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GRADUATE COLLEGE

THE ELAND AS A MEAT PRODUCER IN THE AMERICAN SOUTHWEST: A NEW APPROACH TO LAND-USE

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

By

James E. Humphries, Jr.

Norman, Oklahoma

1972

THE ELAND AS A MEAT PRODUCER IN THE AMERICAN SOUTHWEST:

A NEW APPROACH TO LAND-USE

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DISSERTATION COMMITTEE

This study is dedicated to my wife, Janie, and my son, James III, whose love and patience are beyond comment.

PREFACE

The background for this writer's interest in exotics spans several years and is culuminated by this study. My earliest efforts toward a serious study of exotic mammals in the American Southwest were carried out in 1968 and involved a brief survey of the several exotic mammals that have been introduced into the Edwards Plateau region of Texas. It was during the course of this study that I came upon the idea of using the eland (Taurotragus oryx) as a meat producer in the American Southwest. As with most ideas that suggest a change from tradition, criticism is an almost immediate reward. This one was no different. Encouragement, however, came from a number of my professors and colleagues.

During the course of this study many individuals offered valuable comments, suggestions, and criticisms which were both welcome and necessary for the completion of this work. In addition to these many unnamed individuals, I am especially grateful to professors Joseph B. Schiel, John W. Morris, John E. Steinbrink, James M. Goodman, and Charles C. Carpenter, all of the University of Oklahoma, who served as my Research Committee. Surely, few are fortunate enough to have a committee as helpful and as encouraging as these gentlemen have been. Also, I am grateful to William E.

Dooley, East Texas State University, for his comments, suggestions, and the use of his aircraft for photography and rapid transportation to the study area.

A word of very special thanks is due Charles Schreiner, III, owner of the Y. O. Ranch, Mountain Home, Texas. Mr. Schreiner was kind enough to make available his vast ranch with its numerous exotic mammals for study. Also, thanks are in order for the help extended this writer by Ron White and Robert Snow, both of the Y. O. Ranch. My wife Janie and my son, James III, deserve particular appreciation for their encouragement and patience.

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CHAPTER I

Introduction

The purpose of this study is to explore a new system for more efficient use of the available vegetation and moisture. To this end, the African eland, Taurotragus oryx, was chosen as a potential meat producer that could be introduced into wide areas of the arid and semiarid American Southwest. The animal could be placed on ranges, along side cattle, that have suffered from plant invasions. Efficiency would result because the eland is a browser rather than a grazer and would, therefore, make use of the large amounts of vegetable matter that is not normally utilized by cattle or sheep. Also, the eland can exist, if necessary, entirely without water except that obtained from its daily browse. The thought of introducing a large African antelope into areas that have been traditionally associated with cattle and sheep seems, at first, bizarre. It is this writer's intention to dispel these ideas and to demonstrate that such an approach to land-use would be both possible and ecologically rational.

As the world population increases in an almost geometric progression, food production, especially animal protein production, has not kept pace. Hunger and starvation

are widespread and protein deficiency diseases are increasingly common. It has been estimated that if population continues to grow at present rates there will be an estimated 6.3 billion by the year 2000 and 18 billion by 2050. While it is now known exactly how many people the earth could support, the evidence indicates that the limit is approximately 30 billion. If, however, the earth is to support this many people, the level of living would have to be very near the starvation level.[1]

Various solutions have been proposed to reverse present and future food shortages. All have merit and, in time, should contribute materially to the world's nutritional needs. People, however, are hungry now. All the proposals are presently far from being practical realities and, as will be demonstrated, are somewhat over-optimistic.

For many centuries a significant proportion of mankind has been dependent upon the sea for food. The sea has been viewed as a boundless source of food, limited only by man's ability to tap its riches. Scientific fact does not support this view. Current thinking indicates that a substained-yield fish catch of 150 million tons annually is possible without damage to the productive potential of

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[1]Committee on Resources and Man of the Division of Earth Sciences, National Academy of Sciences, National Research Council, Resources and Man (San Francisco: W. H. Freeman and Company, 1969), p. 5.

the sea.[2] If world fisheries' production should reach the 150 million ton catch level by the end of the century, then the sea, at best, could supply only about 3 percent of the food-energy requirements for the projected world population of 6.3 billion.[3] It would seem obvious that the sea may continue to be a major source of food but, just as obviously, it will not yield food at the levels necessary to alleviate future shortages.

Moving from the sea to the land, the potential is somewhat more encouraging, at least for a time. The best of the world's agricultural land is already in use, and there seems little likelihood that a new land bonanza is forthcoming. New lands will, however, be forced into production, and it can only be hoped that some rational scheme will be developed that will protect these marginal lands from the pressures of continued agriculture.

The future will almost certainly indicate that a greater percentage of the world's food supply be forced into production, and it can only be hoped that some rational scheme will be developed that will protect these marginal lands from the pressures of continued agriculture.

The future will almost certainly indicate that a greater percentage of the world's food supply be composed of grains. Fortunately, rapid progress has been and is

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[2] Ibid., p. 105. [3] Ibid., p. 107.

being made in the production of better grain crops, especially wheat and rice.[4] Newly developed hybrid strains of both wheat and rice seem to be quite promising and, without doubt, will go far toward providing adequate food energy. The price for greatly increased yields, however, is high. To realize the yield potential of these newly developed strains, considerable increases in fertilizers will be needed. Also, if fertilizer levels are not properly maintained, the native fertility of the land is quickly reduced. It should also be pointed out that unless economical means are developed to control the damage done to the environment by the increasingly heavy use of fertilizers and other agricultural chemicals, the prospect of any great increase in yields is somewhat less attractive than first estimated.

Aside from the above mentioned methods, several new innovations in food production have promise. Still experimental is the production of edible protein from the bacterial conversion of petroleum. The future potential of this process is unknown and difficulties will arise from the fact that it depends upon a diminishing and nonrenewable resource. Other newly developed processes include growing yeast on vegetable waste which, when developed further, will perhaps

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[4]Rockefeller Foundation, Toward the Conquest of Hunger, Progress Report, Program in the Agricultural Sciences, New York, 1967.

provide limited quantities of high-grade protein suitable for human consumption.[5] Only time will reveal the degree to which these and other techniques will serve the needs of mankind.

The grazing of cattle and sheep in the American Southwest is a tradition of long standing and has played an important role in the growth and development of the area. Fortunes have been made, cities built, and the land has yielded to the energies and persistance of man. This traditional form of land-use has materially improved the standard of living, but the price has been high. So high, in fact, that the future of the area and the land-use system itself is questionable.

At least seventy-five million acres of the Southwestern United States has suffered from an invasion of woody plants.[6] For the most part this invasion has taken place during the past century and has centered on areas of former grassland prairie. Of the several factors that have been identified as causing these invasions, most are attributed to the activities of man. Production from the vast Southwestern ranges will have to be increased significantly as the world's demand for animal products increases. At present these growing demands are met by increasing the numbers of cattle and sheep

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[5]Committee on Resources and Man of the Division of Earth Sciences, op. cit., p. 5.

[6]For example, mesquite (Prosopis juliflora), juniper (Juniperus monosperma), tamarisk (Tamarix pentendro).

that are grazed, accompanied by the alteration of entire landscapes in order to meet the narrow demands of these animals. It seems obvious that the traditional grazing of cattle in the arid and semiarid American Southwest will not be able to meet successfully the demands of the future without causing considerable damage to the land and vegetation. A more efficient system of animal production must be developed and implemented that will make more efficient use of the vegetation, as it now stands, without causing widespread damage.

Statement of the Hypotheses

Based upon the physiological and behavioral characteristics of the eland and the presently existing conditions of a major part of the American Southwestern ranges, the following hypotheses will be tested.

H_1 Eland would represent an additional productive use of existing vegetation without being directly competitive with cattle.

It will be pointed out in chapter II that there are literally millions of acres of range in the American Southwest that have suffered from invasion by woody plants as well as vast areas that are so arid that their carrying capacity for cattle is extremely limited.[7] Except on

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[7]An excess of 100 acres per head in parts of Arizona, New Mexico, and Nevada.

rare occasions cattle do not browse the various species of shrub and bush that are represented over the area. Yet, in an energy sense, these plant species represent an enormous potential source of feed that is not being utilized to any great degree. In the light of the current condition of the Southwestern ranges, the present system of land-use, namely, the use of grazers, seems to be an inefficient use of the existing vegetation resources. If introduced, the eland would utilize the available browse and would represent an additional use of existing vegetation without being on a competitive level with cattle.

H_2 Eland would fill an existing niche in the area's ecosystem and would help to restore and maintain a more stable vegetation complex.

Recent evidence indicates that the present observed invasions of woody plants into arid and semiarid grasslands represents a reoccupation by these plants into the grasslands which attained a dominant position chiefly through man's actions.[8] Also, evidence points toward large scale extinctions of herbivores during the Pleistocene which left vacant several browsing niches. The contemporary reappearance of these browsing niches leads this writer to the conclusion

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[8]For example see Paul S. Martin, "Wanted: A Suitable Herbivore," Natural History, LXXVIII (2) February, 1969, pp. 34-39; and David R. Harris, "Recent Plant Invasions in the Arid and Semi-Arid Southwest of the United States," Annals of the Association of American Geographers, LVI (3) 1966, pp. 408-422.

that the eland could be introduced to utilize this presently unused source of vegetable energy. Also, with browsing pressure placed on these niches, it is logical to assume that, in time, a more stable vegetation complex would result. By harvesting the surplus eland for meat, man would assume the role of a predator and, therefore, insure a balanced ecology.

H_3 Being physiologically freed of a surface source of water, eland would be able to distribute their browse load over a much larger area than cattle and would make more efficient use of the limited water available to arid and semiarid areas.

Taylor[9] has found that the eland is one of a small number of animals able to obtain the necessary water for survival from the free moisture contained in the browse and from the water that is liberated as the feed is oxidized in the process of metabolism. With this proven ability the eland could utilize a significant amount of moisture that, if only cattle are considered, would be lost for any economically productive purpose. Also, as will be shown, the eland's ability to survive without a source of drinking water would free these animals from the distance-from-water restrictions suffered by cattle. Thus, the eland would be

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[9]C. R. Taylor, "The Eland and the Oryx," Scientific American, January, 1969, pp. 89-95.

able to spread its browse load over a much greater area than cattle. An evenly distributed browse load would certainly be in keeping with ecological principal and, hopefully, should help to stabilize the vegetation complex of the areas browsed.

This study is directed toward the search for a better form of land-use. Geographers have contributed a great many works that have deepened the understanding of how man has used the earth. Unfortunately, most of these studies have been descriptive in nature and have, for the most part, failed to make recommendations and proposals of how the earth and its resources may be more efficiently utilized. Certainly, criticism has been leveled by the Geographer at certain aspects of land-use. Seldom, however, has the Geographer used his broad knowledge to propose entirely new, non-traditional forms of land-use. This failure may be explained and rationalized but not justified. It is the writer's intention not only to describe and criticize an existing form of land-use but to investigate the feasibility of an entirely new system.

Chapter II describes the failure of man to establish an ecologically sound system of land-use in the American Southwest while Chapter III gives a brief sketch of the

African eland. Chapters IV, V, and VI present the procedures for testing the hypotheses, the findings, and the conclusions and recommendations of this study.

CHAPTER II

The Eland: A Potential Meat Producer for the American Southwest

In order to make use of the surplus vegetation covering much of the American Southwest, the African eland, Taurotrangus oryx, was selected for potential introduction.

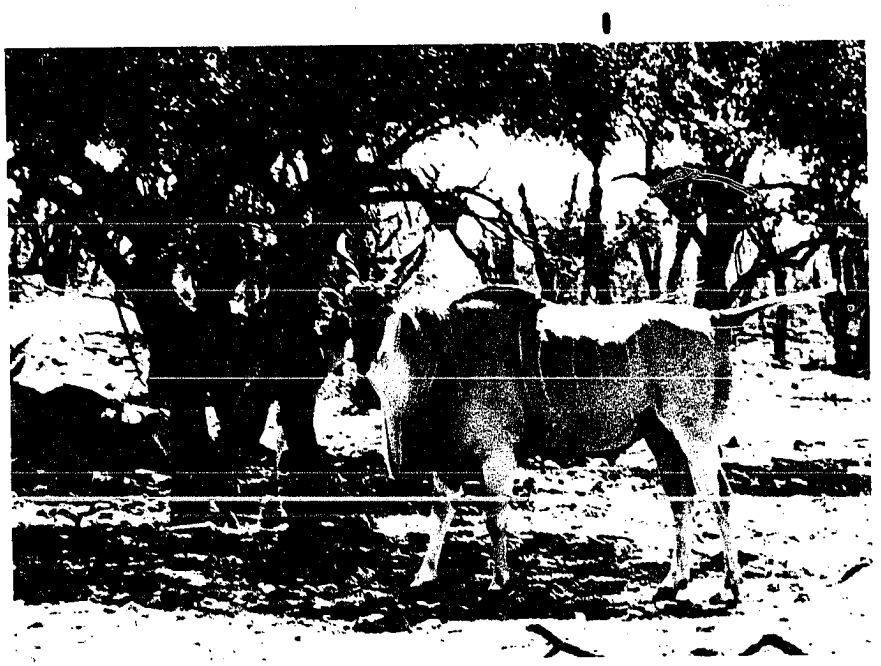

Fig. 1.--Mature Bull Eland, Taurotragus oryx

The eland is a large mammal with a distinctly bovine, very muscular build. It has a strong neck and a head that almost appears too small for the large

body. Mature bulls will stand five and one-half to six feet at the shoulders (depending upon the subspecies) and weigh from 1,400 to 1,600 pounds or more (Fig. 1). The females are somewhat smaller and lighter (Fig. 2). Eland are generally fawn to yellowish-gray or rufous in color, turning to a darker bluish-gray in the old males. The East and Central African subspecies show a number of vertical stripes or lines along the flanks and the shoulders, while the South African subspecies lack these stripes. A white chevron-like mask may also be present between the eyes of both sexes.

Fig. 2.--Mature Cow Eland, Taurotragus oryx

The range of the species originally extended from Cape Agulhas to the Mongalla area of the Sudan. The South African subspecies has been exterminated over

much of its range but can still be found in the south Kalahari. Further, eland have been reintroduced in game reserves and are often kept on private estates.

In Kenya the eland could once be found, in suitable range, over most of the country with their range extending north into Suk country and almost to the southern end of Lake Ruldolf. At present their numbers have been greatly reduced in the more densely settled areas. In Uganda eland are found south and west near the Kagera and Katonga Rivers, Acholi and East Madi.[10]

Man seems to have been a chief cause of the eland's decline over much of its original range. They have been used to furnish meat for the miners of South Africa and the railroad crews as they were linking Africa together. Also, expanding native and European popula-tions have taken over a great deal of territory and have restricted the range of a great number of animals, including the eland. The outbreak of rinderpest that swept Africa in the closing years of the last century is known to have killed thousands of eland as well as domestic livestock.[11] Until recently, it was common practice

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[10]Charles Guggisberg, "The Family of Antelopes," Africana, II (10) December, 1966, pp. 5-15.

[11]A. D. Irvin, "Personal Letter," East African Veterinary Research Organization, Nairobi, Kenya, March 16, 1971. Comments on the diseases of the eland.

to kill large numbers of animals under the guise of disease control in an attempt to keep rinderpest from spreading to domestic cattle. While the effectiveness of this practice is open to question, the result has been that animal populations, including the eland, have been greatly reduced.

Eland are mainly browsers but will also eat grass if adequate browse is not available. Blankenship and King report that the eland has an extremely wide range of feed preferences and have been observed feeding on vegetation ranging from the succulent young grasses that appear after a rain to the last vestages of leaf-type vegetation during the dry season.[12] Acacia (Acacia tortilis) seems to be the favored browse[13] in the native range of the eland, while live oak (Quercus virginiana), cedar (Juniperus mexicana), and mesquite (Prosopis juliflora) seem to be favored by those animals that have been introduced into the Southwestern part of the United States. This wide browse preference plays a key role in the overall philosophy and purpose of introducing eland into the arid and semiarid American Southwest.

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[12]David Blankenship, "Personal Letter," Akira Ranch, Rift Valley, Kenya, April 5, 1971. D. B. has been doing research on the food habits of the eland; and J. M. King, "Personal Letter," East African Wildlife Leadership Foundation, Nairobi, Kenya, March 4, 1971. Brief comments on the general ecology of the eland.

[13]C. R. Taylor, op. cit., pp. 89-95.

Once domesticated, eland are generally mild tempered animals. In their wild state, however, they are timid and hard to approach. They will actively defend their young from predators, and seldom does a mature animal fall prey to any hunter other than man. Guggisberg has reported that eland meat is the best of the antelope and has a taste all its own that could be described as being somewhere between beef and venison.[14] Treus reports that eland meat is generally quite tender and low in fat content. Furthermore, for every 1,000 pounds of dressed eland carcase, there is more than 750 pounds of lean, high-protein meat. In most domestic cattle the ratio would be approximately 550 pounds of lean meat per 1,000 pounds of dressed carcase. Russian investigators have demonstrated that the eland can be fattened, if desired, but the return does not seem to exceed that from a range grown animal. Eland milk has also been shown to be quite high in protein and has potential for expanded use. Most importantly, however, the milk has an unfrigerated shelf-life considerably longer than cow's milk. This is a fact that should not be overlooked when considering the present shortage of protein and the general lack of

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[14]Guggisberg, op. cit., pp. 5-15.

refrigeration facilities over much of the underdeveloped world.[15]

Eland mature at four and three years, respectfully, for the male and the female. Bull eland have been observed, between frequent skirmishes with agressive suitors, sniffing the female during her sexually active periods. After an undetermined period of time, mounting takes place much after the fashion of domestic cattle. The female will drop the calf after 255-270 days. Calves are usually born in protected places such as a thick grove of trees, places where eland would not normally be found. After the calf is born, the female will eat the afterbirth, probably in an attempt to keep scent-directed predators from the newborn calf and the birth area. After a short period of time which enables the calf to gain its strength and footing, both will return to the troop[16] (Fig. 3).

Eland run in troops of ten, twenty, or thirty animals and, at times, the troops will join to form herds numbering 100 or more. Troops usually consist of cows, juveniles, and one or two mature bulls. Bulls that have not established

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[15]V. Treus and D. Kravchenco, "Methods of Rearing and Economic Utilization of Eland in the Askaniya-Nova Zoological Park," Symposium of the Zoological Society of London, XXI, 1968, pp. 395-411.

V. Treus and N. Lobonar, "Acclimatization and Domestication of Eland at Askaniya-Nova Zoo," Conservation, 1967, pp. 130-140.

[16]R. F. Ewer, Ethology of Mammals, (New York: Plenium Press, 1968) p. 370.

a following of cows because of extreme age, immaturity, or physical handicap may be seen singly or in small bachelor herds. Bulls will fight for territory and females and, in some cases, damage to one or both antagonist will result. Eland have been observed in the San Diego Zoological Park attacking other animals when they were allowed to mix.[17] Since this has not been observed in the wild, nor has it been reported at other zoos, it seems safe to say that this behavior represents an individual frustration reaction and should not be considered as representative behavior.

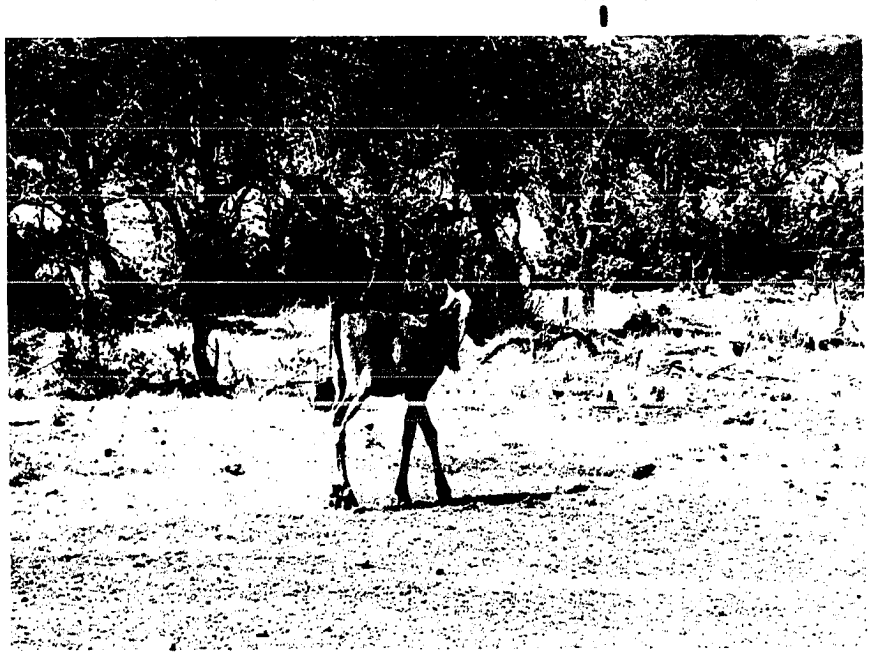

Fig. 3.--Seven Month Old Eland Calf, Taurotragus oryx

[17]Ken Strott, "The Elands," San Diego: Zooway, XII (5) May, 1940, pp. 10-11.

One of the more interesting facts concerning the eland is their remarkable ability to exist without water.[18] This physiological ability is very important to the overall premise of this study. Without being restricted to a surface water supply, the eland is free to roam over a very large area and, therefore, distribute the browse load over a much larger area than is the case with domestic cattle. This would have the effect of making available large areas of rangeland that are, if only grazed by cattle, beyond the daily grazing radius of cattle. Unfortunately, over most of the arid and semi-arid American Southwest, surface water sources are scarce; thus, cattle graze fairly close to the water. As a result overgrazing of parts of the ranges exists while a large part, outside the grazing radius of cattle, is not utilized by domestic stock. Surely, if our rangelands are to produce the quantities of meat and livestock products needed, all the land must be put to some use.

The foregoing discussion has presented a brief picture of a remarkable animal, the eland, and yet little research attention has been focused on its ultimate potential. Recent attempts at harvesting eland and other herbivores on their native ranges have proven quite successful. In

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[18]Taylor, op. cit., pp. 89-95.

fact, at least one operator reports that the sale of wild meat, including eland, yielded more profit than the sale of domestic cattle.[19] While these experiments have been impressive, it must be remembered that the operations were carried out with animals on their native ranges that are different from the environment in the American Southwest.

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[19]R. F. Dasmann, African Game Ranching, (Oxford: Pergamon Press, 1964), p. 75.

CHAPTER III

Vegetation Invasions: Symptoms of Failure

It is common knowledge that in the arid and semiarid portions of the American Southwest massive changes have taken place in the vegetation complex, especially in the last hundred years. Areas that were once vast grasslands have been transformed into mesquite dominated landscapes with only a fraction of their earlier value for livestock grazing. Millions of dollars are spent each year in the southwestern states in an attempt to control the spread of such species as mesquite (Prosopis juliflora), salt cedar (Tamarix pentendro), and juniper (Juniperus monosperma).

Although some control measures are necessary, especially along stream courses, it seems somewhat strange that no matter how much control is practiced in an area, the problem of invasion only worsens. This is largely a direct result of a faulty system of land-use, namely, the grazing of excessive numbers of cattle in areas not suited for that purpose. Yet, in an attempt to meet rising demands for meat and livestock products, increasing pressure is placed on the land each year. This pressure results in additional expenditures for controlling the spread of

unwanted vegetation species. Although unsupported by data, it is the opinion of the writer that the present system of land-use, i.e. livestock grazing, has reached its highest level of efficiency. The recent boom in cattle feed lots, often using feed grown outside the American Southwest would seem to lend support to this idea.

Mesquite

Of the several species of vegetation that have spread over thousands of acres of former grassland during the past century, mesquite has made the greatest advance and as a result created the greatest problem for the American Southwestern stockman. Mesquite could play a very important and productive role in the future of the American Southwest with only slight alterations to the existing land-use systems.

Within the American Southwest, there are three principal varieties of mesquite: the honey mesquite (Prosopis juliflora glandulosa), the western honey mesquite (Prosopis juliflora torreyano), and the velvet mesquite (Prosopis juliflora velutina). While all three varieties may be classed as deciduous, spiney trees or shrubs with deep root systems, they are generally distinguished by their size and leaflets. Honey mesquite may be found throughout Texas, and to a lesser extent westward, and may be either a tree or shrub (depending upon both moisture and

soil conditions) and has long, smooth leaflets. Western honey mesquite has somewhat smaller leaflets than the honey mesquite and shows hair or fuzz on the leaflets. Also, western honey mesquite grows mainly as a shrub rather than a tree and is generally quite common in extreme western Texas and southern New Mexico. The velvet mesquite, which grows as a medium sized tree and has short hairy leaflets, is restricted to the southern third of Arizona.[20]

The mesquite is an extremely hardy plant that seems to thrive under a wide range of environmental conditions. The root system is extensive with a tap root extending as deep as twenty-five feet and a lateral spread of as much as twenty-five feet.[21] This, of course, would enable the plant to draw water from a large area and survive drought conditions. Mesquite seeds are contained within pods or beans. Unlike many members of the Leguminosae, the pods do not split open and scatter the seeds but, are generally injested by animals which are attracted to the sweet, pulpy interior of the pod, and the hard seeds are passed from the animals with the feces. Furthermore, the mesquite seed is hardy and weather resistant. The seed will remain

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[20]M. C. Johnston, "The North American Mesquites," Brittonia, XIV, 1962, pp. 72-89.

[21]W. A. Cannon, "The Root Habits of Desert Plants," Carnegie Institution of Washington Publication, No. 131, 1911, pp. 80-81.

viable in the soil for long periods of time and will germinate only when environmental conditions are favorable. Although the mesquite normally reproduces by seeds, cuttings will take root if covered by soil. As any western stockman will attest, the mesquite is extremely difficult to kill owing to the very deep and widespread root system which sprouts buds just below the surface and the fact that the seeds will remain dormant for long periods of time. In order for mesquite control to be effective, the entire root-bud system must be dug out or else the entire plant must be killed with poison.

Contemporary research indicates that the mesquite (also other species) dominated landscapes of today are the result of human activities.[22] While there seems to be little firm agreement on the exact causes of the spread of mesquite and other non-grass species, current research regards the causes as being linked to at least four interrelated factors. Harris, in his article "Plant Invasions in the Arid and Semi-Arid Southwest of the United States," has identified the four causitive factors as follows:

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[22]See for instance: M. C. Johnston, "Past and Present Grasslands of Southern Texas and Northeastern Mexico," Ecology, XLIV, 1963; L. C. Buffington and C. H. Herbel, "Vegetational Changes on a Semidesert Grassland Range from 1858 to 1963," Ecological Monographs, XXXV, 1965; V. E. Shelford, The Ecology of North America, (Urbana: University of Illinois Press, 1963).

1. grazing and browsing by domestic livestock
2. the effects of rodents and other wild animals
3. short-term climatic fluctuations
4. the cessation of recurrent grassland fires.[23]

As may be seen, all of these factors, with the exception of the short-term climatic fluctuations, are related to human activity.

The phenomenal spread of the mesquite and other woody plants across the American Southwest, especially during the last century, would seem, as Harris puts it "to cast doubt upon the common assumption that these grasslands are the natural vegetation of the flatter surfaces that lie at intermediate elevations between the woodland communities of the lower slopes and the shrub communities of deserts proper."[24] Through modern techniques such as pollen analysis, it now appears that the vast grasslands of the American Southwest are, in fact, secondary or disclimax communities that have been derived from a former woody vegetation cover in which the "mesquite may have been an important element."[25] Evidence points to man and his ageless practice of burning and hunting as chief elements in the initiation of the presently observed change in the vegetation.[26] It is common knowledge that the pre-European

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[23]Don R. Harris, "Recent Plant Invasions in the Arid and Semi-Arid Southwest of the United States," Annals of the Association of American Geographers, LVI (3) 1966, pp. 408-422.

[24]Harris, op. cit., p. 409. [25]Ibid.

[26]Martin, op. cit., pp. 34-39.

Indians of the American Southwest used fire as a means of driving game to pre-determined points during periods of communal hunts. Periodic burning of vast areas seems still to be a practice in many world areas and is practiced by both agricultural and non-agricultural peoples.[27] In the case of the mesquite, the recurrent fire effectively checked the new growth potential while, at the same time, not seriously affecting the grasses. With the coming of the European and his domestic livestock, the fires were ceased and, unknowingly, the process of mesquite invasion began. The fires had burned the accumulation of dead grasses as well as the majority of the young mesquite sprouts. Unless the fire was unusually hot or prolonged, the grasses would reappear the following season. Mesquite seeds, however, are disbursed by cattle and, in past years, bison (Bison bison). As long as the fires continued, the seeds or the shoots were destroyed before any effective invasion could take place. When increasing numbers of cattle were introduced into the American Southwest, plus the cessation of periodic range fires, the mesquite began to spread rapidly over the area. Furthermore, as levels of grazing increased, vast expanses of the region were overgrazed and the hearty stands of grasses greatly weakened. In a recent study of the velvet mesquite in Arizona, it

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[27]C. F. Cooper, "The Ecology of Fire," Scientific American, 204 (4) 1961, p. 150.

was found that mesquite invasion into areas that are well covered with grass was markedly reduced as compared to the survival rate of mesquite seedlings in areas that were covered with grasses weakened as a result of overgrazing. It was concluded that competition for moisture was the controlling factor and that mesquite seedlings had little chance of surviving when competing with a healthy stand of grass.[28]

Once established, the hearty mesquite will begin to gain a slight edge over the grasses due to its ability to survive extreme drought conditions. With its deep roots and subsurface buds, the mature mesquite is not permanently affected by burning. Additional evidence of the effects of burning upon the mesquite invasion comes from an observation made by Josiah Gregg in 1844. His comments were:

> Indeed there are parts of the southwest now thickly set with trees of good size, that, within the remembrance of the oldest inhabitants, were as naked as the prairie plains; and the appearance of timber in many other sections indicates that it has grown up within less than a century . . . It is unquestionably the prairie conflagrations that keep down the woody growth upon most of the western uplands . . . In fact we are not witnessing the encroachment of timber upon the prairies, wherever the devastating conflagrations have ceased their ravages . . . Yet may not the time

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[28]U. S. Department of Agriculture, Reproduction and Establishment of Velvet Mesquite as Related to Invasion of Semidesert Grasslands by G. E. Glendening and H. A. Paulsen, Jr. Technical Bulletin No. 1127. (Washington, D.C.: Government Printing Office, 1955), p. 35.

> come when these vast plains will be covered with timber?[29]

Nearly sixty years later, in 1901, Bray commenting upon the vegetation of western Texas indicates that:

> Regarding the establishment of woody vegetation, it is the unanimous testimony of men of long observation that most of the . . . mesquite covered country was formerly open prairie . . . Apparently under the open prairie regime the equilibrium was maintained by more or less regular eoccurrence of prairie fires . . . It was only after weakening the grass floor by heavy pasturing and ceasing to ward off the encroaching species by fires that the latter invaded the grasslands.[30]

With the coming of fencing to the west, cattle were no longer able to roam over huge areas. When the cattle were able to roam over the range, they were able to make reasonably efficient use of the available grass and, except in periods of extreme drought, were not readily attracted to mesquite browse. When confined by fences, however, the cattle put heavy pressure upon the available grasses, thereby making possible the survival of mesquite seedlings which, when mature, would further reduce the amount of water available to the already weakened grasses. Further, with heavy pressure upon the grass, cattle began to browse

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[29]J. Gregg, Commerce of the Prairies: or Journal of a Santa Fe Trader, During Eight Expeditions across the Great Western Prairies, and a Residence of Nearly Nine Years in Northern Mexico, II, (New York: Henry G. Longley, 1844), pp. 200-202.

[30]W. L. Bray, "The Ecological Relations of the Vegetation of Western Texas," Botanical Gazette, XXXII (1949), pp. 99-123.

more frequently upon the mesquite resulting in more mesquite seeds being spread over the area. With the cessation of the range fires, there was no mechanism for controlling the mesquite invasions.

Compounding the problems caused by overgrazing and the cessation of periodic fires is the spread of mesquite caused by rodents and other wild animals. Mesquite seeds are a favored food of the common kangaroo rat (Dipodomys merriami merriame) and the packrat (Neotoma spp.). The seeds are collected and stored in underground burrows where some will undoubtedly take root and perpetuate the spread of the tree. Also, during the infrequent periods of rain, the rat burrows often fill with water which washes the seeds over a wide area. With an increase of mesquite the grasses are deprived of needed water and their dominance begins to weaken. A mesquite covered landscape represents a favored habitat for the kangaroo rat and generally results in an increase in rat populations. Rat populations are also aided by overgrazing because the grass cover is reduced and the mesquite generally increases.[31] Going somewhat further, the western stockman aided by several departments of the federal government seem to be waging war against almost all predators, especially the coyote (Canis latrans). Tons of lethal poisons have been scattered over the West and

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[31]G. E. Glendening and H. G. Reynolds, "Merriam Kangaroo Rat a Factor in Mesquite Propagation on Southern Arizona Range Lands," Journals of Range Management, II (1949) pp. 193-197.

Southwest in an attempt to kill-off (control) the predators. While it is true that coyotes do, in fact, take sheep, the actual number killed does not in any way justify the wholesale slaughter of thousands of animals. Much to the chagrin of the stockman, the killing of predators has resulted in widespread population booms in rodents and other small animals that would normally be kept at acceptable levels by predators. Many of these small animals and rodents are responsible for the spread of mesquite and other varieties of woody vegetation. Not only do these small animals help spread the mesquite but, the rabbit for instance, grazes upon the same grasses as do cattle and, therefore, are in part responsible for overgrazing the range. Certainly, it would seem more in line with ecological principle if the stockmen and government would get out of the business of predator control and devote their time and energies toward more constructive pastimes.[32]

Finally, Harris points out that short-term climatic fluctuations may have been partly responsible for the mesquite invasions. Long term analysis of climatic records does not point in any positive statistical manner toward an increase in aridity for the area as a whole. If, on the other hand, the statistics for the change in frequency of heavy and light daily rains are considered, then, as Leopold

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[32]Jack Olsen, Slaughter the Animals, Poison the Earth (New York: Simon and Schuster, 1971), p. 287.

has suggested, it can be seen that around the turn of the century there was a statistically significant change in the ratio between heavy and light rains. According to Leopold, "a decrease of the small rains of summer which provide the main moisture for grasses . . . would weaken that portion of the vegetal cover."[33] If this observation is correct, the deep-rooted mesquite and similar species would be favored over the grasses due to a reduction of competition. This would effectively serve to render additional areas open for invasion of mesquite. Once established, mesquite is seldom killed by periods of drought. During those periods of drought, the mesquite further reduces the water available to the grasses.

And so it goes: the grass cover is reduced by overgrazing, the cattle are forced to browse on the mesquite beans and spread seed over a wide area, and the weakened cover of grass is unable to resist the vigorous invasions of the mesquite. As mesquite takes over, improving the habitats for a large number of small animals and rodents, the seeds are spread still further. Without the periodic fires of the past to control the mesquite, the cycle is completed.

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[33]L. B. Leopold, "Rainfall Frequency: An Aspect of Climatic Variation," Transactions of the American Geophysical Union, XXXII, 1951, p. 351.

All of the aforementioned causes of the mesquite invasions taking place in the American Southwest are, of course, interrelated. Man has been the causitive agent and the four so-called causes are nothing more than symptoms of an ill-suited land-use, at least in its present form, to the areas in question.

The present distribution of mesquite landscapes in the American Southwest is a constant reminder that nature has a delicate balance that is easily upset by man and his activities. It has been estimated that at least seventy-five million acres of American Southwestern range lang has been affected by the spread of mesquite in the last 100 years,[34] with Texas showing by far the largest area.[35] It is not possible to arrive at exact figures for the additional area covered by mesquite in the last century because of the lack of accurate nineteenth century records. It is known, however, that invasion has been most extensive and rapid in the arid and semiarid grasslands. Also, the mesquite has invaded quite heavily and rapidly into northwest Texas. Comparison of the few photographs of known areas indicates that there has been a substantial increase

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[34]H. M. Bell and E. J. Dyksterhuis, "Fighting the Mesquite and Cedar Invasion on Texas Ranges," Soil Conservation, IX, 1943, p. 111.

[35]B. W. Allred, "Distribution and Control of Several Woody Plants in Texas and Oklahoma," Journal of Range Management, II, 1949, p. 19.

in the density of woody plants, especially mesquite. Early descriptions of the American Southwest point out that there were few mesquites to be found on the plains and, in fact, the mesquite was fairly well confined to the dense groves that grew along the water-courses and in areas of higher elevations.[36]

Map 1 shows the present distribution of all three varieties of mesquite. The length of the frost-free period appears to set the northern limits of mesquite. In order to successfully reproduce, there needs to be at least a 200 day growing season. Also, the mesquite is severely curtailed at elevations in excess of 5,500 feet. Mesquite thrives in areas of low rainfall. In the United States, mesquite landscapes are common in areas that have three inches of rainfall per year (Yuma, Arizona), and are seen in areas of east Texas with an excess of thirty-five inches of rain per year. Mesquite seems to flourish in almost any type of soil except the highly saline.[37] Mesquite invasion has been particularly serious in the Colorado Valley in Arizona, the Gila in both Arizona and New Mexico, the Rio Grande in New Mexico and Texas, and

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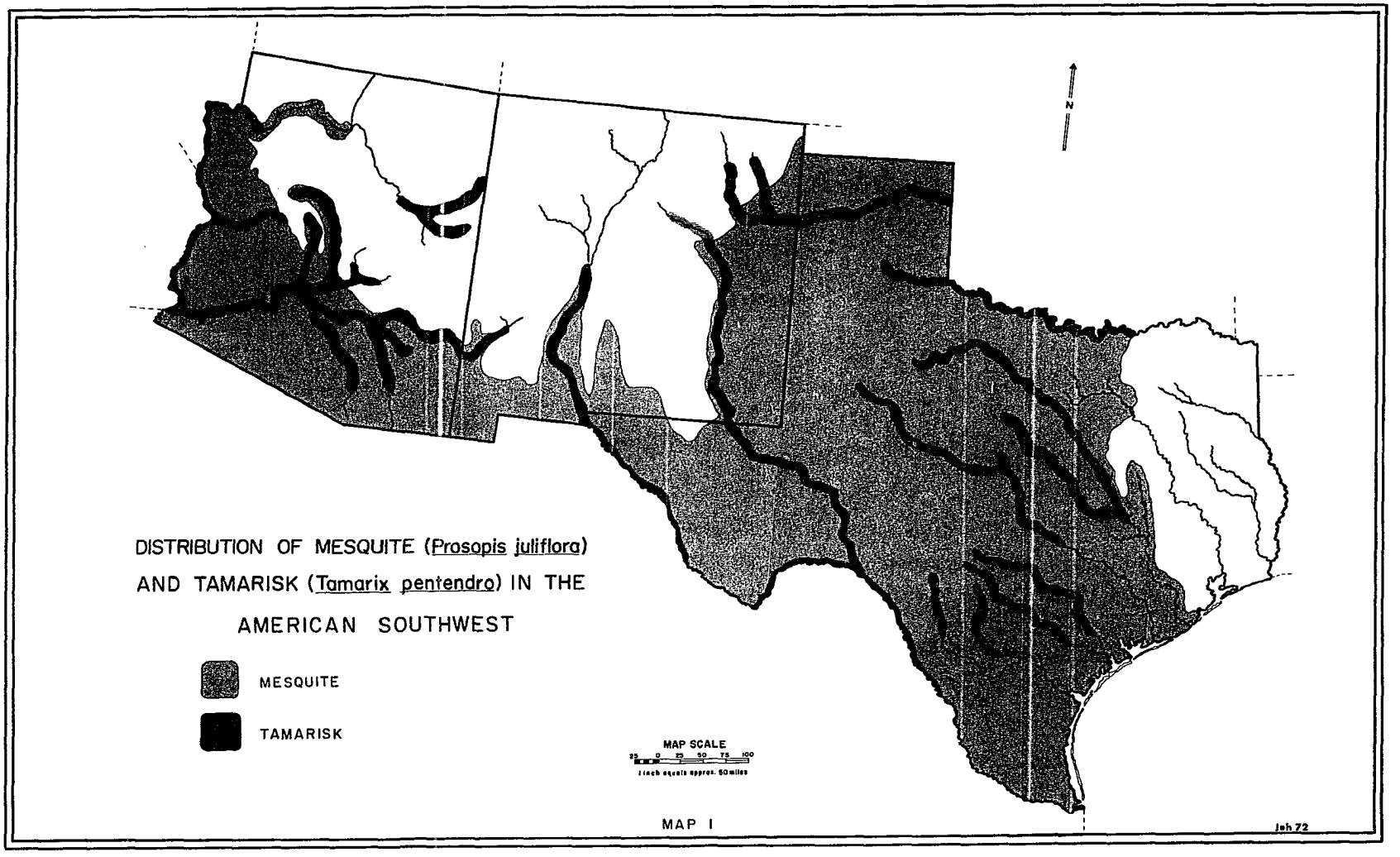
[36]R. R. Humphrey, "The Desert Grassland: A History of Vegetational Change and an Analysis of Causes," The Botanical Review, XXIV, 1958, pp. 198-217.

[37]J. T. Peacock and C. McMillan, "Ecotypic Differentiation in Prosopis (Mesquite)," Ecology, XLVI, 1964, pp. 35-51.


DISTRIBUTION OF MESQUITE (Prosopis juliflora)
AND TAMARISK (Tamarix pentendra) IN THE
AMERICAN SOUTHWEST
MESQUITE
TAMARISK
MAP SCALE
25 0 25 50 75 100
1 inch equals approx. 50 miles
N
MAP I
Jeh 72

the San Pedro in New Mexico. The Tularosa Basin in New Mexico has been seriously affected.[38]

Juniper

Less extensive, but nevertheless serious, has been the spread of juniper. Like mesquite, juniper develops an extensive root system and is drought tolerant. It grows as a small tree or shrub. Juniper leaves are small and tough and the seeds are contained singularly within berries. Unlike mesquite, juniper is an evergreen. Although there are five species of juniper that may be found in the American Southwest, only two, Utah juniper (Juniperus oteosperma), and the one-seed juniper (Juniperus monosperma) are in abundance. The one-seed juniper is by far the most common variety and, therefore, is of primary concern in the arid and semiarid American Southwest.[39]

The causes of the spread of juniper are much the same as those for mesquite. Animal dispersal of the seeds would seem to be a factor since the berries are attractive to a wide variety of birds and browsing animals. Since

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[38]U. S. Department of Agriculture, The Mesquite Problem on Southern Arizona Ranges by K. W. Parker and S. C. Martin Circular No. 908 (Washington, D.C. Printing Office), 1952.

[39]See for example: University of Arizona Agricultural Experiment Station, The Natural Vegetation of Arizona by A. A. Nichol, No. 127, Tuscon: University of Arizona Press, 1952, pp. 197-200; E. F. Catetter, "The Vegetation of New Mexico," New Mexico Quarterly, XXVI, 1956, pp. 270-272; N. Johnsen, Jr., Ecological Monographs, XXXII, 1962, pp. 187-207.

juniper berries are a favorite of birds as well as mammals, it would seem unlikely that the recent, observed spread could be attributed entirely to seed dispersal by mammals alone.

Overgrazing has so weakened the grass cover that juniper, like the mesquite, has been able to establish itself into a permanent stand. Going hand-in-hand with overgrazing has been the suppression of the former burning. Once again, the periodic fires tended to control the spread of juniper by killing the young seedlings before a stand could be established. Also, climatic fluctuations have served the same purpose in the case of the juniper. Combined, these factors have served effectively to weaken the grass cover and permit the extension of juniper over a considerable area.

The environmental demands of juniper tend to limit its spread. This limiting factor is associated with the fact that juniper thrives best in the upland areas on slopes of 4,500 to 6,500 feet and to a lesser extent in the Great Plains area at elevations of 1,000 to 3,000 feet. Rather than invading the pure grasslands, as is the case with mesquite, juniper seems to be associated with the pinon-juniper woodlands where the juniper steadily gains in dominance. In areas of pure grassland, the juniper will invade if the grass cover has been seriously weakened.

In these areas, however, juniper seems not to be able to compete with the mesquite, except in those areas where the frost-free period is less than 200 days. Admittedly, juniper does not present as great a problem as mesquite, primarily because it is normally restricted to upland areas. Even so, as the pressure upon the land increases it is reasonable to assume that juniper will increase because of reduced competition from the grasses.

Tamarisk, Big Sagebrush, Creosote Bush

Southwestern plant invasions have not been limited to mesquite and juniper. Chief among the varieties that have been noted as spreading are tamarisk or salt cedar (Tamarix pentendro), big sagebrush (Artemisia tridentata), and creosote bush (Larrea divaricata). Of these three species, tamarisk probably shows the most dramatic example of recent invasions. Tamarisk or salt cedar is an exotic to the United States, having its origins in Eurasia and being introduced into this country chiefly as an ornamental plant. Of all the plant varieties that have been spreading in the arid and semiarid American Southwest, tamarisk has the most limited distribution since it is confined chiefly within the stream courses.

Tamarisk presents, once again, a case in which man has been the chief causitive agent of the recent spread. By the systemic clearing of the native species along the

stream courses, such as cottonwood, (Populus spp.), willow (Salix spp.), and greasewood (Sarcobatus vermiculatus), the windborn seeds of the introduced tamarisk were able to establish themselves and produce the characteristic dense, almost jungle-like thickets that are very resistant to re-occupation by other species. Furthermore, the salt cedar is one of the heaviest users of water and transpires hugh quantities.[40] Needless to say, this is a loss that is most serious in the American Southwest. Although cattle will, if nothing else is available, browse on young tamarisk shoots, the dense mature stands are impenetrable and, as a result, offer little useable feed for cattle.[41] The present distribution of the tamarisk is shown in map 1.

Other plant invaders include big sagebrush and creosote bush which have spread over enormous areas of American Southwestern desert grassland. These shrubby species have been present in the American Southwest for many millennia but only recently have they begun to move into open grassland areas. Here again, the factors contributing to these invasions are overgrazing and the cessation of the grass

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[40]J. P. Decker, W. G. Gaylor, and F. D. Cole, "Measuring Transpiration of Undisturbed Tamarisk Shrubs," Plant Physiology, XXXVII, 1962, p. 394.

[41]U. S. Department of Agriculture, Utilization of Five-Stamen Tamarisk by Cattle by H. L. Gary, Forest Service Rocky Mountain Forest and Range Experiment Station Notes, No. 51 (Washington, D. C.: Government Printing Office), 1960, pp. 1-4.

fires that once served as a control. Cattle dispersal of the seed is not a major factor since these species are seldom browsed by cattle, owing either to spines, foul taste, or, in the case of burroweed (Haplopappus spp.), a high degree of poisoning. With heavy pressure placed upon the grasses by cattle, the woody plants that are seldom browsed are able to invade and, eventually, establish viable communities.

It is obvious, then, that man and his system of land-use has been the major culprit in the rapid vegetation transformations that have seriously damaged the productive potential of greater parts of the American Southwest. The problem has been over a century in developing. Whatever the time span, the fact remains that most of the American Southwestern range has been seriously affected and is now capable of producing less than in former years. Population and its demand for the productive output from these areas has greatly increased. There is, however, reason for optimism if man begins to take productive advantage of his mistakes. This demands that the present dependence upon cattle and other grazing animals in the American Southwest be re-evaluated in order to conform to the fact that there are millions of acres of high grade vegetation that is not presently being used for any useful purpose. One brief example will serve to illustrate the point. Martin has

stated on page thirty-six of his article, "Wanted: A Suitable Herbivore," that a representative sample of the annual production of desert shrub community yields on the average of 1,200 pounds of dry matter per year per acre. This is roughly twice the annual production of most short-grass prairie ranges in the American Southwest. With all of our technology and unquestioned needs of the world population for additional animal protein, it seems somewhat contradictory to continue man's dependence upon a single specie, and not make use of the enormous nutritional potential of the woody vegetation that has invaded most American Southwestern ranges.

CHAPTER IV

Methodology

In order to test the validity of the hypotheses that were stated in Chapter I, the following methodology and procedures were carried out with the findings to be discussed in Chapter V.

For hypothesis I, that is, "Eland would represent additional productive use of existing vegetation, without being directly competitive with cattle," the following tests were performed.

A. Personal observations by the writer, as well as the statements of a number of other individuals concerning the feeding habits of the eland, were made or noted in order to determine if, in fact, the eland was a browser rather than a grazer. Personal observations at the Y. O. Ranch, Mountain Home, Texas, and at World of Animals, Mesquite, Texas, were made. The observations were necessary to determine whether or not the eland's feeding habits had changed as a result of occupying areas outside its native range.

B. If the eland is to be considered as a potential candidate for meat production in the American Southwest, the animal would have to be able to acclimate successfully

to the proposed area of introduction. Available literature was reviewed in order to determine the eland's ability to acclimate to areas outside its native range. The chief sources of information relating to this question were several studies done by the Soviets[42] and information supplied by Mr. Robert Snow, Manager, and Ron White, Game Biologist, of the Y. O. Ranch. Zoo records were not thought adequate due to the fact that the zoo animals were usually carefully fed, sheltered, and otherwise taken from a native setting.

C. Since this revolves around the introduction of the eland into the American Southwest as a potential meat producer, determination of the browsing preferences was considered essential. Toward this end, the eland at the Y. O. Ranch were observed for a total of six days on two separate occasions.[43] Feed (browse) preference was recorded as well as the vertical height or browsing limit. Since eland, like most animals, seem to favor a small number of species of browse, observations were geared toward determining the chief browse species.

D. Distribution maps of the chief browse species were prepared in order to determine the area that would most nearly fit the browse requirements of the eland.

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[42]V. Treus and N. Lobonar, op. cit., pp. 130-140.

[43]January 3-5, 1972 and February 25-27, 1972.

The above procedures gave valuable information in support of the hypothesis. Specifically, these procedures will answer the following questions:

1. Is the eland, when placed in a non-native habitat, a browser rather than a grazer?

2. What are the chief browse preferences of the eland?

3. Do these browse preferences coincide with the major invading plant species?

4. What geographic area in the United States would meet the browse requirements of the eland?

E. The contemporary reappearance of browsing niches in the American Southwest led to the hypothesis that eland would fill an existing vacant niche and, therefore, utilize a source of plant energy that presently is not being utilized to its maximum potential.

In order to test this hypothesis, the following procedures were used:

1. If eland gravitate toward those browse species that are not being utilized by any large herbivore, the eland may be considered as filling a vacant niche.

2. Literature was surveyed in an attempt to determine if any studies had been made which would support or contradict the hypothesis.

3. If the eland's preferred browse coincided with those plant species that comprise the vacant niche,

then it may be assumed that the eland's browse load would tend to stabalize or at least slow down the invasion of these plant species into valuable grasslands.

F. It has been proven that the eland can exist for an indefinite period of time without having to depend upon a source of surface water. This, as previously stated is possible because the eland has the ability to gain sufficient moisture from its daily browse. In order to test hypothesis III, the following tests were performed:

1. Samples of the eland's preferred browse were collected and weighed. Sample weights were recorded according to species. These samples were then oven-dried at 200°F for a period of twenty-four hours. Dried samples were weighed and recorded. Dry weights of each sample were subtracted from the green weights. The remainder was then converted to a percentage of the green weight and assumed to represent the moisture content of each specie.

2. Taylor has demonstrated that the eland requires from 3.5-5.3 liters of water per day per 100kg of body weight. Furthermore, he has shown that so long as the average moisture content of the daily browse ration is at least 40 percent by weight, the eland can exist indefinitely from the moisture contained

in its feed.[44] It was assumed that the water requirements of the eland as established by Taylor would not differ significantly for animals that are found at the Y. O. Ranch. Therefore, to test the third hypothesis, the moisture content of the collected browse species were compared to the known moisture requirements of the eland in order to determine if the eland could gain the needed moisture for survival.

It must be pointed out that the foregoing procedures were designed to test, in a literal sense, the hypotheses. A great many questions remain unanswered. For any scheme that calls for exotic introduction, the number of ecologic variables is beyond the scope of any one study; this one is no exception. Quite simply, our knowledge of ecological conditions is not yet great enough nor sophisticated enough to identify all of the operating variables. Time will be the ultimate test of the soundness of using the eland as a meat producer in the American Southwest.

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[44]C. R. Taylor, op. cit., pp. 89-95.

CHAPTER V

Findings

Rare indeed is the sportsman in Texas that has not heard of the Y. O. Ranch. For almost a decade the Y. O. has been the center for exotic game breeding in the American Southwest and has been instrumental in several massive breeding programs designed to furnish animals for several world areas. Most notable is the part that the Y. O. played in restocking India with Y. O. bred, Indian blackbuck antelope (Antilope cervicapra).

At present the Y. O. is owned by Charles Schreiner. He inherited the Y. O. in 1933 and has managed to turn the ranch into a highly profitable business, based primarily upon exotic game animals. The Y. O. of today is only a shadow of its former size, 550,000 acres in 1918. The great reduction in size has come from land being distributed among heirs and several land sales.[45] The Y. O. now covers 77,000 acres.

The Y. O. is located in Kerr County, approximately sixty miles west of Fredericksburg, Texas, in the west central

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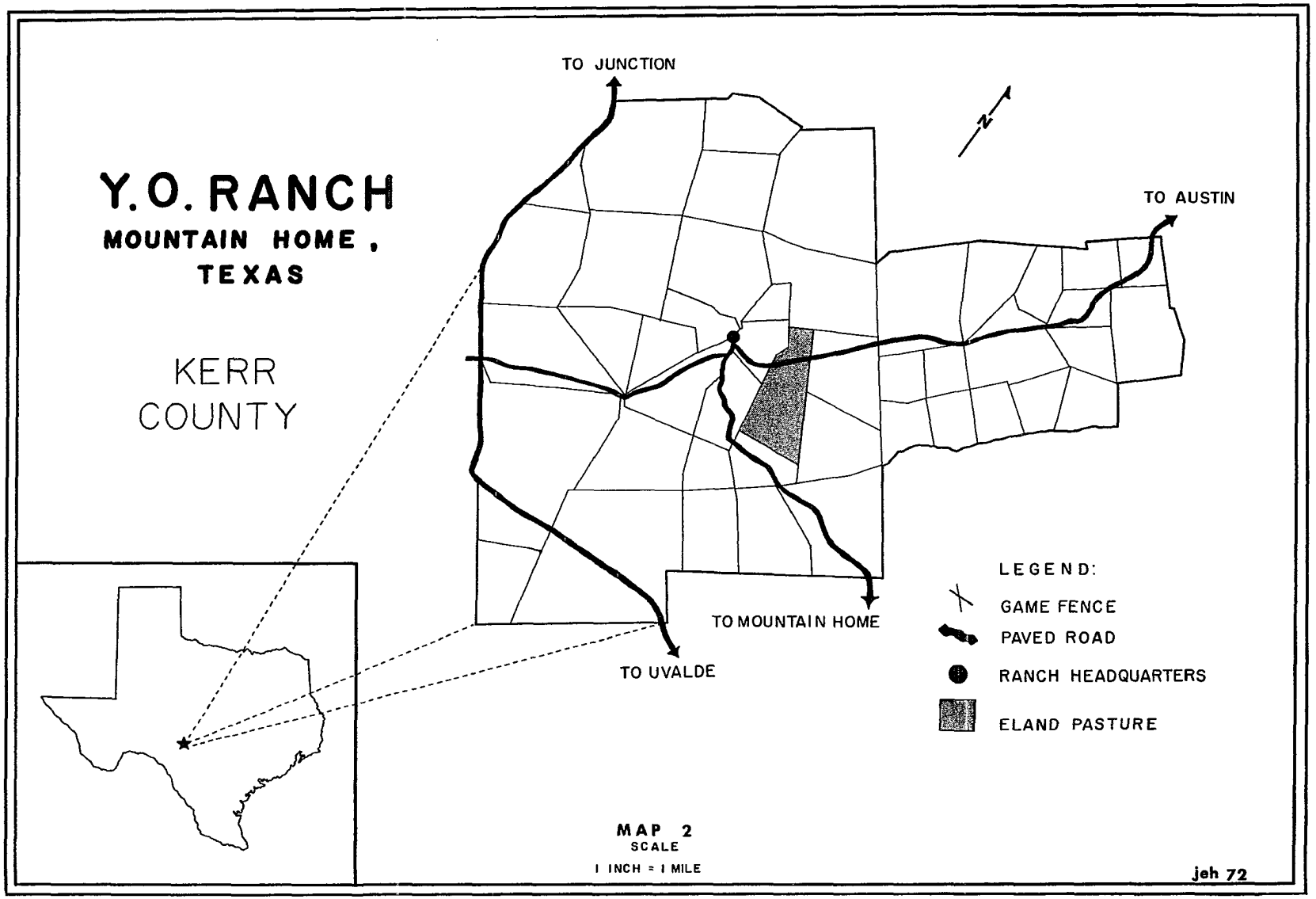
[45]Charles Schreiner, "Personal Interview," Y. O. Ranch, January 3, 1972.

portion of the Edwards Plateau (Map 2). The land is deeply eroded with frequent rock outcroppings. As with most of the Edwards Plateau, the vegetation cover is primarily brush and is dominated by live oak (Quercus virginana) with cedar (Juniperus mexicana), shin oak (Quercus breviloba), and mesquite (Prosopis juliflora glandulosa) covering large areas (Fig. 4). Mesquite is located primarily in the bottoms and is not a dominate part of the vegetation landscape (Fig. 5).

Fig. 4.--Live Oak Dominated Landscape

The exotic wildlife found at the Y. O. include several of the deer species, several sheep species, and four species of antelope, including a herd of twenty-two eland (Table 1).


Y.O. RANCH
MOUNTAIN HOME, TEXAS
KERR COUNTY
TO JUNCTION
TO AUSTIN
TO MOUNTAIN HOME
TO UVALDE
N
LEGEND:
GAME FENCE
PAVED ROAD
RANCH HEADQUARTERS
ELAND PASTURE
MAP 2
SCALE
1 INCH = 1 MILE
jeh 72

The eland was introduced to the Y. O. in early 1961. Since that time additional eland have been purchased from zoos. In 1963, the first eland was born on the Y. O. and the herd has been increasing steadily. It is interesting to note, according to Schreiner and Ron White, Y. O. game biologist, that there are animals from four continents represented at the Y. O. and all have bred well and successfully adjusted to their new habitat.

Fig. 5.--Mesquite Thickets along Stream Courses

Feeding Habits

The first thing to be determined was that the eland on the Y. O. Ranch were browsers rather than grazers. As stated previously, the determination was thought

necessary because there is always the remote possibility that the feeding habits of an animal could change from one habitat to another. On every occasion except one, the eland were noted as browsing. The exception was a yearling, on the afternoon of February 25. He was observed briefly grazing on dry grass. Interviews with the Y. O. Ranch staff verified the author's observations. In short, the eland is a browser, both in his native range[46] and at the Y. O.

TABLE 1

Exotic Species at the Y. O. Ranch, Mountain Home, Texas

Aoudad (Ammotragus lervia)
Axis Deer (Axis axis)
Blackbuck (Antilope cervicapra)
Corsican Sheep (Ovis musimon)
Eland (Taurotragus oryx)
Fallow Deer (Dama dama)
Ibex (Capra sibirica)
Kudu, Greater (Strepsiceros strepsiceros)
Oryx (Oryx beisa)
Sable Antelope (Hippotragus niger)
Sika Deer (Cervus nippon)
Zebra, Common (Equus burchelli)

While observing the eland feeding, a most interesting fact came to light that had not been fully reported in the literature. Except for the older, more mature trees in

[46]Guggisberg, op. cit., p. 10; Taylor, op. cit., p. 95; David Hopcraft, "Personal Letter," Athi, Kenya, March 1, 1971.

the eland pasture, nearly all the trees, especially the live oaks, appeared to have been topped or broken off about five and one-half to six feet from the ground (Fig. 6). Upon questioning, White indicated that the trees had been broken off by the eland. It seems that the eland, in an attempt to reach the upper branches, will fork the tree with their horns and literally twist the top portion of the tree until it breaks. After breaking the top out of the tree or bush, the eland will then feed upon the leaves, green shoots, branches, and small limbs. Repeatedly this writer watched this and the strength of these animals. Such wholesale destruction of young trees seemed to cast serious doubt upon the entire concept of using eland on a large scale for meat production. Upon closer inspection and lengthy talks with Schreiner and White, the apparent destruction caused by the eland turned out to be a great help for nearly all other forms of wild-life. When the eland topped a small tree or bush, the immediate result is that the plant will drop its leaves after a few weeks and appear to be dead. The leaves are lost due to the fact that the plant in question has undergone a considerable shock. The tree, however, is not dead and will put out leaves and new shoots the following season. After being topped the tree spreads out considerably at the base instead of attaining normal vertical growth.

This fact has several important implications. First, when the new growth appears, it is at a level that is low enough to fall within the browsing limits of the smaller browsers such as deer and goats. Also, the eland, when it tops a tree, forces the growth to take place at a lower level and, therefore, effectively causes the greater part of the plant biomass to remain within its vertical browsing limits of nine to ten feet. Wilson reports that eland use their horns for breaking branches to feed on the top parts of a tree.[47] Although Wilson does not specifically mention eland completely topping a tree, it can be assumed that the eland observed at the Y. O. are exhibiting a normal feeding pattern rather than reacting in a totally unique manner to a new habitat. Where the browse is low enough for eland to feed, they do not attempt to break out the tops or upper branches and will browse from tree to tree or bush to bush. With the exception of breaking the tops from trees and bushes, the feeding habits of the eland do not outwardly differ from other browsing species. White reports that during the spring when the grasses are getting green and moisture laden, the eland will "occasionally

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[47]Vivian J. Wilson, "Eland in Eastern Zambia," Arnoldia, IV (12), 1969, p. 8.

graze for short periods of time."[48] This may be verified by reports from several other authorities.[49]

Fig. 6.--Live Oak (Quercus virginiana) after being topped and browsed by Eland

Browse Preferences

Table 2 shows the plant species that the eland at the Y. O. Ranch were observed to be feeding upon. Live oak (Quercus virginiana) was greatly favored by all the animals followed by cedar (Juniperus mexicana) and mesquite

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[48]Ron White, Game Biologist Y. O. Ranch, "Personal Interview," February 25, 1972.

[49]Guggisberg, op. cit., p. 10; Wilson, op. cit., p. 8; Blankenship, op. cit.; Treus and Lobonar, op. cit., p. 135.

beans[50] (Prosopis juliflora). The young animals (approximately one year) were seen to briefly feed on a great number of different species, including grasses. Even the young, however, favored the leaves and green stems of the live oak. White reported that the Y. O. eland have been observed eating prickly pear (Opuntia atrospino). While there is no reason to dispute this report, it can not be verified by direct observations.

TABLE 2

Eland Browse at the Y. O. Ranch (observed)

Live Oak (Quercus virginiana)*
Live Oak, Acrons (Quercus virginiana)
Red Cedar (Juniperus lucayana)*
Rock Cedar (Juniperus mexicana)*
Mesquite (Prosopis juliflora glandulosa)*+
Mesquite, Beans (Prosopis juliflora glandulosa)*
Prickly Pear (Opuntia atrospina)
Shin Oak (Quercus breviloba)+
Shin Oak, Acrons (Quercus breviloba)
Chinkapin Oak (Quercus muehenbergii)+
Chinkapin Oak, Acrons (Quercus muehenbergii)
Post Oak (Quercus stellata)+
Post Oak, Acrons (Quercus stellata)

*Indicates a preferred browse specie.
+Indicates a seasonal specie.

As mentioned earlier in this chapter, live oak is the dominant browse species found on the Y. O. Ranch (Fig. 7).

[50]During time of field observations, mesquite were not leafed-out.

Dominance, plus the fact that live oak remains leafed-out and green all year should partially explain the eland's preference for this particular species. During the winter months at the Y. O., the live oak is one of only a few species that remains green.

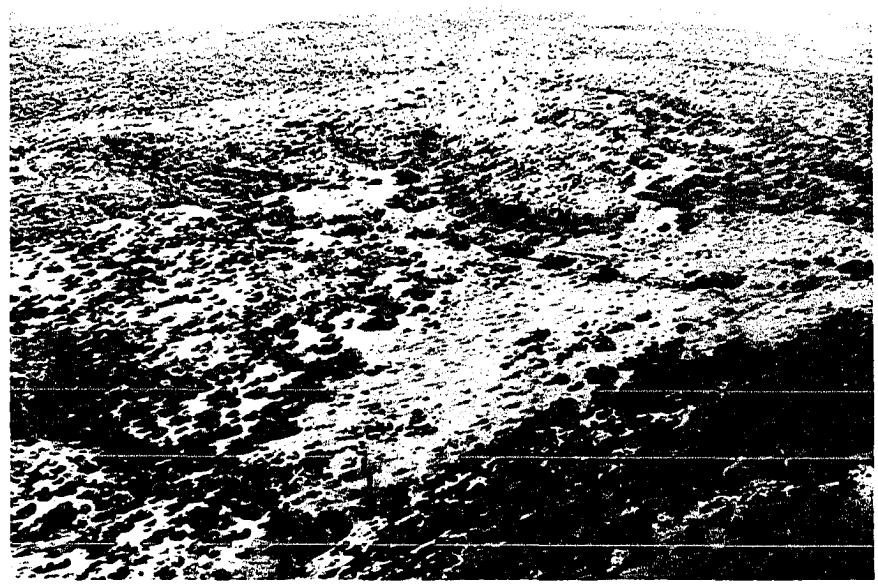

Fig. 7.--Aerial View of Y. O. Ranch

When questioned about the browse preferences of the eland, White indicated that live oak, cedar and mesquite were most frequently eaten but the animals have been observed, at one time or another, feeding from almost everything on the ranch."[51] This would seem to verify

[51]Ron White, op. cit.

the reports of others [52] as well as the observations of this writer. White also reports that the eland have shown no ill-effects from their varied diet. Since 1961, only one eland has died at the Y. O., a mature cow from undetermined causes.[53] Otherwise, the animals all seem to be in excellent health (Fig. 8).

Fig. 8.--Small Group of Eland at Y. O. Ranch

The eland's ability to utilize a wide range of browse species is certainly not unique to the animals that are found in the American Southwest. Many citations can attest

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[52]Robert Dooley, Wildlife Director, World of Animals, Mesquite, Texas, "Telephone Interview," February 21, 1972; Wilson, op. cit., p. 8; Guggisberg, op. cit., p. 10.

[53]Charles Schreiner, op. cit.

to this fact.[54] For a more complete picture of the eland's varied diet, Table 3 lists the identified stomach contents of forth eland, male and female, that were killed in Eastern Zambia. These animals were killed for the purpose of curbing the spread of tsetse flies (Glossina morsitans).[55] The plant species listed in the table represent only those found in the stomachs of all animals; species found in only a few animals are not listed. While there was no attempt to quantify these stomach contents, Wilson reports that Combretum molle, Acacia tortilis, and Piliostigma thonningii were found in large quantities. Although grass was found in the stomachs of all animals killed, it represented a very small fraction and no attempt was made at species identification.

White indicated that the Y. O. eland were fed commercial range cake or pellets approximately every two weeks. The cake or pellets are scattered over a small area near the gate to the 2,000 acre eland pen. This feed is used only to bring the eland in and keep them use to the ranch personnel. Since only a very small amount of feed is distributed, approximately fifty pounds, it can be assumed that the eland are gaining all necessary nourishment from the browse and the small amount of feed that is

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[54]Guggisberg, op. cit., p. 10; Wilson, op. cit., p. 8.

[55]Wilson, op. cit., p. 2.

distributed to them is not a key factor in their dietiary requirements.

Acclimation

One important question that must be answered before any scheme dealing with wildlife introductions can be analyzed is the animal's ability to acclimate successfully to a new and different set of environmental conditions. With respect to the eland in the American Southwest, the question may be answered in the affirmative.

TABLE 3

African Plant Species Identified from Stomach Contents of Eland[56]

Acacia tortilis*
Acaccia nigrescens
Albizzia harveyi
Bauhinia petersiana
Burkea africana
Capparis tomentosa
Combretum mossambicense
Combretum zeyheri
Combretum molle*
Diplorhynchus condylocarpon
Dolichos vigna
Isoberlinia angolensis
Lonchocarpus capassa
Pavetta crassipes
Piliostigma thonningi*
Pseudolachnostylis maprounefolia
Sclerocarya caffra
Terminalis sericea
Simenia caffra
Grass (specie not identified)

* Indicates those species that were found in considerable abundance in all stomachs.

[56]Wilson, op. cit., p. 8.

In 1961, Charles Schreiner brought his first eland from the St. Louis Zoo and placed it on the Y. O. Ranch. This animal, a female named Susie, has received no special care, diet, or shelter and is still alive and healthy (Fig. 9). Since 1961, other eland have been purchased from a variety of zoos and have been actively breeding since 1963. Y. O. personnel all agreed that the eland has proven to be vevy successful in adapting to the ranch conditions and have presented no unusual problems.[57] This is in accord with the Soviet experiences with the eland. Treus has reported that the eland, after being imported into the Ukraine in the late 1890's, have done very well and are reproducing at a normal rate.[58] Robert Dooley, Wildlife Director for World of Animals, Mesquite, Texas, reported that the eland were doing "very well" and presented no special problems.[59] This report was verified by direct observation on March 4, 1972, and the eland did, in fact, appear to be quite healthy. It should be noted, however, that these animals are confined to a very small area (less than two acres), cannot browse because of a lack of vegetation and are sheltered. While the World of Animals is an interesting place to visit, the

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[57]Robert Snow, Manager of Y. O. Ranch, "Personal Interview," January 3, 1972.

[58]Treus and Lobonar, op. cit., pp. 130-140.

[59]Robert Dooley, op. cit.

setting is zoo-like and does not present the student of animal behavior and physiology an accurate picture of true or natural conditions.

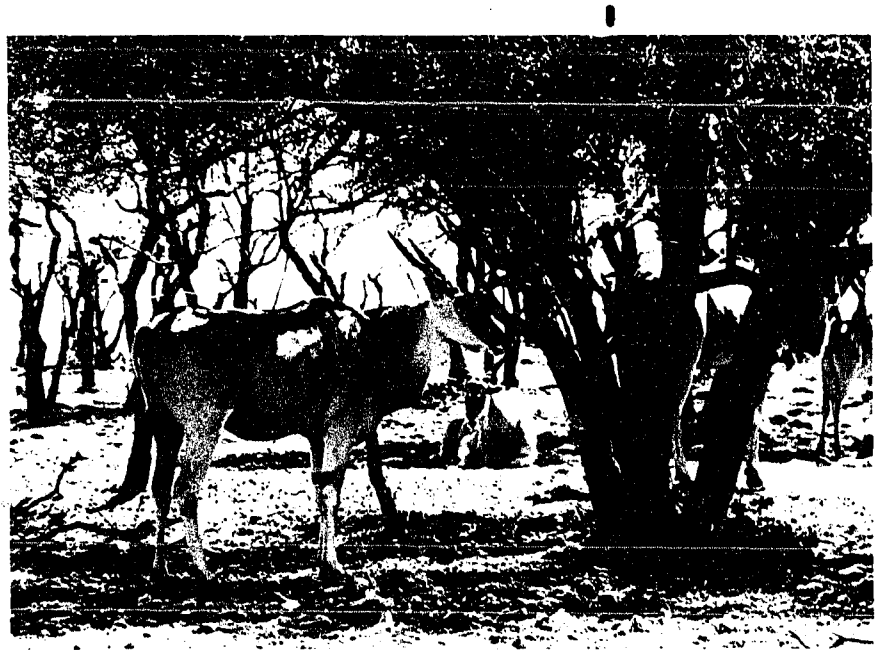

Fig. 9.--Susie, The First Eland Purchased by Y. O. Ranch (Photograph courtesy of Dr. W. E. Dooley)

Even on its native home continent of Africa, the eland presents interesting and informative clues to their native ability to adapt to a wide variety of habitat conditions. The eland could, at one time, be found in almost all parts of Africa, from low rainy areas to the alpine like areas on high mountain slopes.[60] Although eland do

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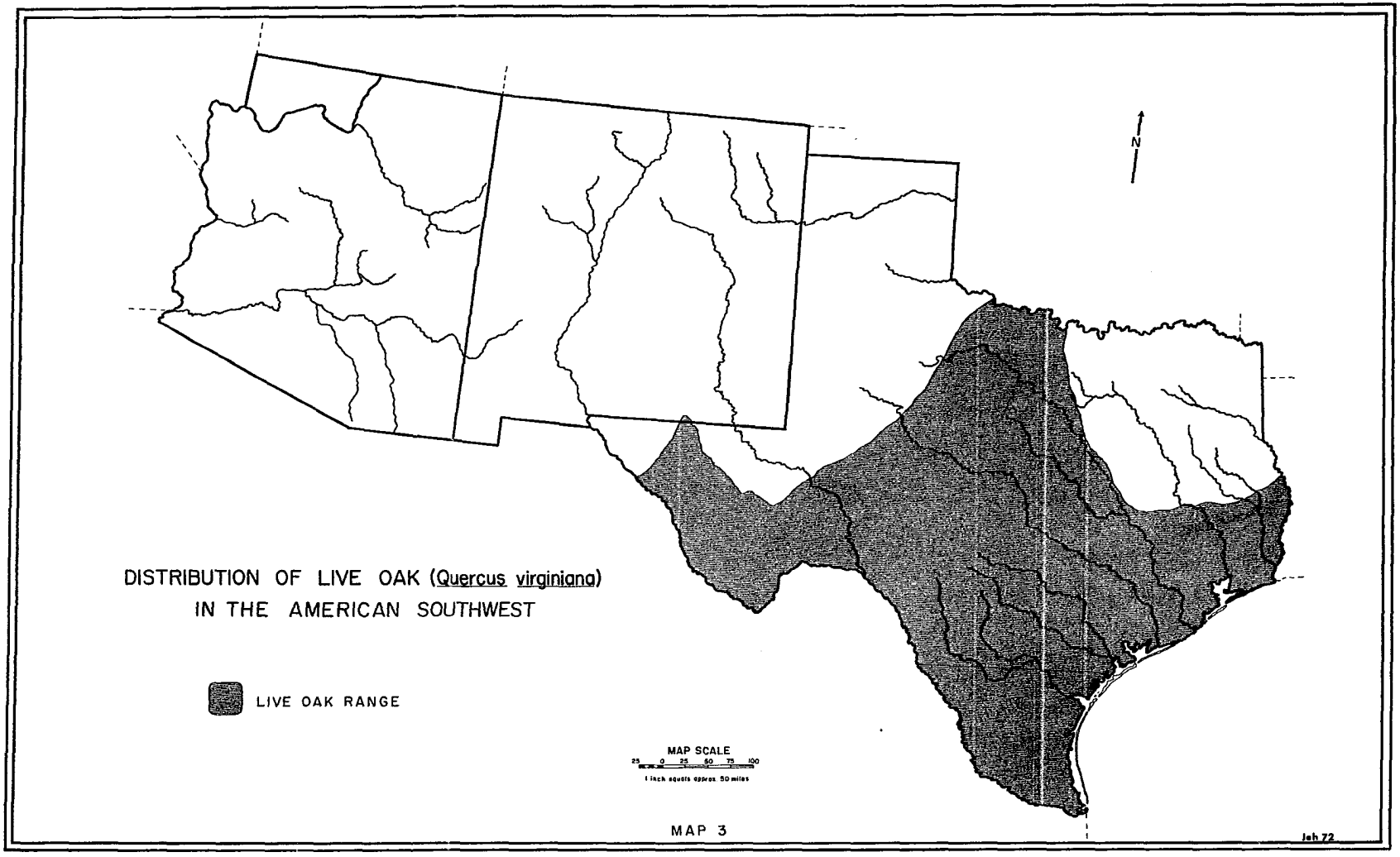
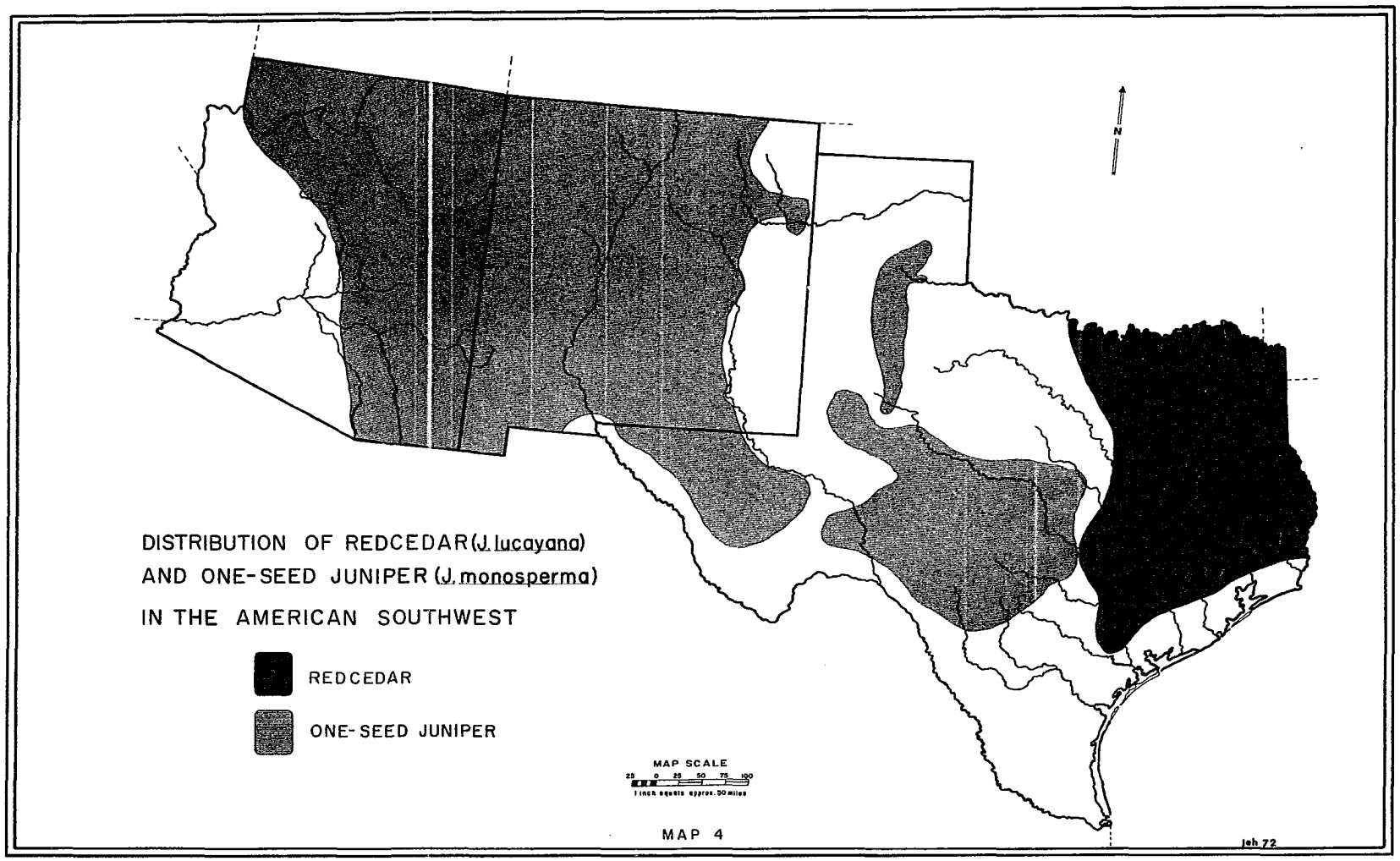
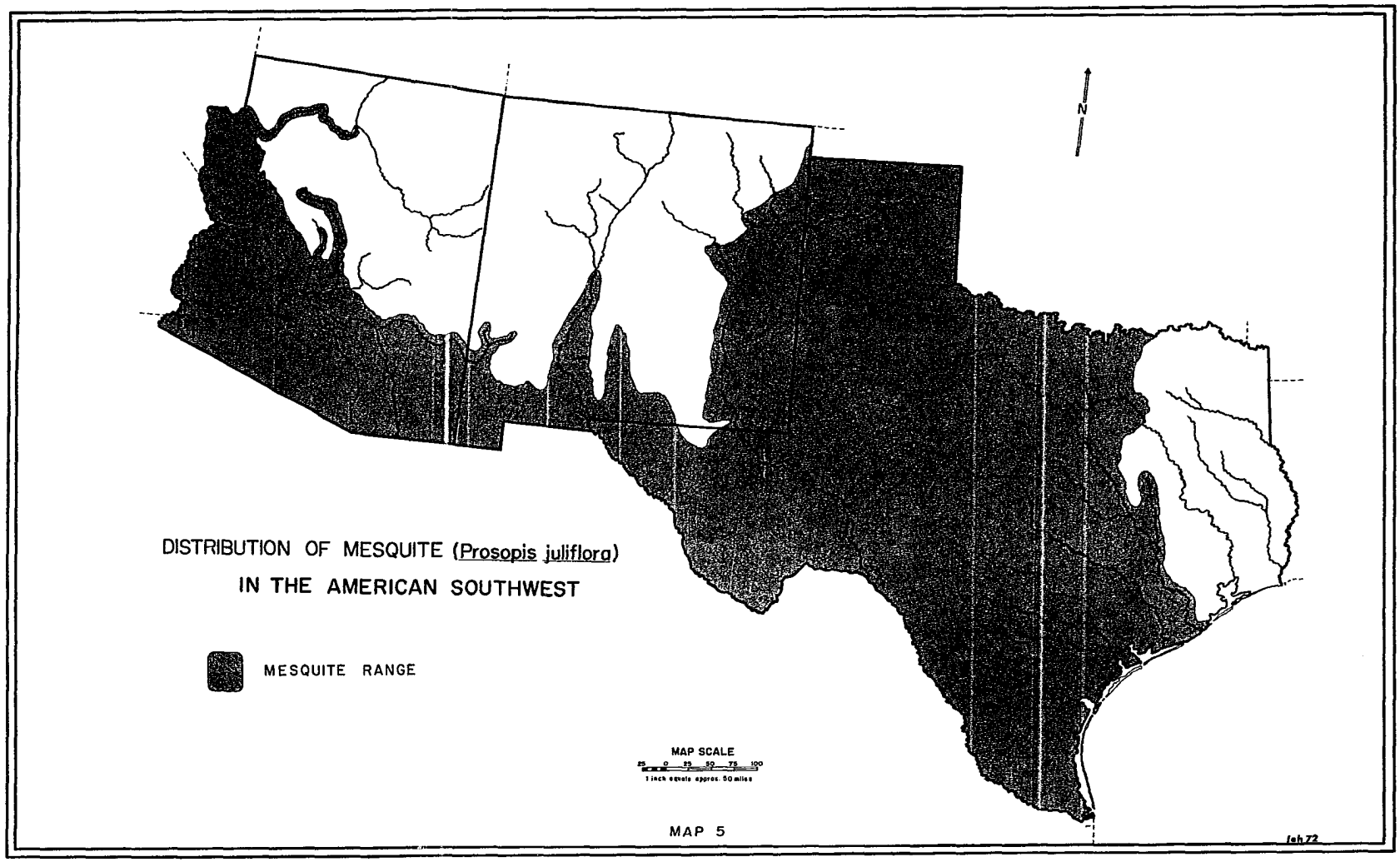
[60]Dasmann, op. cit., p. 75; D. R. Steward and L. M. Talbot, "Census of Wildlife on Serengetti, Mara, and Loita Plains," East African Agriculture and Forestry Journal, XXVIII (1), 1962, pp. 58-60.


N
DISTRIBUTION OF LIVE OAK (Quercus virginiana)
IN THE AMERICAN SOUTHWEST
LIVE OAK RANGE
MAP SCALE
25 0 25 50 75 100
1 inch equals approx. 50 miles
MAP 3
leh 72


DISTRIBUTION OF REDCEDAR (J. lucayana)
AND ONE-SEED JUNIPER (J. monosperma)
IN THE AMERICAN SOUTHWEST
REDCEDAR
ONE-SEED JUNIPER
MAP SCALE
25 0 25 50 75 100
1 inch equals approx. 50 miles
N
MAP 4
Jeh 72


N
DISTRIBUTION OF MESQUITE (Prosopis juliflora)
IN THE AMERICAN SOUTHWEST
MESQUITE RANGE
MAP SCALE
25 0 25 50 75 100
1 inch equals approx. 50 miles
MAP 5
leh 72

seem to favor the drier areas, they are not restricted to dry ranges. It was found that stable herds have been reported in areas that have a yearly average rainfall ranging from 8.15 inches to 75.65 inches, with a yearly average rainfall for 159 stations of 32.91 inches. The temperature tolerance of the eland, like that of rainfall, is quite broad. Eland are established in areas that have yearly average temperatures ranging from 54.70°F to 84.30°F, with a mean temperature of all stations of 67.36°F. There are, of course, a great many factors other than temperature and precipitation that must be considered before an exotic can successfully acclimate, but it would appear that temperature and precipitation would not be a limiting factor for the successful use of eland as a meat producer in the American Southwest.

Maps 3-5 show the distribution within the American Southwest of the eland's chief preferred browse species and serve to show the approximate probable range suitable for introduction. Collectively, these plant species cover most of the respective states. Several of species cover a much larger area than has been mapped but, for the purpose of this study, only Texas (west of the thirty-inch rainfall line), New Mexico, and Arizona have been considered. Also important is the fact that the areas shown in Maps 3-5 closely approximates the areas that have suffered from recent plant invasions (Chapter III) and that the eland

show browse preferences for several of the invading species, most notably the mesquite (Prosopis juliflora).

No definite proof was found to indicate that the eland could or would browse from tamarisk (Tamarix pentendro). It may be assumed that since cattle will feed from young tamarisk, when grass is scarce, that the eland would be able to feed from this particular species also.

Data from this study make it clear that the eland could successfully adapt to most of the vegetation species found in the American Southwest and would represent additional productive use of the existing vegetation. Certainly, the eland's ability to survive under a very wide range of browse conditions indicates that they could be introduced over a much greater area than that considered in this study. It should be pointed out, however, that the eland's specialized physiology, adopted to dry climates, would not be of any particular advantage if they were to be introduced into more humid regions. In the final analysis, it would seem that the eland's range would be limited more by human activity rather than vegetation patterns.

Vacant Niches

Before serious consideration may be given to the use of the eland for meat production in the American Southwest, it must be determined whether or not there is a vacant niche that could be filled. If there is no available niche

that can be filled by the eland, then, if introduction were to proceed, the results could become a very serious problem. In the absence of a suitable niche the eland could simply fail to acclimate properly and would either die-off very quickly or would have to be fed by man. The eland, however, is a hardy animal and would very probably invade an already filled niche and cause serious damage to spread through the food web system. For example, if there were no available niche for the eland in the Edwards Plateau region of Texas, then the eland, if introduced in sufficient numbers, would probably take over the niche structures now occupied by the native whitetail deer (Odocoileus virginianus).

Recent evidence indicates that, over most of the American Southwest and, in fact, over much of the world, there were several waves of megafaunal extinctions which left a large percentage of the niches formerly occupied by large herbivors vacant.[61] The reasons or causes for these extinctions, whether due to climate, man, or both, are unclear. Martin indicates that the

> . . . outstanding features of Pleistocene extinction include the following: (1) It eliminated mainly large terrestrial mammals, with smaller terrestrial vertebrates affected only on certain oceanic islands. (2) The large herbivores (proboscidians, ungulates, perissodatals), plus their associated carnivores,

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[61]Paul S. Martin, op. cit.; Paul S. Martin, "Pleistocene Niches for Alein Animals," BioScience, XX (February 15, 1970) p. 218.

> commensals, scavengers, and parasites, were not replaced by the evolution of new species (for which there was far too little time). There was no replacement by extensive immigration from other regions. Megafaunal extinctions left vacant niches. (3) Massive extinctions took place with variable intensity, apparently striking first in Africa and Southeast Asia roughly 50,000 years ago, later reaching the Americas, and finally within the last 1,000 years sweeping over the larger oceanic islands such as New Zealand and Madagascar. (4) The phenomenon did not leave its mark on either the marine or the terrestrial plant fossil record of the Pleistocene.[62]

Quoting Martin further, he points out that it is not . . .

> possible to recognize any other deterioration of the North American environment, apart from the fact of extinction itself. If the only late Pleistocene fossils known were plants, their pollen, and small vertebrates, I doubt that anyone would have guessed at a major crisis in the life of the large mammals.[63]

There appears to be little doubt that there are a great many unfilled niches in the American Southwest. One has only to look at the abundantly healthy exotics at the Y. O. Ranch and at the very successful exotic introduction program presently being carried on by the New Mexico Game and Fish Department. The animals that have been released in New Mexico have been increasing steadily and there are now limited hunting seasons for several of the species. The point is, that in both cases, the animals are filling vacant niches.

In discussing the study with a great many people, scientist and laymen alike, the writer repeatly was told

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[62]Paul S. Martin, "Pleistocene Niches for Alien Animals," op. cit., p. 218.

[63]Ibid.

that his scheme would greatly upset the natural balance and cause an ecologic disaster akin to the ill-fated Australian experience with introduced rabbits. Certainly there have been ecologic disasters caused by exotic introduction.[64]

Martin, also concerned with these arguments, makes the following statement:

> One serious objection to the introduction of African or Asian exotics has been the belief that the New World fauna of 1492 A.D. was in a natural state, a balance allegedly struck after millions of years of evolutionary adjustment among plants and animals throughout the late Cenozoic. Unaware of the fossil record, conservationists have inferred that new exotics would necessarily crowd native species out of their niches, vulgarize the habitat, and perhaps flood the country-side with an animal as destructive to native vegetation as the rabbit in Australia and the red deer in New Zealand. But even in strictly genealogical terms, it is clear that certain supposedly alien mammals have a valid prior claim to the continent. At higher taxonomic levels, some of the natives are considerably less American than certain foreigners.[65]

The Pleistocene extinctions of large mammals has resulted in a greatly simplified biologic community structure. Also, man's actions in alteration of the landscape has added to the reduced diversity of fauna in the American Southwest. The human introduced replacements for the extinct species have failed to fill completely the

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[64]George Laycock, The Alien Animals, (New York: The Natural History Press), 1966, pp. 132 and 171.

[65]Paul S. Martin, "Pleistocene Niches for Alien Animals," op. cit., p. 218.

existing niche structures. Man has replaced the once diverse herbivore with species not generally suited to the existing vegetation conditions and, more seriously, he has greatly reduced the ecologic efficiency of a vast area; i.e., the American Southwest. Huge quantities of potentially edible natural vegetation is being lost for any productive purpose by the continued enforcement of a greatly simplified biologic community. Evidence in support of the fact that man has forcefully simplified the biologic diversity comes from the fact that those animals that have been carefully introduced into areas such as the Y. O. Ranch, parts of New Mexico, and many other places, have all prospered and have not caused the ecologic disaster that are frequently voiced. These animals are doing nothing more than filling long vacant niches.

Slobodkin lends support to this with the following statement:

> . . . that the more complex a community, in the sense of having a greater number of species and a greater number of interactions between species, the smaller the likelihood that an invader can become established; or, if it becomes established, the smaller the likelihood of its becoming a pest.
>
> The establishment of an invader implies either that the ecological role (or niche) appropriate to the invader was unoccupied in the invaded community, or there had been no natural selection to enforce the most efficient exploitation of the niches by its original occupant. Either condition is less likely in a complex community than in a simple one. The likelihood that an invader will be considered a pest

> increases if it concentrates its ecological effect on one or a few species rather than exerting a small effect on a wide variety of species, and this, again, is more likely in a simple than in a complex community.[66]

The eland at the Y. O. Ranch are confined to an area totaling some 2,000 acres which is sectioned off from the remainder of the ranch by a wire-mesh fence over six feet high. While this small area may not be truly representative of the entire American Southwest, it does offer the student an opportunity to see in operation several of the factors and relationships that have been referred to above.

It has already been stated that the Y. O. Ranch's eland are entirely on their own with respect to gaining the needed nutrition from the available browse and the small amount of feed that they are given does not significantly contribute to their total intake. It may be assumed that these eland have filled an existing niche. Filling a niche, however, can be done at the expense of other species. In this particular case, the only native species that the eland could possible compete with is the whitetail deer (Odocoilous virginianus). Personal observation of the eland pasture as well as interviews with Y. O. personnel indicate that the eland is not a serious competitor with the whitetail deer. In fact, just the opposite seems to have occurred. The eland, with their peculiar habit of

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[66]Lawrence B. Slobodkin, Growth and Regulations of Animal Populations (New York: Holt, Rinehart, and Winston), 1961, pp. 24-25.

topping browse plants, have effectively lowered the browse line so that there is always an abundant supply of edible material available to the deer. With abundant browse available, the deer, which are confined to the same pasture as the eland, would quickly populate to dangerous levels. This is prevented from becoming a reality by thinning the deer population each year during the hunting season.[67]

Aside from the whitetail deer in the eland pasture, there are sika deer (Cervus nippon), fallow deer (Dama dama) and axis deer (Axis axis) (Figs. 10 and 11). Even within the small confines of the eland pasture there appears to be ample browse for all the different species. Furthermore, the eland is a browser while cattle are grazers.

All the available evidence indicates that the original hypothesis was correct in assuming that the eland would fill an existing niche in the area's ecosystem without being competitive with either native wildlife species or domestic cattle.

It could not be proven conclusively that the eland's preferred browse coincided with the invading plant species that were discussed in Chapter III. The chief reason was that the eland available to this writer were located in an area which may or may not have been effected greatly

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[67]Texas Deer Hunting Season, November 15, to January 1.

Fig. 10.--Sika Deer (Cervus nippon)

from these invasions. The eland that were observed did not show mesquite (Prosopis juliflora) as being their chief browse. As has already been noted, there is only a small amount of mesquite at the Y. O. Ranch. Since, however, the eland do frequently eat mesquite and mesquite beans when they are available, it can be assumed that, in those areas where mesquite is dominant, the eland would make use of the mesquite as a source of energy. This would, of course, represent an additional form of land-use

based upon a presently unused source of nutritional energy. The very fact that the eland are browsing on almost everything that grows at the Y. O. Ranch speaks well for this assumption and indicates that they would probably do well in almost any area of the American Southwest. Also, with the eland placing some form of browse load on these unused vegetation species, it may be assumed that the eland would serve to slow-down the rate of new-growth plant invasion currently taking place.

Fig. 11.--Fallow Deer (Dama dama)

One of the most interesting facts associated with the eland is its ability to survive without a source of surface water. In an experiment with the eland and the

oryx (Oryx beisa), Taylor[68] demonstrated that both species could gain all necessary water for survival from the moisture that is contained in their daily browse. Both animals have body mechanisms that reduce the amount of moisture that is lost from the body. These mechanisms include variable body temperatures which prevent the loss of water from evaporative cooling, extremely low water content of the feces, lowered water content of the milk during lactation, and modified respiratory systems which reduce the loss of moisture from respiration to a minimum. Crawford[69] has reported that on the Henderson Ranch, located in Southern Rodesia, eland were gaining weight at one pound per day during serious periods of drought when the cattle were dying; all because the eland could gain sufficient moisture from its daily feed intake whereas the cattle could not.

This ability of the eland, when applied to the arid and semiarid American Southwest could prove to be most important. It is impossible to calculate the total amount of moisture that is contained within the countless tons of vegetation that covers the greater part of the American Southwest. At present, the great majority of this moisture is being lost through evapotranspiration. The eland would,

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[68] C. R. Taylor, op. cit.

[69] S. Crawford, "Wild Protein: A Vital Role for Africa," Animals, XII (December, 1965), p. 542.

therefore, not only make productive use of the vegetation but be able to utilize some of the moisture it contains as well.

In order to test the third hypothesis of this study, samples of the eland's preferred browse were collected, carefully weighed, and dried.[70] Table 4 shows the approximate moisture content of all the vegetation species tested.

Taylor has found that the eland would be able to gain all necessary moisture for survival if the daily browse contained as much as 40 percent moisture by weight. Furthermore, in test with Acacia tortilis he found that even during a severe drought this particular plant specie contained 58 percent water,[71] which would explain how the eland manages to survive the most severe drought.

Using Taylor's figures of 40 percent moisture content needed for survival and comparing it with the moisture contents of the eland's preferred browse, it can be seen that all of the vegetation species tested were well above the minimum level. It should be noted that the moisture content of the various vegetation species will fluctuate from night to day and from month to month. This is caused by changes in both temperature and soil moisture conditions.

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[70]See Chapter IV, page 41, for the procedure.

[71]Taylor, op. cit.

Dr. Bobby J. Ragsdale,[72] Range Specialist, Texas A & M University, stated that the moisture content of practically all plants will remain above 40 percent by weight during the driest periods.

TABLE 4

Moisture Content of Selected Browse+*

Expressed as Percent Moisture

Live Oak (Quercus virginiana)	73.0
Live Oak, Acrons (Quercus virginia)	12.0 (1 year old)
Rock Cedar (Juniperus mexicana)	52.0
Red Cedar (Juniperus lucayana)	58.0
Mesquite (Prosopis juliflora)	70.0
Mesquite, Bean (Prosopis juliflora)	16.0 (1 year old)
Prickly Pear (Opuntia atrospina)	67.0
Shin Oak (Quercus breviloba)	65.0
Shin Oak, Acrons (Quercus breviloba)	10.0 (1 year old)
Chinkapin Oak (Quercus muehlenbergii)	65.0
Chinkapin Oak, Acrons (Quercus muehlenbergii)	No data
Post Oak (Quercus stellata)	70.0
Post Oak, Acrons (Quercus stellata)	10.0 (1 year old)

+ All percentages have been rounded off to the nearest whole number.

* Additional Sources: Texas Agricultural Experiment Station, Composition and Utilization of Range Vegetation of Sutton and Edwards Counties, Bulletin No. 586, College Station, Texas: Agricultural and Mechanical College of Texas, June, 1940, p. 16; and Dr. Bobby J. Ragsdale, Range Specialist, Texas Agricultural and Mechanical University of Texas, "Personal Letter," February 24, 1972.

From this information it can be assumed that the eland could exist in the American Southwest without water so

[72]Bobby J. Ragsdale, "Telephone Interview," February 17, 1972.

long as the browse contained at least 40 percent moisture by weight. This, of course, would enable the eland to utilize a great many areas that are either unavailable to cattle because of a lack of water or are useable by cattle for only the wetter portions of the year.

Upon interviewing both White and Snow, it was learned that the eland at the Y. O. Ranch had never been allowed to go without water. They both indicated that the were aware of Taylor's study and the eland's ability to go without water but were afraid to test these facts with valuable animals when there was no need.[73]

Just as importantly the eland's natural habit of browsing over a very large area would mean that their browse load would be distributed over a much greater area than is the case with cattle. Cattle are not nearly as active as eland and do not naturally move over a great area. This is especially damaging during very dry periods since cattle, not being able to go without water, are forced to remain within a rather narrow radius of a water supply. The result is usually serious overgrazing of a limited area and virtually no pressure placed upon areas that are distant from a source of water.

White indicated that the Y. O. eland are almost always on the move except during the hottest part of the

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[73]Ron White, op. cit.; Robert Snow, op. cit.

day when they will seek shade.[74] This report is confirmed by Taylor.[75] From personal observations of the eland at the Y. O. Ranch, it soon became apparent that they do move about over a very broad area. In fact, they would walk over the entire 2,000 acre pasture during the course of a day. It can only be guessed as to how much area they would cover without being confined inside a fenced pasture. This lends validity to the original thesis that the eland could make productive use of both vegetation and areas that are not being utilized by cattle.

Guggisberg and Blankenship both report that eland can jump a six foot fence with comparative ease.[76] This report of eland behavior cannot be verified by direct observations or by statements from Y. O. Ranch personnel. Schreiner did indicate that the herd bull, San Antonio (Fig. 12), had broken through a fence after being frightened by a gunshot. The bull was quickly returned to the proper pasture after being roped from horseback by one of the ranch personnel. The experiences with eland at the Y. O. Ranch leads one to believe that they could be successfully confined within a desired area so long as there is sufficient browse available. Undoubtedly, however,

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[74]Ron White, op. cit. [75]Taylor, op. cit.

[76]Guggisberg, op. cit.; Blankenship, op. cit.

a six foot fence would be a considerable expense for a prospective eland rancher.

Fig. 12.- San Antonio, Herd Bull

Diseases of the Eland

There are often a great many fears associated with the introduction of an exotic. Many of these fears are related to the possibility that the exotic will either bring in or spread diseases that cause widespread damage and loss to other species. In many cases these fears are entirely well founded. With the eland, however, this is not the case. After consulting with several zoo and

wildlife directors[77] as well as the personnel at the Y. O. Ranch, it may be concluded that the eland present no special or unusual danger from a disease standpoint. They are subject to the same diseases that affect cattle and have proven to be somewhat more resistant. Existing state and federal disease control regulations appear to be entirely adequate in controlling any potential disease problems created by the eland. At present, it would be quite unlikely that the eland could bring into this country any diseases due to the fact that there is a ban upon importing ungulates. All ungulates imported must go to an authorized zoo after spending several weeks in isolation. Any eland purchased by a private individual is second generation or later having been born in this country.

Domestication

After several thousand years of association with the numerous breeds of cattle, man has become accustomed to their presence and generally exhibits no more reaction than a normal respect for a large animal. The eland, however, often presents a different picture. Where the cattle are very familiar sights, the eland is strange and often frightening. The eland is large, fleet, and has menacing horns that could, if the animal were provoked, do considerable damage. Contrary to its appearance, the eland has

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[77]Robert Dooley, op. cit.; Lawrence Curtis, Director of Oklahoma City Zoo, "Personal Interview," April 12, 1971.

Fig. 13.--Eland Become Quite Docile When Domesticated (Photograph courtesy of Dr. W. E. Dooley)

has proven to be very easily domesticated.[78] In fact, the eland at the Y. O. Ranch are very docile animals and can be approached to within a few feet. Susie, the first of the Y. O.'s herd of eland, is very tame and appears to actually enjoy being petted (Figs. 13 and 14). The Soviets have had similar experiences with domesticating eland. They have even gone so far as to selectively breed eland for milk production. While the prospects of milking eland

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[78]Taylor, op. cit.; Guggisberg, op. cit.; Hopcraft, op. cit.; Dasmann, African Game Ranching, op. cit.

[79]Treus and Lobonor, op. cit.; Crawford, op. cit.

for commercial purposes does not enter into this study, it is certainly worth brief comment.

Fig. 14.--Like Cattle, Domesticated Eland May Be Approached Safely

The first eland, four males and four females, were imported to the Ukraine in 1892 and placed in the Askaniya-Nova 200. They have acclimated very well and the herd now numbers in excess of 400. Twenty-one of the Russian-bred animals were trained to tolerate milking. The milk is reported to contain approximately twice as much protein as the milk from conventional domestic cattle and, most importantly, is reported to have a very long shelf-life without refrigeration.[80] Assuming these reports to be

[80]Crawford, op. cit.

correct, the possibility of using eland milk in protein deficient areas of the world where refrigeration facilities are lacking could be very important. Needless to say, the Soviets recognize this potential and are now in the process of deliberate selection for milk as well as meat performance.[81]

Hypotheses Confirmed

Based upon the evidence as presented here, it has been verified that, in general, the original hypotheses, as stated, are valid and representative statements. Needless to say, there are a great many questions unanswered and situations unexplored, most of which can only be subject to speculation until time molds the myriad of diverse facts into some discernable whole. Speculation aside, it can be stated with positive conviction that the eland could make additional productive use of existing vegetation and moisture in the arid and semiarid American Southwest without being directly competitive with already existing forms of livestock. For the student of land-use efficiency the eland would represent a system of double land-use without causing the lasting damage to land and vegetation normally associated with increased productive use of land and vegetation resources.

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[81] Ibid.

CHAPTER VI

Conclusions and Recommendations

With the completion of this study there is little doubt that the eland is a best suited animal for the conditions imposed by the arid and semiarid environment of the American Southwest. It can be concluded from this study that eland could make more efficient use of the existing vegetation of the American Southwest without causing lasting damage to the delicate arid and semiarid communities. this is not to say that cattle should be removed from these areas; any suggestion along this line is unrealistic and fails to take into account the fact that cattle can and do make use of the grasslands whereas the eland could not do so over a long period of time. Also, cattle are the best suited animals in the moderate, well-watered areas. Any future energies must be spent in looking for ways in which to improve our land-use efficiency without having to destroy its biologic diversity, and thus its strength, in the process. This calls for the development of a dual system of land-use, especially in the arid and semiarid American Southwest.

During the course of this study, several individuals after learning something about the eland, remarked something

to the effect that it would be better to try and develop a new animal; an animal that would enjoy the best characteristics of both the cow and the eland. While this may sound reasonable and worth investigation, it is unlikely. First, the literature shows no research or even any mention of such a cross having been attempted. This, of course, does not invalidate the idea. The point is that there is no evidence that would indicate that eland and cattle will breed nor is there any evidence indicating what sort of offspring would be the result. There are probably many basic behavioral and courtship differences that would prevent breeding. One can only speculate, but it appears must likely that even if the eland and cow could breed, the offspring would be a sterile hybrid. The most serious objection to such a scheme has little to do with whether the eland and cow could breed. Rather, it deals with the faulty logic that would make such a cross desirable in the first place. This has been aptly summed up by Crawford.

> One of the major difficulties in bringing a new animal into our domestic stock is that we are inclined to forget the factors really responsible for its excellence in the wild state. For example, in some spontaneous trials on eland utilization, these animals have been placed on grass pastures, an approach unlikely to yield the maximum benefit. Indeed, there is one instance in which five animals became quite ill after living on what was described as an excellent grass field. Of course, this is understandable with animals

> which normally use both grass and browse materials (leaves, twigs, fruits, nuts, and seeds) in their normal diets.[82]

Certainly we could attempt to develop a cross between the cow and eland. Just as certainly, is the fact that any offspring would be something less than the combined total of its genetic parentage. Why take two animals, both superbly adapted to fill specific roles (niches) and attempt to develop something better?

For the same reasons, this writer looks with more than a slight degree of distress upon the Russian experiments with the eland. Without question, selective breeding would (1) produce heavier eland, or (2) eland that give greater quantities of milk, or (3) any number of eland little different from the numerous specialized types of cattle that have been developed. The word specialized is, of course, the key. If eland were selectively bred for special purposes such as meat and/or milk production, almost certainly they would lose their chief point of attraction, namely, their very unspecialized nature and their ability to cope successfully with an amazingly wide range of environmental-feed conditions. One must ask what the point would be when there already exist millions of specialized cattle that could fill the same role, probably better.

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[82] S. Crawford, op. cit.

This study has shown that it is technically feasible that eland could find a niche in the arid and semiarid American Southwest, and that they could make productive use of existing vegetation and moisture. No comment has been made, however, concerning the practicality of such a scheme. Needless to say, there are still a great many questions left unanswered that could influence the outcome.

During the course of this study, several problems did present themselves that justify further comment.

One must fact the fact that the eland's rate of reproduction, even though its gestation period is approximately the same as for the cow, would mean that a number of years would pass before enough animals could be produced to be of any benefit. There are "probably fewer than 300"[83] eland in the entire United States and, with the current U. S. D. A. ban on importation of ungulates it would appear unlikely that this number will increase rapidly. Schreiner indicated that he was aware of the eland's potential as a meat producer and would be willing to devote considerable attention and energies in that direction except for the fact that there simply are not enough animals available. To start such an operation animals must be acquired from the surplus stock of zoos

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[83]Charles Schreiner, op. cit.

and private breeders. He further indicated that most animal suppliers were generally unwilling to sell female eland.[84]

Assuming that herds of sufficient size could be built up, there are numerous problems associated with marketing eland meat. Firstly, there are no present provisions made by the U. S. D. A. for the inspection and grading of the meat. At present, the meat falls under the same rules and regulations as other game species. Certainly, these difficulties apply to a great many other potential foods and could, in time, be overcome.

With any new food, no matter how nutritious, healthful, or tasty, there exist the greatest problem of all; how does one overcome the long-standing food habits and preferences of a potential market population? Few land-owners are going to make the necessary investment in livestock and equipment without being assured of a good market even though they may be personally convniced of the value and utility of the eland. Possibly, eland meat could be marketed through a number of restaurants as an expensive specialty item in the hope that the meat will develop into a highly desirable commodity. Once the meat has established a favorable reputation, and thus a demand, it could be made available on a wider scale. Any wide-scale

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[84] Ibid.

demand for the meat would seem to be sure inducement for land-owners to make the necessary investments. Demands for the product would, hopefully, bring pressure to bear on the U. S. D. A. to make the necessary adjustments in the laws to promote rather than restrict the use of eland as a meat producer. Once in operation such a scheme would have the added advantage of being able to create a market demand at the same time the supply is increasing.

The most serious question relating to the entire proposal is the reaction of the cattlemen and their already well-established and powerful lobbies. In talking with several ranchers (other than the Y. O. personnel) this writer was confronted with everything from outright hostility to blank looks of non-comprehension. In short, the prospect of ranching eland is most often viewed with suspicion as being a potential competitive threat. Without question, this attitude is, in part at least, well-founded. If eland could be placed on range land and utilize the brushy vegetation without having to be fed, then the meat could be sold cheaper than beef and still yield a profit. This would have the potential effect of forcing beef prices down in order to compete. Even though retail beef prices are high, the prices paid the rancher for his beef would represent a serious threat to his entire operation. What most of these individuals fail to understand is the fact that the use of eland as a meat producer

is not proposed as a replacement for cattle operations. Rather, eland would be used alongside cattle in order to utilize vegetation and moisture not utilized by cattle. As already mentioned, this would represent a dual system of land-use and be profitable for the rancher rather than threatening.

In the final analysis, however, the justification for a scheme such as that proposed in this study must come from the needs of a hungry world and increasing population. While the world may feel secure with its familiar and traditional forms of land-use, it may be that they represent an efficiency level related to an era long since past and can be ill-afforded in the future. Men must begin to realize that they are a part of the earth and its natural systems rather than being apart from them and must begin to view their systems of land-use in this light. Men must begin to look toward the future needs of manking and be prepared to make the necessary adjustments in order to meet those needs.

The form of land-use that has been proposed and, hopefully justified, will not meet the entire future needs for animal protein nor will it meet even the present needs. It would, however, make far more efficient use of vast areas that, today, and at best, are being used poorly. The grazing of cattle over much of the American Southwest has resulted in severe damage to both land and vegetation

with a resultant loss in productive potential. The important point to be gained from Chapter III is quite clear; the traditional system of land-use, based primarily upon grazing species of livestock has failed to satisfy the demands of a balanced ecosystem and has resulted in increasing damage and plant invasions. The almost singular dependence upon cattle represents a poor replacement for the extinct species that once roamed the American Southwest.

It is clear from the findings of this study that eland would be a better suited replacement species, especially in arid and semiarid areas of the American Southwest, than cattle and would make much more efficient use of the existing vegetation. By using the existing vegetation there would be little need for the expensive and often ecologically damaging range improvement techniques that are necessary to maintain cattle on the range. Species diversity, both flora and fauna, is the key to maximum energy conversion and community stability. The eland would be a step in the right direction toward achieving species diversity and, thus, maximum yield from our existing vegetation resources.

It is also clear that in order to achieve maximum species diversity and efficiency, a number of other wildlife species would have to be utilized. Investigation could identify a great many of the vacant niches and programs of

exotic introduction could be initiated to ensure that as many niches as possible were filled. Obviously, this would be a massive undertaking and would be met with a great of resistance. It would be, however, an example of the point that this writer is trying to make, namely, that man must begin to look beyond his traditions with a critical eye even if it means massive change. Table 5 shows the estimated amount of animal biomass found in five world areas. Note especially the number of cattle per square mile in Cochise County, Arizona, and the corresponding figures for Tarangire Game Reserve in Tanzania.

This table represents an example of biological efficiency levels and graphically points out that cattle, when placed on an area that is reasonably representative of the greater part of the American Southwest, are very inefficient users of the existing vegetation biomass. With a world population that is increasingly in need of additional animal protein, such inefficiency is difficult to justify.

Dasmann reports that a game cropping program operating on the Henderson Ranch, Rhodesia, yielded a considerably greater profit than the sale of beef.[85] There are numerous other game cropping programs underway in Africa and all show

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[85]R. F. Dasmann and A. S. Mossman, "Commercial Use of Game Animals on an Rhodesian Ranch," Wildlife, III (3) 1961, pp. 7-14.

TABLE 5

Animal Units Per Square Mile[86]

Location	Species	Animal Units Per Square Mile
Cochise County Arizona	Cattle	7
Albert National Park, Congo	Elephant Buffalo Hippopotamus	43
Ngorongoro Crater Tanzania	Zebra Wilderbeest Gazella	35
Tarangire Game Reserve Tanzania	Mixed Game	72
Athi-Kapiti Kenya	Mixed Game	62

similar results.[87] While these programs all are based upon the use of native game species and, therefore, are operating under a different set of conditions than would

[86] F. Bourliere and J. Verschuren, Introduction a L'Ecologie des Ongales du Para National Albert, Institute des Pares Nationaux du Congo Belge, Brussels, 1960; and M. Grizimek, "Census of Plains Animals in the Serengetti National Park," Journal of Wildlife Management, XXIV, 1960, pp. 27-37; and D. R. Stewart and L. M. Talbot, "Serengetti Survey," Africana, (k) 1962, pp. 24-27.

[87] David Hopcraft, "Experiment," Africana, II (6) June, 1965, pp. 5-13.

be operative in the American Southwest, they all point to the fact that wildlife species diversity is a far more efficient system than dependence upon a single species.

Based upon the findings presented in this study, the following recommendations are in order:

1. Research should be carried out with the goal of identifying the available vacant niches that could be filled without disrupting existing systems of land-use.

If efficiency of land-use is to be achieved, it is of vital importance that a full inventory of our land and vegetation resources be made. Furthermore, attempts should be made toward selecting potentially productive animals that would best fill these vacant niches.

2. Market studies should be undertaken in order to determine the most suitable method of marketing eland meat in the United States.

A complete analysis of the potential market is absolutely necessary if land-owners are to become seriously interested in stocking eland.

3. Every attempt should be made to convince ranchers and the public in general of the desirability of more efficient land-use and to dispel the widespread fears relating to controlled exotic introductions.

4. United States Department of Agriculture regulations should be relaxed concerning the importation of potentially

productive ungulates. Of course, the existing quarantine periods should be retained to insure disease control.

5. In order to insure a continued and growing supply of eland, those eland found in zoos should be allowed to breed as frequently as possible.

It has already been pointed out that one of the most serious problems facing the possible implementation of this proposal is a lack of sufficient numbers of animals. There are probably not enough eland in the world to institute such a program within a short period of time, but with the aid of zoos and private breeders, this time lag could be considerably shortened.

6. Using available animals, an experimental ranching program should be started that could serve as a working laboratory. Funding for such a program would probably have to come in the form of a government grant or grants. Also, this operation could be started on federally owned land. This experimental program would have the advantage of being able to research all aspects of the question without having to depend, in the early years at least, upon a virtually non-existent market for the eland meat and would be free to explore both the short and long-range advantages and implications of the program. Universities in the American Southwest which maintain large land-holdings could play a very important role in the implementation of such a program.

Going far beyond the scope but not the intent of this study, a final and most important recommendation is offered that is directedly narrow in its intent but broad in scope and implications.

7. Geographers should make every effort to involve themselves, in a research capacity, in projects that will have practical worth and bearing for mankind. Certainly this is not meant as a blanket indictment of either geographers or their work. It is offered, rather, in the spirit of urgency and concern. The geographer, by the very nature and being of his training, is well equipped to make meaningful contributions toward the rational and ecologically sound use of the earth. Mere description of and adherence to traditional systems will not be enough. In short, the geographer, especially the biogeographer, should work toward becoming predictive rather than merely descriptive. Again, there is nothing wrong with description; it fulfills a vital role and is a most important point of reference. It is, however, simply not enough.

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