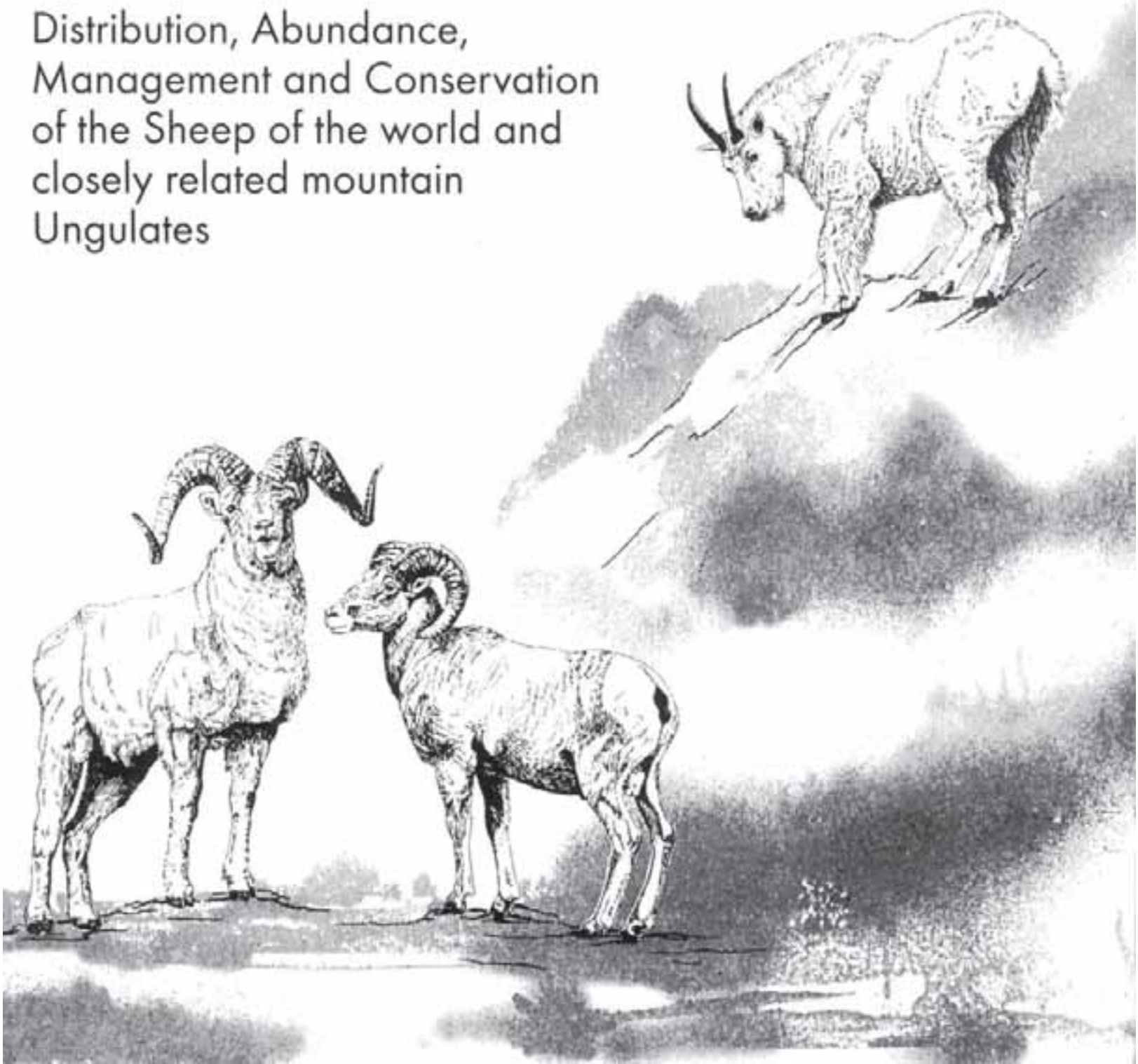
Northern Wild Sheep and Goat Council

Wild Sheep

Distribution, Abundance, Management and Conservation of the Sheep of the world and closely related mountain Ungulates



Northern Wild Sheep and Goat Council

SPECIAL REPORT

Wild Sheep

Distribution, Abundance, Management and Conservation of the Sheep of the World and closely related Mountain Ungulates

Editor : Manfred Hoefs

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Yukon
Renewable Resources

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FOREWORD

The fourth biennial symposium of the Northern Wild Sheep and Goat Council was held at Whitehorse, Canada, April 30 to May 3, 1984. The Whitehorse symposium was the first attempt by the Council to stage an international meeting, and invitations were sent to potential participants not only in North America but also in Europe and Asia. While only a few experts from overseas were able to attend the conference in person, because of the current economic circumstances, the concept of periodic international meetings on wild sheep and goats found widespread support, as the number of papers submitted to this volume as well as to the Conference Proceedings will reveal. At this symposium the present status of wild sheep was one of the agenda items. However, with few exceptions the presented papers addressed primarily the North American situation. The editor, therefore, took on the task of completing this documentation. With the help of conservation organizations, contacts were established in various regions of the world and experts on this subject were persuaded to contribute to this undertaking. This task was at times frustrating and very time consuming, but it was rewarding in the end. This is the first attempt ever to address the status of wild sheep and closely related mountain ungulates on a global scale, and considering the political situation in some of the countries relevant in this context and the level of knowledge on wildlife in others, the information conveyed in this synopsis is perhaps as good as is currently available.

Wild sheep have been successful animals. During the Pleistocene they have dispersed over the entire northern hemisphere and have colonized most suitable mountain ranges in Europe, Asia and North America, reaching a distribution not achieved by any other bovid. They have adapted to habitats with an extreme range of climatic conditions, being found north of the arctic circle as well as in desert environments. They have evolved feeding and digestive mechanisms to utilize very coarse and dry forage, which perhaps few other large mammals could persist on. Their qualities have made them one of the first animals that man has tried to domesticate. Their conservation is imperative, not only for aesthetic reasons, but because they constitute a valuable natural resource. In our era of rapid human population growth, when the future of man himself has become uncertain, when resource use has to be optimized, we cannot afford to forego the genetic potential of an important component of ecosystems that are still little known and largely unexploited by man, and are often referred to as hostile.

The goal of this publication was not only to reveal the current status of wild sheep, but also to stimulate conservation efforts. It is hoped that the progress made in certain countries will serve as an example and will provide incentives for others to follow.

A review of this document will reveal that sheep have suffered greatly and in certain areas are still suffering from the impacts of man and his domestic livestock; but sheep have also been the subject of some remarkable conservation efforts. The Bighorn sheep populations in the United States were reduced during the settlement of the West, but during the most recent decades, population levels have stabilized and in many states populations are growing. The European Mouflon was once restricted to the Mediterranean Islands of Corsica and Sardinia with populations numbering only a few hundred sheep.

Introductions to many countries of Central Europe as well as to certain areas in the New World have rescued this species from the brink of extinction with a world population currently estimated at about 65,000. In many Asian countries wild sheep suffered from competition with domestic livestock, but in the most recent past sanctuaries have been established in a number of countries, hunting is better controlled and livestock grazing on wild sheep ranges has been reduced. It is hoped that the good intentions revealed in these conservation measures will be followed up by more effective enforcement.

While tremendous knowledge gaps remain, while land-use practices, even in our own backyard in Canada will have to be better controlled to lessen their impacts on sheep, and while little is known about the fate of wild sheep populations in war-torn countries, many of the status reports have a positive overtone and perhaps justify cautious optimism.

This project could not have been completed without considerable help. Sincere thanks and appreciation are extended to the following individuals: Elaine Gustafson and Pearl Callaghan for typing the final manuscripts, Hannelore Hoefs and Mike Wagner for assisting with translations, Thom Rodger for designing the cover and for drafting many of the figures and maps, Hannelore Hoefs and Jean Carey for their help with proofreading the papers after wordprocessing.

The financial assistance received from World Wildlife Fund (Canada), Shikar-Safari Club International Foundation and the Yukon Wildlife Branch for publishing this document is gratefully acknowledged.

Editorial work on the papers contributed consisted of assuring that they followed a standard format in language, structure, quality of maps and figures and script. There was no editing of content. The information provided and the opinions expressed are solely those of the authors.

September 1985

Manfred Hoefs
Editor

POPULATION STATUS AND MANAGEMENT OF DALL SHEEP IN ALASKA, 1984

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ABSTRACT

Changes in land status have had profound influences on Alaskan Dall sheep (Ovis dalli dalli) management since 1979. Legislation which officially recognized subsistence hunting and placed more than 25% of Alaska's Dall sheep in National Parks had the additional effect of providing for surveys of the Dall sheep inhabiting these areas. These surveys revealed more difinitely the number of Dall sheep in Alaska. Former, conservative estimates were revised upward to more than 70,000 sheep. This probably resulted from more complete coverage than ever before rather than notable increases in actual Dall sheep numbers. Some populations are in transition, but most continue to exist at nearly stable levels with only slow changes in numbers. Hunter harvest has stabilized at about 1,100 Dall sheep, including both sport and subsistence harvests. Implementation of management plans is proceeding slowly. Subsistence hunting has had minimal effects since establishment of the subsistence priority, but continues to be a potential population threat requiring increased monitoring of affected populations. Nonsubsistence ewe hunting continues on a very limited basis, with little broad public interest. New Dall sheep research in Alaska centres on population definition and ecological description. New research efforts involving radio-collared animals are underway in the Tanana/Yukon Uplands in the western Brooks Range. The Bureau of Land Management and the National Park Service are working jointly with the Alaska Department of Fish and Game on these projects. Behavioral studies by the National Park Services are in progress at Denali National Park. The Alaska Department of Fish and Game continues to study reproductive performance and age-specific survival. The survival of sublegal rams in heavily hunted populations appears to be a fruitful area of management-related research for the near future.

INTRODUCTION

Alaskan political events in the past 15 years have had profound influences on the status of Dall sheep (Ovis dalli dalli) and their management in Alaska. Heimer (1978, 1980, 1982) reviewed the economic and political events which brought Dall sheep to their present population levels, management situations, and present status. It should be emphasized that the true status of Dall sheep in Alaska is

more complex than the sum of their abundance, distribution, and the use/demands which they support. The status and welfare of Dall sheep in Alaska is ultimately determined by their value to the people of the State. This most important aspect of status is beyond the scope of this paper which will be limited to abundance, distribution, and management. These aspects reflect the former status and present uses of Dall sheep in Alaska.

Dall sheep in Alaska inhabit 7 mountain masses which are arranged in 3 major bands of generally continuous habitat extending from west to east for hundreds of miles (Fig. 1). In Alaska, mountains of the Brooks Range extend from the Bering Sea eastward to the Canadian border. In Canada the eastward extensions of these mountains are known as the British Mountains, Barn Range and Richardson Mountains. Dall sheep also inhabit the glacial refugium of the Tanana/Yukon Uplands which may be thought of as an altitudinally lower, westward extension of Canada's Ogilvie Mountains. In central Alaska the Alaska Range forms a band of sheep habitat running from Lake Clark northwesterly to Mt. McKinley, and then generally eastward and somewhat southward toward the Canadian border where it merges with the northern slopes of the St. Elias Mountains in Canada. In Alaska, sheep distribution along the Alaska Range is discontinuous, being interrupted near Mt. McKinley. Hence, habitat is labeled as the Alaska Range "east" or "west" of Mt. McKinley. Sheep distribution is also interrupted by the lowlands of the Tok River. Mountains east of the Tok River are considered as the north side of the Wrangell Mountains. Just south of the central Alaska Range is an "island" of Dall sheep habitat, the Talkeetna Mountains. These mountains are not clearly identified with any major Alaskan or Canadian mountain mass. The southernmost extension of Dall sheep range in Alaska is in the mountains which begin on the Kenai Peninsula and proceed northeasterly to the Turnagain Arm of Cook Inlet near Anchorage. Beyond that point they are called the Chugach Mountains in Alaska, and they merge with the coastal portions of the St. Elias Mountains in Canada. In Alaska, Dall sheep habitats are called the Brooks Range, the Tanana/Yukon Uplands, the Alaska Range east of Mt. McKinley, the Alaska Range west of Mt. McKinley, the Talkeetna Mountain, the Wrangell Mountains, the Kenai Mountains, and the Chugach Mountains (Fig 1). I shall discuss Alaska's Dall sheep by grouping them in these mountain ranges. Dall sheep distribution is limited to the north slopes of the Kenai, Chugach, and Alaska Ranges. Prevailing weather renders the southern sides of these mountains uninhabitable because of heavy snowfall during winter.

MATERIALS AND METHODS

Knowledge of Dall sheep distribution in Alaska is the cumulative record of human observations extending from the oral history of Alaska's aboriginal peoples and early explorers to the present time. The abundance of Dall sheep in modern times has been determined by aerial surveys of known Dall sheep habitats. These surveys have been primarily accomplished using Piper PA-18 150 hp Super Club aircraft. These aircraft accommodate a pilot and an observer seated behind. The

Fig. 1: Distribution of Dall Sheep in Alaska.

observer may look out windows on either side of the narrow fuselage. Super Cubs are safely capable of fairly slow (60-70 mph) flight and have sufficiently high performance that they are suitable for low-level mountain flying in calm weather.

Recently, biologists of the National Park Service developed helicopter survey techniques and applied them broadly in newly created National Parks throughout Alaska (Singer 1981, 1982; Singer and Johnson 1984). The helicopter used in these surveys was a Bell 206B Jet Ranger. Procedures were standardized using a pilot and 3 observers. When this technique is used, large groups of sheep are counted and classified by landing and observation with spotting scopes of high power (15-60X).

The philosophy of Dall sheep management in Alaska depends on land ownership and classification. On State or Federal lands not designated as National Parks, management approach is determined through the regulatory process of the State of Alaska, and management is the responsibility of the Alaska Department of Fish and Game. Under this system, management policies prepared by the Alaska Department of Fish and Game were presented to the public for comment, modified, and then to a politically appointed Board of Game. Upon approval by the Board of Game, the policies functioned as guidelines for management plans which lead to the specific regulations required to manage sheep populations accordingly. Changes in game regulations may be proposed by citizens of Alaska, as well as the Department of Fish and Game. The Board of Game then implements those proposals considered to be consistent with the management goals and in the best public interest.

On remaining Federal lands, management is determined by congressional mandate. Some National Park lands are closed to hunting completely, and some are open to subsistence hunting. Federal lands classified as National Park Preserves are currently managed to allow consumptive use of Dall sheep through the regulatory mechanisms described above.

On all lands open to hunting, hunters are required to report their success, hunt locations, the sex, horn length and base circumference, and estimated age of sheep taken, the method of transport to the hunting area, and length of time spent hunting to the Department of Fish and Game. Reporting from recreational hunters is considerably more reliable and the data gathering system more highly evolved than for subsistence sheep hunting.

RESULTS

Table 1 summarizes population size and management status of sheep by mountain range. Specifics will be discussed for each specific range beginning in the north.

Brooks Range:

Recent surveys by the National Park Service in Gates of the Arctic National Park and the Noatak National Preserve (Singer 1982, Singer and

Table 1. Population size, status, harvest, and management of Dall sheep in Alaska.

Mountain range	Population size	Trend over 10 years	Sheep available to hunt	Legal game	Planned management objective(%)	Average number hunters 1982&83	Annual ram kill	Pursuit of all management goals complete?
Alaska Range E. of McKinley	9,000	Stable	9,000	Full curl ram (open) Full curl ram (permit) Ewe (permit)	Max. opport. (61%) Aesthetics (17%) Trophy (22%)	500	200	Yes
Alaska Range W. of McKinley	4,000	Stable	3,000	7/8 curl ram (open)	Aesthetics (75%) Viewing* (25%)	200	100	No
Denali Nat. Park (McKinley)	3,500	Stable	0	None	Viewing* (100%)	None	None	Yes
Brooks Range	30,000	Stable	15,000	7/8 curl ram (open) Subsistence (permit)	Aesthetics (50%) Viewing* (50%)	350 (sport) 50 (subsist.)	200 100**	No
Chugach	5,000	Stable or increasing	4,000	7/8 curl ram (open) 7/8 curl ram (permit) Ewe (permit)	Aesthetics (100%)	350	100	No
Kenai	1,500	Declining	1,300	7/8 curl ram (open)	Max. opport. (87%) Viewing* (13%)	135	25	Yes

Table 1. Continued.

Mountain range	Population size	Trend over 10 years	Sheep available to hunt	Legal game	Planned management objective (%)	Average number hunters 1982&83	Annual ram kill	Pursuit of all management goals complete?
Tanana/Yukon Uplands	650	Declining	650	7/8 curl ram (open) Full curl ram (permit)	Aesthetics (100%)	40	16	Yes
Talkeetna	3,000	Stable	2,800	7/8 curl ram (open)	Max. opport. (62%) Aesthetics (31%) Viewing* (7%)	200	90	No
Wrangell Mtns. (north)	12,000	Stable	12,000	7/8 curl ram (open)	Max. opport. (75%)	400	200	Yes
(south)	4,000	Stable	3,000	Full curl ram (open)	Aesthetics (19%) Viewing* (6%)	200	90	No
Total	72,650		50,750			2,425	1,121**	
					Aesthetics = 39% Max. opport. = 28% Trophy = 3% Viewing = 30%			

* No hunting allowed.
** Sheep of both sexes.

Johnson 1984) increased the number of sheep known to be present and consequently the estimated population size of Dall sheep in the Brooks Range. Since 1976, approximately 23,000 sheep have been counted in systematic aerial surveys of the Brooks Range. If surveyors saw 80% of the sheep present, the Brooks Range population is approximately 30,000 Dall sheep. Of these sheep, about 11,000 are within the National Arctic Wildlife Refuge (Fig. 1). These sheep are managed according to Alaskan State regulations. The management plan for this area provides for hunting in uncrowded, aesthetically pleasing conditions. Currently, the remoteness and high cost of hunting in this area limit hunters to acceptable levels. A lottery permit system was formerly in place here but was removed when it proved unnecessary to meet the management goal. Other lands open to hunting contain another estimated 3,000 sheep east of the Trans-Alaska Pipeline (Fig. 1). These sheep are also managed to allow aesthetically pleasing hunting opportunities. However, sheep within 5 miles on either side of the Trans-Alaska oil pipeline are managed for viewing and bowhunting since no firearms discharge is allowed within 5 miles of the oil pipeline. West of the pipeline, Gates of the Arctic National Park contains about 12,000 sheep. About 500 of these sheep are available for hunting in Gates of the Arctic National Park Preserve. The remaining 11,500 are protected from recreational hunting in the National Park. However, these sheep are available to subsistence hunters as defined by Congress in the Alaska National Interest Lands Conservation Act (ANILCA). Gates of the Arctic National Park also contains, in fully protected status, most of the sheep in the Noatak drainage of the western Brooks Range. About 700 sheep inhabit the Noatak National Preserve which is also managed to allow consumptive recreational use. In summary, management of about half of the Dall sheep in the Brooks Range (15,000) allows consumptive use under plans which call for aesthetically pleasing hunting conditions, 11,500 are protected in Gates of the Arctic National Park, and the remainder occupy the Trans-Alaska Pipeline Corridor.

About 350 recreational hunters harvest nearly 200 legal, 7/8 curl rams annually from the 15,000 huntable sheep. Most of these rams, about 60% are taken by nonresident hunters who must be accompanied by a guide according to Alaskan statute.

Several areas in the Brooks Range support harvest by subsistence users. Residents of Kaktovik village harvest about 35-40 sheep annually from approximately 2,000 sheep in the Hulahula River drainage of the Arctic National Wildlife Refuge. This hunt is closed to aircraft use for transportation of sheep meat or sheep hunters. Access is by ground transport (snow machine), and harvest occurs in November and April. The season runs from October 1 through April 30 and the bag limit is 3 sheep of any age or either sex. A quota of 50 sheep is set for the hunt each year, and hunters must obtain a registration permit in Kaktovik or Arctic Village before going afield. Crude population studies involving aerial surveys of the entire Hulahula drainage indicate this level of harvest (estimated at 30-40 sheep annually) has not measurably affected population levels in this area since 1976, even though the harvest is predominantly (70%) ewes (Heimer 1983). Within

Gates of the Arctic National Park, villagers of Anaktuvuk Pass harvest about 30 Dall sheep annually. The population supporting this harvest contains less than 1,000 sheep. It is unknown whether harvest by Anaktuvuk Pass residents is materially affecting the welfare of populations they hunt. Anaktuvuk Pass residents hunt in the fall, usually from all-terrain vehicles, and seldom take sheep later than early November. Anaktuvuk residents selectively take rams of all ages but do not kill them after rut has begun because of alleged "poor eating qualities". Some subsistence hunting also occurs in the lower Noatak River and in several other villages scattered throughout the Brooks Range. Harvest levels by these hunters and the sizes of the populations they hunt are unknown. Harvests are thought to be small, and populations are not large.

Research in the Brooks Range includes monitoring the effects of subsistence hunting on local populations and studies of home range and range ecology. Work is being done jointly by the National Park Service and the Alaska Department of Fish and Game.

Tanana/Yukon Uplands

Dall sheep populations of the Tanana/Yukon Uplands (Fig. 1) are thought to contain about 650 individuals. This area is characterized by fairly low, rolling hills; alpine habitat is disjunct with broad, timbered valleys between suitable alpine sheep habitats. This habitat is considered by many as the ancestral refugium of thinhorn sheep, and habitat character is more like the steppe habitats of northern Asia than other Alaskan sheep habitats.

Escape habitat is sparse compared to other Alaskan Dall sheep habitats, and populations have apparently declined somewhat in recent years. Predation pressure is the most often hypothesized cause. The Tanana/Yukon Uplands are in close proximity to population centers, but difficult access limited hunting and harvest in the past. However, since establishment of National Parks (which encompass the habitat of more than 25% of the Dall sheep in Alaska), hunter interest in the Tanana/Yukon Uplands has increased, the access problems have been overcome by more hunters, and hunter participation and harvest are now relatively high. These 650 sheep supported about 40 hunters per year during the last 2 hunting seasons. These hunters took an average of 16 sheep each year during the last 2 years.

Management plans for this area allow hunting under aesthetically pleasing conditions. Since hunters "re-discovered" the Tanana/Yukon Uplands, these conditions have been deteriorating. The anticipated sustainable harvest of rams from 650 sheep should be about 20 rams annually if the population were stable (it is thought to be declining). Still, even at this optimistic level only 1 legal ram is being recruited for each 2 hunters. These statistics indicate crowded

hunting conditions relative to production. As a result, most of the Tanana/Yukon Uplands was placed on lottery permit to restrict hunter pressure in 1984.

Research in the Tanana/Yukon Uplands is being jointly conducted by the Bureau of Land Management and the Alaska Department of Fish and Game. Radio transmitters were attached to 6 ewes a year ago and revealed the ewes in this area are loyal to traditional ranges. They travel through the extensive timbered lowlands between their alpine ranges. Wolves took one marked ewe during the first year of the study (Durtsche 1984).

The most significant threat to sheep in the Tanana/Yukon Uplands is displacement and habitat loss attending developmemt by the mineral industry. The land management agency for the area, the Bureau of Land Management, proposed closing crucial sheep habitat to mineral development in their resource management plan for a National Recreation Area and a National Conservation Area created in the Tanana/Yukon Uplands by ANILCA. Several mineral discoveries are apparently located in the area, but plans for future development have not been publicized. The most clearly identifiable threat is from asbestos and tungsten prospects being developed in areas not withdrawn from mineral entry.

Alaska Range:

The Alaska Range west of Mt. McKinely (Fig. 1) supports a population estimated at a minimum of 4,000 Dall sheep. Three thousand sheep are available to hunters, and about 1,000 sheep are in Lake Clark National Park. Sheep habitat in the Alaska Range is continuous alpine country and is considered classic Alaskan Dall sheep habitat. The western Alaska Range supports about 200 hunters annually, and harvest is about 100 7/8 curl or larger rams. This harvest rate is approaching or exceeding maximum sustainable levels if the number of sheep is actually 3,000 and the population is stable. The management goal for this area is to provide the opportunity to hunt Dall sheep under aesthetically pleasing conditions. Complaints about deterioration of the hunting experience in the western Alaska Range have not yet materialized, but the capacity of this area to continue absorbing pressure without yielding a compromised hunting experience seems questionable. No research is being conducted in the western Alaska Range.

The Dall sheep population of Denali National Park (Fig. 1) (formerly Mt. McKinley National Park) has been established at a minimum of 2,476 (Singer 1981). The population is estimated at about 3,500. These sheep are managed exclusively for nonconsumptive use according to guidelines for National Parks established by congress. Research on rutting behavior is being done in Denali Park by the National Park Service.

The Alaska Range east of Mt. McKinley (Fig. 1) contains approximately 9,000 Dall sheep. These sheep are managed to achieve 3 different management goals. Slightly more than 5,500 are managed to provide for maximum hunting opportunity for Dall sheep. Nearly 1,500 are managed

for aesthetically pleasing hunting conditions, and the management goal for the remaining 2,000 is production of trophy sheep. In total, the Alaska Range east of Mt. McKinley accommodates about 450 to 500 hunters annually. The harvest is about 200 rams. In the trophy area the minimum horn size has been full-curl for 10 years, and the mean harvest there has been about 40 rams annually. Since hunter participation is limited by lottery permits, this harvest rate is surprisingly high, particularly because the management goal defines a submaximal harvest. Still horn size and age among rams harvested is high and stable. A registration ewe hunt with a quota of 20 ewes is also offered in this area. Some local residents consistently hunt ewes, but interest is minimal compared with the ram hunt. In 1984, 1,404 hunters applied for the 120 ram permits issued by lottery drawing. In contrast, an open registration hunt for ewes attracted about 25 hunters. An average 5-7 ewes is taken each year.

Research in the Alaska Range east of Mt. McKinley is being conducted by the Alaska Department of Fish and Game. It centers on population welfare and includes studies of reproductive biology, population dynamics, range ecology, and age and sex specific mortality. Recently, data from studies of ram mortality suggested a strong behavioral mechanism exists which causes greatly enhanced mortality among sublegal rams when heavy cropping of legal rams above the age of 6 years is practiced. As a result, legal horn size for the entire eastern Alaska Range was raised to full-curl in 1984 to see if predicted larger harvests could be achieved.

Wrangell Mountains:

The Wrangell Mountains (Fig. 1) are currently thought to contain 16,000 Dall sheep. Most of these sheep (about 12,000) are on the north side of the mountain range in the Wrangell-St. Elias National Park Preserve. About 400 hunters annually use the northern Wrangell Mountains, and the yearly harvest is about 200 rams. This park preserve is managed to provide the greatest opportunity to participate in sheep hunting. The legal ram definition was changed from 7/8 to full-curl in 1984 due to public demand. It is unlikely the change to a full-curl regulation will have a great effect on harvest because the current harvest rate is low relative to the number of sheep present. However, populations may have declined due to severe winters in 1981-82 and 1982-83, and harvests could decline for the next few years.

The remaining 4,000 sheep in the Wrangell Mountains are on the west and south sides. These sheep (3,000) are mostly within the Wrangell-St. Elias National Park Preserve. The management plan for this area is to provide the opportunity to hunt sheep under aesthetically pleasing conditions. About 200 hunters use this area each year, and the average harvest is about 90 rams with 7/8 curl horns or larger. No research is being done in the Wrangell Mountains. The largest Dall rams in the world remain under total protection from hunting because they are within the Wrangell-St. Elias National Park at the southeast corner of this mountain range.

Talkeetna Mountains:

Sheep in the Talkeetna Mountains (Fig. 1) are estimated to number about 3,000. Most of these sheep are concentrated in the south and east portions of this mountain mass. Two different management goals are defined for the Talkeetna Mountains. Most sheep habitat in the Talkeetna's is managed to provide for the greatest opportunity to participate in sheep hunting. However, the southwest corner has a differing management plan, to provide the opportunity to hunt sheep under aesthetically pleasing conditions. Approximately 200 hunters per year take an average of 75 rams from areas open to hunting. Sheep Mountain, a well-known sheep range supporting about 200 sheep which is close to the Glenn Highway, is closed to sheep hunting and has a management goal of providing the opportunity to view, photograph, and enjoy sheep. This area is one of several areas set aside by the State of Alaska for nonconsumptive use. It has been managed for this goal since 1959. No research is being conducted in the Talkeetna Mountains.

Kenai Mountains:

Generally severe winters from 1970 through the early 1980s reduced the estimated sheep population of the Kenai Mountains (Fig. 1) from 3,000 sheep to an estimated 1,500 at this time. Two different management goals have been proposed for the Kenai Mountains (Spraker, pers. commun.). The Cooper Landing Closed Area is quite similar to the closed area just described for the Talkeetna Mountains. It is adjacent to a road and has been closed to consumptive use by the State of Alaska since statehood in 1959. This population contains about 200 sheep. The remainder of the Kenai Mountains is managed to provide for maximum opportunity to participate in sheep hunting. For the last 2 years an average of 135 hunters have hunted on the Kenai Mountains. They reported taking an average of 25 rams with horns greater than or equal to 7/8 curl. Hunter success averaged 18% during these 2 years, the lowest in Alaska and about half of the statewide average. Low success could be due to mortality losses of the early 1980s centering on older rams or poor ram recruitment in the mid-1970s. The second alternative is more likely. No documented research is currently underway in the Kenai Mountains, but Nichols (1978) formerly conducted population studies there. Trend count areas are surveyed annually.

Chugach Mountains:

The Chugach Mountains (Fig. 1) are thought to contain at least 5,000 Dall sheep. Densities are highest near Anchorage, and decrease toward the east. Dall sheep populations are quite sparse east of the Copper River, but some are found on the north side of the Chugach Mountains south of the Chitina River. Sheep habitat in the Chugach is managed to provide for sheep hunting under aesthetically pleasing conditions.

In one management area near Anchorage this goal is met through a lottery permit system.

Much of this area lies within an Alaska State Park and presents a challenging management situation because of persistent attempts by the State Parks system to manage large portions of it like a National Park, i.e., exclusively for noncomsumptive use.

A lottery permit hunt for 10 ewe sheep has been offered in the northwestern Chugach Mountains for 3 years. An average of 146 applications has been received each year. The average number of hunters participating has been 6, and the average harvest has been 2 ewes per year. Through comparison with the lottery permit hunts offered for rams throughout Alaska, it appears the ewe hunt is not attractive to many sheep hunters. An average of 2,630 hunters apply for lottery ram permits each year and about 2,500 hunters participate in open ram hunting. Less than 50 nonsubsistence hunters go after ewes in open registration (see Alaska Range East) and lottery permit hunts.

Ram harvest is limited to 7/8 curl or greater rams in the Chugach Mountains. The Chugach Mountains usually produce a harvest of about 100 legal rams and support about 350 hunters.

In summary, the estimated number of Dall sheep in Alaska is greater than 70,000. Populations are generally considered to be stable, but some individual populations are apparently increasing as others decrease due to localized causes. Sheep of the Kenai Mountains declined due to winter severity in 1980. They are currently at low levels, but are presumably building. An average of about 2,500 hunters hunted sheep in each of the last 2 years. They reported taking about 1,000 sheep, 600 by residents and 400 by nonresidents each year. During these years, subsistence hunters have probably taken a minimum of 75 sheep annually, and controlled ewe hunts have accounted for less than 10 ewes per year. This totals about 1,100 sheep harvested per year.

Alaska Department of Fish and Game management plans call for sheep to be managed for a variety of human uses. Management goals are being achieved with respect to nonconsumptive use and the maximum opportunity to participate in Dall sheep hunting. Programs for achieving the management goals of providing aesthetically pleasing hunting conditions are approximately 50% operational. Trophy management goals are being actively pursued in 1 of the 2 areas for which they were originally set. The other area is now in a national park.

DISCUSSION

Increases in the total number of Dall sheep estimated in Alaska suggest a re-examination of the distribution of these sheep with respect to prevailing management policy. Gates to the Arctic Park contains an estimated 11,500 sheep, Wrangell-St. Elias about 3,000 sheep, Denali National Park about 3,500, and Lake Clark National Park about 1,000.

These National Parks contain an estimated total of 19,000 Dall sheep. This comes to 27% of the Statewide total. While some subsistence hunting may be allowed on these lands under terms of ANILCA, neither sport hunting nor the use of aircraft for support of subsistence hunting is allowed. Also, state-managed viewing areas and the de facto viewing area along the pipeline contain another 3%. About 30% of the Dall sheep in Alaska are managed primarily for viewing.

A futile effort to reestablish consumptive use as a management option on newly created park lands was made in 1984. It failed. It now seems that the "golden moment" for passage of the Alaska Hunting Bill has faded into history, and it appears unlikely that Congress is likely to deal with the issue in the near future.

Still, the grim consequences predicted by Heimer (1978, 1980, 1982) have, for the most part, not materialized. Heimer assumed sheep hunting effort would continue to show increases even through the huntable population of sheep decreased considerably. Surprisingly, participation in sheep hunting unexpectedly declined by about 20 to 25%. Also, the discovery of more sheep (mostly on the north side of the Wrangell Mountains) acted to diminish the problems anticipated in maintaining harvest. Still, harvest diminished by about the same percentage as hunters afield. As a result, the success rate of hunters remained about the same as before land classifications changed. Hunter numbers are expected to increase in the future.

Subsistence hunting has had unknown effects on those sheep populations which support it. Populations in the Hulahula River, which support subsistence hunters from the village of Kaktovik on Alaska's north coast, were found to be undetectably affected by subsistence hunting in which ewes are predominantly selected. This hunting usually results in harvest of about 24 ewes from a population of 2,000 sheep. It remains to be seen whether other populations can continue to provide the harvest they are yielding at present. Subsistence hunting by the villagers of Anaktuvuk Pass in the central Brooks Range is most interesting. The number of sheep killed relative to population sizes appears to be quite high, but these hunters prefer to take rams. Harvest of this type certainly carries a lower population risk than a ewe harvest. Still, population studies are needed to determine the safety of this management practice.

Benefits resulting from the trauma of the last 6 years of turmoil in Alaskan Dall sheep management should not be overlooked. More complete censuses than ever thought possible have been accomplished because the newly created National Parks were established with funding supplied for a basic resource inventory. Sheep abundance is much better understood as a result. Research programs which were previously far beyond the economic resources of the Alaska Department of Fish and Game have been undertaken in the Brooks Range and the Tanana/Yukon Uplands. Finally, sheep managers were forced to examine the traditional premises upon which the management was based. This led to some interesting hypotheses which are now undergoing evaluation. The application of full-curl management to areas which are to be managed for maximum hunting opportunity is an example. Small-scale studies and theoretical

considerations indicated sustainable yield should be higher at full-curl than at the traditional 3/4 or 7/8 curl levels. This hypothesis is now being tested on a fairly large scale in Interior Alaska.

HUNTER INFORMATION

The annual harvest of Dall sheep in Alaska comes to nearly 1,000 rams. Resident hunters take about 600 rams annually using licenses that cost $20. There is no tag fee for resident hunters. Nonresident hunters take the other 400 rams. A nonresident hunting license costs $60, and nonresidents must purchase a Dall sheep tag for $400. Lottery-type permit drawings are open to both residents and nonresidents. In some hunts, nonresidents are guaranteed a percentage of the permits. Permit applications cost $5, and sheep hunters may apply for only 1 permit hunt each year. Nonresidents may not hunt sheep without hiring a guide licensed by the State of Alaska, or being accompanied by a resident adult within the third degree of kindred. Registered guides charge from $4,000 to $7,000 for a sheep hunt depending on the hunting area, the quality of services offered to the hunter, and the reputation of the guide. For further information, write to: Wayne Heimer, Alaska Department of Fish and Game, 1300 College Road, Fairbanks, Alaska 99701.

LITERATURE CITED

Durtsche, B.M. 1983. Distribution of sheep in the White Mountains. Bureau of Land Management, Fairbanks, Alaska. Mimeo Rep. 14 pp.

Heimer, W.E. 1978. The probable effects of the Alaska National Interest Lands Conservation Act on Dall sheep management in Alaska. Pages 77-87 in D. Hebert and M. Nation, eds. Proc. Bienn. Symp. North Wild Sheep and Goat Counc., British Columbia Wildl. Branch, Victoria

_____. 1980. A summary of Dall sheep management in Alaska during 1979 (or how to cope with a Monumental disaster). Pages 356-382 in B. Hickey, ed. Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. Idaho Dep. Fish and Game, Salmon

_____. 1982. Dall sheep management in Alaska following congressional settlement of the Alaska Lands Issue. Pages 1-9 in J. Bailey and G. Schoonveld, eds. Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. Colorado Div. Wildlife, Ft. Collins.

_____. 1983. Dall sheep survey: Hulahula River, July 1983. Alaska Dep. Fish and Game, Fairbanks. Mimeo Rep. 8 pp.

Nichols, L. 1978. Dall sheep reproduction. J. Wildl. Manage. 42:570-580.

Singer, F.S. 1981. Dall sheep count, 1981. Denali National Park and Preserve. National Park Service, Anchorage, Alaska. Mimeo Rep. 9 pp.

_____. 1982. Aerial Dall sheep count, 1982. Gates of the Arctic National Park and Preserve. National Park Service, Anchorage, Alaska. Mimeo Rep. 17 pp.

_____, and D. Johnson. 1984. Dall sheep numbers and distribution in the Noatuk National Park Service, Anchorage, Alaska. Draft Mimeo Rep. 24 pp.

DISTRIBUTION, ABUNDANCE AND MANAGEMENT OF WILD SHEEP IN YUKON

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ABSTRACT

Inventories carried out for the past decade have covered about 80% of the Yukon's known sheep ranges. It is estimated that the present population size is about 22,000, of which 19,000 are white Dall sheep and about 3,000 are coloured Stone sheep. About 5,400 sheep are under full protection in Kluane National Park and various preserves. Non-resident sheep hunters contribute on the average 72% to the annual harvest of about 280 rams; resident hunters and trappers account for the remaining 28%. Based on trophy quality and hunter success, it is assumed that the present management regime is sustainable. Trophy quality has improved over the past decade, both in respect to horn lengths of rams taken (r=0.793) as well as in age of rams (r=0.668). Presently (1983) the mean horn length is 35.4 inches and the mean age is 9.8 years.

While harvest can be regulated, the existing arrangement of Yukon Government having responsibility over wildlife, while the Federal Government has jurisdiction over lands, causes problems with habitat protection and with the imposition of regulations that would address disturbance of sheep.

INTRODUCTION

The Yukon has the largest wild sheep population of any jurisdiction in Canada. Both subspecies of Thinhorn sheep inhabit this Territory, and this fact has attracted trophy hunters, naturalists and wildlife biologists for almost a century.

The first surveys of Yukon sheep populations were conducted in 1904 and 1905 by an expedition primarily interested in documenting the distribution of various colour phases of this species (Sheldon, 1911). This expedition concentrated its efforts in the Ogilvie Range north of Dawson and in the Pelly Mountains. However, available information from other Yukon mountain ranges was incorporated into the resulting book which includes a preliminary map of sheep distribution in the Yukon and the colour phases of sheep inhabiting various regions. Early this century, few roads had been built in the Yukon, and

Dall ewe and lamb in Kluane National Park
Photo: M. Hoefs

Dall rams in Kluane National Park
Photo: M. Hoefs

Sheep Mountain, Kluane National Park,
well-known Dall sheep winter range
Photo: M. Hoefs

aircraft were not yet available. Considering the logistic difficulties these early explorers were confronted with, their tasks were remarkable indeed. Sheldon's (1911) book, "The Wilderness of the Upper Yukon", has become a classic, and while in specific regions, much more detailed surveys have been carried out recently, his effort on a Yukon-wide scale has never been duplicated.

The Yukon has been of great interest to trophy hunters since the turn of the century, and sheep along with grizzly have always been the most desired quarry. Some of these hunters have published their experience, and from these accounts, additional information on sheep distribution and abundance can be gleaned (Auer, 1917; Bond, 1948; Martindale, 1913; McGuire, 1921; Young, 1947). In 1958, the present registered outfitting areas were formalized in law. Sheep distribution played a major part in boundary delineation. The quality of information available, therefore, was sufficient to be used in such an important legislative matter.

In the years 1961 to 1965, the National Museum of Canada conducted Yukon-wide collections of mammals. Based on these collections and supplementary information published by other investigators, Youngman (1975) published his "Mammals of the Yukon", which includes distribution maps of the 64 species of recent mammals presently inhabiting the Territory. He is the presently accepted authority on the division of Yukon's sheep into white "Dall sheep" and coloured "Stone sheep", and the delineation of their respective ranges. At one time, the Yukon's coloured sheep were referred to as "Fannin sheep", and were given subspecific status. Youngman (1975) classifies Yukon's sheep as Ovis nivicola dalli and Ovis dalli stonei, thereby lumping the white Dall sheep with the Siberian Snow sheep. Most experts continue to use the taxonomic description of Ovis dalli dalli and Ovis dalli stonei for Yukon's sheep.

With the initiation of wildlife management in Yukon in the early 1970's, the documentation of distribution and abundance of this Territory's big game species was considered a priority objective. This report presents the inventory data collected for wild sheep over the past decade.

METHODS

AERIAL SURVEYS

When conducting sheep inventories and monitoring individual populations, an attempt is being made to obtain a total count. Helicopters are used exclusively and the survey method used has been referred to as "drainage-pattern flight technique" (Nowlan et al, 1977, Hoefs, 1978). The survey area is divided into physiographic subdivisions with distinct boundaries. These subdivisions have a size that can be covered in a 2 to 3 hour flight. The most commonly employed aircraft is a Bell 206 helicopter, which can carry 3 passengers in addition to the pilot. The navigator, who is principal observer is seated to the left of the pilot. The other observer is located in the left backseat, the right one being occupied by the recorder. An intercom system allows continuous contact between the survey crew members. Each survey unit is covered by flying around it in a counter-clockwise direction at an elevation appropriate to the prevailing relief. This means

that the elevation of the aircraft chosen and the distance of it from the mountains are such that the observers can keep surveillance over the slopes as well as over the ridge tops and plateaus. Wherever this is not possible with a single pass, several are made at different altitudes. The route flown and the exact locations where sheep are observed are marked on a map. All sightings are verified between the observers. If there is disagreement, another overflight is made.

The observations made are recorded on prescribed forms, which list size and composition of sheep bands, location, time of day, and other relevant information. Surveys are made in July when sheep are on alpine summer ranges. At that time, most of the snow has melted and the light colour of these animals is very conspicuous against the dark background of rocks and alpine meadows. Sheep surveys are relatively easy to conduct since these animals are very nervous and always run when approached by aircraft. By comparison, Mountain goats often hide, and counts obtained are therefore less reliable. It is known from repeated surveys made in Kluane National Park, from comparisons of ground and aerial surveys, and by using 80 marked sheep (Hoefs and Cowan 1977), that this survey technique is fairly reliable in that over 90% of the sheep can be accounted for; underestimates being influenced by terrain type and weather conditions.

While considerable variation can be expected due to terrain type, sheep density and aircraft ferry time, on the average this survey technique translates into about 100 sheep located per helicopter hour or about 120 km^2 of sheep habitat searched per helicopter hour.

TROPHY EVALUATION

Beginning in 1974, all skulls of rams taken by hunters were inspected by wildlife branch staff. Assessment of these trophies include age determination using the horn annulus technique (Geist, 1966; Hemming, 1969), and evaluations of various horn growth parameters (Shackleton, 1973). All skulls were clamped into a specially designed measuring device for these assessments and photographs were taken for permanent records (Merchant et al, 1982).

RESULTS AND DISCUSSION

DISTRIBUTION AND ABUNDANCE

The Yukon Government began a systematic survey of its wildlife in 1973, when the first technical staff members were hired. An assessment of sheep distribution and abundance, along with an evaluation of the impact of hunting, were a top priority in these wildlife inventories. About 72% of the sheep harvest was brought about by non-resident hunters, and the distribution of outfitting areas assured that most of Yukon's sheep populations were subjected to hunting. In 1973, no game management zones existed in Yukon. The only subdivision of the Territory into smaller units was the existence of twenty-two outfitting areas. These outfitting areas covered the southern two-thirds of the Yukon and took in all sheep ranges except those under protection in the Kluane and MacArthur game sanctuaries and in the northern Yukon. Wildlife inventories were therefore carried out on the basis of outfitting areas. From 1973 to 1982, fifteen outfitting areas were surveyed, and two additional ones

TABLE 1 POPULATION ESTIMATES OF YUKON WILD SHEEP

Outfitting Area Geographical Region	G.M.Z.	Numbers of sheep observed ♂	♂≥	♂Y	Nurs	Lbs	Σ	Total number estimated	Survey Date	Info.Source
1	2	281	76	205	743	323	1347	1500[1]	1980	Hoefs & Nette,1980
2	2	96	52	44	263	89	448	551	1978	Larsen,1978
3	2	85	52	33	360	69	514	616	1978	Larsen, 1978
4	2							800		Estimate
5	2							800[2]		Estimate
6	2							400[2]		Estimate
7	4							480[2]		Estimate
8	4	62	62	13	49	132	25	275	1981	Nette & Merchand 1981
9	4							540		Estimate
10	5	236	100	136	537	172	945	1121[2]	1974	Hoefs,1975
11	5	152	65	87	364	108	622	860	1974/82	Hoefs,1975/82
12	5	203	77	126	430	144	777	870	1974/82	Hoefs, 1975/82
13	5	454	196	248	867	213	1534	1784	1974	Hoefs,1975
14	4							540		Estimate
15	8	94	27	67	107	41	242	332	1976/77	Lortie et al 1978
	10	156	51	105	191	61	408	784	1976/77	Lortie et al 1978
16	7	142	60	82	455	151	748	1248	1973	Hoefs,1974
17	8	8	2	6	29	11	48	60	1976	Lortie et al 1977
	7	137	43	94	277	118	532	920	1973	Hoefs, 1974
18	7	305			728	169	1202	1300	1980	Nette,1980
19	8&10	25	10	15	56	21	102	125	1976/77	Lortie et al 1978
20	10&11	35	14	21	71	31	137	160	1976/77	Lortie et al 1978
22	11						177	322[2]	1976	Hoefs&Lortie 1976
Miners Range	5-50	39	5	34	88	34	161	170	1982	Hoefs,1982/83
Knorr Range	2-67 2-71							150		Estimate
Richardson Mountains	1-64	4			10	5	19	25	1977	Hoefs,1978
	1-53,54,58	22			59	26	107	120	1980	Hoefs,1980
	1-14,25							100	1977	Hoefs,1978
British Mountains	1-08 1-07						80	1 100	1974	Hoefs,1974
Kluane Park/ Kluan Sant.	6						4500	1 5000	1972	Hoefs,1973
White Mtns.	3-16	14			16	9	39	40	1980	Hoefs,1980
MacArthur Sanctuary	4-03	14			38	15	67	70	1978	Hoefs,1978
TOTALS							14975	22163		

Explanations for Table 1.

$\sigma^{\prime}$ = Sum of all rams (separated from nursery bands)
σ_{ℓ} = Legal rams in such ram bands
σ_{y} = Younger rams in such ram bands
Nurs = Nursery sheep includes ewes, yearlings and young rams that are still associated with nursery bands, and are usually less than 3 years old.
lbs = lambs (young of the year)
Σ = sum of all sheep observed

The estimated numbers of sheep in general is about 20% higher than the number actually counted. It is a reflection of a correction factor applied, which considers weather conditions during flying, nature of terrain, time of day, number of observers, etc.

For areas not surveyed as yet, the estimated population size is calculated from the age and numbers of rams killed over the past 10 years and the intensity of hunting pressure, as explained in Table 2.

(1) Some sheep in these populations move across the Yukon/Alaska boundary
(2) Some sheep in these populations move across the Yukon/NWT boundary

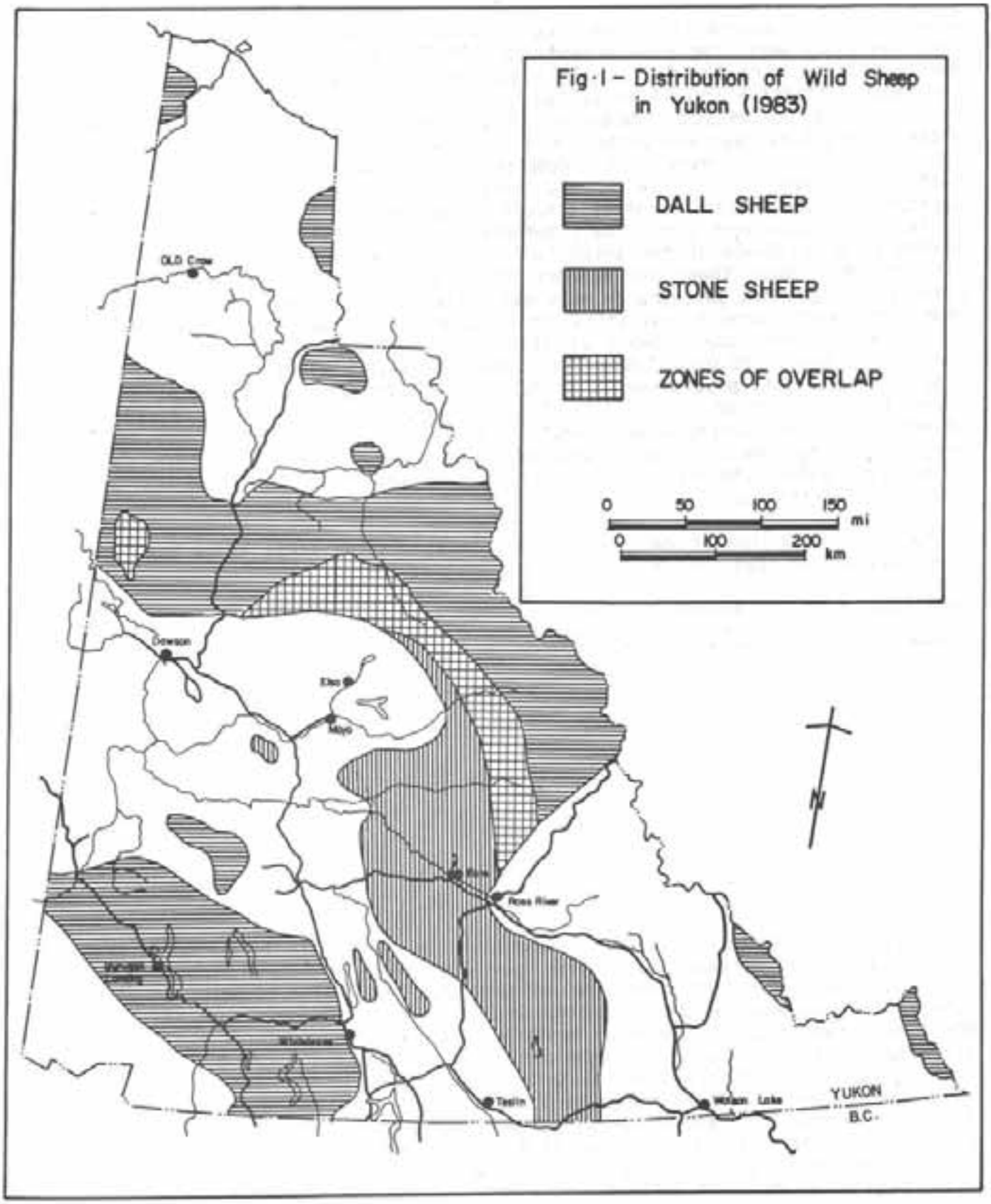
were partially covered by inventories. Kluane National Park and the Kluane Game Sanctuary were completed already in 1972. The British Mountains in the northern Yukon were surveyed in 1974 and the Richardson Mountains in 1978. Only four outfitting areas have so far not been assessed, and in two additional ones, surveys are as yet incomplete. Therefore, about 85% of Yukon's known sheep ranges have been evaluated. Fig. 1 shows the distribution of sheep in Yukon and Fig. 2 reveals the completion of inventories in relation to outfitting areas. In Table 1, the survey results are summarized. Where appropriate, the numbers of sheep actually observed, are listed and identified as legal and sub-legal rams, adult members in nursery bands and lambs. Also listed is an estimate of the total number. These estimates are, in general, 10% to 20% higher than the numbers observed. The numbers of sheep in outfitting areas not surveyed or only partially surveyed, are estimated on the basis of 10-year harvest statistics and the ages of the rams shot, as explained in Table 2. The total number of sheep estimated to inhabit the Yukon at present is around 22,000 (Table 1). Based on 10,165 classified sheep, the composition of this population is as follows: 25.2% mature rams, 56.9% adult sheep in nursery bands, and 17.9% lambs. Mature rams are those found in separate ram bands during summer; adult nursery sheep includes ewes, yearlings, and those young rams still in nursery bands; lambs are young of the year. All these population statistics refer to July counts, when inventories are generally carried out.

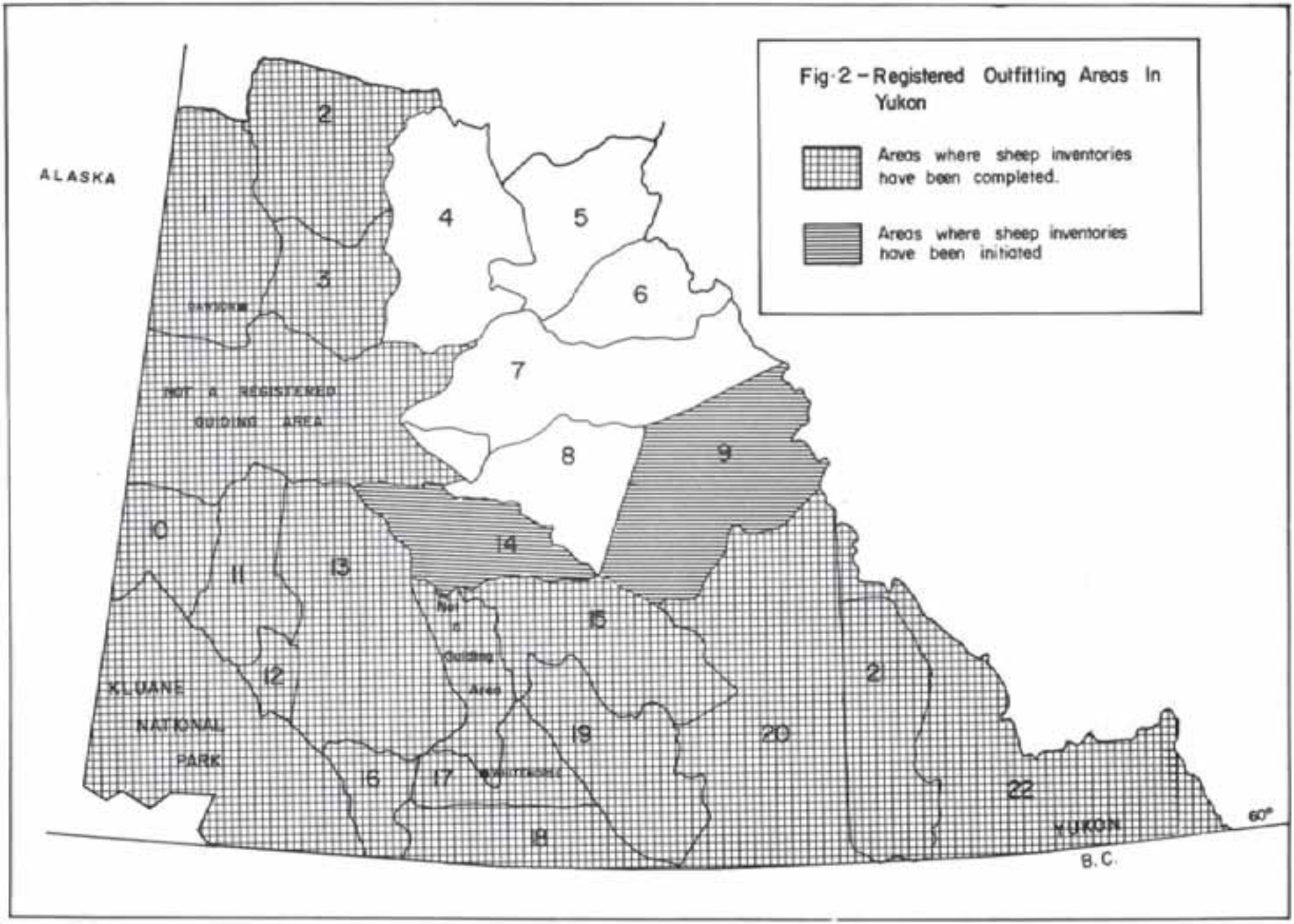
Table. 2. Estimation of numbers of sheep in outfitting areas which have not been surveyed or have only been partially surveyed.

Outfitting Area	Average Harvest (n= ≤ 10 years)	Factor*	Sheep Population Estimate
4	10	80	800
5	10	80	800**
6	5	80	400**
7	6	80	480**
9	9	60	540
14	9	60	540

*This factor, by which the annual harvest is to be multiplied to arrive at the total population estimate, is based on the known percentage of annually recruited legal rams ($\geq$ 9 years old) of the total population (2.5%). It also takes into consideration known hunting pressure. It is assumed that in areas where no competition for sheep by resident hunters occurs, 50% of the annual recruitment of legal rams are removed by outfitter-guided hunting. In such remote areas, a multiplication factor of 80 was applied. In areas where non-residents as well as residents hunt sheep, the hunting pressure is greater. If all legal rams are removed annually, which translates into 2.5% of the total population, a multiplication factor of 40 is appropriate. None of the areas listed here are hunted that intensely, but outfitting areas #9 and 14 receive some pressure by resident hunters.

**These areas border on the N.W.T. boundary, and some of the sheep may occasionally be out of the Yukon.


Fig·1 – Distribution of Wild Sheep in Yukon (1983)
DALL SHEEP
STONE SHEEP
ZONES OF OVERLAP
0 50 100 150 mi
0 100 200 km
N
Old Crow
Dawson
Elsa
Mayo
Ross River
Teslin
Watson Lake
YUKON
B.C.


Fig·2 – Registered Outfitting Areas In Yukon
Areas where sheep inventories have been completed.
Areas where sheep inventories have been initiated
ALASKA
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
22
NOT A REGISTERED GUIDING AREA
KLUANE NATIONAL PARK
YUKON
B.C.
60°

Of some 22,000 sheep in Yukon, about 3,000 are coloured sheep, now classified as "Stone sheep", but formerly kown as "Fannin sheep". Sheep in the Cassiar and Pelly mountains, in the MacArthur Ranges, and on the White Mountains, are all of the coloured variety, while those in the Wernecke, Hess and Ogilvie ranges include a certain percentage of dark sheep. In Table 3, an attempt was made to estimate their frequencies in the relevant outfitting areas, and on Fig. 1, the Yukon-wide distribution of these two subspecies of Thinhorn sheep is shown.

Table 3. Estimated number of Stone sheep (fannin) in Yukon.

Outfitting Area	Estimated Sheep Population Size	Estimated Percentage of Fannin Sheep	Number of Fannin Sheep
8	275	100%	275
14	540	100%	540
15	1116	100%	1116
19	125	100%	125
20	160	100%	160
1	1500	10%	150
4	800	20%	160
2	551	10%	55
3	616	10%	62
7	480	10%	48
9	540	30%	160
17	980	6%	59
MacArthur Rg.	70	100%	70
White Mountains	40	100%	40
		Total	3020

About 5,300 white sheep are under full protection in Kluane National Park, Kluane Game Sanctuary, and the Richardson and British Mountains in Northern Yukon, and so are about 100 coloured sheep in the MacArthur Game Sanctuary and in the White Mountains.

It is assumed that sheep still occupy about 90% of their historic range in Yukon. Therefore, reintroductions to areas where sheep have disappeared may bring the Yukon total population size to about 25,000.

In 1974, Yukon's sheep population was estimated at 22,400 (Hoefs, 1975b), very similar to our present estimate of 22,163. In 1973, only 10% of the sheep ranges had been surveyed, and the information on which estimates were based consisted of harvest statistics and reports from outfitters and hunters. The method used to compute the Yukon's total sheep population was similar to the one applied in this paper for the outfitting areas not yet subjected to sheep inventories.

From repeated surveys of certain herds, it appears that the Yukon sheep population is relatively stable, even though annual fluctuations of up to $\pm$20%

around some mean value can be expected because of varying winter mortalities and lamb productions.

POPULATION DYNAMICS

Ratios between population components are of interest in the study of population dynamics, since they may reflect the degree of hunting pressure a given herd is exposed to, or they may also be a reflection of different productivity or of disturbance through land use activities. Several ratios are given in Table 4. For comparative purposes, the Yukon-wide hunted sheep populations are listed in reference to four unhunted herds. The ratio between rams and nursery sheep averaged 44.1% Yukon-wide, which is a lower ratio than observed on Sheep Mountain (Kluane National Park), White Mountain (GMZ 3), and Grey Ridge (GMZ 9). This difference in ratio is expected since hunting will remove 5 to 10% of the rams annually. It is not known why the Mt. Cronin population in the Richardson Mountains (GMZ 1-53, 1-54, 1-58) has such a low ram/nursery sheep ratio, but the possibility of unrecorded native hunting or migration of young rams can not be ruled out.

Table 4. Ratios between population segments

	Hunted Populations	Unhunted Populations			
	Yukon-wide	Sheep Mt. 1969-81	White Mt. 1980	Grey Ridge 1978-81	Mt.Cronin 1979-81
Rams* / Nursery** sheep	2510 / 5698 = 44.1%	50.0%	87.5%	79.5%	37.3%
Lambs / Nursery sheep	1778 / 5698 = 31.7%	24.0%	62.0%	37.3%	36.5%

*Rams are those mature animals, which are separated from nursery bands in summer; they are usually in their third year and older.

** Nursery sheep includes ewes, yearlings and those young rams still in nursery bands. These rams are usually less than three years old.

Densities of Yukon sheep populations vary widely. They are highest in Kluane National Park, on the neighboring Ruby Ranges (Outfitting Areas #10, 11, 12, 13) and in the Coastal Mountains (Outfitting Areas #16, 17, 18). Here, year-round densities of up to 1.8 sheep/km^2 have been reported (Hoefs and Cowan, 1979). In general, more northern populations are more widely dispersed. The Mt. Cronin population in the northern Richardson Mountains (GMZ 1-53, 1-54, 1-58 at a latitude of 67°N) for instance, has a density of only 0.6 sheep/km^2 (Hoefs, 1978a).

MANAGEMENT

To many hunters, wild sheep are probably the most prized trophy animal in North America. Others value their meat, and the non-consumptive use of sheep for recreational and educational purposes is steadily rising.

In the Yukon, sheep are the main drawing card that attracts non-resident hunters, and the income to outfitters from sheep hunting exceeds that of any other wildlife species and is estimated at more than 1 million dollars annually. Of some 400 non-resident hunters per year, about 300 engage in sheep hunting, and have, over the past decade, accounted for about 72% of the Yukon sheep harvest. Sheep hunting provided some 1,930 recreation days for local hunters in 1978 and about 1,600 recreation days for non-resident hunters.

At present, the primary goal of sheep management in Yukon is the provision of large, old rams for trophy hunting. To achieve this goal, a number of sheep hunting regulations have been implemented over the years mainly for non-resident hunters. While these led to a slight reduction in harvest (Table 5), they have at the same time improved the trophy quality of the rams taken. Relevant regulations can be summarized as follows: Since 1908, the hunting of female sheep has been prohibited; since 1972, only rams can be taken whose horns have reached 3/4 curl or better. A compulsory submission of trophies to the Wildlife Branch, for assessment of age and horn growth parameters, was initiated in 1974. Since 1975, non-resident hunters can only take rams whose horns have reached full curl, and this requirement was extended to resident hunters in 1981. One of the existing 21 outfitting concessions, (#18), was revoked in 1980 and this area is now managed for resident trophy sheep hunting through a limited entry provision.

The Wildlife Branch recognizes the need to accommodate non-consumptive uses of sheep to a greater degree than presently granted, as well as the desires of some resident hunters that would like to take sheep for meat rather than trophies, and these issues will be addressed in a sheep management plan, which is presently being prepared.

In Fig. 3, the Yukon sheep harvest for the past 14 years is graphically displayed. The total take is divided into contributions by non-resident hunters as well as resident hunters and trappers. On the average, 278 rams were taken per year; non-resident hunters, guided by registered outfitters, accounted for 72% of the harvest; resident hunters and trappers took 28%. The harvest by residents has remained fairly stable, while there was a slight reduction in non-resident sheep harvest, particularly in 1980 when one of the 21 outfitting areas (#18) was closed.

The Yukon Wildlife Branch feels that the present harvest is sustainable and that there are no indications of "overuse" of this resource. These claims are supported by the information in Fig. 4., which lists parameters of trophy quality of the rams taken by non-resident hunters. The average age of the rams taken ($r=0.668$) as well as the average horn lengths ($r=0.793$) have remained fairly stable in recent years after improving during the period of 1974 to 1980. With a mean horn length of 35 inches and a mean age of close to 10 years, management for trophy rams may have reached the optimum achievable. Any improvement in average trophy quality can only be brought about at the expense of numbers of available rams. It is known that in older rams the natural mortality rate increases greatly; for the 10 to 11 year cohort, it may amount already to >50% (Hoefs and Bayer, 1983). It is also known that in rams 10 years old and older, the wear rate of the horn tips may exceed the new growth put on at the horn base (Hoefs and Nette, 1982).

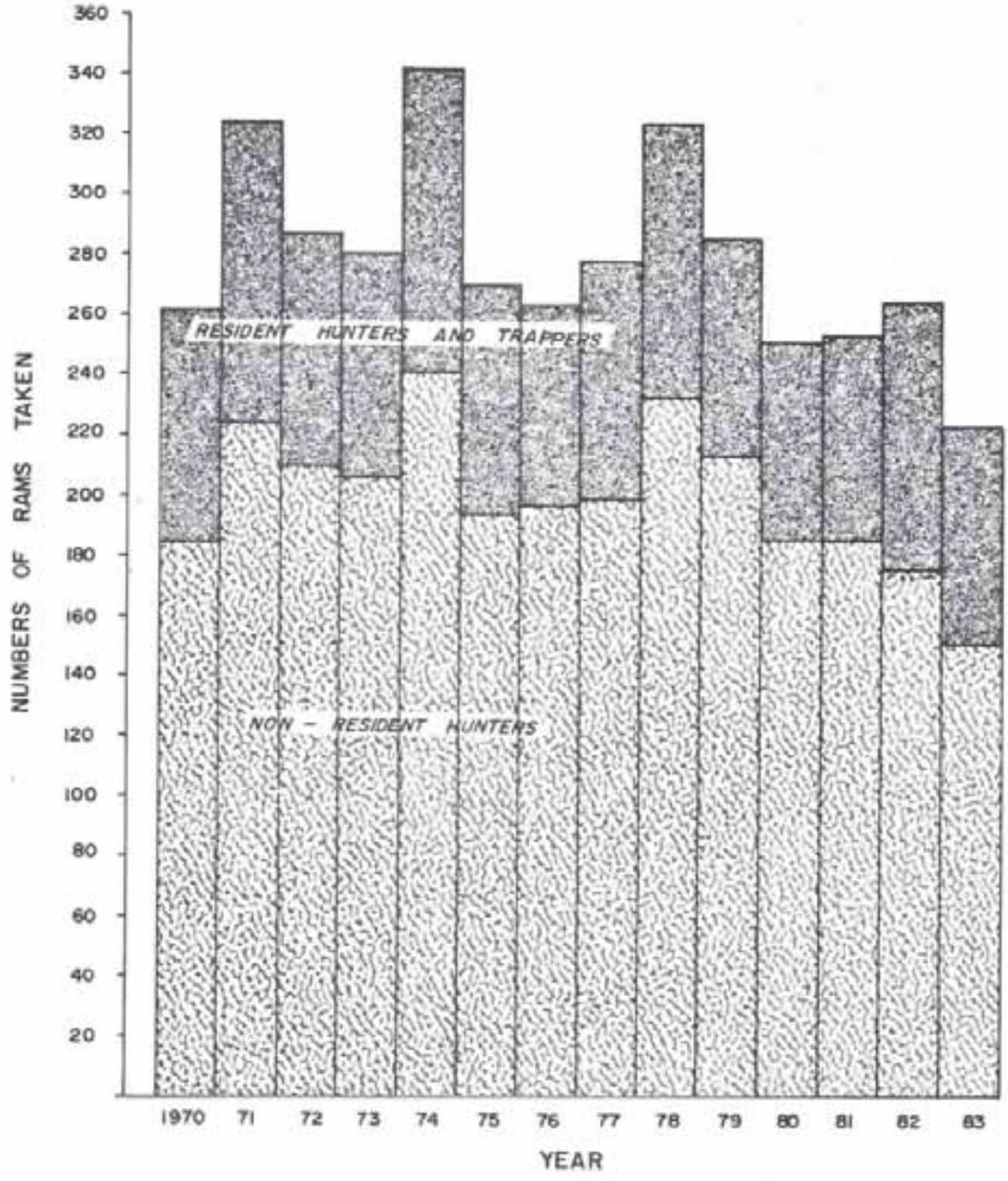
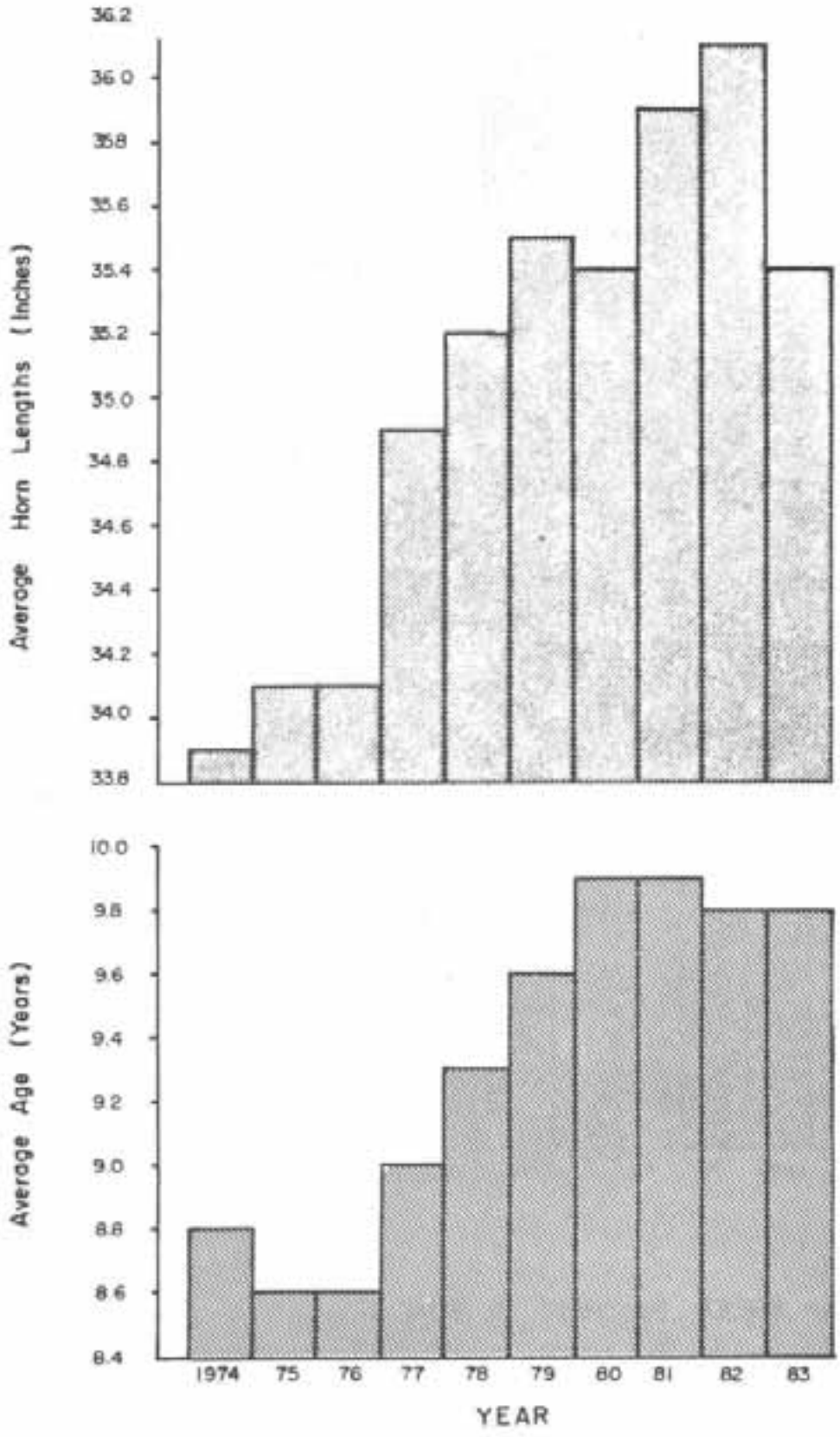


Fig. 3 - SHEEP HARVEST IN YUKON

Fig. 4 - TROPHY QUALITY OF RAMS TAKEN IN YUKON DURING PAST DECADE BY NON-RESIDENT HUNTERS.



The apparent stability in the Yukon sheep harvest is also obvious from the estimated hunter success (Table 5). For the purpose of this assessment, we have computed hunter success by dividing the numbers of rams taken by the number of hunters that have purchased sheep hunting tags, and thereby revealed their intentions to hunt. While this method may not be adequate to quantify success in absolute terms, it may be sufficient for comparative purposes and to establish trends. An inspection of Table 5 will reveal that both non-resident and resident hunters success have remained relatively stable. At this time, we therefore conclude that hunting at the present level is sustainable; no evidence of population declines because of hunting is apparent.

Table 5. Estimated success of sheep hunters.

Year	Tags Purchased by Residents	Harvest by Residents	% success Residents	Tags Purchased By Non-Res.	Harvest by Non-Res.	% Success Non-Res.	Total Harvest
1982	772	88	11.4%	306	177	57.8%	265
1981	853	68	8.0%	283	186	65.8%	254
1980	705	66	9.4%	348	186	53.5%	252
1979	801	73	9.1%	370	213	57.6%	286
1978	891	91	10.2%	393	233	59.3%	324
1977	927	76	8.2%	339	199	58.7%	275
1976	816	50	6.1%	275	197	71.6%	247
1975	743	53	7.1%	N/A	192	N/A	245

We do have concerns, though, with potential impacts other than hunting. While the Yukon Government has jurisdiction over wildlife management, responsibility over land and land-use matters are retained by the Federal Government in Ottawa. This bipartite jurisdictional arrangement poses considerable problems in respect to habitat conservation as well as habitat enhancement work. It also limits the possibilities of mitigating disturbance of sheep through various land-use activities by regulations or conditions on land-use permits. Mining, both hard rock and placer, and mineral exploration have always been very important in Yukon. Judging by the number of claims staked during the past decade, we are presently experiencing a second gold rush. Exploration in the "Hinterland" usually requires helicopter support; promising mineral sites as well as new placer claims are usually made accessible by new roads and trails.

Potential negative impact on sheep is possible through these activities. Improper routing of roads and trails may destroy critical areas such as winter ranges, migration corridors, lambing areas or sites of mineral licks. Trails

ascending mountain ranges provide easy access to hunters and tourists, and may lead to abandonment of such areas if disturbance becomes intolerable to sheep. Low-flying helicopters may cause considerable disturbance.

There appears to be general agreement that sheep are more sensitive to disturbance than other large mammals (Anonymous 1976; Anonymous 1977; Lenarz 1974; Price 1972; Reynolds 1974). Aircraft disturbance of wildlife is generally recognized as a major concern accompanying development activities in remote areas (Anonymous 1976; Geist 1971, Klein 1973; Lenarz 1974). This problem is particularly severe with social animals such as sheep and caribou. Helicopters frighten animals more than fixed-wing aircraft (Klein 1973).

The various negative effects of disturbance have been described in detail by Geist (1971) and only a brief resume is necessary here. The direct consequence of disturbance is usually flight by the animal, with a resultant excessive expenditure of energy, possible injury or even accidental death, fragmentation of social structure (including separation of mother and offspring), withdrawal from critical habitats, and decreased reproductive performance. Disturbance on winter range, when ungulates experience a negative energy balance, is particularly harmful. Because the nutritional status of pregnant ewes influences resorption and abortion rates and the conditions of lambs at birth and their survival, harassment and displacement from winter ranges can severely depress birth rates and increase mortality. Displacement from traditional lambing grounds to unfamiliar terrain will influence early mortality of lambs (Calef and Lortie 1973; Anonymous 1976; Geist 1971, 1975; Anonymous 1977; Klein 1973; Lenarz 1974; Price 1972; Reynolds 1974).

It is these problem areas that must be more thoroughly addressed in Yukon, if wild sheep are to continue to inhabit their pristine ranges in present numbers.

LITERATURE CITED

Anonymous. 1976. Application to the N.E.B. and to D.I.A.N.D. Vol.5B-1 Environmental statement. Foothills Pipelines (Yukon) Ltd., Calgary.

Anonymous, 1977. Initial environmental evaluation of the proposed Alaska Highway Gas Pipeline, Yukon Territory. Alaska Highway Panel. Interdisciplinary Systems Ltd., Winnipeg.

Auer, H.A. 1917. Campfires in the Yukon. Stewart & Kidd Company, Cincinnati. 204pp.

Bond, U.J. 1948. From out of the Yukon. Binfords & Mort Publishers, Portland, Oregon. 220pp.

Calef, G. W., and G. M. Lortie, 1973. Toward an environmental impact assessment of the portion of the MacKenzie Gas Pipeline from Alaska to Alberta. Appendix 1. Wildlife Interim Report No. 3. Prepared by Canadian Arctic Gas Studies Ltd. Environmental Protection Board, Winnipeg.

Geist, V. 1966. Validity of horn segment counts in aging bighorn sheep. J. Wildl. Manage. 30:634-635.

Geist, V. 1971. Is big game harassment harmful? Oilweek, June 14,1971.

Hemming, J.E. 1969. Cemental deposition, tooth succession, and horn development as criteria of age in Dall sheep. J. Wildl. Manage. 33:552- 558.

Hoefs, M. 1973. Ecological investigation in Kluane National Park, Yukon Territory. Can. Wildl. Serv. unpubl. Rep. 60pp.

Hoefs, M. 1974a. Game surveys in southcental Yukon and an evaluation of of the present degree of exploitation. Yukon Wildl. Manage. Br., unpubl. Rep. 30pp.

Hoefs, M. 1974b. Game Branch Activity on Yukon's North Coast. Yukon Wildl. Manage. Br., unpubl. Rep. 25pp.

Hoefs, M. 1975a. Sheep surveys and an evaluation of present harvests in southwestern Yukon. Yukon Wildl. Manage. Br., unpubl. Rep. 38 pp.

Hoefs, M. 1975b. Estimation of numbers and description of present distribution of wild sheep in the Yukon Territory. In "The Wild Sheep in Modern North America". Boone and Crocket Club Publication, 302pp.

Hoefs, M. 1978a. Dall sheep in the Richardson Mountains - Distribution abundance and management concerns. Yukon Wildl. Br. Rep. #78-2, 44pp.

Hoefs, M. 1978b. Sheep surveys in the MacArthur Game Sanctuary. Yukon Wildl. Manage. Br., Unpubl. Rep. 2pp.

Hoefs, M. 1979. Dall sheep distribution, abundance and "critical" areas along the proposed Dempster lateral pipeline route. Foothills Pipe Lines Ltd., Calgary, Alberta. 42pp.

Hoefs, M. 1982. Annual sheep surveys in the Ruby Range (Outfitting Areas #11 & 12). Yukon Wildl. Manage. Br., unpubl. Rep. 5pp.

Hoefs, M. 1983. Annual sheep surveys of the Miners Range (G.M.Z. 5-50). Yukon Wildl. Manage. Br., unpubl. Rep. 3pp.

Hoefs, M. & Mc.T. Cowan, 1979. Ecological investigation of a population of Dall sheep. Syesis 12 (supplement 1):1-81.

Hoefs, M. & G. Lortie, 1976. Big Game inventories in G.M.Z. 11, Yukon Territory. Yukon Wildl. Manage. Br., unpubl. Rep. 86pp.

Hoefs, M. & T. Nette, 1980. Distribution, abundance and harvest of Dall sheep in outfitting district #1 (Ogilvie Mountains - West). Yukon Wildl. Manage. Br., unpubl. Rept. 45pp.

Hoefs, M. & T. Nette, 1982. Horn growth and horn wear in Dall rams and their relevance to management. Bienn. Symp. North. Wild Sheep/Goat Council. 3:143-156.

Hoefs, M. & M. Bayer, 1983. Demographic characteristics of an unhunted Dall sheep (Ovis dalli dalli) population in southwest Yukon. Can. J. Zool. 61:1346-1357.

Klein, D. R. 1973. Reaction of wildlife to aircraft disturbance, Alaska Coop. Wildl. Res. Unit Q. July/September issue.

Larsen, D. G. 1978. Wildlife Inventories in G.M.Z. 2, Yukon Territory with an evaluation of Dall's sheep populations and harvests. Yukon Wildl. Manage. Br., unpubl. Rep. 25pp.

Lenarz, M. 1974. The reaction of Dall sheep to a FH-1100 helicopter. Arctic Gas Biol. Rep. Ser. Vol. 23.

Lortie, G., M. Hoefs, T. Wagner, W. Klassen and L. Mychasiw, 1978. Wildlife inventories in G.M.Z. 8 and G.M.Z. 10, Yukon Territory; with an evaluation of the present levels of sheep harvest (1976 & 1977). Yukon Wildl. Manage. Br., unpubl. Rep. 27pp.

Martindale, T. 1913. Hunting in the upper Yukon. Jacobs & Company, Philadelphia, 320pp.

McGuire, J. A. 1921. In the Alaska-Yukon Game Lands. Stewart & Kidd Company, Cincinnati. 215pp.

Merchant, P., M. Hoefs, T. Nette, W. Kale and M. Janssen, 1982. A simple measuring device for sheep horns. Bienn. Symp. North Wild Sheep and Goat Counc. 3:157-162.

Nette, T. 1980. Annual sheep survey in Permit Areas (G.M.Z. 7). Yukon Wildl. Manage. Br., unpubl. Rep. 6pp.

Nette, T. & P. Merchant, 1981. Distribution, abundance and harvest of mountain sheep in outfitting district #8. Yukon Wildl. Manage. Br., Unpubl. Rep. 17pp.

Price, R. 1972. Effect of human disturbance of Dall sheep. Final report. Alaska Coop. Wildl. Res. Unit, 23(3):23-28.

Reynolds, D. C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks in the Brooks Range, Alaska. Arctic Gas Biol. Rep. Ser. Vol. 23.

Russell, S. & M. Hoefs, 1979. Mount Cronin Dall sheep study. Yukon Wildl. Manage. Br., Unpubl. Rep. 95pp.

Shackleton, D. 1973. Population quality and Bighorn sheep (Ovis canadensis canadensis Shaw). Univ. Calgary, unpubl. Ph.D. thesis.

Sheldon, C. 1911. The wilderness of the upper Yukon. Charles Scribner's Sons, N.Y. 364pp.

Young, C.O. 1947. Alaska-Yukon Trophies won and lost. Standard Publication Inc., Huntington, West Virginia. 273pp.

Youngman, 1975. Mammals of the Yukon Territory. National Museum of Natural Sciences, Publ. in Zoology, No. 10: 192pp.

STATUS OF DALL'S SHEEP IN THE NORTHWEST TERRITORIES, CANADA

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Ron. P. Graf. Department of Renewable Resources, Government of the Northwest Territories, Yellowknife, N.W.T. X1A 2L9. Canada.

ABSTRACT

Dall's sheep (Ovis dalli) are found throughout the mountain ranges of the western border of the Northwest Territories (NWT). Comprehensive surveys have not been carried out over their entire range but our estimate for the NWT is 7,000 sheep. Most harvesting is done through outfitters by non-resident hunters. The annual kill seldom exceeds 200 animals. Present management is fairly passive when compared to other species. However, public concern for management of this species is beginning to increase as non-renewable resource developments begin to encroach on the Dall's sheep habitat and provide better road access into the heart of the range.

Populations of Dall's sheep in the Northwest Territories (NWT) are found in mountainous terrain in the Richardson and Mackenzie Mountains west of the MacKenzie River (Figure 1). Dall's sheep in the NWT are of the dalli subspecies. All are pure white in colour, although on very rare occasions grey sheep are observed in the extreme southwest corner of the Territories (Scotter 1980).

We would like to acknowledge the assistance of the staff of the Northwest Territories Department of Renewable Resources, especially Ray Case for his help with the population estimate using the computer model and Norm MacLean for his help with drafting the figures.

Most studies on Dall's sheep in the NWT have involved surveys in localized areas, such as those undertaken by Simmons et al. (1984) in the MacKenzie Mountains, or surveys periodically carried out in the Richardson Mountains (e.g. Simmons 1973, Hoefs 1978, Latour 1983). A comprehensive survey of the MacKenzie Mountains has never been carried out. For those surveys completed, total counts were attempted from either fixing wing aircraft or helicopters.

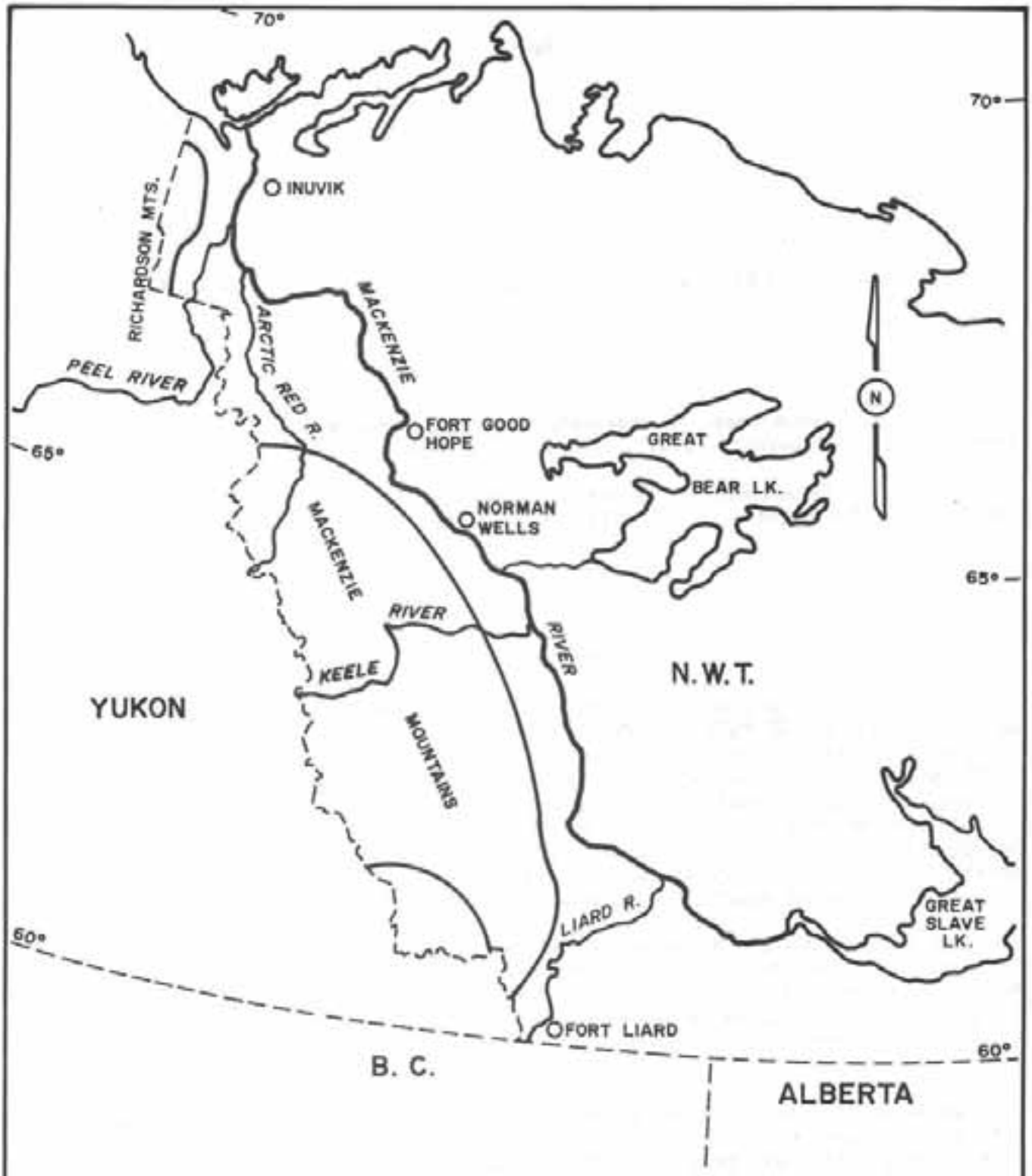

FIGURE - I

DISTRIBUTION OF DALL'S SHEEP IN THE NORTHWEST TERRITORIES.

Harvest data has been collected from non-resident hunters since the late 1960's. Non-residents are Canadians or aliens (non-Canadians) who have not resided in the Territories for at least two years. A resident is a Canadian citizen or landed immigrant who has resident in the NWT for two years or more. Non-resident hunters, restricted to hunting within eight outfitting areas in the MacKenzie Mountains, are required to employ an outfitter and be accompanied by licensed guides while hunting.

Since the early 1970's the lower jaw of sheep shot by non-residents has been collected, and the teeth subsequently aged by counting annuli through sections of the teeth. Although prone to some degree of error, this process will give a reasonably accurate estimate of the average age of sheep harvested.

Harvest data from resident hunters is collected through a harvest questionnaire which covers all large game species, and is mailed out at the end of each hunting season.

RESULTS AND DISCUSSION

POPULATION STATUS

Accurate estimates of the number of sheep in the Mackenzie Mountains are not available. Simmons et al (1984) reported population densities on winter range of 1 sheep/km^2 from three study sites. However, extrapolation from this figure to the entire mountain range is prone to large habitat-related errors. Stelfox (in Nichols 1978) estimates 3,000-8,000 sheep to inhabit the Mackenzies. While potentially accurate, the derivation and validity of this estimate is in question.

Another approach to estimating the number of sheep in the Mackenzies is to use the annual harvest in combination with life tables developed from other long-term sheep studies. Although unknown differences in the survival rates of the populations being compared will affect the results, the method may give a rough idea of population size. We believe that an annual harvest of approximately 150 rams of a mean age of 7-8 years is sustainable (see Current Management). Utilizing age structure data from Kluane National Park (Hoefs and Cowan 1979), and the age-structure of our harvested rams in a simple computer model, we estimated a population size of 6,000 sheep in the Mackenzie Mountains would sustain the harvest of 150 rams per year. We then added the unhunted Nahanni National Park population of about 500 sheep (estimated from partial surveys by Park staff, B. Kozachenko pers. comm., Park Warden, Nahanni National Park, Fort Simpson) to arrive at a minimum estimate of 6,500 sheep in the Mackenzie Mountains.

The sheep populations in the Richardson Mountains represent the northern limit of sheep distribution in the N.W.T. Although there were suggestions of a decline during the early 1980's, two surveys in June and July of 1984 both found in excess of 500 sheep (R. Graf, pers. data, K. Jingfors, pers. comm. Regional Biologist, N.W.T. Renewable Resources, Inuvik), slightly more than had been found in the 1970's (Hoefs 1978). We have concluded that the reported decline was the result of the survey techniques used, and not an actual decline, and that the population has probably remained fairly stable. Thus we arrive at an estimated total of 7,000 Dall's sheep for the N.W.T.

HUNTING PRESSURE

Sport hunters, mostly non-residents, take the majority of Dall's sheep harvested in the N.W.T. The total reported non-resident hunter kill of Dall's sheep increased gradually between 1965 and 1974 then more sharply between 1974 and 1980 (Figure 2). This increase was a result of the initial development of the Mackenzie Mountain outfitting business. Figures on resident harvest are less precise, being based on estimates derived from questionnaire returns. In recent years roughly 20-30 sheep appear to be taken annually by residents.

The total number of sheep harvested is generally regulated by the number of hunters that the eight non-resident outfitters in the Mackenzie Mountains can accommodate each year, not by prescribed quota. Between 200 and 300 non-residents hunt in the Mackenzie Mountains annually. Dalls' sheep and woodland (mountain) caribou (Rangifer tarandus caribou) are the major draw items. The lower than average harvest of sheep over the past two seasons was due to lower numbers of hunters; apparently the general world recession has affected the sheep hunting fraternity with fewer people willing or able to afford the $5,000-$8,000 price tag for hunts in the Mackenzie Mountains.

By virtue of the federal NWT Act natives are able to hunt Dall's sheep of any sex and age, at any time and in unrestricted numbers. The native harvest rate is unknown, but believed to be quite low. Residents of Aklavik and the Mackenzie Delta have, in the past, hunted sheep in the Richardson Mountains, but the harvest has dropped substantially in recent years with seven to ten sheep being taken each year (Latour 1983).

PRESENT REGULATIONS

Resident sport hunters are permitted to hunt Dall's sheep in the entire Mackenzie Mountain range west of the Mackenzie and Liard Rivers, an area encompassing roughly 140,000 km^2. Non-residents are excluded from hunting some of the front ranges along the Mackenzie Valley. As mentioned, sport hunting is not allowed in Nahanni National Park, located in the southern portion of the range.

The sport hunting season presently runs from 15 July to 31 October, although due to adverse weather conditions in late fall, most outfitters and hunters are finished by early October. Residents and non-residents are only allowed to hunt rams that have 3/4 curl horns or better. The majority of rams harvested in the mountains have had full curl horns or better.

Residents are required to purchase a $5.00 license/tag prior to hunting. Non-residents and non-resident aliens are required to purchase a license/tag totalling $10.00 and $25.00, respectively. All non-residents are required to pay a $100.00 trophy fee, if successful. Effective 1 July, 1983 all Dall's sheep horns must be marked with a numbered plug, whether the animal was hunted or the horns picked up. This regulation also applies to horns obtained prior to 1 July, 1983.

CURRENT MANAGEMENT

The major management technique used to monitor sheep populations in the NWT is the collection of harvest data. As mentioned, resident kill information

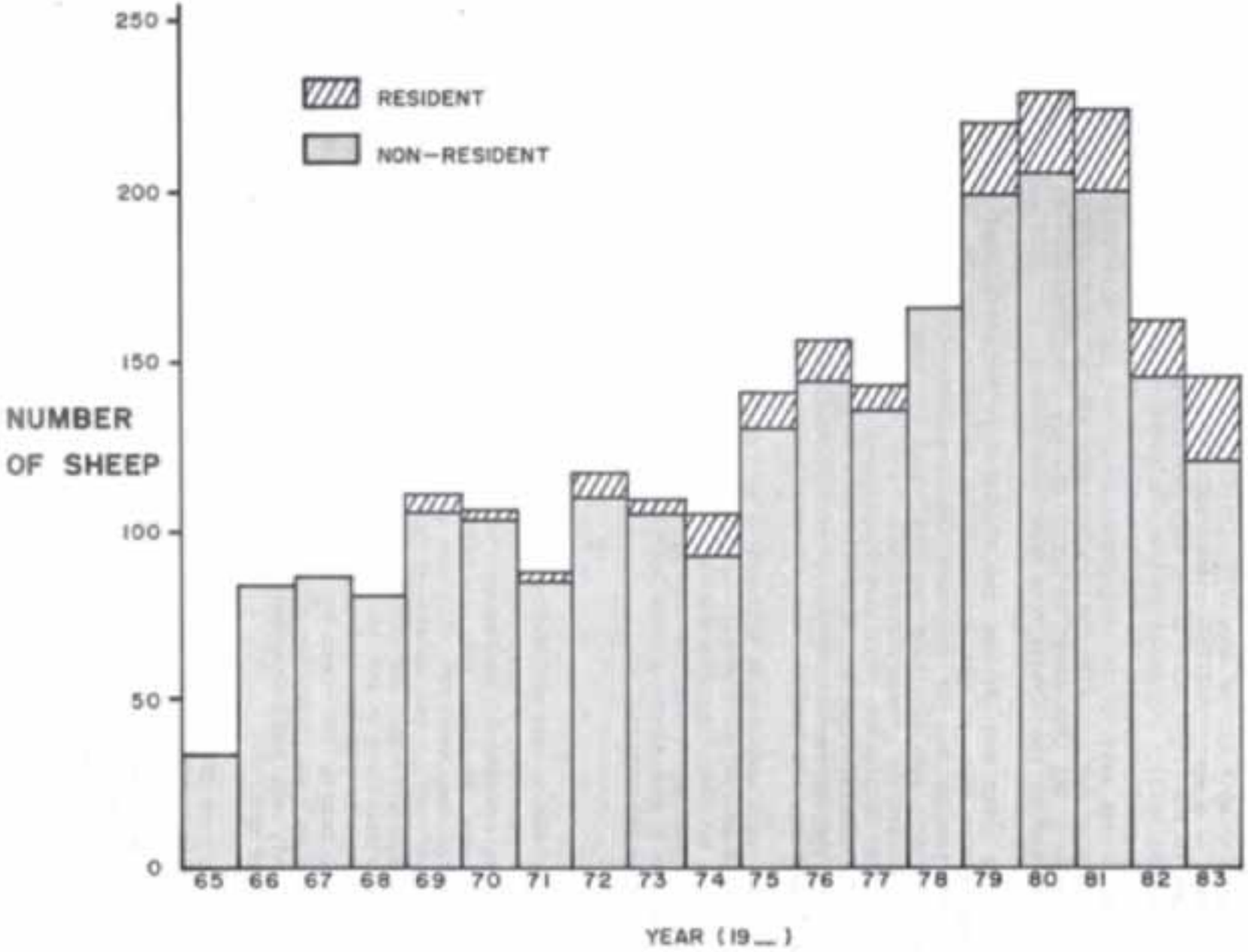

FIGURE 2. DALL'S SHEEP HARVESTED BY SPORT HUNTERS, 1965-1983.

is obtained from annual hunter questionnaires. Non-residents are also required to submit the lower mandible from their rams for age determination.

One possible indicator of excessive hunting pressure on a sheep population is a drastic drop in the age and/or horn size (curl) of harvested rams. A population with most of the legal (>3/4 curl) rams being harvested should show a decreasing mean age of harvested sheep and a lower proportion of full curl or better rams in the kill. Such trends have not become apparent in the Mackenzie Mountains (Figure 3), leading us to the conclusion that the current population is not being overharvested. It can be expected, however, that as the number of residents increases in the communities along the Mackenzie Valley, hunting pressure on the sheep in the front ranges adjacent to these communities will also increase. The Department is aware of this potential problem and will continue to monitor the harvest from these regions.

Loss of sheep habitat and disturbance from industrial exploration and development have not yet had an appreciable effect in the NWT. Some mining operations located in the mountains are presently in the exploration or production stage, but their combined impact on sheep populations is believed to be low. However, the proposed upgrading of the Canol Road from Norman Wells to MacMillan Pass on the NWT-Yukon Border will greatly facilitate access into the heart of the mountain system. This will provide new opportunities for mineral exploration and development, encourage recreational activities such as hunting and back-packing, and increase the opportunity for native harvesting.

Winter roads are already encroaching on the southern Mackenzie Mountains. In the winter of 1983/84 a winter road was pushed into an exploratory well site at the base of Tlogotsho Plateau, an area of prime winter range. Another winter road was built into the mountains west of Fort Simpson. While winter roads will not directly result in an increased sport harvest, they do allow easier access for natives.

THE FUTURE

As has become evident during the 1984 Wild Sheep/Goat Conference at Whitehorse, there is a disparity between the priority assigned to sheep management in the NWT as compared to the Yukon and other regions. The two main reasons for the relatively low priority rating given to sheep in the NWT are firstly, when compared with species such as barren-ground caribou (R. t groenlandicus), moose (Alces alces), and muskoxen (Ovibos moschatus), sheep provide a very small portion of the total meat supply for the majority of the human population in the territories. Secondly, because seven of the eight outfitters live in southern provinces, direct economic returns for residents of the NWT from Dall's sheep hunting are considerably less when weighed against species such as polar bear (Ursus maritimus) and barren-ground caribou. Thus the political, and hence management, efforts are directed towards the higher priority species.

This is not to say that Dall's sheep in the NWT will be ignored or no effort made to manage the species. However, in the near future most management will be mainly of a passive nature; monitoring harvest numbers and the age and size of trophy rams, ensuring that the disturbance of sheep in critical habitats is minimized, and mitigating industrial impacts on local sheep populations. The Land Use Planning process, if it proceeds, is the one item

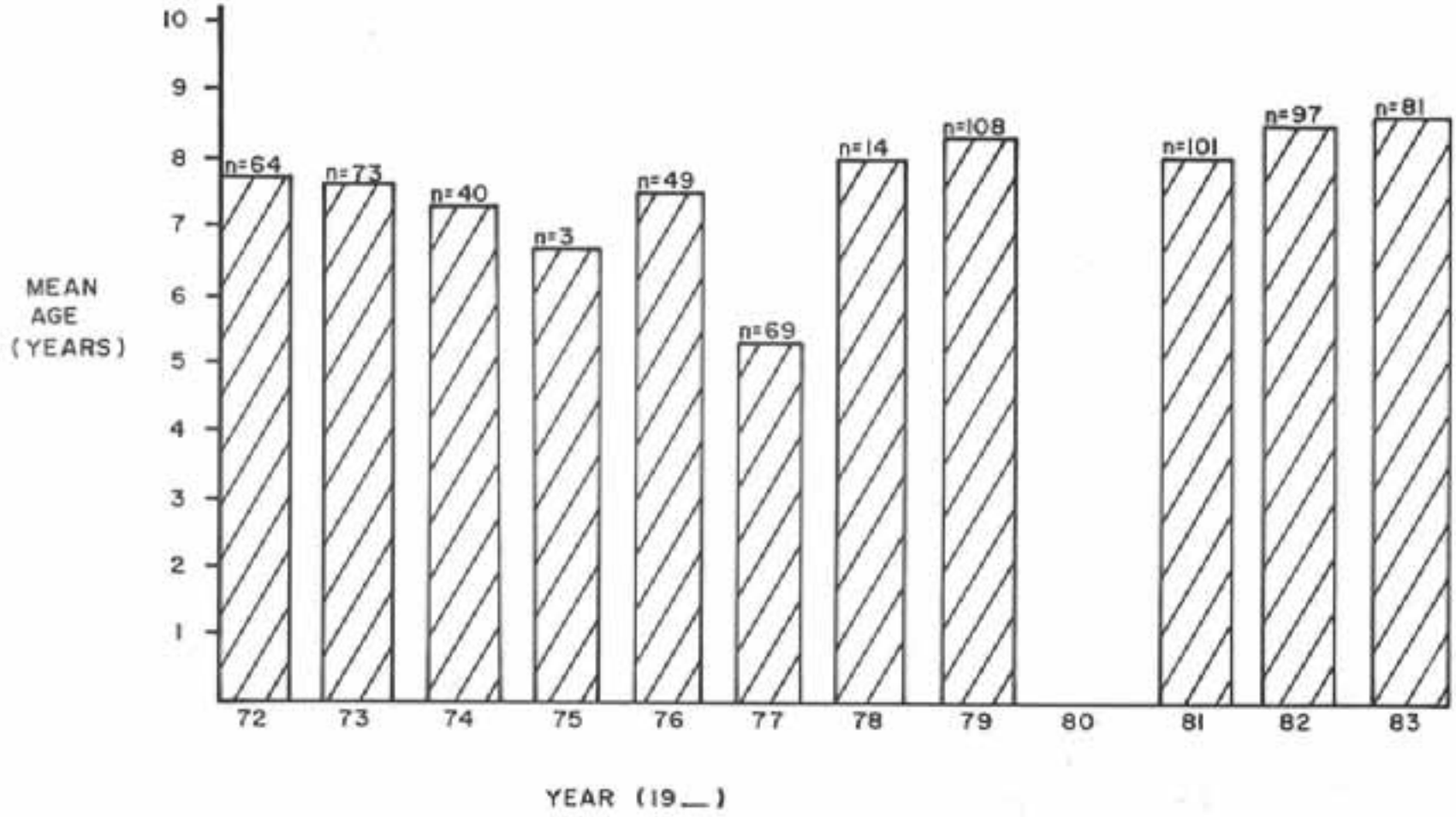

FIGURE 3

MEAN AGES OF DALL'S SHEEP HARVESTED BY NON-RESIDENT HUNTERS, 1972-1983.

which could increase the amount of attention which sheep will receive in the NWT in the near future.

LITERATURE CITED

Hoefs, M. 1978. Dall sheep in the Richardson Mountains - distribution, abundance, and management concerns. Yukon Game Branch No. 78-2. 44pp.

Hoefs, M. and I. McT. Cowan. 1979. Ecological investigations of a population of Dall sheep (Ovis dalli dalli Nelson). Syesis (Vol. 12. Suppl. 1):1-81.

Latour, P. B. 1983. Mt. Goodenough Dall's sheep survey. April 1983. NWT Wildl. Serv., Inuvik, NWT. Unpubl. rep. 14pp.

Nichols, L. 1978. Dall's sheep. Pages 173-189. In: Schmidt, J.L. and D.L. Gilbert. (eds.). Big game of North America: ecology and management. Stackpole Books. Harrisburg, Pa.

Scotter, G.W. 1980. Observation of a dark phase ram. District of Mackenzie, NWT. Can. Field-Nat. 94(4):464-465.

Simmons, N.M. 1973. Dall's sheep harvest in the Richardson Mountains, NWT. Can. Wildl. Serv., Fort Smith, NWT. Unpubl. rep. 16pp.

Simmons, N.M., M.B. Bayer and L.O. Sinkey. 1984. Demography of Dall's sheep in the Mackenzie Mountains, Northwest Territories. J. Wildl. Manage. 48(1):156-162.

THE STATUS OF THINHORN SHEEP (*Ovis dalli*) IN BRITISH COLUMBIA

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ABSTRACT

Both subspecies of Thinhorn sheep *Ovis dalli dalli* and *Ovis dalli stonei* occur in the Province of British Columbia. The white Dall's sheep (*O.d.d.*) is restricted in distribution to the northwestern corner of the province, where about 200 are found, with much larger populations in adjacent Yukon Territory. On the other hand, B. C. has a large Stone's sheep (*O.d.s.*) population, estimated at 10-11 thousand. These are found on suitable mountain ranges north of 56° latitude and west of 122° longitude. Figure 1 shows the distribution of Thinhorn sheep in British Columbia as well as giving an indication of population density. Within their total range, the densest populations have been recorded in the Muskwa River and Kechika River drainages. Surveys indicate that the Province's Stone's sheep population appears to be declining with habitat deterioration and more importantly predation by wolves as causative agents. Currently the total annual harvest of thinhorn sheep in British Columbia amounts to 250 to 300 rams.

INTRODUCTION

Thinhorn sheep (*Ovis dalli*) are represented with two subspecies in British Columbia. The generic white Dall's sheep (*Ovis dalli dalli*) are found in low numbers continguous with populations in the Yukon and Alaska, while the dark Stone's sheep (*Ovis dalli stonei*) are centered on the Kechika-Muskwa ranges of northern British Columbia. Figure 1 gives the generalized range and abundance for these two subspecies in the province. The Pine River marks the southern extent of the species, with no substantial numbers being found until one looks north of the Peace River. It appears that prior to impounding the Peace, Stone's annually travelled back and forth across the river.

The populations are associated with winter ranges receiving snow removal action by chinook winds. Many of the more dense populations have access to early, late, and in some cases mid-winter subalpine grassland ranges. These

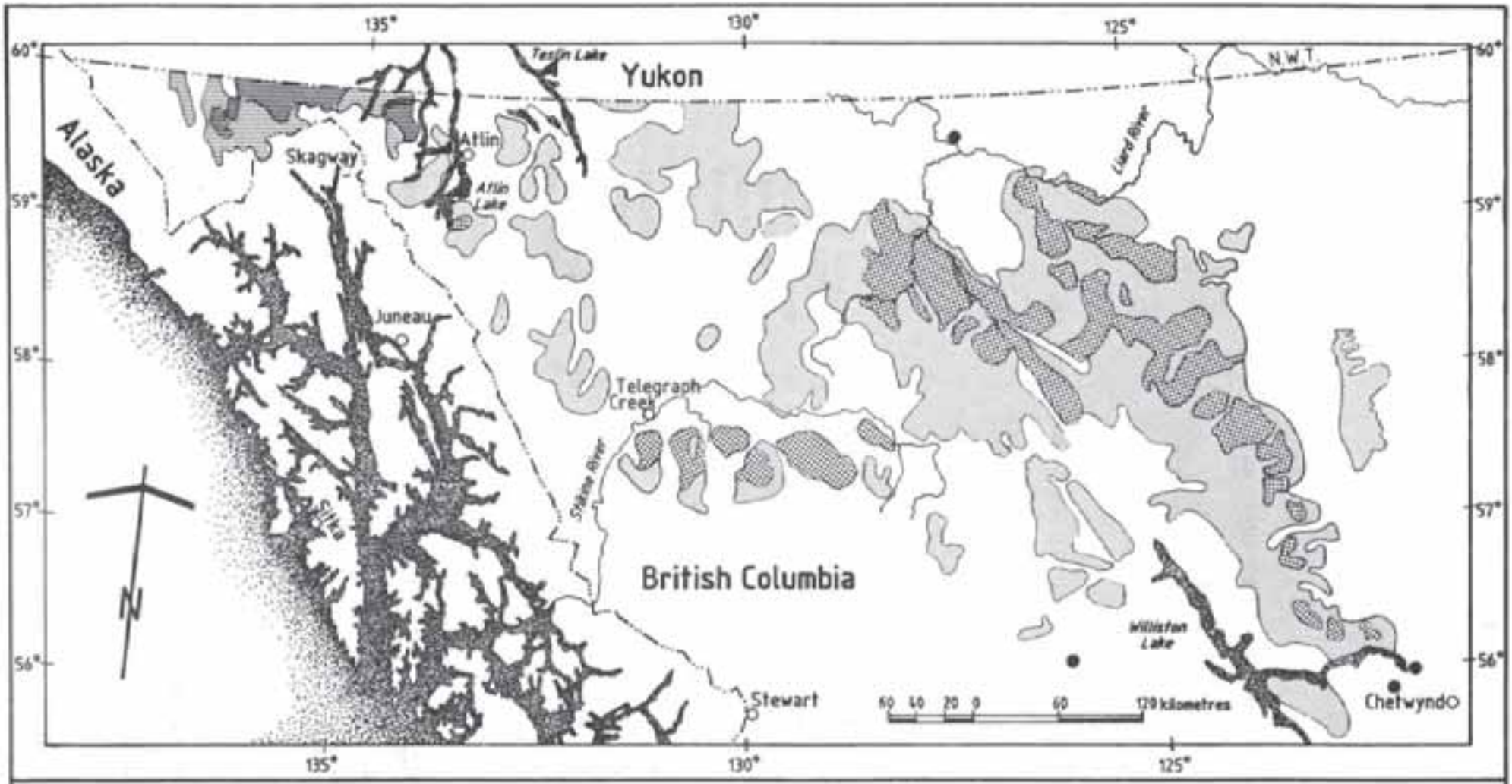

Figure 1: Distribution and Abundance of Thinhorn Sheep in British Columbia, Canada

Subspecies: *Density:*

Stone Sheep — Few/ Very Few; Moderate/ Plentiful

Dall Sheep — Few / Very Few; Moderate / Plentiful

● Rare or occasional sighting

are dis-climax sites resulting from fire. Lack of trees on these sites allows wind action and insolation to remove snow cover.

Thinhorn mountain sheep hunting is substantially the most valued hunting in the province (Reid, in prep.) both for resident and non-resident hunters. This attractiveness has made recreational hunting of these animals a major feature in the economic viability of northern B. C. guide outfitting operations. Further, as the only big game animal in the province which is not found in substantial proportion in other jurisdictions, it holds a unique importance.

METHODS

Information on the distribution, abundance, and trends in thinhorn sheep populations is based on aerial surveys supplemented with reports from local residents. The larger populations of the Liard drainage (downstream of the Dease) have received most study.

Specific surveys involve the determination of population numbers for discrete units of approximately contiguous (to the mountain sheep) winter range. Fairly intensive contour pattern searching of the units was undertaken during winter from helicopter. All likely sheep use areas in a unit were searched. Because of the wider distribution of males this procedure was felt to provide population estimates and proportions for ewes and juveniles only.

Determination of proportions observed and statistical confidence limits has proven difficult in the absence of marked animals. To gain some understanding of these parameters one forty square mile (100 square kilometer) test unit was counted five times over a ten day period utilizing the same observers and a similar (standard) search pattern. The standard deviation (plus or minus) of the counts was seven (7) percent of the mean. While this does not indicate the true population size, the open nature of the winter ranges. the normalized distribution of the estimate and, the narrow deviation suggest that on average the procedure would detect 75-85% of the sheep. For population estimates 75 percent was adopted, with numbers of adult ewes (two or more years of age) used for temporal comparisons.

A number of wintering areas have been searched with the standard technique at different points in time allowing calculation of rates of population growth. Rates for populations undergoing different treatments - unaltered, enhanced range and, reduced predators - have also been examined.

RESULTS AND DISCUSSION

Approximately 200 white Dall's sheep reside year round in the far northwest of the province with a summer influx of a further 200 to 300 from winter ranges outside the province.

Van Drimmelen (pers. comm.) reports that Stone's sheep west of the Dease and in the mountains drained to the Pacific appear to be remaining stable. Approximately 4000 mountain sheep are found in that area with the highest concentration areas being south of the 58th parallel.

The historically larger populations in the eastern half of the province have not faired so well. Utilizing population growth rates from the different units and weighting them based upon the number of ewes and years involved (total sample size of 3,319 ewe years), it was determined that the average population growth was minus 10.0 percent per year for the period 1977 to 1984. This yields a 52 percent population decline during that period.

Estimating that the units in the east searched within the last couple of years incorporate one-third of the Stone's in the east of the province, there are about 3,000 adult ewes remaining. This translates to approximately 6,000 to 7000 total thinhorn mountain sheep in the east, giving a provincial total of about 10,000 to 11,000. This is a substantial reduction from an estimated 17,000 to 18,000 in the late seventies.

Declines in the east appear to be accelerating with late winter counts now yielding about 20 short yearlings per 100 adult ewes and 5 long yearlings for 100 adult ewes.

Range enhancement by burning of accessible low elevation woodland has been found on average to slow population decline by 50 percent. Range burning has been widely applied for Stone's sheep, as it is also found to improve trophy quality (Elliott, 1978). Management of wolf numbers has been found more effective, however. Juvenile mountain sheep survival rates are highly negatively correlated with winter wolf densities and generally increasing wolf densities for several years appear to explain the accelerating sheep declines (Elliott, 1984 a and b).

The hunter harvest for 1983 in British Columbia was 266 Stone's sheep and 10 Dall's sheep. At present the entire Dall's sheep harvest by resident hunters is through a limited entry system as is approximately 2 percent of that of Stone's sheep. Excepting in parks, it is anticipated that there will be a move away from limited entry harvest. Harvest by non-residents is restricted through quotas.

At present 38 percent of the harvest of thinhorn sheep is by resident hunters. Only rams eight years or older, or rams with horn tips extending above the bridge of the nose are legal during open seasons. Some smaller populations are totally protected from hunting (excepting total open hunting by treaty Indians), however these populations seem especially prone to heavy mortality to wolves. Some portions of the range of larger populations are also closed to hunting. Compulsory reporting and horn inspection of hunter kills has been required since 1975.

Presently resident hunters must obtain a hunting license ($17.00) and a mountain sheep license ($50.00) for mountain sheep hunting. Non-residents must obtain a hunting license ($43.00), a mountain sheep license ($300.00) and use the services of a guide. There are now 33 registered outfitters operating within the range of thinhorn sheep in British Columbia.

LITERATURE CITED

Elliott, J. P. 1978. Range enhancement and trophy production in Stone's sheep. Pages 113-118 in Proc. 1978 Northern Wild Sheep and Goat Conference. Pentiction, B. C.

_____. 1984 a. Kechika wolf management project of northeastern British Columbia, 1983-84 annual report. B. C. Fish and Wildlife Branch, Victoria.

_____. 1984 b. Muskwa wolf management project of northeastern British Columbia, 1983-84 annual report. B. C. Fish and Wildlife Branch, Victoria.

Reid, R. in prep. The value and characteristics of resident hunting. B. C. Ministry of Environment. Victoria.

BIGHORN SHEEP POPULATION STATUS IN ALBERTA AND BRITISH COLUMBIA

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ABSTRACT

Based on surveys carried out in 1981/82, it is estimated that about 6,000 bighorn sheep inhabitat provincial lands in Alberta, another 4,000 are known to exist in National Parks. Currently about 200 to 250 rams and 250 to 300 ewes are harvested annually. Population estimates for B.C. are based on questionnaires sent to regional biologists. It is assumed that the current population size is between 4,000 and 4,500 sheep of which about 62% are California and 38% are Rocky Mountain bighorns. The present harvest consists of 60 to 65 rams and 40 to 45 rams of these two subspecies, respectively. Certain populations in both B.C. as well as Alberta, have experienced die-offs in recent years.

INTRODUCTION

The relative status of bighorn sheep populations in Canada and the U.S.A. has been examined periodically in the Northern Wild Sheep and Goat Council Proceedings since about 1970. Population estimates have varied from guesses to stratified surveys with replicates.

The variability of past status reports is still evident in the assessment of bighorn population status in 1984. Quantitative status assessments are not available for most populations in British Columbia, negating quantitative trend assessment.

RESULTS AND DISCUSSION

ALBERTA

Alberta bighorn sheep populations were surveyed in 1981/82 on their winter ranges. It appears that populations have significantly increased since 1976 due to a series of mild winters. Currently, there are approximately 6,000 sheep on Provincial land and another 4,000 in the National Parks.
Since the last survey, a major die-off of sheep occurred in southern B.C. in 1981 and spread into southern Alberta in the fall of 1982. Sheep populations south of the Crowsnest Pass, including Waterton National Park, declined significantly. Mortality figures from 4 aerial surveys estimated the decline at 75 - 80 percent of the late 1970's level, or approximately 300 sheep. Older individuals and lambs were most severely affected.
During December 1983, the lamb:ewe ratio was 25:100. It is anticipated that the affect of the die-off will decline in 1984 and sheep populations will begin to recover. Translocation of northern sheep to the affected area may be possible and necessary.

The Ram Mountain herd of approximately 100 animals has been able to sustain an ewe harvest averaging 8 percent of the annual winter population. The sheep herd has compensated for this mortality through high survival, high lamb production and production from yearling ewes. Resident hunters harvest only 2 - 3 trophy rams each year from this area.

In 1982, the Sheep River winter range maintained about 150 sheep. There is evidence of overcrowding and over utilization of this limited range and lamb development and survival appear related to lungworm burdens of the respective dams.

In 1982, 2,862 trophy sheep licenses were sold and 238 rams were harvested (83% by residents). Approximately 792 non-trophy permits were issued in the same year and the hunter sample estimated that 270 sheep were harvested.

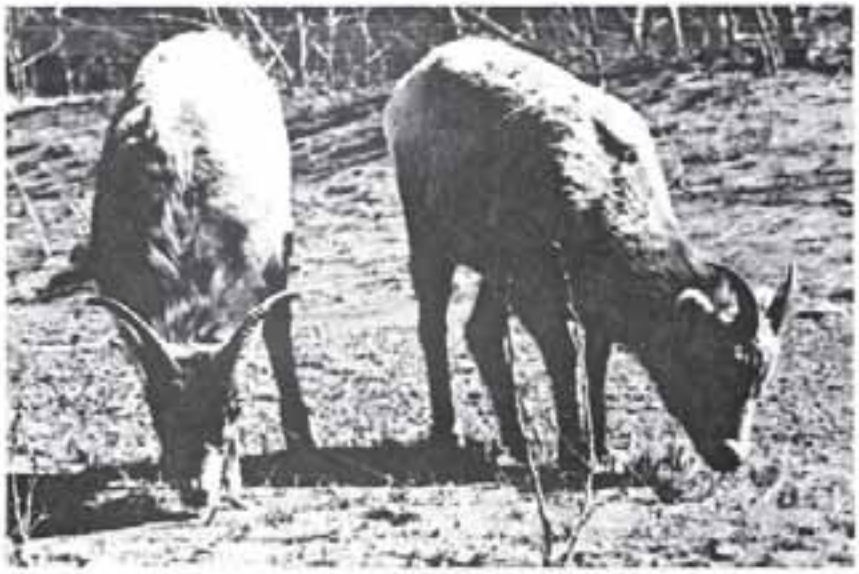
BRITISH COLUMBIA

The status of Rocky Mountain and California bighorn sheep populations was evaluated with questionnaires from Regional Wildlife Biologists (Table 1). In general, sheep populations are increasing or stable in Regions 3, 5, 7 and 8, where a major die-off (Region 4) has not occurred. Most of southern B.C. has undergone mild winters for the past 5 - 7 years. In addition to mild winters, enhancement projects have been undertaken on approximately 21 to 34 sheep ranges.

In specific instances (Junction, Vaseux, Ashnola) populations have increased substantially. This may be due to low harvest mortality, mild weather, enhancement projects or winter feeding.

In the majority of populations, estimates are not due to aerial or ground survey information and composition information may be from an unknown portion of the population. In most cases, population numbers are based on quesses or crude estimates.

Bighorn rams in Jasper National Park
Photo: M. Hoefs



Bighorn ewes in Jasper National Park
Photo: M. Hoefs

FIG. I THE DISTRIBUTION OF BIGHORNS IN BRITISH COLUMBIA AND ALBERTA.

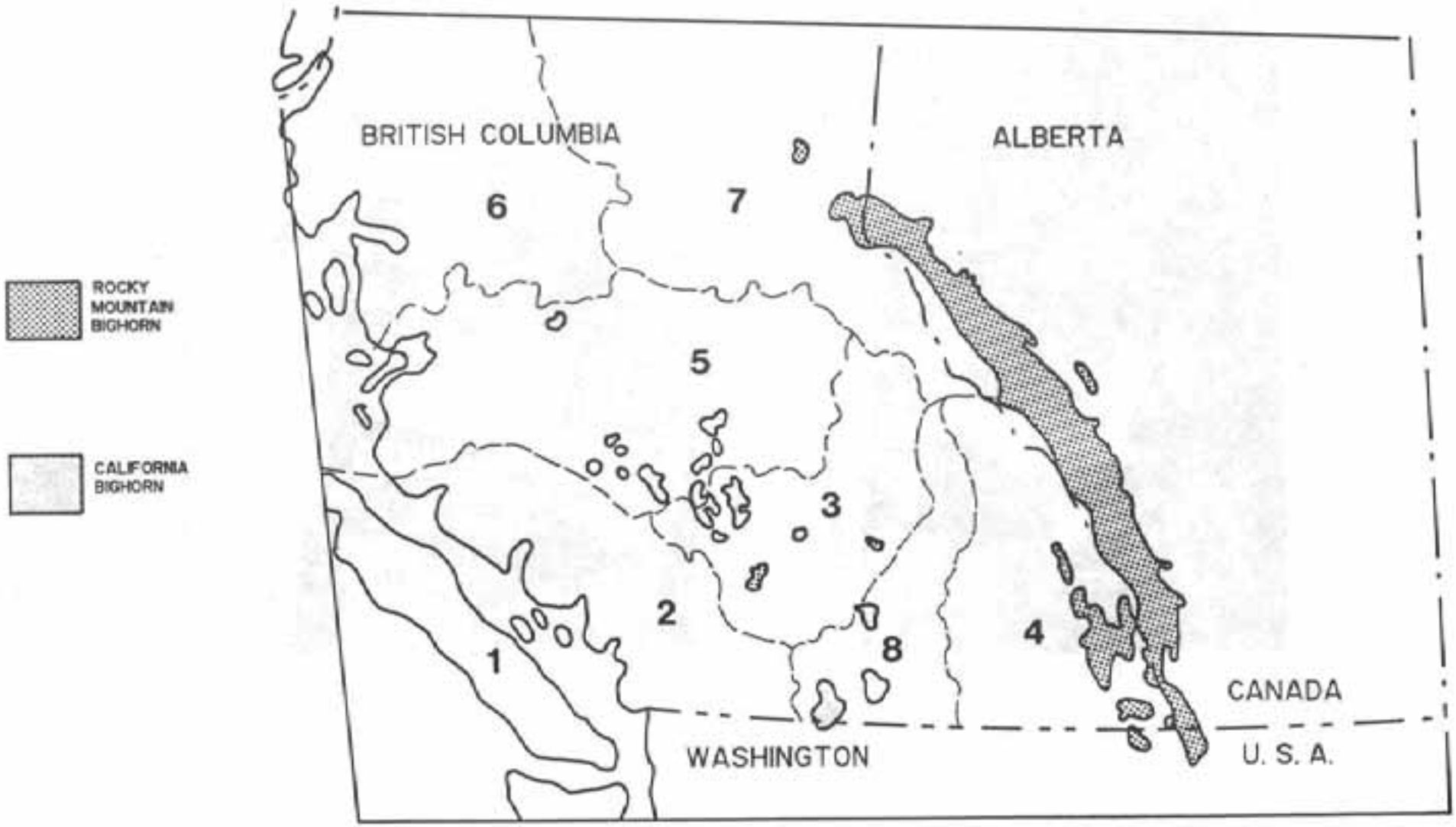


TABLE 1. STATUS OF BIGHORN SHEEP POPULATIONS IN BRITISH COLUMBIA IN 1984.

Pop. Name Reg. 3	Number Survey or Est.	Composition R: E: L	Recent Pop. Trend	Cause	Harvest M+/or F	Open, LEH, Curl Reg.	Range Status	Winter Feed	Enhance-ment	CRMP(2)
Spences Bridge	100	12:17:8	Inc.	Weather	7 M	Full curl	Mod.	No	No	
Chase	40	9:20:9	Stab.	Range	0	No open season	Poor	No	Slashing Pre.Burn	
Kamloops (1) Lk	115	16:21:11	Inc.	Range	<1 M <1 F	LEH 1 ram, 1 ewe/2 yr	Good	No	Pre.Burn	
Limestones (1)	160	32:65:24	Inc.	Weather?	13 M	3/4 curl	Mod.	No	Pre.Burn	
Shulaps (1)	65	?	?			3/4 curl	?	No	Pre.Burn	
Region 5(1)										
Junction Inc.Deer Park	500-600 est	100:14(Mar)	Stab.	Pred.? Escape Terrain	5 M 5 F (1983)	LEH, Full	Good	No	Pre.Burn	Beecher Raven
Churn Cr	350-400 est		Inc.	Weather	4 M	Open, Full	Fair	No	No	Gaspard
Nemaia	70 est		Stab.	Domestic Overgrazg	3 M	Open,3/4	Poor	No	No	
E. Taseko Lk-Tyaughton	200 est		Stab.	Poaching?	4 M	Open,3/4	Fair	No	No	None
W. Taskeko Lk	50 est		Stab.Inc.	Weather	1 M	Open,3/4	Fair-Good	No	No	None
Dog Creek	<10 est	Unknown	Stab.		Nil	Closed	Poor-Fair	No	No	None
Ilgachuz	15 est	8:6:1	Inc.	Immigrtn & recruit	Nil	Closed	Fair	No	No	None

(1) California bighorn sheep
(2) Coordinated Resource Management Plan

TABLE 1. STATUS OF BIGHORN SHEEP POPULATIONS IN BRITISH COLUMBIA IN 1984.

Pop. Name Reg. 4(1)	Number Survey or Est.	Composition R: E: L	Recent Pop. Trend	Cause	Harvest M+/or F Pre Die off	Open, LEH, Curl Reg.	Range Status	Winter Feed	Enhance-ment	CRMP
Phillips Cr	35 est		Stable	Post die-off	1/3yr	Curl reg.	Fair	No.	Sel.log Spacing	No
Maguire Red Canyon	14±7	3:7:4 ±7 est	Inc. Decrease	Die-off	1/3yr	Curl reg.	Fair	No.	Sel.log	No
Wigwam China Wall	100 est	20:74:6	Inc. Decrease	Die-off	7/yr	Curl reg.	Good	No.	Treat(2) Slash burn	No
Bull River	37 obs.	7:18:12	Stable	Die-off	3/yr	Curl. reg.	Exc.	No	Treat Pre.Burn	Yes
Wildhorse R.	14 obs.	3:6:5	Decrease	Die-off	1/yr	Curl. reg.	Poor	No	Sel.log Seed	Yes
Estella	35 est.		Decrease	Die-off	2/yr	Curl reg.	Good	No.	Pre.Burn	No
Premier	76 obs.	27:70:3	Increase		2/yr	Curl reg.	Exc.	No.	Treat Pre.Burn	Yes
Marmalade	35 obs.		Stable	Snow	1/2yr	Curl reg.	Good	No.	Pre.Burn	No.
VanNostrand	14 est.		Decrease	Die-off	1/yr	Curl reg.	Good	No.		No
Whiteswan	20 est.		Decrease	Die-off	1/yr	Curl reg.	Poor	No	Slash burn	No
Columbia Lk	152 obs.	50:83:18	Increase		3/yr	Curl reg.	Poor	No	Treat Sel.log Spacing	No
Windermere	22 obs.	5:12:5	Stable		1/yr	Curl reg.	Fair	No	Treat	No
Stoddart Cr.	130 est.		Stable		1/yr	Curl reg.	Fair	No		No

(1) Rocky mountain bighorn sheep
(2) Treatment - Antihelminthics

TABLE 1. STATUS OF BIGHORN SHEEP POPULATIONS IN BRITISH COLUMBIA IN 1984.

Pop. Name Reg. 4 (cont'd)	Number Survey or Est.	Composition R: E: L	Recent Pop. Trend	Cause	Harvest M+/or F Pre Die off	Open, LEH, Curl Reg.	Range Status	Winter Food	Enhance-ment	CRMP
Simpson R	65 est.		Stable	Snow,Pred.	2/yr	Curl reg.	Good	No	Pre.Burn	No
Sheep Mtn	75 obs.		Increase		1/yr	Curl reg.	Good	No		No
Ewin Todhunter	250 obs.	Ewin 23:101:56	Increase		5/yr	Curl reg.	Good	No		No
West Elk Valley	400 est.		Stable	Deep snow	2/yr	Curl reg.	Good	No		No
Region 7(1)										
Kalowa	94	36:39:31	Inc.slowly	Overharvest & weather	1963-0 1978-82 closed season	Curl reg.	Limited Winter	No	Pre.Burn for 1984	No
REGION 8(2)										
Ashnola	300-400		Increase	Weather/ Feeding(3)	10 M	LEH, curl	Mod	Minor	Yes	Yes
Vaseux	600-900		Rapid Inc.	Weather/ Feeding	20 M	Open,curl	Poor	Major	Yes	Yes
Shorts Cr.	50-75		Stab.		0	No Season	Unknown	No	No	No
Granby R	20(4)		Unknown		0	No Season	Unknown	No	No	Yes

The population traditionally referred to as "Vaseux" now extends from Kelowna to Osoyoos in a series of self-sustaining bands. We may rename this population the "South Okanagan Valley Pop."

(1) Rocky mountain bighoun sheep
(2) California bighorn sheep
(3) Moist summers last four years - sheep benefit
(4) This is a 1984 transplant - first lamb born April 8, 1984

A major die-off in Region 4 has affected at least 8 of 17 Rocky Mountain bighorn populations. The die-off reduced populations in the sourthern portion of the Rocky Mountain Trench while populations north of Columbia Lake and those in the Elk Valley and Simpson River do not appear to have been affected. To date, California Bighorn sheep populations in B.C. have not been affected by die-off.

Rocky Mountain and California bighorn sheep populations number approximately 4,000 - 4,500. Of this total, approximately 62% are California bighorn sheep and 38% are Rocky Mountain bighorns. Population recovery from the die-off of the East Kootenay bighorns should increase the bighorn proportion to about 45% of the total. The harvest of bighorn rams is about 40 - 45/year or 2.4% of the population. Currently, 60-65 rams and 5-7 ewes, about 2.6% of the population are harvested each year from California bighorn sheep populations throughout the Province.

BIBLIOGRAPHY

Blood, D.A. 1961. An ecological study of California bighorn sheep (Ovis canadensis californiana Douglas) in Southern British Columbia. M.Sc. Thesis, U.B.C., Vancouver. 127 pp.

Blood, D.A. 1967. Food habitat of the Ashnola bighorn sheep herd. Can. Field Nat. 81(1):23-29

Demarchi, D.A. & H.B. Mitchell 1973. The Chilcotin River bighorn population. Can. Field Nat. 87:433-454.

Demarchi, R.A. 1965. An ecological study of the Ashnola bighorn winter ranges. M.Sc. Thesis, U.B.C. Vancouver. 103 pp.

Spalding, D.J. & H.B. Mitchell 1970. Abundance and distribution of California bighorn sheep in North America. J. Wild. Mgt. 34(2): 473-475.

Sugden, L.G. 1961. The California bighorn in British Columbia with particular reference to the Churn Creek herd. British Columbia Department of Recreation and Conservation. 58 pp.

STATUS OF CALIFORNIA AND ROCKY MOUNTAIN BIGHORN SHEEP IN THE UNITED STATES

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ABSTRACT

California bighorn (Ovis canadensis californiana) and Rocky Mountain bighorn (O. c. canadensis) sheep reached all time lows in the United States during the first few decades of this century, but they have steadily increased since that time. In the last decade a few herds were lost but many more were established and sheep numbers generally have increased. Successful transplants and reintroductions account for much of the increase. There are now over 2,800 California bighorns and 19,000 Rocky Mountain bighorns in the United States. Transplants, harvest, research, habitat improvement programs, and management problems in each state are discussed.

INTRODUCTION

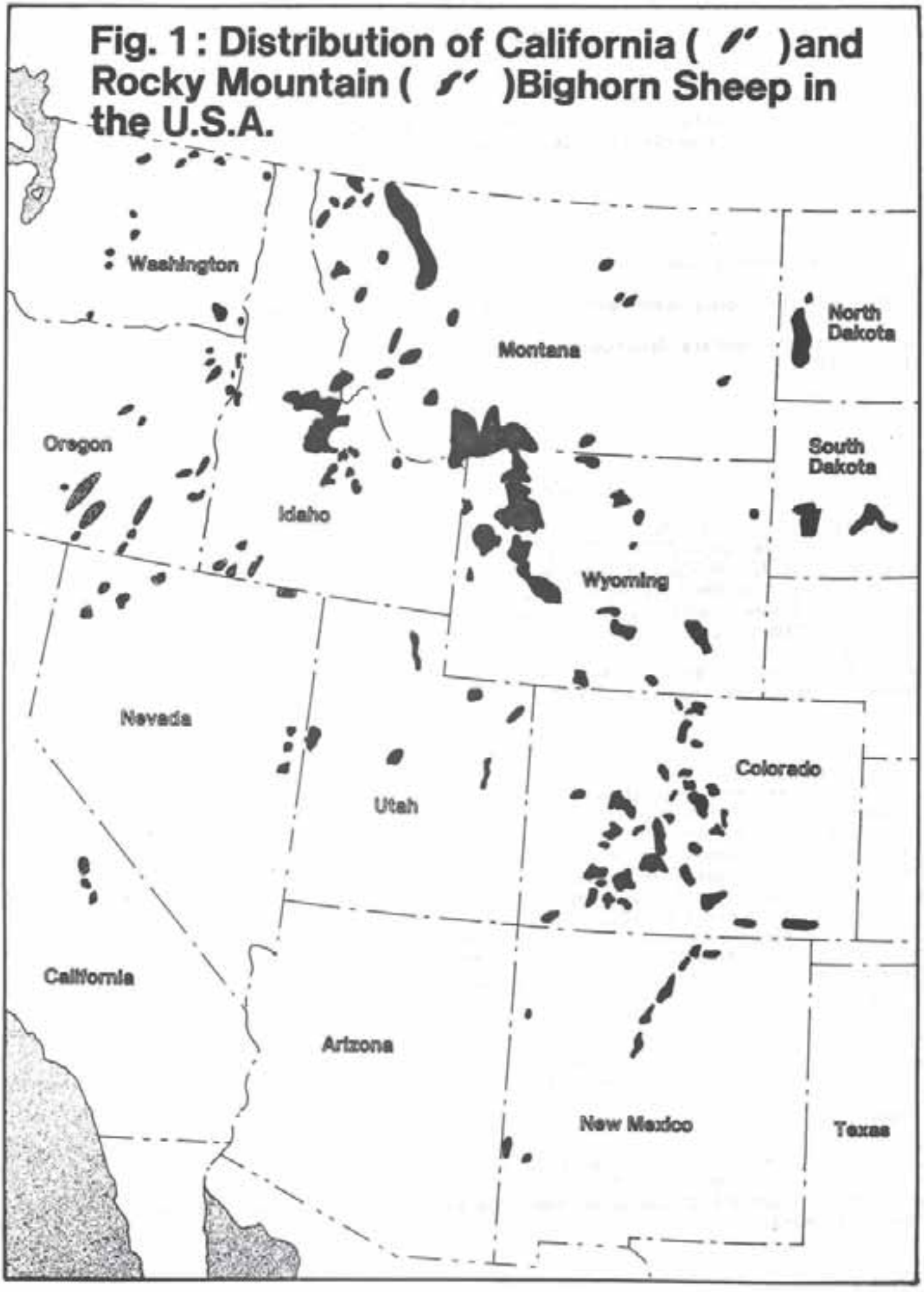
An indepth report on the status of bighorn sheep was last compiled in "The Wild Sheep in Modern North America" (Trefethen, J. B. ed. 1975 Proceedings of the Workshop on the Management Biology of North American Wild Sheep, Boone and Crockett Club, The Winchester Press, New York, 302 pp.), which summarized historic and current status of bighorn by state and province up to 1974. It is the purpose of the present report to summarize changes in status during the past 10 years and determine the status of bighorns in 1984. This report is concerned only with Rocky Mountain and California bighorn sheep south of the Canada-United States border. All remarks regarding 1974 and earlier are from Trefethen (op. cit.), and their map has been updated to show the present distribution (Fig. 1).

STATUS OF CALIFORNIA BIGHORN SHEEP BY STATE

CALIFORNIA

In 1979 there were approximately 195 California bighorns in the Sierra Nevada Range and the number was declining. The California bighorn is listed as rare by the California Fish and Game Commission and has not been legally hunted for over 100 years.

Fig. 1 : Distribution of California (″)and Rocky Mountain (″)Bighorn Sheep in the U.S.A.



Population Status

There are currently a minimum of 300 California bighorns in five herds in California. The largest (195) is the Baxter herd in the Sierra Nevada Range. California bighorns seem to be responding well to transplant programs and the overall number of sheep is increasing. California bighorns in California are inventoried by aerial surveys using fixed-wing aircraft and helicopter and ground searches.

Transplant Program

California's first effort to reintroduce bighorns into historic habitat was made in 1971 when California bighorns from British Columbia were placed in a large enclosure at Lava Beds National Monument. This confined herd was to serve as a source of bighorns for reintroduction and four were released into the Warner Mountains, Modoc County in 1980. In 1981 the entire remaining herd succumbed to pneumonia. Sheep were transplanted from the Baxter herd in 1979 (9), 1980 (31), and 1982 (19) and these transplants appear to be successful. Three of California's five herds are a result of reintroduction, and additional transplants from the Baxter herd are anticipated.

Hunting Opportunity

Currently, hunting bighorn sheep is not allowed in California. Bills to change the legal status of all bighorns failed in the California Assembly in 1968, 1979, and 1982; and in 1983 a bill was submitted seeking to remove Nelson's bighorn (O.c.nelsoni) from the list of fully protected mammals.

NEVADA

In 1974 California bighorns were extinct as free-ranging animals in Nevada. There was one captive herd, which was being held for transplant purposes, on the Charles Sheldon National Wildlife Refuge. California bighorn sheep formerly were common in the mountains of northwest Nevada. The last report of sheep of this race was in the 1930's after there had been a continued decline due to competition with domestic livestock for habitat and the impact of mining.

Population Status

There are five herds resulting from reintroductions in Nevada. They total about 131 animals: Hell Creek 50-70, Eightmile Mountain 31, Granite Mountains 27, Jarbidge Mountains 10, and Jackson Mountains 13 sheep. The last herd is a 1984 transplant. The Hell Creek and Eightmile Mountain herds are increasing while those of Granite Mountains and Jarbidge Mountains are static.

Transplant Program

All herds in Nevada resulted from successful reintroductions. Fifteen potential release sites in historic range have been identified.

Hunting Opportunity

The first legal hunts for California bighorns was held in 1984 when three permits were offered on the Charles Sheldon National Wildlife Refuge. A legal ram is a trophy male at least 7 years old or with a Boone and Crockett score of 144 points. No ewe hunts are planned.

OREGON

Historically, California bighorns inhabited much of Oregon east of the foothills of the Cascade Mountains, except the Columbia Basin. The last native sheep were seen in the State in 1910 to 1912. In 1954 20 sheep were obtained from British Columbia and released into an enclosure in the Hart Mountain National Wildlife Refuge. In 3 years, 28 were released or escaped to form a free-ranging population. From 1960 through 1971 additional releases were made, and in 1974, there were four thriving herds numbering 320 animals. Hunting seasons were opened in 1965.

Population Status

Helicopter, Super cub, and ground counts indicate 10 populations totalling 1,007 sheep (Table 1).

Table 1. Status of California bighorn sheep in Oregon - 1984.

Area	Estimated Numbers
Steens Mountains	250
Alvord Peaks - Black Point	70
Pueblo Mountains	50
Leslie Gulch	200
Hart Mountain	280-300
Abert Rim	40
Alkali Rim	12
Deep Creek	5
Aldrich Mountain	50
Strawberry Mountains	25-30
Total	1,007

Transplant Program

All California bighorns in Oregon resulted from the reintroduction of 20 sheep to Hart Mountain in 1954, and the success of this program has been excellent. Over 22 sites for future reintroduction have been indentified.

Hunting Opportunity

In 1983 5,400 resident applications were received for 38 permits; odds of drawing a permit were 1 in 142. By hunt unit, the chance of drawing a permit

ranged from 0.4 to 1%. The harvest was 34 rams with a success of 89%. A legal ram has a 3/4 horn curl or greater or is an old ram with heavily broomed horns with blunt ends less than 3/4 curl. Hunters are required to attend a orientation session prior to hunting. Five of 10 populations are hunted. In Oregon there is no ewe season; as populations reach management objectives, trapping and transplanting to unoccupied range will have priority.

Habitat Improvement Program

Habitat work has included development of guzzlers and modification of livestock fences from four to three wires.

WASHINGTON

California bighorns once inhabited much of the eastern side of the Cascade Mountains and were relatively abundant. The last native sheep was seen near Hart Pass about 1925. Reintroduction of California bighorns began in 1957 when 18 sheep were obtained from British Columbia. By 1970 their offspring had been transplanted to ten other areas and numbered about 400 animals. However, in 1974 three of those herds had declined in number.

Population Status

Washington has about 550 California bighorns in nine herds (Table 2). Estimates may be questionable for some herds. California bighorns are stable or increasing in Washington.

Table 2. Status of California bighorn sheep in Washington - 1984(1).

Area	Estimated numbers	Apparent trend
Aeneas Mountain	150-200	Stable
Tucannon	40	Increasing
Colockum	10	Stable
Clemans Mountain	40	Stable
Swanke Canyon	30	Stable
Umtanum	75	Increasing
Mount Hull	35	Stable
Vulcan Mountain	70	Increasing
Cottonwood Creek	50	Increasing
Total	550	

(1) Compiled by R.L. Johnson.

Transplant Program

All present day populations are results of reintroductions. The Hull Mountain population is now being controlled by transplant, and transplants in Washington are regarded as successful.

Hunting Opportunity

In 1983 3.549 sportsmen applied for 23 permits; the odds were 1 in 154. Rifle hunters had a 0.1% chance of drawing three permits, muzzle loaders 0.5% chance of drawing two permits, and bowhunters 2.45% chance of drawing 18 permits. Only four rams were taken, three with rifle and one with muzzle loader. Washington restricts harvested to 3/4 curl rams. A ewe season was held in 1973.

IDAHO

Historically, California bighorns inhabited the Nevada-Oregon canyons of southwest Idaho. There was an early decline and gradual disappearance after the introduction of large numbers of domestic livestock and extensive mining development. The last native California bighorns were observed near the turn of the century. Reintroductions from British Columbia began in 1963, and by 1974 there were estimated to be 275-300 California bighorn sheep in Idaho.

Population Status

California bighorns are now confined to the Owyhee River drainage, Bruneau River drainage, and Little Jacks Creek in the southwest corner of the State. The topography is basically a high plateau bisected by numerous abrupt canyons. Based upon the most recent helicopter classification counts, there are 355 sheep in the East Fork Owyhee population, 150 in the Little Jacks Creek herd, and 25 in the West Fork Bruneau River population for a total of 530 animals. Bighorns in the East Fork Owyhee River and Little Jacks Creek are increasing in number, and occupation of available habitat is increasing. Those sheep in the West Fork Bruneau River were recently introduced.

Transplant Program

All three herds result from transplants. Additional sites for future transplants have been identified, and an agreement has been made to provide sheep to Nevada.

Hunting Opportunity

In 1983 11 permits were available for California bighorns. Hunter and public interest in Idaho is high. Since 1974 sportsmen have been allowed to kill only one bighorn sheep in a lifetime. In addition, any person making application for a bighorn sheep hunt is prohibited from applying for any other controlled hunt. Only 3/4 curl or larger rams are legal for harvest. Two of the three populations are hunted.

NORTH DAKOTA

The unglaciated western portion of the State was historic range of the badlands bighorn (O.c.auduboni), which became extinct in North Dakota in 1905.

The State was without bighorns until 1956 when 18 California bighorns from British Columbia were introduced into the Badlands. They were held in an enclosure and by 1974 five releases had been made from the original 18.

Population Status

Currently there are about 225 (±25) bighorns in western North Dakota.

Transplant Program

Nine sheep were transplanted in 1983. This was the first transplant since the mid 1960's, and additional transplants are planned for the future.

Hunting Opportunity

North Dakota closed its bighorn hunting in 1980 after encountering a severe lungworm related problem. A season with six permits was anticipated for 1984. Permits are granted only to residents by lottery, and legal rams must have 3/4 horn curl or greater on the largest side. Harvested sheep must be presented to the Game and Fish Department within 24 hours to be registered and marked. Any person who has received a licence to hunt bighorn sheep cannot be eligible to apply for another such licence. Hunter success in North Dakota is high.

Lungworm Problem

Lungworms were identified as a cause of lamb mortalities in the late 1970's. By 1980 a program of chemotherapeutic treatment for lungworms using apple pulp bait apparently was successful. Confidence in this program has allowed reopening of the hunting season and once again transplanting of bighorns in North Dakota.

STATUS OF ROCKY MOUNTAIN BIGHORN SHEEP BY STATE

ARIZONA

No Rocky Mountain bighorns were reported in Arizona in 1974.

Population Status

There are two small populations in eastern Arizona near the New Mexico border presently. No information is available regarding population trends.

Transplant Program

Both herds are the results of transplants into the same drainage. One herd is shared with New Mexico and a result of a New Mexico transplant. The

other is a result of 20 bighorns received from Colorado and released farther downstream on the drainage.

Hunting Opportunity

There is no hunting of Rocky Mountain bighorns in Arizona.

NEW MEXICO

Native Rocky Mountain bighorns were extirpated by 1906, and present populations resulted from reintroduction. Historically, they occurred in large numbers in the southern Rocky Mountains. There were approximately 350 bighorns in New Mexico in 1974.

Population Status

There now are approximately 500 Rocky Mountian bighorns in eight herds in New Mexico (Table 3). Well over 300 of this estimated number are based upon surveys made by horseback, helicopter, and on foot which are felt to be reliable. The largest herd (200) is in San Francisco Canyon and has a ram:ewe:lamb ratio of 105:100:62 and is increasing. Two other large increasing herds are Turkey Creek (50) and Manzano Mountains (50) with ram:ewe:lamb ratios of 40:100:56 and 45:100:54, respectively. The Pecos Wilderness herd (125) is decreasing and has a ram:ewe:lamb ratio of 54:100:25. Rocky Mountain bighorns in New Mexico generally are increasing.

Table 3. Status of Rocky Mountain bighorn sheep in New Mexico - 1984(1).

Area	Year released	Est. numbers	How obtained(2)	Ratios ram:ewe:lamb	Apparent trend
Sandia Mountains	1940	30	A	-	Decreasing
San Francisco Canyon	1964	200	B,C	105:100:62	Increasing
Turkey Creek	1965	50	D	40:100:56	Increasing
Pecos Wilderness	1965	125	B	54:100:25	Decreasing
Wheeler Wilderness	1968 & 1970	25	A	-	Stable
Manzano Mountains	1972 & 1978	50	D	45:100:54	Increasing
Latir Wilderness	1977	10	B	-	Die-off-1981

Table 3 (contd.)

Area	Year released	Est. numbers	How obtained(2)	Ratios ram:ewe:lamb	Apparent trend
Cimarron Canyon	1970 & 1978	10	A	- (escaped from captivity)	Decreasing
Ft. Wingate	1972				
	Total	500			

(1) Prepared by A.V. Sandoval.
(2) A - incidental observations, not reliable.
B - horseback survey, reliable.
C - helicopter survey, reliable.
D - foot survey, reliable.

Transplant Program

Current distribution and numbers of bighorns in New Mexico are the result of reintroductions begun in 1940. The most recent transplants took place in 1978 into the Manzano Mountains southeast of Albuquerque, Cimarron Canyon southwest of Raton, and the Latir Wilderness northeast of Taos. The Manzano transplant supplemented a release made in 1977. The Cimarron Canyon transplant supplemented a small population that derived from a 1968 release in the Wheeler Wilderness approximately 40 km west of Cimarron Canyon.

Hunting Opportunity

Sport hunting was allowed first in 1959 in the Sandia Mountains and discontinued in 1962 when the population there was used as a source of animals for reintroduction elsewhere in the State. A limited season was held in the Sandia Mountains again in 1965, and since 1970 hunting has been allowed in two or more areas. Hunting is a once in a lifetime opportunity, and only residents and nonresidents who have never held a licence or authorization to buy a license may apply. Licences are issued by public drawing, and resident and nonresident applications are pooled together with equal opportunities of being drawn.

A total of 109 rams have been harvested, with 66 taken since 1974. Hunter success has been 29% in the Sandia area, 34% in the Pecos area, 66% in the Turkey Creek area (no season since 1972), and 75% in the San Francisco area. Demand for permits is high. In 1983, when 11 permits were issued, 468 applications were received for six San Francisco permits and 114 applications were received for five Pecos permits.

Legal rams must have at least one horn with 3/4 curl or a 72-point Boone and Crockett Score. Ewes have never been harvested in New Mexico. Horns of

all bighorns harvested, imported, or picked up must be measured, photographed, and tagged and sealed within 10 days.

Habitat Improvement Program

In addition to limited hunting opportunities, management consists of evaluation of historic habitat and population monitoring. The Department of Game and Fish is currently involved in a statewide habitat evaluation program which has an objective of ranking historic habitats in order of suitability for successful reintroduction of bighorns. There are no ongoing habitat improvement projects; however, salt is provided by helicopter to the Pecos Wilderness population.

Latir Wilderness Die-off

The Latir Wilderness population was established in 1978 by transplant and contained 40 to 45 bighorns by 1981. During the summer of 1981 approximately 115 domestic sheep were grazed in bighorn habitat and shared range with bighorns. An all age die-off occurred that summer. Chronic fibrinopurulent pneumonia was diagnosed and Pasteurella sp. was recovered. Circumstantial evidence suggests domestic sheep were the source of disease to the Latir bighorns.

UTAH

In 1974 Utah reported two populations; a native herd in the Uinta Mountains (est. 100) and a transplant herd of no more than 100 animals on Willard Peak. Historically, Rocky Mountain bighorns occurred in the Uinta and Wasatch Mountains and also inhabited many of the smaller mountain ranges in northern Utah.

Population Status

The current statewide bighorn population is around 200 animals in six herds (Table 4). Population trends, where known, are increasing, but some transplant herds are too new to have established trends. The Dinosaur National Monument herd is not managed or censused by the State and the herd on the Ute Indian Reservation is not under the authority of the State.

Table 4. Status of Rocky Mountain bighorn sheep in Utah - 1984.

Area	Year released(1)	Est. numbers	Ratios ram:ewe:lamb	Apparent Trend
Willard Peak	1966(34)	?		?
Mount Nebo	1981 & 82(48)	57+	50:100:54	Increasing
Bear Mountain	1983 & 84(36)	?		Probably Increasing

Table 4 (cont'd.)

Area	Year released (1)	Est. numbers	Ratios ram:ewe:lamb	Apparent trend
Deep Creek Mountain	1984(16)	?		?
Dinosaur National Monument	1960's (several)	25-50		?
Ute Indian Reservation	? (several)	?		Increasing

(1) Number of sheep reintroduced in parentheses.

Transplant Program

All Utah's present day bighorns are the result of reintroductions. The 1966 transplant of 34 bighorns to Willard Peak involved Canadian and Wyoming sheep. All subsequent transplants have apparently originated in Wyoming. The Mount Nebo transplant of 1981 and 1982 was held in a paddock for lungworm treatment and released just before lambing season.

Wildlife managers in Utah are very optimistic about the Mount Nebo and Bear Mountain transplants and plan reintroduction into three or four additional areas in the northern portion of the State. If these and past reintroductions are successful, transplants into additional areas that are transitional habitat between that of desert and of Rocky Mountain bighorns may be attempted. In the northern portion of Utah, much former bighorn habitat has been lost to urbanization and development.

Hunting Opportunity

There is no hunting for Rocky Mountain bighorns in Utah; to date there has not been a hunting season on the Ute Indian Reservation.

Habitat Management

In cooperation with the U.S. Forest Service, management to enhance bighorn habitat is being conducted on Bear Mountain. Livestock have been removed and the area reserved for wildlife habitat. A portion of the area was burned with apparent good results. In addition, roads have been closed and water has been developed on the mountain top to assure a year-round water supply.

Research

A biologist has been assigned to monitor each recently reintroduced herd, and telemetry is used to assist these endeavors. Utah is optimistic about the success of recent and future reintroductions and is looking forward to the time when there are sufficient rams to allow hunting seasons.

COLORADO

Historically, Rocky Mountain bighorns were numerous in Colorado. There was a general downward trend in sheep numbers until the early 1970's when the Division of Wildlife initiated intensive research and management programs. In 1970 there were thought to be 2,200 bighorns in the State. Legal hunting has been allowed since 1953, and Colorado has tried a variety of horn size restrictions ranging from 1/2 to full curl. In 1961 the Rocky Mountain bighorn was designated as the State animal.

Population Status

In 1984 4,030 bighorn sheep were estimated to be in Colorado. There are 48 herds (Table 5), 32 of which are hunted, and eight herds are a result of reintroductions. In general, Colorado's bighorns are increasing in number.

Transplant Program

Colorado began transplanting sheep in 1944 and in the mid 1970's was a leader in using a drop net trap baited with apple pulp. Since 1974, the transplant program has been very active with one transplant in 1974, one in 1977, four in 1978, one in 1979, three in 1980, two in 1981, three in 1982, and five in 1983. Most of these have involved about 20 animals. Trapping and transplanting is used as a method of population control.

Table 5. Status of Rocky Mountain bighorn sheep in Colorado - 1984(1).

Area (2)	Estimated Number	Apparent trend (3)
Gore	15	Static/decreasing
Snowmass East(H)	120	Increasing
Snowmass West(H)	100	Increasing
Clinetop Mesa	25	Decreasing
Neversummer(H)	180-200	Increasing
Battlement Mesa	40	Static
Dinosaur	80	Static
Cross Mountain(H)	40-60	Increasing(1977)
Indian Peaks	10	Static
Derby Creek	20	Successful(1981)
Basalf(H)	60	Increasing(1972)
7 Castles	25	Static
Geissler Mountain	15	Static
New York Peak	15	Static
Pikes Peak(H)	185	Increasing
Beaver Cr.(H)	75	Decreasing(4)
Texas Cr.(H)	80	Increasing(1982-83)
Sangre de Cristo(H)	200	Increasing
Collegiates No.(H)	150	Increasing
Collegiates So.(H)	90	Increasing

Table 5 (cont'd.)

Area(2)	Estimated Number	Apparent trend(3)
Buffalo Peaks(H)	110	Increasing
Marshall Pass(H)	80	Static
Tarryall(H)	150	Increasing
Rampart	60	Increasing
Browns Canyon(H)	40	Increasing(1980)
Greenhorn Mountain(H)	20	Static(1975)
Pole Mountain(H)	25	Increasing
Apishapa	100	Increasing(1977)
Carrizo	25	Increasing(1980)
Trickle Mountain(H)	400	Static/increasing
Sheep Mountain(H)	50	Static
Cimarron Peak(H)	75	Static
Cow Cr.(H)	200	Increasing
LaGarita(H)	300	Increasing
Taylor R.(H)	70	Increasing(5)
Vallecito(H)	30	Static
Alamoso(H)	75	Increasing
Conejos R.(H)	50	Increasing
Blanco R.(H)	50	Increasing
Lake City	25	Static/decreasing
Poudre R.(H)	70	Decreasing(6)
Lone Pine(H)	100	Increasing
Mount Evans(H)	100	Static/decreasing
Graut(H)	70	Static/decreasing
Waterton	15	Decreasing(7)
Rawahs	25	Static
Kenosha(H)	75	Increasing
Georgetown(H)	75	Increasing
Total	4,030	

(1) Compiled by G.G. Schoonveld.
(2) Hunted population.
(3) Year following trend indicates a transplanted herd and year of transplant.
(4) The Beaver Creek herd experienced an apparent die-off during the winter 1982-83.
(5) The Taylor River herd experienced a die-off in 1981.
(6) The Poudre River herd experienced a die-off during the winter 1983-84.
(7) The Waterton Canyon herd experienced an extensive die-off in 1979 and 1980.

Hunting Opportunity

In 1984 Colorado permitted nonresident sheep hunting for the first time. Thirteen nonresident permits were issued through a random drawing. Hunters may apply for either a sheep or a goat license but not both. All sheep taken in Colorado must be reported to the Division of Wildlife within 5 days, and ram

horns are permanently marked with a metal plug. Since 1979 harvest of a 1/2 curl or larger ram has been a once in a lifetime opportunity. Ewes are hunted in only two areas. In the Mount Evans area, harvest of any sheep is permitted due to the presence of the disease paratuberculosis (Johne's disease). Ewes are hunted in the Pike's Peak area as a means of population control and in an effort to disperse the population.

During the last 5 years averages of 86.0 and 3.6 rams, respectively, have been harvested by rifle and archery hunters, and in the last 3 years, 31 ewes have been harvested, 28 by rifle and 3 by archers. Hunter success has been about 30% among rifle hunters and about 7% by archers. In 1983 2,081 applications were received for 324 rifle licenses and 190 applications were received for 80 archery licenses.

Habitat Improvement Program

Two projects which involve prescribed burning are currently in progress. Colorado's bighorn sheep population has nearly doubled since 1974, and there is reason for optimism. Nonresident hunting, which began in 1984, should increase out-of-state interest in Colorado's bighorn and their management programs.

Research

There are currently two research projects underway in Colorado directed towards bighorn sheep, these are: "Use of Prescribed Burning to Improve Bighorn Sheep and Mule Deer Winter Range" and "Investigation into the Potential Competition Between Mountain Goats and Bighorn Sheep."

Obtaining data on the value of prescribed burning to improve bighorn sheep range is essential if herd managers are to sell land management agencies on the use of this tool for range improvement. Objectives of this study are to (1) quantify the effects of burning mountain shrub and grassland communities on the nutritional status of bighorn sheep during winter, (2) examine the effects of fire on food niche relationships and ecological separation of mule deer and bighorn sheep, and (3) explain changes in responses of forage resources, both in quantity and quality in terms of process in the nitrogen cycle and soil water relationships.

Objectives of the bighorn sheep and mountain goat investigation are to evaluate the extent to which mountain goat populations limit seasonal habitat utilization of bighorn sheep in alpine environments and to describe patterns and rates of dispersal of mountain goats from colonization sites.

IDAHO

Bighorn were once numerous in Idaho, but the State experienced a population decline in the late 1880's and early 1900's. A low of about 1,000 sheep was reached in the 1920's and 1930's. In 1974 it appeared there had been no major change in the status of the Middle Fork Salmon River and Salmon River herds during the previous 30 years. In 1970 Rocky Mountain bighorns were first transplanted into Idaho from Banff National Park, Alberta. Hunting

seasons became controlled hunts in 1971. No estimate of sheep present was given in 1974.

Population Status

Rocky Mountain bighorns occupy the central mountains of Idaho; most are located in the Salmon River drainage. A small remnant population exists on the upper Snake River near Yellowstone National Park, another small population inhabits the upper Selway drainage, and a new population exists in Hells Canyon of the Snake River. Topographically, habitat in Idaho is mountainous, rugged, and rocky. Seventeen herds in Idaho total about 2,800 sheep (Table 6). Eleven are native and six are results of reintroductions. Population estimates, except for Targhee and Badger Creek-Uncle Ike Creek herds, were derived from helicopter counts made during winter.

Population trends are generally increasing, although the rate of increase is slow in most herds. The Panther Creek population grew to about 400 sheep by 1978. Since then three severe winters have occurred, and the population declined to a low of 177 in 1982. The herd has grown during the last 2 years. Very little is known about the Targhee population, and it is assumed they are static. Some, if not all of these sheep move into Montana.

Table 6. Status of Rocky Mountain bighorn sheep in Idaho - 1984(1).

Area	Estimated Number	Ratios ewe:lamb:yrl:ram	Apparent Trend
Middle Fk.			
Salmon River	600	100:45:24:45	Static/increasing
Main Salmon River	475	100:27:--:23	Static increasing
South Fk.Salmon River	150	100:31:14:72	Increasing
Panther Creek	270	100:24:28:60	Increasing
Horse Creek-			
Colson Creek	200	100:49:18:47	Increasing
Morgan Creek	160	100:59:29:67	
Cronks Canyon	30-40	200:22:22:144	Increasing
Birch Creek-			
Bayhorse Ck.	40	100:33:67:67	Increasing
East Fk. Salmon River	140	100:80:45:66	Increasing
Mt. Borah	250	100:20:25:25	Increasing(R)
Elbow-Jaggles Canyon	60-70	100:50:100:113	Increasing(R)
Copper Mtn.-			
Blue Dome	20-30		Increasing(R))
Badger Cr.-			
Uncle Ike Cr.	50		Increasing(R)
Selway River	150	100:51:20:43	Increasing
Targhee	30		Static
Hells Canyon	150	100:63:33:93	Increasing(R)
Captain John Creek			
Total	2,805		

(1) Prepared by W.O. Hickey.
(2) Reintroduced=(R).

Transplant Program

Idaho has an active reintroduction program which generally has been successful. Badger Creek-Uncle Ike Creek (1983 and 1984) and Captain John Creek (1984) are the most recent releases. Other reintroductions are only a few years old; but they appear to be doing well, except the Copper Mountain-Blue Dome reintroductions, which may have failed.

Idaho has many areas with potential for bighorn sheep reintroduction. Management efforts will be in this direction. Environmental analysis reports are being completed for further reintroductions on the Challis and Salmon National Forests as well as the Salmon BLM District. Much remains to be done toward augmenting reintroductions that have already been made.

Hunting Opportunity

Permits are issued for rams in seven of the 16 populations. The unhunted populations are either recently reintroduced or small remnant populations. Only 3/4 curl or larger rams are legal for harvest. Idaho has not had an open season on ewes, and surplus ewes are regarded as valuable transplant stock. Public comment has indicated a preference that ewes be used to start new populations rather than be hunted.

As with California bighorn hunting in Idaho, sportsmen have been limited since 1974 to one Rocky Mountain bighorn in a lifetime. Statewide hunter success during 1979 through 1983 varied from 31% to 50%. Number of rams harvested during this 5-year period ranged from 31 to 1980 to a high of 63 in 1982, and the harvest trend has been upward. If the new proposal for defining a legal ram is adopted, the harvest in all probability will increase 80%.

All sheep hunting is by controlled hunt, and in 1983 126 permits were offered. Numbers of permits should increase as reintroduced populations produce sufficient ram cohorts. Odds for drawing a permit in 1983 were one in eight statewide. Odds of successful draw have decreased during the last 5 years.

Habitat Improvement Program

Personnel of the Salmon BLM District have been burning winter range on the East Fork Salmon River and Morgan Creek. There are plans to expand this program. Winter ranges of Panther Creek sheep have been burned on the Salmon National Forest. Installation of guzzlers in arid areas of several sheep ranges has recently been initiated.

Research

Recent programs have been completed, and no new projects are planned.

NEVADA

Native Rocky Mountain bighorn sheep were recorded last in 1929 on Wheeler Peak, White Pine County. Apparently, there were none in Nevada in 1974.

Population Status

Two herds, resulting from introduction, Moriah Mountain (30) and Wheeler Peak (40), occur in Navada at present and total about 70 animals. The Mount Moriah herd is static, and the Wheeler Peak herd is increasing.

Transplant Program

Both herds resulted from reintroductions, most of which have been made in the last 5 years. Four potential reintroduction sites have been identified, and additional releases into existing reintroduced populations are considered desirable.

OREGON

Historically, Rocky Mountain bighorns were confined to the Wallowa and Blue Mountain ranges in the northeastern corner of the State. By the mid 1940's, only a few sheep remained in the Wallowa Mountains. Disease, competition with livestock, and overharvest were probably responsible for the decline. In 1971, bighorns from Jasper National Park, Alberta were released in the Snake River Canyon near Hells Canyon dam and on the Lostine River drainage of the Wallowa Mountains. By 1974 the Hells Canyon group could not be located and the Lostine River herd contained at least 30 animals.

Population Status

There are six Rocky Mountain bighorn sheep herds in Oregon, all of which are results of reintroductions (Table 7). Most recent transplants are Wenaha (1983), Bear Creek (1984), and Hass Ridge (1984). The 1984 population in Oregon is estimated to be 250 animals, based upon aerial counts from a Super Cub. The estimates are thought to be reliable.

Table 7. Status of Rocky Mountain bighorn sheep in Oregon - 1984(1).

Area	Population Estimate
Lostine River	110
Lower Imnaha River	50
Battle Creek	30
Wenaha	15

Table 7 (cont'd.)

Area	Population Estimate
Bear Creek	10
Hass Ridge	10
Misc. strays from several transplants	25
Total	250

(1) Compiled by V.L. Coggins and A.R. Polenz.

Transplant Program

Oregon has had mixed results with reintroductions of Rocky Mountain bighorns. Although the Lostine transplant has been very successful, the first Hells Canyon transplant failed. There were two failures at Bear Creek and one at Hass Ridge. Considerable dispersal has occurred from the release sites at both Wenhaha and Battle Creek. All these transplants were made with Lostine River stock; many bighorns returned to their home range from as far as 64 km away. Perhaps the main problem was the close proximity of release sites to the home range of the Lostine sheep and dissimilarity in habitat types. The 1979 Lower Imnaha River reintroduction, made with Salmon River stock, has been very successful. Nineteen sites for future releases have been identified in northeast Oregon. Several have low priority because of domestic sheep grazing in the potential habitat.

Hunting Opportunity

In 1983 1,344 applications were received for six permits, 1 in 224 odds. As of 1983 a total of 38 permits had been issued at a rate of six yearly and 34 rams had been harvested for an 89.5% success rate. All hunting is restricted to the Lostine River. A legal ram is 3/4 curl or more or an old ram with heavily broomed horns with blunt ends less than 3/4 curl.

Habitat Improvement Program

A 328 ha habitat purchase was made for Rocky Mountain bighorns, and an additional 64 ha purchase is under consideration. These two purchases would complete acquisition of winter range for the Lostine River sheep. Some burning and conifer clearing is planned in the future.

Research

There are no current research projects. Management studies involve transplant monitoring by telemetry and population and composition surveys. The Lostine herd is treated for lungworm.

WASHINGTON

Rocky Mountain bighorn sheep historic range is limited to the Blue Mountains of southeastern Washington and the Selkirk Mountains of northeastern Washington. The last native sheep was believed killed in 1917 in southeastern Washington. In 1972 bighorns were first reintroduced into the State from Waterton Lakes National Park, Alberta. At the end of 1973 this herd on Hall Mountain in the Selkirks numbered 20 sheep.

Population Status

Three herds in Washington total 101 Rocky Mountain bighorns. These are the Hall Mountain (40), Joseph Creek (45) and, Wenha-Tucannan Wilderness (16) herds. All three are increasing in numbers.

Hunting Opportunity

Rocky Mountain bighorns are not hunted in Washington.

WYOMING

Most mountainous, foothill, and river-break areas in Wyoming historically were sheep habitat, and bighorns were numerous in Wyoming. Sheep declined around the turn of the century and continued to decrease until the 1920's and 1930's. Hunting has always been permitted in Wyoming. In the 1930's sheep were placed on special permits for 3/4 curl rams. Land acquisition for winter range has been a very successful program, especially with the Whiskey Mountain herds. The first transplant was made in 1934; and after 1956 reintroduction was an important management tool. In 1974 the Wyoming Rocky Mountain bighorn sheep population was estimated to be 4,000 to 5,000 animals.

Population Status

There are 18 herd units in Wyoming at present, and the estimated population is 6,305 Rocky Mountain bighorns (Table 8). Population estimates are based upon trend counts and limited modeling; although likely not too accurate, they probably err on the conservative side. Seventeen herds are hunted and eight are reintroductions. In general, bighorns in Wyoming are increasing and objectives are to reach a statewide population of 7,180 sheep. Bighorns in Wyoming occupy an estimated 20,262 square miles of habitat, 127 square miles is critical winter range.

In 1940 2,500 bighorns were estimated to be in Wyoming. Since then they apparently have increased by about 2% per year. Hunter harvest has probably had a negligible influence during the past 43 years, and this low rate of increase, although encouraging, points out a precarious balance between natality and natural mortality. A slight increase in mortality could turn an increasing trend into one of decline. The extreme care necessary in land uses and human activities that have a potential to adversely impact sheep is apparent.

Table 8. Status of Rocky Mountain bighorn sheep in Wyoming - 1984(1).

Area(2)	Estimated number	Population objective	Apparent trend(3)
Clark's Fork(H)	500	500	Stable
Trout Peak(H)	450	440	Decreasing
Wapiti Ridge(H)	875	875	Stable
Yount's Peak(H)	900	900	Stable
Franc's Peak(H)	979	600	Stable
Targhee(H)	100	125	Stable
Jackson(H)	460	500	Decreasing
Sheep Mountain(H)	35	100	Decreasing
Whiskey Mountain(H)	960	1,000	Stable
Temple Peak(H)	152	250	Stable
North Bighorn(H)	50	200	? (R)
Paintrock Creek	20	40	? (R)
Barnum	4	300	Decreasing(R)
Sweetwater	0	150	Decreasing
Ferris	0	150	Decreasing(R)
Douglas Creek(H)	245	350	Increasing(R)
Laramie Peak(H)	310	500	Increasing(R)
Encampment(H)	160	200	Increasing(R)
Darby Peak	45	?	Increasing(R)
Dubois Badlands(H)	60	?	Stable
Total	6,305		

(1) Compiled by W. Gasson.
(2) H=hunted population.
(3) R=reintroduced.

Transplant Program

Wyoming actively transplants Rocky Mountain bighorns, providing sheep for reintroduction both within the State and in neighboring states. Sheep are transplanted only from the Whiskey Mountain wintering herds. Transplant is used as a means of population control, and the number removed each year is based upon winter range forage production and utilization and sheep productivity. Consequently, thriving herds are artificially held stable. They are monitored frequently for the presence of diseases and, to date, remain healthy. Since 1975, 566 bighorns have been transplanted. With the exception of those in the Big Horn Mountains, most recent transplants in Wyoming have been successful. Transplants seem more likely to succeed when larger numbers of sheep are used. Sites identified for future transplants include the Ferris Mountains, Sweetwater Rocks, Sheep Mountain near Laramie, and the Big Horn Mountains, using larger numbers of sheep than previously.

Hunting Opportunity

From a strictly consumptive and economic perspective on a per-harvested animal-basis, bighorns are the State's most valuable animal. Hunters spent

over $2,500 for each sheep harvested in 1982, nearly half a million dollars entering the State's economy. Hunter interest is high and demand seems to be increasing. All sheep hunting in Wyoming is by limited entry permits. In 1983, 4,211 applications were received and 360 permits were issued (Table 9). One fourth of the permits are reserved for nonresidents. No ewes are hunted in Wyoming. Only 3/4 curl or larger rams are legal. Within 10 days of harvest, horns must be presented at a Game and Fish Department office for registration, including measurements and photographs and permanent tagging.

Habitat Improvement Program

The only habitat improvement activities are on the Whiskey Mountain winter ranges. Land purchases by the Game and Fish Department and reservation of land by the U.S. Forest Service and Bureau of Land Management have resulted in protection of large winter ranges for bighorns. A meadow is irrigated and resultant grass saved for sheep forage during severe weather. During the last 3 years, apple pulp bait has been used to extend sheep distribution onto a previously unused site. This appears to be very successful. Burning, fertilization, and gouging are being used on small scales to improve forage production.

Research

An extensive ecology study using telemetry and focusing on distribution, migration patterns, habitat use, and sheep numbers is being conducted on the Trout Peak herd. A controlled study at the Sybille Wildlife Research Unit and University of Wyoming is examining heart rate and physiologic responses to stress.

Problems

Many herds need to be better described and most population estimates are inadequate. Hunter interest far exceeds ability to produce enough sheep to satisfy demand (Table 9). A small pneumonia induced all age die-off occurred in a segment of the Jackson herd in 1982 and disease remains a threat. Scabies has been diagnosed in three herds, and efforts are being made to control the disease. Seismic exploration threatens some herds with excessive disturbance.

Table 9. Wyoming bighorn sheep permit drawing (1983) and harvest (1982) statistics.

Area	Resident permits (1983)		Nonresident permits (1983)		No. of hunters	Hunter days/ram	Total Recreation days	Hunter success (%)
	Number issued	Odds to draw	Number issued	Odds to draw				
1	18	16:1	6	9:1	24	17	255	63
2	24	9:1	8	12:1	32	12	233	59
3	24	21:1	8	20:1	32	10	257	81
4	45	11:1	15	18:1	60	21	668	53
5	45	11:1	15	10:1	59	21	553	44
6	6	4:1	2	3:1	7	22	44	29
7	18	22:1	6	20:1	21	14	202	67
8	3	13:1	1	7:1	ND	ND	39	ND
9	2	7:1	8	5:1	71	19	732	55
10	30	21:1	10	13:1	6	107	107	17
11	6	4:1	2	4:1	0	0	0	--
17	3	106:1	1	29:1	8	11	55	63
18	6	21:1	2	21:1	ND	ND	ND	ND
19	6	25:1	2	13:1	4	3	10	100
21	3	45:1	1	44:1	0	0	0	--
22	3	23:1	1	21:1	4	14	43	75
23	6	20:1	2	17:1	ND	ND	ND	ND
Totals	248		90					

MONTANA

Mountain sheep once ranged throughout Montana with the badlands bighorn occurring in the east and Rocky Mountain bighorns being found in the mountainous west. Legal, controlled hunting began in 1953. Trapping and transplanting was initiated in 1947, but it has been used more intensively as a management tool since 1976. No population estimate was given in 1974.

Population Status

There are 12 native and 20 transplant populations in Montana. Native populations contained approximately 2,100 bighorns, and transplant herds supported about 2,500 sheep during winter 1983-84, a total of 4,600 animals (Table 10).

Transplant Program

Trapping and transplanting do not occur every year. Recent mild winters have made bighorns difficult to capture, and no major reintroductions have taken place in the last couple of years. The large Sun River herd has traditionally been Montana's main source of transplant stock. However, in the near future sheep from Thompson Falls, Wildhorse Island, Yellowstone-Gallatin, Upper Rock Creek, and National Bison Range herds will likely be used for transplant.

Hunting Opportunity

Limited entry and unlimited hunting areas occur in Montana. Ten of the 12 native and 13 of the 20 transplant herds are hunted. Fifteen areas are limited entry areas. Under limited entry permits in 1983, there were 23 any ram, 18 3/4 curl ram, 72 either sex, and 288 mature ewe licences granted. Eight native populations support unlimited hunter numbers, but the harvest is strictly regulated on a quota system. In 1983, the most recent year for which data are available, 676 hunters took advantage of the unlimited season. The total quota for that year was 21 3/4 curl rams. In two of these unlimited hunting districts, a late season, limited entry hunt was held in 1983 with three permits available for 3/4 curl rams. Horns of all bighorn rams harvested in Montana must be plugged by Montana Department of Fish, Wildlife and Parks personnel.

Table 10. Status of Rocky Mountain Bighorn Sheep in Montana - 1984(1).

Area	Estimated number	Apparent trend	Population origin(2)
Kootenai Falls	175	Stable	T
Thompson Falls	475	Stable	T
St. Regis Cutoff	80	Increasing	T
Berray Mountain	160	Stable	T
Wild Horse Island	50	Stable	T
Flathead Reservation	30	Stable	T
Ural-Tweed	40	Stable	N
International Boundary	40	Stable	N
Moise Bison Range	60	Stable	T
Lost Creek	180	Increasing	T
Upper Rock Creek	185	Decreasing(2)	T
Lower Rock Creek	55	Decreasing	T
Petty Creek	75	Stable	T
West Fork Bitterroot	80	Stable	N
East Fork Bitterroot	100	Stable	T
Yellowstone	300	Decreasing	N
Spanish Peaks	150	Stable	N
Hilgards	35	Stable	N
Absaroka	75	Stable	N
Highlands	150	Increasing	T
Sun River	1,100	Decreasing	N
Beartooth	350	Decreasing	T
Dupuyer	80	Decreasing	T
Stillwater	50	Decreasing	N
Monument Peak	35	Stable	N
West Rosebud	75	Stable	N
Hellroaring	100	Stable	N
Pryor	15	Stable	T
Little Rockys	80	Stable	T
Mickey Brandon	60	Stable	T
Iron Stake Ridge	50	Stable	T
Mizpah	100	Stable	T
Total	4,590		

(1) Compiled by S.T. Stewart.
(2) T=transplant, N=native.

Habitat Problems

Elk in south central Montana are undergoing a tremendous increase in number on bighorn winter ranges. Policy differences between the State and National Park Service make it nearly impossible to control elk in some areas. Other habitat problems that impact many bighorn herds include conflicts with domestic livestock, particularly domestic sheep; loss of range due to large scale hydroelectric developments and hard-rock mining operations and deteriorating range conditions due to conifer and knapweed encroachment.

Sun River Herd Die-Off

The pasteurellosis outbreak that started in British Columbia and spread into Alberta recently moved through Glacier National Park and reached the Sun River herd this winter. Prior to this outbreak, there were approximately 1,100 bighorns in this largest herd in the State. Thus, the potential for significant loss is extremely high.

SOUTH DAKOTA

The now extinct Audubon's bighorn sheep were native to South Dakota. In 1922 Rocky Mountain bighorns were transplanted to Custer State Park to replace Audubon's bighorn. An all-age die-off in 1959 reduced the population to one female lamb. Additional sheep were reintroduced in 1964, and the population again leveled off at about 125 to 150 bighorns. Also in 1964, Rocky Mountain bighorns were released in the Badlands National Monument with an objective of using progeny of these sheep for transplant stock. In 1974 there were estimated to be 100-150 Rocky Mountain bighorns in South Dakota.

Population Status

The Custer State Park herd contains about 125 sheep, and there are approximately 40 animals in the Badlands National Monument herd, for a total of 165 bighorns.

Transplant Program

No transplant projects are currently underway. However, studies are being conducted in preparation for proposing a transplant onto U.S. Forest Service lands in the Black Hills of South Dakota.

Hunting Opportunity

Only residents of South Dakota are eligible to apply for once-in-a-lifetime opportunities to hunt bighorns in Custer State Park. Approximately five licences have been available each year since 1970. Hunter success is 100%.

Habitat Improvement Program

In Custer State Park all timber management is scheduled by management units and entries are performed according to schedule in the Vegetative Management Plan for the Park. Habitat improvements are accomplished through timber harvests, tree stand improvements, controlled burning, and protection of critical use areas.

Research

Current bighorn sheep related research projects include: Reproductive success and lamb mortality in Custer State Park bighorn sheep; Summer habitat use by Custer State Park bighorn sheep, Ram movements and spatial segregation in bighorn sheep, and a survey of disease status of big game animals of Custer State Park.

Problems

Custer State Park bighorns are infected with Muellarius sp. lungworms and mortalities have occurred. Anthelminthics have been used to control lungworms, but reinfection occurs within 1 year. In 1985 ivermectin will be used to determine if it provides more effective control of lungworms.

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THE STATUS OF THE DESERT BIGHORN IN THE UNITED STATES

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ABSTRACT

Desert Bighorn Sheep (*Ovis canadensis nelsoni*, *O. c. mexicana*, *O. c. cremnobates*) occur in seven states and number approximately 16,000 animals. The overall trend in numbers is up. This can be attributed to intensive management programs. New Mexico is an exception with a declining desert bighorn population. Three states allow limited hunting, offering approximately 180 permits per year. The following review is based on the most recent literature as well as an unpublished personal communication. For more detailed assessments on the status of individual herds and management problems in specific states, the reader is referred to annually published Proceedings of the Desert Bighorn Council.

RESULTS AND DISCUSSION

TEXAS

Estimates currently put the number of desert bighorns in Texas at 120. Historically, all the mountain ranges west of the Pecos River had bighorn sheep. In 1903 the hunting of bighorn was prohibited. Less than 150 bighorn remained in Texas by the 1940's and they were extirpated by 1960. The first attempt to reintroduce desert bighorn anywhere, was made in Texas in 1957. Stock was waterhole trapped in Arizona and released in a 400 acre paddock. The current management program centers around propagating bighorn in enclosures for release into the wild. By using four enclosures totalling 38 acres, Texas hopes to release into the wild 20 or more animals annually until they have fully stocked five mountain ranges deemed suitable. Bighorn for the progagation facility have been obtained from Arizona, Utah, Nevada as well as retrapped in Texas.

NEW MEXICO

It is estimated that there are at present 100 desert bighorn in New Mexico. Bighorn are found free ranging in three mountain ranges. Historically, most of

the mountain ranges in the southern one-half of the State were desert bighorn sheep habitat. By 1930, these sheep were found in only four mountain ranges and by the late 1940's they occurred in only two. In 1941 the San Andreas Mountains were made a National Wildlife Refuge. In 1972, New Mexico began captive breeding for reintroduction. In 1978, an outbreak of scabies mites depleted the San Andreas Mountain population. It is estimated that this population fell from 250 to 25 that year. Desert bighorn were state listed as endangered in 1979. Also that year an introduction was made into the Big Hatchet Mountains to augment a declining population. In 1980, a reintroduction was made into the Peloncillo Mountains with stock obtained from Arizona. More reintroductions are planned. Scabies is still found in the San Andreas Mountain bighorn in spite of treatments with Ivermectin. Mountain lions made inroads into the small remnant and introduced populations and the State went into a removal program.

ARIZONA

The current estimate of desert bighorn in Arizona stands at 4,000. Historically, all the mountain ranges in the western one-third of the state were considered bighorn habitat. There are two National Wildlife Refuges in Arizona, the Kofa and the Cabeza Prieta. Approximately 50 hunting permits are available each year. The Arizona Desert Bighorn Sheep Society is a very active group, working cooperatively with the Game and Fish Department to raise funds for management programs. The State has improved 85 water catchments. The State also has a very successful reintroduction program dating back to 1958. Thirty-three transplant sites have been identified.

CALIFORNIA

Estimates currently put the numbers of desert bighorns in California at 4,000. These sheep historically occurred in most of the desert mountain ranges in the southeastern portion of the State. Today they occur in about 50 mountain ranges. Bighorn have been fully protected in California for more than 100 years. Bills have been introduced to change the legal status but always fail to pass in the Legislature. Water development programs with the aid of volunteers and some private funding have been the main thrust of management. The first reintroduction of desert sheep in California was made in 1983 when captures were made on two mountains and releases into two historic ranges. It is anticipated that trapping and reintroductions will be made every year, subject to funding, until all the suitable range is restocked. It is believed the bighorn numbers can be doubled. The Santa Rosa Mountain populations of Riverside County have been experiencing low lamb recruitment and a declining trend for several years. The Bighorn Research Institute is investigating this problem. Titers for the following viral diseases have been found in this population: Bluetongue (BT), contagious ecthyma (CE), Epizootic hemorrhagic disease (EHD), para influenza (Plz). One or some combination of these viral diseases is believed to be predisposing the lambs to bacterial pneumonia.

NEVADA

Nevada's desert bighorn population is presently estimated at 5,200. Historically, all the mountain ranges in southern Nevada were desert bighorn habitat. Today desert bighorn occur in 24 mountain ranges. The Desert National Wildlife Range was established to provide protection for bighorn.

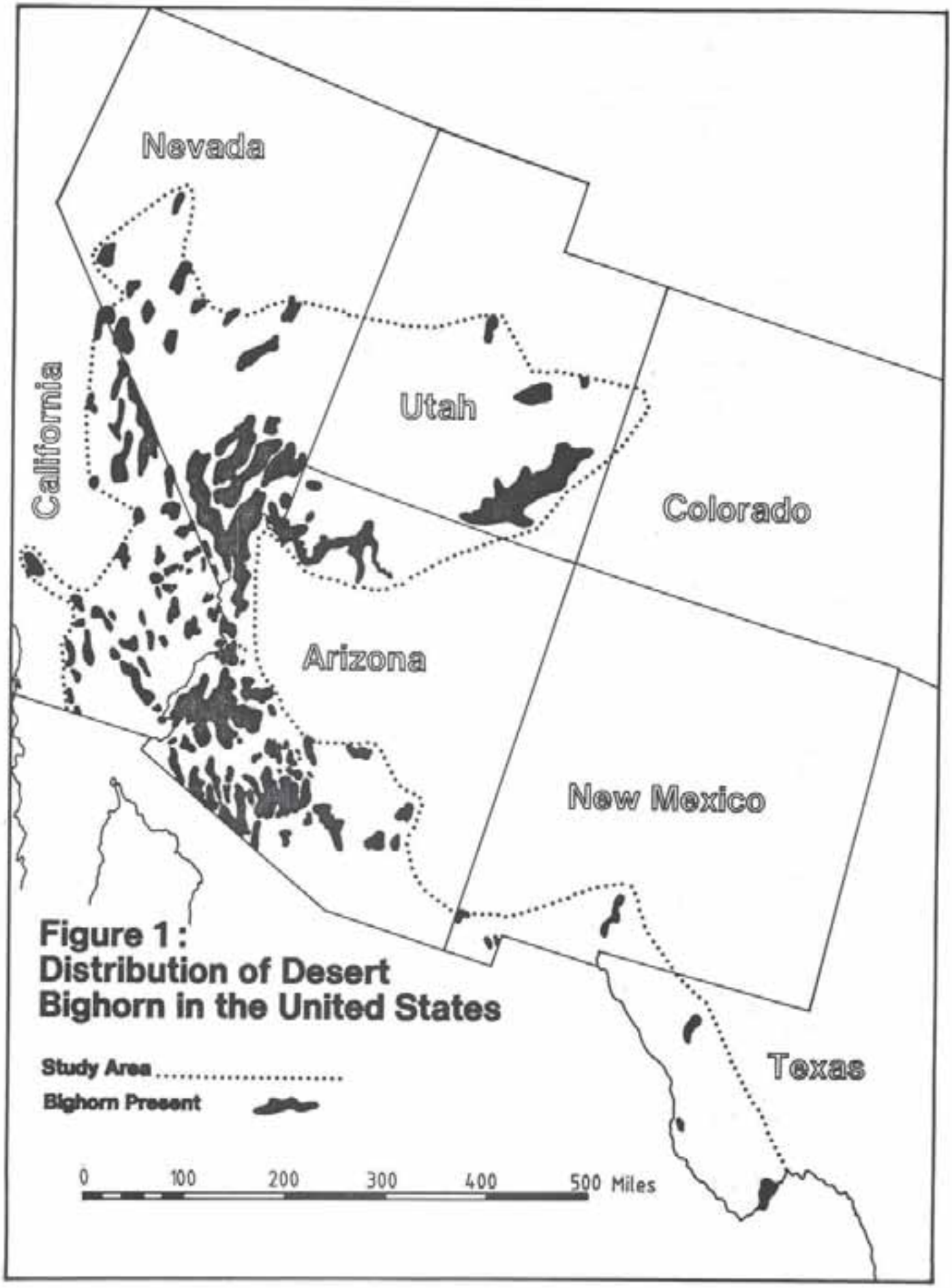

Figure 1:
Distribution of Desert Bighorn in the United States

Bighorn hunting was closed in 1917 and reopened in 1952. The number of tags issued are based on helicopter counts made every two years. There were 119 tags available in 1982. Nevada has a very active and successful reintroduction program. Beginning in 1968 and through 1983, 13 reintroductions have been made in 8 mountain ranges. Additionally, animals have been provided for Zion National Park in Utah, Coloradio National Monument in Colorado and Texas. In 1983, 117 animals were successfully trapped for reintroduction both in and out of the State.

UTAH

The desert bighorn population in Utah is currently estimated at 2,500. Historically, desert bighorn occurred in all canyons of the Colorado, Green and San Juan Rivers. In 1899, the State was closed to bighorn hunting and reopened in 1967 with about 10 permits per year available for trophy hunting. Relocation efforts began in 1973. Through 1983, 133 bighorn have been relocated onto seven historic sites. Helicopter drive netting is the method of choice that works well in this State. Studies, captures, and reintroductions are cooperative efforts with the National Park Service that administers large blocks of habitat.

COLORADO

This State has minimum population of desert bighorn of 60 animals. It is not well documented that the bighorn found in the extreme western portion of the State and in adjacent Utah are desert bighorn. However, it is a desert type of habitat. Reintroductions were made beginning in 1979. Releases have been made in and near Colorado National Monument and near Grand Junction. Stock was obtained from Nevada and Arizona.

CONCLUSION AND SUMMARY

Conflicting land uses are the most common problem experienced in desert bighorn habitat, which includes recreation, mining, and grazing of both domestic and feral animals. Disease, although identified in several areas, has been documented as a problem only in New Mexico and California herds.

Texas and New Mexico are propogating bighorn in an enclosure for reintroduction. The other states are making free releases into the wild. Waterhole trapping, baiting with apple pulp and drive netting and darting have been used successfully to capture bighorn. Bighorn have been drop netted and driven into nets. Netting and drop netting is a method of preference but it is not always possible to get addiction to bait.

Water development programs to enhance the habitat are widely used and perhaps have the greatest success in increasing bighorn population in Arizona and California.

Arizona, Nevada, and Utah have successful hunting programs. Hunter clinics are conducted in Arizona and Nevada to educate the tag holder on the legal ram requirements and other information.

The future looks bright for bighorn in the desert areas. The private sector is playing an important role in this conservation effort.

STATUS OF BIGHORN SHEEP IN THE REPUBLIC OF MEXICO

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ABSTRACT

Due to limited finances and manpower, quantitative data are lacking regarding the numerical and geographical distribution of desert bighorn sheep (Ovis canadensis) in the Republic of Mexico. Based on incidental field observations conducted by personnel of the Direccion General de Flora y Fauna Silvestres (Federal Wildlife Agency), local ranchers and hunters, approximately 5,000-9,000 desert bighorn are presently found in Mexico.

Factors affecting population growth include competition with domestic livestock, particularly goats (Capra hircus), illegal hunting, detrimental land use activities, unpredictable precipitation and resultant forage, less than optimum water availability and predation.

Management programs include attempts to educate the people on the importance and aesthetics of bighorn sheep, establishment of sanctuaries specifically for the propagation and protection of bighorn sheep, implementing stiff penalties to discourage the illegal taking of sheep, the development of tinajas (potholes) to ensure year-long water supplies, providing hunting opportunities and transplant efforts to re-establish new populations on suitable habitat.

INTRODUCTION

Bighorn sheep, regarded as one of the most important mammals in North America, have been the subject of numerous qualitative and quantitative studies. However, due to their relatively low numbers, scattered distribution and inaccessible habitat the rate of data collection has been slow and in many cases, the data have been inconclusive. This is particularly true in the Republic of Mexico, where very little has been published with respect to desert bighorn sheep. Insufficient funding is available to proceed with comprehensive, long-term studies of population dynamics, food habits, nutrition, behavior and competition with other species, including man. This paper is a general synopsis

on the status and management of bighorn sheep in Mexico, and is based on the available literature and personal correspondence with biologists affiliated with the Direccion General de Flora y Fauna Silvestres.

PAST AND PRESENT DISTRIBUTION

Historically, desert bighorn sheep occurred over broad regions in six states of northern Mexico. Available evidence reveals that desert bighorn occupied most of the arid and rugged mountain ranges of Baja California Norte, Baja California Sur, Sonora, Chihuahua, Coahuila and Nuevo Leon (Cossio 1975, Monson 1980). Currently, desert bighorn are found only in Baja California Norte, Baja California Sur and Sonora (Alvarez 1976). Unconfirmed reports suggest that isolated populations leading a precarious existence may occur in Chihuahua and Coahuila.[1] (Figure 1).

Three of the four ecological races collectively known as desert bighorn (Cowan 1940) are found in Mexico:

O.c. mexicana Merrian, 1901. Merrian, 1901. Mexican bighorn. Type from Lago de Santa Maria, Chihuahua, Mexico. The Mexican bighorn is currently found in the northwestern part of Sonora, and Tiburon Island located in the Sea of Cortez (Gulf of California).

O.c. cremnobates Elliot, 1904. Peninsular bighorn. Type from Matomi, Sierra San Pedro Martir, Baja California Norte, Mexico. The Peninsular bighorn is found in the northen two-thirds of Baja California.

O.c. weemsi Goldman, 1937. Weems bighorn. Type from Canon de Tecomaja, Sierra de la Giganta, Baja California Sur, Mexico. The Weems bighorn occurs in the southern one-third of Baja California.

POPULATION TRENDS

Historically, desert bighon were widely distributed and occured in sizable numbers throughout much of northern Mexico. Bighorn sheep have been extirpated from Nuevo Leon, Coahuila and Chihuahua (Cossio 1975, Mendoza 1976). Isolated populations of questionable viability are found scattered in northeastern Sonora. Desert bighorn still persist in northwestern Sonora, although their numbers have declined precipitously since the advent of European man.[2] Baja California contains the largest concentration of desert bighorn in Mexico, and current numbers might be as high as those prior to the exploitation period (Alvarez 1976).

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[1]Jorge E. Mendoza, Jefe de la Oficina de Fauna Terrestre, Netzahualcoyotl 109 1er. Piso, Mexico, D.F. 06080.

[2]Jose C. Trevino, Jefe de Officina de Fauna Silvestre en Chihuahua, Aldana Numero 315, Chihuahua, Chihuahua, Mexico.

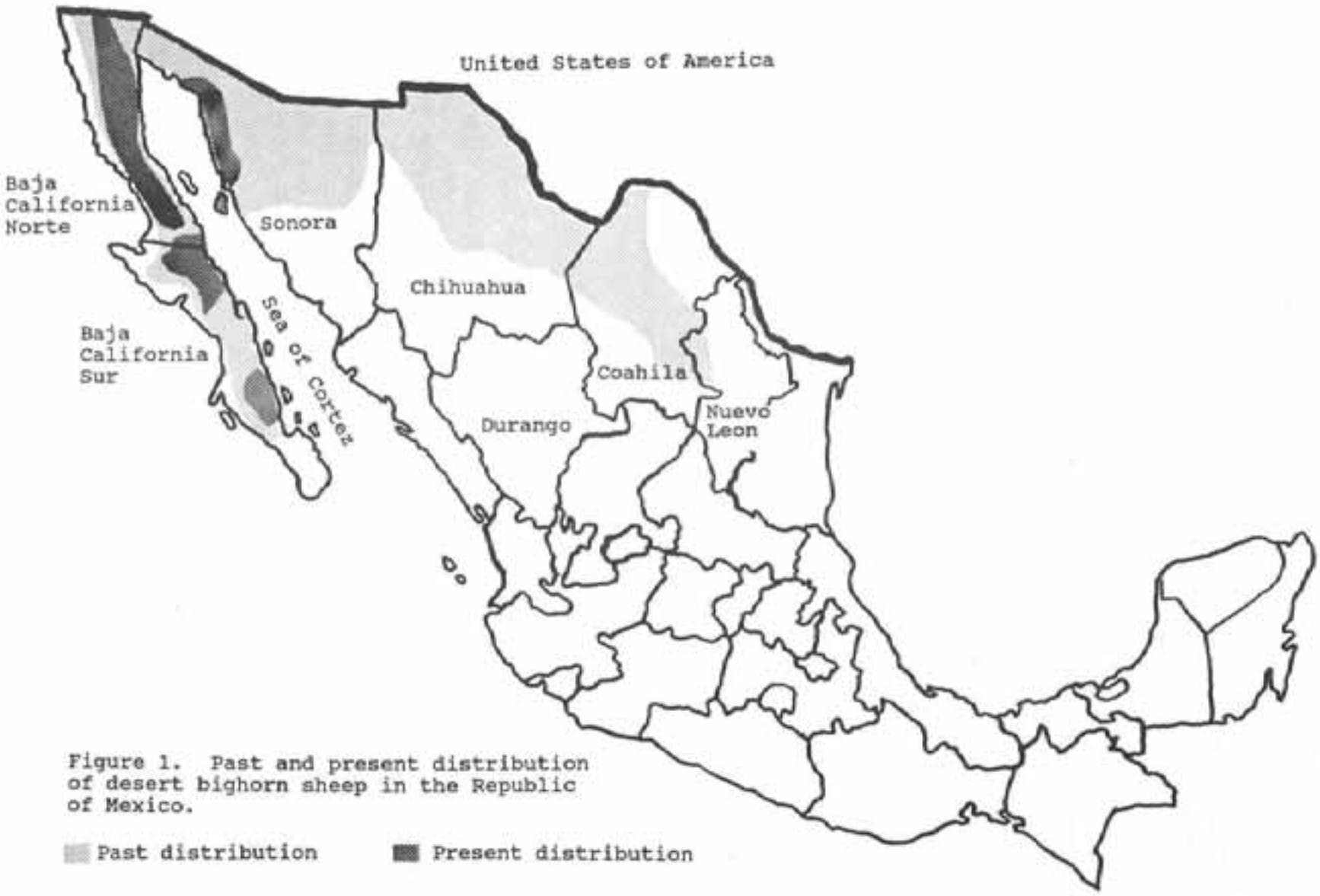

Figure 1. Past and present distribution of desert bighorn sheep in the Republic of Mexico.

SURVEYS

Baja California

Numbers. Since the distribution of desert bighorn in Mexico is not completely known, population estimates are difficult and imprecise. Organized efforts to census bighorn sheep in Baja California were initiated in 1974. Biologists were assigned to accompany every hunter for 10 days, during four different hunting periods. The size of the areas surveyed was determined planimetrically from maps, to aid in calculating the relative density of sheep. Approximately 1,764 km^2 were surveyed during 279 man-days. Based on these results, Alvarez (1976) calculated a maximum of 0.63 sheep/km^2, and a minimum of 0.38 sheep/km^2 (Table 1). Based on mean densities of sheep and size of suitable habitat, Alvarez (1976) obtained a rough estimate of 4,500 to 7,800 desert bighorn in Baja California. This estimate should be considered an approximation, subject to a considerable margin of error due to a lack of knowledge concerning the exact distribution of bighorn sheep.

Table 1. Summary of bighorn sheep surveys conducted in Baja California, Mexico during February and March 1974. Data from Alvarez (1976).

Area	Size-Km^2 y/	Rams		Ewes		Lambs			Density/km^2
		Max.	Min.	Max.	Min.	Max.	Min.		
Matomi	59	25	15	100	68	8	6		1.50
La Assamblea	412	144	78	183	115	43	32		0.54
San Juan	1,179	59	30	138	61	28	15		0.09
Las Virgenes	114	25	10	48	25	26	10		0.39
Total	1,764	253	133	469	269	105	63	$\bar{X}$	0.63

y/ Size of areas actually surveyed.

Population Structure. After subtracting all possible duplicate sightings, the minimum number of sheep observed is 465 (Table 1). These data yield a ram/ewe/lamb ratio of 49:100:23, and a population structure composed of 58 percent ewes, 29 percent rams and 13 percent lambs.

The lamb/ewe ratio suggests poor lamb production and/or survival. Nevertheless, these data should be interpreted cautiously since the survey was conducted prior to the end of the lambing season, and no apparent differentiation was made between ewes of non-reproductive and productive age. These factors would erroneously suggest poor lamb production.

Ewes observed during the spring months may include: (1) ewes with lambs, (2) gravid ewes, (3) ewes that were never gravid, or that had resorbed or aborted their off-spring, and (4) ewes that lambed but lost their off-spring prior to the time they were observed.

Sonora

Numbers. Quantitative population data for Sonora are not available. Mendoza (1976) obtained population estimates based on field observations, interviews with local ranchers and accounts from hunters. Approximately 1,000 desert bighorn sheep are currently found in 10 separate ranges in Sonora (Table 2).

Table 2. Desert bighorn sheep population estimates, Sonora, Mexico. Data from Mendoza (1976).

Area	Estimated Population
Sierra del Viejo	350
Posada-Pico Johnson	300
Isla Tiburon	125
Sierra del Chino	85
Los Mochos	75
El Plomito	30
El Pinacate	30
La Tordilla	25
El Marmol	20
Punto Cirios y Las Cuevitas	20
Total	1,060

MANAGEMENT

Wildlife management in Mexico is still in its infancy. Major emphasis has been placed on people management -- educating the people on the importance and aesthetics of wildlife. Species and habitat management oriented programs also have been implemented on a limited scale.

Management programs for bighorn sheep and other species as well, are severely hampered by very limited finances, and the legal and political structure concerning jurisdiction over wildlife. The Direccion General de Flora y Fauna Silvestres under the Subsecretaria de Ecologia (Under-Secretary of Ecology) exercises authority over all wildlife throughout the Republic. This arrangement has resulted in resentment, and a lack of communication and cooperation between the federal and state wildlife agencies.[1]

[3]Raul Valdez, Professor of Wildlife Science, New Mexico State University, Las Cruces, New Mexico.

Considering the obstacles, Mexico has made progress in the management of bighorn sheep, particularly during the past ten years. Management programs include protective measures by providing monetary incentives to the natives to discourage the killing of sheep for meat, establishment of wildlife preserves, increased surveillance in sheep habitat and implementation of stiff penalties to discourage the illegal taking of sheep. Transplant efforts to re-establish new populations on suitable habitat also have been undertaken. Habitat oriented schemes include the development of tinajas (potholes) to ensure year-long water supplies, and eradication of feral burros (Equus asinus) and goats from bighorn habitat.

PROTECTION

Although wildlife resources are federal property and are managed by the Federal Government, almost all the land us under private ownership. To induce landowners to protect wildlife on their lands, a portion of license fees goes to the landowners. The objective is to provide a monetary incentive, beyond what could be derived from killing bighorn sheep for meat. Licenses income also is set aside for local community improvements, i.e., road maintenance and public services (Cossio 1975).

Mexico is attempting to discourage the illegal taking of bighorn sheep by establishing stiff penalties, and through increased surveillance in sheep areas. Surveillance is carried out through a coordinated system of air and ground reconnaissance. Additional vigilantes (game wardens) have been employed, and outfitted with modern equipment, i.e. 4-wheel drive vehicles, 2-way radios and spotting scopes. Vigilantes on horseback patrol areas inaccessible to vehicles (Araujo 1976).

Certain areas, namely San Pedro Martir National Park, Baja California Norte, have been set aside as wildlife preserves, specifically for the protection of bighorn sheep and their habitat (Cossio 1975). However, without a public education program, sufficient funding, authoritative support and control in the form of law enforcement, refuge designation has little or no meaning.

A zoological park and interpretive area containing desert bighorn sheep was established in 1984, in Hermosillo, Sonora. This project was undertaken by the state government, with the assistance of the Bighorn Sheep Research Institute.[4]

RESTORATION

Mexico has undertaken two bighorn sheep transplants. Both transplants were from Sonora to two different islands located in the Sea of Cortez. In 1975 New Mexico Department of Game and Fish personnel assisted Mexican officials in the capture of 20 bighorn sheep (16 ewes and 4 rams), and subsequent release on Isla Tiburon (Montoya and Gates 1975). This transplant was successful, and the

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[4]James R. Deforge, Executive Director, Bighorn Sheep Research Institute, Palm Desert, California 92261.

current population is estimated at 125 animals.[3] In 1979, Direccion General de Flora y Fauna Silvestres biologists attempted a transplant on Isla Angel de la Guardia. Five sheep (three ewes and two rams) were captured, but only three (two ewes and one ram) survived to be released. This transplant was not successful.[1,2]

HUNTING

The first protective legislation intended specifically for the conservation of wildlife in Mexico was passed in 1894. In 1921, a complete closed season for a period of ten years was proclaimed on bighorn sheep throughout the country (Leopold 1959). Bighorn sheep hunting was again prohibited in 1944. No provision was made for enforcement, and the law was little heeded. In 1963, an open season was held. Fifty permits were issued by random drawing (Cossio 1975). Annual hunts have been conducted in Baja California and Sonora through the present, with intermittent closures in Sonora.

Fifteen of the 25 record-class trophy desert rams belong to the subspecies cremnobates, and all have been taken in Baja California (Valdez 1982). Seasons have averaged ten days in length, and hunter success has averaged between 40-50 percent (Subsecretaria Forestal y de Fauna 1976). Sheep permits cost approximately $15,000.00[1], and also cover the expenses for a professional guide, two spotters, two porters and a cook (Araujo 1976).

Mexico has experimented with a point system, and horn curl criteria in the definition of a legal ram. A point system was enacted in 1974. Under this system a ram in Baja California Norte had to measure a minimum of 180 Boone and Crockett points, and in Baja California Sur, the minimum was set at 170 points to be legal. A fine of 5,000 pesos for each point below the established minimum was implemented. During the 1974 hunt, only 1 of 19 rams harvested exceeded 180 points (Subsecretaria Forestal y de la Fauna 1976). Numerous hunters felt that 180 points was unrealistic. Few people are capable of determining the minimum points established. Most hunters will take a smaller sheep, pay the fine and leave. Few sheep over 180 points were observed.

PROBLEMS AFFECTING BIGHORN SHEEP MANAGEMENT

FINANCES

The most obvious and immediate shortcoming of bighorn sheep management in Mexico is the absence of an effective plan of protection and law enforcement. The inadequacy of present bighorn sheep programs stems directly from lack of financial support by the federal government. Funds for operation of wildlife programs are drawn from the general appropriation, but the actual allocation of support from this source is pitifully low. The wildlife program does not even receive for its own use the equivalent funding generated from hunting license fees.

HABITAT MANAGEMENT

The entire legal structure of bighorn sheep conservation is based on the premise that regulation of hunting is the number 1 problem. Granted that the most immediate problem is the enforcement of regulations, the law should not

be limited to that objective but should be broadened to provide for phases of bighorn sheep management that include environmental conservation. The patterns of agriculture grazing and forest use have profound effects upon local game populations, but they are dictated by economic needs and are not easily changed to favor wildlife.

PUBLIC EDUCATION

Bighorn sheep conservation in Mexico must have its beginnings in the minds of the rural population. In general, the rural Mexican lives according to the traditions established by his ancestors, and seldom does he accept innovations. He believes what he was taught at home and what he sees with his own eyes.

A bighorn sheep conservation program will not be effective until the public education phase catches up with the limited technical and legal advances. Therefore, an aggressive educational effort concurrent with existing conservation programs is needed, since few people understand the critical situation of Mexico's wildlife resources.

TECHNICAL TRAINING

Technical knowledge and trained personnel will be essential to promote bighorn sheep conservation efforts. At the present time, no wildlife management curriculum exists in any of the educational facilities in Mexico.[5] Therefore, a source of personnel trained in wildlife does not exist. Most of the employees of the Direccion General de Flora y Fauna Silvestres are trained in zoology or related fields. A few biologists have completed advanced wildlife training in the United States.

EXOTIC UNGULATES

At least two introductions of aoudad (Ammotragus lervia) have taken place on historic desert bighorn range in Coahuila and Nuevo Leon. These exotics have increased and dispersed over a relatively large area (Rangel and Simpson 1979). The release of aoudads in Mexico was not designed to supplement the endemic fauna for sport hunting purposes, rather to fulfill the interests of individuals for a private collection of exotics.

The existence of aoudada on historic bighorn sheep habitat will render these areas unsuitable for the restoration of bighorn, and the unchecked dispersal of aoudad into occupied bighorn habitat could have a deleterious impact on the remnant bighorn populations found in northeastern Sonora.

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LITERATURE CITED

Alvarez, T. 1976. Status of desert bighorns in Baja California. Desert Bighorn Council Trans. 20:18-21.

Araujo, E. 1976. Development of the program for protection of bighorn sheep in Baja California. Desert Bighorn Council Trans. 20:12.

Cossio, M.L. 1976. Report from Mexico. Pp 72-74. In the Wild Sheep in Modern North America, J.B. Trefethen (ed.). The Winchester Press, N.Y. 302 pp.

Cowan, I. McT. 1940. Distribution and variation in the native sheep of North America. Amer. Midl. Nat. 24:505-580.

Leopold, A.S. 1959. Wildlife of Mexico. Univ. of California Press, Berkeley and Los Angeles. 568 pp.

Mendoza, J. 1976. The bighorn sheep of the state of Sonora. Desert Bighorn Council Trans. 20:25-26.

Monson, G. 1980. Distribution and abundance. pp 40-51 In The Desert Bighorn G. Monson and L. Sumner (eds.). The Univ. of Arizona Press, Tucson. 370 pp.

Montoya, B. and G. Gates. 1975. Bighorn capture and transplant in Mexico. Desert Bighorn Council Trans. 19:28-32.

Rangel, E. and C.D. Simpson. 1979. Status of Barbary sheep in Mexico. Pp 30-32 In Symposium on Ecology and Management of Barbary Sheep, C.D. Simpson (ed.). Texas Tech Univ., Lubbock. 112 pp.

Subsecretaria Forestal y de la Fauna. 1976. Borrego Cimarron. Talleres Graficos de la Nacion, Canal del Norte Num. 80, Mexico 2, D.F. 231 pp.

Valdez, R. 1982. The wild sheep of the world. Wild Sheep and Goat International, Mesilla, New Mexico. 186 pp.

STATUS AND DISTRIBUTION OF *Ammotragus lervia*: A WORLDWIDE REVIEW

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ABSTRACT

The so-called Barbary sheep or Aoudad, designated by a number of native and European names, is the only member of its genus. Both males and females are distinctive because of their large horns and long chap hair on the forelegs. Fossil remains have been found at a number of locations in North Africa, and similar forms have been recovered in Europe and North America. Rock paintings in Algeria and Egyptian tomb and temple reliefs all suggest an animal of considerable ecomonic and cultural importance. *Ammotragus* is probably ancestral to the Eurasian sheep, and might also be an ancestor of the goats. The probable phylogenetic relationship of *Ammotragus* to the other Caprini strongly supports the view that it should be maintained as a full and separate genus. Six subspecies are recognized. Barbary sheep occupy arid mountains or canyons in areas of rugged terrain throughout their endemic and exotic ranges. In North Africa, the species inhabited all the major mountain massifs of North Africa above about 10°N latitude within historic times, although some populations have been extirpated as a consequence of intensive hunting and poaching. In Europe, Barbary sheep were recently released in Spain; earlier introductions in Germany and Italy were unsuccessful. In the United States, there are at least five major free-ranging populations in Texas, New Mexico, and California, and the species is expanding its range. At lease four introductions occurred in Mexico, but apparently all of the wild populations have now been extirpated. Populations in North Africa appear to be threatened, but aoudads compete with native wildlife in the southwestern States.

INTRODUCTION

The Barbary sheep (Ammotragus lervia) is the sole member of its monotypic genus within the Tribe Caprini of the Subfamily Caprinae and Family Bovidae. The species is sometimes referred to as the Arui, or more commonly as the Aoudad, particularly in Mauritania. Other native names include Arouy in Algeria (Lataste 1885: 288, Hartert 1913: 36); Kebsh el Gebel and Wadden in Egypt (Osborn and Helmy 1980); Drrui in Morocco (Cabrera 1932); Beddan (males only) or Tedal/Teytal in Nubia (Blyth 1839: 76); Naded, Naddan, or Oudad in Tunisia (Schomber and Kock 1960); and Wodad by some Arabian tribes of North Africa (Khushal Habibi, personal communication, 1984). Old males are sometimes called Fischthal (Michel Anciaux de Faveaux, personal communication, 1984). In Europe, the species is known as the Mouflon à manchettes, Mouton Berbère, Mähnenspringer, Mähnenshaf, Muflone Berbere, and Arrui.

The following combination of gross morphological characteristics is diagnostic for Ammotragus (Gray and Simpson 1980): the presence of true horns (on females as well as males), subcaudal gland, ventral neck mane, and chap hair on the front legs of adults (particularly evident on males); and the absence of preorbital, interdigital, or inguinal glands, and an inter-ramal chin beard. Although a mane is found on other caprines, chaps are apparently peculiar to aoudads (Figure 1).

The purpose of this paper is to summarize the status and distribution of Barbary sheep throughout the world.

METHODS

My familiarity with the historic status and distribution of Barbary sheep is a result of two efforts: (1) background information I gathered before conducting field research on Barbary sheep biology in Palo Duro Canyon, Texas (Gray 1980); and (2) additional literature sources that were consulted while preparing the species' account for the Mammalian Species series (Gray and Simpson 1980). Information on current status and distribution was solicited in letters sent to over 70 members of the American Society of Mammalogists residing in countries where wild Ammotragus populations were known or thought to exist.

FOSSIL RECORD AND ARCHEOLOGICAL EVIDENCE

In North Africa, Barbary sheep remains (Ovis paleotragus) were recovered from Villafranchien deposits near Constantine (Joleaud 1918) and at Mansoura in Algeria; they were common in Mousterian and Upper Paleolithic deposits, but rare in the Neolithic (Pomel 1898). Quaternary sediments also yielded remnants of the species (Thomas 1884), and they have been found in caves in the Akouker and Haizer massifs at Djurdjura (Arambourg 1927). Ammotragus fossils, called A. palaeotragus, were dated to the Pleistocene according to Trouessart (1904-5). More specifically, Vaufrey (1955) noted this species among the Pleistocene fauna in the Maghreb (Atlas massif), and Arambourg et al. (1934) recorded Barbary sheep at Beni Segoual.

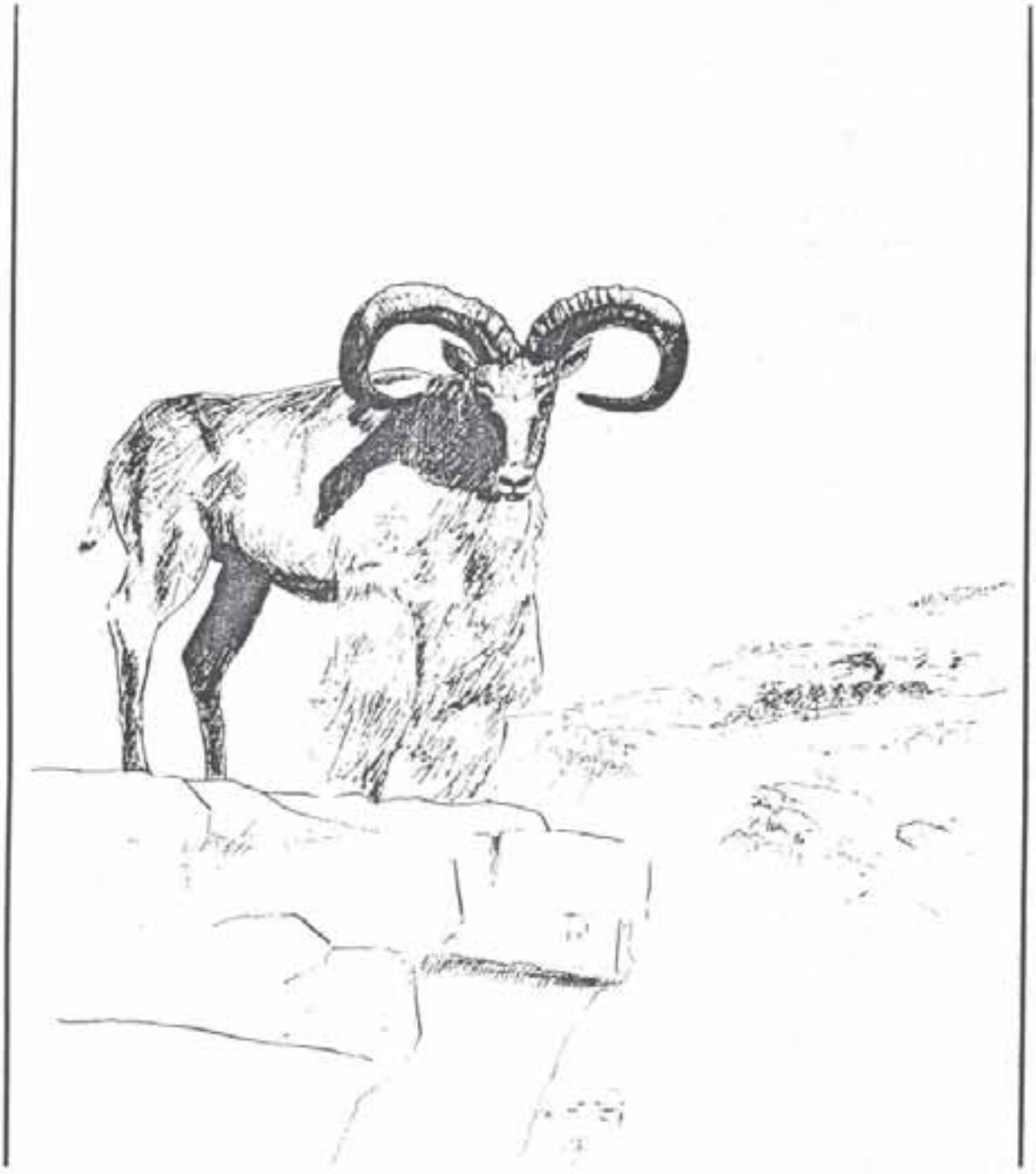

Figure 1. ***Ammotragus lervia***, apparently the only caprine with chap hair on the forelegs, occupies arid mountains and canyons within its endemic North African distribution, and in its exotic range in Spain and the southwestern United States. Drawing by J. David Renwald.

McBurney (1967) found Ammotragus remains at Haua Fteah, a large natural cave on the northern coast of Cyrenaican Libya, in a number of deposits that ranged in age from about 85,000 to 2,000 years old. Bate (1955) discussed the vertebrate faunas, including Barbary sheep, from Quaternary deposits in Cyrenaica.

Fossil sheep remains have been recovered from superficial deposits in Europe and were referred to as Ovis tragelaphus fossilis by Seres (1848:149), and O. magna and O. primoeva by Gervais (1852:76). Lydekker (1912:310) commented that these "sheep were akin to the modern arui of North Africa."

Osborn (1910:433) wrote of the Pleistocene in North America and mentioned "a wild sheep (Ovis paleotragus) very similar to the existing Barbary sheep."

B. Brentjes (1980) commented that rock paintings in North Africa and in early Algerian hunting camps indicate that Barbary sheep were more widely distributed in the past than they are now. Thus, he considered their recent distribution to represent a remnant population range.

A Central African subtropical (or tropical) fauna dominates the oldest rock paintings from the North African region. About 2,000 years ago Barbary sheep began to appear with increasing frequency in rock paintings, although Brentjes (1980) remarked that the species was evidently widespread prior to this period.

Barbary sheep are present in hunting scenes on pottery from the Negade culture (late 4th century B.C.) that probably came from the periphery of the Nile Valley (Brentjes 1980). Pictographs of Barbary sheep are less frequent during the transition to the Dynastic Era, and are limited to representations of captive animals. Brentjes further conjectured that human colonization of arable lands might have driven Barbary sheep out of this area, and that they moved both eastward and westward. Meanwhile, the species was used in rituals and sacrifices and had become quite scarce. For this reason, some Barbary sheep may have been maintained in enclosures (Brentjes 1980).

A different view was expressed by Zeuner (1963) who contended that Barbary sheep, unlike other native bovids, were never domesticated. They were hunted by the ancient Egyptians and presented as offerings (Butzer 1959). In any event, Barbary sheep were obviously widespread in ancient North Africa, and their portrayal in Egyptian tomb and temple reliefs suggests an animal of some economic and cultural significance.

PHYLOGENETIC RELATIONSHIPS

Valerius Geist (1971) provided a plausible explanation for the evolutionary relationship of Ammotragus to the other caprines. He arranged the Eurasian mountain sheep in a cline based on external appearance and geographic distributions, and considered Barbary sheep to be ancestral to this Palaearctic sheep lineage. This hypothesis was based on the observation that Barbary sheep exhibit more rupricaprine characteristics than any other

caprine. Rupricaprines, of which the chamois (Rupicapra) and Rocky Mountain goat (Oreamnos) are living representatives, are thought to be the progenitors of the Caprinae.

Several studies have been conducted to clarify the phylogenetic relationship of Ammotragus to the other Caprini using techniques from biochemistry, molecular biology, and immunology. Serum protein analyses by Schmitt (1963) and immunoglobulin cross-reactivity studies by Curtain and Fudenburg (1973) indicated a close relationship between Ammotragus and Ovis. The amino acid sequence of various hemoglobin chains examined by Manwell and Baker (1975) showed that Ammotragus hemoglobin was more nearly similar to than from the domestic goat (Capra hircus) that from the domestic sheep (Ovis aries), but also exhibited some unique characteristics. However, an immunological technique adapted for computer analysis by Hight and Nadler (1976) demonstrated a closer relationship between Ovis and Capra than between either of these and Ammotragus!

Based on chromosome studies, Nadler et al. (1974) suggested the following summary of caprine evolution:

> "The cytogenetic evidence suggests there are two main lineages among surviving caprines. Starting from a hypothetical rupicaprine-type ancestor with a primitive 2n = 60, FN = 60 karyotype, one lineage evolved through an intermediate, aoudad-like form to the true sheep, with reductions in diploid number. In the true goat (Capra) lineage, morphological differentiation proceeded while the karyotype remained conservative; in contract, the thar (Hemitragus) has remained morphologically close to the hypothetical rupicaprine ancestor while its chromosome number has been reduced (2n = 48). The 5th member of the tribe Caprini, the bharal (Pseudois nayaur) has a reduced chromosome number (2n = 54) but morphologically exhibits convergence toward true sheep."

This supports Geist's (1971) view that: (1) Ammotragus is ancestral to the Eurasian sheep, and more nearly resembles the Armenian urial (Ovis orientalis gemelini) and the Elburs urial (Ovis o. orientalis) than other members of the genus Ovis; and (2) Ammotragus could also be an ancestor of the goats, particularly the round-horned ones, and forms a cline of similarity and geographic distribution through the Caucasian tur (Capra cylindricornis) to the bharal (Pseudois).

TAXONOMIC STATUS

Linnaean binomial nomenclature was first applied to the Barbary sheep by P.S. Pallas, who referred to it as Ant(ilope) lervia in 1977. Two synonyms, Ovis tragelaphus (Afzelius 1815:216) and Ovis ornata (Geoffroy Saint-Hilaire 1827:264), were used during the 19th century before the current name combination was applied by Thomas in 1902. The genus name Ammotragus--meaning "sand goat" (Valdez and Bunch 1980)--had first been used by J.E. Gray (1950). A succession of generic or subgeneric reassignments from 1840 to 1902 may have contributed to confusion about the taxonomy of the species. These other name combinations were listed by Gray and Simpson (1980) for the convenience of those interested in the systematics of Barbary sheep.

Ansell (1971), Corbet (1978), and Van Gelder (1977) all included Barbary sheep in the genus Capra. Their justification for this assignment was that Barbary sheep will interbreed with goats--sometimes producing live hybrid offspring--and that Ammotragus is anatomically closer to Capra than to other Caprini. Geist (1971) discounted the ability of Barbary sheep to hybridize with goats as an indicator of a closer phylogenetic or taxonomic relationship. He hypothesized that reproductive barriers between Ammotragus and Ovis were established during the Pleistocene when they had a sympatric distribution in North Africa. Ammotragus and Capra were not sympatric and therefore had no cause to develop reproductive barriers.

Based on the evidence I have summarized, Gray and Simpson (1980) maintained Ammotragus as a full genus. Nowak and Paradiso (1983:1301) subsequently concurred in this view by listing Ammotragus as a separate genus in the most recent edition of Walker's Mammals of the World.

GEOGRAPHIC DISTRIBUTION OF SUBSPECIES

G.M. Allen (1939) recognized six subspecies of Ammotragus lervia, and Gray and Simpson (1980) summarized the type locality of each. However, Michel Anciaux de Faveaux (personal communication, 1984) collated detailed geographic distributions of four of these subspecies, and much of the summary that follows is based on his account.

A. l. lervia was described as inhabiting "Africae borealiori propria" by Pallas (1777:12), but the type locality was later restricted to the "Department of Oran, western Algeria" by Harper (1940:327). It is present in the mountains of Morocco and Tunisia, the northern part of Algeria (in the Saharan Atlas Mountains at Bèchar à Gafsa [Le Berre 1983:390]), and in the regions of Air and the Tibesti massif (Lhote 1957:88); but was approaching extinction in Algeria and Tunisia, according to Schomber and Kock (1960:279). This is apparently the subspecies that was imported to European zoological gardens in the late 1800's, and from there to American zoos about 1900 (Ogren 1965:6). Surplus zoo stock was later sold to private individuals and subsequently escaped (or was released) to form the basis of free-ranging populations in the western United States. It has also been introduced in the Sierra de Espuna Mountains of Murcia in Spain (J.R. Vericad, personal communication to M. Anciaux de Faveaux, May 1982).

The type locality of A. l. ornata was defined as "pres des portes de la ville du Caire" (= Cario, Egypt) by I. Geoffroy Saint-Hilaire (1827:264). Its distribution was given by Osborn and Helmy (1980:521) as being the central part of the Eastern Desert in Egypt, as well as central and southwestern parts of the Western Desert. This subspecies was rather rare, and Heinemann (1972:493) indicated it may already be extinct.

The type locality of A. l. sahariensis was given as "Oued Mya" (Rothschild 1913:459), which is located between El-Golea and In-Salah, 28°30'N, 3°E, in the Algerian Sahara. This subspecies has a very large geographic distribution that includes parts of southern Morocco, the Sahara of Southern Algeria, southern Tunisia, southeastern Libya, Sudan, Mali (Adrar des Iforas), Niger (Air and Djado), Mauritania, and the Tibesti Mountains. It has been introduced into the "Park for the Preservation of Saharan Fauna" in Almeria, Spain (Cano and Vericad 1983).

The type locality for A. l. blainei was listed as the "Border of Dongola Provice and Kordofan" in the Anglo-Egyptian Sudan (Rothschild 1913:460). Schomber (1960) called this the Kordofan Barbary sheep and indicated its range was restricted to isolated mountains in the provinces of Darfur, Dordofan, and Nubia. In 1923 this subspecies was introduced into the Sabaloka reserve on the Sixth Cataract of the Nile.

The type locality for A. l. angusi was recorded as "Tarrouaji Mt. Asben, 3,100 ft," French West Africa (Rothschild 1921:75); and Heim de Balsac (1934:489) placed it at Adrar des Iforha (18°-20°N and 1° -3°E).

The type locality for A. l. fassini is the Garian range of northwestern Libya (Lepri 1930:271). It also occurs in the extreme southern part of Tunisia (Schomber and Kock 1960:280), and has been introduced into the "Park for the Preservation of Saharan Fauna" in Almeria, Spain (Cano and Vericad 1983).

ECOLOGICAL DISTRIBUTION

Perhaps the greatest variation in altitudinal distribution of Barbary sheep was recorded within its endemic North African range in Morocco. There, the species is known to have inhabited desert mountains of the Sahara, ranging from sea level up to the extent of snow-free areas at about 3900 meters (10,694 feet) (Jolead 1928). In this region, Barbary sheep habitat is characterized by rough, rocky slopes covered with loose stones of all sizes, from pebbles to boulders (Rodd 1926). Vegetation is sparse, limited to a thin cover of grasses, scattered shrubs, and a few acacias (Brouin 1950).

Reginald Barrett (1967) distinguished three somewhat different types of Barbary sheep habitat in Africa:

> "One is the Atlas Mountain region, straddling the 35°N parallel. Besides being steep and rocky, this habitat is characterized by elevations of up to 13,000 feet (3960 meters), where much of the 10-25 inches (25.4-63.5 centimeters) of precipitation falls as snow. It is not on the lower desert, but up on the mountain slopes that the aoudad lives (Joleaud 1927, Panouse 1957).
>
> "A second habitat is that of the true desert mountains, such as the Tibesti, Ahaggar, and Air massifs, lying between 15° and 25°N latitude. Although these mountains rise as high as 11,000 feet (3351 meters); the climate is dry, averaging one to five inches (2.54 to 12.7 centimeters) annual precipitation.
>
> "The third habitat includes the rugged canyons eroded into the plateaus of much of the Sahara (Brown 1965:44). Many such canons are characterized by steep cliffs which provide good aoudad cover. Areas such as this in north central Libya receive less than five inches (12.7 centimeters) of rainfall a year".

Introduced free-ranging populations in the southwestern United States occupy canonlands with gorges to 244 meters (800 feet) in depth at elevations up to 1829 meters (5,015 feet) in Palo Duro Canyon of the Texas Panhandle; mean January and July temperatures are 2.8°C (37.1°F) and 24.3°C (75.5°F), respectively, with an average annual precipitation of 53.6 centimeters (21.1 inches). In the Canadian River gorge of northeastern New Mexico, Barbary sheep habitat is situated in canyons more than 305 meters (1,000 feet) deep at elevations of 1371 to 1828 meters (4,500 to 6,000 feet). This area has mean January and July temperatures of -1.2°C (29.9°F) and 20.7°C (69.3°F), respectively, and a mean annual precipitation of 32 centimeters (12.6 inches). The population in Largo Canyon of northwestern New Mexico lives at an altitude of 1739 to 2040 meters (4,916 to 5,594 feet) (Bird and Upham 1980), whereas most sightings in the Rio Hondo Valley and surrounding vicinity of southeastern New Mexico were between 1219 and 2312 meters (3,342 and 6,340 feet) (Dickinson and Simpson 1980).

Barbary sheep throughout the southwestern United States are found most often in rugged terrain (Ogren 1965, Evans 1967), and habitat utilization is greatest in areas of precipitous topography (Hampy 1978, Simpson and Gray 1983). Typical vegetation at occupied sites in this region includes ponderosa, white, or pinyon pine (Pinus spp.) at higher elevations. Juniper (Juniperus spp.), mountain mahogany (Cercocarpus montanus), and mesquite (Prosopis glandulosa) are important components of the shrubby vegetation at lower altitudes. A variety of shortgrass prairie and semiarid grasses and forbs comprise the understory plants in these areas.

The California population on the West Coast of the United States inhabits an area characterized by a Mediterranean climate with wet, cool winters and dry, hot summers. Annual precipitation there is 63.5 to 88.9 centimeters (25 to 35 inches), of which snow may comprise a small fraction (Barrett 1966). Topography in the Santa Lucia Mountains is less rugged than the terrain in most other locations occupied by Barbary sheep, but several fairly distinct herds are each associated with a large rock outcrop surrounded by oak (Quercus spp.) woodland (Barrett 1980). The other important plant communities in areas utilized by Barbary sheep are grassland, coastal sage scrub, and introduced pine (Pinus spp.) forest (Johnston 1980).

STATUS AND DISTRIBUTION IN NORTH AFRICA

Ammotragus may have shared the epithet "Ophion" with Ovis ammon in ancient accounts written by Pliny and others (Cuvier 1827:359). However, "Caio Britannico described a large wild sheep that populated the mountains of North Africa" in 1561 (Scortecci 1957:492). This is probably the earliest European account we have of Barbary sheep.

Lhote (1957:88) designated the species' range as being all the hills of the Sahara, especially the Hoggar, Tassili, Ayr, and Tibesti mountains. Barrett (1967) summarized the endemic geographic distribution

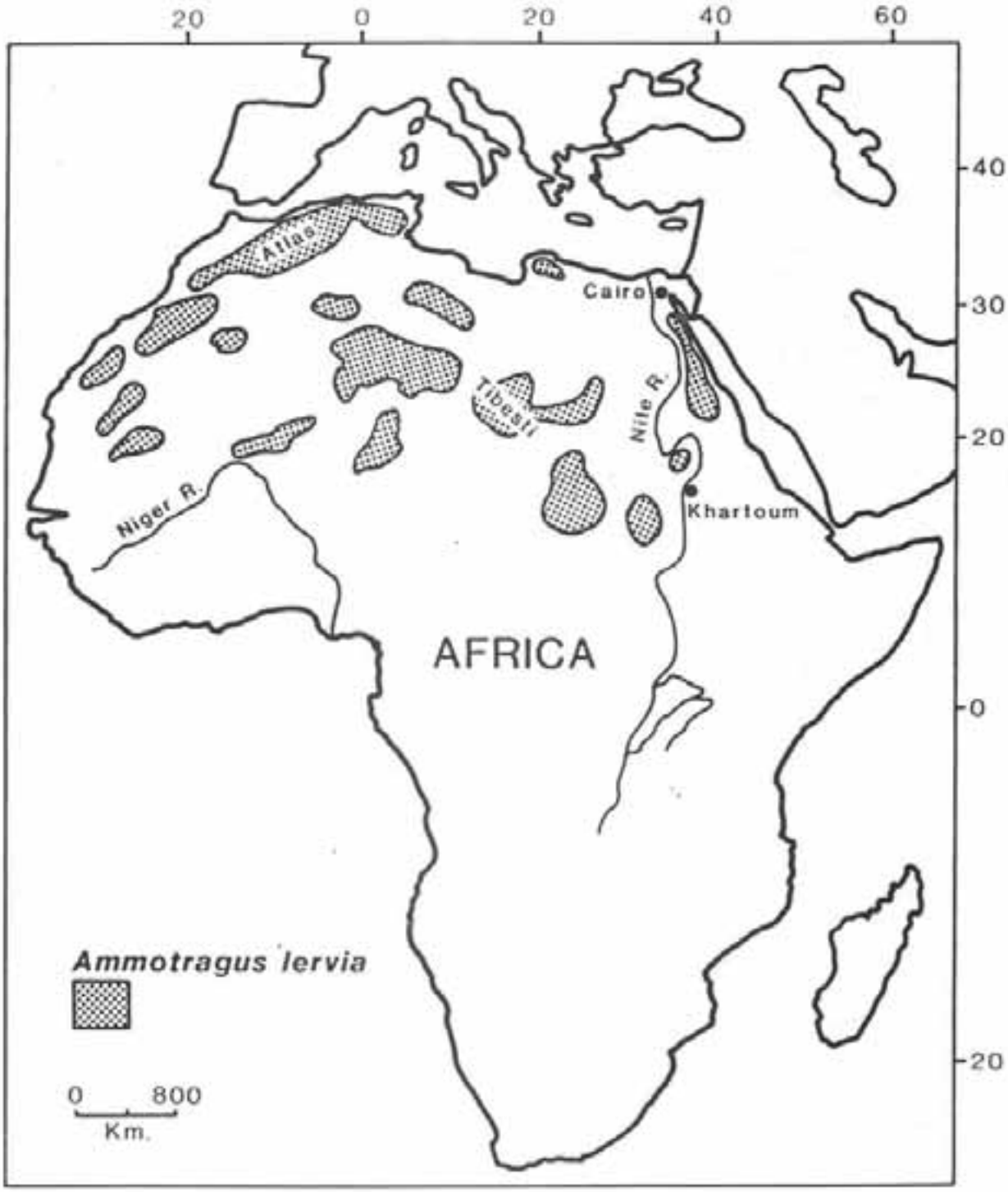

Figure 2. The approximate geographic distribution of *Ammotragus* in North Africa. Adapted from G.B. Schaller, 1977, Mountain Monarchs: wild sheep and goats of the Himalaya, University of Chicago Press, Chicago and London

of Barbary sheep and indicated that the species inhabited all the major mountain massifs of North Africa above 15°N latitude; his sources included Bigourdan and Prunier (1937), Rode (1943), Brouin (1950), Malbrant (1952), and Edmond-Blanc (1957).

Schaller (1977:63) stated: "The aoudad confines itself to Africa north of 10° latitude, being found in many of the ranges and isolated massifs that lie in and around the Sahara--Atlas, Ahaggar, Air, Tibesti, Dar Fur, Adrar des Iforas, and others (see Joleaud 1929)." The approximate distribution of Barbary sheep in North Africa shown in Figure 2 is based on Schaller's (1977:53) range map.

Brentjes (1980) suggested that Barbary sheep may have penetrated into Central Africa at the height of the Pleistocene glacial period. During this time the dunebelts extended southward, and he considered that large parts of North Africa may have been too dry even for Barbary sheep. As a consequence, Brentjes commented that populations in the southern part of the species' range, and those around the Red Sea, should be regarded as remnant populations.

In Algeria, K. De Smet (personal communication, 1984) of the Department of Forestry at the Institut National Agronomique in El Harrach described the status and distribution of Barbary sheep in a recent letter to me. I have paraphrased his account, as follows:

Although the species is fully protected by law, Barbary sheep are subjected to heavy poaching as they occur in areas where law enforcement is very poor. One positive point is that for security reasons (to prevent assassinations), hunting is only allowed by lead pellets: high-powered rifles with telescopic sights are prohibited all over the country. Therefore, hunters have to approach Barbary sheep as closely as 30 meters or so in order to kill them, which is far from easy!

Probably a lot of poaching is done by snares, but the Touaregs are known to kill them by cutting their throats after jumping on them in the early morning or at night in places where they sleep!

The only protected area where the species occurs is the Tassili National Park in the south (Djarnet), but there is a lot of poaching even there because the Libyan border is so close. We intend to introduce them in a 1200-hectare reserve (Mergueb) located 170 kilometers south of Algiers, but law enforcement is still too inadequate to release them at this time. The zoo at Algiers has a little breeding stock and they intend to capture some more animals to avoid inbreeding.

De Smet also enclosed two maps on which he outlined the distribution of Barbary sheep in Algeria. I have consolidated this information into one map shown in Figure 3.

In Egypt, Ralli (1957) said Barbary sheep did not exist in the northern part of the Nile Valley mountains, but were present near the center of that massif close to Assiouh. He further commented that a fair number had been there for 30 years, but that numbers were diminishing. They were said to be easy prey for the Bedouins because they inhabit less rugged terrain--and are less agile--than the ibex, even though they cannot be approached as closely as the ibex.

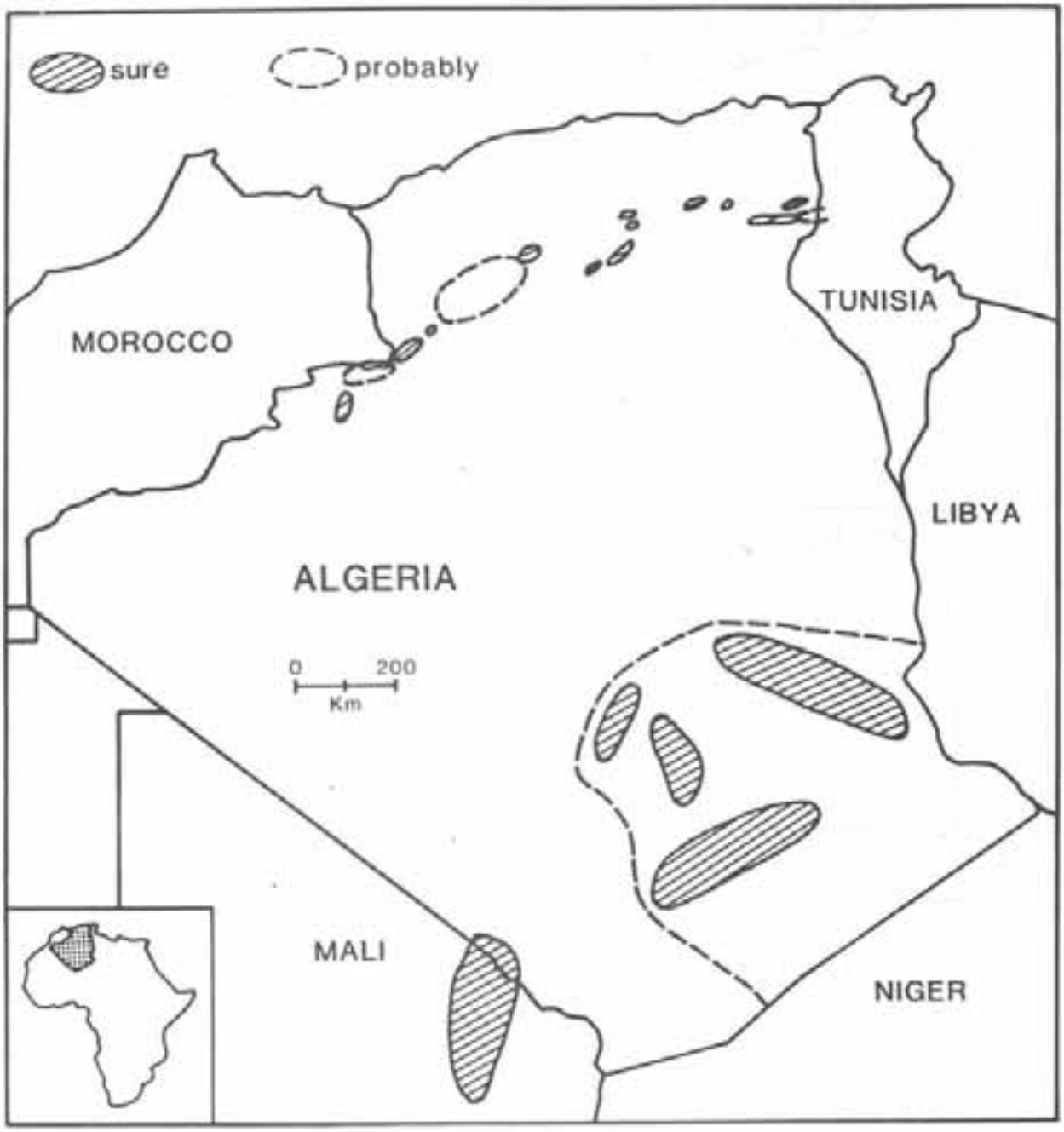

Figure 3. Present distribution of ***Ammotragus*** in Algeria. Adapted from K. DeSmet (personal communication, 1984), Département de Foresterie, Institut National Agronomique, El Harrach, Algéria.

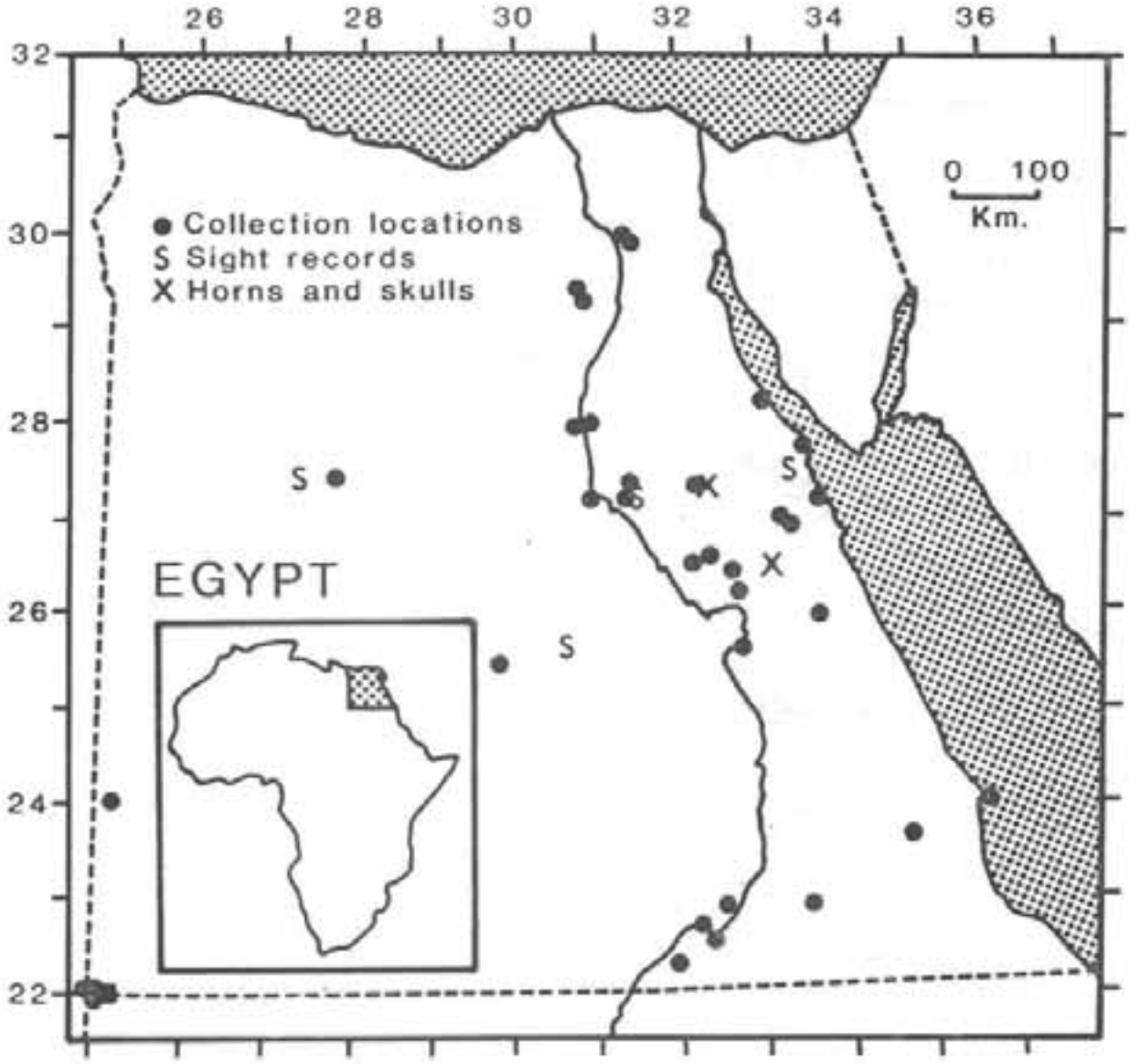

Figure 4. Historic distribution of ***Ammotragus*** in Egypt , based on collection locations of whole animals, of horns and skulls only, and documented sightings. Adapted from D.J. Osborn and I. Helmy, 1980, The contemporary land mammals of Egypt (including Sinia), Fieldiana Zool. No.5 (new series), Publ. 1309

Osborn and Helmy (1980) listed records of kills and observations in Egypt published from 1832 to 1971. Under the heading of "historical notes," Osborn and Helmy indicated that:

> "Within historical time, Barbary sheep probably inhabited most of the Eastern Desert and areas of rugged terrain in the Western Desert. In the Eastern Desert, incidentally, a well, a wadi, and a mountain are called Umm Kibash (Mother of wild sheep). The type of A. I. ornatus was shot "outside the gates of Cairo" (Rothschild, 1913, p. 459), and Barbary sheep were reported to have existed in the hills east of Cairo in the late 1700's (Anderson, 1898). Russell (1831) commented that sheep lived in the rocky deserts bordering the Nile, but did not occur habitually in the vicinity of Cairo. Numberous explorers since have observed Barbary sheep and their remains and published these, together with reports from guides. Many of these references pertain to Wadi Qena, Wadi Asyuti, and adjacent drainages in the Maaza Plateau. Flower (1932, p. 435) stated that, although the Barbary sheep was said to occur on both sides of the Nile in Upper Egypt during 1900-1909, by 1910, it had become 'really scarce.' Bedan (1928) killed a Barbary sheep in Wadi Asyuti in February 1927. He commented on the hunting pressure during World War I in the Wadi Asyuti area and said that a 1920 expedition had found no game. Some sheep, he thought, took refuge in an inaccessible cliff east of Wadi Asyuti on the west side of Wadi Qena. Russell (1949ab, 1951) recounted the decimation of Barbary sheep and ibex in the Wadi Qena-Wadi Asyuti country by commercial hunters, particularly during the war years when meat was scarce and expensive. He concluded that wild sheep no longer existed north of Gebel Elba.
>
> "Of interest is the comment by Hoogstraal (1964, p. 237) that 'Legends of wild sheep on Gebel Elba are rife among Bishareen, but we obtained no specimens.' We do not know if sheep ever existed in the Elba mountains, although they were known to occur on Gebel Hisse (Isse or Is) 100 km. SW of Elba (Sclater, 1895).
>
> "Recent observations of Barbary sheep in Wadi Asyuti and Wadi Mellaha in the Eastern Desert and Ain Dalla and Gebel Uweinat in the Western Desert (see above) indicate that small populations survive in isolated areas. The most recent record is a specimen killed by a hunter in 1972 near Bir el Obeiyid NW of Farafara Oasis. Further indication of the former extent of distribution is the horns found in 1927 in Qattara Depression near Minqar Abu Dweiss (Murray, 1967)."

A map of locations in Egypt where Barbary sheep were killed, where horns and skulls were collected, or where sightings occurred (Figure 4) is adapted from Osborn and Helmy (1980). This indicates the historic distribution of the species in Egypt, but it is clear that only small numbers of the original populations remain in widely scattered groups.

In Libya, Toschi (1957) stated that Barbary sheep were present in the mountains south of Nabut and Garian, near Syrte and Mizda and east to Gebel Soda, at Ouaddan near Aruggi, and particularly in the vicinity of Ghat and mountains to the south. According to Khushal Habibi (personal communication, 1984), they apparently still "occur in viable numbers in the

Tibesti mountains...(that) form a chain between Chad and Libya," but little scientific work has been done on them. Dr. A. Darwash, who worked in Libya for 11 years, reported the presence of about 50 animals in an enclosure, probably near Tripoli. They had been captured by the Italians who worked in Libya before Gaddafi seized control of the country (Khushal Habibi, personal communication, 1984).

In Morocco, Bourgoin (1958) indicated that the population in the southern part of the country was "severely threatened" and that a special reserve for Barbary sheep had been created in French West Africa. Panouse (1957) remarked that the species occurs in the Empire chérifien ("Kingdom of the Shieks") where it is concentrated in the High Atlas and Anti-Atlas mountains. Barbary sheep numbers were said to be highly variable in other areas. At the time Panouse's monograph was published, the Department of Water and Forests had a policy of limiting Ammotragus populations in this region because of their damage to plantations and vineyards.

Panouse (1957:53) included a map of the geographic distribution of Barbary sheep in Morocco, but more recent information has come from Michel Thevenot and Stephane Aulagnier (personal communication, 1984) of the Université Mohamed V in Rabat. They remarked that Barbary sheep are still present in the Middle Atlas, High Atlas, and the Occidental Sahara (where investigations have not been possible since 1974). Thevenot and Aulagnier are working on a Catalog of Moroccan Mammals, and provided a map showing the geographic distribution of Barbary sheep by map quadrangel (54 X 46 kilometers). The Moroccan distribution of Barbary sheep shown in Figure 5 is adapted from their map and is based on information Thevenot and Aulagnier compiled from Brosset (1960), Panouse (1957), Morales Agacino 1949, 1950), and Valverde (1957), as well as their own data.

In Niger, John Grettenberger (a former Peace Corps volunteer in Niger) reported some Barbary sheep were still present in that country (Khushal Habibi, personal communication, 1984).

In the Sudan, Molloy (1957) remarked that Barbary sheep had been common in the hills along the Red Sea, and were still found in the hills around Beja north of the Port Sudan railroad, at Atbare, and west of the Musmar station longitude. Furthermore, they were common in the hills of North Kordofan and North Darfour, near Jebel Meidob, and northeast of Koutoum. A reintroduction in the Shabluka hills 100 kilometers north of Koutoum, where they had been exterminated at the end of the 19th. century, was said to have been successful. Another account, by Schomber (1960), indicated:

> "The Barbary Sheep, in several sub-species, is distributed in the Sahara regions from the Atlas Mountains to the Sudan. The number has decreased and is mainly restricted to isolated mountains in the provinces of Darfur, Kordofan and Nubia."
>
> "An estimate of the number in the Sudan is in no way possible. To what extent the population of Barbary Sheep suffers from illegal trapping I am unable to say. The maned sheep is clearly included in Schedule III as a protected species. The possessor of an A or D class licence is, however, allowed to kill up to two animals."

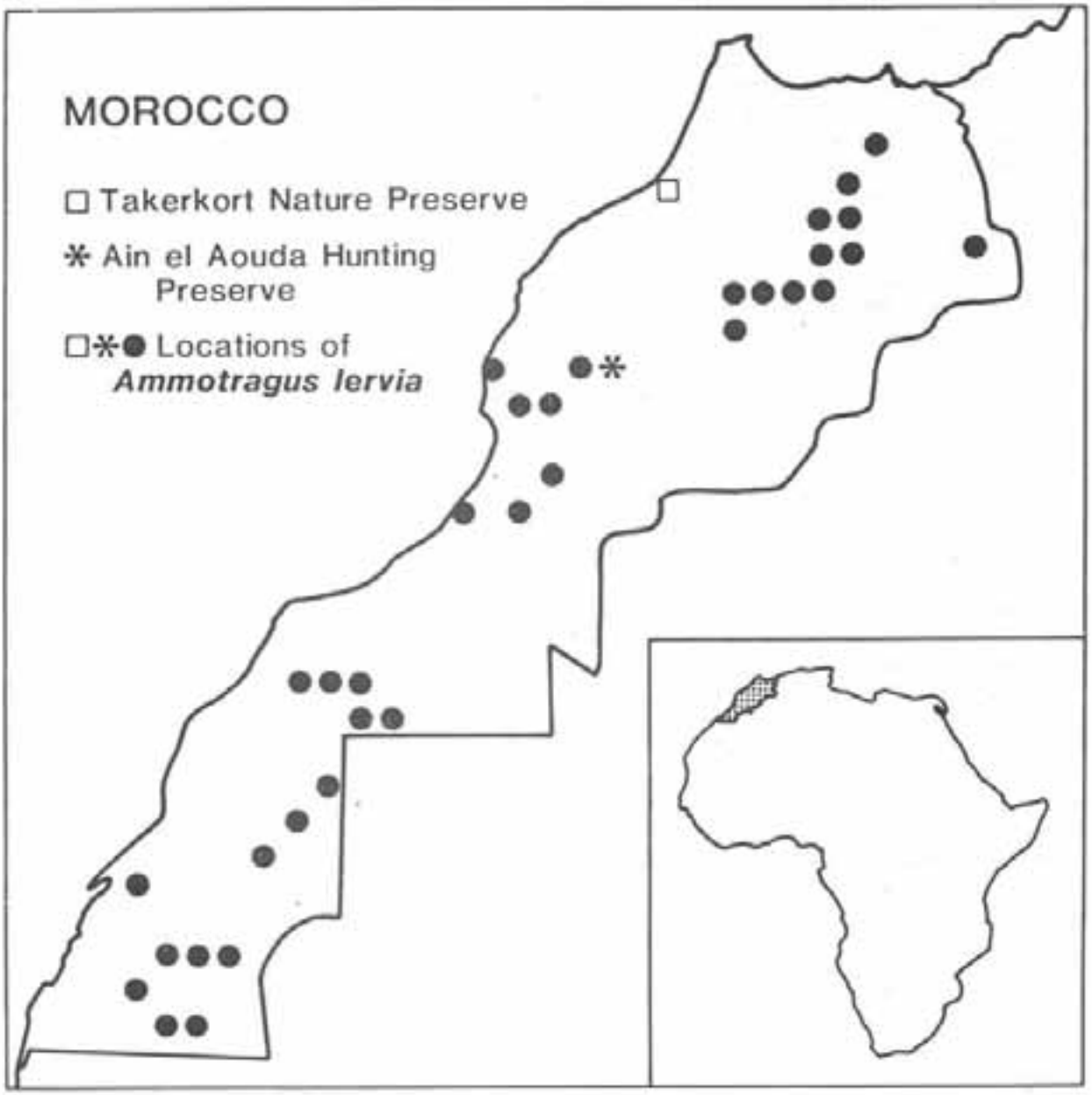

Figure 5. Present distribution of ***Ammotragus*** in Morocco. Adapted from M. Thevenot and S. Aulagnier (personal communication, 1984), Institut Scientifique, Université Mohamed V, Rabat, Maroc.

In Tunisia, Schomber and Kock (1960) stated:

> "This northern sub-species, which is characteristic of Northern African mountain fauna, is found in the Atlas Mountains and the foothills from Morocco to Tunisia. But although the rocky wastes of the largely barren mountains offer the sheep excellent protection, which is enhanced by the similarity in colour of the animal to the rocks, nevertheless its existence is seriously endangered through being hunted continuously. In the uninhabited Atlas Mountains in Morocco it is safe, whereas in Algeria it has already decreased alarmingly and in Central Tunisia there appears to be no chance of saving any of the species. The maned Atlas sheep, as it is called, can be stated with certainty still to exist in small numbers on the Djebel Bou Hedna, at Foum el Khanga near Tamerza, where it alternates between Algeria and Tunisia, according to the fluctuations of the local disturbances, and in a herd of 14 to 15 in the mountains north of Chott Fedjady. Its favoured habitat was in the mountains, carpeted more or less with sparse bush or at least with adequate grazing. With the exception of Morocco it may by now have been completely ousted from this biotope by the herds of the Nomads.
>
> "The Tripoli maned sheep of sourthern Tunisia does not differ from the northern sub-species in either habitat or normal habits. Its area of distribution starts in the barren mountains south of Remada, whereas fifty years ago it was still to be found near Foum Tatahouine, 100 kilometres further north. Shortly before our arrival a specimen was killed at Djebel Kambout, about 10 km south of Remada. The local Bedouins told us that the maned-sheep was still said to exist between Remada and Bordj Bourgiba. It was observed in small herds in Djebel Segdel and in Merbah Safsaf in the spring of 1959.
>
> "The survival of the Tripoli species in the southern districts is somewhat less in jeopardy since only a few Arabs indulge in this difficult hunting and Europeans only in exceptional cases."

STATUS AND DISTRIBUTION IN EUROPE

In Italy, Zammarano (1930) mentioned that Barbary sheep were introduced onto game preserves. However, I have been unable to determine whether they still exist there.

In Germany, the species was introduced at two locations in the north--near Lopshorn in Lippe in 1883 (Lons 1908), and later in the Teutoburger Wald (Strasson 1916). Both introductions failed, and no further introductions have been attempted in northern Germany (Rolf Schoppe, personal communication, 1984). Information from Ralf Angst (personal communication, 1984) indicates that Ammotragus is a familiar animal in German zoos, that they breed successfully, and the zoos have a problem selling young males. Angst also sent a photocopy of two pages from a book by Niethammer (1963) that gives some details of the Lopshorn release.

According to Niethammer (1963), Prince Waldemar of Lippe released two maned sheep from the Dresden Zoological Garden in his 6600-hectare preserve near the Lopshorn Hunting Lodge in 1883. Eight young were obtained from Antwerp the same year, and were kept confined for six weeks in the abandoned fortress Steinbruch on Stemberg before being released. An early notice (Zool. Garten 31:376, 1890) indicated some success, but Schacht (1904) reported that the project soon failed. Later attempts were also unsuccessful, and the last male was killed in 1902. The explanation for the failure of this venture was that the maned sheep could not find enough nutritious food and therefore had to be kept half-tame so they could be fed.

Blume (1911) mentioned that the brothers von Born kept maned sheep in their animal park at Neumarktl/Krain about the turn of the century, but these were tame and not hunted. Von Turcek commented that maned sheep were hunted for 30 years in Inovec-Gebirge, but these presumably were animals purchased as Mufflons (Niethammer 1963).

In Spain, M. Delibes of the Estacion Biologica de Donana in Sevilla has kindly furnished me with a short manuscript on the status of Ammotragus that will appear in the next volume of the Handbuch der Saugetiere Europas.

According to his account (Delibes in press), there is a single free-living Barbary sheep population in Europe at the present. It is located in the Sierra Espuna near Murcia in southern Spain (37°50'N, 1°35'W), and was established in 1970 using eight animals of each sex from the zoo in Casablanca as well as 8 males and 12 females from the zoo in Frankfurt am Main, Germany. This stock was held in enclosures, after which 9 male and 18 female zoo animals were released along with 2 males and 5 females that were born in the enclosures. When released, they dispersed up to 80 kilometers (50 miles).

By 1973 there were 79 animals, and the population increased at an average annual rate of 30 percent a year to 1982 when numbers totalled approximately 750. The population has been hunted since 1977, and has been reduced to about 500 animals since hunting began. The location of the free-ranging population in Spain is indicated in Figure 6.

There are also private herds of Barbary sheep in fenced enclosures in the provinces of Ciudad Real, Toledo, and Cadiz. An introduction of the species was made on one of the Canary Islands, La Palma, but failed.

STATUS AND DISTRIBUTION IN NORTH AMERICA

In California, on the West Coast of the United States, the history of the Barbary sheep population was recounted by Reginald Barrett (1980). Barbary sheep were apparently among the first ungulates procurred when a private zoo was established in 1924 on the estate of William Randolph Hearst near San Simeon in San Luis Obispo County. These animals were probably obtained from the Fleishacker Zoo in San Francisco. Although the Hearst Ranch included about 100,000 hectares (1000 square kilometers; 386 square miles) by 1940, only 810 hectares (about 2,000 acres) were enclosed by a 2.44-meter (8-foot) woven wire fence; this fenced area was subdivided into eight paddocks.

Figure 6. Location of the ***Ammotragus*** population in Spain. Adapted from M. Delibes. In press. ***Ammotragus lervia*** (Pallas, 1777)-Mahnenschaf . ***In*** Handbuch der Saugetiere Europas (G. Niethammer, ed.).

By 1937, Barbary sheep numbered 20 to 30 and the herd was said to have been productive. Records showed a herd size of 98 in 1949. During 1950 and 1951, 81 animals were sold to an animal dealer. Some of these formed the basis for introductions in the Canadian River Gorge of northeastern New Mexico and Palo Duro Canyon of the Texas Panhandle. The Hearst Zoo census noted 58 Barbary sheep in 1950, 55 in 1951, and 67 in 1952. In 1953 the private zoo was disbanded and about 85 Barbary sheep escaped from the deteriorating enclosures. These animals were the foundation of the present free-ranging population.

Soon after their escape Barbary sheep were observed on and around Red Rock, a large basaltic plug 1.5 kilometers east of the Hearst Castle. By 1954, the first animals had moved to Vulture Rock, 14 kilometers south of the Castle. Ten years after the escape there were estimated to have been 172 Barbary sheep in the area between the Hearst Castle and Red Rock. Meanwhile, many sightings of one to six individuals were made as far as 30 kilometers north and 65 kilometers south of the Hearst Castle. A number of sightings were made by deer hunters, who shot aoudads (which are not protected by closed season or bag limit in California).

Barrett's (1980) paper indicated the presence of four major female-young herds in this area. The Red Rock herd is limited to the present confines of the 30,800-hectare (76,106-acre) Hearst Ranch. This herd was composed of a least 258 animals in August 1965 (Barrett 1980), but numbers were reduced to about 154 by 1977 as range conditions deteriorated (David S. Johnston, personal communication to R.H. Barrett, 1979). Thus, the density of the Red Rock herd declined from 0.84 to 0.5 per square kilometer (2.2 to 1.3 per square mile) from 1965 to 1977. The Glazier Ridge herd occupies an area around large rock outcrops on the western slope of the Santa Lucia mountains just east of the Red Rock area. There were at least 143 Barbary sheep in the Glazier Ridge herd in the mid-1960s, but it is thought to have declined to as few as 50 animals.The Cline Peak herd, east of the Santa Lucia crest, was estimated to include over 80 aoudads in the 1960s, but has also declined to about 50. Poaching as well as changing range conditions were probably responsible for reductions in the Cline Peak herd. The Vulture Rock herd was comprised of about 100 animals in 1964, but was reduced to minimize competition with beef cattle for scarce forage. This herd is intensively harvested on a fee hunting basis, and subject to some mountain lion (Felis concolor) predation. Several years ago the herd was fluctuating in size from 40 to 60 animals. The approximate location of the population in California is noted in Figure 7.

In New Mexico of the southwestern United States, 12 Barbary sheep--four males and eight females--were released at Old Mills Canyon of the Canadian River gorge by the New Mexico Department of Fish and Game in January 1950 (Ogren 1965:8). These 12 original animals were obtained from the Joe McKnight Ranch in Picacho, New Mexico. McKnight had gotten his stock about 1940 from the St. Louis (Missouri) Zoological Park and the San Diego (California) Zoological Garden. Ogren made a number of inquiries and finally determined that some of the Barbary sheep from the Hearst Ranch that had been sold to animal dealer Louis Goebel were later dispensed to San Diego, and from San Diego to McKnight's Ranch. In November of the same year another 45 animals (26 females including 6 juveniles, and 19 males including 5 juveniles) that had been procurred directly from the Hearst Ranch in California were liberated on a state game refuge near the north end of the Canadian River Gorge (Orgen 1965:8).

A second New Mexico population resulted from the unauthorized release of 21 Barbary sheep (also purchased from animal dealer Louis Geobel) in Largo Canyon of the northwestern sector by the San Juan County Wildlife Federation in 1956 (Ogren 1965:8). One 1979 population estimate for this area was 200-250 animals (1-1.5 per square mile; 0.4-0.6 per square kilometer) according to Bird and Upham (1980), although Bruce Morrison (personal communication, 1980) has said that aerial censuses indicated a density of about 4 Barbary sheep per square mile (1.54 per square kilometer).

Two major free-ranging Barbary sheep populations in southeastern New Mexico--in the Hondo Valley and Guadalupe Mountains-- and a number of smaller herds or bands were all derived from seven animals (three males and four females) placed in a 810-hectare (2,000-acre) game enclosure on the McKnight Ranch in 1940. McKnight has estimated that about 10-20 Barbary sheep escaped each year from 1943 to 1979. In addition, approximately 100 animals escaped in 1965 and 50 in 1977. Dickinson and Simpson (1980), who researched the dispersal and establishment of Barbary sheep in this area, ventured a conservative estimate of 510 escapees from the McKnight game enclosure over the last 36 years. Their data suggested a yearly dispersal rate of 0.3-2.4 square kilometers per year, so that Barbary sheep occupied an area of at least 7000 square kilometers (2,700 square miles) in southeastern New Mexico by 1979. Aerial censuses by the New Mexico Department of Fish and Game suggested a population density of 3.85 per square mile (1.5 per square kilometer) in the Hondo Valley (Bruce Morrison, personal communication, 1980).

Another herd, north of the Grants area in northwestern New Mexico, apparently resulted from long-range dispersal (Simpson and Krysl 1981). However, it is not known whether animals in this area came from the Canadian River gorge or moved south along the Continental Divide from Largo Canyon.

Dispersal of Barbary sheep from the Canadian River gorge has been greater toward the north and west, although there has been some emigration in most directions (Simpson and Krysl 1981). Most dispersal from the Hondo Valley population has been northeast, west, and south through the Sacramento and Guadalupe mountains, but some animals have moved northward into the Jecarilla and Capitan mountains. The Largo Canyon population has expanded its range onto adjacent public lands, but there are no confirmed records of long-distance movements.

Apparently, long-distance movements are not unusual for Barbary sheep. One animal was shot illegally 105 kilometers (65 miles) east-northeast of Roswell, and another within 32 kilometers (20 miles) of Hobbs. These records represent distances of about 129 and 113 airline kilometers (80 and 70 miles), respectively, from the closest rough terrain considered suitable for Barbary sheep. The 1979 sighting of a male in the San Francisco River drainage north of Glenwood was almost 200 miles (322 kilometers) from the closest known release site (Simpson and Krysl 1981).

From 1955 through 1978 a total of 1,008 Barbary sheep were legally harvested in New Mexico. A 1980 estimate suggested the species numbered about 2,500 in the state. At present, some estimates range from 1,000 to 3,000, but Bruce Morrison (personal communication, 1985) of the New Mexico Department of Game and Fish believes the total is closer to 5,000. The distribution of Barbary sheep in New Mexico is shown in Figure 7.

Barbary sheep continue to present management problems in New Mexico and the state is beginning to address these problems. Bruce Morrison (personal communication, 1985) recently wrote: "We have abolished our so-called trophy hunt areas and opened the entire state to Barbary hunting. The hunts are concurrent with our deer seasons and during the month of January. The bag limit is any two Barbary sheep. This year, we are proposing to open the southwest quarter of the state to year-round hunting" for Barbary sheep. He also noted that the species does not seem to be confining itself to any specific habitat type, an that there seem to be no barriers to its range expansion.

In Texas of the southwestern United States, 31 Barbary sheep (8 males, 13 females, and 10 juveniles) were released into the Dry Creek branch of Palo Duro Canyon on the Christian and Harrell ranches southwest of Claude in December 1957 (DeArment 1971). This area is situated in Armstrong County at 34°58'N, 101°31'W, approximately 38 kilometers (23.6 miles) southeast of Amarillo. Another 13 animals, 4 males and 9 females, were liberated about 64 kilometers (40 miles) southeast, near Quitaque in Briscoe County in February 1958. Reports by ranchers in the vicinities of these introduction sites indicated that most Barbary sheep remained within 16 kilometers (10 miles) of release points for about two years (Wallace 1959, 1960). However, Wallace documented two sets of sightings from as far away as 32 kilometers (20 miles), and several animals moved from the Armstrong County site on the Christian and Harrell ranches to an area 19.5 airline kilometers (12 miles) south.

Subsequent dispersal to the west and north by animals released in Armstrong County was limited by the canyon head and human activity in Palo Duro State Park. As a consequence, most movement was directed southward down the canyon. Dispersal of Barbary sheep from the more southerly Briscoe County site was toward more precipitous portions of the canyon to the north (Hudgins 1962), so that the two groups converged.

Reliable reports in the late 1970s documented the presence of Barbary sheep along the Caprock escarpment east of Lubbock, an airline distance of about 98 kilometers (60 miles) south of the Briscoe County release area. The species has also been sighted along the Red River north of Vernon, which is about 178 kilometers (110 miles) east of the Briscoe County site (Gray 1980). There is no indication of when Barbary sheep reached these areas or how much further they may have dispersed.

Studies of Barbary sheep in the original Dry creek release area of Palo Duro Canyon 20 years after their introduction showed that group sizes of more than 60 were not unusual where animals were attracted to winter wheat (Triticum aestivum) fields along the canyon rim. However, the mean size of groups observed during seven aerial censuses ranged from 6 to 15 animals (Gray and Simpson 1982). The results of these aerial counts also suggested a minimum population density in the Dry Creek area of 0.35-1.57 Barbary sheep per square kilometer (0.9-4.1 per square mile) (Gray and Simpson 1983).

From 1963 through 1979 a total of 1,125 Barbary sheep were legally harvested in Palo Duro Canyon. Some estimates of the Palo Duro Canyon population were as low as 1,400-1,600 in 1979 (Dvorak 1980), but Simpson et al. (1980) thought that as many as 2,500 were present.

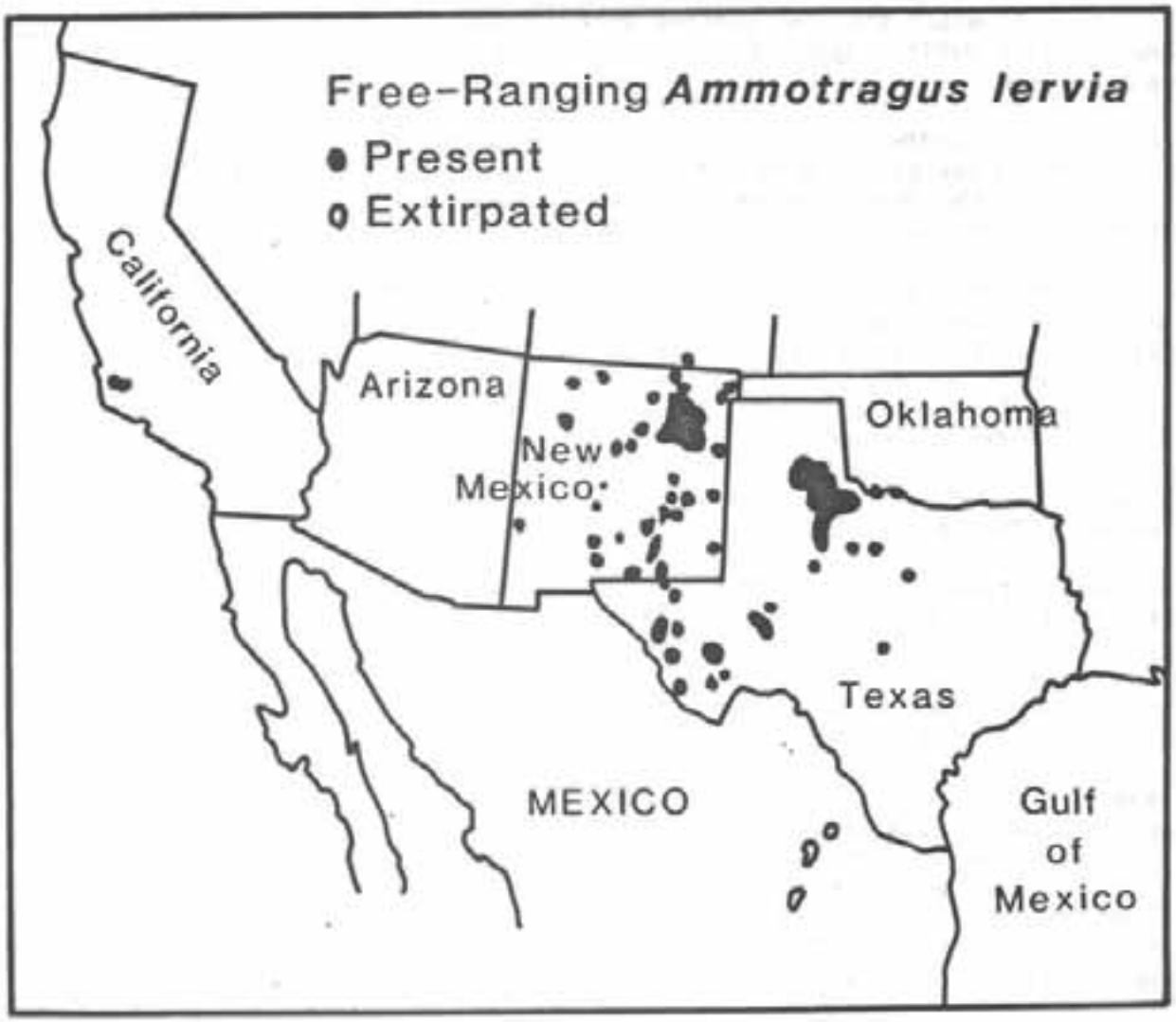

Figure 7. Location of introduced free-ranging ***Ammotragus*** populations in North America . Adapted from C.D. Simpson and L.J. Krysl , 1981. Status and distribution of Barbary sheep in the Southwest United States. Trans. Desert Bighorn Coun. 25:9-15.

Three other releases of Barbary sheep were made by private landowners in the Trans-Pecos region of southwestern Texas during the 1960s (Decker 1978), but details were not recorded. In addition, four escapes from confined herds in the Edwards Plateau of central Texas and one escape in the Rolling Plains of north-central Texas have resulted in two small free-ranging populations (Simpson and Krysl 1981). Based on information compiled from all sources, Simpson and Krysl (1981) estimated the total number of free-ranging Barbary sheep in Texas at 3,750 in 1980. The distribution of Barbary sheep in Texas is noted in Figure 7.

Other locations in the southwestern United States, have reported Barbary sheep sightings as result of dispersal from the populations already mentioned, or due to releases or escapes that have not been reported. Barbary sheep seen on a ranch in Oklahoma about 32 kilometers (20 miles) north of the Red River probably reached this area by following the rugged terrain along the Prairie Dog Town Fork of the Red River as they dispersed out of Palo Duro Canyon. Simpson and Krysl (1981) speculated that 25-40 animals might be present in southern Oklahoma. Occasional reports of sightings in southern Colorado have probably been animals dispersing northward from the Canadian River gorge. There were three separate records of Barbary sheep in southern Colorado during the early 1960s (Simpson and Krysl 1981), and I heard of one observation in the 1970s; however, it seems doubtful that any populations have become established. Unconfirmed reports indicate that Barbary sheep may have expanded their range into eastern Arizona, but there is still no definitive evidence (Bruce Morrison, personal communication, 1985).

In Mexico, Barbary sheep were released in three places; these introductions were summarized by Rangel-Woodyard and Simpson (1980). One release, probably the first, occurred on the Sierra Morena Ranch, a major cattle operation in northwestern Nuevo Leon. Ownership of the ranch changed several times before it was subdivided to comply with land reform policies. As several species of exotics, including Barbary sheep, were not continued within a suitable enclosure, they moved off the ranch; many of these animals were killed by subsistence hunters from surrounding settlements. However, a group of Barbary sheep escaped into the eastern foothills of the Sierra Madre Mountains. There, the herd became established, increased in numbers, and dispersed along the range resulting in a population in excess of 100 animals.

A second release occurred in the Sierra Pajaros Azules, located along the boundary between the northwestern part of Nuevo Leon and the eastern section of Coahuila. Rangel-Woodyard and Simpson (1980) were unable to obtain any information on this introduction, but they were able to confirm an established population on the east side of the Sierra Madre Oriental.

The third release was on private land in the northwestern part of San Luis Potosi. Twelve animals (2 males, 8 females, and one juvenile of each sex) were liberated in 1975-76. They were not confined by a game-proof fence when released and are said to have remained on the ranch in the general vicinity of the release site.

Each of these releases was apparently prompted by individual interests in having exotic animals rather than to supplement native animals for sport hunting. In two of these cases, Barbary sheep escaped, dispersed into relatively inaccessible mountainous terrain, and became established as free-ranging populations. At the time, both were thought to have increased and dispersed over a relatively large area of suitable habitat (Rangel-Woodyard and Simpson 1980).

Recent information from Bernardo Villa-R (personal communication, 1985), of the Universidad Nacional Autonoma in Mexico, indicated that Barbary sheep were also released on Espiritu Santo Island in the Sea of Cortez. Here, they were heavily hunted and eventually extirpated. According to Villa-R, the other three populations have also been eliminated and there are no longer any free-ranging Barbary sheep anywhere in Mexico. It is possible that some ranchers may still maintain small groups--but if so, Villa-R is not aware of where or how many might exist under these conditions.

NOTES AND COMMENTS

Simpson and Krysl (1981) estimated the total number of all Barbary sheep introduced in the western United States at approximately 400 animals. More than 1,000 Barbary sheep have been killed by hunters in Palo Duro Canyon, Texas, another thousand have been harvested in New Mexico, and an unknown--but undoubtedly much smaller--number slain in California. Still, their survey indicated that the number of free-ranging Barbary sheep in the western United States had increased to about 6,500 by 1980 (Simpson and Krysl 1981).

Clearly, the management of this species poses distinctly different challenges in its exotic range in the southwestern United States than it does within its endemic distribution in North Africa. In the United States, Barbary sheep in some areas are valued for the challenging sport hunting they provide (Christian 1980), whereas populations in other places may be viewed as a nuisance or even a direct threat to native wildlife such as desert bighorn sheep (Ovis canadensis) (Simpson et al. 1978). In North Africa, Barbary sheep in many areas seem to be subject to intensive hunting and poaching pressure. Increasing numbers of people, improved transportation, the development of Saharan oil and mineral resources, and continuing political and social strife will probably result in further population declines in many areas. Thus, North American populations are increasing and continuing to disperse, while the species is probably threatened at many places in North Africa. A future paper will discuss management considerations for Ammotragus populations under various conditions in different localities throughout the world.

Three publications on Ammotragus may be of interest to persons involved with conservation, management, or research on this species. One, entitled "Ammotragus lervia" (Gray and Simpson, 1980, Mammalian Species 144:1-7), was published by the American Society of Mammalogists. It is available from the author of this status and distribution review. A second is the Proceedings of the Symposium on Ecology and Management of Barbary Sheep held at Texas Tech University in 1979. It was edited by C. David Simpson and contains a keynote address, seven agency reports on Barbary sheep,

15 papers on various aspects of Barbary sheep biology and management, two summaries, and appendices. This is available from Dr. Henry A. Wright, Chairman, Department of Range and Wildlife Management, Texas Tech University, P.O. Box 4169, Lubbock, Texas 79409, U.S.A. The third is Herman A. Ogren's classic monograph, Barbary Sheep (New Mexico Department of Game and Fish, Bulletin No. 13, 117 pages, 1965). It is still available from Mr. Bruce L. Morrison, Assistant Chief of Game Management, New Mexico Department of Game and Fish, Villigra Building, Santa Fe, New Mexico 87503, U.S.A. There is no charge for any of these publications. In addition, an international symposium on hunting wildlife was held in Fez in 1983 during which Barbary sheep were discussed. The text of this symposium may be available from: My Y. Alaoui, Service de la Protection de la Nature, Division de la chasse, de la peche et de la protection de la nature, Direction de Eaux et Forets, RABAT, Maroc (Morocco).

I would like to receive reports on Ammotragus status, distribution, introductions, research results, and management from workers throughout the world on a continuing basis. I also would be willing to act as an intermediary and share this information with other interested biologists.

This review of Barbary sheep status and distribution is respectfully dedicated to Dr. Herman A. Orgen in recognition of his pioneering research on the species.

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LITERATURE CITED

Afzelius, A. 1815. De Antilopis in genere et speciation Guineensibus. Nova Acta Regiae Soc. Sci. Upsala 7:195-270.

Allen, G.M. 1939. A checklist of African mammals. Bull. Mus. Comp. Zool. 83:548.

Anderson, J. 1898. Zoology of Egypt. Vol I, Reptilia and Batrachia. Bernard Quaritch, London. 371 pp.

Ansell, W.F.H. 1971. Order Artiodactyla. Pages 1-84, in The mammals of Africa, an identification manual (J. Meester and H.W. Setzer, eds.). Smithsonian Institution Press, Washington.

Arambourg, C. 1927. Recherches Paléontologiques dans le Djurdjura (Ammotragus lervia). Bull. Soc. Hist. Nat. Afr. Nord 18(8):196-200.

Arambourg, C., M. Boule, H. Vallois, and R. Verneau. 1934. Les grottes paléolithiques des Beni Segoual, Algerie. Institut de paléontolgie humaine, Paris. Archives, Mem. 13:1-242.

Barrett, R.H. 1966. History and status of introduced ungulates on Rancho Piedra Blanca, California. M.S. Thesis. Univ. of Michigan, Ann Arbor.

Barrett, R.H. 1967. Some comparisons between the Barbary sheep and the desert bighorn. Trans. Desert Bighorn Coun. 11:16-26.

Barrett, R.H. 1980. History of the Hearst Ranch Barbary sheep herd. Pages 46-50, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Bate, D.M.A. 1955. Vertebrate faunas of Quaternary deposits in Cyrenaica. Pages 274-291, in Prehistory and Pleistocene geology in Cyrenaican Libya (C.B.M. McBurney and R.W. Hey, eds). Cambridge Univ. Press, Cambridge.

Bedan, -. 1928. A desert expedition. Blackwood's Mag. 223(1350):519-548.

Bigourdan, J., and R. Prunier. 1937. Les Mammifères sauvages de l'ouest Africain et leur milieu. Encycl. Biol., Paris 23:182-184.

Bird, W., and L.L. Upham. 1980. Barbary sheep and mule deer food habits of Largo Canyon, New Mexico. Pages 92-96, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Blume, S. 1911. Das Steinwild in Österreich. Wild und Hund 17:230.

Blyth, E. 1839. An ammended list of the species of the genus Ovis. Proc. Zool. Soc. London 8:12-13.

Brentjes, B. 1980. The Barbary sheep in ancient North Africa. Pages 25-26, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Brosset, A. 1960. Les Mammifères du Maroc Oriental, Leur répartition, leur statut actuel. Bull. Soc. Sci. Nat. Phys. Maroc 40:243-263.

Brouin, G. 1950. Contribution a l'etude de l'Air. Notes sur les ongulés du cercle d'Agadez et leur chasse. Mém. Soc. Hist. Nat. Afr. N., Alger 10:425-455.

Brown, L. 1965. Africa: a natural history. Random House, New York.

Bourgoin, P. 1958. Les ongulés dans les territoires de l'union Française. Mammalia 22:371-381.

Butzer, K.W. 1959. Studien zum vor- und frühgeschichtlichen Landschaftswandel der Sahara. III. Die Naturlandschaft Ägyptens während der Vorgeschichte und der Dynastischen Zeit. Akad. Wiss. Literatur. Math. Naturw. 2:1-122.

Cabrera, A. 1932. Los mamoferos de Marruecos. Trab. Mus. Nac. Ciencias Natur. Madrid, Ser. Zool. 57:1-361.

Cano, A., and J.R. Vericad. 1983. Rapport des recherches en faune saharienne de la "Estacion Experimental de Zonas Aridas" (Almeria, Espagne). Symp. on International Conservation and Gestion faune sauvage méditerranéenne, Fez (Maroc), 16-17 March. 6 pp.

Christian, T.T. 1980. Development and economic role of aoudad hunting in a cattle ranching operation. Pages 104-105, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.) Texas Tech Univ. Press, Lubbock.

Corbet, G.B. 1978. The mammals of the Palaearctic region: a taxonomic review. British Museum (Natural History) and Cornell Univ. Press, London and Ithaca. 314 pp.

Curtain, C.C., and H.H. Fudenburg. 1973. Evolution of the immunoglobulin antigens in the Ruminantia. Biochem. Genetics 8:301-308.

Cuvier, G. 1827. The animal kingdom, arranged in conformity with its orgainization...(C. Griffith et al., compilers). G.B. Whittaker, London 5:1-391.

DeArment, R. 1971. Reaction and adaptability of introduced aoudad sheep. Final Report. Div. of Fed. Aid in Wildlife Restoration Proj. No. W-45 R-21, Texas Parks and Wildl. Dept., Austin. 20 pp.

Decker, E. 1978. Exotic. Pages 229-256, in Big game of North America: ecology and management (J.L. Schmidt and D.L. Gilbert, eds.). Wildlife Management Institute/Stackpole Books, Harrisburg, PA.

Delibes, M. In press. Ammotragus lervia (Pallas, 1777) - Mähnenschaf. In Handbuch der Säugetiere Europas (G. Niethammer, ed.).

Dickinson, T.G., and C.D. Simpson. 1980. Disperal and establishment of Barbary sheep in southeast New Mexico. Pages 33-45, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Edmond-Blanc, F. 1957. Le grand livre de la faune Africaine et de sa chasse, vol. 1. Rene Kister, Geneva.

Evans, P.K. 1967. The aoudad sheep, an exotic introduced in the Palo Duro Canyon of Texas. Proc. Southeastern Assoc. Game and Fish Comm. 21:183-188.

Flower, S. 1932 Notes on the recent mammals of Egypt, with a list of the species reported from that kingdom. J. Zool., London 2:369-450.

Geist, V. 1971. Mountain sheep: a study in behavior and evolution. University of Chicago Press, Chicago. 383 pp.

Geoffroy Saint-Hilaire, I. 1827. Le Mouflon a manchettes. Pages 264-268, in Dictionnaire classique d'histoire naturelle, 2nd. ed. (J.B.G.M. Bory de Saint-Vincent, ed.). Mus. Nat. Hist., Paris.

Gervais, P. 1852. Zoologique et paleontologie Françaises... Arthur Bertrand, Paris.

Gray, G.G. 1980. Aspects of Barbary sheep (Ammotragus lervia) biology in Palo Duro Canyon, Texas. Ph.D. Dissertation. Texas Tech Univ., Lubbock. 175 pp.

Gray, G.G. and C.D. Simpson. 1980. Ammotragus lervia. Mammal. Species 144:1-7.

Gray, G.G., and C.D. Simpson. 1982. Group dynamics of free-ranging Barbary sheep in Texas. J. Wildl. Manage. 46:1096-1101.

Gray, G.G. and C.D. Simpson 1983. Population characteristics of free-ranging Barbary sheep in Texas. J. Wildl. Manag. 47:954-962.

Gray, J.E. 1850. Gleanings from the menagerie and aviary at Knowsley Hall. Hoofed quadrupeds. Publ. by the author, Knowsley, England 2:1-76 + 4.

Hampy, D.B. 1978. Home range and seasonal movement of Barbary sheep in the Palo Duro Canyon. M.S. Thesis. Texas Tech Univ., Lubbock 83 pp.

Harper, F. 1940. The nomenclature and type localities of certain Old World mammals. J. Mammal. 21:322-332.

Hartert, E. 1913. Ruminants and other large mammals of the central western Sahara. Novit. Zool. 20:33-37.

Heim de Balsac, H. 1934. Mission saharienne Augiéras-Draper, 1927-1928. Mammifères. Bull. Mus. Nat. Hist. Natur. Paris 6(6):482-489.

Heinemann, D. 1972. Barbary sheep, tahr, and blue sheep. Pages 492-496, in Grzimek's animal life encyclopedia (B. Grzimek, ed.). Von Nostrand Reinhold, New York 13(4):1-566.

Hight, M.E., and C.F. Nadler. 1976. Relationships between wild sheep and goats and the aoudad (Caprini) studied by immuno-diffusion. Comp. Biochem. Physiol. 54B:265-269.

Hoogstraal, H. 1964. A brief review of the contemporary land mammals of Egypt (including Sinai), 3: Carnivora, Hyracoidea, Perissodactyla and Artiodactyla. J. Egypt. Publ. Hlth. Assn. 39(4):205-239.

Hudgins, B. 1962. Reaction and adaptability of introduced aoudad sheep. Div. of Fed. Aid in Wildlife Restoration Proj. W-45-R-12, Texas Parks and Wildl. Dept., Austin. 4 pp.

Ionides, C.J.P. 1948. Some interesting animals of the Sahara desert of northwestern Sudan, No. 2. Nature in East Africa, Nairobi, No. 5:5-8.

Johnston, D.S. 1980. Habitat utilization and daily activities of Barbary sheep. Pages 51-58, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Joleaud, L. 1918. Noice géologique et paléontologique sur la grotte des Pigeons, près de Constantine. Rec. Notes & Mem. Soc. Archeol. Constantine (1916) 40:1-11.

Joleaud, L. 1928. Le mouflon a manchettes. Mém. Soc. Biogeogr., Paris 2: 35-37.

Lataste, F. 1885. Etude de la faune des Vertébrés de Barbarie. Actes Soc. Linn. Bordeaux 39(9):129-299.

LeBerre, M. 1983. Guide des Vertébrés du Sahara. Labor. Ethologie Exp. Univ. Claude Bernard, Lyon. 582 pp.

Lepri, G. 1930. Sopra una nuova sottospecie del genere Ammotragus. Atti Pont. Acad. Sci. Nuovi Lincei, Roma 83:271.

Lhote, H. 1957. Le grand livre de la faune Africaine et de sa chasse, vol. 2. Rene Kister, Geneva.

Lönns, H. 1908. Einbürgerung von Wirbeltieren. Jber. Naturhist. Ges. Hannover 55-57, 128-133.

Lydekker, R. 1912. The sheep and its cousins. Ballantyne, Hanson & Co., Edinburg. 315 pp.

Malbrant, R. 1952. Faune de Centre Africain Français (mamifères et oiseaux). Encycl. Biol., Paris, 2nd. ed. 15:59-61.

Manwell, C., and C.M.A. Baker. 1975. Ammotragus lervia: progenitor of the domesticated sheep or specialized offshoot of caprine evolution? Experentia 31:1370-1371.

McBurney, C.B.M. 1967. The Haua Fteah (Cyrenica) and the Stone Age of the south-east Mediterranean. Cambridge Univ. Press, Cambridge. 387 pp.

Molloy, P.G. 1957. Le grand livre de la faune Africaine et de sa chasse, vol. 2. Rene Kister, Geneva.

Morales Agacino, E. 1949. Datos y observaciones sobre ciertos mamiferos del Sahara occidental e Ifni. Bol. Soc. Esp. Hist. Nat. 47:13-44.

Morales Agacino, E. 1950. Datos y observaciones sobre ciertos mamiferos del Sahara occidental. C.R. le Conf. Int. Afr. Ouest 1:217-227.

Murray, G.W. 1967. Dare me to the desert. Allen and Unwin, Ltd., London. 214 pp.

Nadler, C.F., R.S. Hoffman, and A. Woolf. 1974. G-band patterns, chromosomal homologies, and evolutionary relationships among wild sheep, goats, and aoudads (Mammalia, Artiodactyla). Experentia 30:744-746.

Niethammer, G. 1963. Die Einbürgerung von Säugetieren und Vögeln in Europa, Ergebnisse und Aussichten. Verlag Paul Parey, Hamburg and Berlin.

Nowak, R.M. and J.L. Paradiso. 1983. Walker's mammals of the world, 4th edition. Johns Hopkins Univ. Press, Baltimore and London 1362 pp.

Ogren, H.A. 1965. Barbary sheep. New Mexico Dept. Fish & Game, Santa Fe, Bull. 13:1-117.

Osborn, H.F. 1910. The age of mammals in Europe, Asia and North America. Macmillan, New York. 635 pp.

Osborn, D.J. and I. Helmy. 1980. The contemporary land mammals of Egypt (including Sinai). Fieldiana Zool. No. 5 (new series), Publication 1309. 579 pp.

Pallas, P.S. 1777. Antilope lervia. Spicilegia Zool. 12:12.

Panouse, J.B. 1957. Les mammifères du Maroc. Trav. Inst. Sci. Chérifien, Sér. Zool. 5:169-173.

Pomel, P. 1898. Les Ovides. Carte Geol. Algerie, Paleontol. Monogr. 40 pp.

Rangel-Woodyard, E., and C.D. Simpson. 1980. Status of Barbary sheep in Mexico. Pages 30-32, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Ralli, A.M. 1957. Le grand livre de la faune Africaine et de sa chasse, vol. 2. Rene Kister, Geneva.

Rodd. F. 1926. People of the veil. Macmillan, London.

Rode, P. 1943. Faune de l'Empire Français II. Mammifères ongules de l'Afrique Noire, Part I: Famille des Forides, genus Ammotragus Blyth, 1840. Faune Tropicale 2:31-34.

Rothschild, W. 1913. On Ovis lervia Pallas and its subspecies. Novit. Zool. 20:459.

Rothschild, W. 1921. Captain Angus Buchanan's Air expedition. III. Ungulate mammals. Novit. Zool. 28:75.

Russell, M. 1831. View of ancient and modern Egypt with an outline of its natural history. Oliver and Boyd, Edinburgh. 480 pp.

Russell, Th. 1949a. Egyptian service. John Murray, London. 294 pp.

Russell, Th. 1949b. Desert fauna. Bull. Zool. Soc. Egypt 8:5-8.

Russell, Th. 1951. The fauna of the Egyptian deserts. Bull. Zool. Soc. Egypt 9:19-21.

Schacht, H. 1904. Ende der Mufflons im Teutoburger Wald. Zool. Garten 45:276.

Schaller, G.B. 1977. Mountain monarchs: wild sheep and goats of the Himalaya. University of Chicago Press, Chicago and London. 425 pp.

Schmitt, J. 1963. Ammotragus lervia Pallas, Mahnenschaf oder Mähnenziege? Z. Säugetierk. 28:7-12.

Schomber, H.W. 1963. Wild life in the Sudan: Part 4, Desert and semi-desert game animals. Afr. Wild Life 17:117-124.

Schomber, H.W., and D. Kock. 1960. The wild life of Tunisia: Part 2, Some larger mammals. Afr. Wild Life 14:277-282.

Sclater, P.L. 1895. On the occurrence of the Barbary sheep in Egypt. Proc. Zool. Soc. London 1895:85-86.

Scortecci, G. 1957. Animali. Vol. 1, Mammiferi. Edzioni Labor, Milano.

Serres, M.de. 1848. Fossil bones. Cavernes, Paris.

Simpson, C.D., and G.C. Gray. 1983. Topographic and habitat use by sympatric Barbary sheep and mule deer in Palo Duro Canyon, Texas. J. Range Manage. 36:190-194.

Simpson, C.D. and L.J. Krysl. 1981. Status and distribution of Barbary sheep in the southwest United States. Trans. Desert Bighorn Coun. 25:9-15.

Simpson, C.D., L.J. Krysl, D.B. Hampy, and G.G. Gray. 1978. The Barbary sheep: A threat to desert bighorn survival. Trans. Desert Bighorn Coun. 22:26-31.

Strasson, O. (ed.) 1916. Brehm's Tierleben. Allgemeine Kunde des Tierreichs. Säugetiere-Viert Band. Bibliogr. Inst., Leipsiz und Wien.

Thomas, O. 1902. On the mammals collected during the Whitaker Expedition to Tripoli. Proc. Zool. Soc. London 1902(2):1-13.

Thomas, P. 1884. Sur quelques formations d'eau douce quaternaires d'Algérie (Bovidae, etc.). C.R. Acad. Sci. Paris 98(6):381-383.

Toschi, A. 1957. Le grand livre de la faune africaine et de sa chasse vol. 2. Rene Kister, Geneva.

Trouessart, E-L. 1904-5. Catalogues mammalium. R. Friedländer, Berolini.

Valdez, R., and T.D. Bunch. 1980. Systematics of the aoudad. Pages 27-29, in Proc. of the Symp. on ecology and management of Barbary sheep (C.D. Simpson, ed.). Texas Tech Univ. Press, Lubbock.

Valverde, J.A. 1957. Mamíferos. Pages 354-406, in Aves del Sahara espanol, estudio ecologica del disierto. Consej. Sup. Insvestig. Cient, Madrid.

Van Gelder, R.G. 1977. Mammalian hybrids and generic limits. Amer. Mus. Novitates 2635:1-25.

Vaufrey, R. 1955. Préhistorie de l'Afrique. I. Le Maghreb. Publ. Inst. Hautes Etudes Tunis, Masson, Paris 4:1-435.

Wallace, N.F. 1959. Reaction and adaptability of introduced aoudad sheep. Div. of Fed. Aid in Wildl. Restoration Proj. W-45-R-8, Texas Parks and Wildl. Dept. Austin. 4pp.

Wallace, N.F. 1960. Reaction and adaptability of introduced aoudad sheep. Div. of Fed. Aid in Wildl. Restoration Proj. W-45-R-9, Texas Parks and Wildl. Dept. Austin. 6 pp.

Zammarano, V.T. 1930. Fauna e caccia. Minist. Colonie, Rome, pp. 24-26.

Zeuner, F.E. 1963. A history of domesticated animals. Hutchinson, London. 560 pp.

THE MUFFLON (OVIS AMMON MUSIMON SCHREBER, 1782) IN THE SOUTHERN AND WESTERN COUNTRIES OF EUROPE.

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ABSTRACT

For more than a hundred thousand years the range of the Mufflon was restricted to small retreat areas such as Corsica and Sardinia, Isles in the Tyrrhenian Sea, which these wild sheep had already occupied during the Diluvium period. Heavy human population increases on the European continent associated with the destruction of the natural landscape through the creation of settlements and transportation corridors brought about a reduction of arable lands and wildlife habitat.

Important autochthonous game species, such as red deer (Cervus elaphus), were forced back into certain retreat areas, and their numbers were substantially reduced. As a consequence of these developments ecological niches came into being that were suitable for less pretentious wildlife species. During the last 100 years the Mufflon, which was formerly rather unimportant, has been introduced to numerous areas on the European continent. The stock has gradually built up particularly since the second world war, and is estimated to have reached about 60,000 in 1984. Considerable knowledge has been gained in recent decades regarding the biology and ecology of these wild sheep, which has led to the establishment of quantitative and qualitative management standards important for proper hunting regulations and conservation.

INTRODUCTION

The existence of wild sheep of the "Argali-type" living during prehistoric miocene and pleistocene periods can be demonstrated through fossil evidence from the Sea Alps and other mountain ranges on the European continent in the vicinity of the Mediterranean Sea. During the middle of the pleistocene period sheep of the "Mufflon-type" appeared as well. These were members of populations which had to withdraw to the south because of advancing ice masses in northern and central Europe, and they found a new home in the Tyrrhenian Mountains. Tectonic changes resulting in disruption of landbridges brought into existence the Isles of Corsica and Sardinia. For thousands of years the distribution of these recent representatives of European-Near Eastern wild sheep has been restricted to these two isles.

RESULTS AND DISCUSSION

First evidence of the existence of Mufflon on the European mainland can be found in documents relating to the construction of a Renaissance Palace in Vienna, Austria, in the years 1566 to 1569. The original stock, whose offspring were later transplanted to many areas of Europe, were obtained from the Isle of Sardinia and brought to Vienna by Prince Eugen of Savoy in 1729. Being kept first at the Prince's Belvedere palace and afterwards in the Imperial Zoological Garden Schonbrunn in Vienna, the Mufflon were moved in 1840 to the Lainzer Tiergarten near Vienna, an enclosure 2600 ha in size. Almost all existing European Mufflon populations are descendants of this original Lainzer stock.

The first free-living Mufflon population on the European continent was the result of a transplant to the North Italian Apenine Mountains in 1780 by Duke Leopold of the Toscana, German Emperor from 1790 to 1792. Another transplant followed about 100 years later to an area presently known as Slowakia (C.S.S.R.), and in the following decades numerous transplants were conducted. For the first half of the 20th century, 10 European nations reported Mufflon populations totalling about 8,000 in 1939. Today almost all central and southeastern European countries have more or less well-established Mufflon stock, as Table 1 will reveal as well as the accompanying report on the Mufflon sheep in eastern Europe by Uloth (1984).

Table 1. Numbers of Mufflon in the countries of western and southern Europe (1978).

Nation	Numbers of Sheep	Percentage of Europe's Total Population
Austria	6,000	11.4
Denmark	200	0.4
France	4,500	8.5
France-Corsica	300	0.6
German Federal Republic	7,200	14.0
Italy	3,350	6.3
Italy-Sardinia	400	0.7
Luxembourg	75	0.0
Netherlands	400	0.7
Spain	3,000	5.6

In 1978 the number of Mufflon for all of Europe was estimated at 53,100 head. For 1984 no estimates are available as yet, however a further build-up of stock to 60,000 is assumed.

In contrast to other wild sheep species the Mufflon is a forest dweller and its range of distribution is directly related to forest cover density. Its adaptability to very different biotope conditions is astonishing. Thus, it is found in habitats with a great range of altitudes, ranging from sea level (Isles of Corsica and Sardinia) up to 2,000 m a.s.l. (Austrian Alps). Accordingly, the reproductive capacities of given populations vary accordingly and range from 40 to 70% expressed as increases in relation to numbers of females in spring. The expected sex ratio is 100 males: 100 females. In order

FIGURE 1. MUFFLON SHEEP IN EUROPE EXPRESSED IN THOUSANDS.

Fig. 1: Adult mouflon Ram (Photo: E. Mader)

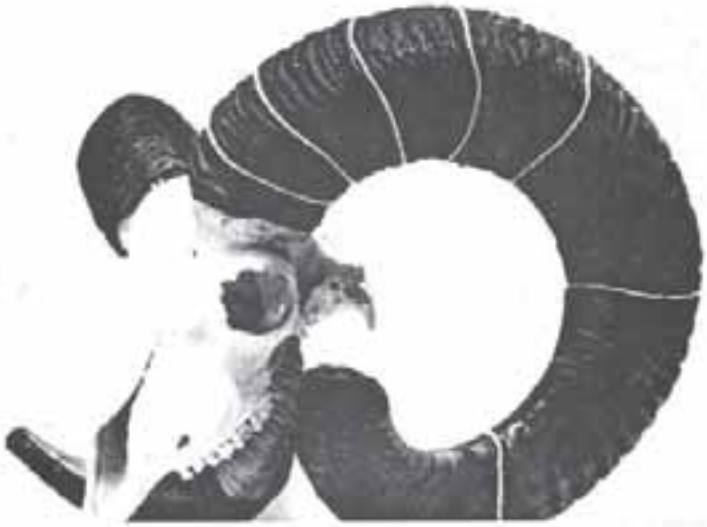

Fig. 2: Skull of mouflon ram with annual horn growth increments indicated by white lines (Photo: H. Tomiczek)

Fig. 3: Mature mouflon ewe with twin lambs. (Photo: W. Tilgner)

to avoid damage to forest plantations and agricultural fields and to fullfill certain requirements in relation to landscape maintenance, densities of Mufflon populations are kept to a rate of 3 to 10 heads per 100 ha, with the average being about 6 sheep per 100 ha.

The horns of Mufflon rams grow in a circular manner similar to North American sheep and reach a length of 700 to 900 mm at an age of 6-8 years. Horn lengths over 1,000 mm are rare. The horn spread varies between 400 and 500 mm, the circumference at the horn base between 230 and 270 mm, with 330 mm being the reported maximum.

Population dynamics parameters as well as individual body growth rates vary with habitat quality, and great differences between populations have been documented. On the average rams without head and eviscerated weigh between 20 and 28 kg, ewes between 16 and 23 kg. However, weights exceeding these averages by as much as 100% have been documented.

Mufflon crossbreed readily with various domestic sheep races and produce fertile offspring. For this reason many crosses have been done intentionally until the beginning of this century in order to improve domestic breeds in relation to body size, trophy quality and resistance to diseases. By the same token, crosses (intentionally as well as unintentionally) have changed the genetic make-up of wild Mufflon populations. Attempts are being made, to establish standards for a true, genetically pure, Mufflon, and to eliminate totally all elements of alien blood in "mixed" populations. This strategy has not always nor everywhere been successful, therefore, differences remain in quality of various European populations.

Recently the lynx has been reintroduced to several areas in western Europe, after being absent for many decades. It appears that observations made in Eastern Europe, where wolves as well as lynx were able to reduce or even eliminate Mufflon populations, will be repeated here.

SUMMARY

It has been possible to preserve the Mufflon, Ovis ammon musimon, on its very restricted original range on the Isles of Corsica and Sardinia, and to subsequently spread its distribution to many countries on the mainland of Europe over the past 100 years. The total European stock is now estimated at 60,000 head. Without any doubt, these large-scale conservation attempts have resulted in an enrichment of the large mammal fauna on the continent of Europe. However, considering the much more numerous populations of red deer, roe deer and wild pigs, and the associated hunting economy, the Mufflon is still not a very important local big game species.

LITERATURE CITED

Hoefs, M. 1982. Die Muffelwildvorkommen im Lande Nordrhein-Westfalen. Zeitschrift für Jagdwissenschaft 28:31-49, 28:88-108.

Langrehr, H. 1977. Zur Herkunft des Mufflon. Allgemeine Forstzeitung, München.

Lochman, J. 1979. Mufloni zver. Prag, C.S.S.R.

Perco, F. 1977. Il Muflone. Edagricole, Italy.

Silvestri, A. 1975. Il Muflone sardo. Editrice Forum, Sardinia, Italy.

Tůrcke, F. and H. Tomiczek, H. 1982. Das Muffelwild. Verlag P. Parey, Hamburg.

Uloth, W. 1976. Das Muffelwild, Die Neue Brehm Bücherei, Wittenberg.

Uloth, W. 1984. Die Muffelwildvorkommen in Osteuropa. Proceedings of the 4th symposium of the Council for Northern Wild Sheep and Goats.

THE HISTORY OF INTRODUCTIONS OF MOUFLON SHEEP (Ovis ammon musimon, Schreber 1782) IN CENTRAL AND EASTERN EUROPE, AND THE DEVELOPMENT AND MANAGEMENT OF THESE WILD SHEEP POPULATIONS.

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ABSTRACT

The first important transplant and release of mouflon sheep on the mainland of Europe took place during the second half of the 19th century, when Karoly Forgach released these wild sheep in the Tribec Mountains of Czechoslovakia (Uloth, 1972, 1976, 1979). Czechoslovakia has more than half of the European stock of mouflon, which in the eastern half of that continent increased from 10,000 to 27,500 in the years 1968 to 1978. Economic considerations for mouflon management are meat production per given area of habitat (kg wild meat per 100 ha of forest), as well as the trophy quality obtained by rams, which is revealed in the scores obtained in periodically held international hunting exhibitions. Record scores reached by mouflon trophies inproved from 236,95 C.I.C. points in Budapest, 1971, to 240,65 C.I.C. points in Plovidv, 1981. Both these exceptional trophies came from Czechoslovakia. Conditions for the production of good trophies include the proper choice of suitable habitat for these sheep when introductions are made, a selective harvest of all age classes and both sexes to maintain a desired population structure, and lastly, a minimum of age for the harvest of rams with good horn development of 8 years.

Initial comparisons of trophies of mouflon rams from Europe with those originating from sheep introduced to North America revealed that the European mouflon in general have a greater mean horn length, while those in North America have a greater mean horn circumference at the horn base.

INTRODUCTION

Little is presently known about the origin of the mouflon sheep on the

Mediterranean Islands of Corsica and Sardinia, nor whether these sheep were truly "wild" or "feral domestic" sheep, as suggested by certain experts (Poplin, 1979). It is also not known when the first transplants to the mainland of Europe took place.

In this paper, a brief review is given of the history of documented transplants to the countries of central and eastern Europe, and of the development and management of these introduced mouflon herds (Ovis ammon musimon, Schreber, 1982).

RESULTS

Historically speaking, the mouflon populations in Czechoslovakia and Hungary were created through transplants near the end of the 19th century, while those of Poland, the German Democratic Republic, Romania, Yugoslavia and Bulgaria came into being during the first half of the present century. Transplants of significance to above countries were made according to the following schedule: 9 mouflons to the Tribec Mountains, Jelenec (Czechoslovakia) in 1868 and 1883, 5 mouflons to the Harz Mountains (German Democratic Republic) in 1906, and 13 mouflons to the Krim Peninsula (U.S.S.R.) in 1910 and 1913 (Uloth, 1972, 1976, 1979). The first breeding population in Bulgaria was established at the wildlife station at Palamara, to which mouflon were introduced repeatedly from herds in Czechoslovakia and Hungary (Dragoer, 1978).

Table 1: Development of mouflon populations in the German Democratic Republic (after Prien, Peukert and Telle, 1982).

Year	Number of Populations	Total Number of Mouflon
1931	8	about 240
1934	17	about 670
1939	43	2,360
1955	20	750
1976	54	3,680

Table 2. Development of mouflon populations in countries in Central and Eastern Europe.

Country	Total Number of Mouflon Sheep 1968	1978
Czechoslovakia	5,000	14,370
Hungary	2,000	5,000
German Democratic Republic	1,500	3,000
Yugoslavia	200	2,732
Bulgaria	50	1,300
Romania	150	600
U.S.S.R.	500	500
Poland	180	200

FIGURE 1. MUFFLON SHEEP IN EUROPE EXPRESSED IN THOUSANDS.

The introduced herds, in general, expanded rapidly except for temporary declines as a result of the War. In Table 1, the development of the mouflon population is given for the German Democratic Republic.

The development of the mouflon population in all the countries under discussion here are given by comparing the 1968 estimates (Uloth, 1976, 1979) with the 1978 estimates (Lochman, 1979).

Important considerations for the management of mouflon sheep in Europe are their meat production, expressed as "kg of meat produced per 100 ha of wooded habitat", and the trophy quality of the rams. During the 1970's, the meat production of mouflon with 25,940 kg amounted to only 0.03% compared to that of the other wild ungulates (Dezhskin, 1983). However, for the German Democratic Republic, Siefke (1971) ranked the importance of the mouflon as a wild meat producer second only to the fallow deer as follows: Fallow deer - Mouflon - Red deer - Roe deer. The management of the mouflon for trophy quality in central and eastern Europe was undoubtedly a success. This is obvious from Table 3, where we have listed the trophy quality achieved, expressed as numbers of heads awarded gold medals during the International Trophy Exhibition in Budapest 1971 and in Plovdiv 1981 for 5 countries (Prien, Peukert and Telle, 1982).

Table 3. Improvement of trophy quality of mouflon rams taken in five countries of central and eastern Europe, expressed as numbers of heads awarded gold medals.

Country	Numbers of Gold Medals Awarded for Mouflon Trophies	
	International Trophy Exhibition	
	Budapest, 1971	Plovdiv, 1981
Czechoslovakia	70	327
German Democratic Republic	25	32
Yugoslavia	11	16
Hungary	7	11
Bulgaria	--	7
	129	422

The top trophies in both international shows came from Czechoslovakia and reached 236,95 (1971) and 240,95 (1981) C.I.C. points respectively. Mouflon sheep were also introduced to North America, primarily Texas, and their development is of considerable interest to wild sheep experts. An initial comparison between top trophies of Europe (Botev et al, 1981), with those of North America (Temple, 1982), lead us to conclude that European rams have a greater mean horn length, while those from North America have a greater basal circumference of the horns (Uloth, in press).

LITERATURE CITED

Botev, N., I. Kolev, and N. Ninov. 1981. World Exhibition of Hunting. Catalogue of hunting trophies. Izd. Otecestvenija Front, Vol. I and II, Sofia. 710 pp.

Dezhskin, V. V. Hunting and hunting management of the world. Izd. Lesnaja prom-st', Moskva. 357 pp. (In Russian)

Dragoev, P. 1978. Supplement of the game fauna in Bulgaria. Izd. Zemizdat, Sofia. 101 pp. (In Bulgarian)

Lochman, J. 1979. International advice to the management of the mouflon. Myslivost, no. 5:98-99. (In Czech)

Poplin, F. 1979. Origine du Mouflon de Corse dans une nouvelle perspective paleontologique: par marronage. Ann. Genet. Sel. anim. 11:(2):133-143.

Prien, S., R. Peukert, and R. Telle. 1982. Results and tasks in the management of the mouflon game (Ovis ammon musimon Pallas) in the GDR. Wildbiologie und Wildbewirtschaftung, 11:208-235. (In German)

Siefke, A. 1971. The hunting-economic productivity of the hoofed game in the GDR. Beitrage zur Jagd-u. Wildforschung VII: 29-44. (In German)

Temple, T. B. 1982. Records of Exotics. 1982 Edition Volume III. Herring Printing Company, Kerrville. 362 pp.

Uloth, W. 1972. On the history of the distribution, introduction and cross-breeding of the Tyrrhenian mouflon in Europe and overseas. Acta Theriologica 17:(31):412-413.

Uloth, W. 1976 and 1979. Mouflon game. Ziemsen-Verlag, Wittenberg/Lutherstadt. 104pp. (In German)

THE PRESENT STATUS AND RESEARCH ON WILD CAPRINAE IN CZECHOSLOVAKIA

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ABSTRACT

At present, populations of three wild species of Caprinae occur in the territory of Czechoslovakia (Europe): Ovis musimon, Capra aegagrus and Rupicapra rupicapra. Only subspecies R. r. tatrica is autochthonous, the remaining species including R. r. rupicapra were introduced into this territory.

O. musimon, the most abundant of the species, inhabits almost all of Czechoslovakia. In relation to the quality of its trophies it is the world's best population. In this species the variability of cranial characters and horn growth dynamics are being studied in order to establish criteria for the selection of prospective breeding individuals. Cytogenetic examinations of individuals from various localities revealed no deviations from the standard chromosome complement. In R. rupicapra, of both the autochthonous and introduced subspecies, craniometry, horn growth dynamics and epigenetic variability of discrete cranial characters were studied to ascertain incidental changes due to introduction, and to specify the taxonomic differentiation of ssp. tatrica. A herd of C. aegagrus occurs in a single locality.

INTRODUCTION

At present, three species of wild Caprinae inhabit the territory of Czechoslovakia: The mouflon sheep, Ovis musimon Pall., the wild goat, Capra aegagrus Erx., and the chamois, Rupicapra rupicapra Linn. Populations of these species (except C. aegagrus) are the object of zoological and game ranching investigations which will provide base data for their management. Except for the autochthonous population of R. r. tatrica, the species under study were introduced into Czechoslovakia. For that reason attention has been paid, in recent years, to their ecology, systematics and, incidentally, racial purity. The results obtained so far have been summarized, e.g. by Solinova et al (1973), Blahout (1976) and Lochman et al (1979). Most of the introduced populations orginated from small groups of individuals. For that reason we have concentrated on studies of the craniometric, cytogenetic and epigenetic

characteristics of the chamois and the mouflon in order to find out whether or not their populations show any deviations from the autochthonous ones due to inbreeding and genetic drift. In the case of the mouflon, moreover, the cytogenetic investigations are aimed at determining the presence, if any, of chromosome transformations (e.g., Robertsonian translocations) which could negatively affect the reproductive capacity of the species. We also compared the cytogenetic characteristics of mouflon and domestic sheep.

RESULTS AND DISCUSSION

a) The Current Status of Caprinae in Czechoslovakia

The mouflon populations of Czechoslovakia originated from introductions of authochthonous animals from Corsica and Sardinia in the middle of the 19th century. At present, the Czechoslovakian mouflon population is the world's best in regard to trophy quality. Besides, the mouflon of Czechoslovakia are considered to be least affected by possible previous hybridizations with both various wild caprines and domestic sheep. Mouflon live in suitable localities throughout the country (Figure 1) both in the wild and in game enclosures (Lochman et al 1979). The upper limit of their vertical distribution lies at 1,100 m above sea level. The development in their numbers is characterized by a continuous increase.

Table 1. Population size and hunting pressure of mouflon in Czechoslovakia (data from the statistics of the Czech. Hunters' Union)

Year	Numbers of Individuals	Numbers Shot
1970	9,350	1,150
1975	12,550	3,000
1980	14,900	6,000
1983	16,000	6,500

The second most abundant species is the chamois. An autochthonous population of R. rupicapra tatrica occurs in the territory of the Tatra National Park (Figure 1). Since World War II, the numbers of this population have shown considerable variation, slightly increasing only in recent years. At present, the population is comprised of some 900 head and is protected year round.

Table 2. Population size and hunting pressure of chamois in Czechoslovakia (data from the statistics of the Czech. Hunters' Union)

Year	Numbers of Individuals	Numbers Shot
1970	395	-
1975	737	10
1980	1,012	79
1983	1,123	96

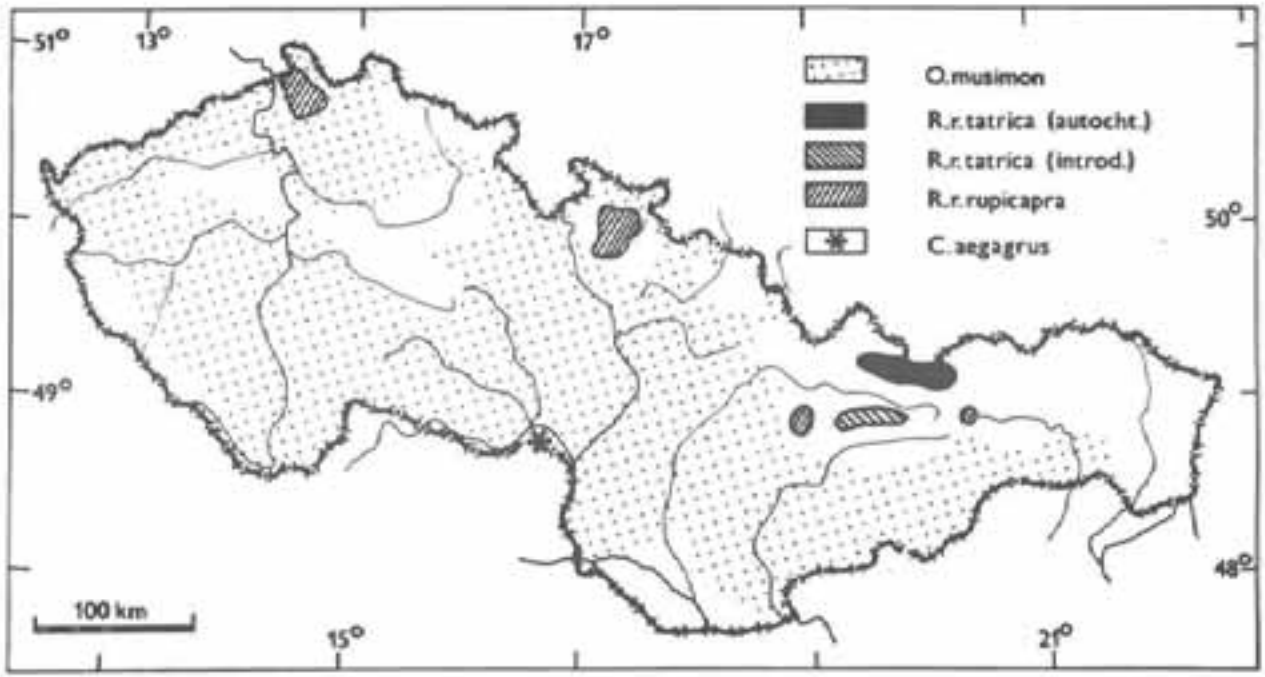

Fig. 1. Present distribution of wild caprines in Czechoslovakia.

The mountain ranges at the northern border of the country (the Luzicke hory Mts., the Jeseniky Mts.) are inhabited by introduced populations of the nominate Alpine subspecies, R. r. rupicapra, their origin going back to the beginning of the 20th century. Since the development of their numbers has been favorable during recent years and no further increase is desirable, hunting of these chamois has been permitted.

To complete the listing of chamois populations in Czechoslovakia, one must mention also those populations, though small in numbers, of the autochthonous subspecies which has recently been introduced into the Low Tatra Mts. National Park, and those of the nominate subspecies introduced into the Velka Fatra Mts. and the Slovensky Raj area.

The third local species is the wild goat. In the fifties of the 20th century, it was introduced into an enclosure, 300 hectares in size, on the Pavlovske vrchy Hills, a xerothermic limestone locality in southern Moravia (Figure 1). The individuals which originated this population came from zoological gardens and their exact origin is unknown. In their morphology these wild goats are closest to ssp. cretica (Lochman et al 1979). In Czechoslovakia this species is of no economic importance, the value of its gene pool is low and thus an increase in population size is undesirable. Therefore, it is not the object of specialized investigations.

b) Management and hunting of Mouflon.

The management of mouflon populations has attained the highest level, as indicated not only by their increasing numbers and by the size of individuals harvested, but first of all by the production of trophies of good quality. In the production of medal trophies, particularly of gold medals (205.0 or more points C.I.C.), there is no match for the Czechoslovakian mouflon management at present. Thus, for example, of the 30 foremost mouflon trophies exhibited at the last World Trophy Exhibition in Plovdiv in 1981, 23 came from Czechoslovakia. In all, 325 gold trophies were exhibited from Czechoslovakia. The present world record (240.65 points C.I.C.) comes from a Czechoslovakian mouflon population.

The present status of mouflon management in Czechoslovakia is the result of long-term culling of individuals unsuitable for further breeding, that is, of such individuals whose exterior morphological features fall short of the standard for the Central European mouflon. The criteria of this cull are primarily based on knowledge of the architectonics and coloration of horns and of the dynamics of their growth in successive years. The cull is also aimed at stabilizing the age structure of the populations. For that reason, the harvest of mouflon is realized in three age groups (age group I, 1-3 years; age group II, 4-6 years; age groups III, 7 years and over). The optimum sex ratio of 1:1 is maintained by culling a corresponding number of females. The principles of selection are also applied in the culling of kids.

In Czechoslovakia, mouflon are hunted between 1 September and 31 December. Most of the mouflons are shot by local hunters but part of the trophy rams are assigned to foreign hunters. The price depends upon the demand and is determined by the point value of each trophy. The following are the prices of mouflon rams as specified in the 1984 catalogue of the CEDOK Travel Agency:

Table 3. Prices to be paid by foreign hunters, for bagging trophy class mouflon rams.

C.I.C.Points (trophy quality)	Price in DM (German currency)
up to 175	910.-
175.01 - 180	1 250.-
180.01 - 185	1 610.-
185.01 - 190	2 170.-
190.01 - 200	3 045.-
200.00 - 205	145.- per point
205.01 - 210	165.- per point
210.01 - 220	240.- per point
220.01 and over	405.- per point

c) Selected Research

Selected mouflon populations are the subject of long-term studies of their morphology and craniometry, aimed primarily at the variability of skull characteristics. Besides, a study is in progress of mouflon horn growth dynamics for the purpose of selecting prospective breeders. Our aim has been to contribute to the description of the exterior standard of central European mouflon populations by establishing the range of variations of basic cranial dimensions. Our cytological examinations involved several dozen individuals from various localities. No deviations from the standard chromosome complement (2n = 54, FN = 60) were found. The karyotypes of mouflon and domestic sheep were compared using various chromosome banding techniques, but no differences were documented that would permit identification of hybrid individuals.

Similar problems are being studied in the chamois. We have concentrated on studies of craniometry and horn growth dynamics in individuals of both autochthonous and introduced chamois populations in Czechoslovakia (Hrabe and Koubek 1982, 1983, 1984; Koubek and Hrabe 1983 a, 1984). These studies were primarily motivated by endeavours to detect incidental changes in skull dimensions of individuals from introduced populations, but also by the fact that the raising and management of this ungulate has almost no tradition in this country. Hence, a need has been felt for basic information on management and also on hunting that would be in harmony with the ecological requirements of this species. For this study we measured a total of 450 chamois skulls of different origins, taking a total of 53 different skull and horn measurements. Having compared the skull dimensions of individuals from chamois populations introduced into Czechoslovakia with those from the autochthonous ones in the Alps, we found most characters investigated to be significantly larger in the introduced populations. Also most skull dimensions of the authochthonous ssp. tatrica were larger than those of the Alpine chamois. This fact leads us to study the same skull dimensions in additional subspecies of R. rupicapra (i.e., caucasica and carpatica, Koubek and Hrabe 1983 b) in order to assess the hitherto used differentiating subspecific characters.

The difference between the introduced and autochthonous chamois populations was also demonstrated by a study of epigenetic variability of discrete cranial characters. Using this method, a characteristic variation pattern was found in R. r. tatrica. The karyotypes of the introduced chamois

populations do not differ from the chromosome complements of individuals from the Alps or from the Tatra Mts. (Zima and Holubova 1983).

CONCLUSION

The pattern of the present distribution of wild Caprinae in Czechoslovakia resembles a mosaic comprising island-like occurrences of both authochthonous and introduced populations, having originated at different times. The introduced populations inhabit habitats which, in some cases, only remotely resemble those in their original ranges and often are quite different. This creates a suitable model situation to study various general problems of the effects of introduction upon wild ungulates and on the course and rate of changes in their biological properties. So far, we have endeavoured to tackle these problems by methods of classical morphology and craniometry and by studying epigenetic and cytogenetic characteristics. The methods used provided certain data on the divergence between authochthonous and introduced populations as well as between different introduced populations. In future it will be necessary to supplement these data by further ecological, behavioural and more detailed genetic studies.

The data obtained are of importance for proper management of these populations. Thus, based on an age structure determination of the introduced chamois population in the Jesenky Mountains, we recommended that changes be made in regard to the open season and the optimum size and structure of the annual harvest. Considering the inbred character of the introduced chamois populations and the assumed decrease in genetic variability it is recommended to exchange breeders between the individual localities.

A unique position among Czechoslovakian caprine populations is that of the autochthonous Tatra Mountains chamois population, R. r tatrica. Due to its numerous typical characters, confirmed and supplemented by our study, and due to its comparatively small size, this relict population deserves strict protection to preserve its gene pool. In this connection it is essential to prevent contact between this autochthonous population and individuals from the introduced populations of Alpine origin to avoid incidental hybridization. Also in the case of mouflon it is necessary to prevent any possible hybridization of free-living populations with domestic sheep, which might result in a deterioration of the gene pool of this wild sheep species.

LITERATURE CITED

Blahout, M. 1976. The chamois. Priroda, Bratislava. 171pp. (in Slovak, with summaries in Russian, German and English).

Hrabe, V., and P. Koubek, 1982. Craniometric characteristics of chamois (Rupicapra rupicapra) in the Jeseniky Mts. Folia zool. Brno, 31(3):227-241.

_____ 1983. The horns of the chamois, Rupicapra rupicapra rupicapra (L.) from the Jeseniky Mtns. (Czechoslovakia). Folia zool. Brno, 32(1):23-31.

_____, 1984. Craniometrical characteristics of Rupicapra rupicapra tatrica (Mamm., Bovidae). Folia zool. Brno, 33(1):73-83.

Koubek, P., and V. Hrabe. 1983a. Dynamics of horn growth in the Jeseniky Mts. population of chamois, Rupicapra rupicapra rupicapra (CSSR). Folia zool. Brno, 32(2):97-107.

_____, 1983b. Craniometrical characteristics of Rupicapra rupicapra caucasica. Folia zool. Brno, 32(3):213-223.

_____, 1984. Morphological characteristics and horn growth dynamics in Rupicapra rupicapra tatrica (Mamm., Bovidae). Folia zool. Brno, 33(4):289-302 (in press).

Lochman, J., A. Kotrly, and J. Hromas, 1979. Cavicorn game. Statni zemedelske makladatelstvi Praha. 378pp. (in Czech, with summaries in Russian and German).

Stolinova, V., O. Kokes, J. Horackova, I. Heran and J. Skultety, 1973. Erforschung der Huftiere in der Tschechoslowakei. Lynx, n. s., Suppl. III:1-80. (in Czech, with German summary).

Zima, J. and K. Holubova, 1983. Chromosome analysis of the chamois, Rupicapra rupicapra (L.) from Hruby Jesenik Mts., Czechoslovakia. Vertebrat. zpravy, 1983:57-58. (in Czech, with English summary).

STATUS OF MOUFLONIFORM (URIAL) SHEEP IN ASIA

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ABSTRACT

Mouflonifoms, consisting of 1 species and 9 subspecies in Asia, range from Cyprus through the montane regions of Anatolia, Iraq, Iran, Soviet Turkmenistan, Afghanistan, northwestern India, and Oman. Human encroachments on wild sheep habitats through livestock overgrazing and farming and subsistance overhunting have greatly reduced their numbers. Remnant herds remain in Turkey, Oman, Iraq, Pakistan, Afghanistan, and northwestern India. Significant populations of Asiatic moufloniforms exist only in Soviet Turkmenistan and Iran. Some 200 sheep exist on the island of Cyprus.

INTRODUCTION

Moufloniforms are an anatomically and chromosomally diverse group of wild sheep constituting one species (Ovis orientalis) (Valdez 1978). Valdez (1982) recognized 9 subspecies in Asia. They are distributed from Europe (restricted to the Mediterranean islands of Corsica and Sardinia) to Cyprus, Iraq, Iran, Oman, Soviet Turkmenistan, Afghanistan, Pakistan, and northwestern India (Fig. 1). Males weigh from 55 kg (120 lbs.) to 90 kg (200 lbs.) with shoulder heights of 64 cm (25 in.) to 99 cm (39 in.). Valdez (1982) described the variation in external anatomy as follows:

> All possess a clearly delineated white rump patch, males in the winter coat possess a neck ruff (length of neck ruff hair up to 9 inches) restricted to the front of the neck and brisket, and both sexes usually exhibit white legs from the knee to the hoofs. The rump patch is restricted below the base of the tail and the back of the hind quarters. However, they are variable in horn curl shape, presence or absence of a bib, neck ruff, and saddle patch and neck ruff. The bib, neck ruff, and saddle patch are phenotypic characters present only in the winter coat of males.

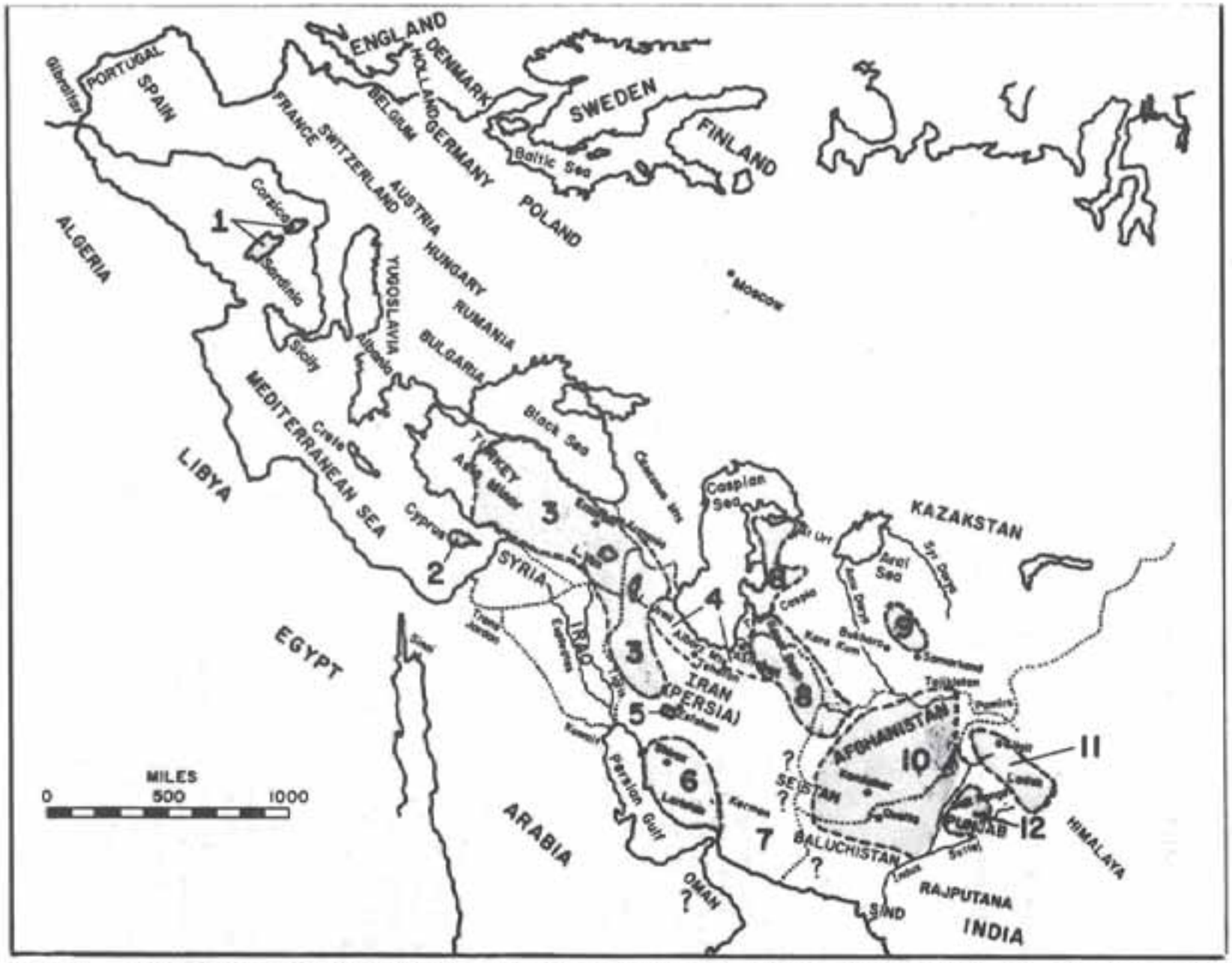

Figure 1. Distribution of moufloniforms. (1) European mouflon, (2) Cyprian mouflon, (3) Armenian mouflon, (4) Alborz red sheep hybrid, (5) Esfahan mouflon, (6) Laristan mouflon, (7) Kerman hybrid, (8) Transcaspian urial, (9) Severtozov's urial, (10) Afghan urial, (11) Ladak urial, (12) Punjab urial.

Body color varies from chestnut brown grading to blackish in the European mouflon to reddish buff in eastern subspecies; desert forms approach a straw brown color. Punjab and Ladak urials sometimes possess a two-colored saddle patch, black in front followed by a white area, but some may possess only a white saddle patch or none. European, Cyprian and Armenian mouflon ewes commonly lack horns. Basal circumferences of male horns do not exceed 13 inches.

Humankind developed its major animal husbandry advances in the midst of Asiatic wild sheep habitat. Wild sheep have been subjected to the influence of man's often deleterious agricultural practices for thousands of years. Hence it is not surprising that wild sheep have not fared well in many areas of Asia. Humankind's spiralling population growth and the resultant demands on the earth's resources including overgrazing by domestic sheep and goats and subsistance overhunting spelled doom for many moufloniform populations.

In many areas, moufloniform survive only as remnant populations. Their high fecundity, resistance to livestock disease, and their ability to benefit from agricultural practices by feeding on cultivated crops enable them to survive where most other wild ungulates would have been extirpated.

Only in Iran and the Soviet Union did Asiatic moufloniforms greatly increase in modern times. The progressive conservation programs of the two countries resulted in the establishment of wildlife refuges in prime moufloniform habitat (Firouz 1971). In one national park alone in northeastern Iran there were about 10,000 Transcaspian urials. After the recent revolution in Iran, the national parks and wildlife refuges remain intact and as a consequence wild sheep continue to exist in large numbers The establishment of large refuges with an adequate protective system can prevent their extirpation over large areas of Asia, but considering the worsening ecomonic and political situation of Southwest Asia, it is unlikely that tracts of land will be set aside for wildlife refuges.

STATUS OF MOUFLONIFORM POPULATIONS

The following discussion is a cursory overview of the status of populations of moufloniforms by subspecies in Asia. Refer to Figure 1 for approximate distributions of moufloniform sheep.

Cyprian Mouflon (O.o. gmelini)

Armenian mouflon formerly occurred through most of Anatolia, northeastern Iraq, southern Armenia in the USSR and northwestern Iran through at least the Central Zagros in western Iran. Only in Iran do large numbers still exist. On Kabudan Island in Lake Rezaiyeh (Urmia) there are an estimated 1,000 wild sheep while substantial numbers occur in scattered populations on the mainland. In Anatolia, van Haaften (1974) reported only 100 animals in 1970 in the Konya-Bozdag Reserve 270 km south of Ankara. They have been extirpated through most of their former distribution outside of Iran. Their status in the Soviet Union is unknown.

Transcaspian Urial (O. o. arkal)

The Transcaspian urial (photo) occurs in large numbers in northeastern Iran and the Soviet Union in Turkmen SSR. There were a minimum of 20,000 in Iran up to 1980 and several thousand occur in the USSR in the Kopt Dagh Mountains.

Severtzov's Urial (O. o. severtzovi)

Severtzov's urial occurs only in the Soviet Union northwest of Samarkand, Turkmen SSR. There are protected populations in nature reserves but population numbers are unavailable.

Laristan Mouflon (O. o. laristanica)

Within the Bamou National Park north of the city of Shiraz in southwestern Iran there were an estimated 2,500 animals in 1980. Several thousand occur in scattered populations throughout southwestern Iran.

Afghan Urial (O. o. cycloceros)

Only remnant populations remain in Pakistan and Afghanistan. Schaller (1977) reported occasional sightings in Khambu Hill in the Kirthar National Park and the Geshk area south of Quetta, Pakistan. For the Baluchistan Province of Pakistan the population is estimated at 2500 to 3000 (Roberts, these proceedings). Fortunately, large numbers exist in southeastern Turkmen SSR in nature reserves such as the Badchyz Wildlife Reserve.

Punjab Urial (O. o. punjabiensis)

This subspecies was once common in the Kala Chitta and Salt ranges of the Punjab region in India. Schaller (1977) estimates a world population of no more than 2,000 animals, lower numbers yet are reported by Roberts (these proceedings).

Ladak Urial (O. o. vignei)

Schaller (1977) reported fewer than 1,000 in Pakistan and recent estimates by Roberts (these proceedings) range from 1200 to 1400. For Indian, Mallon (these proceedings) gives an estimate of 1000 to 1500 Ladak urials. This subspecies faces difficulties throughout its range in northern Pakistan and India.

LITERATURE CITED

Firouz, E. 1971. Conservation and wildlife management in Iran. Iran Game and Fish Dept., Tehran. 63 pp.

Schaller, G.B. 1977. Mountain monarchs. Univ. of Chicago Press, Chicago. 425 pp.

Valdez, R. 1982. The wild sheep of the world. Wild Sheep and Goat International, Mesilla, New Mexico. 186 pp.

Ovis orientalis arkal (Photo by R. Valdez)

Valdez, R., C. F. Nadler, and T.D. Bunch. 1978. Evolution of wild sheep in Iran. Evolution, 32:56-72.

Van Haaften, J.L. 1974. The mouflons of the Mediterranean region. Pages 155-158 in I. Kjerner and P. Bjurholm, eds. XI International Congress of Game Biologists. National Swedish Environment Board, Stockholm.

DISTRIBUTION AND STATUS OF MOUNTAIN UNGULATES IN AFGHANISTAN

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ABSTRACT

As of 1978 (more recent data are not available), viable populations of Marco Polo sheep occurred in Afghanistan. Isolation from populated areas and a royal decree forbidding illegal hunting enabled the survival of the species then. Widely distributed in the major mountain ranges, the urial was then surviving in adequate numbers. The status of markhor, however, was even at that time considered to be endangered. Excessive hunting continued to reduce its numbers. Few data were available on the distribution and status of the wild goat. Hunting pressure and livestock grazing forced these animals to retreat to isolated and rugged ranges. Observed only in small groups, the future of the species was considered tenuous. Though adapted to the most precipitous terrain of the Hindu Kush ranges, both subspecies of ibex populations still occurred in large numbers.

INTRODUCTION

Few data are available on the biology of mountain ungulates in Afghanistan. It is clear from historical records (Aitchison 1889, Babur 1970) however, that the once abundant fauna of the country has been greatly diminished. The introduction of modern firearms, roads and increasing human population resulted in impoverishing faunal communities throughout the country.

To ensure effective management and to stimulate economic tourism, a natural resources conservation program was launched in 1972 with the cooperation of the Food and Agriculture Organization of the United Nations. As a first step, detailed ecological studies of ungulate species were conducted. This report summarizes those efforts and recorded findings on the distribution and status of Afghanistan's wild sheep and goats prior to 1978.

In the early 1970's the government sought help from the World Wildlife Fund to assess the status of the endangered Bactrian deer (Cervus elaphus bactrianus). Two years later, with the assistance of FAO, a wildlife conservation project was started under Dr. Ronald G. Petocz. The establishment of 5 wildlife sanctuaries in 1978 marked a turning point in the history of Afghan conservation. Despite the good intentions of the project, however, the promising indications that conservation was taking hold in the country faded after the 1978 switch in government.

DISTRIBUTION AND STATUS

MARCO POLO SHEEP

The range of Marco Polo sheep (Ovis ammon poli) is restricted to the Afghan Pamirs in the Wakhan corridor (Figure 1). This panhandle, originally created as a buffer strip between British India and Tsarist Russia is sandwiched between the Soviet Union and the Gilgit district of Pakistan.

Living above 4000 meters, the animals inhabit sedge meadows, alpine steppes and talus slopes. Like some other wild sheep (Geist 1971), the Marco Polo sheep is adapted to open terrain and rarely utilizes steep cliffs. Glaciers, however, are frequently used by both ram and ewe groups during the summer months. Petocz et al (1978) divided the population in the corridor into 3 parts on the basis of population characteristics and general movements:

The Big Pamir Segment

Seasonal concentrations occur in both the western and eastern ends of the Big Pamir. Valleys in between are infrequently used. In the west, sheep concentrations occur throughout most of the year. Major north-south movements which exclude females occur in this sector in winter between Afghanistan and the Soviet Union. In the eastern sector animal concentrations move east-west between Afghanistan and the Soviet Union from late June to October.

The Small Pamir Segment

In this segment the area north of Aksu River is utilized by the wild sheep. Female nursery groups use the area throughout the year with major concentrations occurring from June through January. Rams are found mainly during the pre-rut and rut (October through mid-January). Major seasonal movements are north-south between the Soviet Union and Afghanistan. Evidently little intermixing between the Big and Small Pamir sub-populations takes place.

The Waghjir Valley Segment

Although few data were available on the distribution of sheep in the area, local inhabitants reported concentrations of rams during summer months in valleys extending into China and the Soviet Union. Some animals were believed to move between Afghanistan and these countries.

Due to its isolation and value as a spectacular trophy, the Marco Polo sheep has been well protected in Afghanistan. Declared as a protected species through a royal decree by the former king, its hunting was banned without special permission from the Afghan Tourist Organization. As a result, the largest concentrations of the species probably occurred in the Afghan Pamirs

An estimate of its numbers in the Big and Small Pamir was made by Petocz (1978). The census indicated that about 1,300 animals lived in the 2 areas. Prior to the 1978 political upheaval, 12 hunting licenses were issued annually to foreign hunters for the Big Pamir segment. Although hunted in the Small Pamir by pastoral Kirghis, such activity did not cause significant demographic or social damage to the wild sheep population. The Kirghis, as a complete tribe, migrated to Pakistan in 1979.

The removal of over 50,000 head of Kirghis livestock from the Afghan Pamirs probably has benefited the wild sheep population through reduced competition for food resources. The present status of the animals in the Wakhan corridor, however, is unknown. According to press reports, the entire area has been sealed off from the rest of the country.

URIAL

The Urial (Ovis orientalis) prefers open country of rolling hills. A major portion of its range is composed of fairly dry alpine valleys and steppes ranging in altitude from 500-4000 meters.

At least 2 sub-species of urials are believed to occur in Afghanistan. The species ranges from the Zebak Mountains in the northeast to the Siyah Koh range in central Afghanistan (Figure 1). The Afghan urial (O. o. cycloceros) has the widest distribution of any native wild ungulate occurring throughout the Hindu Kush and Siyah Koh ranges (Habibi 1977). A disjunct population is found in the Feroz Koh chain near Herat and the Mughab River basin (Figure 2).

Considerable work is needed before the distribution patterns of urials in other parts of the country can be clarified. Sightings in 1976 of urials in the Zebak valleys confirmed their presence in that area. The extent of its range in other parts of Badakshan is not known. Near Kabul the urial is known only from specimens collected by hunters in the Lataband mountains. The Baluchistan urial (O. o. blanfordi) is believed to occur in the steppe country south of Ghazni but its distribution there has yet to be confirmed.

Insufficient data are available to assess the present status of this widespread species. Certainly Afghan urial must number in the thousands but population size of Baluchistan urial probably is much smaller in view of its limited distribution.

MARKHOR

The markhor (Capra falconeri) is limited to the eastern portion of Afghanistan. The most common of the 3 sub-species, the Kashmir markhor (C. f. cashmiriensis) is widely distributed in the Nuristan and Laghman monsoon forests (Roberts 1969, Petocz 1972) (Figure 3). Seasonal movements of the

Figure 1. Map of Afghanistan showing major mountain ranges and areas of mountain ungulate distributions.

Figure 2. Distribution of Marco Polo sheep (Ovis ammon poli) dark area and urial (Ovis orientalis) cross hatched.

animals are more altitudinal than otherwise. Exposed alpine slopes and steppes are used mainly during the summer months. In winter, the animals prefer the more sheltered coniferous forests at somewhat lower elevations, where a variety of browse species are available.

During the 1977 reconnaissance survey Petocz observed a total of 350 Kashmir markhor in western Nuristan (Petocz and Larsson 1977). Although the groups seen seemed to be only a small fraction of the animals present in the area, the markhor population there had been declining steeply during previous years (Caughley 1970, Schaller and Khan 1975). Goat herding in the alpine meadows and agriculture in the oak forests and valley bottoms evidently interfered with markhor movements. As traditional hunters, stalking has always been an important activity of the Nuristani peoples. Their hunting appeared even before 1978, to have decimated the Kashmir markhor population in several localized sections of its range.

Once widespread, the range of Kabul markhor (C.f. megaceros) has been greatly reduced during recent years. Its numbers have declined so low that the race is threatened with extinction. It is believed to survive now only in the Kabul gorge and the nearby Kohe Safi region (Petocz 1973). After a survey of the animal's range, Petocz (1973) reported that about 50-80 markhor survived in the Kohe Safi region. Only a few animals were believed to exist in other isolated pockets.

Little is known about the distribution of the Badakshan markhor (C.f. heptneri) in the far north Darwaz "peninsula". During the 1970's, about 150 of these animals were believed to survive in the western section of that district (Petocz, pers. comm.).

WILD GOAT

The range of the wild goat (Capra aegagrus) includes the barren mountains of Gezab and the headwaters of the Hilmand and Arghandab rivers extending towards the Siyah Koh range in central Afghanistan (Habibi 1977). No animals were observed in the Gezab range during a field survey in May of 1976 but local shepherds reported seeing a female group on steep bluffs in the Gezab Valley. Westward, the species is occasionally spotted in valleys forming the headwaters of Farah Rud (Figure 3).

Although no data are available on its numbers, hunting pressure and heavy grazing competition by livestock had reduced the population extensively even a decade ago. The species probably persists now only in small isolated bands in the most pecipitious parts of its range.

IBEX

Two sub-species of ibex (Capra ibex) occur in Afghanistan. The alpine ibex (C.i. ibex) is found in large numbers in the Ajar Valley reserve of the central highlands (Shank et al. 1977). Forming an arc through the Hindu Kush it is seen as far northeast as southern Badakshan (Sultani, pers comm.). To the west, it persists in the Feroz Koh mountains (Figure 4). Despite an influx of human settlements, it has managed to survive in the Kohe Baba range near

Figure 3. Distribution of markhor (Capra falconeri) dark areas and wild goat (Capra aegagrus) cross hatched.

Figure 4. Distribution of alpine ibex (Capra ibex ibex) cross hatched and Siberian ibex (C. i. sibericus) dark area.

Kabul. To the east it probably persists in isolated pockets in the forests of Spinghar range.

The Siberian ibex (C.i. sibericus) is distributed throughout the Wakhan corridor including the glaciated peaks south of Wakhan River and also in the Darwas "peninsula" and the alpine valleys of Zebak (Habibi 1977). Southward, it extends deep into western Nuristan (Figure 4). Extensive seasonal movements occur between Nuristan and the neighboring northern province of Badakshan (Petocz and Larsson 1977).

Well adapted to rocky terrain the ibex was abundant in several parts of its range a decade ago. About 5,000 animals were estimated to concentrate seasonally in the Ajar valley reserve (Shank et al. 1977). Although not censused, the Pamir population of the Siberian ibex was likely greater than 4,000 animals during the late 1970's.

CONSERVATION

The concepts of modern conservation are new in Afghan society. Ordinances dealing with the preservation of wildlife species and their habitat have been pronounced but are seldom enforced. With the majority of the population living in tribal areas, at least prior to 1978 most men carried arms and shot at any wild animals seen. In addition, floral communities have been modified by centuries of heavy grazing pressure by livestock (Frietag 1971). With only a small remnant of the original vegetation left in areas inaccessible to domestic stocks the country still faces the threat of widespread desertification. Wildlife and mountain ungulates in particular have been forced to take refuge in the most remote and steepest terrain of their serene habitat. There they doubtless are exposed to the most severe environmental hazards and harsh climatic conditions.

With the intensification of political turmoil in 1979, all wildlife work came to a standstill. Fighting was reported around the sanctuaries and reports reached Kabul of Soviet soldiers and the local population killing wild animals (Alexander 1980). The wildlife conservation program, which had taken years of planning and dedicated work to get established, was officially pronounced suspended in 1980. Assiduously hunted and with no effective means to enforce conservation the future of the country's wildlife seems to be facing gradual extermination.

LITERATURE CITED

Aitchison, J. E. T. 1889. The zoology of the Afghan delimination commission. Trans. Linn. Soc. 5:53-142.

Alexander, D. 1980. Report from a troubled land. Int'l. Wildl. 10:45-48.

Babur, Z. M. 1970. Babur Nama (Memoirs of Babur, 1494-1530). Translated by A. S. Bevridge. Oriental Reprint Books, New Delhi. 874pp.

Caughley, G. 1970. Wildlife resources. Report to the government of Afghanistan. FAO, Rome. 28pp.

Frietag, H. 1971. Die natürliche Vegetation Afghanistans. Vegetatio. 22:285-334.

Geist, V. 1971. Mountain sheep. A study in behavior and evolution. The University of Chicago Press, Chicago. 383pp.

Habibi, K. 1977. The mammals of Afghanistan. Their distribution and status. Field document No. 1. FO:DP/AFG/74/016. FAO, Rome. 91pp.

Petocz, R. G. 1972. Report on the Laghman markhor survey. Report to the government of Afghanistan. 17pp.

_____1973. Kabul markhor and urial in the Kohe Safe region of Kapisa province. Report to the government of Afghanistan. 10pp.

_____and J. Larsson. 1977. Ecological reconaissance of western Nuristan with recommendations for management. Field document No. 9. FO:DP/AFG/74/016. FAO, Rome. 57pp.

_____1978. Report on the Afghan Pamir. Ecological reconaissance. Field document No. 5. FO:DP/AFG/74/016. FAO, Rome. 33 pp.

_____, K. Habibi, A. Jamil and A. Wassey. 1978. Report on the Afghan Pamir. Biology of Marco Polo sheep (Ovis ammon poli). Field document No. 6. FO:DP/AFG/74/016. FAO, Rome. 42 pp.

Roberts, T. 1969. A note on Capra falconeri (Wagner, 1839). Z. Saugetierk. 34:238-49.

Schaller, G. and S. Khan. 1975. The status and distribution of markhor (Capra falconeri). Biol. Cons. 7:185-98.

Shank, C., R. G. Petocz and K. Habibi. 1977. A preliminary plan for the Ajar valley wildlife reserve. Field document No. 4. FO:DP/AFG/74/016. FAO, Rome. 35 pp.

DISTRIBUTION AND PRESENT STATUS OF WILD SHEEP IN PAKISTAN

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ABSTRACT

The following report is based on a review of relevant literature, as well as recent interviews with people knowledgeable about the present status of wild sheep in Pakistan. Four different types of wild sheep inhabit suitable habitats in Pakistan. Three are subspecies of the Urial or Asiatic Red Sheep (Ovis orientalis): 1) the Baluchistan Urial or "Gad" (O.o. blanfordi); 2) the Punjab Urial (O.o. punjabiensis), and 3) the Shapu or Himalayan Urial (O.o. vignei); the fourth wild sheep in a subspecies of Argali (Ovis ammon), the Marco Polo's sheep (O.a. polii). All these sheep are threatened because of ongoing illegal hunting and competition with domestic stock.

METHODS

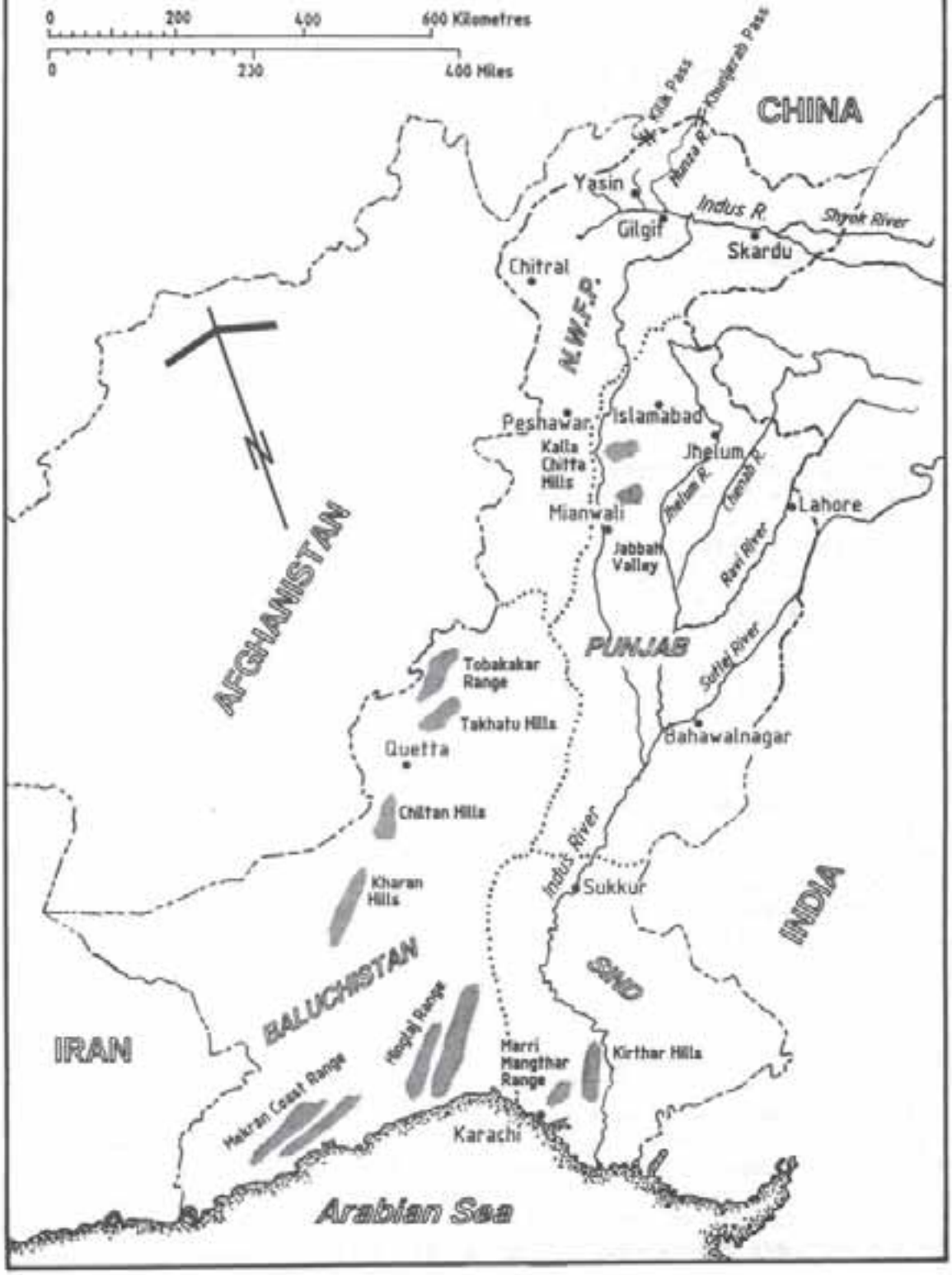
Early in 1985 government staff and other people knowledgeable about the status of wild sheep in their respective areas were interviewed. Data based on these interviews were supplemented by a review of relevant literature as well as personal observations. Since few detailed surveys have been undertaken in this country, the population data provided are estimates only. The attached map (Fig. 1) gives the localities mentioned in the text.

RESULTS AND DISCUSSION

URIAL OR ASIATIC RED SHEEP (Ovis orientalis)

Pakistan still has three somewhat disjunct and distinct populations which have been assigned to three sub-species. All are threatened due to continuing hunting pressure and competition from domestic grazing stock. There has been a total ban on all hunting of mammals for the past two years in Pakistan but this has been impossible to enforce, especially in the remoter mountain areas along the western and northern mountainous boundaries of Pakistan.

Fig. 1:
Distribution of Wild Sheep in Pakistan



BALUCHISTAN URIAL, OR "GAD" (Ovis orientalis blandfordi)

This subspecies is characterized by a slimmer longer-legged build than the other two races, with males carrying a long and flowing neck ruff of white and black hairs. The horns tend to be smaller in circumference than in the other two races, but in mature males grow into an almost complete concentric ring and measure in overall length more than Punjab specimens.

It is still very widely distributed from arid ranges along the Mekran coast, eastwards to the hill ranges on the borders of Sind province and with scattered population on nearly all the major mountain ranges in northern and central Baluchistan. Unfortunately no comprehensive surveys have ever been conducted in all these mountain ranges and those in southern Baluchistan are unapproachable by road and often politically inaccessible as well. Reports indicate that it is everywhere subject to some hunting pressure from local villagers most of whom include one or two professional hunters, except in Sind where it is protected. Here, there are two populations which are monitored. One in the Marri Mangthar range about 40 miles due north of Karachi comprises between 40 to 50 animals. In the Kirthar National Park further north in Dadu district between 400 and 500 are now estimated to survive on the Kambhu and Kirthar ranges where they are sympatric with Sind Ibex (Capra hircus) (Malik Asad Khan, Honorary Wildlife Warden and tribal chief of the area, Pers. Comm., April 1985).

In Baluchistan there are recent confirmed reports of small numbers surviving in the Tobakakar Range, in Mashlaq Reserve south of Chaman, on the western slopes of the Chiltan Hills, on the Takhatu Range, as well as further south in the Kharan Hills and Hinglaj Range. After discussion with Mohammed Aslam, Divisional Forest Officer (Wildlife) for the province of Baluchistan (April, 1984), and with Mr. Hamid Ali, Deputy Conservator (Wildlife) in the National Council for Wildlife Preservation, Islamabad in April 1985, an intelligent guess of the total Baluchistan population (excluding Sind) is between 2,500 and 3,000, but most of these animals comprise small isolated populations on scattered mountain ranges, hence all are vulnerable, especially as nomadic tribes graze their sheep and goat flocks in all these ranges except the Chiltan hills which are a National Park and Wildlife Reserve.

PUNJAB URIAL (Ovis orientalis punjabiensis)

This animal is characterized by a very poorly developed chest ruff, often absent in 2nd. and 3rd. year males. Also the horns are more massive than in other sub-species, tending to be less re-curved and to slope backwards.

World Wildlife Fund (WWF) (Pakistan) carried out detailed surveys in 1972-73 and sixteen small scattered populations were located in various parts of the northwest Punjab Salt Range area, with two major concentrations in the Kalla Chitta Hills and in the Kalabagh Sanctuary in the Jabbah Valley (Z.B. Mirza, mimeographed reports, 1974). No recent surveys appear to have been attempted, but enquiries reveal that the Kalla Chitta population has suffered very heavy poaching pressure, in which, regrettably the Wildlife Department officials have been involved (Major Amanullah Khan, former administrator WWF Pakistan, Pers. Comm, March 1985). According to Mr. Zahid Beg Mirza, the total population outside of the Jabbah Valley (a sanctuary) is not more than 500 and probably well below 300, in view of adverse reports about the Kalla Chitta Hills.

Jabbah Valley was declared a WWF Sanctuary in 1970 and is owned and protected by the Nawab of Kalabagh. During studies there by Dr. George Schaller in 1970-71, he estimated a population of about 500 (Schaller, Mountain Monarchs and other publications). Since then the herd was reported to have increased to "over 750" (Malik Allah Yar, head of the Kalabagh family). In 1983 they were decimated by an unknown epidemic thought to have been introduced by ticks carried by camels who were allowed into the area (by the Kalabagh family) for controlled fuel wood felling and charcoal burning. As many as 20 dead urial could be found during one day's survey at the height of the epidemic and numbers were estimated to have fallen to 300. Since that time a high proportion of lambs have been reared and the herd seems to have made an astonishingly rapid recovery and to be estimated at well over 700 today as lambing is now in progress (Malik Allah Yar Khan, Pers. Comm., April 12th., 1985).

SHAPU OR HIMALAYAN URIAL (Ovis orientalis vignei)

This subspecies besides being noted for its larger than average size, is distinguished by the rams bearing relatively massive horns, which are of a rather open or short curvature. The chest ruff in this subspecies also tends to be rather short.

Again this is a very widely distributed and scattered population but there have been no systematic or reliable attempts at population estimation. They occur on the lower foothill spurs and valley slopes of the Chitral Valley, as well as Mastuj Valley further north. Westwards, they occur in Gilgit, especially around Yasin, Bunji and up the Hunza Valley. On the east boundary of Pakistan's northern regions, they occur in Baltistan in the Indus Valley and its tributaries, the Shigar and Shyok Valleys.

In Chitral due to unrelenting hunting pressure, its numbers are very low (Mohammed Mumtaz Malik, Conservator Wildlife Government of NWFP, Pers. Comm., April, 1985). The status is more favourable in the upper reaches of the Gilgit Valley and also in the northern regions of the Hunza Valley (Ghulam Rasool, DFO Wildlife, Gilgit Agency, 1984). In Baltistan, due to the greater poverty of the local people, there are fewer firearms and less hunting pressure than in Gilgit, but numbers are considered low when compared with the Himalayan Ibex population (M.N. Bhandara, Governor WWF Pakistan, based upon a visit in June 1984, Pers. Comm.).

At Skardu, the capital of Baltistan there is a huge outcrop of rock standing in the bed of the Indus whose flat "table mountain" top covers some 550 hectares, and a small band of Shapu still survives on this rock despite its proximity to the town and accessibility to humans. Their numbers may well be less than 25 (author), but it is encouraging testimony to the species ability to survive, especially as the available vegetation on this rock is extremely scanty and appears to be comprised mostly of Artemisia maritima and a small succulent compositae. Intelligent guesses of the Baltistan population are between 500 and 600 and of the Gilgit/Hunza population between 700 and 800.

MARCO POLO'S SHEEP (Ovis ammon polii)

This spectacular animal has always attracted attention amongst Pakistan's wildlife enthusiasts, especially amateur hunters. A reserve was created specifically for this sheep in 1974 and called the Khunjerab National Park.

This is on the northeastern border of Hunza where it joins the international boundary with Chinese Sinkiang. The area of suitable and available habitat in the Khunjerab Valley is however very limited (it lies at over 5180 metres in elevation) and there is no permanent population of Marco Polo sheep, but small bands are sighted in the autumn, winter and early summer months. According to Shuja-ul-Islam, Member Governing Council WWF Pakistan, who visited the Khunjerab in July 1984 and saw 2 animals, a local Game Warden Hajijan, had counted a maximum herd of over 70 animals in that region in the early spring of 1984 (Pers. Comm., March 1985).

Unfortunately poaching still occurs, with a recent reliable report involving an army officer serving in the border region who secured two trophy heads. Marco Polo sheep still wander into the Kilik Pass area to the northwest of Khunjerab and as this remote area is outside of the national park, there are reports of continuous poaching in this region also (Major Amanullah Khan, Pers. Comm., April, 1985). There are no estimates of numbers on the Kilik Pass but they are believed to be very low with a single band of 4 or 5 up to one dozen being encountered in one day's survey.

LITERATURE CITED

Roberts, T.J. 1977. The Mammals of Pakistan. Ernest Benn, London, 361 pp.

Schaller, G.B. 1977. Mountain Monarchs. The University of Chicago Press, Chicago, 425 pp.

Valdez, R. 1982. The Wild Sheep of the World. Wild Sheep and Goat International, Mesilla, New Mexico, 186 pp.

STATUS REPORT ON WILD SHEEP IN INDIA

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ABSTRACT

Two species of wild sheep occur in India. The distribution of both is restricted to the Transhimalayan district of Ladakh, in the northernmost corner of the country. The population of both species is small, but conservation prospects are reasonably encouraging. The status of both species in India should be regarded as vulnerable.

INTRODUCTION

Two species of wild sheep are found in India: Ladakh urial (Ovis orientalis vignei) and Tibetan argali (Ovis ammon hodgsoni). Within India both species occur regularly only in Ladakh, in the northeast of the State of Jammu and Kashmir, on the border with Pakistan and Tibet. Neither species is found south of the main Himalayan watershed.

Several works on the fauna of India (e. g. Prater 1965) list a third variety, Marco Polo's sheep (Ovis ammon poli). This is known in the extreme north of Hunza, on the Chinese border. Since partition of the subcontinent in 1947 this area has been on the Pakistani side of the cease-fire line.

Ladakh covers an area of 98,876 square kilometres, of which 37,555 have been under Chinese administration since 1962. At the time of the last census, in 1971, the human population was 105,291, excluding a large military presence.

Ladakh lies to the north of the Himalayan watershed and is entirely Transhimalayan in character. The climate is continental, with hot summers and severe winters. Aridity increases northwards and eastwards, as one crosses the main ridge of the Himalaya.

The whole area is mountainous and most of the land lies above 3000 metres above sea level. The lowest point is around 2700 metres while the highest summits exceed 7000 metres. The east of Ladakh consists of a high tableland

4000 metres above sea level, which forms the western limits of the Tibetan plateau.

The vegetation consists largely of steppe and semidesert plant communities, made up of species from a number of widely occurring Central Asian genera. There are no forests, and trees are restricted to thick scrub in valley bottoms and a few junipers (Juniperus spp.).

The two sheep species occupy different habitats: urial are found in the lower hills along major river valleys, while argali prefer the highlands of the eastern plateau. Their ranges overlap slightly, but they are usually separated altitudinally. In the latter part of the last century there were reports of interbreeding between the two species in Ladakh. One head obtained in Ladakh which had at first been assigned specific status (as Ovis brookei) was later presumed to represent a hybrid form. There are no recent records of urial-argali hybrids in India, or even of direct contact between the two species, which even in winter are normally found at different altitudes.

METHODS

Information on the wild sheep was obtained in the course of a survey of the mammals and ecology of Ladakh. Survey work was carried out on five expeditions, between July 1980 and April 1984, covering a total of 17 months in Lakakh. Information on the wild sheep was collected on every visit; two expeditions, in the winters 1980-81 and 1981-82, had as a primary aim a survey of the distribution and numbers of the Ladakh urial. Information was also obtained from printed accounts, from Forest Department personnel and from a large number of local informants.

LADAKH URIAL

Distribution and Numbers

Ladakh urial are distributed in northern India and Pakistan, and in parts of the southwest Pamirs in Afghanistan and the U.S.S.R. In India they occur only within Ladakh and they are distributed in a narrow band of low hills along the Shyok, Nubra and Indus river valleys and their tributaries (see Figure 1). Their range along the Indus runs from approximately 78°E, downstream to the cease-fire line with Pakistan, a distance of some 200 kilometres.

Within this range the distribution of urial is not continuous. In some places there are good populations, while in others they are seen only occasionally. They are least common in the central section of the Indus valley, which contains most of the large villages and is the most developed part of Ladakh, although two urial were seen on the outskirts of Leh, the main town, in Spring 1982, and small resident populations exist within 20 kilometres of Leh.

In an earlier report (Mallon 1983) I noted the apparent disappearance of the urial from the area around the Fotu La pass, which lies to the west of the Indus. Subsequent observations have shown that a small population does in fact occur there, though it is unclear whether this represents a previously overlooked remnant or a recolonization.

Figure 1: Distribution of Wild sheep in India.

Figure 2: Ladakh urial in the Indus valley.

There are reports that Ladakh urial also occur in Zanskar and northern Tibet (Blanford 1888-90; Prater 1965). I made several visits to Zanskar, an area to the south of Ladakh, where I found neither suitable habitat nor any trace of this species. Furthermore it was unknown to the Forest Department and to all the local inhabitants I spoke to. It seems likely that there has been some confusion with the Zanskar Range, whose northeastern end contains some urial territory. The occurrence of urial in Tibet was based upon a report by a single traveller, and was doubted by another visitor to Ladakh and Tibet (Rawling 1905). There have been no other reports or sightings since, and the species was not included in the list of mammals of Tibet given by Shen (1963). The habitat and altitude are both unsuitable and I regard the report of urial occurrence in Tibet as erroneous.

From early printed accounts by sportsmen and the testimony of local informants, it is clear that urial were once more numerous than they are today. It seems equally clear that overharvest has been the cause of this reduction, which has been most marked over the last 20 years (Ganhar 1979; Ranjitsinh 1981). This period coincides with the arrival in Ladakh of large numbers of military personnel and other outsiders. Urial in particular have suffered from overharvest, as they occupy the lower, more accessible slopes and the main road from Srinagar to Leh runs along the Indus valley through the middle of their range and offers easy access to most parts of urial territory. All hunting has been illegal since 1978, the decline in the urial population has been reversed and they are slowly increasing again. They are spread thinly throughout their full range, and in one or two places can be described as fairly common, though nowhere here are they abundant. I would estimate current numbers at 1000-1500.

Habitat

Urial in India may be found between 3000 and 4250 metres, most commonly in the lower part of this altitudinal range. Only 5 per cent of my records of urial were above 4000 metres.

In many places along the Indus valley a series of shales and sandstones has weathered to form steep, rounded hills which provide excellent wild sheep habitat, and these areas contain the largest urial populations. However, they also occur in rockier habitats such as are formed on the adjoining granite and although they prefer open areas, they frequently cross steep rocky terrain and cliffs when necessary.

These habitats can be summarized as arid montane steppe and semidesert; vegetation is scanty and the carrying capacity of the land is low. Snowfall is rarely heavy and south-facing slopes clear within a few hours of exposure to the sun. Urial range, in the lower hills along the major river valleys, coincides with most of the human settlements and the urial graze the same slopes as the domestic flocks. They can be seen near to, and often from, many villages.

Predation

Natural predators on the Ladakh urial are the wolf (Canis lupus), Snow leopard (Panthera uncia) and Golden eagle (Aquila chrysaetos). I have seen Golden eagles attempting to take urial lambs, though they do not pose a threat

to adult animals; the Snow leopard may prey on urial in winter, when it descends to lower altitudes, and the main predator is the wolf, which occurs throughout the urial range in India.

Competition

There is little competition with other wild ungulates: in some places the range of the urial adjoins or overlaps that of the ibex (Capra ibex) and bharal (Pseudois nayaur), but while both these species sometimes graze at low altitudes, they are usually found above the urial and they occupy a different habitat as they require steeper, rockier ground. Two species of hare (Lepus capensis and L. oiostolus) and, in a few places, marmots (Marmota bobak) also compete for grazing.

Of greater importance is competition with domestic livestock, mainly sheep and goats. Large flocks of these graze the same slopes around the villages as the urial. In addition, villagers collect the woody shrubs for use as fuel, thereby depriving both domestic and wild animals of fodder.

TIBETAN ARGALI

Distribution and Numbers

The range of the Tibetan argali covers the entire Tibetan plateau east at least to northern Bhutan. Within India it occurs regularly only in eastern Ladakh where the high plains form the western rim of the Tibetan plateau. It is here at the western limit of its world range. Very occasionally it may stray to other Transhimalayan districts of India such as Spiti (which lies to the southeast of Ladakh) and perhaps to the extreme north of Sikkim (Prater 1965) (see Figure 1).

Occasionally, small groups of argali wander westwards into the mountains of central Ladakh. Since the winter of 1979-80 a small group of argali has been established around the 4900 metre Ganda La pass on the watershed between the Indus and Markha valleys, to the south of Leh, and some 50 kilometres west of their normal range. In autumn 1981 I observed a group of six argali feeding on the north side of this pass. The vegetation around the pass is similar to the prevailing vegetation in their normal range on the eastern plateau. Argali were still present there in April 1984.

No detailed census of the argali population in India has been carried out, but it is unlikely to number more than a few hundred. Their numbers appear to be stable. The enormous horns of the males have long made it a much sought-after trophy. Like the urial, it has been protected since 1978 and it is further protected by the remoteness of its habitat. In recent years there have been several attempts from abroad to persuade the State government to grant hunting licenses for argali, but these have so far been unsuccessful.

Habitat

The habitat in India consists of rolling hills and stony valleys at altitudes between 4500-5000 metres. In winter these sheep may descend to the shelter of the lower valleys, but have few opportunities to descend below 4100 metres.

The climate of the eastern plateau is more arid and more severe than in other parts of Ladakh. It freezes on most nights of the year, and strong cold winds are frequent. The dominant plant is Caragana, a thorny shrub. These bleak highlands support a very small human population, and the main inhabitants are a few semi-nomadic Tibetans who wander the area with their flocks.

Predation and Competition

The only natural enemies of the argali in India are the wolf and Snow leopard. The latter species is rare on the eastern plateau and the main predator is the wolf.

The only other ungulate species whose range coincides with that of the argali in India is the bharal, which in general occupies steeper and rockier habitats. Hares, marmots and other small rodent species also compete for grazing.

CONSERVATION AND MANAGEMENT

The Social Background

Certain aspects of the social conditions in Ladakh have had important consequences for wildlife conservation. Firstly, the human population is very small and Ladakh has the sparsest population density of any area in India. The rate of increase has always been very low, as a result of the traditional practice of polyandry, the comparatively high proportion of the population who spend celibate lives in the Buddhist monasteries, and a very high rate of infant mortality.

Since 1962, and following the border war between India and China, many changes have taken place in Ladakh. A big development plan was launched; there was a large influx of military personnel and administrators, and in 1974 Ladakh was opened to tourists. This sudden increase in outside contact helped to weaken traditional social patterns and the decade 1961-71 saw a 17 percent rise in the population. However, there was not a significant increase in the rural population as many people were able to obtain employment with the administration, armed forces and in the tourist industry. Thus, there has never been the severe pressure on the land from a rapidly expanding human population that has occurred in most other parts of the Himalaya and Karakoram mountains.

Secondly, the predominant religion in the area under discussion is Tibetan Buddhism, one of whose precepts forbids the taking of life. While this prohibition has never been universally observed, it has greatly reduced the number of hunters active in Ladakh.

Hunting

Some hunting of the wild ungulates in this part of northern India for meat has always gone on, but never on a large scale. Traditionally, guns are the exception rather than the rule in all the areas where urial and argali occur, and many people in Ladakh are strongly opposed to hunting. Systematic trapping or poisoning of wildlife as happens, for example in parts of Nepal, is unheard of.

From about 1860 to 1940 many British sportsmen visited Ladakh in pursuit of trophies, including urial and argali. The heads of argali were especially prized. Strict game laws were in force, and some reduction in the numbers of the wild sheep species was noted, but good populations survived until recently.

There was a steady increase in hunting after 1948, and again after 1962, with the arrival of many non-Buddhist newcomers, many of them armed with modern weapons. As noted above, the urial in Ladakh suffered most. In 1978, a wildlife protection law was introduced by the State government of Jammu and Kashmir, which outlawed the hunting of all animals. The Forest Department is responsible for enforcing this law, although it is not easy to police such a large area with a limited number of personnel. Some illegal shooting still goes on, but on a small scale. The Forest Ranger in Leh has secured several prosecutions against poachers and the vigilance of the Forest Department certainly deters much illegal hunting.

Conservation

The wildlife protection law has removed the biggest threat to the wild sheep population in India. The argali, in its remote highland range is unaffected by development activities and any changes in the tiny human population are of negligible significance. Urial however, which occupy a lower habitat in the most populated part of Ladakh are more vulnerable to a range of threats. They are the easiest target for poachers. Any increase in the rural population would result in the collection of more potential fodder for fuel, while an increase in the numbers of domestic animals would increase competition for grazing. The proximity of large numbers of domestic animals also carries the risk of possible introduction of disease or parasites to the urial population. A new road at present under construction will run for 40 kilometres along the northern edge of the best urial range in the Indus valley. As the main road already runs along the southern edge of this, it is to be hoped that the Forest Department will carefully monitor the effects and take steps to prevent any increase in poaching that this improved access will provide.

A series of reserves and national parks has been designated in Ladakh. None of these specifically protects wild sheep, but the largest of these, the Hemis High Altitude National Park, contains two separate urial populations and the very small, isolated group of argali around the Ganda La. If properly wardened, it should provide them with full protection.

Little wildlife research is carried on in Ladakh owing to a shortage of personnel in the Forest Department. Recently however, a separate Department of Wildlife Protection has been established by the State government, and this may allow more resources to be devoted to wildlife.

CONCLUSIONS

Wild sheep in India have a very restricted distribution and the two species which occur are represented by small populations. These remain vulnerable to outbreaks of disease and exceptionally adverse weather conditions. However, both species appear to be stable at present, and urial at

least are increasing slowly. The status of both species in India should be regarded as vulnerable rather than endangered. They have full legal protection and the benefit of unique social and demographic conditions which save them from the severe pressure which occurs in many neighboring areas. The prospects for the survival of both species in India at current levels are good. However some measures could be taken to aid the conservation of wild sheep. Reserves created specifically for urial and argali should be set up in the most favourable parts of their ranges; tighter controls should be put on illegal shooting, especially along the Indus; regular monitoring should be conducted of the remaining wild sheep populations to census numbers and identify matters of ecological concern. Finally, an overall management plan is needed, which will consider the needs of the wild sheep populations in Ladakh in the light of changes and development in Ladakh so as to ensure their continued survival in India.

LITERATURE CITED

Blanford, W. T. 1888-90. The fauna of British India: Mammalia. Taylor & Francis, London.

Ganhar, J. N. 1979. The wildlife of Ladakh. Haramukh Publications, Srinagar.

Mallon, D. P. 1983. The status of Ladakh urial Ovis orientalis vignei in Ladakh, India. Biol. Conserv. 27:373-381.

Prater, S. H. 1965. The book of Indian animals. Bombay Natural history Society, Bombay.

Ranjitsinh, M. H. 1981. Himalayan fauna. In the Himalaya: aspects of change. Ed. by J. S. Lall, 64-76, Oxford University Press, New Delhi.

Rawling, C. G. 1905. The great plateau. Edward Arnold, London.

Shen, S. 1963. Faunal characteristics of Tibetan mammals and the history of their organization. Acta Zoologica Sinica 15:139-150, (in Chinese).

THE STATUS OF PSEUDOIS NAYAUR AND OVIS POPULATIONS IN NEPAL

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ABSTRACT

The status of blue sheep (Pseudois nayaur) and great Tibetan sheep (Ovis ammon hodgsoni) in Nepal was ascertained from a review of the relevant literature and more recent personal investigations. At the time of observation, three blue sheep populations were increasing and one was stable. Great Tibetan sheep may range south into the northern regions of Nepal, but reliable verification is needed. A call is made to initiate more biological fieldwork throughout the country.

INTRODUCTION

Historically, bharal (or blue sheep Pseudois nayaur) have ranged throughout the main Himalayan axis and the Tibetan Plateau (Blanford 1888-91). At their extreme western distribution, bharal have been observed in considerable numbers in upper Hunza and north of the Karakoram range in Pakistan (Roberts 1977). Bharal then ranged southeast through the Ladak region of northern India, and through northwest Nepal with southern populations existing in northwestern Bhutan and possibly in Sikkim along the Kanchenjunga range (Schaller 1977). The eastern limit of the species' distribution lies in western China, along the Tibetan-Szechwan border (Clark 1964, Sheldon 1975).

The precise range of the Tibetan argali (Ovis ammon hodgsoni) remains obscure (Schaller 1977), but the species appears to be limited to the Tibetan plateau and does not range south of the Himalayan axis (Blanford 1888-91), as do some populations of bharal. In general the Tibetan argali inhabits higher, drier slopes than bharal and has adapted to the rolling high steppes of the plateau, whereas the shorter, stouter bharal inhabits slopes near rugged cliffs. The extreme range of the Tibetan argali appears to be west from northern Ladak and east through the Plateau to areas north of Sikkim and Bhutan

(Blanford 1888-91). At their southernmost range, argalis cross the Tibetan border in a few places into Nepal (Schaller 1977) and Bhutan (Gee 1967).

The objective of this report is to ascertain the current status of bharal and Tibetan argali populations in Nepal from published field studies and more recent personal investigations.

METHODS

Censuses of bharal populations in Nepal were via direct counts as bharal herds are invariably found above treeline. In general, south facing slopes were searched from promontory points with binoculars and spotting scopes (Schaller 1973 and 1977, Wegge 1976 and 1979, Wilson 1981 and 1984). Herds seem to have preferred ranges, thus a reliable census is attainable after repeated counts of a continuous ridgeline. Once located, herds were enumerated and animals were classified to sex and age class. The age classes of male bharal differed between published reports, and these minor differences have been discussed by Wilson (1981).

RESULTS AND DISCUSSION

BHARAL

Information on surveyed bharal populations are presented in Table 1.

Table 1. Summary of surveyed bharal populations in Nepal.

Location	Population Estimate	Area (km^2) Surveyed	date(s) Surveyed	Source
Lapche	50	35	March 1972	Schaller 1973
Kanjiroba	500 - 700	550	Oct - Dec 1973	Schaller 1977
Shey	175 - 200	20	Nov - Dec 1973	Schaller 1977
Dhorpatan	800 - 900	960	Apr - May 1976 Sept - Dec 1976 Apr - Jun 1977	Wilson 1977 & 1981
Langu	(under study)		1982 to 1985	Jackson (pers. comm.)

Locations of these populations plus the historical range of the species in Nepal are presented in Figure 1. Densities of sheep compare closely between the surveyed areas: 0.8 - 0.9 bharal/km^2 in Dhorpatan, 0.9 - 1.3/km^2 in the Kanjiroba Range, and 1.4/km^2 in Lapche. The bharal at Shey were concentrated during the winter breeding season at a density of 8.8 - 10.0 per km^2 (Schaller 1977). A more precise measure of sheep densities in the Dhorpatan area indicated about 2.7 bharal/km^2 on sheep habitat above treeline (Wilson 1981).

Productivity of bharal in Nepal has been discussed by Wilson (1981), as have been differences between populations in herd structure, lamb production,

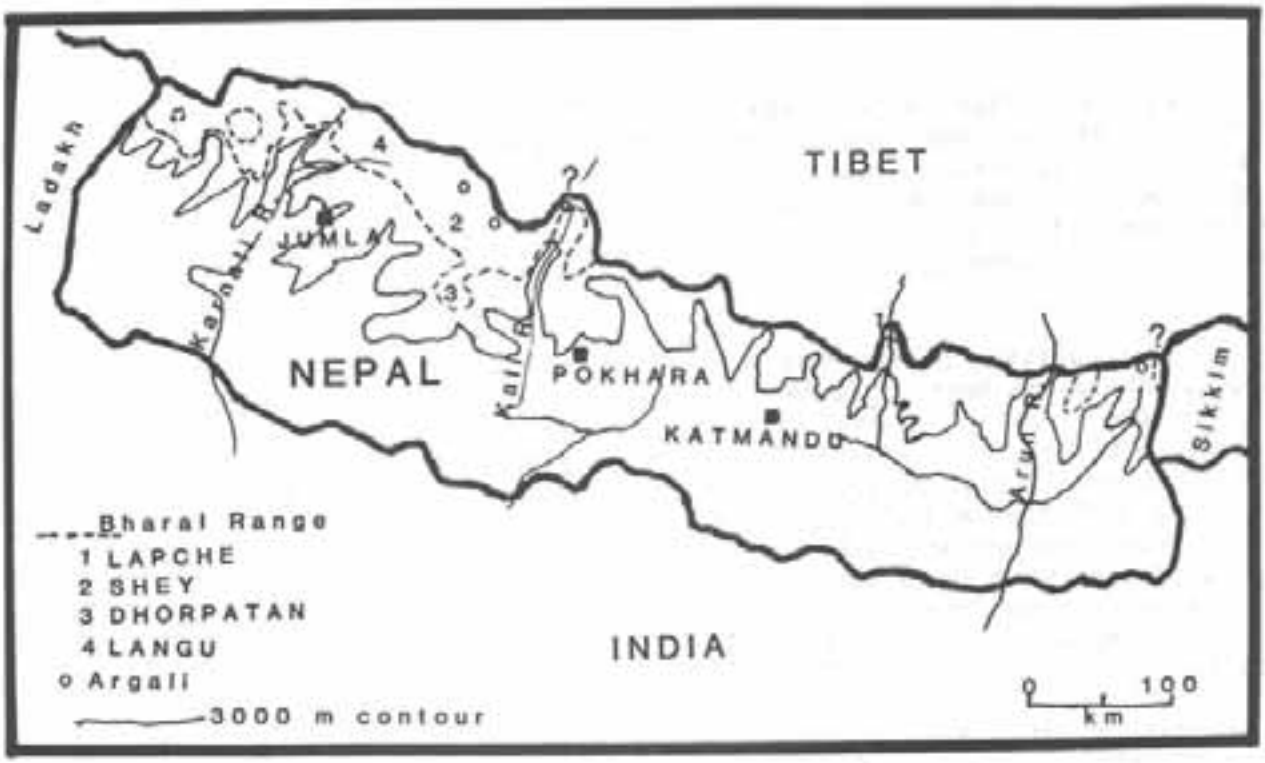

Fig. 1: The Status of Pseudois nayaur and Ovis populations in Nepal

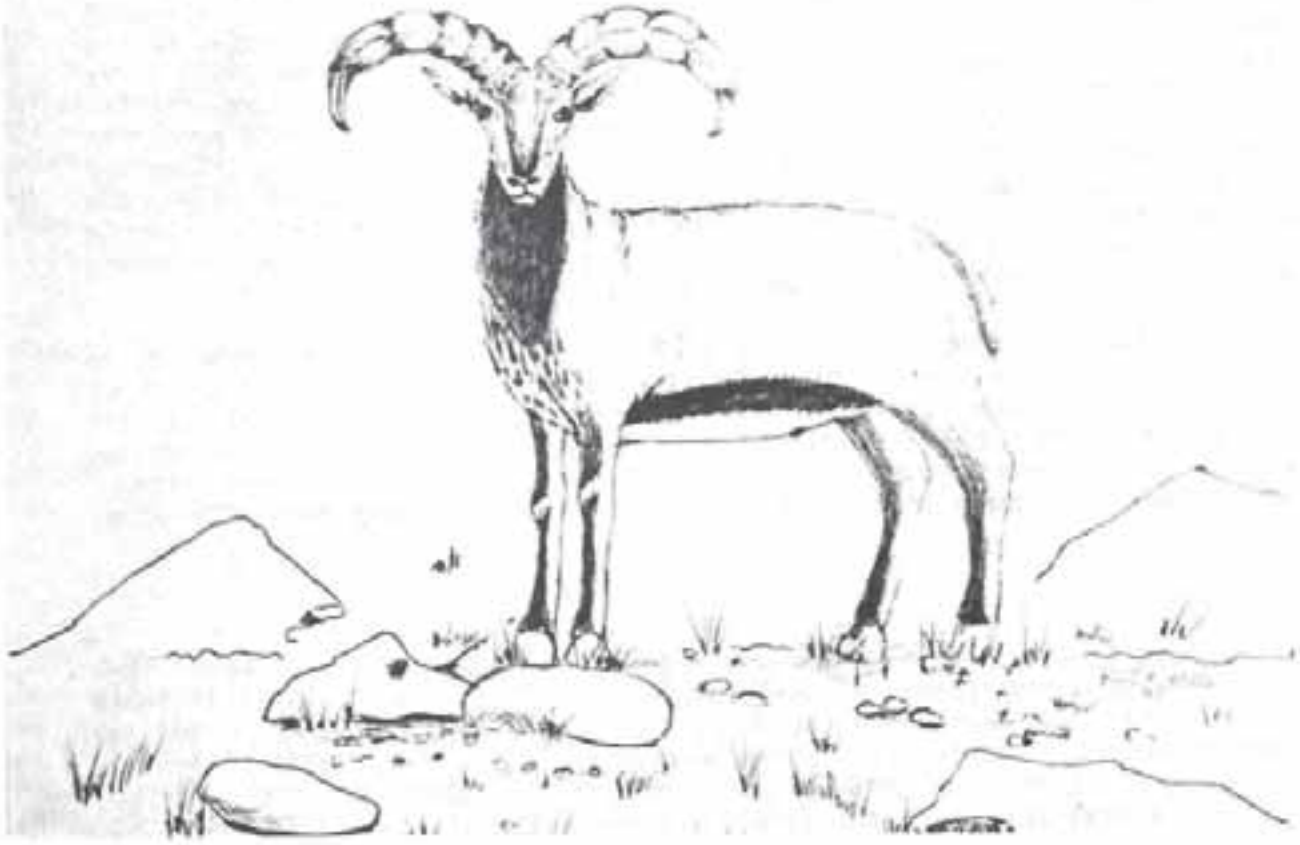

Fig. 2: Drawing of blue sheep by Rose A. Szabo

and sex ratios (Wilson 1984). Data from Schaller (1977) indicate that the male composition of the Shey population was more skewed than reported by Wilson (1984) (R. Jacks, pers. comm.). Analyses by R. Jackson and G. Alborn resulted in 42.3% males in the Shey population (Classes I - V) with 10% yearlings, 34.2% females, and 13.7% young. This resulted in a ratio of 124 males per 100 females, which compares closely with the Sun Dah population in Dhorpatan (Wilson 1984).

These population differences may assist in an explanation of the current status of bharal in Nepal. To briefly review: Dhorpatan and Lapche herds all had high pregnancy rates and high lamb/ewe ratios (75 - 83 young per 100 females) (Schaller 1973, Wilson 1981). These populations have also shown high yearling survival, e.g. 80 yearlings per 100 ewes in the Dhorpatan area (Wilson 1981). In addition, a small percentage of yearling females may possibly come into oestrous and produce lambs at 2 years of age (Wegge 1979). In contrast, reproduction at Shey Gompa was reduced (40 young/100 females), probably due to range deterioration from overgrazing by domestic livestock, and also possibly due to predation by wolves (Canis lupus) and snow leopard (Panthera uncia) (Schaller 1977).

Mortality rates also differed considerably between populations. Due to the difficulty in aging females, all reported information has been on mortality rates of males. The Shey population appeared to be stable as the number of yearling males entering the adult age class was roughly equal to the number of adult males disappearing through death and emigration (Schaller 1977). In contrast, two populations were probably inceasing at the time they were surveyed: Lapche (Schaller 1977) and Dhorpatan (Wilson 1981). A recent estimate (M. Busynat, pers. comm.) of 200 sheep in the Dogadi block of the Dhorpatan reserve compares closely with the 1977 census (Wilson 1977). In addition, the more recently studied Langu population is probably increasing (R. Jackson, pers. comm.). Major sources of mortality were snow leopard predation in Lapche (Schaller 1973), wolf and snow leopard predation in Shey (Schaller 1977), snow leopard and aboriginal hunters in Langu Valley (Jackson 1979), and trophy and aboriginal hunters in the Dhorpatan area (Wilson 1981). Common leopard (Panthera pardus) was present in the Dhorpatan area, but did not have a significant impact on the bharal population (Wilson 1981).

Trophy hunters select large adult male bharal, and the number of males in at least one Dhorpatan hunting block was seriously reduced after five years of heavy hunting pressure (Wilson 1984). Probably more detrimental is the selective harvesting of male bharal by aboriginal hunters who place poison stakes in areas where sheep frequent. Adult male bharal in rut race between herds of ewes and impale themselves more frequently than wary ewes with young (Wilson 1981).

TIBETAN ARGALI

The long-legged Tibetan argali inhabits open, rolling plateaus where they can observe and outrun potential predators (Clark 1964). Such habitat is found only in remote northern areas of Nepal, e.g. northern Dolpo district and Mustang district. Schaller (1977) saw several skulls in Dolpo district and was informed by villagers that argalis were once fairly common but their numbers had declined drastically in the past 10 years (approximately 1965 to 1975).

Reasons for the decline are unknown, but any argalis found in Nepal were at the extreme southern edge of their range and were probably at very low densities. In addition, severe winters with heavy snowfall and heavy wolf predation could possibly have decimated the population (Schaller 1977).

In April of 1977, I conducted interviews of villagers as they crossed the Jangla Bhanjyang pass enroute to their homes in Dolpo district. Photographs of snow leopard, common leopard, bharal, and Tibetan argali were individually shown to villagers and the villagers were asked to identify the species. I determined that residents of Dolpo could distinguish the different species whereas Nepali villagers in the Dhorpatan area could not separate the two species of leopard nor the two species of wild sheep. Dolpo residents informed me that Tibetan argalis were present but in small herds (4 - 6 sheep) and at very high altitudes (4700 m). The villagers indicated that argalis inhabit terrain in the northern reaches of the district which is probably near the Nepal - Tibet border.

Another area of Nepal where Tibetan argalis were once observed is Mustang district. Mustang is on the Tibetan plateau north of the Himalayan rain shadow. The area was most well known for the main trade route which ran north through the district into Tibet. I interviewed a Nepali who shot an argali in 1965 at 5325 m in a valley somewhere in southern Mustang. The argali was a full-curl ram - with broomed horns - that supposedly weighed close to 180 kg. I do not know how the weight was determined but I verified the species, sex, and age from four photographs taken by the hunting party. More recently, Mahesh Busnyat conducted a survey in the southern half of Mustang and found no evidence of argali populations being present in the area.

Locations of suspected Tibetan argali populations (Figure 1) are based on interviews by Schaller (1977) and this author. From available information, I assume that argalis have not been observed in Nepal since 1965.

CONCLUSIONS

The information currently available suggests that of four bharal populations surveyed during the 1970's and 1980's, two were stable and two were increasing. With the exception of the Langu Valley population (currently under study in Mugu district), information is old and is in need of updating.

Information on the status of Tibetan argali is in more serious need of immediate verification by scientists. The Tibetan argali has been virtually ignored by Indian and Nepalese biologists. Studies of the southern populations of this species may be the first step in more long-term population studies on the Tibetan Plateau.

An increasing number of Nepalese biologists have received training and/or education in Europe and the United States. Unfortunately, new research and fieldwork have not been forthcoming. Hopefully, the new Nepal Wildlife Trust, with input from the World Wildlife Fund, will improve both the quality and quantity of biological studies in Nepal. Such results will be dependent on biologists initiating fieldwork and utilizing their new skills and knowledge.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Blanford, W. T. 1888-91. The fauna of British India, including Ceylon and Burma. Taylor and Francis. London. 617pp.

Clark, J. L. 1964. The great arc of the wild sheep. Univ. of Oklahoma Press. Norman. 247pp.

Gee, E. P. 1967. Occurrence of the nayan or great Tibetan sheep, Ovis ammon hodgsoni Blyth in Bhutan. J. Bombay Nat. Hist. Soc. 64:553.

Jackson, R. 1979. Aboriginal hunting in West Nepal with reference to musk deer (Moschus moschiferas moschiferas) and snow leopard (Panthera uncia). Biol. Conserv 16:63-72.

Roberts, T. J. 1977. The mammals of Pakistan. Ernest Benn, Ltd. London. 361pp.

Schaller, G. B. 1973. On the behavior of blue sheep (Pseudois nayaur). J. Bombay Nat. Hist. Soc. 69:523-537.

_____. 1977. Mountain monarchs; wild sheep and goats of the Himalaya. Univ. of Chicago Press. Chicago. 425pp.

Sheldon, W. 1975. The wilderness home of the giant panda. Univ. of Mass. Press. Amherst. 196pp.

Wegge, P. 1976. Himalayan shikar reserves: surveys and management proposals. FAO NEP/72/002, Field Document No. 5. Tribuvan Univ. Press. Kathmandu. 96pp.

_____. 1979. Aspects of the population ecology of blue sheep in Nepal. J. Asian Ecol. 1:10-20.

Wilson, P. 1977. Blue sheep census. HMG, Nat. Parks and Wildl. Conserv., Kathmandu (Unpublished report).

_____. 1981. Ecology and habitat utilization of blue sheep (Pseudois nayaur) in Nepal. Biol. Conserv. 21:55-74.

_____. 1984. Aspects of reproductive behavior of bharal (Pseudois nayau) in Nepal. Z. Säugetierkunde 49:36-42.

WILD SHEEP IN MONGOLIA

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ABSTRACT

The Argali is the only species of wild sheep which occurs in the Mongolian People's Republic. It is widely distributed in suitable habitat in most of the montainous parts of the country, though it has disappeared from two areas. During the first half of this century, shooting reduced the numbers of Argali, which have enjoyed protected status since 1953. Stocks are now good, and the survival of an adequate Argali population in Mongolia seems assured for the foreseeable future. Hunting of Argali by foreigners generates hard currency earnings for the Mongolian government.

INTRODUCTION

The Mongolian People's Republic (MPR) was formerly known as Outer Mongolia, as distinct from Inner Mongolia which is a part of China. In this paper, the term 'Mongolia' is used to refer exclusively to the territory of the MPR.

The MPR is a large country covering an area of 1,565,000 square kilomentres in northern Central Asia, situated between Eastern Siberia and China. It is mountainous in character, most markedly in the north and west; the average elevation of the country was estimated by Murzaev (1948) to be 1,580 metres above sea level.

Murzaev also divided the MRP into six regions, based on vegetation types, and wild sheep occur within four of these: alpine, steppe, desert and semidesert. Full descriptions of these zones, together with lists of the predominant plant species occurring therein, can be found in Murzaev (1948) and Thiel (1958).

The climate of the MPR is continental, with severe winters, large diurnal and annual variations in temperature, low relative humidity and low precipitation, of which approximately 70 percent falls during the summer months. The amount of precipitation varies from around 50 millimetres annually in parts of the south, to over 400 millimetres in some of the northern mountains. The average number of days with snow cover increases from 60 - 70 in the south, to around 170 in the north.

ARGALI IN THE MPR

The only species of wild sheep which occurs in the MPR is the Argali Ovis ammon ('argali' is the Mongolian word for this animal). A detailed account of the Argali in Mongolia was given by Bannikov (1954) based on his field work from 1942 to 1945. Since then, short, overall accounts with distribution maps have been provided by Shagdarsuren (1966), Dulamtseren (1970) and Sokolov & Orlov (1980); several other papers have referred to the Argali in particular localities.

DISTRIBUTION

The distribution of Argali in the MPR covers almost all of the mountainous areas of the country. The extreme south-eastern corner of the MPR contains a small part of the Hingan mountains; Argali do not occur there, although they are found in other parts of the Great Hingan, in China (Corbet 1978).

Argali are no longer found in the hills to the east of Lake Hovsgol the Hentei mountains and the hills on the north bank of the R. Onon (Onon Steppe). According to Bannikov (1954) quoting Radde, Argali were found in these areas in the first half of the nineteenth century, but in small numbers. Radde also said that they disappeared from the Onon Steppe following an unusually heavy snowfall in the winter of 1931-32. Bannikov (1954) also quoted a Mongolian informant as saying that Argali were occasionally met with in Hentei in the early part of this century, but had since died out. Argali have also become extinct in Transbaikalia, the adjoining part of the U.S.S.R.(Heptner, Nasimovich & Bannikov 1961). Possible former links between these Argali, those of Mongolia, and the Argali of the Great Hingan were referred to by Nadler et al (1973).

Current Argali distribution in the MPR covers all the remaining mountains and can be divided for the purposes of description, into four areas: the Lake Hovsgol region; Hangai mountains; Altai mountains; and the Transaltai Gobi.

Argali occur to the west of Lake Hovsgol, in the mountains forming part of the watershed of the upper Yenisei; that is, on the Horidil Sardag and Bayan Uul ridges immediately west of the lake, and on the Ulaan Taiga ridge. A short way to the south-west, some Argali are found in the hills forming the eastern end of the Tannu Ola range, around the upper reaches of the river Shavaryn.

In Hangai, Argali occur in the alpine zone, running along the whole of the main ridge; in the Bulnain Nuruu, lying between Hangai and Hovsgol, on the north bank of the river Ider; in the Han Hohii range which runs westwards from the north west end of the Hangai; and, according to Shagdarsuren (1966), also in the Delgerhangai, a low (1913 metres), isolated range in the semidesert zone, to the south-east of Hangai proper.

In the north-west MPR, in addition to the Altai, Argali are found on the Turgen Jul massif and in the Sailiugem range along the MPR-USSR border. Argali are found along the entire Altai range, which runs from the north-west corner of the MPR, south-east then east, for about 1,500 kilometres. It is usually divided into two parts, the Mongolian Altai (the higher, western part) and the Gobi Altai (the lower, eastern section).

The Transaltai Gobi is the area lying to the south and south-east of the Altai mountains. It consists of desert and semidesert, containing numerous isolated hills and mountains. Argali occur on virtually all of these mountains; Bannikov (1954) said that they could be found everywhere in the Transaltai Gobi, except in desert basins and the widest valleys. In the east of this area, where the easternmost spurs of the Altai fall away into the desert, Argali occur in the lowest desert hills, approximately up to longitude 110°E. At one time they ranged as far as Zamyn Uud, 112°E, but according to Bannikov (1954) none had been seen there over the previous few decades.

A map showing the distribution of Argali in Mongolia is given in Fig. 1.

HABITAT

Argali are not distributed uniformly within the range described above; factors affecting distribution and numbers in a locality include habitat suitability, human disturbance, competition with domestic livestock, and hunting pressure.

In the Altai and in northern Mongolia, Argali are high mountain animals, restricted to the upper slopes and alpine zones, though in the Gobi Altai, they may occasionally descend to lower valleys. These habitats contain a variety of alpine, steppe and semidesert plant communities. In the Transaltai Gobi, Argali occur in a desert environment and at all altitudes, being found much lower than elsewhere in the MPR, and at all levels on the mountains. At the eastern end of their range, they occur in low hills of 1000 - 1500 metres in altitude.

Within this altitudinal range, Argali tolerate a variety of habitat types, so long as they are treeless and in general they avoid rocky and precipitous areas, which in the MPR are usually occupied by the Ibex Capra ibex sibirica. Argali and Ibex have a sympatric distribution on the MPR, and are separated by habitat. Argali prefer open slopes which may be steep or gentle, plateaus and ridges, montane valleys and an absence of extensive, rocky terrain and cliffs. Ibex are rarely seen away from rocky areas, ridge crests and cliffs.

On visits to one area in the Gobi Altai , and three separate areas in the Mongolian Altai, including the Hoh Serh reserve, in 1976 and 1977, I found that the difference between Ibex and Argali habitat was immediately apparent. In all the localities, Ibex were seen in areas of large cliffs, ravines and expanses of precipitous and broken, rocky terrain. Argali occupied broad alpine valleys, open slopes that were steep but not precipitous, flat summits, small plateaus and a series of rounded ridges at around 3000 metres.

In the Transaltai Gobi, Bannikov (1954) said that Argali avoided rocky ridges and wide areas of Saxaul (Haloxylon) and Ephedra desert, though they crossed the latter when necessary. Kowalski (1968) said Argali were usually seen in badlands at the foot of mountains, in desert vegetation.

According to Bannikov (1954), Argali habitat in Hovsgul and the Tannu Ola consists of steppe plateaus, treeless ridges and wide steppe valleys. Argali avoided any kind of forested localities, and were rare on cliffs, where they were replaced by Ibex.

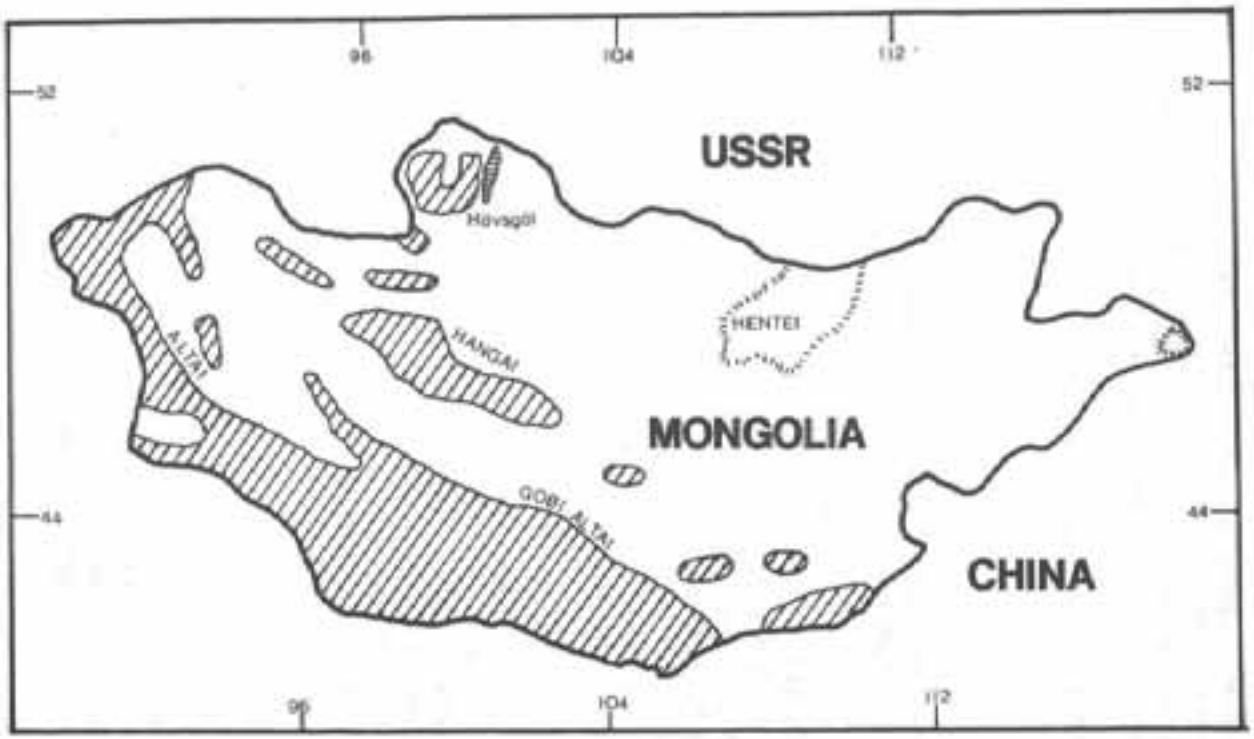

Figure 1: The distribution of Argali in the MPR.

NUMBERS

Hunting wild animals for meat and furs has always been a part of the way of life in Mongolia, and expert hunters are greatly respected. Argali have long been hunted for their meat, and, in more recent times, for the horns of the male animals, which are regarded by some people as a desirable trophy. There are a number of accounts of such hunting by European sportsmen and travellers (see, e.g. Demidoff 1900; Carruthers 1913).

The amount of hunting in the MPR has increased steadily during this century with the growth in the human population, improved access to remote regions offered by motor vehicles and the introduction of modern firearms, with their greater range and accuracy.

Such an increase in hunting inevitably resulted in a decline in numbers of many species of wild mammal, including the Argali. According to Shagdarsuren (1966), the decrease in the Argali population due to hunting was most marked from 1940 to 1950. This may have been due in part to an increased need for meat from wild animals to replace meat normally provided by domestic herds, much of which at this time was sent by the Mongolian government to the USSR as a contribution to the Soviet war effort.

In 1953 the Argali was declared a protected species in the MPR, and Shagdarsuren (1966) said that its numbers had recovered. He described it as rare in places, and most common in the three contiguous provinces of Hovd, Gobi-Altai and Bayan Hongor. These three provinces together contain a large proportion of the Altai range, and most of the Transaltai Gobi. Zevegmid and Dawaa (1973) also said that the Argali population had increased, thanks to the protection measures taken.

Kowalski (1968) described Argali as fairly numerous in those parts of the Transaltai Gobi which he visited, and Dash et al. (1977) reported that they were common in another range of the Transaltai Gobi, the Edrengiin Nuruu.

In the Gobi Altai, Argali appear to be common in the reserve on Gurvan Saihan, and local informants told me that they were common on Baga Bogd and Ih Bogd - where Formozow (1931) had said they occurred in significant numbers.

In the Mongolian Altai, I found Argali fairly common in the Burhan Buudai mountains, where groups of up to 85 animals were seen, and there are said to be good numbers in the reserve on Hasagt Hairhan, and elsewhere. Dziecolowski et al. (1980) reported on the Hoh Serh reserve in the Altai, which was set up specifically for the conservation of Argali and Ibex. (In their paper, the authors used a Polish transliteration from the Mongolian and spelt the name of the reserve Khuhsyrh; I have followed a conventional English system of transliteration and spelt it Hoh Serh). These authors estimated that a population of 600 Argali lived in the reserve, which covers 835 square kilometres. They reported a mean density of 0.8 - 1.2 animals/square kilometre for Argali over the whole reserve, and 2.0 - 2.3 animals/square kilometre in a part of the reserve constituting Argali habitat.

During a two year stay in Mongolia, 1975 - 1977, I was able to obtain information on the wildlife from many people: colleagues at the State University, biologists, local experts, hunters and local people from all parts

of the country. The consensus of opinion among all these informants was that Argali existed in good numbers in the MPR, were common in several places, and were not in any way endangered.

HUNTING AND CONSERVATION

HUNTING

Reference was made above, to the role played by hunting in the reduction of the Argali population, and it was noted that Argali were given protected status in 1953. This protected status was renewed in the new game laws of 1972, which also set a heavy fine of 2000 tugriks for illegal shooting (Zevegmid, Stubbe and Dawaa, 1974). Hunting remains a popular activity in Mongolia and there are many licensed hunters, but the game laws are strictly applied, and there can be little doubt about their effectiveness.

Following the recovery in numbers of Argali, some carefully controlled shooting is now allowed. Small local quotas are set in certain areas, depending on local abundance, and in three areas Argali hunting is reserved for foreigners. The three hunting camps are in the High, Middle and Low Altai, and charges vary from one to the other, depending on the expected size of the trophies. The largest rams are found in the High Altai, which is the most expensive area. In 1981, the charge for ten days hunting plus one Argali and one Ibex was US $16,500; an additional Argali cost $9,000. The Basic hunting charge in the Middle Altai was $10,000 and $4,000 for an extra ram, while in the Low Altai the figures were $6,000 and $3,000. As there appears to be no shortage of people willing to pay these sums for an Argali trophy, the government of Mongolia annually earns a considerable sum of foreign exchange. The Argali population is regularly monitored to ensure that the numbers shot are not excessive. A brief news item (Anon. 1982) said that 300 Argali were shot annually in Mongolia.

RESERVES

Several reserves protect Argali populations: the Hoh Serh reserve covering 835 square kilometres in the Mongolian Altai; Hasagt Hairhan, also in the Mongolian Altai, covering approximately 300 square kilometres; the Yolyn Am reserve in the Gurvan Saihan group in the Gobi Altai; and the Great Gobi Reserve which covers 45,000 square kilometres in the Transaltai Gobi. There are also several hunting reserves.

COMPETITION AND DISTURBANCE

The only other wild ungulate species widespread in the mountains of Mongolia where Argali occur, is the Ibex, which as indicated earlier, is generally separated on habitat grounds. Bannikov (1954) quoted an instance in the Gobi Altai where Argali were grazing in the same valley as the Goitered gazelle Gazella subgutturosa and Wild ass Equus hemionus. Both these species occur widely in the Transaltai Gobi and are potential competitors for grazing there. Other herbivores are Hares Lepus spp., Pikas Ochotona spp., Marmots Marmota spp., and several other small rodent species.

In 1971, there were over 22,500,000 head of domestic livestock (cattle, yaks, sheep, goats, camels, horses) in the MPR, which in many areas are in direct

competition for grazing with Argali, and human disturbance must also have an adverse effect on the Argali population. However, despite the large numbers of livestock, there remain many places where Argali can graze undisturbed, and although the human population has risen sharply in recent decades, the average density remains low.

According to the government statistics (Central Statistical Board 1971) the mean population density in the MRP rose from 0.47 persons/square kilometre in 1935, to 0.79 persons/square kilometre in 1970. Taking together the three provinces listed by Shagdarsuren (1966) as having the largest numbers of Argali, the mean density in 1970 was 0.49 persons/square kilometre, and in the Transaltai Gobi, the figure is even lower.

PREDATION

Lynx Felis lynx and Fox Vulpes vulpes may kill Argali lambs, but the only carnivores occurring in the MPR which could attack adult Argali are the Snow leopard Panthera uncia and Wolf Canis lupus. Both species are known to prey on Argali, but in neither case do Argali appear to constitute a major prey item. Snow leopard prey mainly on Ibex, and take Argali more rarely (Bannikov 1954), while wolves are more dependent on domestic livestock. My local informants were agreed that the wolf was the main natural predator on Argali, but that only a small number were taken.

SUBSPECIES

The systematics of Ovis are not settled, and several arrangements have been proposed at both specific and subspecific level. In so far as the MPR is concerned, seven races of O.ammon have been reported by various authors. There is general agreement that the nominate subspecies occurs in the Altai and northern Mongolia, and that a different form occurs in the Transaltai Gobi. The forms that have been listed are darwini, jubata and kozlovi but there is little agreement on which of these forms occurs, or their relations to each other.

CONCLUSION

The government of MPR is committed to the conservation of its wildlife; Article 1 of the 1972 game laws states that the object of these laws is to protect the stock of wild animals in the country, which it regards as one of its most important natural resources. There is the added incentive, in the case of the Argali, of a regular source of foreign exchange from hunting, provided stocks are maintained. The former nomadic way of life of the Mongols has given them a strong sense of indentity with the land and public support for the conservation of wildlife is readily available.

In addition to these advantages, game laws are strict, human population density is low, and reserves exist, that will further protect the Argali. Since its numbers are now good, the survival of a viable Argali population in the MPR seems assured for the foreseeable future.

LITERATURE CITED

Anon. 1982. Hunting in Mongolia. Oryx 16:220.

Bannikov, A.G. 1954. Mlekopitayushchie Mongol'skoi Narodnoi Respubliki. Akademia Navk, Moscow

Carruthers, B. 1913. Unknown Mongolia. 2 vols., Hutchinson, London.

Central Statistical Board, 1971. 50 years of the MPR: statistical collection. Central Statistical Board of the Council of Ministers, Ulan Bator.

Corbet, G.B. 1978. The mammals of the palaearctic region: a taxonomic review. British museum (Natural History) and Cornell University Press, London and Ithaca.

Dash, Y., Szaniawski, A., Child, G.S. and Hunkeler, P. 1977. Observations on some large mammals of the Transaltai. Djungarian and Shargin Gobi, Mongolia. La Terre et la Vie 31:587-597.

Demidoff, E. 1900. After wild sheep in the Altai and Mongolia. Rowland Ward, London.

Dulamtseren, S. 1970. Mongol orny höhtön amitan todorhoilog bichig. Academy of Sciences, Ulan Bator, (in Mongolian).

Dziecolowski, R., Krupka, J., Bayandelger, and Dziedzic, R. 1980. Argali and Siberian Ibex population in the Khuhsyrh reserve in Mongolian Altai. Acta Theriologica 25: 213-219.

Formozow, A.N. 1931. Ueber die Säugetiere der nördlichen Mongolei. Fol. Zool. Hydrob. 3: 41-78.

Heptner, V.G., Nasimovich, A.A. and Bannikov, A.C. 1961. Mlekopitayushchie Sovietskogo Soyuza - parnokopytnye i neparnokopytnye. Vysshaya Shkola, Moscow.

Kowalski, K. 1968. New data on the distribution of mammals in the Mongolian People's Republic. Acta Zool. Cracoviensia. 13:1-11.

Murzaev, E.M. 1948. Mongol'skaya Narodnaya Respublika: fiziko-geograficheskoe opisanie. Akademia Navk, Moscow.

Nadler, C.F. Korobitsina, K.V., Hoffmann, R.S., and Vorontsov, N.N. 1973. Cytogenetic differentiation, geographic distribution and domestication of palaearctic sheep (Ovis). Z. Säugetierk. 38:109-125.

Shagdarsuren, O. 1966. Mongol orny agnuuryn undsen and amitad. Academy of Sciences, Ulan Bator, (in Mongolian).

Sokolov, V.E., and Orlov, V.N. 1980. Opredelitel' mlekopitayushchikh Mongol' skoi Narodnoi Respubliki. Navka, Moscow.

Thiel, E. 1958. Die Mongolei. Isar Verlag, München.

Zevegmid, D., and Dawaa, N. 1973. Die seltenen Grossäuger der Mongolischen Volksrepublik und ihr Schutz. Arch. Naturschutz. u. Landschaftsforsch. 13: 87-106.

Zevegmid, D., Stubbe, M., and Dawaa, N. 1974. Das neue mongolische Jagdgesetz vom 6. Januar 1972; die Naturschutzgebiete und Wirbeltierarten der MVR. Arch. Naturschutz. u. Landshaftsforsch. 14: 3-36.

CONSERVATION AND UTILIZATION OF THE MONGOLIAN ARGALI (Ovis ammon ammon) - A SOCIO-ECONOMIC SUCCESS -

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ABSTRACT

The largest and heaviest sheep trophies in the world have been picked-up heads originating from the highest massif in the Mongolian High-Altai, Khukhtsyrh. This area, as indeed the entire Altai range down to the Gobi desert, has been for decades submitted to heavy seasonal grazing by domestic sheep and goats, as well as by horses, camels and yaks. Competition between argali and domestic stock for available grazing has been severe, as well as for access to water in the Gobi Altai. Furthermore, some poaching was carried out by herders with old military rifles originally meant for defense of stock against wolves. Safaris for sheep and ibex (as well as for maral stags, roedeer and bear in the taiga areas) were providing annually over a million dollars in foreign exchange. It was, however, apparent that the resource was diminishing.

Six years ago, the International Foundation for the Conservation of Game (IGF), under the impulse of its Founder-President, Weatherby-award winner H.I.H. Prince ABDORREZA, signed with the Government of the Mongolian People's Republic an agreement providing technical support towards game conservation and development. Its first objective was the creation of the Khukhtsyrh Game Reserve, covering 70,000 hectares, from which all domestic stock would be phased out over a 5-year period. Game counts of argali, Siberian ibex, snow-leopard, wolves, etc. have been carried out and vegetation inventoried and monitored by a number of scientific expeditions, sponsored by the Foundation, made up of Polish scientists, in collaboration with the Mongolian Hunters Association. The Reserve is being opened up this year for the first time to a selected few sport-hunters.

Recovery of sheep and ibex populations has been spectacular. Eight different snow-leopards inhabit the Reserve. It is expected that this area, unhunted now for ten years, will yield a succession of world record sport-hunted trophies.

INTRODUCTION

Following a visit in the early 1970s by the Founder-President of the International Foundation for the Conservation of Game (IGF), H.I.H. Prince Abdorreza, the attention of the Government of the Mongolian People's Republic was drawn to the fact that heavy competition for grazing and for drinking water was taking place between wild sheep of the Altai Mountains and the domestic animals which traditionally make up the basis of the Mongolian rural economy.

It was quite obvious already that the ratio of domestic livestock (goats, sheep, horses and yaks) to wild sheep (Ovis ammon ammon, Linnaeus 1758) was at least 50 to 1 over the greater part of the Mongolian Altai, that heavy competition existed for pasture between domestic and wild animals, that the wild sheep could only come to wintering ranges at night, particularly in the dry Gobi Altai area and that in general the wild sheep were probably under stress from human disturbance. Some poaching was also taking place, particularly with old military rifles used by the shepherds to defend their livestock against attack by wolves.

The argali are the largest species of wild sheep in the world. An adult male getting to be as big as a pony and reaching weights between 4 and 500 pounds.

It was pointed out by H.I.H. Prince Abdorreza that conservation of this species was not only important per se, but also that the financial return in hard currency, which the Government of the MPR was getting from tourist safaris, already amounting to more than 1 million dollars per year, would be seriously jeopardized if the argali were not available for hunting. The other game species which was attracting tourists to Mongolia was the Ibex (Capra sibirica - Meyer 1794); but it was of secondary importance.

Following this intervention, the Parliament of the **Mongolian People's Republic** decreed in 1977 the creation of a reserve in the High Altai for the conservation and management of the argali and of course of the High Altai ecosystems and other species of wildlife. These species are mainly the Siberian ibex (Capra sibirica), the snow leopard (Panthera uncia), the wolf, fox, marmot (Marmota bobak), hare (Lepus tolai), rock partridge (Alectoris graeca), eagles as well as a variety of bird species (see Appendix I).

FORMAL AGREEMENT

A formal agreement was signed between the Government of the Mongolian People's Republic, represented by the Vice-Minister for Forestry and Woodworking Industries, President of the Mongolian Hunters Association, Mr. N. Gombojav, and the Founation on September 14, 1978. This agreement specified that:

" ... the Khukhtsyrh Reserve, created in the western part of the High Altai, longtitude east 90°53' to 91°18' and latitude north 47°40' to 48°05', covering an area of nearly 70,000 hectares would gradually be fully available for wildlife, grazing by domestic livestock being phased out entirely over a period of 5 years, i.e. to be terminated at the latest in 1983."

The Mongolian Government would participate in scientific expeditions in the reserve, hire a director and a number of game-guards and protect the wildlife until such time as a controlled harvest could be carried out within the framework of a management plan.

The Foundation would provide, through collaboration with the Polish Hunting Association, the University of Cracow and the Agriculture Academy of Lublin, the scientific personnel necessary for this work and for training of Mongolian counterparts (see Appendix II).

This Agreement was solemnly signed in Ulan-Bator in both russian and english languages.

DESCRIPTION OF THE RESERVE

The Khukhtsyrh Reserve lies in the northwestern part of the MPR and is named after the highest peak within the resere, which culminates at 4,318 meters; perennial snow occurs on Khukhtsyrh as well as on two other summits within the Reserve. The reserve is situated within semi-desert and alpine biomes with plant formations typical for them. Mountains are completely devoid of forests. Peaks and tops of ridges are rocky with only sparse tufts of grasses. Slopes are covered with dwarf shrubs of Caragana spp. and dry grasses. It is only in valleys, along streams, where single trees of poplar (Populus laurifolia) and shrubs of willows (Salix spp.) are to be found. There are to be found, within the resere, along with small water resevoirs, particularly in its northern portion, rather numerous, permanent and temporary streams. There is "sheep habitat" and there is "goat habitat" (Clark 1970). Both types of habitat are to be found in Khukhtsyrh reserve.

Sheep habitat consists of grassy areas that are not too steep. These are usually found on the sunny side of the mountains, on the lofty open slopes with nearby outcrops of rocks which provide for a quick getaway in case of a surprise attack. Sheep habitat covers the central part of the reserve (see Fig. 1). Mountain ranges along the western boundary of the reserve and in the southern tip are inaccessible for sheep during winter, while the eastern part is intensively penetrated by humans with herds of their domestic animals. Argali, similar to bighorns in North America (Deforge 1976) are imposed to stress through man's impact. Stress appears to be the major limiting factor in the argali's struggle for survival. The adaptations of the wild sheep have been highly successful, evolving basically outside the influence of man. This ice age mammal has become very specialized. It is this specialization and man that are testing its survival today.

Goat habitat, on the other hand, is on the rougher, more precipitous slopes, which are also backed by rocky outcrops. Here wild goats find the coarser vegetation which they seem to prefer, leaving the shorter, sweet grass to the sheep. The southern portion of the reserve provides a prime habitat for wild goats.

Fig. 1: Location of Khukhtsyrh Reserve in the Mongolian People's Republic

RESEARCH PROGRAM

FIRST EXPEDITION - Early 1979

Research was immediately undertaken that same winter by a first expedition of eleven persons carried out in early February 1979, under the leadership of Prof. Dr. Ing. Jerzy Krupka, whose nomination by the Foundation as coordinator of the project had been accepted by the Mongolian authorities. The aims of this first expedition were to carry out:

a) a preliminary inventory of game animals within the reserve during winter;

b) to evaluate the degree of human presence and number of livestock animals.

This first expedition on horseback and on foot covered a number of survey routes which, assuming a 5 kilometer visibility on each side, covered nearly 70% of the reserve area.

Duplication of surveys along the same route on consecutive days revealed considerable variations in the number of animals observed. This is due to the fact that, although average herd size is 15-30 for both argali and ibex, single herds of more than one hundred animals were sighted, and the crossing of a hilltop by one such herd would change the result considerably. Furthermore, it is obvious that the animals are quite mobile. It is current knowledge, confirmed from many sources, that the argali sheep in particular, ewes with lambs as well as rams, can, in this country, where there are no fences, travel easily up to 100 kilometers from their usual ground. This would be specially true, of course in the presence of human disturbance. The expedition documented through visual observations 242 argalis and 748 ibex, which gave a conservative estimate of 400 sheep and 1200 goats respectively.

However, the local people, including the newly nominated Director of the reserve, estimated that the reserve held normally about 1,000 argalis and 3,000 ibex. This difference in population estimates may be due to the rough nature of the ground, which effects visibility considerably.

The observed sex-ratio for argali was 100 ♂ 120 ♀ and for ibex 100 ♂ 200 ♀. The productivity was good, being 34,3% lambs to each adult ewe and of 81,7% kids per adult female goat.

The ratio between argali and ibex numbers was 1 to 3, which is reasonably close to that observed by Bannikov (1954) in the Gobi Altai.

DOMESTIC LIVESTOCK

The expedition, while travelling its various routes, observed the presence of 20 shepherd's yurtas, which probably translates into approximately 20,000 domestic animals. These consist mainly of sheep and goats, but also horses and yaks were present in the area. Furthermore, a number of kazakh cabins, which provide for winter living quarters and winter grazing, were also observed.

It was ascertained during a later expedition that the number of domestic animals present during summer was, during the 2 months of July and August at the start of our agreement with the MPR Government, 50,000 domestic animals. On the other hand, the winter grazing, which means actually pretty much year-round grazing by the kazakh tribes up in the north of the reserve out of their permanent cabins, would probably amount to no more than 10,000 domestic animals at the start of the project.

SECOND EXPEDITION - Summer 1979

A second expedition was mounted to count the game animals in the reserve during summer, after the period of reproduction. The area surveyed calculated along the same standards as before was about 65%. The number of argali observed was 667 with a lamb to ewe percentage of 75.4%. The number of ibex was 539 only with a productivity of 56.1%. The expedition furthermore observed several packs of wolves and obtained evidence of four different snow leopard in the southern part of the reserve, where the prime ibex habitat is located.

OTHER EXPEDITIONS

Other expeditions were then organized in July and August 1980, September and October 1981, October and December 1982, September to December 1983 and June and July 1984.

As early as summer 1980, guards had been employed by the Government and were living permanently in the yurtas positioned at the main accesses to the reserve. A fence had been built across the main access valley to the reserve from the east, the boundaries marked and the number of domestic animals grazing in the reserve in summer had been reduced from 50,000 to 17,000.

It was in July-August **1980** that the Polish-Mongol mission made the first inventory of the flora of the reserve. The expedition identified the floristic composition of the argali's and the ibex's habitats and estimated the biomass produced in the different areas - mountain tops, mountain side with south and north exposures and fertile moist depressions. Biomass produced was respectively from 0.75, 1.10, 2.24 and 3.41 tons per hectare. Strong exposure to sunshine on the southerly oriented slopes increased evapotranspiration, and resulted in only half the primary production of northerly exposed slopes; furthermore grasses on south-facing slopes were mostly Leimus sp. (0.2 tons per hectare) whereas ibex habitat facing north was predominantly covered by Festuca sp. (1.3 tons per hectare). Of the more than 30 species of plants identified, only 5 were common to both exposures. By **1981** , domestic stock had been further reduced and the expedition could only observe 10 yurtas. Furthermore, any poaching of argali or ibex which may have been carried out before was now definitely controlled after confiscation of the military type rifles in the area. Also, vehicles, motorcycles and other equipment had been supplied for the guards. By **1982** , all yurtas had been permanently taken out of the Reserve, and no more grazing by domestic livestock was taking place.

FINAL MISSION - JUNE/JULY 1984

The winter of 1983 was very severe in that part of the world and temperatures of -50°C have been observed. Reports have been obtained of great

losses to domestic stock in the areas surrounding the Reserve and it was expected that a certain higher amount of natural mortality would be found after that severe winter among game species. Indeed, the expedition found the bodies of 57 dead ibex, 4 dead argalis and also one snow leopard. It was observed that in both ibex and argalis, some of those deaths could be attributed to scabies, which may of course have occurred due to fragile conditions of the animals, during the hard winter. However, the expedition documented visually 171 argalis and 978 ibex. The recruitment observed was slightly lower than in 1979, but still over 60% for the argali.

The expedition also, on this occasion, discovered a certain number of caves exposed on the southern slopes, in the south part of the reserve where the ibex gave birth to their young. These caves would protect the female ibex from the attack of eagles. During this expedition, time was made to study the diurnal activity of the ibex. These animals were spending daily about 5 hours feeding, drank once a day in early or mid-morning, and spent the rest of the time resting (3 hours) or moving about. It was also noted, on this occasion, that both argali and ibex could be approached much closer than five years previously, i.e. to a distance of 150 to 200 meters.

It is obvious, however, that since the observed number of argalis and ibex seems rather stable over the last three years, and since the recruitment each year is shown to be quite large, that there must be a rather large emigration out of the reserve into the neighbouring territories. This supports the theory of the mobility of argalis and shows that the Khukhtsyrh Reserve, even though it is of large size, is certainly not a closed exosystem as far as these sheep are concerned. The buffer zone will have to be surveyed as well. Also methods of finding out to which extent the Khukhtsyrh Reserve is acting as a reservoir must be established to ascertain the production of argalis which then emigrate to the rest of the Altai Range.

HUNTING

In 1984, after total protection for ten years, it was decided with the agreement of the Mongolian Authorities, that a management plan, which would provide for a harvest of 5 to 10 argalis, and 10 to 20 ibex per year, could be implemented.

The enclosed picture (Fig. 2) is of a 62 inch ram taken by one of the four hunters who came to the Reserve that year.

In addition to those safaris, a group of U.S. tourists and bird-watchers came to the Reserve. The total income generated to the benefit of the Mongolian Government in this first year of operation amounted to more than 50,000 US dollars.

Here was the award for the Mongolian Government of having established this Reserve. Furthermore, its effect for repopulating the middle-Altai range with wildlife is not to be ignored and will have to be evaluated in the coming years.

Fig. 2: Large Argali trophy taken in 1984, after the Reserve was opened to limited hunting.

THE FUTURE FOR KHUKHTSYRH RESERVE

In the future, other expeditions will continue monitoring wildlife populations and vegetation. Studies will be undertaken on the feeding habits of the argalis and on the biology of the snow-leopard so that a nation-wide conservation strategy can be established for these species.

It must be mentioned, as a matter of information, that the success of the establishment of this reserve has prompted the Government of the MPR to ask the Foundation its support for the creation of another reserve ten times the size of Khukhtsyrh, but this time in the taiga area, i.e. in the southern boreal forest north of the capital city of Ulan-Bator. This area is completely unpopulated and there is at present no human exploitation of wildlife or of forests.

At the suggestion of the Foundation, the Mongolian Government has declared the southern part of that new reserve a National Park, which will be used for local as well as foreign tourism. The northern area which has a surface area of more than one-half million hectares will be used as a wildlife management area for controlled harvesting; a museum and wildlife biology research station will be established with the help of the Foundation's scientists.

ACKNOWLEDGEMENTS

I would like to express thanks to all the people who have contributed to this project, and particularly to the members of the Polish and Mongol expeditions. The data given in this report is **their** data and I would like them to get full credit for gathering it in conditions which were often indeed very difficult.

LITERATURE CITED

Bannikov, A.G. 1954. Mlekopitajusce Mongolskoy Narodnoy Respubliki. Izsdatelstvo Akademii Nauk SSSR, Moskva, 669 pp.

Clark, J.L. 1970. The Great Arc of the Wild Sheep. University of Oklahoma Press. Norman, 247 pp.

Deforge, J.R. 1976. Stress: is it limiting bighorn? Desert Bighorn Council 1976 Transactions: 30-31.

Dzieciolowski, R., Krupka, J., Bajandelger & Dziedzic, R., 1980. Argali and Siberian Ibex Populations in the Khukhtsyrh Reserve in Mongolian Altai. Acta theriologica, Vol. 25, 16: 213-219, 1980. Forestry Res. Inst., Wery Kostrzewy 3, 02-362, Warszawa, Poland).

APPENDIX I

LIST OF 64 BIRDS SPECIES DOCUMENTED FOR THE KHUKHTSYRH RESERVE

Milvus migrans Bodd., Buteo hemilasius Temm., Aquila chrysaetos L., Gypaetus barbatus L., Aegypius monachus L., Falco cherrug Gr., Falco tinnunculus L., Lagopus lagopus L., Lagopus mutus Mont., Tetraogallus altaicus, Alectoris chukar Gr., Perdix dauuricas Pall., Eudromias morinellus, Tringa glareola L., Actitis hypoleucos L., Gallinago stenura, Gallinago solitaria, Columba rupestris Pall., Cuculus canorus L., Bubo bubo L., Otus scops L., Athene noctua Scop., Caprimulgus europaeus, Apus pacificus Lath., Upuna epops L., Ptvonoprogne rupestris, Delichon urbica L., Eremophila alpestris L., Anthus godlawskii Tacz., Anthus campestris L., Anthus spinotetta L., Motacilla citreola, Motacilla cinerea Tunst., Motacilla personata Gould., Lanius cristatus L., Pica pica L., Pyrrhocorax pyrrhocorax L., Corvus corone L., Corvus corax L., Cinclus cinclus L., Prunella collaris Scop., Prunella himalayana Blyth., Prunella fulvescens Sever., Sylvia curruca L., Phylloscopus griseolus Blyth., Saxicola torquata L., Saxicola insignis Gray., Oenanthe oenanthe L., Oenanthe isabellina Temm. 50. Monticola saxatillis L., Phoenicurus ochruros Gm., Phoenicurus erythrogaster Guld., Tichodroma muraria L., Passer Montanus L., Petronia petronia L., Montifringilla nivalis L., Leucosticte brandti Bonap., Leucosticte arctoa Pall., Bucanetes mongolicus Sw., Acanthis flavirostris L., Carpodacus erythrinus Pall., Carpodacus rubicilla Guld., Emberiza aureola Pall., Emberiza cia L.

APPENDIX II

LIST OF COOPERATING SCIENTISTS

A (From Poland): Prof. J. Krupka, Prof. R. Dzieciolowski, Dr. R. Dziedzic, Dr. A. Szaniawski, Dr. J. Zielinski, Mr. L. Drozd, Mr. J. Bojarski

B (From Mongolia): Ing. N. Gombojav, Ing. O. Towuu, Ing. Bouindilger, Ing. Tsyringotsho, Ing. Rincin, Mr. Altangerel, Mr. Badrah.

A GENERAL VIEW OF ARGALI SHEEP (Ovis ammon) IN CHINA

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The Chinese government considers the Argali sheep (Ovis ammon) an important component of the local large mammal fauna, and provides it with special protection from hunting and live capture.

The argali is a large species of wild sheep. It has a heavy body and relatively short legs. The pelage consists of short, coarse and thick hair, with longer hair around the neck region. The tail is short and hardly noticeable. The lachrymal glands are very obvious. Both sexes have horns. Those of the rams are heavy, long and wind in a spiral shape. Certain subspecies of Ovis ammon have larger horns than any other wild sheep. On the other hand, the horns of ewes are relatively short, thin and only slightly curved.

Though the argali is a typical alpine animal, its habitat is somewhat different from that of the Blue sheep (Pseudois nayaur). It prefers relatively open areas with bare rocks and the basis of higher mountains. The altitudinal distribution ranges from 3000 m to 5500 m. Argali are social animals. The most commonly observed band size is around a dozen. Rams and nursery bands are segregated except during the rutting season. Lambs and young animals are with the female bands. Argali use their habitat in a traditional manner. During winter heavy snow forces them to migrate to lower elevation near the valleys. In summer they move up again and spend that season near the permanent snowline. These seasonal migrations are observed every year. Argali are grazers, and the major component of their diet consists of plants of the grass family.

According to investigations by the author, argali reach sexual maturity after two years of age. The rutting season is in fall, and after a gestation period of about 180 days, lambs are born the following spring. Ewes only give birth to single lambs.

Arali range over much of central Asia. They have been divided into numerous subspecies, the following being recorded for China.

1)	Ovis ammon hodgsoni	Blyth, 1941
2)	Ovis ammon darwini	Przewalski, 1883
3)	Ovis ammon polii	Blyth, 1841
4)	Ovis ammon dalailamae	Przewalski, 1888
5)	Ovis ammon sairensis	Lydecker, 1898
6)	Ovis ammon littledalei	Lydecker, 1902

Among the subspecies noted, the author is only familiar with the following three: O.a. hodgsoni, O.a. darwini, and O.a. polii. Further investigations and taxonomic research is required to clarify the status of the other subspecies in the future. Argali have a wide distribution in China, but for many years proper conservation efforts for this species were not in existence. Therefore, argali are almost extinct in certain areas now. For example, in the

Helan Mountains in Ningxia, argali were widespread in the past, but there is no recent record about this species in that region now. Also, in the mountain region of the Huanqyuan County west of Xining City, argali used to be recorded regularly, while there are no recent observations.

Among the three subspecies listed above, which the author is familiar with, O.a. hodgsoni has the largest distribution. Its habitat ranges over Tibet, Qinghai and Kansu. In remote and inaccessible areas the population size of this sheep is considerable. On the other hand, O.a. polii is in China only found in the district of Xinjiang. It is much less numerous than the Tibet sheep (O.a. hodgsoni). The third subspecies, O.a. darwini, is distributed over the districts of Hebei, Shansi, Inner Mongolia, Shensi as well as certain localities in Ningxia. However, the population size is small.

It has to be admitted, that conservation work is inadequate in China. In certain respects, it has only begun recently. It must be strengthened in the days to come. The government departments concerned ought to take effective steps to devote much attention to conservation efforts as well as to education work among the public. Violations of conservation laws, formulated by the government must be acted on with prosecution. At the same time the government must assist local people and agencies with their protection and conservation efforts, by carrying out supplementary feeding during winters, conduct relevant research projects, support the development of enhancement measures, and cooperate and exchange experience with conservation organizations abroad. The author believes that great progress would be achieved in this respect before long.

PRESENT STATUS OF ARGALI SHEEP POPULATION IN THE U.S.S.R.

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ABSTRACT

Recent taxonomic revisions suggest that three subspecies of Argali (Ovis ammon) inhabit the Territory of the U.S.S.R., namely Ovis ammon polii, O. a. nigrimontana and O. a. ammon. Based on recent literature and personal investigation the present status of these three subspecies of Argali is assessed, and wherever possible comparisons are drawn to previous status reports to document trends. It is estimated that 33,000 to 34,000 Argali are presently inhabiting the U.S.S.R., with the subspecies Ovis ammon polii being the most numerous one. Population densities vary greatly with habitat quality and other factors with extremes ranging from 25 sheep per 1,000 ha in the cold deserts of the northern parts of the Kokshaaltou mountain ridge (Andreenkov, 1983) to as low as 1.2 to 1.6 sheep per 1,000 ha on the northern extremity of Tarbagatai, where subsequently a further reduction in population size occurred (Fedosenko and Kapitonov, 1983). Population declines are reported for a number of areas, with competition by domestic livestock and accompanying range deterioration being considered as the most important causative agents. In certain areas hunting also may have negative impacts on sheep, because proper controlling is difficult. On the other hand, predators are not considered important in the regulation of Argali population size. Severe weather conditions as well as parasites have had influence in certain years in specific areas. More reserves are needed for the conservation of Argali and their habitat.

RESULTS AND DISCUSSION

In the U.S.S.R. Argali (Ovis ammon) inhabit the Pamirs, Alai and Zaalai mountain ridges, the Tien Shan and Giungar Alatau, South and North Sub-Balkhash, Central Kazakhstan (Kazakh upland), Tarbagatai, Saur, the Kalbin Altai, the Altai and the Saiany (Tuva).

According to Sokolov (1959) five subspecies of Argali inhabit the U.S.S.R., but if we analyze the most recent information (Sopin, 1982), it is more likely that only three subspecies occur here: Ovis ammon polii, O. a. nigrimontana and O. a. ammon.

Ovis ammon polii inhabit the central and eastern parts of the Alai and Zaalai Mountain ridges. The western boundary of their distribution on the Pamirs is in the area of Sarez Lake, Bazardara, the northern portion of the Alichur Mountain ridge, and the areas surrounding Jashilkol Lake. From there their area extends southward to Lengar (Sapozhnikov, 1976).

Before World War II Argali were so numerous in certain areas of the Pamirs, that they exerted a negative impact on their range. In many alpine collective farms watchmen had to be sent out at night in order to scare Argali away to preserve the pasture for domestic stock (Egorov, 1955). Meklenburtcev (1948) estimated the Argali density at that time in the Bashgumbez valley and in the upper part of the Aluchur valley (East Pamirs) at 10 animals per 1,000 ha, but the author considers these rates too low.

Argali were rather numerous along the frontier and especially in the Kyzyl-Giaik and Shaad-Put nature areas and also in the vicinity of Rangul Lake and Karakol Lake up to the middle of the 1960's. According to Sapozhnikov (1976) the population density in these areas ranged from 36.5 to 80.2 individuals per 1,000 ha during the early 1960's, and the total population size of Argalis in the Pamirs was estimated at 70,000 to 80,000. But it appears that these assessments were too high even for those years. If we apply the transect method used by this author, we obtain a density of about 19 to 37 animals per 1,000 ha for the whole area occupied by Argali in the Pamirs and a total population of about 33,000 sheep.

In our opinion Sokov (1975, 1977a, b) gives reliable data on Argali during the first half of the 1970's for this region. He cites a population density of about 7.7 to 30 animals per 1,000 ha for the northeastern parts of the Pamirs, and one of 2 to 28 animals per 1,000 ha in the southwestern part. He determined a total Argali population of 20,000 for those years.

As far as the Tien Shan is concerned the distribution and density of Argali have undergone more drastic changes than on the Pamirs. According to Severtcov (1873) Argali were numerous during the middle of the last century on most ranges, especially in the central and interior Tien Shan. Recently Andreenkov (1983) stated that argali are presently only found in the interior Tien Shan on a range about 270,000 ha in size, and their number here is estimated at 3,500 head. The largest number and highest population density of Argali (about 2,000 sheep or 25 animals per 1,000 ha) are found in the cold deserts of the northern part of the Kokshaaltau Mountain ridge, where there is no pasture for domestic stock. Argali are not very numerous on the western part of this mountain ridge, in the Arpa and Aksai River basins, nor in other areas of the interior Tien Shan. Only small numbers of Argali are found on the eastern part of the Susamyr mountain ridge, on the central part of the Giumgol Mountain ridge and in the headwaters of the Naryn River (Andreenkov, 1983). Population declines have also been reported for central Tien Shan. For the end of the 1970's Vyrypaev (1980) recorded 360 to 380 Argali, amounting to a density of 3.6 to 3.8 sheep per 1,000 ha. Argali numbered about 400 head in the eastern part of the Terskei Alatau at the beginning of the 1970's. According to our data the population density amounted to 1.7 sheep per 1,000 ha in the valley at the Baiankol River in 1977. Presently about 1,500 Argali inhabit the central Tien Shan.

Within the west Tien Shan Argali are found only in Karzhantau on the right bank of the Badam River and in the western part of the Talass Alatau, but they are not very numerous, amounting to not more than 350 to 400 sheep. The largest number of these animals are found in the Aksu-Diabagly Reservation, where their population density is about 14 individuals per 1,000 ha (Grachov, 1981).

Few Argali inhabit the northern Tien Shan, and they have disappeared from certain areas. Kapitonov and Lobachov (1977) encountered these sheep only on the western part of the Kirgiz Mountain ridge. They are very rare now everywhere. Prior to the 1950's they were usually found on the Chu-Illinsk Mountains, where one could meet 200 sheep en route during one day. Now they are very rare and have completely disappeared from certain places. Even in the 1860's Argali only inhabited the west and in the east the Zailiii Alatau mountain ridge. Now there are about 150-170 animals in this area. There are no Argali on the northern extremes of the Kungei Alatau mountain ridge, nor did they inhabit this area before, except for individuals during years of extreme drought (Sokolov, 1939). During the 1940's Argali were numerous on the low hills of Karatau, Elchinbiiriuk and Zhabyr, located between Terskei Alatau and Ketmen Mountain ridges (Mikulin and Jsaeva, 1945). Presently they are very rare there, as well as on the western part of the Ketmen Mountain ridge. They are more commonly encountered on the eastern boundary area of this mountain ridge. In total, there are not more than 400 to 500 Argali inhabiting the northern Tien Shan.

During the years immediately following World War II Argali were numerous on the southwest spurs of Giungar Alatau (Antipin, 1947). Rather rapid population declines began at the end of the 1950's and at the beginning of the 1960's. Argali disappeared from the Kapchagai nature area (the right bank of the Ili River) early in the 1960's (Fedosenko, 1977). Not more than 20 to 30 sheep were left in Chulak and 80 to 100 on the 10,000 ha Kalkan nature area. Small numbers of Argali remained on the arid dry hills, such as Kaktutau, Aktau and Dulantau.

Argali are also very rare on the south and west portions of the main mountain ridge. They are more frequently encountered east of Giungar Alatau, as in the Aksai, Terekta, Sarybukhter, Tastau and Altybai mature areas. Grachov and Savinov (1975) determined the number of argali in this area to be 600 head near the end of the 1960's, and this number was reduced to 400 at the end of the 1970's.

Argali are also inhabiting the low desert hills of southeast sub-Balkhash on the right bank of the Lepsa River, and on the left bank of the Aiaguz River in the Kyskash, Arkharly and Arganaty Mountains. We observed 22 sheep in an area of 5,000 ha or a density of 4.4 animals per 1,000 ha on the Arkharly Mountains in December 1981. According to the regional hunting inspector's data, there are presently about 70 sheep in the Arganaty Mountains.

The northern limit of Argali distribution on the Kazakh uplands is found in the Koitas Mountains, but farther south they are more common in the Ermentau Mountains. They are found in the vicinity of Uzunbulak Village as well as on the following mountains: Sholakkain, Edyge and Solan. They also inhabit the northeastern part of the Kazakh uplands (Kapitonov and Makhmudov, 1977).

The Argali were retained on the Zhuantobe and the Shonkal Mountain masses. They are rather often encountered farther south on the Keregetas Mountains not only in summer, but in winter as well.

Argali were rather rare but did occur fairly recently in the southern and western parts of the Baianaul Mountains. To the southeast these sheep are still fairly common the Kyzyltau, Arkalyk, Murzhik and Edrei Hills. They inhabit primarily the central part of the upland, their range extending to the Ulutau Mountains in the west, and to the southwest part of the upland to the following mountains: Aktau, Kyzyltau, Kyzyltas, Kyzylhar, Uzuntau, Bolshoi Alabas, Karamatak and Shunak. Argali are common farther south on the Bektauata massif. In 1970 the total population size of Argali on the Kazakh upland was estimated at 7,000 head, and the density at 0.3 to 20.0 individuals per 1,000 ha (Savinov, 1974). Up to 1981 the argali population in this region declined. Later assessments put the population densities in some areas at 0.5 to 6 animals per 1,000 ha, with an average of 1.8 per 1,000 ha (Fedosenko and Kapitonov, 1983). Presently, the total number of argali on the Kazakh upland does not exceed 5,000 head.

At the beginning of the 1960's Argali were common on the northern extremity of Tarbagatai and were also encountered farther south, but less frequently. The total population was assessed at 800 to 900 head with a population density of 1.2 to 1.6 animals per 1,000 ha (Fedosenko and Kapitonov 1983). Apparently, now this number has been reduced to 50%. Argali are still found on the Monrak Mountain ridge between the Kusty and Kyzylkain Rivers, where about 50 sheep inhabit the area of the Stchorbas Mountains (Stcherbakov and Kochnev, 1982).

Argali were encountered in Saur within the Kenderlyk River basin during the middle of the 1960's, where they were more common during winter. We have no recent information on the present status.

During the middle of the 1970's Argali were still observed between Tarbagatai and the Kalbin Altai, - a vast territory of small hills and low mountains (Kapitonov, 1978), but already starting with the beginning of the 1970's these sheep began to disappear.

In the middle of the 1960's very small numbers of Argali permanently inhabited the Kalbin Altai. They were found on the Koktau Mountains as well as farther south in the Daubai, Kyzylbastau, Karaotkel, Tastau nature areas and the Ktarazhal Mountains. Argali are still retained in Kalba. The regional hunting inspector observed small groups of 6 to 13 individuals in the vicinity of Tochka village, in the nature areas of Koktau and Taldy at the end of February 1979 as well as in spring and fall of 1980 and spring of 1981. Every year hunters see one or two Argali in the mountains of Three Monasteries (Stcherbakov and Kochnew, 1982).

Ovis ammon nigrimontana inhabit the western part of the Karatau mountain ridge (Syrdar'inskii), extending far to the northwest from its boundary with the west Tien Shan. The numbers of these sheep was high before World War II as well as 10 to 15 years afterward. Now not more than 250 animals remain (Grachov, 1982). We observed 10 sheep (2 animals per 1,000 ha) during a week in the southwestern part of Karatau (Kumysta nature area) on October 1979.

Ovis ammon ammon inhabit the southern and southeastern Altai as far east as Tuvinskaia ASSR. Argali were common in the southern Altai in the headwaters of the Bukhtarmna River, on the Naryn and Kurchum Mountain ridges during the last century. Small numbers of Argali were observed on the southern portion of the Tarbagatai Mountain ridge, the headwaters of the Karakaba River, at the end of the 1950's. They were retained in the headwaters of the Bukhtarma River and on the southern spurs of the Kurchum mountain ridge. About 30 animals were met on the Kolmachikka (the right tributary of the Bukhtarma River) in the springs of 1979 and 1981. Argali dwell also along the Archata River. At the beginning of the 1970's Argali were documented for the southeastern Altai on the Ukok Plateau, the Sailugem Mountain ridge, in Talduair, on the Chikhachev Mountain ridge, the southern part of the Shapshal Mountain ridge, the southeast Chui ridge, and on the Kurai Mountain ridge (Sopin, 1975). There were about 600 sheep in this region in the middle of the 1970's, and the population density on the Chikhachev Mountain ridge and in Talduair was estimated at 8.5 individuals per 1,000 ha. Subsequently, the Argali population declined sharply with only about 100 animals remaining there in 1980 (Bondarev, 1982). Apparently, up to the present time Argali populations are declining on the Kurai and South-Chui Mountain ridges and on the Ukok plateau.

During most recent years Argali populations increased in several places. We encountered 130 animals (including lambs) in an area of 10,000 ha on the Chagan-Burgaz, between the Saryzhdumaty and the Bainn-Chagan Rivers (Sailugem) during June and July of 1984. We also have some information about Argali appearance in other nature areas and also in Talduair. Apparently, there are now more than 300 sheep inhabiting this part of the Altai.

Argali inhabit the Tcagan-Shibetu mountains (the headwaters of the Tolailyg River and the right bank of the Barlyk River) within Tuvinskaia ASSR, the Mongun-Taiga Mountain mass to the west and the eastern part of the Tannu-Ola on the Sangilen upland. But they were always very rare. According to Nikiforov (1977) some 250 to 300 sheep inhabit Tuva.

SUMMARY AND CONCLUSION

In summary the largest number of Argali in the USSR inhabit the Pamirs (20,000), fewer are found in the Tien Shan and Giungar Alatau (7,000) and on the Kazakh upland (5,000). About 1,000 sheep occur in Tarbagatai, Saur and the Kalbin Altai, and 600 animals inhabit southern Siberia. Therefore, the total number of argali presently inhabiting the USSR is estimated at 33,000 to 34,000.

If we analyse this information on the basis of subspecific status, Ovis ammon polii is the most common Argali sheep, followed by Ovis ammon nigrimontana and Ovis ammon ammon.

The main reason for the declines in Argali populations and their complete disappearance from certain habitats has been severe competition with livestock. Argali are being driven back to more inferior ranges, where they are faced with more severe environmental conditions. Because of deep snow in the upper parts of the Pamirs in winter sheep have to descend to the intermountain valleys, where these winter ranges have deteriorated. They are forced back to the upper

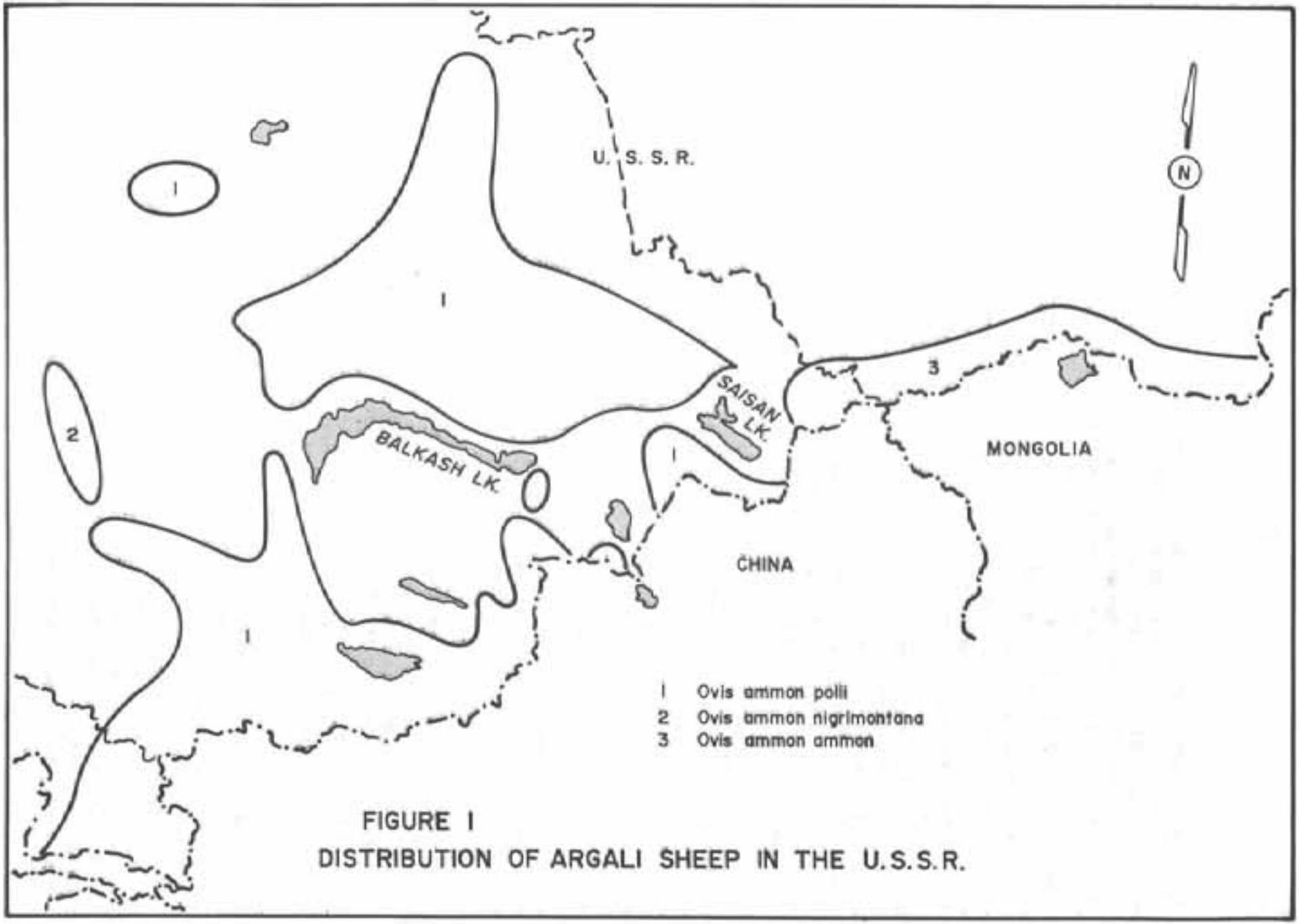

FIGURE 1
DISTRIBUTION OF ARGALI SHEEP IN THE U.S.S.R.

Young female Argali sheep
Photo: A. Fedosenko (1977)

Male Argali sheep on Mount
Kalkany (Kazachstan)
Photo: A. Fedosenko (April 1976)

In the background is shown Mount Kalkany (Kazachstan), habitat of Argali sheep.

Photo: A. Fedosenko

Female group of Argali sheep in Sailjugem area, Altai.

Photo: A. Fedosenko (October, 1984)

parts of the mountains with less suitable habitat even for summer use (Andreenkov, 1983).

The great majority of habitats, presently or previously used by Argali, are now occupied by domestic sheep or other domestic animals. The most severe competition is for winter ranges.

During winter Argali are forced to feed in areas above the domestic sheep herds, where the snow is very deep and pastures are spoiled even in summer. This is one of the reasons for the high mortality of lambs and the low recruitment rate in Argali populations. Hunting, poorly controlled in some areas, also exerts negative influence on the numbers of argali, affects the sex ratio and age composition of the populations, which in turn have an influence on productivity of given herds. Many sheep falling victims to hunters are rams older than 5 years.

Predators have little impact on the numbers of argali, and their influence is not very important. Populations have been reduced in certain drought years with deep snow in winter, for instance, in the winters of 1965-1966 and 1968-1969, but on the whole we have not been able to document great reductions in Argali population sizes because of climatic parameters during the last 20 years. There have been several structural changes of Argali herds in the western Tien Shan because of scabies epizootic, affecting not only argali but Siberian Ibex populations as well during the years 1968 to 1970.

In the U.S.S.R. there are only two wildlife reservations where Argali occur. They inhabit an area of about 17,000 ha in the Aksu-Diabagly reservation and the Kapchagai hunting reserve (Kalkany nature area), with an area of 10,000 ha. There are 350 sheep in these reservations. We also need reservations for Argali in the Pamirs, Syrdar'an Karatau, central Kazakhstan, Altai and Tuvinskaia ASSR.

LITERATURE CITED

Andreenkov, V.T. 1983. Problems of the conservation of mountain sheep on Tian-Shan. Redkie vidi mlekopitajutchich fauni SSSR i ich ochrana. Moskwa: 155-157.

Antipin, V.M. 1947. Ecology, origin and settling a wild sheep of Kazachstan. Isv. AN Kas SSR, ser. zool., (6):3-22.

Bondarev, A. Ja. 1982. Status of mountain sheep and other animals of Altai. Ischezajutchie i redkie rastenia i zivotnie Altaiskogo vraja i problemi ich ochrani. Barnaul: 33-34.

Egorov, O.V. 1955. Ecology of Siberian Ibex. Trudi ZIR AN SSSR (16): 7-134.

Fedosenko, A.K. 1977. Argali in Iliisk Valley. Redkie i istchesajutchie averi i ptici Kazachstana. Alma-Ata: 111-114.

_____, and V.J. Kapitonov. 1983. Argali. Mlekopitajutchie Kazachstana. Alma-Ata., t.3., ch.3: 144-209.

Grachov, Jr. A. 1981. Change of quantity of ungulate and carnivora mammals in Aksu-Diabagly Reservation. Isv. AN Kas SSR, ser. biol.(s).

_____. 1982. Rare species of mammals on Aksu-Diabagly Reservation and Caratau range (Sirdarjinskii). Tes. dokl. 3 sjezda teriolog. Ob-wa. Moskwa, t.1:101.

_____, and E.F. Savinov. 1975. Change of quantity of Siberian Ibex and argali in northeast Djungarskii Altau. Kopitnie fauni SSSR, Moskwa: 76-77.

Kapitonov, V.J. 1978. Argali. Red Book of Kazachstan. Alma-Ata: 68-71.

_____ and Ju. S. Lobachov 1977. Distribution of argali on Kirgiz and Talass ranges (Tian-Shan). Redkie i ischeza-jutchie zveri i ptici Kazachstana. Alma-Ata: 68-71.

_____ and I.M. Machmudov. On the distribution and ecology of arali on the northern border areas in Kazach Uplands. Redkie i ischezajutchie zveri i ptici Kazachstana. Almza-Ata: 7-21.

Meklenburtcev, R.M. 1948. The Marco Polo sheep (Ovis polii polii Blyth). Bull. MOJP, otd. biol., t. 53(5): 65-84.

Mikulin, M.A. and A. Ja. Jsaeva. 1945. Materials on mammals in headwaters of Tekes and Kegen Rivers. Isv. AN Kaz SSR, ser. zool. (5).

Nikiforov, N.M. and V.V. Shurigin. 1977. Distribution of rare ungulates in Tuvin ASSR. Redkie vidi mlekopitajutchich i ich ochrana. Moskwa: 220-222.

Sapozhnikov, G.N. Wild sheep (genus Ovis) of Tadjikistan. Dushanbe: 200 pp.

Savinov, E.F. 1974. Results of counts of argali in Kazah Uplands. Govremennoe sostojanie i puti rasvitija ochotovedtch. Nauki v SSSR. Kirov: 168-169.

Severtcov, N.A. 1873. Vertical and horizontal distribution of turkestanic mammals. Isv. Ob-wa ljubitelei estestwoznanija, antropologii i etnographii, t.8 (2).

Sokolov, T.T. 1959. Ungulate (Perissodactyla and Artiodactyla). Fauna USSR, mammals, vol. 1 (3): M-L: 639 pp.

Sokolov, S.S. 1939. Materials on the ecology of argali (Ovis polii) and other ungulates in the Alma-Ata Reservation. Zool. zh., t 18(3): 444-450.

Sokov, A.T. 1975. The influence of anthropogenic factors on the population of Marco Polo's sheep in Tadjukistan. Kopitnie fauni SSSR. Moskwa: 279.

_____, 1977a. Present status of some populations of wild perissodactyls of Tadjukistan. Redkie vidi mlekopitajutchich i ich ochrana. Moskwa: 229-230.

_____, 1977b. Defense of Marco Polo's sheep. Priroda, N3: 129-131.

Sopin, L.V. 1975. Wild Sheep of South Siberia. Avtoref. kand. diss. Irkutsk: 23 pp.

_____, 1982. On the systematics of argali. Jes. dokl. 3 sjezda teriolog. ob-wa. Moskwa, t.1.: 77.

Stcherbakov, B.V. and A.G. Kochnev. 1982. On rare and disappearing mammals of eastern Kazach province. Zivotnii miz Kazachstana i problemi ego ochrani. Alma-Ata: 203-204.

Vyrypaev, V.A. 1980. Factors having influence on the quantity of argali in Central Tian-Shan and measures of conservation. Kopitnie fauni SSSR, Moskwa: 233-234.

SNOW SHEEP (OVIS NIVICOLA) IN THE U.S.S.R.

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ABSTRACT

The snow sheep (Ovis nivicola) of the U.S.S.R. have been divided into 5 subspecies, however, subspecific differences are not well defined. Estimates of total population size vary from 60 to 90,000, and the total range occupied is estimated at 500,000 km^2. However, within this large area occupancy is not continuous but is clumped in suitable, mountainous habitats. Population densities vary with habitat quality and range from 0.1 to 0.3 sheep per 1,000 ha on the Aldan-Uchur and Yano-Oimyakon highlands to as high as 3.3 sheep per 1000 ha on certain experimental ranges in the Putoran Mountains. Sheep habitat extends to a maximum altitude of 2,000 m, with southern slopes being the preferred wintering areas. Certain populations undertake long seasonal migrations to wintering areas. Snow sheep have a maximum life expectancy of 18 to 20 years, which is longer than that of any other wild sheep species. Hunting of snow sheep is presently outlawed in the entire territory of U.S.S.R., and one subspecies (Ovis nivicola borealis) is declared endangered in the Red Data Book of the U.S.S.R. The following summary is based on a survey of the most recent literature on snow sheep.

RESULTS AND DISCUSSION

The snow sheep (Ovis nivicola Esch.) has 5 subspecies in the Territory of the U.S.S.R. These are the following:

1) The Kamchatka sheep, (O. n. nivicola), which is the largest subspecies with monochromatic coloration. It has the heaviest horns and its distribution is primarily found in Kamchatka.

2) The Koriak sheep, (O. n. Koriakorim), which is a smaller subspecies of lighter coloration. Its main distribution is found on the Koriak uplands northward of Kamchatka.

3) The Okhotsk or Allen sheep, (O. n. alleni), which has light spots behind the scapulas, and the tips of its horn turn forward. It inhabits the

Stanovoi Range, the Dzhugdzhur Range the southwestern portion of the Kolyma Range, and the mountains of the Taiganoss peninsula.

4) The Yakut sheep, (O. n. lydekkeri), is the subspecies with the lightest coloration, its horns are thin and short. It is widely distributed in Yakutia, where it inhabits the Verkhoyan Range, the Chersky and the Momsky Ranges, etc., as well as the northern parts of the Kolyma Range in the Anadyr Territory (Chukotka).

5) The Putoran or Norilsk sheep, (O. n. borealis), is of light coloration. It is widespread on the Putoran Uplands in the watersheds of the Enisei and Lena Rivers, southward to the Taimyr peninsula.

The subspecific characteristics of these sheep vary greatly, reliable differences have not been established. The largest males of the Kamchatka sheep, (the largest subspecies), have body lengths of up to 160 cm, heights at withers of about 100 cm; with females reaching 140 cm in length and 85 cm in height. The maximum weights of rams approach 150 kg. The smallest subspecies, the Yakut sheep, reach heights at withers of 93 to 108 cm for males.

The present distribution of snow sheep extends from the Putoran Mountains to Kamchatka and from the coasts of the Arctic Ocean to the northern slopes of the Stanovoy Range. In the recent past this area was slightly larger, reaching the region of Irkutsk and the northern Kurile Isles. The total extent of the present range of this species amounts to 500,000 km^2. However, distribution is not continuous over this large area. Distribution is patchy with many gaps. There are many isolated habitats, since these sheep only occupy mountains. It was also noticed that these sheep are absent from areas which appear to constitute suitable habitat.

The total population size of this species of wild sheep was estimated to be 60,000 (Rubkov, 1979). Other authors assessed their numbers to equal 70-90,000, but these appear to be overestimations (Gribkov and Fil, 1977). Sizes of some populations are given on Table 1.

Table 1. Numbers of sheep in some selected populations (after Gribkov and Fil, 1977).

Location	Population Size
Putoran Uplands	1200-1500
Kamchatka	200-300
Koriak Highlands	6-8000
Chukotka	5-8000
Yakutia	44-55000
Trans Baikal area	
Northern parts of Amur River area	15-20000
Magadam Region (except Chukotka)	

Scientists have paid special attention to the sheep inhabiting an isolated section of the Putoran Mountains. The main habitats are situated in the northeastern part of this upland, covering an area of 120,000 km^2. The densest population inhabits an area of about 40,000 km^2. The 5 control

sites investigated, covering an area of some 5,376 km^2, revealed a population density of 3.3 sheep per 1,000 ha (Borzhonov et al., 1979). The total population of sheep on the Putoran uplands is estimated at 1,400 to 1,450.

In Yakutia regular aerial censuses were carried out by helicopter in the years 1977 to 1980. This technique proved to be quite successful in that 2,356 animals were counted during 72 flying hours over a flight route 9,000 km in length (Fertikov, 1979). The population of this wild sheep species on the Aldan-Uchur and Yano-Oimyakon highlands was found to have a density of 0.1 to 0.3 animals per 1,000 ha. Considering that the total habitat covers an area of 27,100 km^2, the sheep population here is estimated to be 300 to 800 head. A high population density of sheep was documented for the northern part of the Verchoyansk Range, where it amounted to 2.86 animals per 1,000 ha. Sheep habitat here covers an area of 99,600 km^2, and the total sheep population is estimated at 28,500. In the southern part of the Verchoyansk Range the population density is much lower, amounting to only 0.57 animals per 1,000 ha. This range extends over an area of 79,300 km^2, with an estimated sheep population of 33,000. On the Chersky Range sheep density amounts to 1.1 animals per 1,000 ha. With a range size of 113,500 km^2 the sheep population is estimated at 12,500 head. The population density in the Territory of the Momsky Range is estimated at 0.9 sheep per 1,000 ha; with a range size of 21,800 km^2 the sheep population will be around 2,000. The entire area of Yakutia has a sheep population of 48 to 50,000 (Revin, 982).

In the territories adjacent to Yakutia, such as those in the Trans-Baikal area, the northern part of the Amur River area and the Magadan Region (except Chukotka) the size of the sheep population is thought to be 15 to 20,000 head. Rather detailed investigations have been carried out in Chukotka and on the Koriak Uplands. Certain ranges here have a fairly high sheep density. For instance, for the Pikulnei Range the density is estimated at 1.2 to 3.2 animals per 1,000 ha, and for the Anadyr plateau at 0.7 to 1.8 per 1,000 ha. In total, the sheep population size in Chukotka approaches 5 to 8,000 head and on the Koriak Uplands 6 to 8,000 head. This includes some 200 to 300 sheep living in central Kamchatka (Gribkov, 1969; Zheleznov, 1975; Chernyavsky, 1977). The initial assessments of sheep densities on the Koriak Uplands, ranging from 8 to 18 animals per 1,000 ha, appeared to have been an overestimation (Chernyavsky, 1971; Gribkov, 1977). At the same time, there can be no doubt that with further economic growth and human settlement in this territory, and with the construction of various roads and urban centres, the population of sheep will decline.

These sheep usually inhabit mountain ranges that do not exceed 2,000 m in elevation, and as a rule seek the upper parts of these ranges, the zone of bald mountain peaks. These mountains are usually oval-shaped, elongated ranges stretching from north to south or to southwest. The eastern slopes of the ranges usually consist of steep cliffs, while the northern, western and southern ones are more flattened and curved with talus debris or tundra vegetation. The cliffs are usually used by sheep for resting, while the other slopes constitute grazing areas. In winter the animals feed primarily on southern slopes, in spring and fall then prefer to use western slopes, and in summer they seek northern ones.

In terms of altitudinal range, the sheep habitat extends from the upper limits of the forested zone upward to the limits of vegetation. In regions

located far north, sheep range extends northward of the continental tree line, and in such locations embraces the entire length of the mountain slopes. The living conditions for the sheep are extremely severe in winter. Temperatures may dip to -60°C, snowfalls are abundant and heavy, often the snow surface is covered with ice. Also, the winds here are very strong. These factors force sheep in Yakutia to undertake annual migrations of 80 to 120 km in distance from the western slopes to the eastern slopes, where the snow cover is less severe. Similarly, in Kamchatka migrations of over 50 km have been documented.

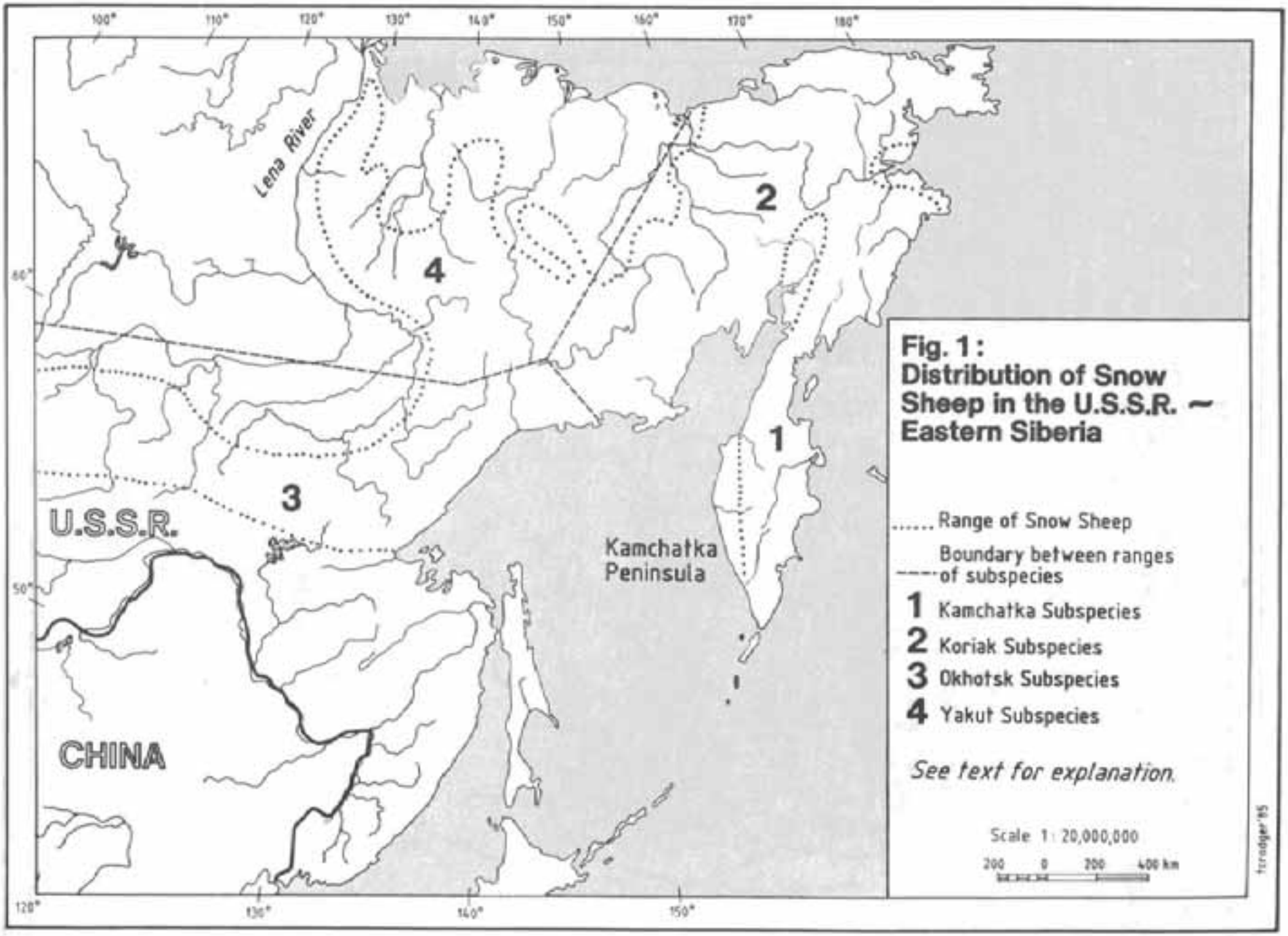
The main forage items of sheep consist of various lichen, grass, sedge, shrub, moss and mushroom species.

The structure of sheep populations is similar in all parts of their range. Rams of 6 years and older comprise 11.6 to 21.5%, those 2 to 5 years of age 7.5 to 15.5%, adult females make up 34.5 to 37.3%, yearlings 7.2 to 17.2%, and young of the year constitute 23.3 to 25.4% of the population (Chernyavsky, 1963; Gribkov and Fil, 1977).

Three types of population components appear to segregate themselves from others: adult rams over 4 to 5 years of age, ewes and lambs, and thirdly young males of 2 to 4.5 years of age. Band sizes average 6 to 7 animals and never exceed 20 sheep (Chernyavsky, 1970; Rudkov, 1979).

Rams and ewes reach sexual maturity at 2 years of age. The rutting season lasts 1.5 months, and typically occurs in December and January. The pregnancy period extends over 6 months, therefore, the lambs are born at the time when the snow melts and green vegetation emerges. Single births are the rule. The lambing period peaks in July. The mortality rate of lambs during the first 3 months of life amounts to 30%, that over the entire first year of life reaches 50%. Therefore, the annual growth rates of sheep herds are not very great. Tooth replacement is completed by the fourth year of the animal's life, and by the age of 14 to 15, the teeth are completely worn down. However, the maximum life expectancy is known to be 18 to 20 years, which is longer than for any other wild sheep species. The most important predator of sheep is the wolf. However, they are also hunted by the wolverine, and their lambs are attacked by foxes, golden eagles and white-tailed eagles. Some sheep perish accidentally by falling down steep mountain slopes or by getting caught in avalanches. Nevertheless, the abundance of sick or crippled animals in many populations testify to the rather insignificant pressure of predators.

Sheep have been hunted by the local people since ancient times. Presently, the largest number are taken by people who work as herdsmen of reindeer. However, hunting is also carried out by geologists and residents of northern settlements. All these hunting operations are illegal, since the taking of snow sheep is outlawed in the entire territory of the U.S.S.R., and the Putoran subspecies (Ovis nivicola borealis) is listed as endangered in the Red Data Book of the U.S.S.R. As a matter of principle, wild sheep specialists do not object to the hunting of these sheep as such, since their population densities are rather high. However, proper regulation and licensing of hunting must take into consideration a proper network of inspection and enforcement, and the rather remote and inaccessible terrain these sheep inhabit presents great difficulties in these matters.


100°
110°
120°
130°
140°
150°
160°
170°
180°
60°
50°
120°
130°
140°
150°
Lena River
U.S.S.R.
CHINA
Kamchatka Peninsula
1
2
3
4
Fig. 1:
Distribution of Snow Sheep in the U.S.S.R. – Eastern Siberia
..... Range of Snow Sheep
---- Boundary between ranges of subspecies
1 Kamchatka Subspecies
2 Koriak Subspecies
3 Okhotsk Subspecies
4 Yakut Subspecies
See text for explanation.
Scale 1: 20,000,000
200 0 200 400 km
troedger '85

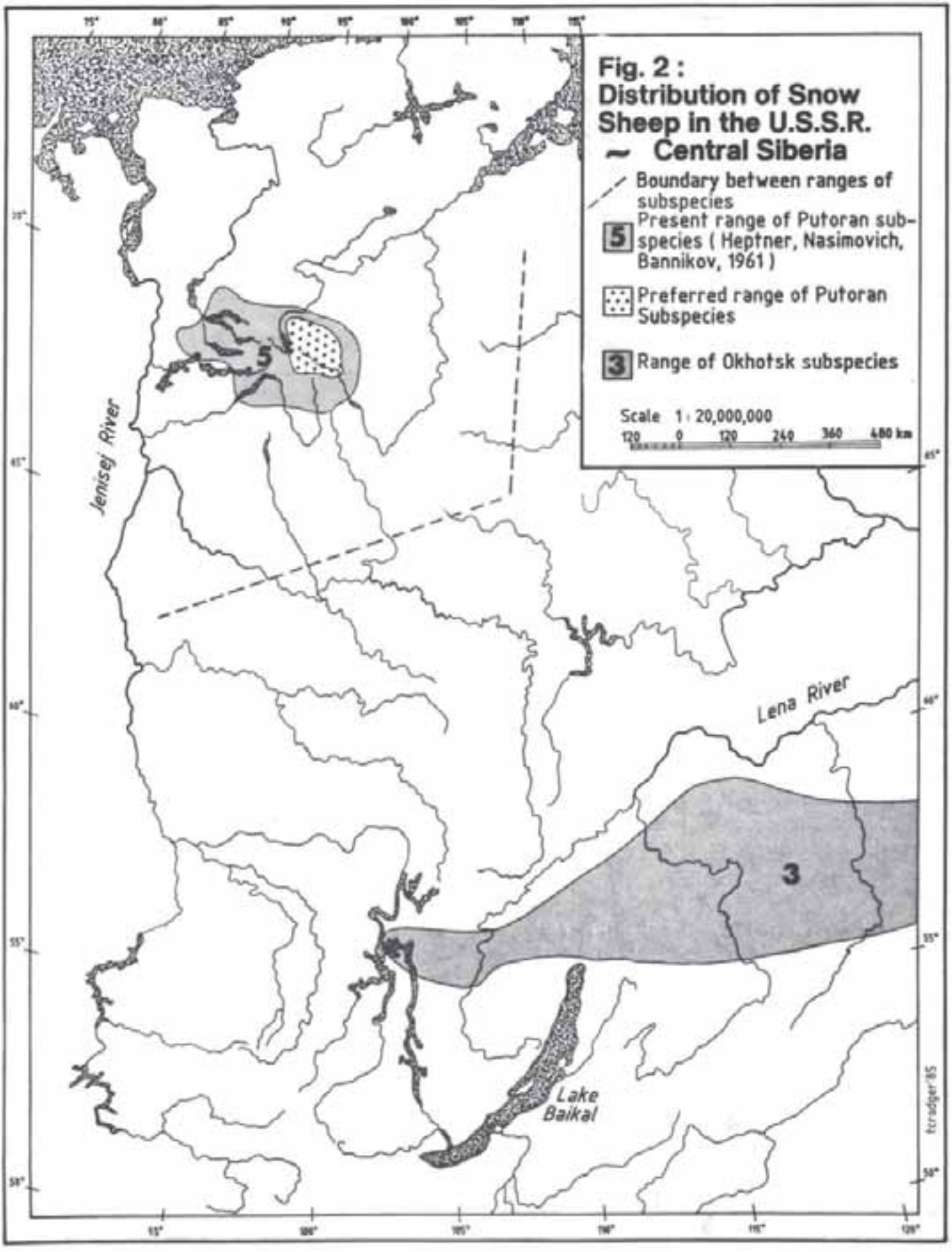


Fig. 2 :
Distribution of Snow Sheep in the U.S.S.R.
~ Central Siberia
Boundary between ranges of subspecies
5 Present range of Putoran subspecies (Heptner, Nasimovich, Bannikov, 1961)
Preferred range of Putoran Subspecies
3 Range of Okhotsk subspecies
Scale 1 : 20,000,000
120 0 120 240 360 480 km
Jenisej River
Lena River
Lake Baikal
5
3
ttrüdiger'85

It is believed that on ranges with average sheep densities, a hunting rate of some 50 to 60 animals for every 1,000 could be sustained, and for ranges with optimum densities one of 80 to 90 sheep (Gribkov and Fil, 1977).

Now under investigation are possibilities of transplanting sheep to the mountains of Putoran and adjacent ranges, where this species has almost disappeared. Such recolonization attempts are regarded as vital and necessary in view of the fact that these animals are rather conservative and traditional in the use of their ranges and tend to follow a non-migratory pattern of life. Some scientists have suggested to transplant these sheep to the Kurile and Commandor Islands (Petrashov, 1982).

LITERATURE

Borzhonov B.B., Dorogov V.F., Zyryanov V.A., Katsarksky O.P., Kiselev V.A., Kolpaschikov L.A., Pavlov B.M., The Snow Sheep of the Putoran Mountains. (In Russian). Nauchnye trudy Nauchnoissledovatelskogo instituta selskogo khozyaistva Krainego Severa, t. 26, 1979, p.44-56.

Calkin, V. Mountain Sheep of Europe and Asia (in Russian), M. Nauka 1951, 344 p.

Chernyavsky F.B. The snow sheep of the Koriak upland (in Russian). Avtoreferat of the Cand. Sc. theses (in Russian), L., 1963, 16p.

Chernyavsky F.B. Some experience of visual census of snow sheep in Chukotka and on the Koriak upland (in Russian). - In: Trudy IX Mezhdunarodnogo kongressa bologov-okhotovedov., M., 1970, p. 345-349.

Chernyavsky F.B. Following the footprints of the bighorns (in Russian), M., Mysl', 1971, 157pp.

Chernyavsky F.B. Distribution, population numbers and tasks of preservation of the snow sheep in the northeast of Siberia (in Russian). - In: Rare mammalian species and their preservation (in Russian). Tezisy II Vsesoyuznogo soveschania po redkim vidam mlekopi tayushchikh. M., Nauka, 1977, p. 241-242.

Chernyavsky F.B. Mammals of Far North-East of Siberia, (in Russian), "Nauka", 1984. 388 pp.

Fertikov V.I. State of populations of the Yakut snow sheep (in Russian), Priroda, N 12, 1979, p. 86.

Fil V.I. Ecological aspects of the use and preservation of the snow sheep populations (in Russian). -In: "Ungulate Faunas of the USSR (in Russian) (Ecology, morphology, use, preservation). Tezisy Vsesoyuznogo soveshchaniya po kopytnym SSSR, M., Nauka, 1975, p. 281-282.

Gribkov P.F. The state of population of the Snow sheep in the central part of Kamchatka (In Russian) - Zoologichesky zhurnal, t. 48, vyp. II, 1969, p. 1716-1721.

Gribkov P.F., Fil V.N. The Snow sheep (In Russian). - The Ungulate Animals (In Russian), M., Lesnaya promyshlennost", 1977.

Heptner V.G., Nasimovich A.A., Bannikov A.G. Mammals of the Soviet Union. Artiodactyla and Perissodactyla. "Visshaya shkola", Moscow, 1961, v. 1, 776 p.

Petrashov V.V. Problems of transplantation of snow sheep and sika deer in the RSFSR. (In Russian). - In: Increasing the productivity of game grounds (in Russian), M, 1982, pp.138-150.

Revin Yu. V. On the distribution and populations of snow sheep in Yakutia. (in Russian). In: Distribution and ecology of mammals in Yakutia (in Russian), Yakutsk, 1982, p.82-97.

Rudkov A.S. Habitat conditions and biology of snow sheep (in Russian), Priroda, N 12, 1979, p. 82-85.

Zheleznov N.K. The snow sheep of Chukotka (In Russian), - Trudy Vsesoyuznogo selskokhozyaistvennogo instituta zaochnogo obucheniya, vyp. 104, 1975, p. 67-74.