older, fossil strewn layers now lie on the surface (Shaw, 1989). The over use of vegetation has accelerated rates of erosion resulting in bare sheet rocks devoid of any soil layers. The rocks are composed of limestone and sandstone or both. At some places infertile red marl is exposed due to similar reasons and the steep geological tilt resulting in frequent slips. The plant cover is poor on sandstone and red marl. The density of vegetation on southern aspects is poor while the northern slopes are comparatively bettered covered with vegetation.

The habitat type prevailing in the area is dry sub-tropical semi-evergreen scrub forest (Roberts, 1991). The dominant plant species are Acacia *modesta, Olea ferrugenia, Salvadora alights, Zizyphus nummularia, Dodonea viscosa, Prosopis glandulosa, Justiciar adhatoda, Calotropis procera.* Shrubs are sparse with scattered *Zizyphus nummularia* and, *May tenus Rawlins* except in some ravines and on the high ridges where *Daytona viscosa* is prominent and grasses like *Cymbopogon jwarancusa, Eleusine compressa, Heteropogon contortus, Aristida adscensionis, Cynodon dactylon and Saccharum species*.

Salt Range had a varied and abundant wildlife species in the historic times. Punjab urial, Chinkara, important carnivores, Chukar, See-see, grey and black partridges Ire in plenty due to nature of vegetation and topography. Which has been over hunted in the past and led to marked reduction in the numbers and restriction of the range of most species. Chinkara is nearly extinct from the Salt Range. Punjab urial population is also declining day by day. To protect urial population, one National Park five wildlife sanctuaries and two game reserves have been established in its distribution range. But this protective system of management has not been able to rise in its population or even stop decline in population.

Methods

The marking of Punjab urial lambs was started in 2002 in KGR to study the survival rate. The Rufford Maurice Laing Foundation, London provided one year partial funding that was used in this ongoing project in 2005. Some aspects/results of this project is presented in this report with marking and survival of lambs in 2005. I studied Punjab urial in two areas of the Salt Range, Pakistan from 2002 to 2005. The state-managed eastern section of the Salt Range (Lehri, Jalalpur and Kotal kund, referred to as ESR, 32° 41' N, 73° 23' E), covers an area of about 518 km^2. The community-managed Kalabagh Game Reserve (KGR, 32° 52' N, 71° 39' E) extends over about 137 km^2. Protection against poachers is vigorously enforced in the KGR, where urial have been protected for the last 70 years by the Reserve's private owners, who employ more than 30 game guards. Livestock grazing within the KGR is strictly prohibited in a core area of about 20 km^2 with the greatest urial density, and only a few cattle and sheep are allowed in other parts of the reserve where urial occur. Human access is limited to a few unpaved roads at low elevations where urial are rarely observed. Cutting of wood or grass is prohibited in the core urial habitat. On the contrary, in ESR law enforcement is lax, lamb captures are common and adult urial are illegally hunted. ESR is heavily grazed by livestock and people commonly collect fuelwood and cut grass. Awan et al (2004) reported that KGR supports about 500 animals, ESR only about 160.

Weather data (mean monthly temperature and precipitation) Ire obtained from Meteorological Department weather stations at Mianwali, 30 km southeast of KGR and Jhelum, about 20 km from ESR. The climate of the area is sub-humid sub-tropical continental. Rain is strongly seasonal and 60% falls in summer. Monsoon rains start around mid-July and last to mid-September. Winter rains begin in January and persist to early March. January is the coldest and June the hottest month of the year. Maximum daily temperature are usually >40 ℃ in June. In December and January the temperature often drops below zero. Average rainfall over 30 years (1961-90) was 1239 mm in Eastern Salt Range and 452 mm in KGR. Topography is similar in both areas, with an average

elevation of 1000 m. The habitat type prevailing in the area is dry sub-tropical semi-evergreen scrub forest (Roberts 1991).

Observations Ire made for 7 hours each day. Sex ratios Ire calculated from observations obtained over the entire study period.

Peak parturition is during the first half of April (Awan 2001). The rut is during the last week of October and the first weeek of November (Schaller & Mirza 1974). Observations Ire made primarily during early morning and late evening, using a Nikon 60X spotting scope and binoculars. Yearling females could only be distinguished from adult females from less than 200 m. Males 2 years of age and older could easily be distinguished from females by body size and horn shape and size, and I made a special effort to identify yearling males through horn shape and presence of a scrotum. I used horn length, horn curl and neck ruff size (Schaller & Mirza 1974) to classify adult rams into four age classes: Class I (2-years old), Class II (3 years), Class III (4 to 6 years) and Class IV (>6 years old). When possible, horn annuli Ire counted with a 60X spotting scope to estimate the exact age of rams. Because in older individuals annuli are difficult to distinguish, I pooled all rams >6 years (Schaller 1977) as class IV.

I used Analysis of Variance (ANOVA) to test for seasonal variation in-group size. Mean group sizes at KGR and in ESR Ire compared with Mann-Whitney U-test. I also calculated typical group size as the average group size experienced by all members of the population (Jarman 1974).

Fecundity was estimated from lamb: ewe ratios from April 5 to 26 (two weeks after the birth peak date) as recommended by Nichols & Bunnell (1999). Lambs found dead or poached soon after parturition Ire included in calculating lamb: ewe ratios. To assess lamb survival to 9 months, I calculated January lamb: ewe ratios following Festa-Bianchet (1992) and Jorgenson (1992). To estimate survival to yearling age I compared the lamb: ewe ratio in April to the yearling: ewe ratio in July the following year. Lamb: ewe and yearling: ewe ratios Ire calculated only for groups observed from less than 200 m, where yearling ewes could be classified. Yearling ewes Ire excluded from the calculation of lamb: ewe ratios. I marked 13 lambs (8 males and 5 females, all <2 days old) at KGR in April 2005 with small Allflex colored and numbered plastic ear tags. Newborn

lambs Ire captured by hand. The survival of marked lambs was monitored until January 2006, during 3 surveys of KGR lasting 5 days each.

Information on poaching of newborn lambs was collected from the market and directly from persons involve in poaching, on the understanding that this information would be used only for study purposes. Documentation of illegal shooting of adult urial was collected from local people and confirmed by the hunter or a witness. Unconfirmed reports of poaching Ire not included, therefore I likely underestimated the prevalence of poaching. Dead urial Ire carefully examined to determine cause of death. Eight predation attempts Ire observed.

Results

A total of 3508 urial sightings Ire classified into sex-age classes (Fig. 1) in KGR and ESR. Males aged 6 years or older Ire absent from ESR, whereas in KGR they represented about 17% of the population. Sex ratio varied seasonally in both areas (Fig. 2).

Only 3% of the urial seen Ire solitary. Mean group size was 4.4 (SE = 0.11), with a high coefficient of variation (Table 1). Group size varied seasonally ($F_{3, 863}$ = 23.81, P<0.0001) and was smaller during lambing than in winter and summer. Groups Ire larger in KGR than in ESR (4.7 vs. 3.2, P <0.05 Mann-Whitney U-test). Typical group size was about 7 urial and followed a pattern similar to mean group size (Table 1). During the rut, the frequent occurrence of solitary rams accounted for the wide discrepancy between mean and typical group size (Table 1).

Table 1. Mean, Standard Error (SE) and Coefficient of Variation (CV) of Punjab urial group size in the Salt Range, Pakistan, 2002 -2005. The typical group size (the group size experienced by the average individual in the population) is also provided.

Season	N groups	Mean	SE	CV (%)	Range	Typical group size
Rutting	136	4.55	0.39	100.8	1-23	9.87
Lambing	319	3.22	0.13	72.36	1-13	4.95
Winter	164	5.56	0.27	63.66	1-22	7.54
Summer	248	5.16	0.22	69.37	1-18	7.80
Overall	867	4.43	0.11	79.00	1-23	7.54

Mixed groups (37%, n = 320) Ire the largest and most common social aggregation, while all-male and nursery groups, including only ewes, lambs and yearlings each accounted for 25% of all groups seen. Mixed groups Ire most common during the rut and least common during lambing. An overall ram: ewe ratio of 89:100 among adult urial was observed during the study. The female/male adult sex ratio was close to unity in KGR but it was biased towards females (1.7) in ESR.

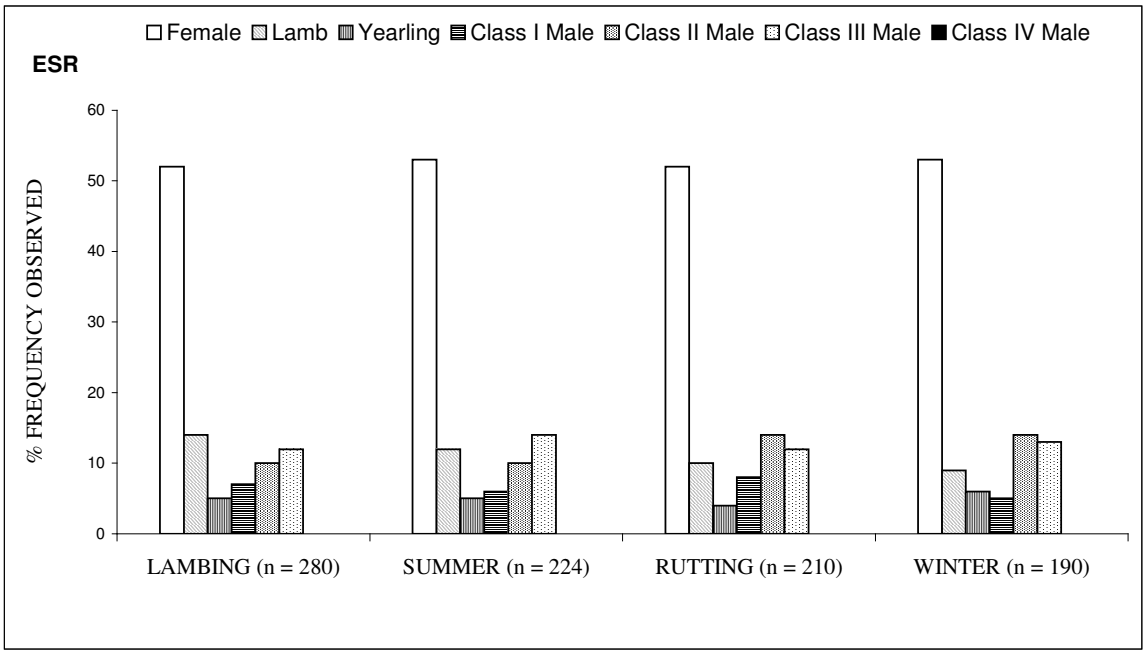

Figure 1: Sex-age composition of Punjab urial in KGR and ESR from 2002 - 2005.

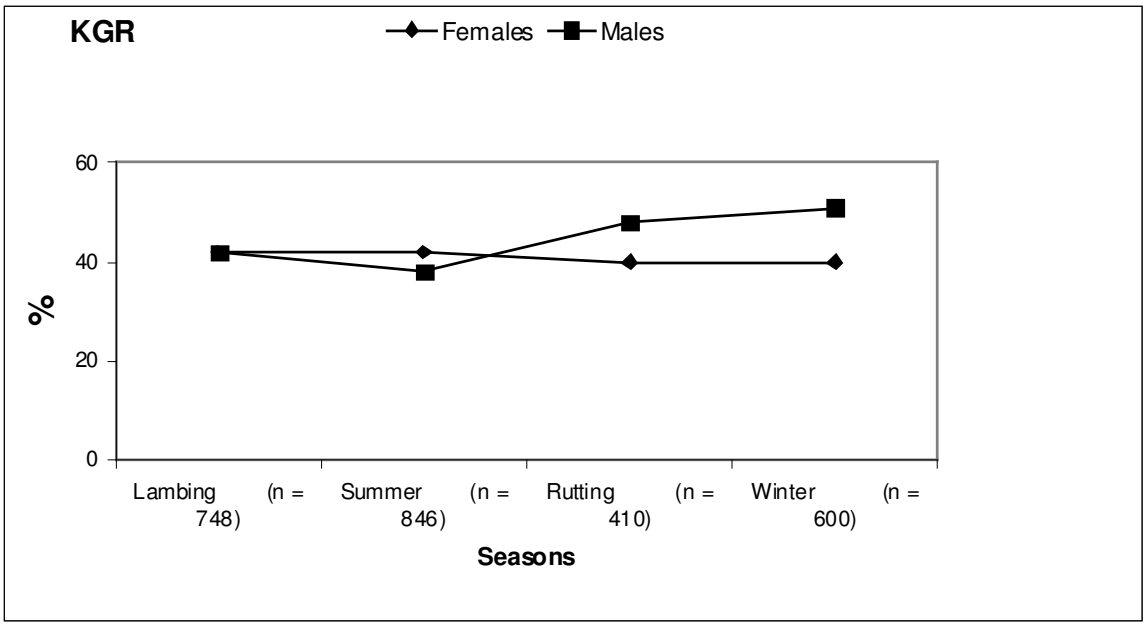

Figure 2: Seasonal sex-ratio of Punjab urial in KGR, 2002-2005

To assess litter size at birth, only considered 34 ewes at KGR whose lambs Ire captured soon after birth (12 ewes) or that Ire seen immediately after parturition (22 ewes), before they joined other ewes. Six of these ewes (18%) had twins, for an average litter size of 1.18.

Mortality of marked lambs

Of 13 lambs marked at KGR in 2005 (Table 2) within 2 days of birth, one died within 3 weeks. Two male lambs died in November. The mortality rate from birth to the following January was 23%, similar to the 25% estimated from changes in lamb: ewe ratio at KGR (Table 2).

Changes in lamb: ewe ratio

Lamb production and mortality varied among years and areas (Table 3). Lamb: ewe ratios declined substantially from April to the following January. Over 3 years, estimated mortality from birth to January averaged 65% at ESR and 35% at KGR. Yearling recruitment in July averaged 7 yearlings per 100 ewes in ESR and 26 yearlings per 100 ewes in KGR (Table 3).

Table 2. Punjab urial lambs tagged at KGR in April 2005.
All measurements in cm and kg. Male lamb = Orange color tag in left ear, Female lamb = Yellow color tag in right ear

#	Tag #	Sex	Age	Weight	Body length	Shoulder height	Hind limb	Fore limb	Girth	Remarks
1	105	♂	> 1 day	1.8	48	42	19	16	6.5	Twin
2	104	♂	> 1 day	1.9	47	42	20	15	8	Twin
3	100	♂	> 1 day	1.9	47	38	21	17	8.5	
4	114	♂	> 2 day	2.1	52	43	18	13	7.5	
5	30	♀	> 1 day	2	51	44	21	16	9	
6	34	♀	1 day	2.1	53	46	21	17.5	8	
7	119	♂	2day	2.2	52	41	19	16	7.5	
8	45	♀	1day	2	51	39	17	14	8	
9	115	♂	2day	2.4	53	42	17	14	8	
10	33	♀	< 1 day	1.9	50	38	19	15	7	
11	116	♂	< 2 day	1.9	50	42	20	15	7.5	
12	118	♂	> 1 day	2.2	53	43	20	17	7.5	
13	49	♀	1 day	1.9	54	42	21	18	7	Twin

Table. 3. Seasonal lamb: ewe and yearling: ewe ratios for Punjab urial in two areas of the Salt Range, Pakistan, 2000 - 2002.

Year	Area	April	January	Following July
		Lamb: ewe	Lamb: ewe	Yearling: ewe
2000				
	ESR	0.49 (n = 52)	0.22 (n = 59)	0.08 (n = 50)
	KGR	0.70 (n = 124)	0.43 (n = 118)	0.26 (n = 122)
2001				
	ESR	0.55 (n = 43)	0.15 (n = 39)	0.06 (n = 40)
	KGR	0.63 (n = 110)	0.37 (n = 106)	0.21 (n = 99)
2002				
	ESR	0.60 (n = 46)	0.19 (n = 42)	0.06 (n = 47)
	KGR	0.71 (n = 130)	0.53 (n = 123)	0.30 (n = 132)
Mean	ESR	0.55	0.19	0.07
	KGR	0.68	0.44	0.26

Poaching of newborns and predation Ire the main causes of lamb mortality. Predators include leopard (*Panthera pardus*), wolf (*Canis lupus*), jackal (*Canis aureus*), red fox (*Vulpes vulpes*), yellow-throated marten (*Martes flavigula*) and steppe eagle (*Aquila rapax*). Yellow-throated marten, eagle and jackal Ire documented to prey on lambs in early summer. Six night-time surveys Ire conducted in each of KGR and ESR. A goat's hide was first dragged behind a vehicle for 7 km, and then the same route was searched by spotlight. On average, for each km of survey I saw 0.14 Jackal and 0.28 foxes in KGR and 1.42 Jackal and 0.57 foxes in ESR.

Of 86 cases where the cause of lamb death or disappearance could be determined, 29 Ire attributed to predators and 64 Ire due to poaching (Table 4). On average, more than a quarter of the lamb crop was known to be poached in ESR. The actual extent of lamb poaching was likely greater. Of the 10 adult urial known to be illegally shot during this study in ESR and KGR, three rams Ire taken just outside KGR and seven (2 females and five rams) in ESR.

Table 4. Documented Punjab urial predation and poaching in the Salt Range, Pakistan, from 2002 - 2005.

Predator	Observed predation attempts	Urial killed by predator	Prey sex/age
Leopard	-	3	Rams/1 class II ram and 2 class IV
Indian wolf	One wolf chasing a ram	2	Ram/class II and III
Asiatic jackal	Two unsuccessful pursuits	15	lambs
Yellow-throated marten	Two unsuccessful pursuits	5	lambs
Steppe Eagle	Three predation attempts	2	lambs
Man (lambs captured to keep as pet)	-	64	lambs

Lack of awareness is evident in policy making and public attitudes to almost all forms of natural resource management including urial conservation. This lack of awareness lies at the heart of unsustainable uses of Salt Range natural resources. Recreational hunters Ire found to be generally unaware of the threatened and endangered status of the species. Custodian communities also lack awareness about the importance of Urial and their associated biodiversity and continue to degrade these through harmful practices.

Due to an acute shortage of investment in equipment and physical resources, lack of enforcement of conservation related legislation is a core issue leading to degradation of salt Range ecosystem. This results in the continuation of harmful activities such as hunting of this endangered species within protected areas. Similarly, extraction of timber and fuel wood from government forests and mining are unchecked due to lack of staff and other physical resources. Lack of training, skills and physical resources also hinders the provincial Wildlife Departments in formulating management plans, monitoring biodiversity and

implementing in-situ conservation measures. Additionally these departments lack the experience in integrating custodian communities in conservation.

In the KGR locally community is fully involved in conservation and now the population of urial in the reserve is viable for both population and genetic processes and a sustainable use trophy harvest quota is established from 2004 hunting season.

Discussion

Punjab urial formed larger groups in winter than in other seasons. In the winter when forage quality is low sheep use more open habitat and may decrease vigilance and increase bite rate by increasing group size (Jarman 1974, Risenhoover & Bailey 1985). Edge & Olson Edge (1990) reported that group size of wild goats (*Capra aegagrus*) in Khirthar National Park, Pakistan shoId a similar seasonal trend.

Single births Ire much more common than twins. Jerdon (1874) suggested that urial usually have twins and Prater (1965) suggested that one or two young are produced at birth. Schaller (1977, 1980) reported twins in feIr than 10% of births at KGR.

Schaller & Mirza (1974) and Schaller (1977) reported an even sex ratio for adult urial at KGR. Our study suggested a female-biased sex ratio for the entire Salt Range. In sexually dimorphic ungulates, male mortality is typically higher than female mortality, leading to female-biased adult sex ratios (Geist 1971, Clutton-Brock, Guinness & Coulson 1982, Jorgenson, Festa-Bianchet, Gaillard, & Wishart 1997, Loison, Festa-Bianchet, Gaillard, Jorgenson & Jullien 1999). For Punjab urial, hoIver, the female-biased adult sex ratio may partly be due to the selective harvest of males as trophies. Hunting is strongly biased towards males with large horns, and has an important impact on population structure. Male lambs also fetch a higher price than female lambs. Because lambs are very difficult to catch, however, I suspect that all lambs caught are kept.

Lamb production rates in this study Ire similar to those reported for other wild sheep, but yearling recruitment was lower than for stable or increasing populations (Portier, Festa-Bianchet, Gaillard, Jorgenson & Yoccoz 1998). The pet trade appears to be the greatest short-term threat to the survival of Punjab urial. While the protected KGR population seems relatively stable, numbers in the remainder of the Salt Range have declined to less than half what they Ire about 25 years ago (just over 3 urial generations). The two study areas are only about 100 km apart and have similar topography, but KGR is a community-managed game reserve, while ESR is managed by the state. It therefore

appears highly likely that differences in population dynamics in these two areas are driven by differences in protection status.

The lamb: ewe ratio in April was not markedly different between KGR and ESR, suggesting that poor lamb production was not the source of the population decline in ESR. I suggest that spatial and temporal changes in lamb survival, due mainly to different intensities of poaching, drive Punjab urial population dynamics. In ungulates, adult survival typically varies little over space and time (Gaillard & Yoccoz 2003) and changes in juvenile survival are often the key variable in population growth (Caughley 1977, Gaillard, Festa-Bianchet & Yoccoz 1998).

Lamb production in ESR and at KGR varied little between years, but the mortality of lambs from birth to January was about double at ESR than at KGR. Lambs may die from many causes, particularly in the ESR, where a variety of potential predators exist. In particular, there may be more jackals at ESR than at KGR because human settlements in and near ESR provide food for jackals in the form of garbage. I estimate that about 25% of the lamb crop was poached in ESR, compared to 5% in KGR.

Schaller & Mirza (1974) and Schaller (1977) reported 75 and 65 lambs/100 adult females, and 35 and 42 yearlings/100 adult females at KGR in 1971 and 1973. I counted on average 68 lambs and 26 yearlings/100 adult ewes at KGR, but only 55 lambs and 7 yearlings/100 adult ewes for ESR. Part of the difference could be explained by an increase in the pet trade, although predators may also have increased. Schaller & Mirza (1974) and Schaller (1977) reported that leopard and wolf Ire absent. During our study, leopard and wolf accounted for 24% of the known cases of predation. Over the last 50 years, however, the human population in the Salt Range has increased by 2.8 times (Government of Pakistan 2000), greatly increasing pressure to exploit natural resources in wild areas and accelerating the rate of habitat deterioration.

Estimated average survival to yearling age was about 12% in ESR and 38% in KGR. Gaillard, Festa-Bianchet, Yoccoz, Loison & Toigo (2000) reported 27 – 45 % post Ianing mortality for bighorn sheep and mean annual mortality of 11 % for female bovids. Assuming a 10 % annual mortality for adult ewes (Loison et

al. 1999) and an equal sex ratio among yearlings, yearling recruitment was insufficient to sustain the urial population at ESR, which averaged only 4 female recruits per 100 ewes each year. Consequently, the population will continue to decline if the existing levels of mortality and poaching are maintained. The 26 yearlings per 100 ewes seen in KGR are possibly enough to maintain numbers, assuming 13 of them are females, although more information is required on other vital rates, particularly adult female survival.

Outside the KGR, in most of the Salt Range most mature males Ire shot. Interviews with local people revealed that urial poaching occurs with the tacit accord of wildlife officials. In ESR, 80% of males Ire aged 2-4 years and no ram >6 years was observed, suggesting a high level of illegal hunting.

The government of Punjab in 1999 granted permission to keep pet Punjab urial for an annual license fee of 50$ per urial. Subsequently, the removal of lambs to keep as pets appeared to increased. A supply chain of poachers and merchants is established from the Salt Range to the major cities. The illegal trade in lambs is fuelled by their high price, ranging from 6,000 to 12,000 rupees or about US $ 100 to $ 200. To place these prices in a local perspective, an unskilled labourer may earn as little as 80 rupees a day while low-ranking conservation officers are often paid less than 6,000 rupees a month.

Because of the lucrative pet trade, some urial owners also interbreed them with domestic sheep, leading to a risk of genetic pollution if any hybrids Ire to escape. Despite the urial's protected status under the Punjab Wildlife Act of 1974, it enjoys little real protection outside the KGR. Commercial use of wildlife is a major threat to conservation (Geist 1994), particularly if it is culturally and politically sanctioned and the harvest is uncontrolled, as appears to be the case for Punjab urial.

The community-managed KGR currently constitutes the last remaining stronghold for wild ungulates in the Punjab Province, because it maintains sections of prime urial habitat with low human penetration. Most of the remaining range of this species is under continuously increasing human pressure. A reduction in poaching, increased law enforcement and a broader

conservation awareness of the local people are urgently required. If strong measures are not taken, Punjab Urial outside the KGR may soon become extinct.

Management recommendations

Existing legislation provides no means of community participation in wildlife management. Community participation in ESR should increase local interest in urial management. The practice of keeping urial as pets should be banned, and strict enforcement is required to curtail both the pet trade and cross-breeding of urial with domestic sheep.

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