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A Comparison of Selected Habitats of Fallow Deer (Dama Dama) in the United States

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A COMPARISON OF SELECTED HABITATS OF FALLOW DEER (*DAMA DAMA*) IN THE UNITED STATES

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A COMPARISON OF SELECTED HABITATS

OF FALLOW DEER (DAMA DAMA)

IN THE UNITED STATES

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INTRODUCTION

Statement of Problem

The introduction of plants and animals to new habitats is as old as the history of man himself. In the earlier days, food supply (semi-domesticated crops and animals) was the motivating force, but as time went by many plants and animals were transplanted to enhance the sport of hunting and/or to add variety to a given flora or fauna. There are few places in the world that do not have some exotic species. With the exception of carnivores and some dangerous herbivores, most species have had some of their number moved away from their natural habitat, to become a part of a different biome, sometimes only temporarily.

The introduction of exotic animals into North America in modern times began when Spanish soldiers unloaded their horses. Since then numerous species have been released in various areas throughout the United States to add to the fauna of that area. One of the most interesting animals introduced to the United States is the fallow deer.

The fallow deer (*Dama dama*) L. is a native of the Mediterranean regions of southern Europe and Asia Minor. It has been introduced to many regions of the world and is now found in a variety of distinctively different habitats.

Considerable information has been recorded in previous accounts of the introduction of fallow deer to different parts of the world, however, much of this information deals only with historic aspects of the stocking of this ungulate or a description of its characteristics. There appears to be no comprehensive study of the geographical distribution of the habitats to which this deer has become adapted. The purpose of this work is to present a descriptive and geographic comparison of some of the physical environments (or habitats) in the United States to which the fallow deer has been successfully introduced. The study was confined to those areas of the United States that have well established herds. Three distinct environments within the United States were studied. Those areas selected were:

1. Western Kentucky's "Land Between the Lakes"
2. The Beaver Creek Valley of Nebraska's Sandhills
3. Texas' "Hill Country" of the Edwards Plateau

Literature Survey

The introduction of fallow deer to regions of the world outside of its native range dates back to the ancient Egyptians, who brought this graceful animal to their homeland and to the Romans, who are said to have introduced it to the British Isles (Goodwin, et al., 1954). Bigalke (1937) gives an account of fallow deer being introduced to the Vereeniging Estates of South Africa in 1914, but mentions little of the habitat into which they are released.

In his article on the deer of the world, Cahalane (1939)

gives the native range of the fallow deer as southern Europe from Portugal to Greece, parts of Asia Minor, the islands of Sardinia and Rhodes, and northwestern Africa. He reports that they have been kept in parks in England for almost 20 centuries since the Romans first introduced them to that island. Cahalane also states that for the last four to five hundred years these deer have been a "living ornament" on every wealthy nobleman's estate. Cahalane describes the characteristics of the species, some of its habits, and locates it as being found in a semi-domesticated state in southern Sweden, in Italy, and in Tasmania. A related species, the Persian fallow deer (Dama mesopotamica) L., is found in the mountains of Iran.

Cabrera and Yepes (1940) describe the introduction of fallow deer to various estates in the vicinity of Buenos Aires, Argentina, in the early 1920's. Ellerman and Morrison-Scott (1951) speak of fallow deer in North Africa but mention no details as to habitat.

Goodwin, et al. (1954) describe the characteristics and habits of fallow deer in Europe and mention some early instances of its introduction to other areas outside of its native range.

De Vos, Manville, and Van Gelder (1956) in their extensive work on exotic mammals give a history of the introduction of fallow deer to various parts of the world. They state that fallow deer were introduced into central Europe during the Middle Ages and that the species is mentioned in Danish literature as early as 1231 A.D. when it was introduced for hunting by Danish kings. Small populations of fallow deer have been in Germany

since the Middle Ages. These animals were introduced into Tasmania in 1829 and now represent the bulk of the deer population on the island. Some of them were later sent to Melbourne and other parts of Australia. In Australia, the deer proved to be very destructive and had to be shot to keep the populations small and manageable. Fallow deer were introduced to New Zealand in 1864, from British stock, for sporting purposes. In about 1890 they were introduced into the Bialowies Forest of western Russia but failed to survive; however, they have survived in other parts of Russia. De Vos, et al. also report that German fallow deer were released between Temuco and Puerto Montt in Chile on various estates during the 1920's. Several accounts were given of fallow deer being introduced to various parts of the United States, but as in the preceding reports, little or no mention was made of the habitats or environments into which they were released.

Bently (1957) gives a brief account of the introduction of fallow deer to Tasmania and Australia. He states the introduction took place about 1850 conflicting with the 1829 date stated by De Vos, et al. (1956).

Flerov (1960) describes the fallow deer in Russia and reports that plains or slightly hilly country with either dense, grassy coves and sparse woods, or brushy areas are its most characteristic habitat.

In describing the dispersal rates of exotics released in New Zealand, Caughley (1963) lists the fallow deer as having a rate of 1/2 mile per year dispersal after their introduction

(studied over a 50 year period).

Howard (1964) describes the effects of introduced animals on the soils and vegetation of New Zealand. He notes that the fallow deer do only moderate damage. Walker (1964) describes the general characteristics and behavior of fallow deer. Davidson (1965) identifies the habitat of fallow deer in New Zealand as being fern, scrub and grassland country, or light forests bordering these. He states that these deer are normally not brush inhabiting animals.

Chapman and Chapman (1969) report on the biology of fallow deer in the Epping Forest near Essex, England. They noted that the food consists mainly of grasses. Other foods listed as being occasionally eaten are acorns, apples, chestnuts, wheat, and the leaves of beech, holly and ivy. Reinhardt and Schenk (1969) report that protective measures must be taken to prevent the extinction on Sardinia of its native fallow deer (only 8 to 12 head remain).

Prins and Geelen (1971) describe the fallow deer habitat of the Kroondomeinen area of the Netherlands as having sandy soil, a mild marine climate (average precipitation 32 inches; average temperature 10.3 degrees C, January 2.2 degrees C), and alternating areas of coniferous woods (Scotch pine), moor, and grass meadows within a 22,000 acre game management area.

History of Fallow Deer in the United States

Fallow deer were brought to the United States during the 1800's for display in zoos and parks. They were not released into the wild until the early 1900's. Presnall (1958)

notes that the first introduction into the wild took place in Western Kentucky about 1900 when they were released on the KentuckyWoodland National Wildlife Refuge in Trigg County, now a part of TVA's Land Between the Lakes. Nall (1971) estimated that the introduction took place about 1920. The exact date of introduction is unknown due to the lack of records being kept. Regardless of conflicting dates, this is the oldest naturalized herd in the United States. It is thought by Nall (1971) that the original herd contained about 24 fallow deer. Nall estimates the present population of this herd to be approximately 1,000 head.

Fallow deer were released in Worcester County, Maryland, between 1920 and 1930. They were also released in Talbot County, Maryland, in about 1945 but very few of these animals remain. In 1930, twelve head were released in Marin County, California, and had increased to a population of about sixty by 1958. In 1937, about twenty head were released in Mendocino County, California, and increased to eighty animals by 1958. In the early 1940's an unknown number of fallow deer escaped from the Hearst Ranch in San Luis Obispo County, California, but have done little more than maintain themselves. Fallow deer were released in Colorado in the late 1920's in Conejos County, about 1935 in Larimer County, and in 1944 in Rio Blanco County near Buford. By 1958 there were between fifty and seventy-five head in Colorado (Presnall, 1958).

With some inaccuracies, Packard (1955) relates the release of white fallow deer in the Beaver Creek Valley of central

Nebraska. He also gives accounts of sightings of fallow deer in several counties to indicate the range of dispersal. The bulk of his short article describes the breeding activities of fallow deer which he observed in 1950 near Petersburg, Nebraska. He also includes a very generalized map showing the distribution in central Nebraska. Presnall (1958) accurately relates this introduction when he describes the release of twenty head in 1939 and fifty-three head in 1940 by ranchers of the Beaver Creek Valley. These deer, all of the white color phase, were obtained from Pioneer Park in Lincoln, Nebraska, and released on the Ray Hall Ranch west of Petersburg in Boone County. They have spread up and down the valley and into neighboring counties. The population had reached between 350 and 400 head by 1958 (Presnall, 1958). The population has declined in recent years for reasons that will be discussed later.

Between 500 and 600 fallow deer were released on the Aransas Peninsula near Corpus Christi on the Texas Gulf Coast during the period from November 1930 to August 1936. These animals came from zoos in Alabama, California, and Wisconsin. By December 1938 only twenty-two of the animals had survived, and they were removed by trapping after the federal government bought the peninsula for a wildlife refuge. The last of the deer were removed by 1941 (Halloran and Howard, 1956).

A small herd of less than fifty fallow deer has barely maintained itself near Camp Gruber in Muskogee County, Oklahoma since 1946. Another small herd has been maintaining itself in Wilcox County, Alabama since 1947. Several small privately

owned herds are reported in New Mexico, but no detailed information was available (Presnall, 1958).

Swigett (1972) reports that the first fallow deer released in Texas were released by Leroy Denman in 1934 on his Black Jack Peninsula Ranch. The first successful stocking probably took place in the early 1950's on the Rickenbacker Ranch in Kerr County (De Vos, et al., 1956). Ramsey (1969) reports that fallow deer have been widely introduced in Texas since 1950. Ramsey noted fourty-three ranches in the state having these deer and estimated the population in 1966 to be approximately 450 head. A more recent survey conducted by the author in August 1972 revealed over 1,100 fallow deer on twenty-six ranches in three Texas counties, Kerr, Real, and Bandera.

Fallow deer were introduced to the island of Martha's Vineyard, Massachusetts in 1932 and appeared to have reached a stabalized number of 150 animals by 1958 (Presnall, 1958). They are said to compete for food with white-tailed deer on the island (De Vos, et al. 1956).

Of the areas mentioned above, three were selected for study in this paper--western Kentucky, central Nebraska, and southcentral Texas. These areas were chosen because they each had well established herds and each was in a different environment. The characteristics of the three areas will be presented for comparative purposes with the native range and with each other.

Field Methods

The information and data presented were collected between September 1971 and September 1972. The three study areas

were visited. Field observations were made by using an automobile or truck on roads through each area and by use of a four-wheel drive vehicle and hiking in the off-road areas. Observations were made at various times of the day and night.

Over three hundred photographs and slides were taken of fallow deer and their habitats in the three study areas. Photographic equipment consisted of 35 mm camera (Nikon and Leica) equipped with a variety of lenses from 35 mm to 1,000 mm in focal length. High intensity strobe lights were used for night photography. Black and white and color films were used.

Game biologists, farmers, ranchers, and residents were interviewed in all three study areas. Soil Conservation Service specialists were interviewed and provided information concerning soils and vegetation of the areas. Local climatic summaries were obtained from stations near the areas of interest.

Hunters were interviewed during the fall hunting season of 1971 at the Land Between the Lakes study area in Kentucky to determine any differences in the habits and sporting qualities between the fallow and the native white-tailed deer.

The remainder of this study will discuss the characteristics of the fallow deer and its native range. This will be followed by a discussion of the three study areas and a comparison of these areas with the native habitat and with each other.

DARK DOCUMENTS "May Not Film Well."

CHAPTER II

GENERAL CHARACTERISTICS

Taxonomic Description

The fallow deer (*Dama dama*) is of the order Artiodactyla, family Cervidas, and genus *Dama*. Two species of fallow deer are now recognized. *Dama dama*, indigenous to the Mediterranean regions of southern Europe and northwest Africa, is the typical species and the most common of the two (Figure 1). Dama mesopotamica, the Persian fallow deer, is native to Iran and other portions of Asia Minor (Dollman, 1962).

Figure 1 Fallow deer in dappled summer pelage (Kentucky Study Area).

In general, the two fallow deer species are similar in appearance. The following description of the genus is of the typical species, Dama dama. The coloration of the body is darkest posteriorly, blending into a black or dark brown stripe extending onto the dorsal surface of the tail. Body coloration gradually becomes lighter toward the abdomen which is buff or white. The underside of the tail is also white. The body is dappled in both the young and adult animals, but the dappledness becomes indistinct in the winter pelage (Figure2). Summer coloration is reddish brown trimmed with white or buff. Winter coloration becomes dark brown trimmed in dark buff or dun. Ramsey (1969) described the coloration as being grayish red or red during the summer and gray or reddish gray during the winter. Cahalane (1939) describes the summer coloration as being yellowish-brown and heavily dappled with white on the back and sides. He describes the Persian fallow deer (Dama mesopotamica) as being larger and more brightly colored than the typical species (Dama dama). Albinism and melanism are so common in fallow deer that they are generally referred to as color phases--the white phase and black (or dark brown) phase (Figure 3). These color phases are not dappled.

All external glands of the animal are strongly developed. Metatarsal glands are padded with a dense cushion of whitish hair and the glands between the toes are deeply set. The preorbital glands are small. The sexual regions of both male and female are characteristically covered with bundles of long hair.

This medium-sized deer ranges in size from about 35 to

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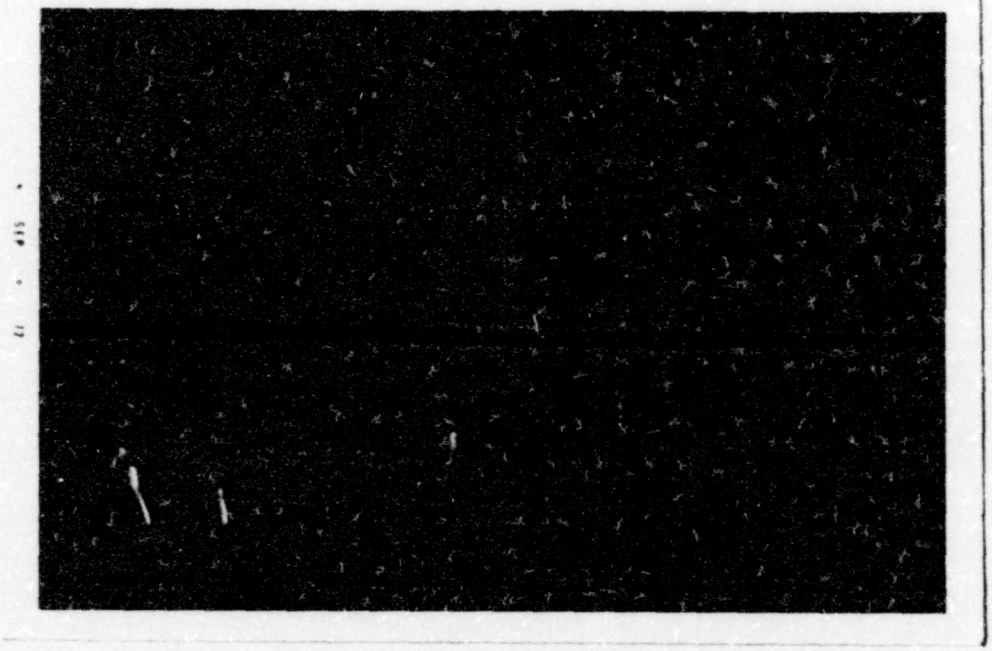


Figure 2 Fallow deer in the winter pelage (Kentucky Study Area).

Figure 3 White fallow deer in Texas.

39 inches in shoulder height, 50 to 63 inches in body and head length, plus about 6 to 7 inches in tail length. Adults range in weight from 80 to 180 pounds (Walker, 1963 and Flerov, 1960). As in most deer, the male is larger than the female.

The male supports large antlers, with many points, which flatten or palmate in about the fourth year. The fallow deer usually shed their antlers from April to June and have a new full-grown set, free of velvet, by August. The length of the antlers of a mature buck ranges from 25 to 37 inches along the outer curve of the beam with a spread between tips of from 12 to 30 inches (Walker, 1964).

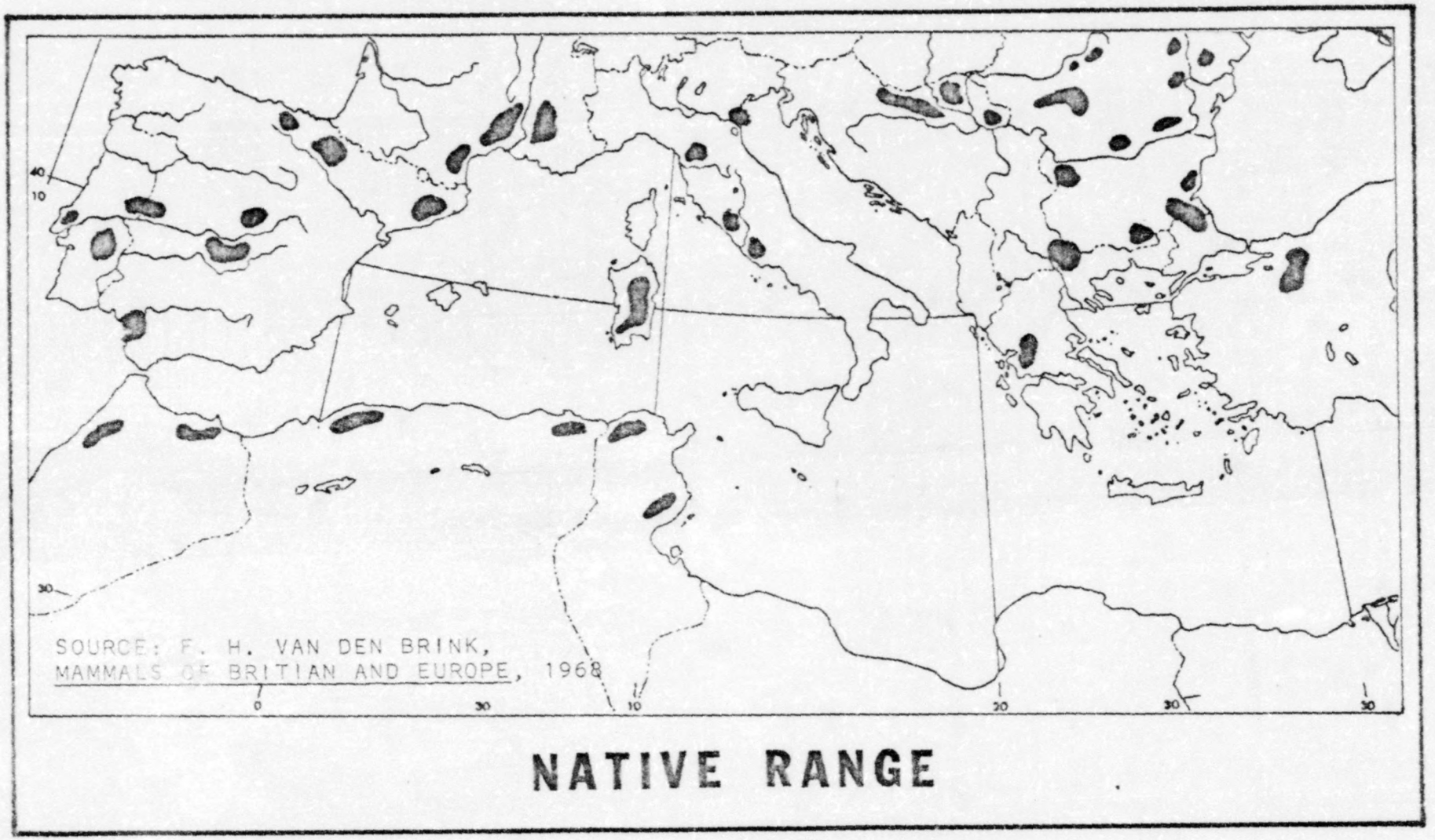
Habitat

The original range of the fallow deer is the Mediterranean regions of southern Europe--from Portugal to Greece, parts of Asia Minor, northwestern Africa, Rhodes and Sardinia, and the mountains of Iran (Cahalane, 1939) (Map 1).

The fallow deer has been widely introduced and has become naturalized in the wild state through much of western Europe, the western Ukraine, the Baltic countries, and in Great Britain where it has been found since the Middle Ages or earlier (Walker, 1964). Since the early 1800's it has been introduced to various areas of Tasmania, Australia, New Zealand, South America, South Africa, and the United States. It has become naturalized in many of these areas (De Vos, et al., 1956) (Map 2).

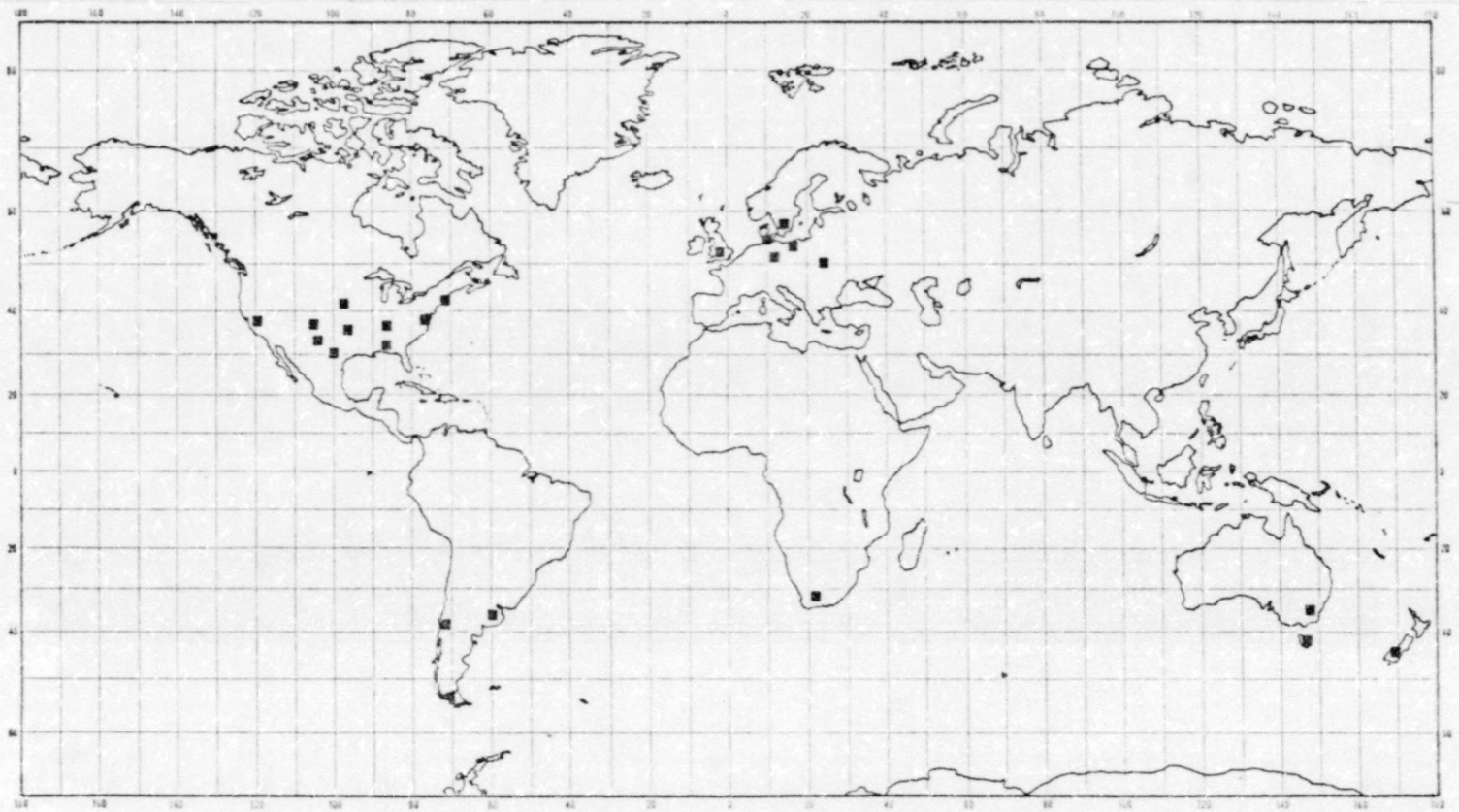
The native habitat of the fallow deer is the Mediterranean lowlands in which two main types of plant communities dominate. These plant communities are frequently identified

MAP 1



NATIVE RANGE

MAP 2



WORLD DISTRIBUTION

AREAS OF INTRODUCTION ▪

by the French terms maquis and garrigue. Eyre (1968) states that most of the area now occupied with maquis was once forest. The forest has long since been removed due to the cultivation and herding practices of man with the result being the scrubby live oak-wild olive-lentisk association. Of the live oaks (evergreen), the holm oak (Quercus ilex) L. is common west of the Dardanelles in Europe and westward from Cyrensica in Africa with the cork oak (Quercus suber) L. being very common around the western basin of the Mediterranean Sea near sea level.

Isolated individuals and stands of stone pine (pinus pinea) L., maritime pine (Pinus pinaster) Ait., and Aleppo pine (Pinus halepensis) Miller are found distributed among the maquis along the northern seaboard of the Mediterranean basins. Other species of the maquis are wild olive (Olea europeaea) L., carob (Ceratonia siliqua)L., lentisk (Pistacia lentiscus) L., Kermes oak (Quercus coccifera) L., Valonia oak (Quercus aegylops) Auct., Quercus macedonica DC., cistus (Cistus spp.), and arbutus (Arbutus unedo)L. These species are sclerophyllous (have leathery leaves which enable them to withstand summer drought) and are often mixed with heathers (Erica spp.), gorse (Ulex spp.), and broom (Genista spp.).

Grass understory common in both maquis and garrigue include orchardgrass (Dactyllis glomerata) L., smooth brome (Bromus inermis) Leyss., cheat grass (Bromus tectorum) L., and ripgut (Bromus rigidus) Roth.

The garrigue also covers large areas of the Mediterranean and is common on the more pervious outcrops of limestone Typical garrigue communities are low-growing, prickly shrubs,

characterized by aromatic herbaceous plants. Species of the mint family (Labiatae) and thyme (Thymus spp.) are characteristic although some maquis species are often intersperced in the garrigue. Maquis and garrigue communities are thought to have been climax communities in the more barren areas of the Mediterranean region. Maquis and garrigue species have invaded the remaining areas after the removal of forest vegetation by man (Eyre, 1968).

The Mediterranean climate (Csa in the Koppen classification) can be described as having a modest amount of yearly precipitation concentrated during the winter months with the summers nearly or completely dry. The climate has warm-to-hot summers with mild winters and abundant sunshine with few clouds, especially during the summer months. Temperatures average in the mid 40's to 50's during January and in the mid 70's to 80's during July and August (See Appendix A). Rainfall varies from as low as 15.7 inches (Athens, Greece), to as high as 34.3 inches (Naples, Italy). In some areas, the summers have no precipitation for as long as three months. As a result of the very dry, hot summers, the Mediterranean climate places severe stress upon plants and animals.

Since the fallow deer has become naturalized in several parts of Europe outside its natural range during the past 1,000 to 2,000 years, a brief description of these habitats will be included in this discussion of its natural habitats.

In great Britain, the Netherlands, Germany, Denmark, and western Russia, the fallow deer has been introduced to park like areas of mixed forests with open grassy meadows and/or moors.

The mixed forests of central Europe and Great Britain are dominated by English oak (Quercus robur) L., birch (Betula spp.), and European beech (Fagus sylvatica) L. intermingled with different associations of Scotch pine (Pinus sylventris) L., Norway spruce (Picea abies) Karst., and silver fir (Abies venusta) Koch. Some areas are dominated by coniferous forest while others are almost entirely composed of the deciduous species (Eyre, 1968). Common grasses of the region include red top (Agrostis alba) L., oatgrass (Arrhenatherum elatius) L., wild oat (Avena fatua) L., sheep fescue (Festuca oviuna) L., and bluegrass (Poa pratensis) L.

Climate is of the mild marine west coast type (Cfb in the Koppen classification). This climate is characterized by damp, cold winters, with frequent snow and cold rain. The summers are mild and rainy. Temperature averages range from the mid 30's during January to the mid to upper 60's in July and August. Rainfall varies from about 23 to 40 inches (See Appendix A).

Flerov (1960) states that fallow deer habitat is characteristically plains or slightly hilly country with sparse woods or brushy areas and dense grassy meadows. In mountainous regions they inhabit only places where terrain is level or gently sloping and are seldom found in rocky, mountainous areas.

Feeding Habits

The basic food of fallow deer is grass, however, they are browsers to a limited extent. Cahalane (1939) reports that their chief diet comes from grasses and herbs and that they con-

sume large quantities of horse chestnuts when they are ripe. He states that in some areas of northern Europe they must be fed hay and grain during the winters because the habitats are generally overgrazed and without sufficient food. Goodwin, et al., (1954) reports that they eat considerable amounts of grass, but also browse on shoots, leaves, and shrubs. Flerov (1960) notes that in Russia they feed on grass during the summer, on chestnuts and other nuts during the fall, and on leaves, bark, dry grass, mosses, lichens, and young shoots during the winter. Chapman and Chapman (1969) note the food of English fallow deer consists mainly of grasses (probably bluegrass which is the most abundant and palatable grass in England) supplemented with acorns, apples, chestnuts, wheat, and leaves of holly , beech, and ivy. Fallow deer feed during the early morning and late evening hours during the summer months and feed most of the day during the winter (Walker, 1964 and Flerov, 1960).

Feeding habits of fallow deer introduced to the United States appear to be similar to the habits in their native range. These deer have been observed feeding in all three study areas by the author.

Mating Behavior and Reproduction

The rutting or mating season for fallow deer takes place in September and October, but can last into December in some localities. Bucks fight violently during the rut and make considerable noise when their large antlers crash together. Occasionally they lock antlers and both animals starve to death or die from exaustion (Figure 4). The antlers are shed from April

DARK DOCUMENTS "May Not Film Well."

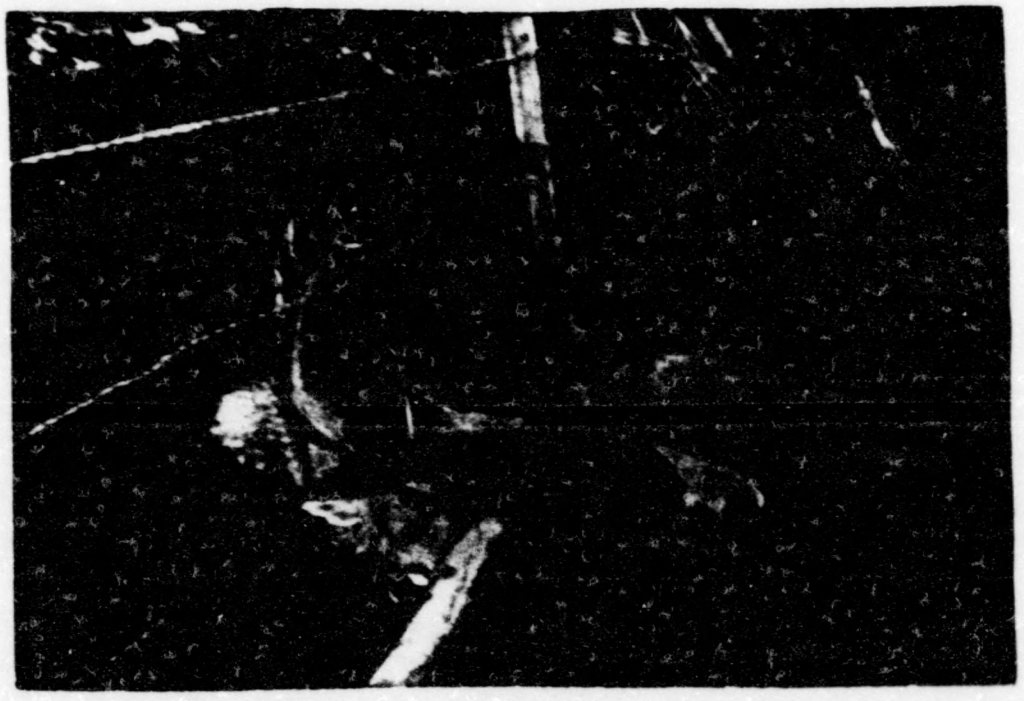


Figure 4 Two fallow bucks dead after locking antlers (Nebraska Study Area).

to June. Agestation period of 8 months is normal, with the fawn being born in June or July. Doe normally breed in their third year athough they have been known to breed by the second year. During the mating season, older doe are the first to breed and give birth before the younger. A single fawn is normal, with twins being rare. The fawn nurse for about a year, but supplement their diets with grass.

Herd Structure and Behavior

In the wild, female fallow deer collect in small groups or herds with their young. Herds can range in size from just a few animals to as many as fifty or more. The adult males collect in smaller herds and are seldom seen near the females except during the rutting season. When the rut begins, large bucks

gather harems by chasing away their rivals. However, some harems may be serviced by more than one buck. The males are vocal during the rutting season when they bellow in a deep voice to challenge or warn their rivals. Males and females will occasionally bark or bellow when they are startled during any season of the year.

CHAPTER III

THE STUDY AREAS

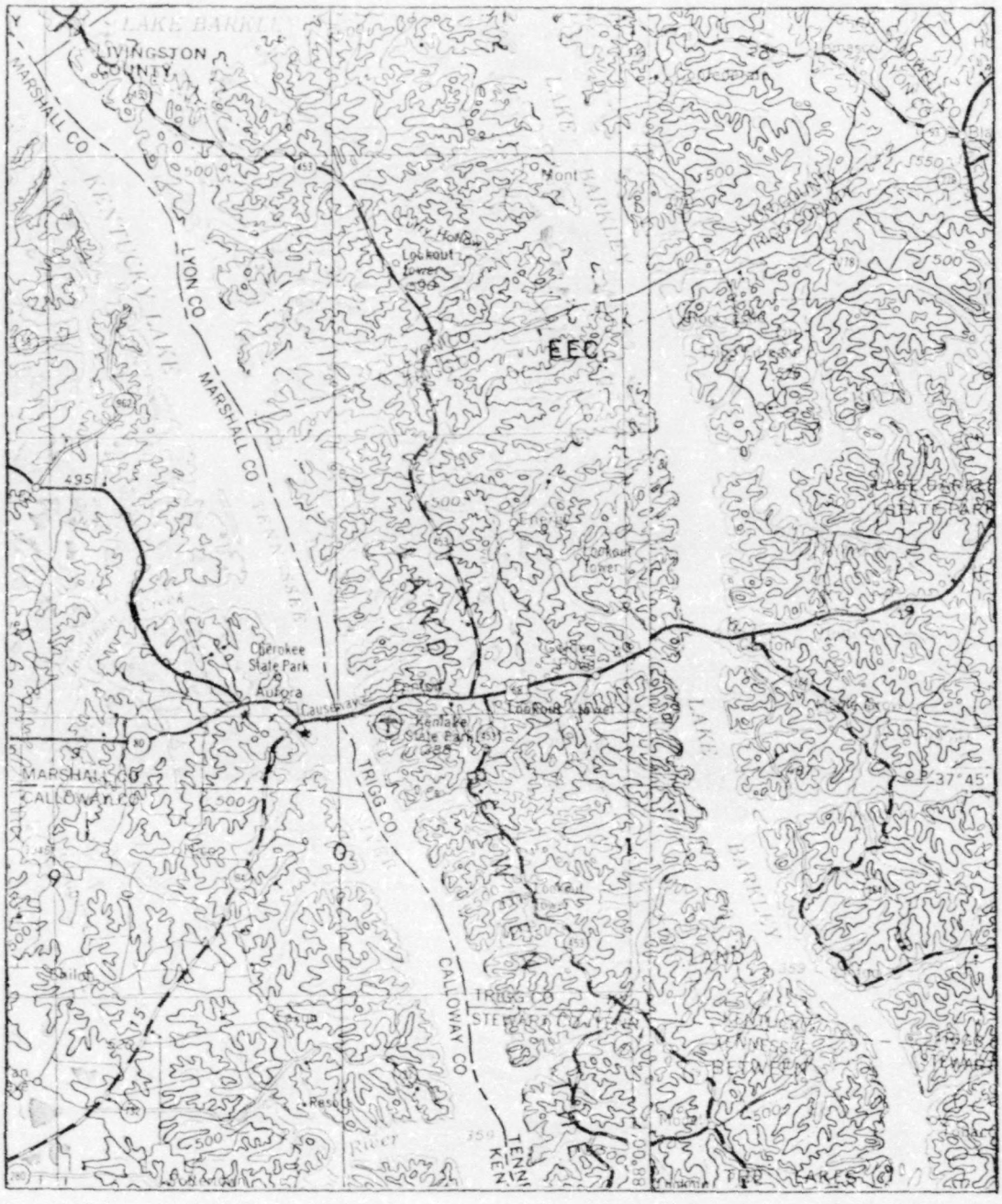
Procedure

The three areas selected for study will be presented separately beginning with the oldest herd area, western Kentucky, followed by central Nebraska and then by the Edwards Plateau "Hill Country" counties of Texas--the most recently established herd of the three areas. Each area will be described and then comparisons will be made between all three and the native ranges. Vegetation and climate will be the principle factors compared. However, other factors will also be discussed to indicate the variability of habitat occupied by this unusually adaptable deer.

Western Kentucky's Land Between the Lakes

Land Between the Lakes is a national outdoor recreation and conservation development sponsored by the Tennessee Valley Authority (TVA). Land Between the Lakes (LBL) is located in western Kentucky in portions of Lyon and Trigg counties and in northwestern Tennessee in a portion of Stewart County (Map 3). LBL is a peninsula approximately fourty miles long by seven miles wide (about 265 sq. miles or 170,000 acres) located between Kentucky Lake on the Tennessee River and Lake Barkley on the Cumberland River. This large tract of land is in its ninth year of operation as a Federal public use area since the completion

MAP 3



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KENTUCKY AREA

SOURCE: USGS

and impoundment of Lake Barkley in 1963 (Kentucky Lake was completed in 1944).

The peninsula is a drainage divide between Cumberland Valley and Tennessee Valley. It is mainly an area of rolling, heavily wooded land with many ridges and hollows or ravines. Many small streams drain the divide to the east and west and flow into the numerous bays and coves on the two lakes. Local relief is as much as 250 feet. Elevation of both lakes is 359 feet above sea level with elevations on the peninsula reaching over 600 feet above sea level.

The portion of Land Between the Lakes which is inhabited by fallow deer is that part north of U.S. Highway 68. This area covers approximately one-half of the land area of the peninsula and is about eighteen miles long by eight miles wide at its largest dementions, including about 80,000 acres. This portion of the peninsula comprises the Kentucky study area. A few sightings of fallow deer have been reported outside of this area, but the primary range appears to be within this part of the peninsula.

As mentioned earlier, the herd was introduced sometime between 1900 and 1920 in the old Kentucky Woodland National Wildlife Refuge. This area is now contained in the Environmental Education Center (EEC) portion of Land Between the Lakes and is located in the east central part of the study area covering about 5,000 acres. The fallow deer were confined primarily to this area until the Federal Government purchased the adjoining farmland and LBL was formed in 1963. The deer have dispersed from

the EEC area but are still concentrated there, especially during the hunting season when this small portion of the peninsula is closed to hunters and acts as a refuge for game. Some deer have been transplanted by game biologists to other parts of the peninsula, but for the most part the present distribution appears to be due to normal dispersal.

Flora and Fauna

The vegetational cover of the peninsula is dominantly a dense hardwood forest with interspersed areas of abandoned cultivated fields and meadows. The hardwood forests in the area are primarily of three types or associations: the open forest on large areas of level to gently rolling terrain, the forested ridges, and the forests in hollows or ravines. The dominant species in the open forest includes chestnut oak (Quercus prinus) L., black oak (Quercus velutina) Lam., hickories (Carya spp.), post oak (Quercus stellata) Wang., and blackjack oak (Quercus marilandica) Muenchh. On the ridges, post oak and blackjack oak dominate, while in the ravines or hollows beech (Fagus grandifolia) Ehrh., yellow poplar (Liriodendron tulipifera) L., sugar maple (Acer saccharum) Marsh. and white oak (Quercus alba) L. are the major species. Most of the forested areas are immature and have dense understory. They have not yet reached a park-like development although some of the narrow well sheltered ravines are park-like in appearance. Due to agricultural practices, many areas were cleared of their trees (in fact this entire area is secondary seral growth timber) and some have since become grasslands. Many of these

abandoned fields are in the normal stages of succession. They are being invaded by eastern red cedar (Juniperus virginiana) L., sumac (Rhus spp.), and sassafras (Sassafras albidum) Nutt. as well as other species and will eventually return to forest vegetation if not disturbed. Some of the grasses and forage plants, both native and introduced, in the area include broom sedge (Andropogon virginicus) L., orchardgrass (Dactylis glomerata), smooth brome (Bromus inermis), cheatgrass (Bromus tectorum), Johnson grass (Sorghum halepense) L., bluegrass (Poa pratensis), Fescues (Festuca spp.), lespedezas (Lespedeza spp.), sweet clovers (Melilotus spp.), and others (See Appendix B).

One of the management programs at LBL involves wildlife habitat improvement. In this program woods clearings (two to eight acres in size) are created and planted, along with abandoned farmlands, in corn (Zea mays) L. and other foodcrops to provide forage for wildlife and to maintain open land throughout the area (Figure 5) (Anon., 1972).

The fallow deer occupy all parts of the Kentucky study area. It appears that they occupy the wooded habitat mainly for cover and protection. The majority of their feeding activity takes place in the open meadows and grass areas. The author has observed as many as fifty head feeding in one small field at the same time. Over two hundred head have been observed in a day's time.

The vertebrate fauna of the area includes many species of songbirds and small mammals. Those mammals of primary importance include the cottontail rabbit (Sylvilagus floridanus),

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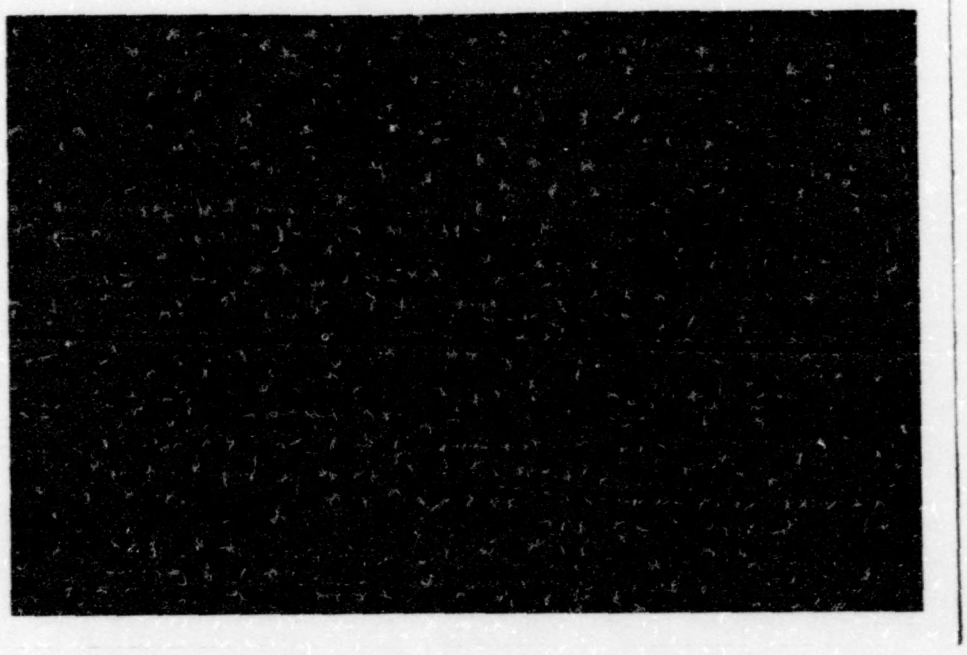


Figure 5 Fallow deer feeding in a cultivated field in Kentucky.

gray squirrel (Sciurus carolinensis), raccoon (Procyon lotor), opposum (Didelphis virginiana), gray fox (Urocyon cinereoargenteus), and white-tailed deer (Odeocoileus virginianus). Important birds include the mourning dove (Zenaidura macroura), bobwhite quail (Colinus virginianus), wild turkey (Meliagris gallopavo), several species of ducks (Anatidae family) and geese (Branta spp. and Chen spp.), several species of hawks (Accipitriidae family), and eagles (Haliaeetus spp.). It is not known whether the fallow deer competes with the white-tailed deer or any of the other animals in LBL although they have been observed feeding in the fields with white-tailed deer. However, the fallow deer is primarily a grazer, while the white-tailed deer is primarily a browser. A team of researchers

from Southern Illinois University is currently studying the fallow deer in LBL and their interaction with other animals.

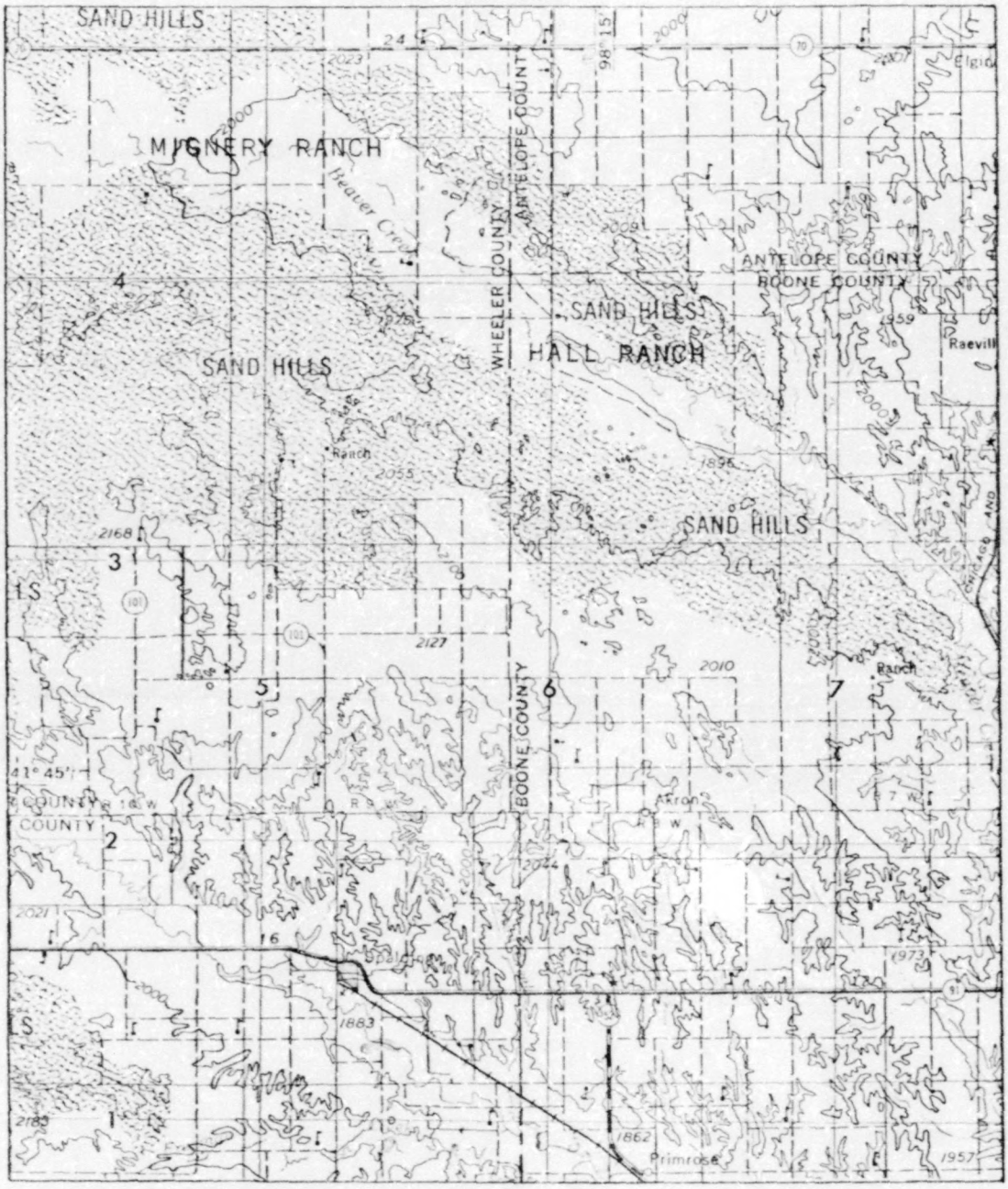
Climate

The climate of western Kentucky is of the Humid Subtropical (Cfa in the Koppen classification) type. The winters, although generally mild, can be very cold and raw with snow and ice storms that are of short duration. The winters and springs are rainy while the summers are hot and humid and the falls are mild and pleasant. Average July temperature in the study area is about 78°F with January temperatures averaging approximately 38°F. Yearly rainfall is about 47.5 inches and has the Tennessee pattern of rainfall distribution--March is the wettest month while October is the driest month. At no time during the year is there a dry season (See Appendix A and Table 2 in Habitat Comparisons).

Nebraska's Beaver Creek Valley

The Beaver Creek Valley is a small valley in central Nebraska in portions of Wheeler, Boone, and Antelope Counties, bordered on both sides by the Nebraska Sand Hills (Map 4). As previously stated, fallow deer were introduced to this area in 1939-40 in the vicinity of Petersburg in Boone County. Since their introduction, the deer have established themselves in the valley from Petersburg to Cummingsville, near the headwaters of Beaver Creek. The valley is approximately thirty miles long by two mile wide (about 38,500 acres) between these two locations and is the main range of the fallow deer in Nebraska.

MAP 4



NEBRASKA AREA

0 5
Miles

NEBRASKA
LOCATION

SOURCE: USGS

DARK DOCUMENTS

"May Not Film Well."

Some of the deer move out of the valley during the summer months, but return during the fall and winter. There are two main herds that winter in the valley--one herd winters on the old Hall Ranch (now owned by Wagner) in Boone County and the other, larger herd winters on the Mignery Ranch in Wheeler County (Figure 6).

Figure 6 Native grass meadows of Beaver Creek Valley with cottonwood grove.

The fallow deer herds in Nebraska are composed primarily of animals of the white color phase. Mignery (1972A) related that there had been a buck of the black color phase on his ranch for several years and that several others had seen one or two does of the black phase in the area. The bulk of the herd has remained the white color phase. The introductory

animals came from all white zoo stock. Animals of the black color phase are melanos (the result of over abundant pigmentation--the opposite of an albino).

After reaching a peak of about 400 animals in 1958, the herd leveled off and then began a decline in population in the middle 1960's as will be explained later. The present population is estimated at less than seventy-five animals (Havel, 1972; Presnall, 1958).

The habitat occupied by fallow deer in Nebraska is primarily the flat native grass meadows and the dense shrub and tree bordered creekbanks in the valley (Figure 7). Occasionally they have been sighted out in the sandhills, but normally they remain in the valley near the protective cover of the creek banks or in the cottonwood groves.

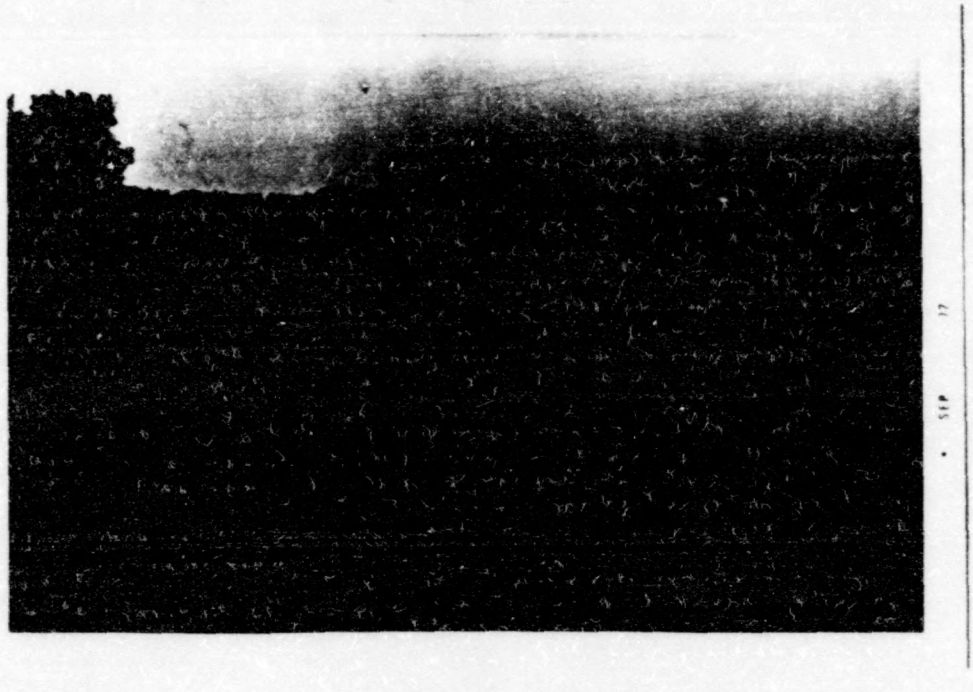


Figure 7 Fallow deer feeding in a freshly mowed meadows near Beaver Creek.

Flora and Fauna

The Beaver Creek Valley area of Nebraska is Medium and Tall Grass Prairie and is covered primarily with native grasses. Several types of grass communities are found in the study area due to the relationship to drainage and depth of groundwater.

The major grass community found in the valley, and the one that is most important to the fallow deer, is in association with the subirrigated soil sites where the water table varies from ten to sixty inches below the surface. The soils in these sites range from fine sand to silty clay loam with high organic matter content in the surface soils. This grass community is dominated by big bluestem (Andropogon gerardi) Vitman with switchgrass (Panicum virgatum) L., indiangrass (Sorghastrum nutans), Nash and little bluestem (Andropogon scoparius) Michx. being major species (Appendix B). Some areas are supplimentally seeded with timothy (Phleum pratense), bluegrass (Poa pratensis), red top (Agrostis alba), red clover (Trifolium pratense) L., and alsike clover (Trifolium hybridum) L. Most of the valleys in the sandhills with this type community are noted for their high quality bluestem hay. In the vicinity of Petersburg and toward the east, this vegetation has largely been replaced by irrigated corn (Zea mays), sorghum (Sorghum vulgare) Pers., and alfalfa (Medicago sativa) L. The easten portion of the valley, where cultivation begins, appears to be the eastern limit of the fallow deer range.

On the gently rolling slopes, where the valleys merge with the sandhills, is found a second type of grass assocaition. This site is used to a lesser extent by the deer. The soils

are sandy loams and silt loams. The principal forage plants are blue grama grass (Bouteloua gracilis) Lag., side-oats grama grass (Boutelona cutipendula) Torr., needle-and-thread or needle-grass (Stipa comata) Trin., western wheatgrass (Agropyron smithii) Rydb., and threadleaf sedge (Carex filifolia) Nutt. (See Appendix B). In areas with precipitation over twenty inches, big and little bluestem are very important. This association has also been put into irrigated corn cultivation in the eastern portions of the study area.

The third grass community or association (probably used only in the summer) is found in the deep, loose sands of the sandhills which border the valley on both sides. This area of undulating, "wave-like hills" has sand bluestem (Andropogon hallii) Hack., prairie sandreed (Calamovilfa longifolia) Scribn., little bluestem, switchgrass, sand lovegrass (Eragrostis trichades) Wood, and needlegrass as the primary forage plants (See Appendix B). This area is subject to severe wind erosion if vegetational cover is removed and is therefore not cultivated.

The vegetation along Beaver Creek provides sufficient cover for the deer during periods of severe weather or when hunted or frightened. This vegetation is dominated by sandbar willow (Salix longifolia) Muchl. and cottonwood (Populus deltoidea Marsh. and Populus trichocarpa) Hook with some ash (Fraxinus pennsylvanica) Marsh. and boxelder (Acer negundo) L. being found there. There are also a few isolated groves of cottonwoods found in the valley.

The fauna of the study area includes many species of songbirds, small mammals, and some reptiles. The major bird species of the area include several species of ducks (Anatidae family) and geese (Branta spp. and Chen spp.), bobwhite quail (Colinus virginianus), mourning dove (Zenaidura macroura), sharp-tailed grouse (Pedioecetes phasianellus), prairie chicken or pinnated grouse (Tympanuchus americanus) ringneck pheasant (Phasianus colchicus) an exotic species, and several species of hawks (Accipitriidae family). Large mammals include the white-tailed deer (Odocoileus virginianus), a few mule deer (Odocoileus hemionns) and pronghorn antelope (Antilocapra Americana) in the sandhills, and a few coyotes (Canis latrans). It is not known whether any competition takes place between the fallow deer and the above mentioned species. The fallow might compete for food with the white-tailed deer during the winter months when the fallow deer is forced to feed on browse and hay due to snow cover. Coyotes are not thought to present a serious threat to the deer as a predator because of their small number.

The primary economic activity in the study area is cattle ranching. Cattle are grazed in the sandhills during the summer months and are wintered in feedlots in the valley during the winter. The meadows in the valley are mowed during the summer and provide a high yield of hay which is used for cattle forage during the winter. Some fallow deer fatalities are associated with this haying activity as some of the newborn and very young fawn have been killed or injured by the mowing machines. Mignery

(1972B) reports that as many as seventy head of fallow deer moved into his hay yards and fed with his cattle during the frequent periods of moderate to heavy snow cover in the winter months.

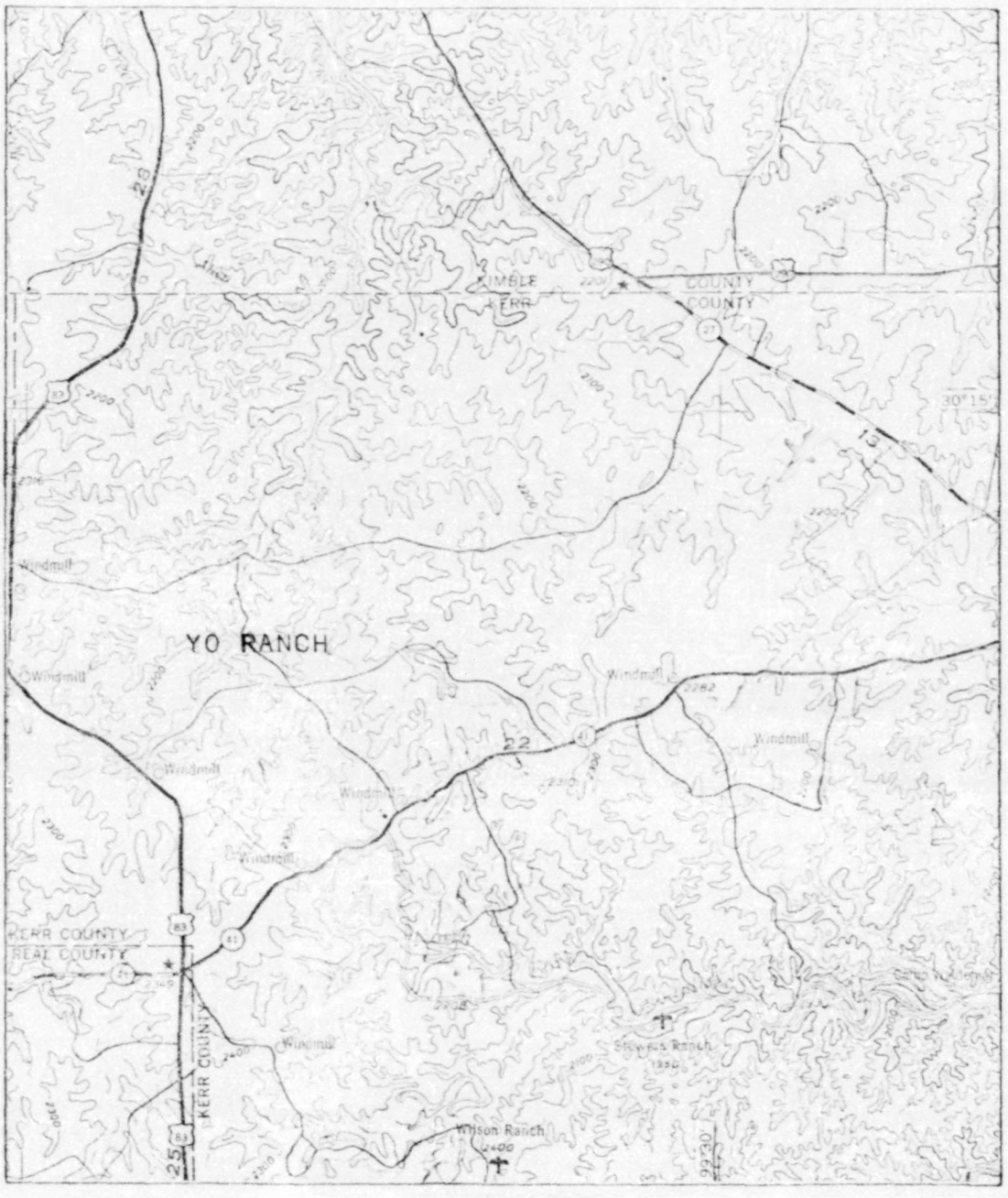
Climate

The climate in the Nebraska study area is classified as Humid Continental with warm summers (Dfa in the Koppen classification). The January mean temperature is about 19oF with three of the winter months averaging below freezing temperatures. Summer temperatures average about 77°F in July. Rainfall on the eastern side of the study area is about twenty-four inches per year. Rainfall decreases toward the western end of the valley. Four months average below an inch of precipitation, November through February (See Appendix A and Table 3 in Habitat Comparisons). Most of the precipitation during the winter is in the form of snow with a yearly total of about twenty-eight inches. The ground is generally covered with snow from December to mid-March. Snow depth is variable due to the strong prevailing westerly winds, which persist throughout the year. These winds add to the severity of the winters upon wildlife.

Texas' Hill Country

The fallow deer has been introduced to many areas of Texas and is now found in thirty-three counties in the state. The majority of these animals, however, are found concentrated in a three county area--Kerr , Real, and Bandera, in the central portion of the Edwards Plateau (Ramsey, 1969). Fallow deer

MAP 5



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TEXAS AREA

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Miles

LOCATION

SOURCE: USGS

have adapted well to the habitat in the "hill country" area of the Edwards Plateau. Kerr County has over 800 head on eighteen ranches; Real County has about 180 animals on four ranches, and Bandera County has approximately 130 deer on four ranches. These ranches range in size from about 1,000 acres to over 70,000 acres (the YO Ranch near Mountain Home). The majority are in the 1,000 to 6,000 acre size ranges. A herd of 75 fallow deer have been reported on a ranch in Menard County and an equal number on a single ranch in Blanco County (Matthews, 1968). Ramsey (1969) reports over fifty head in both Robertson and San Saba Counties in the state. Texas law makes exotic game animals the property of the owner whereas in Nebraska and Kentucky these animals are the property of the state. For this reason, exotic game animals have been stocked extensively throughout the state of Texas by landowners for the purpose of commercial hunting and/or aesthetic reasons. The animals are generally confined within high (6 to 10 feet) game proof fences in large pastures covering several hundred to several thousand acres. The Texas study area (Kerr, Real, and Bandera Counties) is in the heart of the commercial hunting area and contains the majority of the state's fallow deer.

The study area is located in the rugged divide or "hill country" section of the Edwards Plateau where elevations range from 1,400 to 2,400 feet. This area is drained by the Frio, Medina, and Guadalupe Rivers. It is basically an area of rocky, undulating and flat-topped hills with a few narrow deep valleys. The area is dominated by a live oak and cedar (juniper) savanna (Figure 8) where the main economic activities

DARK DOCUMENTS "May Not Film Well."

are angora goat, sheep, and cattle ranching. Increasingly popular health and recreation resorts with commercial hunting and wildlife tours are developing as a major source of income.

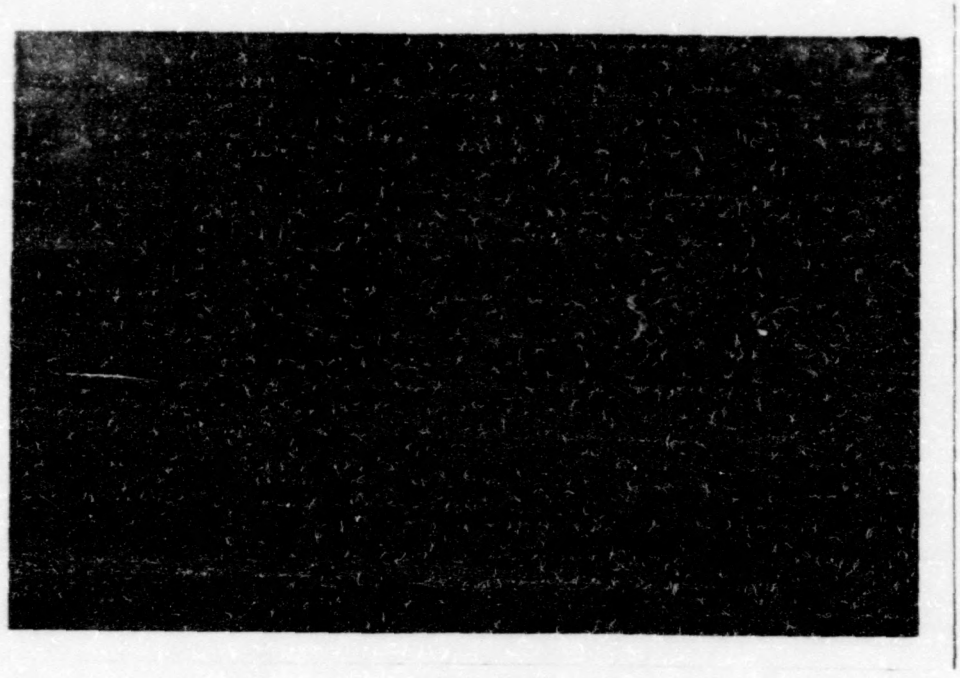


Figure 8 Live oak-cedar savanna of Texas' "Hill Country".

Flora and Fauna

This area of Texas was originally a savanna grassland but early settlers over-grazed the range with their livestock to the extent that live oak (Quercus virginiana) Mill., cedar or ashe juniper (Juniperus ashei) Buchholz, curly mesquite (Prpsopis pebescens) Benth., and prickly pear (Opuntia spp.) rapidly invaded and now cover most of the stony hills (Figure 9). The area can now be described as a live oak savanna in which ashe juniper and shin oak (Quercus annulata)

Buckl. are conspicuous.

Figure 9 Live oak, yucca, prickly pear, and grasses on the stony soils in Texas study area.

Brister (1972) provided much information on soils and vegetation in the study area. This included range site descriptions from Soil Conservation Service files, which indicate that there are at least ten different vegetational associations which can be found in the study area. These sites range in species and density from grassy savanna to live oak savanna. The most common grasses within all of the associations are little bluestem, sideoats grama grass, indian grass, big bluestem, and switchgrass (see Apendix B). Little bluestem is the most important and most dominant of all the grasses in this area. Live oak, shin oak, Texas oak (Quercus texana) Buckl.,

and ashe juniper are the most dominant woody plants in the area as a whole, but black walnut (Jugland nigra) L., pecan (Carya illinoensis) Koch, elm (Ulmus americana) L., willow (Salix nigra) Marsh., and sycamore (Platanns occidentalis) L., are common along the river banks and in the bottomlands of the valleys. Fallow deer have been found on all range sites in the area, but no detailed study has been conducted to determine which vegetation association is most used by these deer.

Forage conditions during the summer season are poor due to unpredictable rainfall. The poor condition of vegetation and excessive competition with livestock (overgrazing) during the summer can cause extensive die-off of deer and livestock during extremely dry summers (McMahan, 1964).

The native fauna of the study area includes white-tailed deer, wild turkey, javelinas or peccaries (Pecari angulatus), bobcats (Lynx ruffus), raccoons, ring-tailed cats (Bassariscus astutus), oppossums, Skunks (Mephitis nigra), squirrels (Scuirus spp.), quail (Colinus spp.), and many species of small mammals, songbirds, and reptiles. Fallow deer probably do not compete for food with many of these species including the white-tailed deer since the fallow deer is primarily a grazer while the white-tail is predominantly a browser. The fallow deer does compete with domestic stock which graze in the same area.

The study area abounds in a great variety of exotic game which have been stocked for commercial hunting and/or as tourist attractions (see Appendix B). One species of particular interest is the mouflon sheep (Ovis musimon) which is native

to Corsica and Sardinia in the Mediterranean region, the same area from which the fallow deer originates. This wild sheep has probably been the most successful exotic species stocked in Texas (Ramsey, 1969).

Climate

The climate of the Texas study area is a transition between the semi-arid Steppe (BSh in the Koppen classification) and the Humid Subtropical (Cfa in the Koppen classification) climatic types. This condition arises due to the irregularity of rainfall in this area--one year the climate might be classified one type and the next year, due to rainfall differences, the climate could fall in the other classification. There is little difference in temperatures throughout the study area for a given season. Rainfall varies from eighteen to twenty inches in the western portion to about thirty-one inches in the eastern portion of the three county area. The region is characterized by dry winters with humid summers and has a double rainfall maxima, the first in May and the second in September-October. January temperatures average from 46° to 49° F while July and August both have a mean of about 81° F (see Table 4 in Habitat Comparison).

Habitat Comparison

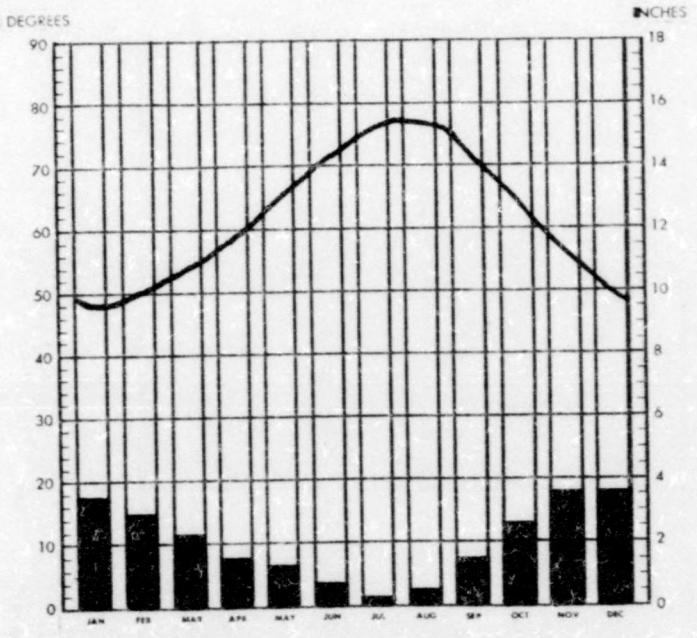
To determine which of the study areas has a habitat which might be best suited for the fallow deer, the climate and vegetation of each area will be compared with the native ranges and then with the other study areas. Since climate and vegetation are directly related to each other, they will be

discussed together.

When climatic data for stations near the Kentucky study area are compared with various stations in the native Mediterranean range of the fallow deer, two distinct differences become apparent. The temperature differences in the winter months contrast considerably with the Kentucky stations recording temperatures that are 10° to 15°F cooler than those of the Mediterranean stations. The second major difference involves yearly precipitation totals and distributions. The Kentucky area receives fifteen to thirty inches more rainfall which is fairly evenly distributed throughout the year while the Mediterranean area is much drier during the summer months (see Table 2). The Kentucky area, with its more abundant rainfall and lack of dry season, supports a much more dense and luxuriant growth of vegetation than does the Mediterranean. The Land Between the Lakes study area supports a dense deciduous hardwood forest compared to the evergreen scrub oak savanna of the Mediterranean maquis and garrigue. The two areas do, however, share several species of forage grasses. Orchardgrass, smooth brome, and cheatgrass, all native to the Mediterranean, have been introduced to Kentucky and are now common in the study area.

When Kentucky's LBL is compared with those areas of Europe where the fallow deer is naturalized, it can be seen that the Kentucky climate is from 8° to 18°F warmer during the summer months and receives from seven to twenty-five inches more yearly precipitation (compare Tables 1 and 2). The vegetation in both of these areas is similar with hardwood forests

TABLE 1



MEDITERRANEAN STATIONS
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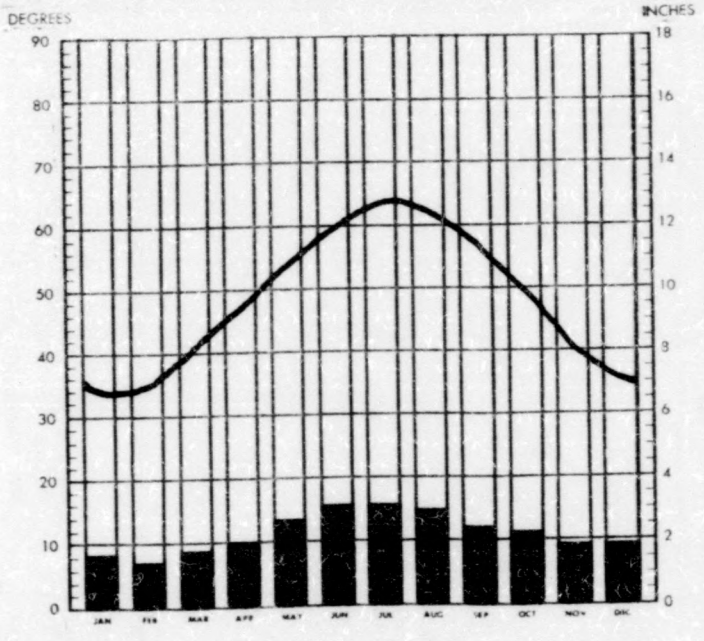
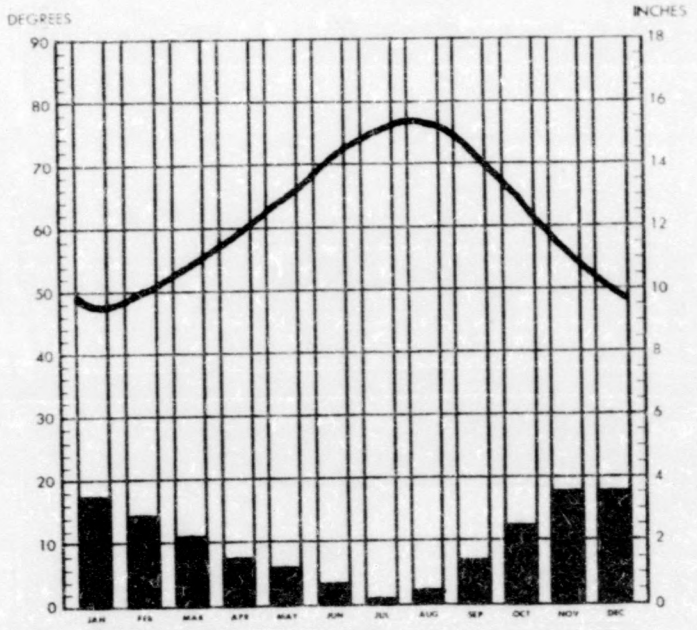
MEAN ANNUAL PRECIP. 24.1"



EUROPEAN STATIONS
MEAN ANNUAL TEMP. 48°
MEAN ANNUAL PRECIP. 27.2"

TABLE 2



MEDITERRANEAN STATIONS
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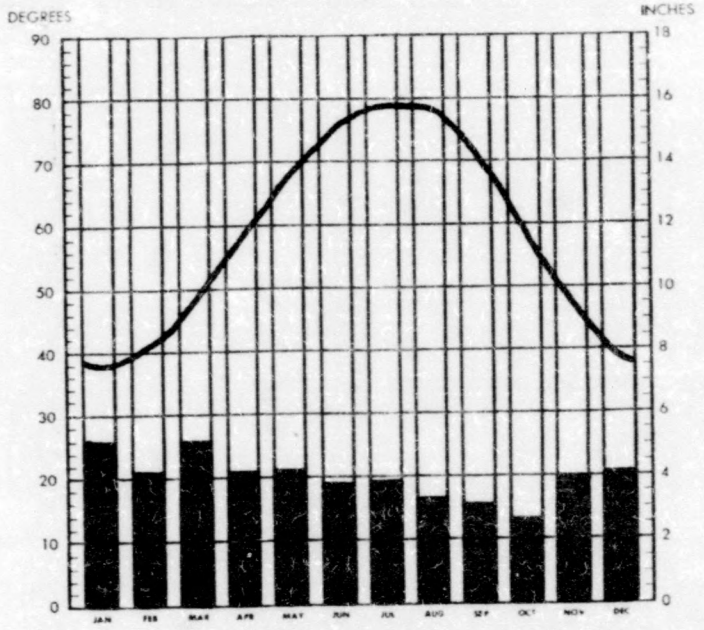
MEAN ANNUAL PRECIP. 24.1"



KENTUCKY STATIONS
MEAN ANNUAL TEMP. 59°
MEAN ANNUAL PRECIP. 47.6"

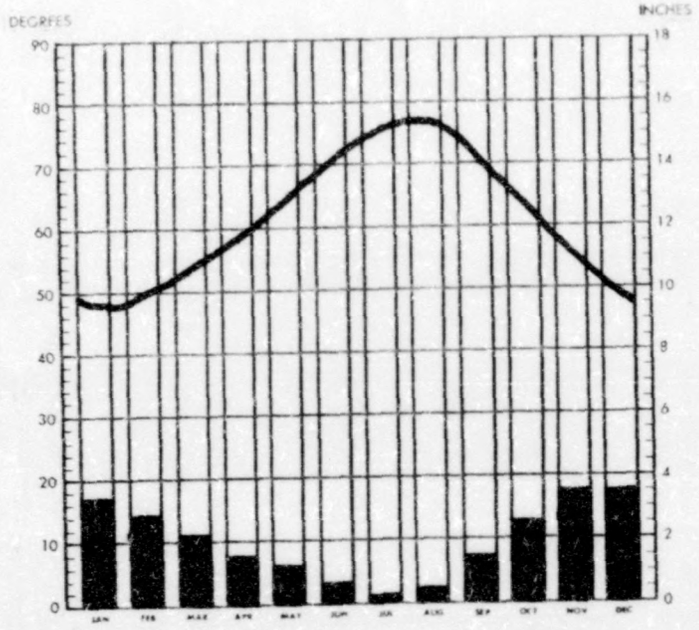
and grass meadows; however, the European forests are more park-like (less understory) due to the climatic differences and the agricultural activities of the Europeans. Bluegrass is a major European species which is also common in the Kentucky study area.

A comparison between the Kentucky study area and the Nebraska study area reveals a great difference in vegetation, forest dominated compared to grassland dominated. This difference in vegetation can be attributed to the climatic differences of the two areas. In Nebraska the January temperature averages about 19° F colder than in Kentucky although the summer temperatures are about the same. The Kentucky area receives about twenty-three and one-half inches more precipitation than the Nebraska study area (compare Tables 2 and 3).

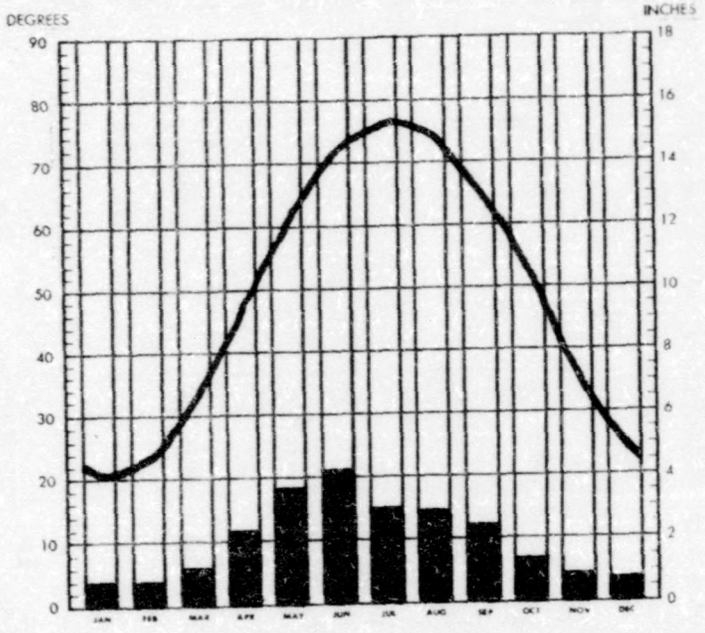
The Texas study area differs from the Kentucky area during the winter months when it is 8° to 10° F warmer than Kentucky. Rainfall is a large variable between the two with Kentucky receiving from seventeen to twenty-nine inches more precipitation than the Texas area (compare Tables 2 and 4). Grasses are more dominant in the scrubby liveoak savanna of Texas than they are in Kentucky which is dominated by hardwood forests.

In comparing Nebraska's Beaver Creek Valley with the Mediterranean region, it can be noted that the winters are 26° to 35° F colder in Nebraska although the summer temperatures are almost equal. Nebraska has a dry winter compared to the Mediterranean's dry summer, although yearly precipitation is about the same for both areas (see Table 3). A comparison of vegetation between the two areas reveals that Nebraska has a larger percentage of land covered by grasses with the absence of scrub-

TABLE 3

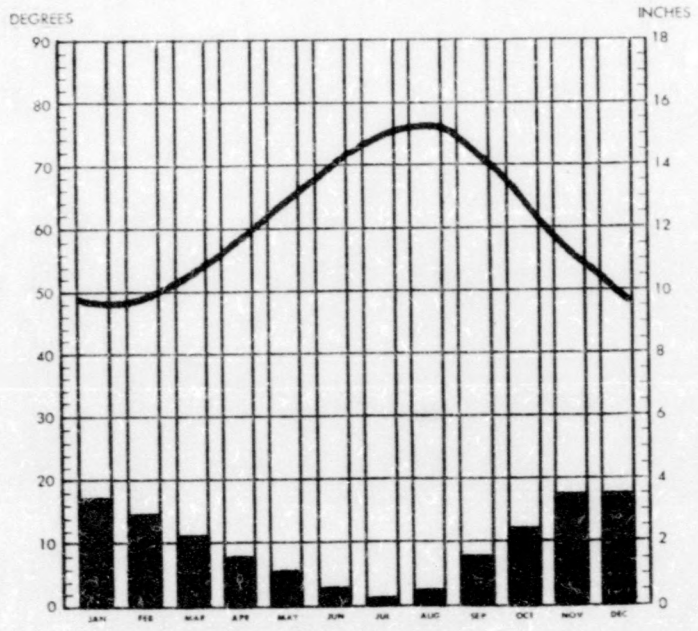


MEDITERRANEAN STATIONS
MEAN ANNUAL TEMP. 62°
MEAN ANNUAL PRECIP. 24.1"

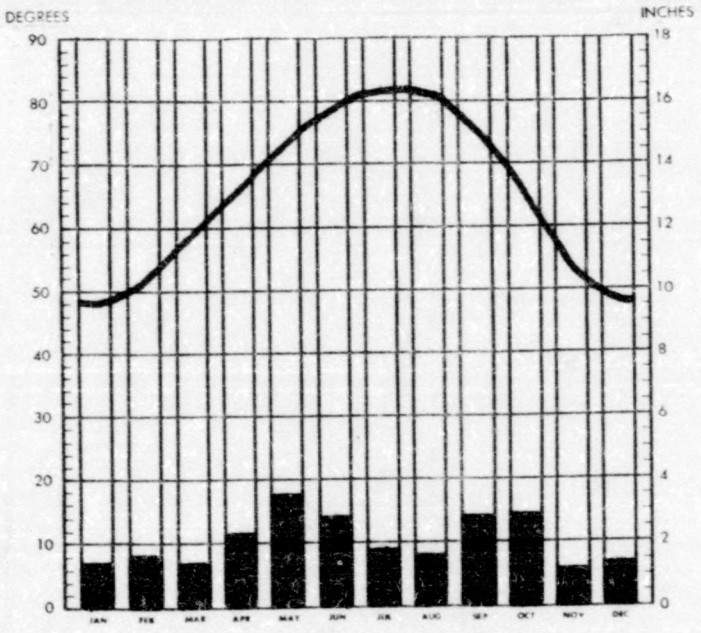


NEBRASKA STATIONS
MEAN ANNUAL TEMP. 49°
MEAN ANNUAL PRECIP. 23.3"

TABLE 4



MEDITERRANEAN STATIONS
MEAN ANNUAL TEMP. 62°
MEAN ANNUAL PRECIP. 24.1"



TEXAS STATIONS
MEAN ANNUAL TEMP. 65°
MEAN ANNUAL PRECIP. 24.5"

by vegetation except along the creek banks.

Nebraska's climate has colder winters (14° to 22°F colder) and warmer summers (8° to 17°F warmer) than those stations in Europe that are an extension of the fallow deer's native range. The Beaver Creek Valley receives from two to ten inches less rain than the European areas (compare Tables 1 and 3). The European habitats support a greater amount of forest vegetation than is possible in the Nebraska study area. A few of the European grasses have been introduced into the Nebraska habitat but it remains dominated by native species.

In comparing the Nebraska climate with that of the Texas study area the cold Nebraska winters stand out as the main difference just as they have in the other comparisons. The January temperature average is about 30°F colder in Nebraska than in Texas. Rainfall in the Texas area varies from about six inches less to about seven inches more than the Nebraska yearly precipitation. Both areas have the rainfall peak during the summer season (compare Tables 3 and 4). Several species of grasses are common between the two areas with bluestems and grama grasses being abundant in both areas. If the plant life in the Texas area were in a climax state it would probably be closer in appearance to the Nebraska grasslands, although the dominant species might be different between the two areas.

The fallow deer apparently have not adapted as well to the Nebraska habitat and climate as they have to the other areas. Havel (1972) states that there appears to be a low survival rate among new born fawns but the exact cause for this has not been determined. No doubt the mowing accidents, as

previously described, have an impact; but the primary cause for the low survival is still unknown. It could be a result of the severe winters leaving the pregnant does in poor health for the May through June fawning time. It could also be the result of hereditary deficiencies due to inbreeding, a condition which Cahalane (1939) describes as being common in zoo raised animals. The Nebraska deer all came from the same zoo herd.

The habitat of the Texas study area is more analogous to the Mediterranean habitat than any of the other areas studied. Average temperatures of both areas are nearly identical throughout the year. Yearly rainfall is similar in amount for both areas but the rainy seasons are different--the Mediterranean has a dry summer and the Texas area has a rather dry winter. The high summer temperatures in Texas, along with undependable summer rainfall, cause evaporation to exceed precipitation with the result being a summer deficiency of rainfall which can be compared in effect to the summer drought of the Mediterranean climate (see Table 4). As a result of climatic similarities between these two areas, they also have vegetational similarities. Both areas have live oak-grassland savanna with various associations of grasses and scrubby woody vegetation. Although the species are different between the two areas, the same general types of vegetation exist. The Texas area appears to provide a habitat greatest in similarity to the native range of the fallow deer in the Mediterranean region.

CHAPTER IV

SUMMARY

Many of the facets of fallow deer introduction to the United States have previously received considerable attention. Significant factors concerning naturalization have been studied in part, but no previous attempt has been made to investigate the range of this animal nor to compare the various habitats into which it has been introduced with its native land. This study was undertaken for that purpose. An attempt was made to investigate naturalization on the basis of herd growth in a given environment. Climate, vegetation, and topography for certain study sites were compared with the same features in the native range. The results show the wide range of adaptability of this interesting animal.

The characteristics of the fallow deer were first presented along with a description of its native range. As the animal is indigeneous to the Mediterranean, extending from Portugal to Iran, its natural range is immediately quite extensive. Though all Mediterranean areas bear great similarities, there are enough differences in this vast expanse to indicate the adaptability of the animal even in its homeland. Its ability to withstand the adverse effects of the hot, dry Mediterranean summers is an indication of its tolerance for high temperatures and low rainfall or droughts. It has also survived the pop-

ulation pressures of man and his use of the Mediterranean land.

It is estimated that fallow deer were introduced to England and other parts of western Europe by the ancient Romans as much as 2,000 years ago. The animal has maintained itself in these areas since those early times, but this is probably due in part to the protection it has been given by man. Herds were maintained for special hunting purposes and for aesthetic values, but regardless, the deer has been able to live and compete in an environment considerably different from its native land. It has adapted there under cooler and damper conditions but with a greater variety of foods.

When comparing the three study areas in the United States with those in the Mediterranean and/or Europe, with the possible exception of Texas they are extensively different. Though the animals have not been in the United States as long as they have in western Europe, the study herds show some definite trends.

The Kentucky herd, which is the oldest in the United States, appears to be gradually increasing in numbers. Here the environment seems to favor the animal in all aspects. The rolling topography has ample forest cover for their protection plus abundant browse, grasses, and cultivated fields which are planted and maintained for the purpose of wildlife forage. Park-like areas of open woods and grasslands are found in the many draws and valleys and provide ample food and cover. The temperate climate, with its definite seasonality, appears to be well within the tolerance ranges of the animal.

The Beaver Creek Valley herd in Nebraska is exposed to

the most harsh environment of any of the United States herds. Although spring, summer, and fall are within its natural tolerances, the winters are so severe in this area that it is necessary for the deer to be supplied with supplementary food by feeding in the hay lots which ranchers have prepared for their cattle. The white fallow deer is so easily located in this area (except when they are bedded down in the dense but limited cover along Beaver Creek) that the mature buck have been killed off in recent years during the hunting seasons. At the present time, there exists a low ratio of buck compared to doe and this has undoubtedly limited the reproductive potential of the herd. There is also a problem of low fawn survival which may be attributed to inbreeding. These factors are probably responsible for the numerical decline of the herd in recent years.

The environment of the Texas study area is more like that of the native range than that of any of the other areas studied. The rolling hill and plateau topography with its few narrow valleys abounds in savanna like vegetation similar to the native Mediterranean range. The dominance of live oak and grasses is comparable in both areas. With the exception of the different seasonalities of precipitation, the temperature and amount of rainfall are very similar. The herd is increasing in numbers, both by natural increase due to reproduction and by continued introduction by ranchers for commercial hunting purposes.

The fallow deer has proved to be very adaptable, both in the United States and abroad. It is now widely distributed

throughout the world mostly through the efforts of man's quest for variety of game animals for sporting purposes.

Although much remains unknown about the ecology of fallow deer, it is felt that this work has provided insights into the variability of habitats and physical environments to which the animal has become adapted or naturalized.

APPENDIX A

CLIMATIC DATA FOR NATIVE RANGE AND STUDY AREAS
(Temperature in degrees Fahrenheit and Precipitation in inches)

Mediterranean Stations

		J	F	M	A	M	J	J	A	S	O	N	D	Year
Lisbon, Portugal	Temp.	51	52	55	58	62	67	71	72	69	63	57	52	61
	Precip.	3.3	3.2	3.1	2.4	1.7	.7	.2	.2	1.4	3.1	4.3	3.6	27.2
Madrid, Spain	Temp.	41	44	48	54	61	69	77	76	68	57	48	40	56
	Precip.	1.3	1.3	1.6	1.7	1.7	1.3	.4	.6	1.5	1.8	1.9	1.4	16.5
Algiers, Algeria	Temp.	54	55	58	62	66	72	77	78	75	69	61	56	65
	Precip.	4.4	3.3	2.9	1.6	1.8	.6	.1	.2	1.6	3.1	5.1	5.4	30.0
Naples, Italy	Temp.	48	49	53	58	64	71	76	76	72	64	56	51	61
	Precip.	4.8	3.5	1.7	1.8	2.2	.7	.6	1.3	4.3	4.6	4.1	4.7	34.3
Athens, Greece	Temp.	48	49	53	59	68	76	81	81	74	67	58	51	64
	Precip.	2.2	1.5	1.4	.8	.8	.6	.2	.4	.6	1.7	2.8	2.7	15.7
Jerusalem, Israel	Temp.	48	49	56	62	69	73	75	76	74	70	62	52	64
	Precip.	5.1	5.1	2.5	1.1	.1	.1	.0	.0	.1	.5	2.8	3.4	20.8

European Stations

		J	F	M	A	M	J	J	A	S	O	N	D	Year
Birmingham, England	Temp.	40	39	42	46	51	57	62	60	56	49	43	39	49
	Precip.	2.0	1.7	1.9	1.7	2.2	2.3	2.3	2.7	1.8	2.8	2.4	2.7	26.5
Clermont, France	Temp.	37	39	44	50	56	62	66	65	61	52	44	39	51
	Precip.	1.3	1.3	1.7	2.0	2.7	3.2	2.4	2.6	2.8	2.2	1.7	1.3	25.2

		J	F	M	A	M	J	JJ	A	S	O	N	S	Year
Munich, Germany	Temp.	28	31	38	45	54	60	63	62	56	46	36	31	46
	Precip.	1.7	1.4	1.9	2.7	3.7	4.6	4.7	4.2	3.2	2.2	1.9	1.9	34.1
Berlin, Germany	Temp.	30	32	39	46	55	60	64	63	57	48	38	33	47
	Precip.	1.9	1.3	1.5	1.7	1.9	2.3	3.1	2.2	1.9	1.7	1.7	1.9	23.1
Kentucky Stations														
Hopkinsville, Kentucky	Temp.	37	40	47	58	67	75	79	78	71	60	47	39	58
	Precip.	5.4	4.0	5.1	4.1	4.2	4.1	3.9	3.4	3.0	2.4	3.9	4.0	47.5
Murray, Kentucky	Temp.	38	41	48	59	68	76	79	79	72	61	48	40	59
	Precip.	5.2	4.1	5.3	4.1	4.2	3.5	3.9	3.3	3.1	2.9	4.0	4.1	47.6
Nebraska Stations														
Norfolk, Nebraska	Temp.	19	23	33	48	60	71	77	75	65	53	36	25	49
	Precip.	.8	.8	1.6	2.2	3.7	4.3	3.0	2.6	2.3	1.2	.9	.7	24.0
Albion, Nebraska	Temp.	22	26	36	50	61	71	78	76	66	54	38	27	50
	Precip.	.7	.8	1.4	2.2	3.4	4.0	2.4	2.9	1.9	1.1	.8	.8	22.5
Texas Stations														
Sonora, Texas	Temp.	49	52	59	66	74	80	82	81	76	66	55	49	66
	Precip.	.8	1.0	.6	1.5	2.9	2.8	1.7	1.4	1.4	2.7	.7	.8	18.3
Kerrville, Texas	Temp.	46	50	56	65	71	78	81	81	75	66	54	48	64
	Precip.	1.9	2.2	1.9	2.9	4.0	2.9	2.1	1.9	4.3	3.1	1.6	1.9	30.8

APPENDIX B

VEGETATION AND WILDLIFE

Mediterranean Area

Flora

Common Name	Scientific Name
holm oak	Quercus ilex
cork oak	Q. suber
Kermes oak	Q. coccifera
Valonia oak	Q. aegylops
Stone pine	Pinus pinea
Aleppo pine	P. halepensis
Wild olive	Olea europaea
carob	Ceratonia siliqua
lentisk	Pistacia lentiscus
Cistus	Cistus spp.
arbutus	Arbutus unedo
heather	Erica spp.
gorse	Ulex spp.
broom	Genista spp.
orchardgrass	Dactylis glomerata
smooth brome	Bromus inermis
cheatgrass	B. tectorum
ripgut	B. rigidus
mint	Labiatae family
thyme	Thymus spp.

European Area

English oak	Quercus robur
birch	Betula spp.
European beech	Fagus sylvatica
Scotch pine	Pinus sylventris
Norway spruce	Picea abies
silver fir	Abies venusta
redtop	arostis alba
oatgrass	Arrhenatherum elatius
wild oat	Avena fatua
sheep fescue	Festuca ovina
bluegrass	Poa pratensis

Kentucky Area

Flora

Common Name	Scientific Name
chestnut oak	Quercus prinus
black oak	Q. velutina
post oak	Q. stellata
blackjack oak	Q. marilandica
white oak	Q. alba
hickory	Carya spp.
beech	Fagus grandifolia
yellow poplar	Liriodendron tulipifera
sugar maple	Acer saccharum
eastern red cedar	Juniperus virginiana
sumac	Rhus spp.
sassafras	Sassafras albidum
alfalfa	Medicago sativa
Bermudagrass*	Cynodon dactylon
broomsedge	Andropogon virginicus
chess brome	Bromus secalinus
cheatgrass*	B. tectorum
smooth brome*	B. inermis
reed canarygrass	Phalaris arundinacea
orchardgrass*	Dactylis glomerata
spreading crabgrass	Digitaria decumbens
crown vetch	Coronilla varia
tall fescue	Festuca arundinacea
meadow fescue	F. elatior
foxtail	Setaria italica
timothy	Phleum pratense
Johnsongrass*	Sorghum halepense
sorghum*	S. vulgare
bicolor lespedeza*	Lespedeza bicolor
kobe lespedeza*	L. striata
Korean lespedeza*	L. stipulacea
sericea lespedeza*	L. cuneata
bluegrass	Poa pratensis
corn	Zea mays
soybean*	Glycine max
buckwheat	Fagopyrum esculentum
white clover	Melilotus alba
yellow clover	M. officinalis

Fauna

cottontail rabbit	Sylvilagus floridanus
gray squirrel	Sciurus carolinensis
raccoon	Procyon lotor
opposum	Didelphis virginiana
gray fox	Urocyon cinereoargenteus

Common Name	Scientific Name
white-tailed deer	Odocoileus virginianus
morning dove	Zenaidura macroura
bobwhite quail	Colinus virginianus
wild turkey	Meliagris gallopavo
ducks	Aratidae family
geese	Branta spp. and Chen spp.
hawks	Accipitriidae family
eagles	Haliaeetus spp.

Nebraska Area

Flora

cottonwood	Populus deltoidea and P. trichocarpa
ash	Fraxinus pennsylvanica
boxelder	Acer negundo
sandbar willow	Salix longifolia
big bluestem	Andropogon gerardi
little bluestem	A. scoparius
sand bluestem	A. hallii
switchgrass	Panicum virgatum
Scribner panicum	P. scribnerianum
indiangrass	Sorghastrum nutans
side-oats grama	Bouteloua curtipendula
blue grama	B. gracilis
hairy grama	B. hirsuta
needle-and-thread (needlegrass)	Stipa comata
porcupine grass	S. spartea
prairie sandreed	Calamovilfa longifolia
western wheatgrass	Agropyron smithii
slender wheatgrass	A. trachycaulum
sand lovegrass	Eragrostis trichodes
purple lovegrass	E. spectabilis
prairie cordgrass	Spartina pectinata
reedgrass	Calamagrostis canadensis
sand dropseed	Sporobolus cryptandrus
Canada wildrye	Elymus canadensis
prairie junegrass	Koeleria cristata
indian ricegrass	Oryzopsis hymenoides
lead plant	Amorpha conescens
blowout grass	Redfieldia flexuosa
sand paspalum	Paspalum stramineum
red top*	Agrostis alba
Kentucky bluegrass*	Poa pratensis
timothy*	Phleum pratense
alfalfa*	Medicago sativa
red clover	Trifolium pratense
alsike clover	T. hybridum
threadleaf sedge	Carex filifolia

Common Name	Scientific Name
sedges	Carex spp. and Cyperus spp.
corn*	Zea mays
sorghum*	Sorghum vulgare

Fauna

bobwhite quail	Colinus virginianus
morning dove	Zenaidura macroura
ducks	Anatidae family
geese	Branta spp. and Chen spp.
sharp-tailed grouse	Pedioecetes phasianellus
prairie chicken (pinnated grouse)	Tympanuchus americanus
ringneck pheasant*	Phasianus colchicus
hawks	Accipitriidae family
white-tailed deer	Odocoileus virginianus
mule deer	O. hemionus
pronghorn antelope	Antilocapra americana
coyote	Canis latrans

Texas Area

live oak	Quercus virginiana
shin oak	Q. annulata
Texas oak	Q. texana
lacey oak	Q. laceyi
post oak	Q. stellata
blackjack oak	Q. marilandica
ashe juniper	Juniperus ashei
curly mesquite	Prosopis pubescens
black walnut	Juglans nigra
pecan	Carya illinoensis
elm	Ulmus americana
willow	Salix nigra
sycamore	Platanus occidentalis
bald cypress	Taxodium distichum
prickly pear	Opuntia spp.
yucca	Yucca spp.
big bluestem	Andropogon gerardi
little bluestem	A. scoparius
cane bluestem	A. spp.
pinhole bluestem	A. perforatus
switchgrass	Panicum virgatum
Scribner panicum	P. scribnerianum
fall witchgrass	P. dichotomiflorum
indiangrass	Sorghastrum nutans
bristlegrass	Setaria viridis and S. lutescens
Canada wildrye	Elymus canadensis
lovegrass	Eragrostis spp.

Common Name	Scientific Name
sideoats grama	Bouteloua curtipendula
buffalo grass	Buchloe dactyloides
dropseed	Sporobolus spp.
triodia	Triodia spp.
paspalum	Paspalum spp.
melic	Melica spp.
threeawn	Aristida spp.
muhly	Muhlenbergia spp.

Fauna

white-tailed deer	Odocoilens virginianus
javelina (peccary)	Pecari angulatus
bobcat	Lynx ruffus
raccoon	Procyon lotor
ring-tailed cat	Bassariscus astutus
opposum	Didelphis virginiana
skunk	Mephitis nigra
squirrels	Sciurus spp.
quail	Colinus spp.
wild turkey	Meliagris gallopavo
sika deer*	Cervus nippon
red deer*	C. elaphus
moufion sheep*	Ovis musimon
aoudad*	Ammotragus lervia
blackbuck antelope*	Antilope cervicapra
axis deer*	Axis axis
wild boar*	Sus scrofa

*Introduced species

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