United States Grasslands and Related Resources:

An Economic and Biological Trends Assessment[1]

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[1] Financial support of this report was provided by the National Cattlemen's Beef Association, The Nature Conservancy, and Ducks Unlimited.

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Executive Summary

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Where are the grasslands?

Historically, grasslands occupied approximately one billion acres in the US—about one half of the landmass of the 48 contiguous states. The vast majority of the grasslands were found west of the Mississippi River. However, some native grasslands were scattered throughout the Midwestern and Southeastern States.

Most existing privately owned grasslands are in the Central Plains region between the Mississippi River and the foothills of the Rocky Mountains. At pre-settlement, 64% of the US grasslands were east of the Rocky Mountains. Grasslands west of the Rocky Mountains (approximately 332 million acres) were largely retained under federal management, while more than 90% of those lands east of the Rockies (approximately 565 million acres) were placed under private ownership.

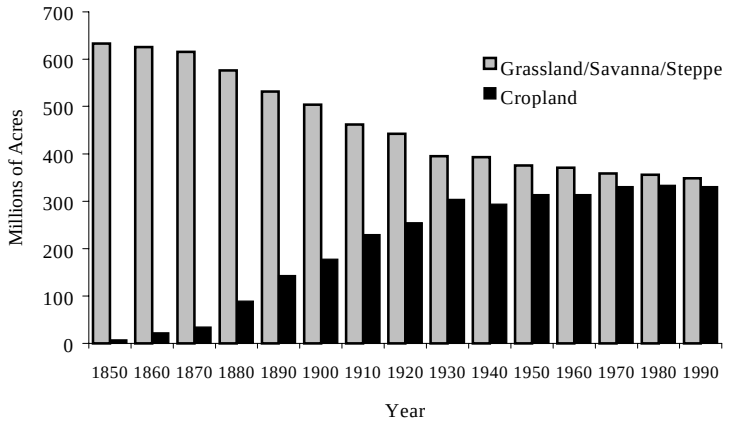
Over 80% of the pasture and rangeland in the 22 western states is in operations whose owners are sole proprietorships, partnerships, or family-held corporations and are operated by persons over 45 years of age. Approximately 90% of the pasture and rangeland is in farms or ranches that contain 6,000 or more acres and have operators who own either all or part of the land they operate.

Why are grasslands important?

Grasslands provide both ecological and economic benefits to local residents and society in general. The importance of grasslands lies not only in the immense area they cover, but also in the diversity of benefits they produce.

Ecological Significance

Grasslands provide valuable ecological services such as nutrient cycling and storage of substantial amounts of atmospheric carbon. In general, these ecological functions can be sustained under moderate to light grazing. However, following cultivation grassland soils are likely to lose up to 50% of their original carbon within the first 40 to 50 years.



Estimated land coverage by native grassland/savanna/steppe *versus* croplands in the US west of the Mississippi River, 1850-1990.

Grasslands are key to an efficient hydrologic cycle. The quality and quantity of water runoff and infiltration is dependent upon the quality of ground cover. Converting grasslands to other uses, like cropping, results in increased soil erosion and decreased water quality through increases in sedimentation, dissolved solids, nutrients, and pesticides.

The biotic diversity of North American grasslands is probably the most altered by human impact of any of the continent's terrestrial ecosystem. The ecological status of many existing grassland systems are heavily influenced at the local level by combinations of habitat fragmentation, undesirable habitat changes due to fire exclusion, declining range conditions due to improper grazing management, and loss of habitat values due to the spread of invasive and non-native plants. Further complications arise from demographic trends related to changes in land ownership. As a result, many species endemic to grasslands have declined substantially in the recent past.

Economic importance of grasslands

Native grasslands and rangelands directly support the livestock industry. Over 86% of the breeding sheep in the US are located west of the Mississippi River along with numerous domestic goats and horses whose main feed source is derived from grasslands. The January 1 inventory of cows that have calved in states west of the Mississippi River have averaged over 25 million head this past decade. Grasslands make up over 95% of the deeded acreage it takes to maintain beef cattle in the Great Plains and Western US.

Grasslands also support recreational based activities. According to the US Fish and Wildlife Service, more than 27 million people in the states west of the Mississippi participated in fishing, hunting, and wildlife observation in 1996. Expenditures related to these activities exceeded $37 billion.

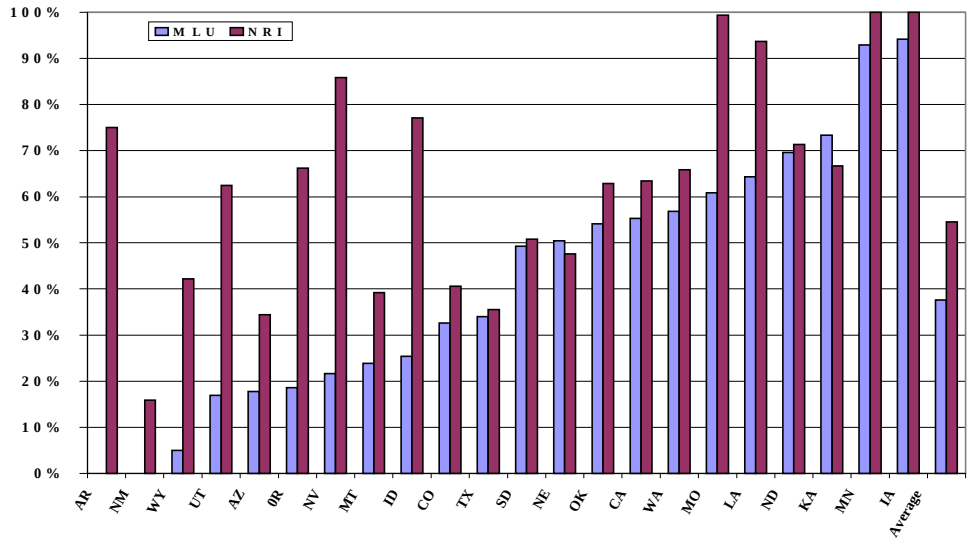
The benefits of open space and scenic amenities afforded by private grasslands are increasingly recognized. Land prices bordering open space have been found to be 7 to 32% higher than those not bordering open space. Large working farms and ranches also make fewer demands on community services than the rural residential development that often replaces them.

Trends in grasslands

In the 100 years from 1850 to 1950, grasslands west of the Mississippi River declined by 260 million acres as shown above, with the majority converted to cultivated cropland. In the 40 years from 1950 to 1990, another 27.2 million acres of grassland was lost. About 36% (9.8 million acres) of these recent losses were conversions of grasslands to uses other than cropland.

Differences in the definition of grasslands make estimating current acreage difficult. The following figure compares the percent of potential grassland acres lost as indicated by the 1997 Major Land Use (MLU) and 1997 National Resources Inventory (NRI) reports. Federal grasslands are included in the estimate of potential grassland acreage and in the MLU data, but excluded in the NRI data. The MLU and, to some extent, the NRI include non-native seeded pastures. Thus, the NRI will underestimate the area of remaining grasslands for states with federal lands, while the MLU, and possibly the NRI, will overestimate remaining native grasslands in states with relatively more non-native pasture. Despite these discrepancies, it is clear there are few native grasslands remaining in Arkansas, Iowa, Louisiana, Minnesota, and Missouri. Many other western states still have significant acreage of native grasslands remaining, much of which is under private ownership. By 1997, USDA reported 402 million acres of "rangeland" in the 22 states west of the Mississippi River, excluding federal lands.

Examination of areas in Colorado, Idaho, Montana, North Dakota, South Dakota, and Texas not only supported a general decline in grasslands, but also showed the dynamics involved. While 4 to 9% of the land classified as rangeland in each state was converted to other uses (mostly cropland, pastureland or urban land) between 1982 and 1997, in aggregate, loss in rangeland was less because of land being converted back to rangeland. While this reversal softens the total loss in rangeland, the ecological function of re-converted rangeland is reduced compared to undisturbed native grasslands. Converted rangeland is also more likely to be in smaller, discontinuous parcels, reducing its value as wildlife habitat relative to native grasslands. A variation in loss of rangeland within areas of each state also existed, with some areas experiencing a greater than 20% loss in rangeland and pastureland.



Percent of potential grasslands lost as indicated by 1997 Major Land Use (MLU) report of grassland pasture and range and National Resources Inventory (NRI) report of non-federal rangelands for the 22 western states.

Factors influencing grassland use

Pressure from growth in human population and per capita income, and the resulting demand for property and services, is an ever-increasing threat to the traditional use of grasslands. Between 1990 and 2000, the 22 states west of the Mississippi River gained more than 16.5 million people—a 17.3% increase. This growth was achieved in spite of nine Great Plains states growing by less than 10%.

In general, the policy of the federal government has been to support US production agriculture through protection or subsidization. A common, unintended result of many agricultural support policies has been to provide incentives to convert grasslands to crop production and/or to thwart the re-conversion of cropland back to grass. These "perverse" incentives are provided anytime a policy is the cause of land being more profitable if used as cropland in lieu of grassland. The Federal Estate Tax has also been cited as a cause of fragmentation of rural landholdings, although the presence of this tax creates incentives to retain lands in agriculture using perpetual conservation easements.

Many of the remaining grasslands are located in areas with high natural amenities. Low direct economic incentives to an aging population of grassland owners, combined with the longest economic boom in US history, advances in telecommunications and other socio-economic changes, contribute pressure to convert grasslands into large lot, rural or x-urban homesites.

Between 1990 and 2000, the market price of agricultural land increased 66% in the western US, indicating a significant increase in the demand for land. Most of this demand originated from non-agricultural interests as prices notably exceeded the productive value of the land.

Conclusions

Historically, the greatest threat to grasslands in the US has been the plow. While the trend of converting rangeland to cropland is still important in some areas, during the past several decades other trends have arisen that continue to threaten the existence and health of grasslands. Among these are relatively low returns to the ranching industry, coupled with an increased demand for grasslands for development purposes. Unless abated, these demands will not only continue to remove grasslands from their historical uses, but will continue to fragment that land so that the remaining grasslands may not be of sufficient size to support their natural biodiversity. One way to abate these pressures for fragmentation is to develop government programs to provide mechanisms and financial incentives to private grassland owners to facilitate grassland retention and restoration (e.g., conservation easements).

Revising government policies to ensure that they do not provide incentives to retain marginal cropland, or convert grassland to cropland, would enhance retention and restoration of grasslands under private ownership. Expanding programs that provide incentives to retain or restore wildlife habitat and encourage wildlife-based land use enterprises could also benefit the restoration and retention of grasslands (e.g., USDA-NRCS's Environmental Quality Incentives Program).

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United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 1: Why are grasslands important?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Vast expanses of prairies, savannas, and steppes once dominated much of the current arable land in the US. These were grasslands, the largest vegetation formation in North America. During settlement and subsequent development, these grasslands represented a substantial ecological resource that sustained a large portion of the US economy. Through time, the ecological and economic functions of these lands have changed. Much of the historical grassland area has been converted to other land use – perhaps irreversibly. Much of the remaining historical grassland area is degraded to the point that it can no longer support the same level of ecological and economic services. However, many natural grassland systems are resilient, and they may recover much of their ecological and economic potential following restoration efforts.

The interaction among climate, soils, and terrain mainly establishes the potential productivity of grasslands. However, it is ultimately the influence of grazing animals, fire, vegetation management, economic land use, and other human activities that largely determine the realized productivity of grasslands. Of the historical grasslands in the US, those with the greatest potential for productivity are on private lands. As a result a national grasslands conservation strategy must include programs designed to gain conservation benefits from private resource stewardship.

Scope of this report

The purpose of this report is to provide an assessment of economic and biological trends of US grasslands, focusing on private lands. Our goal is to provide the background and context for policy-makers to design an effective set of incentive-based programs for conserving natural grasslands. As such, we focus the assessments in this report on those areas that are at present, or were once, in a state of natural grassland. In particular, we examine land use trends across landscapes dominated by private and other non-federal ownerships.

What distinguishes grasslands?

Prevailing climate is the largest controlling factor in the development of natural grasslands (Lauenroth 1979). In the US, grasslands generally occupy areas receiving between 10 and 40 inches of annual precipitation, with both a wet and dry season; and having mean annual temperature of 32-79^{o}F, with seasonal extremes (Lieth 1975). Grassland development is more specifically controlled by complex climatic factors such as the ratios between precipitation and evaporation and the seasonality of precipitation in relation to the temperature regime (Risser *et al.* 1981). Although trees can, and do, grow in many grassland systems, the seasonal variability in precipitation in most grassland areas generally precludes full forest development.

In this assessment, we distinguish between *natural grasslands* – those that are climatically controlled; and *derived grasslands* – those that are created as a product of human management. We recognize two types of derived grasslands: successional grasslands and agricultural grasslands. Successional grasslands are a product of forest or shrub removal and subsequent maintenance of a grassland condition by combinations of burning, mowing, or grazing (Lauenroth 1979). Successional grasslands can be highly productive (at least initially), due to the high precipitation that sustained the previous forest. Agricultural grasslands are a result of intensive agronomic practices, usually including cultivation and planting of improved or introduced grasses and maintained by irrigation, mineral fertilization, or both (Lauenroth 1979). Many areas of potential natural grasslands are now converted to agricultural grasslands.

US grasslands: Global context, distribution, and classification

Global context

Grasslands (prairies, savannas, steppes, shrub steppes, desert grasslands, and alpine meadows) are, potentially, the naturally occurring vegetation on almost 13 million square miles (>8 billion acres) of the Earth's surface (Table 1.1), accounting for approximately 25% of the global land area (Shantz 1956; Risser *et al.* 1981; Ramankutty and Foley 1999). Major concentrations of the world's grasslands are located in tropical Africa, the Newly Independent States of the former Soviet Union, tropical South America, China, and Western North America.

Global trends

Between 1700 and 1992, approximately 20% of the world's grasslands were converted to other land use and cover. Conversion rates in the US were substantially greater than the cumulative global average during this period. Over that period, almost 50% of US grasslands were converted to other land uses – mostly cropland (Ramankutty and Foley 1999). Post-settlement conversion of grasslands in the US has

outpaced the conversion rates in most major temperate grassland systems of the world (Figure 1.1). The former Soviet Union has lost 381 million acres of its grasslands, compared to 339 million acres converted in the US. However, a higher proportion of the former Soviet Union's grasslands remain compared to the US.

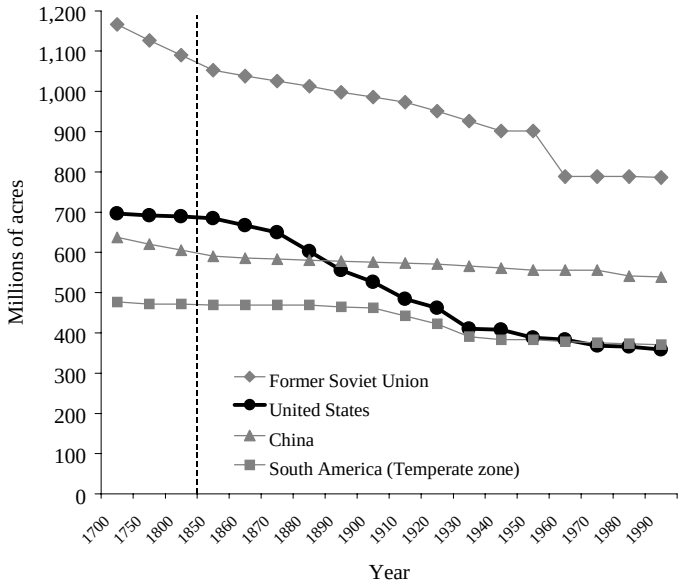

Figure 1.1. Estimated trends in coverage by native grassland/savanna/steppe in 4 major temperate zones, 1700-1990. Note that intervals prior to 1850 are at 50-year increments, and 10-year increments thereafter. Data source: Ramankutty and Foley (1999b)

US distribution

The potential natural grasslands of the United States occupied portions of six major physical provinces (Figures 1.2-1.5, maps and associated information adapted from Kuchler 1974, Omernick 1986, and Ricketts *et al.* 1999). From east to west, these are the Central Lowlands, the Coastal Plains, the Desert Southwest, the Great Plains, the Great Basin, and the Central Valley of California. These grasslands can be divided into 2 major biomes: the Central Plains and Western Grasslands, which are separated from north to south by the Rocky Mountains (Figure 1.2). The Western Grasslands and those of the Central Plains differ greatly in their terrain, climate, predominant land use, and ownership status.

Central Plains. – Of the historical grasslands throughout North America, those of the Central Plains are the most extensive, dominating a region of about 688 million acres (Figure 1.3, Table 1.2). The terrain of the Central Plains slopes gently from the base of the Rocky Mountains to the banks of the Mississippi River. Along that west to east transition, annual precipitation gradually increases, and grassland

ecosystems correspondingly shift from shortgrass prairie, to mixed-grassed prairie, tallgrass prairie and, finally, savanna (Figure 1.3). Thus, four major grassland regions are generally identified with the Physical Provinces of the Central Plains: 1) shortgrass prairies of the Great Plains; 2) mixed-grass prairies of the Great Plains; 3) tallgrass prairies of the Central Lowlands and Coastal Plains; and 4) the savannas of the Central Lowlands and Coastal Plains (Table 1.2).

At 424 million acres, the Great Plains is the largest grassland province in North America. From the west, the boundary of the Great Plains begins at the base of the Rocky Mountains and terminates, as a general rule, between the 95th and 100th Meridian (Figure 1.3). At its the southern boundary, the Great Plains converges with the Cross-timbers of Oklahoma and Texas as well as the more dissected terrain of the Edwards Plateau.

In the Central Lowlands, and Coastal Plains east of the Great Plains, tallgrass prairies and savannas were the dominant vegetation across 260 million acres. In many areas along its eastern edge, the tallgrass prairies graded smoothly into tallgrass savannas with oaks as an overstory, and the latter gradually merging into oak forest. A "prairie peninsula" once extended eastward through Illinois and Indiana, with some tallgrass prairie extending as far as central Ohio (Benninghoff 1964; Oosting 1956; Harrington and Harmon 1985). Fire probably played a critical role in maintaining the tallgrass prairies and savannas, especially in the areas of transition with oak woodland (Harrington and Harmon 1985). Tallgrass prairies and savannas were once scattered throughout several states east of the Mississippi River. Important and notable occurrences of natural grasslands are documented in Wisconsin, Michigan, Illinois, Indiana, Ohio, Kentucky, and Tennessee (Figure 1.5). A large majority of these Eastern Grasslands have either been converted to other land uses or have been transformed to woodland by virtue of fire exclusion. Conservation of those Eastern Grasslands that do remain would seem to be a critical component of an overall grassland conservation strategy.

Western Grasslands. – The Western Grasslands dominate the US landscape west of the Rocky Mountains and east of the Cascades. Western Grasslands lie in 2 major physical provinces, the Great Basin and the Desert Southwest, and spread across a region of 386 million acres (Table 1.2). The grassland area within this region is dissected by mountainous terrain and intermingles with various forest types (Figures 1.4-1.6). The Mediterranean Grasslands in California's Central Valley are also part of the Western Grasslands.

Much of the western landscape classified here as "grassland" falls more comfortably under a broader definition of rangeland. That is, those areas "which by reason of physical limitations – low and erratic precipitation, rough topography, poor drainage, or cold temperatures – are unsuited to cultivation…"(Stoddard *et al.* 1975). Grasses might not always dominate much of that which is considered western rangeland. In fact, much of the land identified here as Western Grassland is naturally occupied by shrub-dominated ecosystems, as well as sparsely vegetated desert terrain.

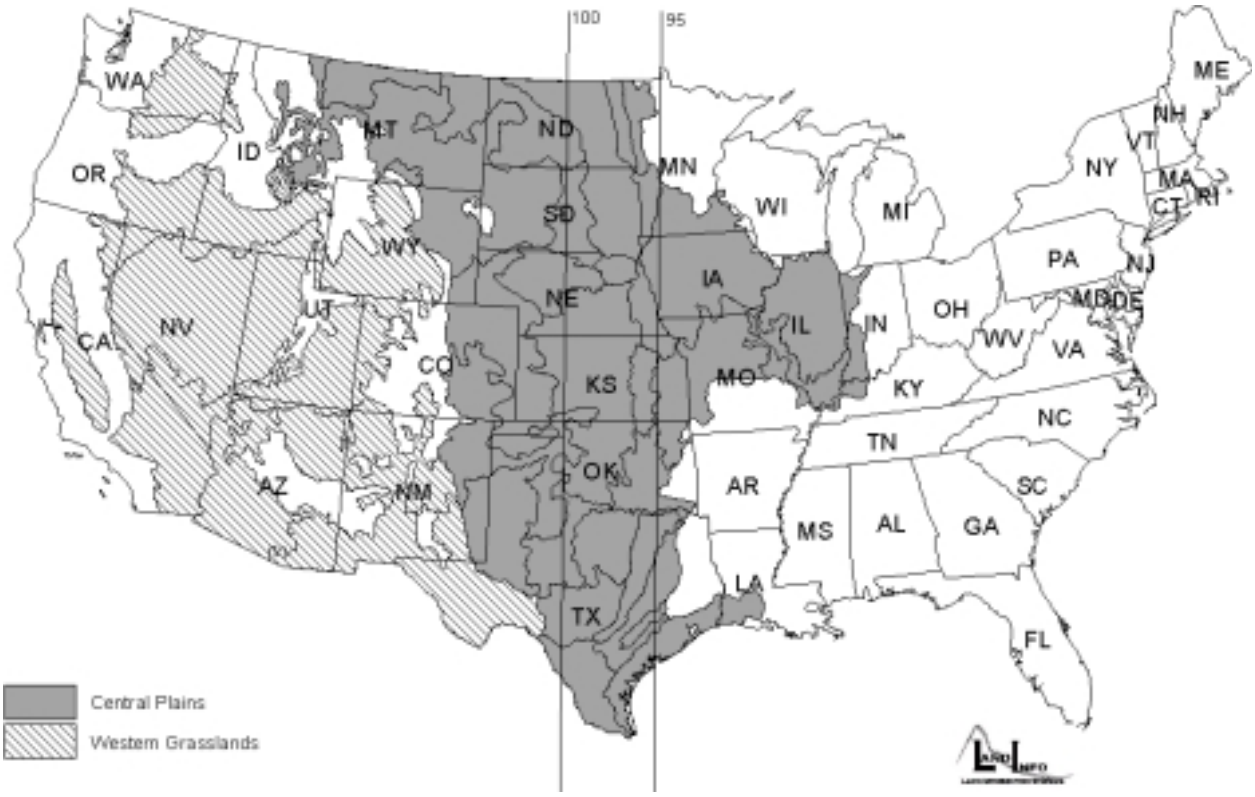

Figure 1.2. The 2 major grassland biomes of the contiguous US, the Central Plains and Western Grasslands.

Figure 1. 3. The Great Plains and 2 adjacent grassland types (savannas and tallgrass prairies), together constituting the Central Plains of the US. The vertical lines represent the 100th and 95th Meridians.

Figure 1. 4. Grassland provinces of the Western US.

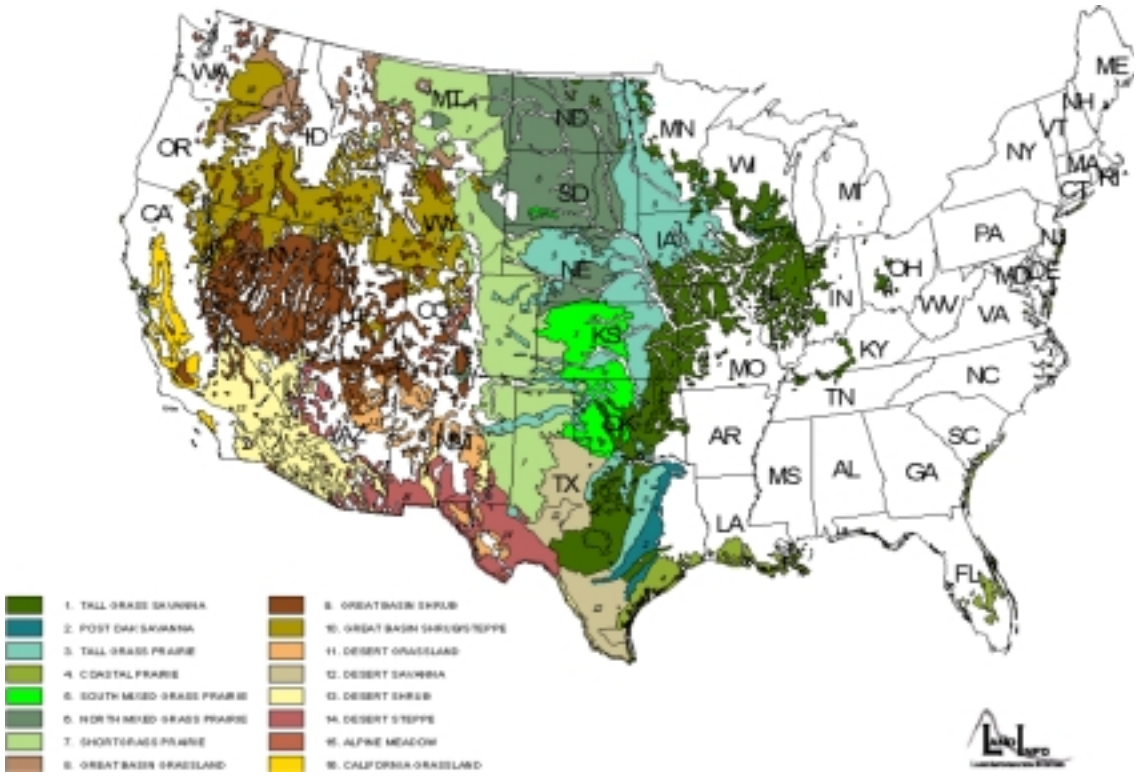

Figure 1. 5. Coverage of pre-settlement grasslands in the contiguous US, by type. Adapted from Kuchler (1974).

Extent of US grasslands: State-level

Pre-settlement. – As depicted in Figure 1.5, we estimate the total extent of potential grassland in the US at about 923.1 million acres. We assume this to be the extent of grasslands prior to Euro-American settlement. Historically, about 29 million acres of grassland occurred east of the Mississippi River, or about 4% of the grasslands in the US. About 25 million acres of this area were tallgrass savanna located in Illinois, Indiana, Ohio, and Kentucky, which is now, largely, under cultivation or converted to other land uses. The remaining four million acres includes small, scattered pockets of tallgrass prairies and savannas, as well as a belt of Coastal Prairie through the Southeastern US (Figure 1.5).

Within those states west of the Mississippi, the pre-settlement extent of grasslands was approximately 882.9 million acres (Table 1.3). Together, Texas and Montana account for about 23% of the potential grassland in the contiguous US. The cumulative acreage found in Nevada, California, Arizona, New Mexico, and Wyoming account for another 27% of the potential. The smaller Great Plains states of Kansas, Nebraska, South Dakota, and North Dakota were almost completely dominated by natural grasslands prior to settlement (Figure 1.5).

Ownership status. – In contrast to the private farmlands and ranchlands in the Central Plains, the majority of Western Grasslands are under federal ownership (Figure 1.6). Notable exceptions include the California Grasslands, the desert steppes and grasslands of Trans-Pecos Texas, and the Great Basin shrub/steppe and grasslands of eastern Washington (Figure 1.5). The US Bureau of Land Management (BLM) administers most Western Grasslands.

Compared to those in the west, federal parcels in the Central Plains are small and scattered (Figure 1.6). Federal ownership of grasslands in the Central Plains amounts to about 18 million acres. The BLM administers about 8.8 million of these acres. The USDA Forest Service manages about 7 million acres, 4 million of which are in the National Grasslands System. The USDI Fish & Wildlife Service manages about 1.6 million acres, and the National Park Service manages about 330,000 grassland acres. Combined federal management accounts for approximately 4.2% of the pre-settlement grasslands of the Central Plains (Licht 1997). However, about 84% of these federal lands are in the more arid shortgrass prairies, leaving the mixed-grass and tallgrass systems with more limited federal administration.

Figure 1. 6. Federal ownership of lands in the contiguous US.

For each state west of the Mississippi, the area of pre-settlement grassland in regions dominated by non-federal ownerships was estimated (Table 1.3). Using these figures, we estimate that approximately 582.5 million acres of grasslands once occupied those landscapes that are now dominated by non-federal management, primarily private ownership. Nationwide, this accounts for about 63% of the pre-settlement grasslands. When ranked by our non-federal grassland estimates, the 13 states of the Central Plains (still including only those west of the Mississippi) rise to the top of the list of non-federal grasslands. The combined non-federal land in these 13 states account for about 93% (about 541 million acres) of the pre-settlement grassland acreage across those areas dominated by private ownership (Table 1.4).

Trends in land use

Post-settlement trends--Very little conversion of native grasslands had occurred west of the Mississippi River prior to 1850. However, in the 100 years from 1850 to 1950, the area of cultivated cropland west of the Mississippi expanded by nearly 3.1 million acres/year (Figure 1.7). As a direct result, grassland area declined 2.6 million acres/year on average over the period. Most of this plow-up was concentrated in the Central Plains. The tallgrass prairies and savannas were the earliest to be converted to cropland, now representing the bulk of the western Cornbelt. Most cropland conversions in the drier mixed- and shortgrass prairies were not undertaken prior to major Federal encouragements. In the 1880s, booms in homesteading and wheat farming in the shortgrass prairies followed passage of the Homestead and Timber Culture Act (Helms 1981). Successive droughts, commodity price fluctuations, speculation, and agricultural productivity encouragements (associated with both World Wars), all combined with the economy of a growing nation, resulted in continued conversion of Great Plains grasslands well into the middle of the 20th Century (Helms 1981; Laycock 1987; and Willson 1995). Much of the plow-up in both the 1920s and 1940s included several millions of acres that soil erosion experts considered unsuitable for cultivation. As a consequence, the relatively moderate droughts in the decade following each of these plow-ups resulted in the “dust bowl” of the 1930s and the “Filthy Fifties” (of the 1950s).

All told, about 50% of the pre-settlement grasslands in the US have been converted to cropland or land cover other than native grasses. Notably, the grassland types in the Central Plains have suffered disproportionately relative to their pre-settlement area. Some estimates suggest that the tallgrass prairies and savannas of several mid-western states have declined by as much as 99% (Sampson and Knopf 1994). Likewise, the mixed-grass prairies have declined by an estimated 30-81% and shortgrass prairies by an estimated 20-80%, with estimates varying by state (Sampson and Knopf 1994).

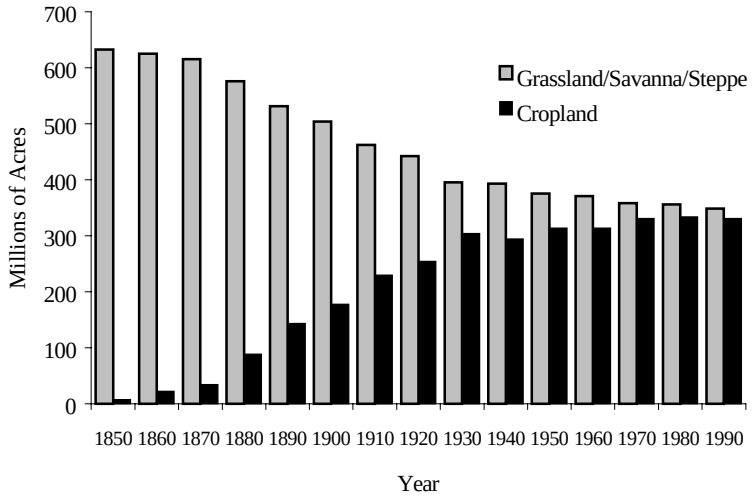

Figure 1. 7. Estimated land coverage by native Grassland/Savanna/Steppe versus Croplands in the US west of the Mississippi River, 1850-1990. Data Source: Ramankutty and Foley (1999b).

***Note**: Although Ramankutty and Foley (1999b) also based their analyses on the designations of Kuchler (1975), their overall total for pre-settlement grassland falls approximately 245.38 million acres short of our estimates (see Table 1.3). By visual inspection of Ramankutty and Foley's maps, it appears they did not include Desert Steppe, Desert Savanna, Desert Shrub, Great Basin Shrub, and Post Oak Savanna in their analyses – these types account for 246.67 million acres. We attribute the additional 1.2 million acre disparity to mapping errors and rounding errors in acreage calculation.*

In addition, several types of Western Grasslands have suffered disproportionate losses, primarily on privately-owned landscapes. For example, more than 99% of Great Basin (Palouse) grasslands have been lost to agricultural use (Ricketts *et al.* 1999). Likewise, land use conversions and exotic introductions have left most of the grasslands of California's Central Valley with less than 1% of their native flora (Ricketts *et al.* 1999). The fact that other Western Grassland types may have escaped large-scale conversion should not be taken to mean that they remain unaltered. In fact, the flora and fauna of many Western Grassland types have undergone dramatic changes since pre-settlement, while remaining as native grassland

Recent trends—Market incentives and farm policies have frequently encouraged the cultivation of millions of acres of grasslands that are unable to ecologically or economically sustain intensive farming practices. While the amount of grassland acreage in the US continues to vary with the economic and political ebbs impacting agriculture, the grassland conservation programs started in the 1950s and continued today may have tempered the damage incurred by successive cycles of drought and cropland plow-up. In the 40 years from 1950 to 1990, net gains in cropland were about 432 thousand acres/year (Figure 1.7). However, the loss of grasslands during this period was about 680 thousand acres/year –

suggesting that as much as 36% of the losses of grasslands over the last 50 years may be attributed to conversion to uses other than cropland.

Trends according to land use— Statistical surveys and studies conducted by agencies within the US Department of Agriculture help to provide a current and more spatially detailed look at trends in the uses of grasslands and former grasslands. The three major sources available to examine current trends in land use are Major Land Use (MLU) reports, the National Resource Inventory (NRI) and the Census of Agriculture. Although all three data sources are differ in their spatial and temporal coverage, as well as in the ownership of the land included in their designations, they all classify land by its use and, to some extent, ground cover. While these data sources don't define "grasslands" as such, they all focus on land that is used for grazing, land that is not in forest and land that is not part of a rotational cropping system (see Appendix A).

According Major Land Use[3] statistics, all but approximately 29 million acres, or 95%, of the nation's private and public grasslands (i.e., pasture and rangeland used for grazing) are located in the 22 contiguous states west of the Mississippi River (Vesterby and Krupa 2001). Over 606 million acres of grasslands in private and public ownership existed in this area in 1945. Currently, 551 million acres of grasslands are in private and public ownership, amounting to a loss of over 1 million acres per year. Most of this decline occurred by 1969, after which the rate of decline slowed (Figure 1.8). Some of the decreases in grassland pasture and range in western states can be attributed to an increase in wilderness areas that are not used for grazing or an increase in land that was reclassified as unsuitable for grazing (Vesterby and Krupa 2001). Declines in grassland pasture and range are generally associated with an increase in cropland conversion, especially during periods when the demand for crop products is high (Vesterby and Krupa 2001). Land use also may change to recreational, wildlife or environmental uses or it may revert to forested lands.

[3] The Economic Research Service publishes Major Land Use statistics at intervals coinciding with the US census of agriculture. Data from census, public land management agencies, conservation agencies and other sources are synthesized to estimate a consistent time series of public and private land uses for each state. Approximately 61% of total acreage classified by MLU statistics as grassland pasture and range in the US is in private holdings.

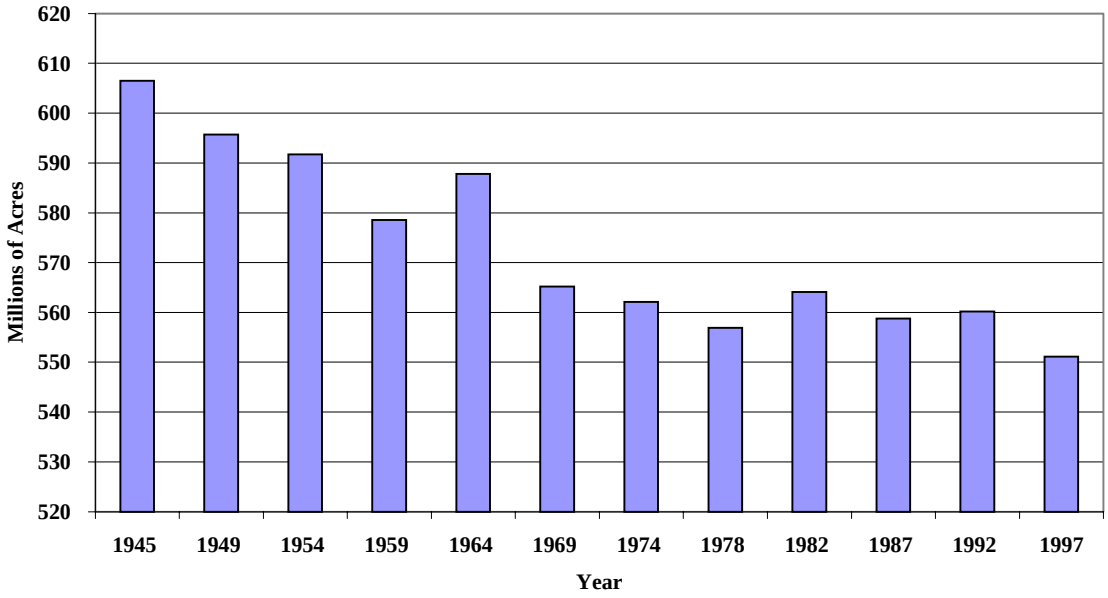

Figure 1. 8. Major Land Use estimates of trends in grassland pasture and range in the 22 contiguous states west of the Mississippi River, 1945 to 1997. Source: Vesterby and Krupa 2001.

The decline in grassland pasture and range has been most notable in many midwestern and western states. Iowa (-74.35% change), Minnesota (-59.62% change), Kansas (-38.17% change), Missouri (-37.17% change) and Utah (-33.01% change) experienced the largest decline in grassland pasture and range from 1945 to 1997 (Figure 1.9). A few states had a slight increase in grassland during this period, including Texas (+8.07% change) and Louisiana (+5.26% change).

Perhaps the most scientifically based inventory of the nation's land cover/use is the National Resource Inventory[4]. There was a 3.8% decline in what the NRI classifies as total rural land from 1982 to 1997. This downward trend was manifest in cropland, pastureland and rangeland. Over one half of the total rural land in the 22 contiguous states west of the Mississippi River was classified in 1997 by the NRI as rangeland (44%) or pastureland (7%) (Figure1.10). Cropland (27%) and forest land (16%) are the two other major components of total rural land (USDA/NRCS 2000).

[4] The National Resources Inventory (NRI) is conducted by the US Department of Agriculture's Natural Resources Conservation Service in cooperation with the Iowa State University's Statistical Laboratory (USDA/NRCS 2000). Data are collected at scientifically selected sample sites throughout the United States, Puerto Rico and the Virgin Islands. Data collection methods include photo-interpretation and other remote sensing methods, USDA field records, soil survey and wetland inventory maps and reports, plus other ancillary materials. Land is identified in the NRI by the type of land cover and land use. Land cover refers to the type of vegetation or kind of material that covers the land surface, while land use is the type of human activity that is centered on the land (USDA/NRCS 2000).

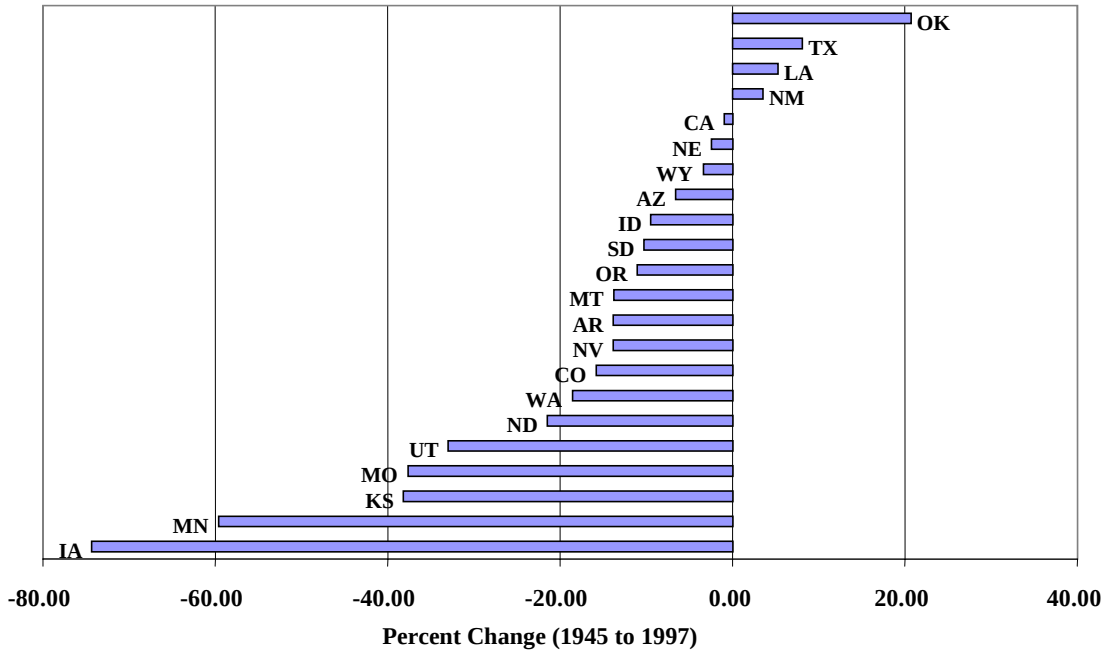

Figure 1. 9. Percentage change in grassland pasture and range for each of the 22 contiguous states west of the Mississippi River as determined by Major Land Use inventory estimates, 1945 to 1997. Source: Vesterby and Krupa (2001).

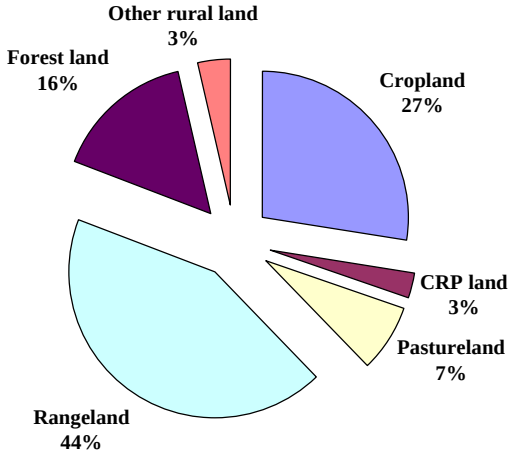

Figure 1. 10. Allocation of rural land in the 22 contiguous states west of the Mississippi River as determined by the National Resource Inventory, 1997. Source: USDA/NRCS 1997.

The movement of land in and out of different classifications is a dynamic process, with land cover/use continually changing. The NRI provides an estimate of how land changes between classifications for the 48 contiguous states, Hawaii and the Caribbean (Table 1.5). In 1982, there were 549 million acres in rangeland and pastureland over this area. By 1997, acreage in rangeland and pastureland had declined to 526 million acres. While this represents a net loss of 23 million acres, 62 million acres were actually removed from rangeland and pastureland between 1982 and 1997 (mostly to cropland) and 39 million acres was converted to rangeland or pastureland (Table 1.5).

Nationwide, most acreage enrolled in the CRP was previously classified as cropland (30.4 million acres), followed by pastureland (1.3 million acres), rangeland (0.7 million acres) and forest land (0.1 million acres) (Table 1.5). Much of the CRP acreage will be reclassified by 2007, as most of the CRP contracts are expected to expire between 2001 and 2006 (FSA/USDA 2001). In the 22 states under primary consideration, over 26 million acres were enrolled in the Conservation Reserve Program (CRP) as of 1997 when the last NRI was conducted (USDA/NRCS 2000). Texas (3.9 million acres), Kansas (2.8 million acres), North Dakota (2.8 million acres) and Montana (2.7 million acres) had the greatest number of enrolled acres (Table 1.6).

According to NRI statistics, the overall change in an individual state's rangelands was generally less compared to changes recognized in the MLU inventory. Iowa witnessed a –22% change in rangeland and pastureland from 1982 to 1997. The next highest changes occurring in Missouri (-14%) and Minnesota (-11%, Figure 1.11). Five states (Louisiana, Nevada, Utah, Wyoming and Arizona) experienced a slight increase in land classified as pasture or range.

A third source that can be used to examine trends in grassland acreage is the US Census of Agriculture (USDC/BC various years, USDA/NASS 2000). For the 22 states examined, 370,068 farms reported acreage in what the census terms "other pastureland and rangeland"[5]. In contrast 406,657 farms reported other pastureland and rangeland in 1978.

States with a large proportion of grazing on federal lands had a disproportionate decrease in other pastureland and rangeland, as defined by the census, compared to the acreage in grassland pasture and range obtained from the MLU reports. For example, Nevada and Utah had 46.3 million and 23.7 million acres in grassland pasture and range according to MLU statistics, which include public lands, but showed only 5.2 and 9.2 million acres classified under the US Census of Agriculture (see Tables 1.7 and 1.8).

[5] Because of inconsistencies in definitions, pastureland and rangeland data collected prior to 1978 are not presented.

Acreage in other pastureland and rangeland, as reported by the census, decreased between 1978 and 1997 in each state except for Utah and Missouri (Figure 1.12). Nevada had the largest decrease (-41.85% change) followed by Idaho (-32.32% change), Arizona (-25.47% change), California (-3.61% change) and Minnesota (-21.54% change). Most of the reduction in other pastureland and rangeland occurred between 1978 and 1982 and can probably be attributed to an increased demand for cropland commodities.

All three inventories (NRI, MLU and census) show a slight decline in total rangeland/pastureland from 1982 to 1997 (Figure 1.13 and Table 1.9). The MLU classification of grassland pasture and range gave the largest estimate of acreage. This was expected because federal and state lands were included in their inventory.

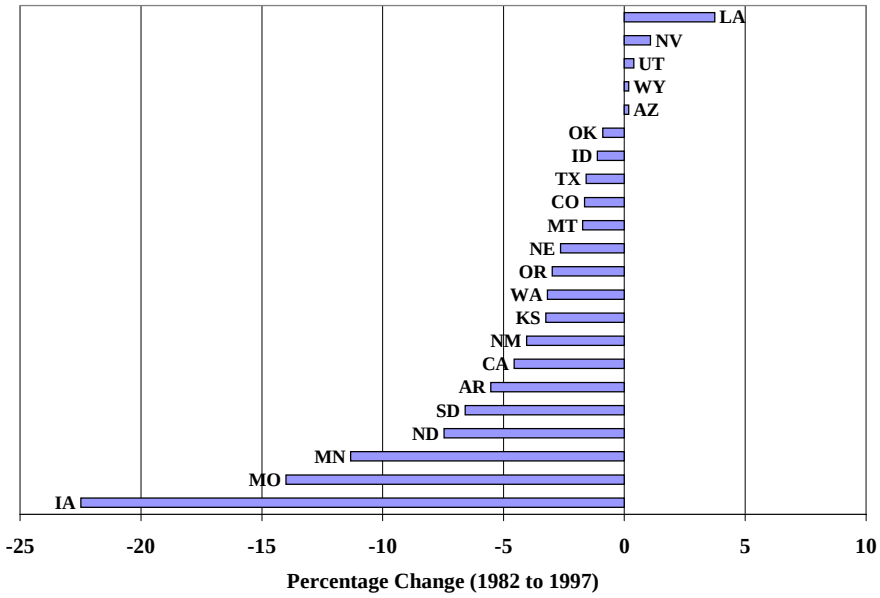

Figure 1. 11. Percentage change in rangeland and pastureland for each of the 22 contiguous states west of the Mississippi River as determined by the National Resource Inventory, 1982 to1997. Source: USDA/NRCS 1997.

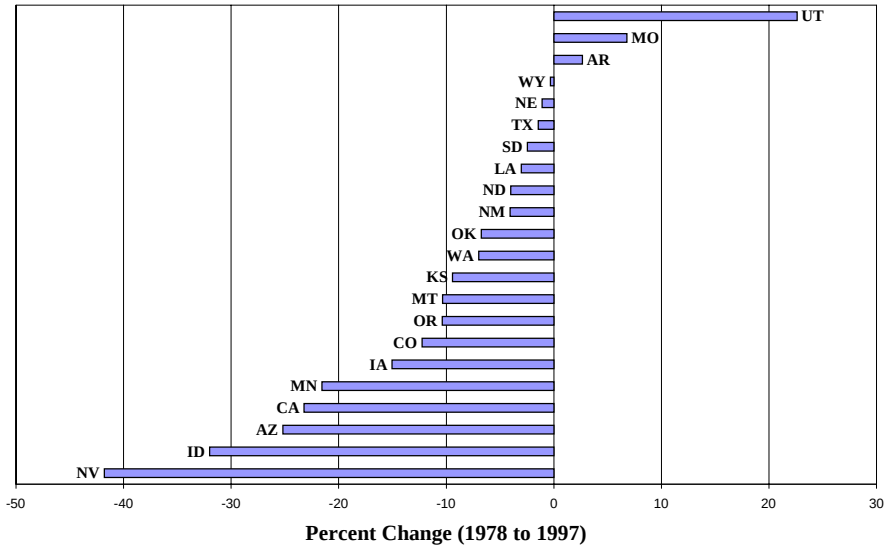

Figure 1. 12. Percentage change in rangeland and pastureland acreage for each of the 22 contiguous states west of the Mississippi River as determined by US Census of Agriculture inventory estimates, 1978 to 1997. Sources: USDC/BC various years, USDA/NASS 1997

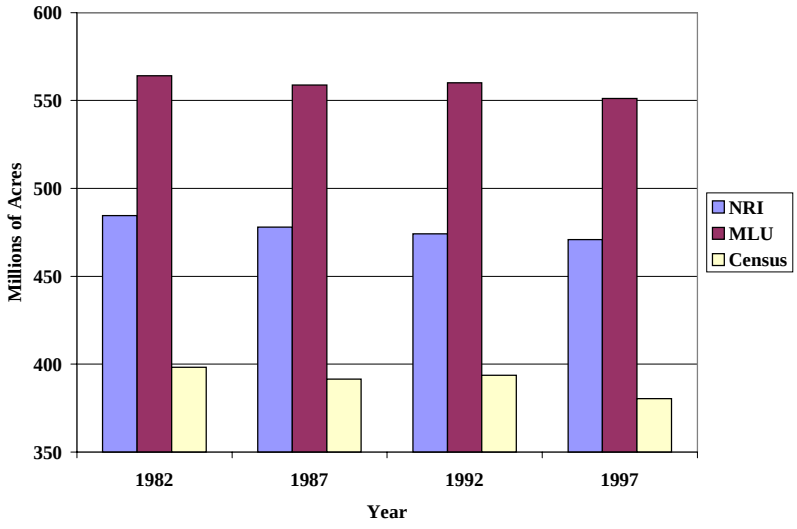

Figure 1. 13. Acres in rangeland/pastureland in the 22 contiguous states west of the Mississippi River as defined by the National Resource Inventory (NRI), Multiple Land Uses (MLU) and US Census of Agriculture. Sources: USDA/NRCS 1997; USDC/BC various years; USDA/NASS 1997; Verterby and Krupa 2001.

In general, current land use statistics show that grazing lands are mostly declining over time. Land classifications are dynamic, however, with land use and cover moving in and out of the different categories. Land reported to move back into rangeland from another category will not immediately provide the same ecological functions as the same, or similar, land that had been allowed to continuously remain as a grassland.

Ecological importance of grasslands

Ecological services/functions

Grassland ecosystems can be viewed as two related, but different, physiological processes: energy flows and chemical (nutrient) cycles (Briske and Heitschmidt 1991). The sun is the source of energy, which must first be utilized by plants via photosynthesis. The energy can then be stored in plant tissue and made available to grazing animals (herbivores). Animals convert the plant material to useable energy through the digestive process. Some of the herbivores are, in turn, consumed by carnivores or utilized by humans. Throughout this process some energy is dissipated by respiration. In addition, some of the plants and animals simply die and decompose and dissipate heat through microbial respiration. Once dissipated as heat, the energy cannot be recovered and reused. The energy flow through the ecosystem is thus dependent on the continuous supply of energy from the sun to be sustained.

Nutrient cycling

A second essential function of grassland ecosystems is to provide and transfer nutrients including carbon (C), nitrogen (N), and phosphorus (P), which are critical components of the biochemical processes of plant and animal life. Unlike energy, nutrients cycle from their reservoir within the soil, or atmosphere, through the plants and animals and then back into the soil or atmospheric reservoir. Plants initially assimilate many of the essential nutrients from the abiotic environment. Some nutrients become available for absorption by plants from weathering of soil parent material (eg. rock). Others, including nitrogen, must be converted into usable forms for plants by symbiotic microorganisms, in spite of the fact that they exist in large quantities in the atmosphere. Animals use the nutrients in their organic form (amino acids and proteins) by consuming the plants (herbivores) or other animals (carnivores). Some of the nutrients are then converted back to inorganic forms through the byproducts of digestion and respiration. This “mineralization” process is critical to grassland ecosystems because a large part of the essential nutrients in the system are bound with organic matter within the soil and cannot be absorbed by plants until they are transformed to inorganic forms through microbial decomposition (Briske and Heitschmidt 1991).

Some studies have shown that moderate to light grazing of grasslands with domestic herbivores does not increase nutrient losses from the system (Wilkinson and Lowery 1993; Woodmansee 1978; Floate 1981). In these cases, it appears that atmospheric nitrogen inputs and the increased cycling rates induced by the herbivores offset the losses due to human off-take of the animals. Heavy grazing of domestic animals results in nutrient losses to the system as animals removed for human consumption. Any grazing of domesticated animals on formerly native grassland changes the distribution of some nutrients via concentrating animal feces near watering and loafing areas (Holechek et al. 1995).

Carbon

General concern over the rapid rate of increase in CO_2 in the atmosphere has heightened during the past two decades. Grasslands, because of their natural capacity to create soil organic matter, and the natural occurrence of many US grasslands on highly basic soils formed on calcium (Ca) rich parent material, are capable of sequestering relatively large amounts of carbon. The carbon is held both in organic (SOC) and inorganic (SIC) forms. According to Lal et al. (1999), soil productivity decreased by 71% in the 28 years of cultivation following grassland sod breaking in the semi-arid Great Plains. Grassland soils are likely to lose between 20 and 50% of their original SOC within the first 40 to 50 years under cultivation.

In another report, Follett et al. (2001) estimate that reconverting cropland back to grassland can result in SOC sequestration rates ranging from 400 to 1,200 kg C/ha/yr. They further estimate that this rate could be maintained for approximately 25 years before the reconverted grasslands would reach a steady state where the annual soil output of C to the atmosphere would equal its input.

Recent international climate change discussions and proposed changes in US agricultural policy could result in incentives to landowners to adapt C-sequestering management practices (SWCS 2000). These incentives might be in the form of marketable C-credits or annual payments for participation. Regardless, one likely result of such a policy would be the re-conversion of additional acreage from cropland back to grassland.

Water

On most grasslands in the United States water is the most limiting factor to plant production. From a global perspective, however, there is a constant amount of water. Its specific form and location are regulated by the water (hydrologic) cycle. The hydrologic cycle is the continuous process whereby water is transported from the oceans to the atmosphere, then to the land and back to the oceans (Schuster 1996). Evaporation of water from the surface of oceans, lakes and streams lifts water as vapor into the

atmosphere where it forms clouds. The clouds are moved across the earth by wind currents. Soil, plants, animals, factories and motorized vehicles also contribute to this vapor. When sufficiently concentrated, the water vapor condenses and falls to earth as precipitation. Some of the precipitation, however, evaporates before it reaches the Earth's surface and returns to the atmosphere as vapor. About 70% of the precipitation that falls on grasslands evaporates (Holechek *et al.* 1995). The remaining precipitation infiltrates the soil, or moves laterally off the site as runoff into streams and lakes. Plants and animals use part of the water that infiltrates the soil or runs off, returning it to the atmosphere as vapor through transpiration and respiration. The remainder of the water that infiltrates the soil percolates through the soil profiles and accumulates in ground water aquifers. The water in aquifers may remain there, be pumped out through wells, or may move laterally across impermeable strata and emerge as spring flow into streams and other water bodies. Because of this interaction, land use actions that impact runoff and infiltration commonly impact the quality and/or quantity of both surface and ground water.

Quantities of water runoff and infiltration are dependent on land use, land cover, soil type, slope, and a number of other factors, in addition to the amount and intensity of precipitation. The grasslands in the US experience average annual precipitation ranging from about 10 inches in the West to 40 inches in the East (NOAA 2000). Consequently, average annual runoff in the region ranges from less than one inch per unit area in the drier areas to almost 20 inches in the wetter eastern portions (Holechek *et al.* 1995).

According to the USGS (2000) about 80% of all the water used by humans in the US comes from surface-water sources. However, more than 50% of our people, including almost everyone who lives in rural areas, use ground water for drinking and other household uses. Some ground water is also used by about 75% of US cities. Surface water use by the states west of the Mississippi River and the percent of total withdrawals from surface sources for 1990 are shown in Table 1.10. Fresh surface water uses in the US are in the power generation industry (50%), irrigation (33%), public/municipal (9%), industry (6%) and other (2%). These surface water sources, such as rivers and lakes, are supplied almost entirely by runoff from precipitation.

When other factors are held constant, land use and land cover, as influenced by human management, can have large impacts on infiltration and runoff. High infiltration results in a larger percent of precipitation being stored in the soil for plant use and for recharging groundwater aquifers. Alternatively, high rates of surface runoff may result in increased soil erosion and flooding. On grasslands, the primary factor influencing infiltration is vegetative cover. Welch et al. (1991) illustrate that, with a ground cover of bunch grasses, soil loss (erosion) from a 10 cm rain in 30 minutes was only 200 kg/ha with 24% of the

precipitation running off. Alternatively, with the same rainfall, soil loss was 1,400 kg/ha and 45% runoff with sod grass ground cover and 6,000kg/ha soil loss and 75% runoff for land with no vegetative cover.

Human activities, such as the conversion of grassland to cropland, result in reductions in vegetative cover and dramatically increase the potential for soil loss due to wind or water erosion. Average annual soil loss differences of 10 to greater than 60 times have been measured for similar watersheds with perennial grass cover versus continuous cropping (Krishna et al. 1988; Richardson 1988).

In addition to increasing the potential for erosion, the conversion from grassland to cropland also increases the likelihood that runoff water will carry excess chemical constituents that may impair water quality and negatively impact aquatic life and/or the use of surface water for public water supply. The chemical constituents are commonly grouped as dissolved solids, nutrients, pesticides and sediment (Huntzinger 1995).

Inorganic compounds such as sodium, calcium, and sulfate comprise the dissolved solids commonly found in surface water. While some of the excessive concentrations of these compounds result from the natural dissolution of rocks (e.g., sodium), agricultural activities, such as irrigation return flows, are a primary source in some areas.

Large concentrations of nutrients such as nitrogen and phosphorus in runoff water often result from the use of these nutrients as fertilizers on cropland. Elevated concentrations in surface water stimulate production of aquatic plants, depletion of oxygen and impairment of aquatic habitat.

The use of pesticides in agriculture has become pervasive over the past century and is part of the reason for the dramatic increases in agricultural productivity. In recent years, however, concerns about the potential effects of pesticides on humans and aquatic organisms have also heightened. According to Huntzinger (1995) several studies of large numbers of water samples from across the US have detected pesticides in less than 2% of the samples with the exception of Atrazine. One of the studies found several herbicides (most often Atrazine) in concentrations exceeding the USEPA maximums in spring and summer months in about half of the streams tested in the northern and central Great Plains.

Sediment is primarily the product of erosion and consists of solid materials suspended in and transported by water. Just as conversion of grasslands to cropland increases average annual soil loss, it elevates the quantities of sediment in the runoff water, which supplies our streams and lakes. Transport of sediment

can result in its deposition in stream and lakebeds, thus decreasing their ability to convey or store water and altering the associated aquatic habitat.

The estimates by Ramankutty and Foley (1999b) (Figure 1.7) indicate that almost half of the US grasslands were converted to cropland between 1850 and 1990. The accompanying increased exposure to soil erosion and deterioration in surface water quality in the region are immense.

Wildlife and Biodiversity

The biotic diversity of North American grasslands is probably the most altered by human impact of any of the continent's terrestrial ecosystem. The ecology of grassland ecosystems is dominated by the influence and interactions of human activities, herbivores, drought, and fire. The fauna and flora of North American grasslands has been altered and transformed by human activities for thousands of years. In fact, at the time of Euro-American arrival, the biological resources of most North American grasslands was already dramatically different than that experienced by earlier human occupants.

Impacts of early humans – Paleo-Indians arrived in North America a little less than 12,000 years ago. At that time, the Great Plains were occupied by a diverse assemblage of large-bodied herbivores, including horses, camels, rhinoceros, bison, tapirs, and elephants (Benedict *et al.* 1996). Skilled Paleo-Indian hunters occupied the Plains for approximately 3,000 years, contributing to the extinction of 32 genera of mammals – the peak of which was between 9,000 and 10,000 years ago (Flores 1995). Humans essentially abandoned the Plains about 6,000 years ago, due to the Altithermal, a 2,000 year drought that reduced plant diversity in the Plains by as much as 50% (Flores 1995).

Endemic species. – Endemic species are those that are naturally confined to a particular habitat type, likely owing to the fact that the species evolved there. Due to their close association with particular ecosystems, the population trends of narrow endemic species are likely to serve as indicators of ecosystem conditions (Knopf and Samson 1997). In the case of grasslands, monitoring those species that are least resilient to degradation and loss of native grasslands may provide the useful index to long-term changes in the overall ecological conditions of grassland systems.

Although grasslands provide habitat to a diverse assemblage of species, it appears that only a small proportion of the contemporary North American grassland fauna actually evolved in grassland regions. Most species presently occupying the grasslands were derived in other North American ecosystems and colonized grasslands from surrounding habitats. In one inventory of 138 mammals in the north-

central prairie states, 11.6% of the species were thought to have actually evolved in the Great Plains (Benedict *et al.* 1996 and citations therein). Of the grassland bird fauna, a minority are thought to be endemic to grasslands; 9 of 29 widespread "grassland birds" were classified as endemics by Knopf (1996) and Biddy *et al.* (1992). Likewise, of 124 species of reptiles and amphibians occupying the Central Plains, 15 are distributed primarily in the prairies (Corn and Peterson 1996).

Large mammals. – Large free-ranging herbivores continued to exert influence on the continent's grasslands through the mid-1800s. According to Shelford (1963:332), bison and pronghorn each numbered about 45 million in the grasslands of North America at the turn of the 17th century. While bison primarily dominated the Central Plains, pronghorn ranged much further into the arid Western Grasslands. These immense herds of grazing animals supported a large population of Gray Wolves, once conservatively estimated at 80,000 (Licht 1997), which are now largely extirpated.

By 1889, massive hunting efforts had reduced the Great Plains' bison herd to 541 individuals (Shelford 1963), virtually eliminating a major ecological driver of the biological development of grassland ecosystems. Likewise, pronghorn numbers were reduced to about 30,000 animals by 1924 (Shelford 1963). Through conservation efforts, bison and pronghorns had recovered to about 11,000, and 350,000 individuals, respectively by 1969 (Grossman *et al.* 1969). Populations have continued to increase, but there is no reasonable expectation that the full ecological functions of these species will be restored throughout significant portions of their former range in no small part due to the now pervasive influence of incompatible human activity in the region.

Bison were once an integral part of the various functions provided by native grasslands, including the development and maintenance of certain habitats for other species. In the absence of wild free-ranging grazing animals, managed grazing with domestic livestock seems to be a reasonable alternative in spite of the fact that native species, traditional and modern domestic livestock grazing regimes may differ substantially. Sims *et al*. (1978a) found that the biotic processes on grazed grasslands were more closely linked to abiotic variables than on ungrazed grasslands. This led them to propose that the consideration of grasslands without the interactions of large herbivores is an unnatural situation. However, the potential for long-term ecological damage from overgrazing by domestic livestock poses substantial management challenges on remaining grasslands that are not easily addressed by generalizations.

Prairie dog associates. – Prairie dogs (5 species) were estimated at 5 billion animals in the 1870s, and their colonies occupied between about 100-250 million acres of short- and mixed-grass prairies at the turn of the century (Bonham and Lerwick 1976; Miller *et al*. 1994). A single colony in Texas once occupied almost 16 million acres (Merriam 1902). The combined effects of land use conversion and eradication programs have reduced prairie dogs to as little as 2% of their former range (Miller *et al.* 1994). The absence of prairie dogs from a large portion of their previous range may have implications for numerous other species that prey on prairie dogs and use the unique habitats created by prairie dog grazing and their burrows.

Through their grazing and burrowing actions, prairie dogs can actually influence nutrient cycling and change the character of the surrounding prairie habitat. Grassland bird diversity and numbers can be locally increased in the area of prairie dog colonies (Agnew *et al.* 1986). In the shortgrass prairie, grassland birds such as burrowing owls, mountain plover, and horned lark tend to prefer grassland vegetation modified by prairie dogs, whereas some species such as grasshopper sparrows may favor grassland habitats undisturbed by prairie dogs (Baker and Sedgewick, Unpublished Report). As prairie dog numbers have drastically declined, the numbers of several species known to be associated with the habitats created by prairie dog activities have also declined. Thus, prairie dogs are frequently cited as a "keystone" species in maintaining the biotic diversity of prairie ecosystems (e.g., Miller *et al.* 1994).

While declining prairie dog numbers may be detrimental to several important species, the "keystone" role of prairie dogs might only apply to a subset of grassland species. Kotliar *et al.* (1999) critically reviewed a list of 208 vertebrate species that have been cited as being associated with prairie dogs and finally concluded that a tight dependence on prairie dogs was supportable for 9 of the cited species – these include the black-footed ferret, burrowing owl, mountain plover, ferruginous hawk, golden eagle, swift fox, horned lark, deer mouse, and grasshopper mouse. The federally endangered Black-footed ferrets prey upon prairie dogs, and prairie dog eradication efforts are directly implicated in the extirpation of that species throughout much of its former range in Great Plains. Kotliar *et al.* (1999) concluded that several of the other species closely dependent on prairie dogs are likely to suffer population declines with continued declines in prairie dog colonies.

Grassland birds. – Endemic grassland birds appear to be among the most rapidly declining groups of birds in North America (Knopf 1995). The North American Breeding Bird Surveys (BBS) supplies an extensive database for tracking changes in bird populations by species for various regions (Sauer *et al.* 2000). BBS trend data for 31 species of grassland birds in the contiguous US for the period 1966-1999

were reviewed (Table 1.11). The populations of 12 (39%) of the 31 species were found declining; 4 (13%) species were increasing; and the statistical significance of the remainder was too weak to draw a conclusion (Table 1.11). Of particular note, 7 of 9 species of grassland sparrows were in decline. Two declining sparrow species (Cassin's and Baird's) are endemic to grasslands.

When trends were examined separately for 16 Central Plains states (we included Idaho and 2 states east of the Mississippi in this analysis), some distinct regional trends emerged among the most northerly states of the Central Plains (Table 1.12). For several grassland birds, declining populations were most apparent in the Tallgrass Savanna/Prairie dominated states of Minnesota, Wisconsin, and Illinois; while several states in the northern Great Plains actually had increasing populations of several species.

While BBS data can be used to determine overall trends in numbers of relatively common and widespread species, there are several other species of grassland birds that are declining. Some declining bird populations are probably not the result of an overall loss of grassland area, but rather a long-term change in grassland habitat associated with land use. These changes are often the result of fire exclusion and unmanaged grazing, at times resulting in brush encroachment and other changes in vegetation structure. As a result, many of the former grassland habitats are increasingly colonized by eastern species that are more adaptable to increasingly woody vegetation. Species that rely on open grassland habitats have had diminishing habitat alternatives.

Implications for other species. – While large mammals, prairie dog associates, and grassland birds represent only a fraction of the native biotic diversity of grasslands, their status may hold implications for other species, and may well represent an overall loss in native biodiversity of grasslands. Grassland birds, due to their wide geographic range, but relatively narrow habitat affinities, may gauge the status of grassland species in other taxa. For example, Swengel and Swengel (1999) demonstrated that three grassland bird species (Henslow's sparrow, grasshopper sparrows, and Dickcissels) were correlated with five species of prairie butterflies across 109 sites in tallgrass prairie regions, suggesting that a trend in these bird species might indicate a trend in a close habitat associate.

Economic importance of grasslands

Land uses – Direct

Forage for grazing animals - Grassland forage is considered an intermediate good whose demand is derived from the demand of a final output, such as livestock or wildlife (Bartlett 1986). There are few

estimates of the total forage consumed by livestock on grasslands. Researchers have typically relied upon estimates of livestock numbers to examine the trend in the use of grazed forages (Gee *et al.* 1992).

The inventory of cows that have calved in the 22 contiguous states west of the Mississippi River peaked in 1975 at almost 34 million head and followed a downward trend until the early 1990s (Figure 1.14). The inventory of heifers 500 lbs and over essentially follows the same general trend as cows that have calved, with some lags due to cattle cycle effects.

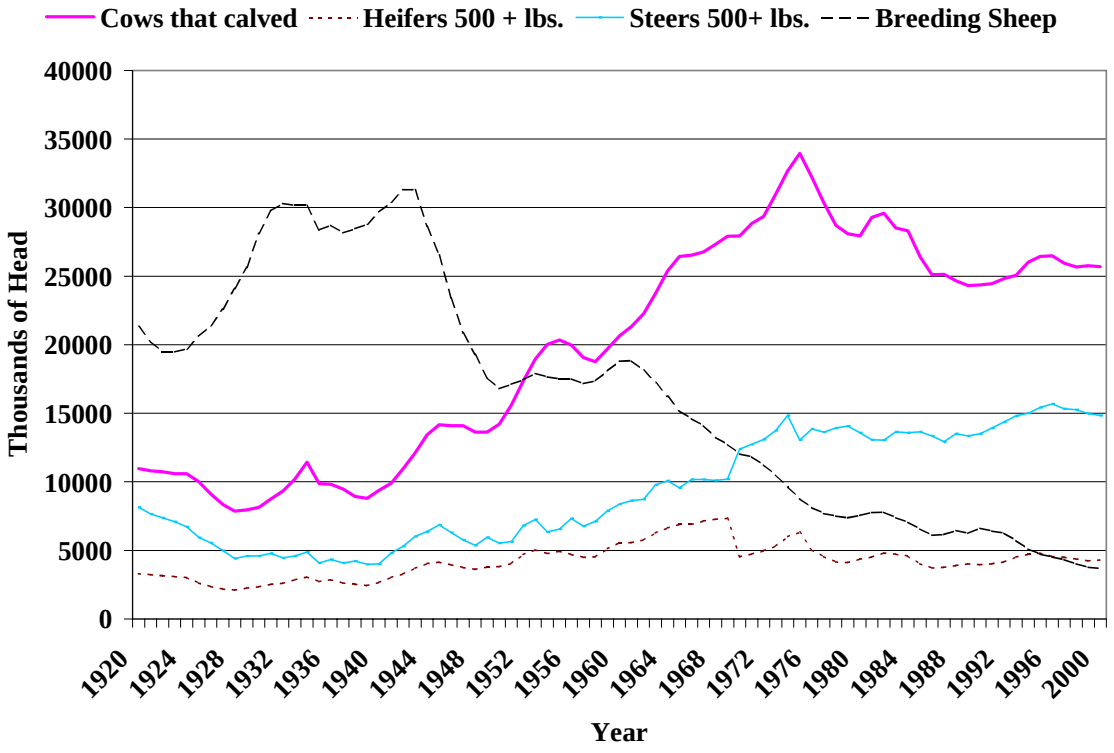

Figure 1. 14. January 1 inventory of cows, heifers, steers, and breeding sheep in the 22 contiguous states west of the Mississippi River, 1920 to 2000. Source: USDA/NASS 2000.

The inventory of steers 500 lbs and heavier have continued a steady increase for the last several decades (Figure 1.14). While many of these cattle will depend primarily on grazed forage as a feed source before entering a feedlot, the weight at which they enter the feedlot is dependent upon the cost of gain and the price of the animals. The increase in retention of stocker cattle for grazing forages can be due to feedlots reducing feeding costs and the desire of cow-calf operators to retain ownership of the calves longer to capture potential profits from additional growth (Gee and Madsen 1988).

In 1980, Gilliam (1984) examined the acreage of various forage sources grazed on cow-calf farms and ranches. In the Great Plains (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas and the front range parts of Montana, Wyoming, Colorado and New Mexico), dry range made up over 96% of the 13.48 acres it took to maintain a cow, excluding Bureau of Land Management (BLM) and US Forest Service (USFS) leases. In the remaining Western States not included in the Great Plains, almost 95% of the 20.44 acres required to maintain a cow, excluding BLM and USFS permits, were comprised of dry rangeland.

The direct economic returns to cattle production are usually the sole income generated from pasturelands used by ranchers. In 1999, pasture costs accounted for 14 to 33% of the estimated $408 to $486 per bred cow in operating costs for the typical cow-calf operation in the states west of the Mississippi (ERS/USDA 2000). These cost were separate from the costs associated with grazing cropland pasture and public land costs. When only operating costs were accounted for, profit (loss) averaged -$191.67 to 79.14 per bred cow. Subtracting overhead costs (e.g., capital recovery of equipment and opportunity cost of land) placed producers in a precarious economic situation with losses averaging between -$351.98 and -$667.36 per bred cow.

Sheep constitute the second most important rangeland dependent livestock industry in the United States. Over 86% of the breeding sheep in the United States are located in the 22 states being examined. The inventory of breeding sheep in these states peaked in 1943 at over 31 million head and has steadily declined to 3.7 million head in 2000.

According to Gee and Madsen (1988), the main source of grazed forages for beef cattle and sheep is deeded non-irrigated grazing land. In 1985, they conduced a study using livestock inventory numbers and survey data to estimate feed requirement for beef cattle and sheep on an animal unit month (AUM) basis. In the Pacific Northwest (PN), California (CA), Southwest (SW), and Northern Rockies (NR), cattle obtained 74%, 79%, 64% and 81% of their grazed forages from deeded non-irrigated land. This amounted to 9.9, 12.1, 8.3, and 95.7 million AUMs in the four regions. Sheep obtained 31%, 52%, 59% and 31% of their grazed forages from deeded non-irrigated land in the PN, CA, SW and NR regions. This accounted for 0.3, 1.1, 0.8, and 2.4 million AUMs in the PN, CA, SW and NR regions. Sheep obtained the majority of AUMs from public land grazing in the PN and NR regions.

Other types of livestock depend upon grassland for feed to differing degrees, including horses and goats. The amount of grazed forages consumed by horses and goats is small in comparison to sheep and cattle.

The number of horses on farms peaked at 20 million in the 1920s and has steadily declined since that time, in part due to the introduction of tractors. In the 22 states considered in this study, numbers of horses on farms (Figure 1.15) steadily increased from 1974 to 1987 before declining in 1997 (USDA/NASS 2000, USDC/BC various years). The National Agricultural Statistical Service (USDA/NASS 1999) inventoried the total population of horses in 1998 and 1999 and found that approximately the same number of horses existed off-farm as on-farm.

According to the US Census of Agriculture (USDA/NASS 2000, USDC/BC various years), goat numbers, in the 22 states under consideration, most recently peaked in 1992 at just over 2 million head, but declined in 1997 to less than 0.9 million head (Figure 1.15). This inventory includes both milking and angora goats.

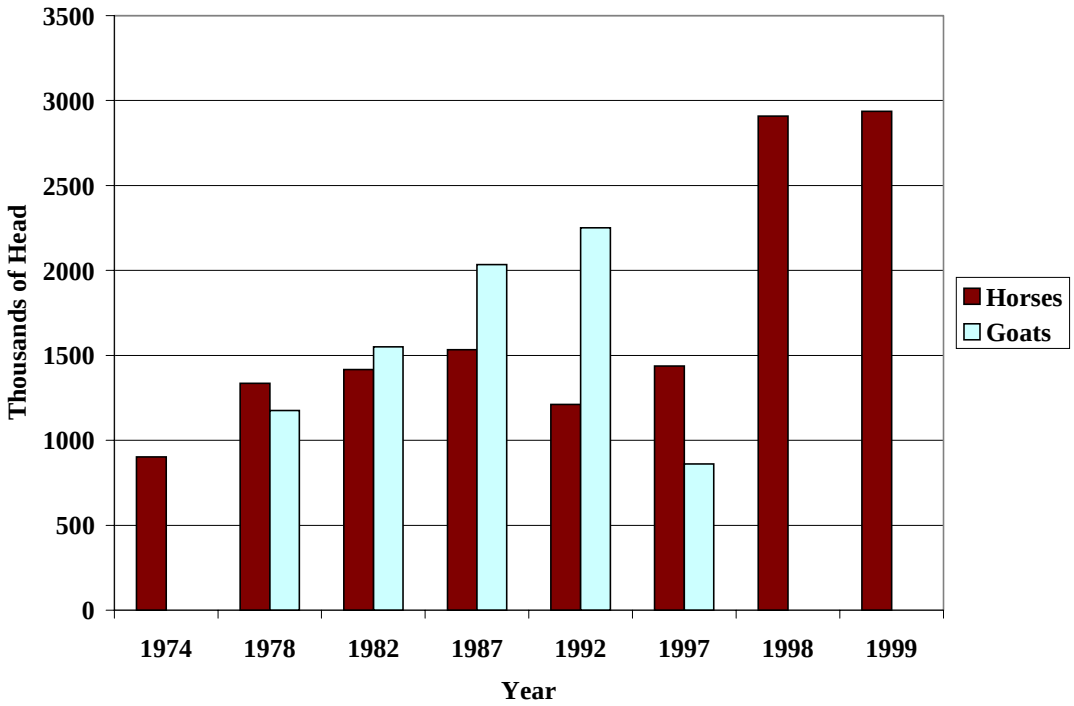

Figure 1. 15. US Census of Agriculture estimates of on-farm goat and horse inventories for the 22 contiguous states west of the Mississippi River, 1974 to 1997, plus the 1998 and 1999 National Agricultural Statistical Service estimates of total horses**.** Sources: USDC/BC various years, USDA/NASS, 1997 USDA/NASS 1999.

Economic importance of grassland-based fish and wildlife - Fish and wildlife are the basis for significant recreational activities and expenditures. According to the US Fish and Wildlife Service (2001) nearly 77 million people in the US participated in fishing, hunting, and wildlife observation, feeding and photography in 1996. Expenditures related to these activities were in excess of $100 billion.

Number of participants and expenditures in 1996 for the states west of the Mississippi River are reported in Table 1.13. For these states, there were a total of more than 27 million participants and $37 billion in expenditures for outdoor recreational activities on both private and public lands. It should be noted that these are statewide statistics and do not allow for the partitioning of the recreational activities related to grasslands from those related to other land types (e.g., mountains). Not only are the number of participants and levels of expenditure significant, but they also appear to be growing rapidly, as expenditures nationwide increased by over $40 billion between 1991 and 1996.

Community economic impacts of ranchette development

Low, or negative, direct economic benefits to aging pastureland, rangeland and grassland owners combined with the longest economic boom in US history, recent advances in telecommunications and the coming "geezer" boom (baby boom + 40 yrs) contribute to the pressure to convert lands into large lot, rural or x-urban homesites. Beyond the now familiar "trophy home," this continuing trend has spawned a number of new terms in the American lexicon including: "rurban development," "starter castles," and "McMansions."

The private decision to sell range and grasslands for higher density uses has important public finance impacts. Research on the cost of rural land development shows that residential development requires more expenditures than the revenues it generates for county government. County revenues are stretched to pay for service and infrastructure demands as rural populations grow (Burchell and Listokin 1992). Service demands by ranchette owners tend to cost more than do larger scale working ranches (Taylor *et al.* 1997). The American Farmland Trust studies indicate that agriculture asks for 37 cents of government services for every dollar of revenue contributed. Rural residences ask for $1.15 in government services for every dollar contributed (AFT, 1999).

Using the AFT methodology, Peters (1990) estimated that relatively high density ranchettes converted from large ranches generated $1.36 in costs for every dollar of revenue. Similarly, Taylor *et al.* (1997) estimate county government cost to county government revenue ratios for different rural Wyoming households. Rural residential ratios ranged from a high of $2.35 assuming minors and no job to $1.27

with one person employed and $0.92 with two working adults. Smith *et al.* (1991) estimated significant cost increases relative to tax revenue increases when specific parcels of private open space were converted to rural residential uses. Moreover, pastureland and grassland conversion trends have important consequences for ranches in terms of production and income, the viability of input suppliers and the economic base of rural regions.

Indirect economic values

Pasturelands and grasslands are not only production inputs, but provide other benefits. The nonagricultural amenities that rural citizens value are not traded in markets. The development of grasslands and pasturelands into rural residences has adverse consequences for wildlife habitat and migration patterns, local water supplies, the amount of scenic lands, access to public lands and the rural sense of community. Residents of rural communities enjoy a particular quality of life arising from the pasturelands and grasslands surrounding their communities. Benefits of these lands include income from extractive or recreational industries, wildlife enjoyment and scenic viewing. Different land use patterns may give rise to distinct social arrangements and community ties. Rapid rural growth through the conversion of ranches to residential or commercial development tends to diminish local social networks and identification with community.

Landscape fragmentation occurs as pasturelands and grasslands are diverted from historical uses to residential developments. Fragmentation adversely impacts wildlife habitat and migration corridors (Theobald *et al*. 1997). Ranches become isolated, reducing the operation's viability and re-investment incentives while the operator awaits a real estate offer (Zollinger 1998). Housing construction reduces scenic values along valley floors and mountain ridges. This is particularly the case as ranches are subdivided into ranchettes or rural subdivisions (Knight *et al.* 1995). In addition, arable soils and water resources are lost to development as increased density of habitation leads to increased demand for water and land.

Private and public land management practices impact the flows of public goods originating from both private and public lands. Residential development adjacent to public land impacts strategies for wildlife and fire management. Public land regulations may also affect rancher viability (and development attitudes) through diminished access to public grazing. Several factors (scenery, wildlife habitat, on-parcel recreation opportunities, distance from incorporated areas, proximity to public lands) potentially increase the likelihood that pasturelands and grasslands will be converted to residential uses.

Policy makers are increasingly recognizing the public goods aspects of private pastureland and grassland. Environmental benefits, open space, and scenic amenities are viewed as valued reasons for living in a community (Inman and McLeod 2000; Loomis *et al.* 2000; Power 1996; Rudzitis 1993). Residential and community attachment affects support for land preservation (Fortmann and Huntsinger 1989; Green *et al.* 1996; McLeod *et al.* 1998). Community ties generate shared knowledge, ideas, and values that can build trust and support for collective decisions, but can also build the opposite (Portes and Sensenbrenner 1993). Social cohesion is adversely affected by greater population turnover, as the formation and duration of social ties is reduced (Sampson 1991).

Spahr and Sunderman (1995) use Wyoming ranchland sales data to model the contribution of scenic and recreational quality to land price. Low, medium and high quality, based on the judgment of area appraisers, are represented by dummy variables in their statistical model. These variables are statistically significant with high scenic quality contributing to higher sale price. Weicher and Zeibst (1973) found that land prices bordering open space were 7-23% higher than those not bordering open space and Correll et al. (1978) found a 32% increase for similar land attributes. Loomis et al. (2000) employ a hedonic approach to identify the implicit valuation of 36 rural land attributes cited in more than 200 conservation easements in Colorado. They find, for example, that open space, rural lifestyle, carbon sequestration, and flood control attributes of agricultural lands contribute to the value of conservation easements purchased by governmental agencies and through public-private partnerships in Colorado (Loomis et al. 2000). Ready *et al.* (1997), Bergstrom *et al.* (1985), Beasley *et al.* (1986), Willis *et al.* (1993), Willis and Garrod (1993), Bateman *et al.* (1994), and Drake (1992) all find positive public willingness to pay for the maintenance of traditional agricultural enterprises in a community.

Summary

In this chapter the importance of grasslands to economic and biological system functions in the United States is explored. Grasslands are defined and their historical extent worldwide was established. Global trends in land use related to grasslands were explored and the US distribution of grasslands was established in this context. This Chapter identifies several data issues and definitional concerns regarding pasture and grassland trends and then identifies some of the nationwide and state level trends in grassland conversion over the past century. Chapter 1 demonstrates that:

1. Historically, grasslands are of great global and national importance and that the amount of grassland in the world and the nation is diminishing;

2. Nutrient cycling, water quality and quantity, biodiversity conservation, terrestrial and aquatic wildlife habitat are among the important ecological services that grasslands provide.

3. Grasslands provide important direct and indirect economic benefits to the nation including: livestock, hunting fishing, wildlife viewing and other forms of outdoor recreation, and open space, for example.

Detailed accounts of the status and drivers of change for US grasslands at the national, state and local levels will be explored in subsequent chapters.

Table 1.1. Estimated global coverage of potential grassland types (Shantz 1954)

Grassland Type	km^2 (millions)	mi^2 (millions)
High Grass Savanna	7.25	2.80
Tallgrass Savanna	10.10	3.90
Tallgrass Prairie	4.09	1.58
Shortgrass Prairie	3.11	1.20
Desert Grass Savanna	5.96	2.30
Mountain Grassland	2.05	0.79

Table 1.2. Approximate area of 7 grassland forms of the contiguous US separated by major biome and region -- see Figures 1.2-1.4. Adapted from Omernik (1986) and Ricketts et al (1999).

Biome Region *Grassland Form*	Area (acres)
Central Plains	
Great Plains	
Mixed-grass Prairies [a]	316,811,605
Shortgrass Prairies	107,526,553
Central Lowlands and Coastal Plains	
Tallgrass Prairies [a]	120,985,102
Savannas	143,120,814
Western Grasslands	
Great Basin	
Shrub Steppe	181,066,479
Desert Southwest	
Shrublands	80,650,969
Desert Grasslands	111,897,505
Mediteranian Grasslands	
California Grasslands	12,099,252

[a] Portions extend into Canada

Table 1.3. Area (Millions of acres) of potential grassland by state; and potential grassland in non-federal landscapes, by state for the United States west of the Mississippi River (designations per Kuchler 1975).

Grassland Type	AZ	AR	CA	CO	ID	IA	KA	LA	MN	MO	MT	NE	NV	NM
Tallgrass Savanna	.	0.16	.	.	.	9.32	6.43	.	5.82	15.36	.	0.04	.	.
Post Oak Savanna	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tallgrass Prairie	.	.	.	2.18	.	16.13	12.73	.	16.04	.	.	26.10	.	1.56
Coastal Prairie	.	.	0.58	.	.	.	.	4.43	.	.	.	.	.	.
Northern Mixed-grass Prairie	.	.	.	1.23	.	.	0.86	.	.	.	6.78	12.44	.	0.36
Southern Mixed-grass Prairie	.	.	.	0.07	.	.	22.23	.	.	.	.	0.35	.	.
Shortgrass Prairie	.	.	.	26.30	.	.	4.93	.	.	.	39.08	5.12	.	12.75
Alpine Meadow	.	.	0.82	3.51	0.11	.	.	.	.	.	1.01	.	0.00	0.15
California Grassland	.	.	13.95	.	.	.	.	.	.	.	.	.	.	.
Great Basin Grassland	.	.	.	.	2.72	.	.	.	.	.	11.16	.	0.30	.
Great Basin Shrub/Steppe	.	.	3.63	3.94	23.56	.	.	.	.	.	2.44	.	10.98	.
Great Basin Shrub	6.58	.	5.80	4.10	1.97	.	.	.	.	.	.	.	42.28	3.27
Desert Savanna	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Desert Grassland	6.91	.	.	.	.	.	.	.	.	.	.	.	.	12.02
Desert Steppe	10.60	.	.	.	.	.	.	.	.	.	.	.	0.00	13.45
Desert Shrub	25.17	.	25.17	.	.	.	.	.	.	.	.	.	5.52	3.98
Potential Grassland	49.26	0.16	49.96	41.34	28.36	25.45	47.18	4.43	21.86	15.36	60.47	44.05	59.07	47.55
Non-federal potential grassland [a]	0.00	0.00	13.95	28.48	2.72	25.45	47.18	4.43	21.86	15.36	46.87	44.05	0.00	24.77

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.3 (continued). Area (Millions of acres) of potential grassland by state; and potential grassland in non-federal landscapes, by state for the United States west of the Mississippi River (designations per Kuchler 1975).

ND	OK	OR	SD	TX	UT	WA	WY	Total
0.86	15.31	.	.	26.39	.	.	.	79.69
.	.	.	.	10.59	.	.	.	10.59
3.33	6.81	.	7.39	15.45	.	.	0.00	107.72
.	.	.	.	8.01	.	.	.	13.02
33.12	.	.	36.48	.	.	.	4.59	95.87
.	13.06	.	0.65	1.50	.	.	.	37.86
.	2.57	.	.	22.58	.	.	14.42	127.74
.	.	0.31	.	.	0.27	1.66	0.97	8.83
.	.	.	.	.	.	.	.	13.95
.	.	4.92	.	.	0.36	6.82	0.44	26.73
.	.	19.84	.	.	4.53	8.70	24.55	102.17
.	.	2.43	.	0.25	23.32	.	2.24	92.24
.	0.01	.	.	41.12	.	.	.	41.14
.	.	.	.	3.73	.	.	.	22.67
.	.	.	.	17.42	.	.	.	41.47
.	.	.	.	1.29	0.11	.	.	61.24
37.31	37.76	27.51	44.51	148.33	28.59	17.18	47.21	882.90
37.31	37.76	4.92	44.51	148.33	0.00	15.52	19.01	582.49

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.4. Area (Millions of acres) of potential grassland (Kuchler 1964); potential grassland in non-federal landscapes; and land classified as Pasture and Range (NRI Data), by state for the 13 States of the central plains west of the Mississippi River.

Grassland Type	CO	IA	KA	MN	MO	MT	NE	NM	ND	OK	SD	TX	WY	Total
Tallgrass Savanna	.	9.32	6.43	5.82	15.36	.	0.04	.	0.86	15.31	.	26.39	.	79.53
Post Oak Savanna	.	.	.	.	.	.	.	.	.	.	.	10.59	.	10.59
Tallgrass Prairie	2.18	16.13	12.73	16.04	.	.	26.10	1.56	3.33	6.81	7.39	15.45	0.00	107.72
Coastal Prairie	.	.	.	.	.	.	.	.	.	.	.	8.01	.	8.01
Northern Mixed-grass Prairie	1.23	.	0.86	.	.	6.78	12.44	0.36	33.12	.	36.48	.	4.59	95.87
Southern Mixed-grass Prairie	0.07	.	22.23	.	.	.	0.35	.	.	13.06	0.65	1.50	.	37.86
Shortgrass Prairie	26.30	.	4.93	.	.	39.08	5.12	12.75	.	2.57	.	22.58	14.42	127.74
Alpine Meadow	3.51	.	.	.	.	1.01	.	0.15	.	.	.	.	0.97	5.64
California Grassland	.	.	.	.	.	.	.	.	.	.	.	.	.	0.00
Great Basin Grassland	.	.	.	.	.	11.16	.	.	.	.	.	.	0.44	11.60
Great Basin Shrub/Steppe	3.94	.	.	.	.	2.44	.	.	.	.	.	.	24.55	30.93
Great Basin Shrub	4.10	.	.	.	.	.	.	3.27	.	.	.	0.25	2.24	9.87
Desert Savanna	.	.	.	.	.	.	.	.	.	0.01	.	41.12	.	41.14
Desert Grassland	.	.	.	.	.	.	.	12.02	.	.	.	3.73	.	15.75
Desert Steppe	.	.	.	.	.	.	.	13.45	.	.	.	17.42	.	30.87
Desert Shrub	.	.	.	.	.	.	.	3.98	.	.	.	1.29	.	5.27
Potential Grassland	41.34	25.45	47.18	21.86	15.36	60.47	44.05	47.55	37.31	37.76	44.51	148.33	47.21	618.38
Non-federal potential grassland [a]	28.48	25.45	47.18	21.86	15.36	46.87	44.05	24.77	37.31	37.76	44.51	148.33	19.01	540.94
1997 Pasture	1.21	3.57	2.32	3.43	10.85	3.44	1.80	0.23	1.13	7.96	2.11	15.91	1.15	55.12
1997 Range	24.57	.	15.73	.	0.09	36.75	23.09	39.99	10.69	14.03	21.88	95.74	27.30	309.86

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.5 Changes in land cover/use between 1982 and 1997, 48 contiguous states, Hawaii & Caribbean.

	Land cover/use in 1997								
Land cover/use in 1982	Cropland	CRP land	Pastureland	Rangeland	Forest land	Other rural land	Developed land	Water areas & federal land	1982 total
	---------- 1,000 acres ----------								
Cropland	350,265.30	30,412.10	19,269.40	3,659.20	5,606.50	3,158.90	7,097.50	1,485.10	420,954.00
Pastureland	15,347.00	1,329.60	92,088.30	2,567.90	14,091.40	1,619.00	4,230.00	732.8	132,006.00
Rangeland	6,967.50	728.5	3,037.20	394,617.40	3,021.60	1,702.70	3,281.30	3,383.20	416,739.40
Forest land	2,037.10	128.8	4,168.20	2,098.80	380,343.30	1,754.80	10,279.20	2,528.00	403,338.20
Other rural land	1,386.80	93.1	1,013.60	719.1	2,767.70	42,713.30	726.9	227.8	49,648.30
Developed land	196.7	1.2	78.6	110.8	227	12	72,618.70	0.8	73,245.80
Water areas and federal land	797.5	2.7	336.6	2,204.00	897.7	180.8	18.1	443,760.60	448,198.00
1997 total	376,997.90	32,696.00	119,991.90	405,977.20	406,955.20	51,141.50	98,251.70	452,118.30	1,944,129.70

Source: Summary Report 1997 National Resources Inventory Revised December 2000, USDA, NRCS, ISU Statistical Laboratory, p.35.

This table contains both the 1982 and the 1997 land cover/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 416,739.4 and the 1997 total was 405,977.2, with 394,617.4 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 1.6 Conservation reserve program (CRP), pastureland and rangeland acreage in 1997 and the percentage change in rangeland and pastureland from 1982 to 1997 according to the National Resource Inventory.

	CRP land	Pastureland	Rangeland	Pastureland	Rangeland
	- - - - - - - - - - 1,000 acres - - - - - - - - - -			- - % change: 1997-1982 - -	
Arizona	0.0	72.6	3,2323	-19.06	0.23
Arkansas	230.4	5,351.4	37.9	-5.44	-17.25
California	172.8	1,048.8	18,269.3	-22.23	-3.30
Colorado	1,889.9	1,211.0	24,574.1	3.98	-1.91
Idaho	784.8	1,314.8	6,500.5	2.82	-1.88
Iowa	1,739.4	3,572.0	0.0	-22.49	0.00
Kansas	2,849.0	2,321.9	15,727.9	7.50	-4.66
Louisiana	140.3	2,385.3	277.2	3.88	2.51
Minnesota	1,544.0	3,434.3	0.0	-11.32	0.00
Missouri	1,606.1	10,848.7	87.5	-13.71	0.00
Montana	2,720.7	3,442.5	36,750.9	11.98	-2.85
Nebraska	1,245.1	1,800.5	23,089.1	-9.03	-2.11
Nevada	2.4	279.0	8,372.4	-10.75	1.53
New Mexico	467.1	230.8	39,989.5	28.72	-4.18
North Dakota	2,802.3	1,128.8	10,689.4	-12.48	-6.90
Oklahoma	1,137.7	7,962.7	14,032.8	10.41	-6.34
Oregon	482.6	1,960.7	9,286.3	-4.52	-2.66
South Dakota	1,685.9	2,108.2	21,876.4	-22.23	-4.74
Texas	3,905.5	15,914.4	95,744.7	-6.97	-0.62
Utah	216.2	694.9	10,733.4	29.00	-1.03
Washington	1,016.8	1,193.2	5,856.9	-8.35	-2.06
Wyoming	246.7	1,145.6	27,302.4	50.50	-1.21
Total	26,885.7	69,422.1	401,521.6	-5.64	-2.29

Source: USDA/NRCS 1997.

Table 1.7 Major Land Use classifications of other grassland pasture and range by state, 1945 to 1997.

	1945	1949	1954	1959	1964	1969	1974	1978	1982	1987	1992	1997
						1,000 acres						
Arizona	43,365	46,763	44,838	42,455	41,169	41,354	40,941	41,506	41,565	41,504	40,641	40,509
Arkansas	2,328	1,585	2,298	3,463	2,373	2,895	2,559	2,055	2,948	2,950	2,532	2,006
California	22,555	27,544	26,661	22,621	23,280	22,856	23,910	22,890	22,580	21,833	24,434	22,343
Colorado	33,096	32,073	33,237	29,436	29,017	29,711	29,274	28,731	28,198	27,898	28,087	27,867
Idaho	23,386	24,505	25,766	22,289	22,352	22,073	20,840	21,004	20,407	19,943	20,219	21,165
Iowa	5,759	3,731	3,799	5,153	3,248	2,089	2,152	1,755	2,065	1,882	1,518	1,477
Kansas	20,315	17,378	17,796	17,907	18,524	15,453	15,950	15,995	13,907	13,255	13,880	12,560
Louisiana	1,503	2,152	2,721	2,760	3,343	2,674	2,270	1,866	2,073	2,070	1,619	1,582
Minnesota	3,825	2,618	2,722	3,321	3,354	2,311	1,954	1,590	1,689	1,661	1,673	1,544
Missouri	9,637	6,036	6,625	8,100	7,718	4,833	6,610	5,812	6,540	6,465	6,478	6,010
Montana	53,386	53,296	54,742	50,641	50,558	49,873	49,465	48,869	48,395	47,139	47,364	46,039
Nebraska	22,373	22,154	22,542	22,266	23,731	22,179	22,137	22,133	21,232	20,435	20,917	21,828
Nevada	53,714	56,218	46,070	48,510	48,231	48,638	46,673	45,976	45,909	45,735	46,061	46,278
New Mexico	50,417	51,801	50,178	48,446	51,471	51,025	50,525	51,382	51,217	51,818	52,478	52,188
North Dakota	14,425	13,121	13,300	13,457	12,988	11,278	10,528	10,888	11,028	11,187	10,951	11,329
Oklahoma	14,347	13,744	16,203	15,022	18,449	16,599	16,235	17,549	18,396	17,754	17,364	17,314
Oregon	25,176	24,340	25,561	23,217	22,709	22,756	23,172	23,119	22,011	22,913	22,456	22,395
South Dakota	25,182	24,402	24,764	26,113	25,432	24,030	24,670	24,192	23,529	22,261	23,947	22,594
Texas	90,739	80,318	88,150	94,217	99,929	94,750	95,803	93,928	103,890	104,656	101,301	98,059
Utah	35,433	34,850	27,577	24,665	25,775	24,893	23,711	23,503	23,238	23,080	23,760	23,737
Washington	9,093	8,666	7,628	8,127	8,318	6,982	6,679	6,586	7,705	7,235	7,590	7,406
Wyoming	46,446	48,355	48,484	46,390	45,826	45,911	46,016	45,537	45,594	45,146	44,905	44,873
Total	606,500	595,650	591,662	578,576	587,795	565,163	562,074	556,866	564,116	558,820	560,175	551,103

Table 1.8: Number of farms reporting acreage in other pastureland and rangeland[1], by state, according to the U.S. Census of Agriculture, 1978 to 1997.

	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 1.9 Percentage change in grasslands/rangelands as classified by the National (NRI), Major Land Use (MLU) and US Census of Agriculture classifications of acreage pasture and range by state from 1982

	NRI	MLU	Census
Arizona	0.17	-2.54	-24.91
Arkansas	-5.53	-31.95	-2.56
California	-4.56	-1.05	-19.99
Colorado	-1.65	-1.17	-5.90
Idaho	-1.12	3.71	-24.44
Iowa	-22.49	-28.47	-9.46
Kansas	-3.25	-9.69	-0.16
Louisiana	3.47	-23.69	-1.50
Minnesota	-11.32	-8.58	-16.03
Missouri	-14.00	-8.10	5.72
Montana	-1.73	-4.87	-6.95
Nebraska	-2.64	2.81	6.52
Nevada	1.08	0.80	-38.96
New Mexico	-4.04	1.90	-3.11
North Dakota	-7.46	2.73	6.04
Oklahoma	-0.90	-5.88	1.58
Oregon	-2.99	1.74	-4.79
South Dakota	-6.59	-3.97	0.84
Texas	-1.58	-5.61	0.01
Utah	0.39	2.15	33.14
Washington	-3.18	-3.88	-1.68
Wyoming	0.17	-1.58	0.28
Total	-2.80	-2.31	-4.44

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 1.10 Total surface water withdrawals and percent of total for states west of the Mississippi River, 1990 (Mgal/d – million gallons per day)

State	Surface water withdrawals, in Mgal/d	Percent of total withdrawals	State	Surface water withdrawals, in Mgal/d	Percent of total withdrawals
Arizona	3,830	58.3	Nebraska	4,147	46.4
Arkansas	3,128	39.9	Nevada	2,279	68.0
California	31,920	68.2	New Mexico	1,722	49.4
Colorado	9,915	78.0	North Dakota	2,535	94.7
Idaho	12,125	61.5	Oklahoma	760	45.7
Iowa	2,369	82.7	Oregon	7,661	90.9
Kansas	1,719	28.3	South Dakota	341	57.6
Louisiana	8,013	85.7	Texas	17,341	68.8
Minnesota	2,477	75.7	Utah	3,506	78.3
Missouri	6,203	89.5	Washington	6,493	81.7
Montana	9,098	97.7	Wyoming	7,199	94.7

Source: USGS

Table 1.11 Estimated average annual rates of change (percent increase or decrease) for grassland bird populations in the contiguous US for 1966-79, 1980-99, and 1966-1999.

Species	No. Routes [a]	Relative Abundance [b]	Trend Estimates [c] 1966-79	1980-99	1966-99
Grassland Endemics					
Ferruginous Hawk	176	0.3	5.4	2.9 *	3.4 ***
Mountain Plover	37	0.3	2.2	8.6 *	-0.9
Long-billed Curlew	183	1.4	2.3	-1.7	-1.5
Sprague's Pipit	37	0.7	-7.0 **	1.8	0.8
Cassin's Sparrow	224	15.8	0.5	-1.0 **	-2.3 ***
Lark Bunting	304	47.2	-3.5 *	-0.3	-2.7
Baird's Sparrow	52	1.8	-2.9	-3.3	-3.4 **
McCown's Longspur	39	2.0	2.3	6.7	5.4
Chestnut-collared Longspur	97	10.3	2.5	-2.9 *	-2.0
Widespread Grassland Associates					
Mississippi Kite	151	0.7	-0.2	-1.2	-0.3
Northern Harrier	676	0.5	-1.6	0.0	-0.6
Swainson's Hawk	508	0.8	-0.2	-0.4	0.0
Prairie Falcon	140	0.1	6.7 **	2.2	1.9
Sharp-tailed Grouse	77	0.8	0.9	-0.1	1.2
Greater Prairie-Chicken	33	1.0	16.0 ***	-5.3	1.1
Upland Sandpiper	447	2.7	2.6 **	-1.5 **	0.9 **
Burrowing Owl	271	0.6	-0.3	2.9	-0.7
Short-eared Owl	110	0.2	17.6	-1.9	-0.5
Horned Lark	1619	26.5	-0.4	-2.2 ***	-1.6 ***
Clay-colored Sparrow	226	3.0	-1.8 **	3.6 ***	0.6
Vesper Sparrow	1191	8.8	-1.4 **	-0.3	-1.1 ***
Lark Sparrow	974	4.5	-5.3 ***	-2.5 ***	-3.3 ***
Savannah Sparrow	1085	5.2	-1.0 *	0.4	-0.7 *
Grasshopper Sparrow	1362	4.7	-4.3 ***	-2.4 ***	-3.5 ***
Henslow's Sparrow	147	0.2	-5.7 **	-6.6 *	-7.8 ***
Dickcissel	826	15.1	-5.5 ***	0.2	-1.5 ***
Bobolink	871	5.1	-1.7 **	-1.3 **	-1.2 ***
Le Conte's Sparrow	53	0.5	-7.2	9.9 **	6.1 **
Sedge Wren	266	1.5	-3.3 **	1.7 *	2.6 ***
Eastern Meadowlark	1845	21.1	-1.6 ***	-3.1 ***	-2.8 ***
Western Meadowlark	1311	53.2	-1.2 *	-0.2	-0.5 **

Data Source : Breeding Bird Surveys (Sauer et al. 2000); designation of grassland birds follows Knopf (1996) with additions of grassland breeding birds from Sauer et al. (2000).

[a] Number of routes in which the respective species occurred during 1966-1999.

[b] Relative abundance expressed as an average number of individuals recorded per BBS route 1966-99.

[c] Statistical sigificance indicated by asterisks; * = P<0.10, ** = P<0.05, *** = P<0.01.

Table 1.12. Estimated annual rates of change in grassland bird populations in the contiguous US and in 16 grassland states, 1966-1999.

	State-level Trends [a]																
Species	MN	WI	IL	IA	MO	ND	SD	NE	KS	OK	MT	WY	CO	TX	NM	ID	US Trends [b]
No. Species [c]	13	13	10	8	7	19	13	12	9	8	18	11	12	9	7	7	31
Grassland Endemics																	
Ferruginous Hawk	.	.	.	.	.	.	.	.	.	.	**7.1**	.	.	.	.	.	**3.4** ***
Mountain Plover	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.9
Long-billed Curlew	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6.6**	-1.5
Sprague's Pipit	.	.	.	.	.	.	.	.	.	.	**8.5**	.	.	.	.	.	0.8
Cassin's Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	-5.4	-2.8	.	.	-2.3 ***
Lark Bunting	.	.	.	.	.	-4.2	.	.	.	.	**4.3**	.	-2.2	.	.	.	-2.7
Baird's Sparrow	.	.	.	.	.	-3.7	.	.	.	.	.	.	.	.	.	.	-3.4 **
McCown's Longspur	.	.	.	.	.	.	.	.	.	.	.	**9.3**	.	.	.	.	5.4
Chestnut-collared Longspur	.	.	.	.	.	.	-7.1	.	.	.	.	.	.	.	.	.	-2.0
Widespread Grassland Associates																	
Mississippi Kite	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.3
Northern Harrier	.	**2.1**	.	.	.	.	.	-8.0	-8.5	-15.3	.	.	.	.	.	.	-0.6
Swainson's Hawk	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
Prairie Falcon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.9
Sharp-tailed Grouse	.	.	.	.	.	**5.5**	.	.	.	.	.	.	.	.	.	.	1.2
Greater Prairie-Chicken	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1
Upland Sandpiper	.	-3.3	.	.	.	**1.7**	.	**2.6**	**1.8**	.	.	**19.4**	.	.	.	.	**0.9** **
Burrowing Owl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.7
Short-eared Owl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.5
Horned Lark	.	.	-0.8	.	-2.8	-2.2	.	.	.	.	-2.3	.	.	-3.2	-3.4	-4.3	-1.6 ***
Clay-colored Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6
Vesper Sparrow	-3.0	-4.4	.	-3.1	.	**2.2**	.	.	.	.	-1.5	.	**3.9**	.	-3.9	.	-1.1 ***
Lark Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-3.3 ***
Savannah Sparrow	.	-1.7	-6.2	-3.5	.	.	.	.	.	.	**3.8**	.	.	.	.	.	-0.7 *
Grasshopper Sparrow	-7.2	-8.7	-6.8	-6.4	-2.0	-5.6	-3.4	.	-2.0	.	.	.	.	.	.	.	-3.5 ***
Henslow's Sparrow	.	-7.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-7.8 ***
Dickcissel	.	-12.5	-3.4	.	-2.5	-9.2	.	.	.	1.2	.	.	.	.	.	.	-1.5 ***
Bobolink	.	-2.2	-9.5	-7.6	.	.	.	.	.	.	.	.	.	.	.	.	-1.2 ***
LeConte's Sparrow	.	.	.	.	.	**11.2**	.	.	.	.	.	.	.	.	.	.	6.1 **
Sedge Wren	**2.7**	.	.	.	.	**10.3**	.	.	.	.	.	.	.	.	.	.	2.6 ***
Eastern Meadowlark	-3.4	-2.3	-2.3	-1.2	.	.	.	-8.6	-2.3	-1.8	.	.	.	-2.3	-2.9	.	-2.8 ***
Western Meadowlark	-6.7	-9.0	.	.	.	.	.	-0.7	.	-1.5	.	.	.	.	.	-1.4	-0.5 **

Data Source: Breeding Bird Surveys (Sauer et al. 2000); designation of grassland birds follows Knopf (1996) with additions of grassland breeding birds from Sauer et al. (2000).

[a] Estimated annual rate of change (%); only those trends with a statistical significance of P<0.10 are listed; positive trends are highlighted and underlined for visual clarity.

[b] US trend estimates are expressed as an annual rate of change for the species throughout the entire US, which may include survey areas other than the states represented here. Statistical sigificance indicated by asterisks; * = P<0.10, ** = P<0.05, *** = P<0.01.

[c] Number of species recorded on more than 14 BBS routes.

Table 1.13 Participants in and expenditures for wildlife-related recreation by participants state of residents for states west of the Mississippi River, 1996

State	Expenditures ($1,000)	Number of participants (in 1,000s)	State	Expenditures ($1,000)	Number of participants (in 1,000s)
Arizona	1,413,052	1,210	Nebraska	559,407	539
Arkansas	1,448,640	890	Nevada	738,453	365
California	8,557,248	7,097	New Mexico	624,156	501
Colorado	2,184,869	1,535	North Dakota	309,954	190
Idaho	711,548	484	Oklahoma	1,392,587	1,199
Iowa	1,018,631	1,032	Oregon	2,052,441	1.260
Kansas	975,514	793	South Dakota	408,299	249
Louisiana	1,962,584	1,271	Texas	6,607,315	4,695
Minnesota	2,729,101	1,663	Utah	607,705	558
Missouri	2,206,154	1,888	Washington	2,008,190	1,908
Montana	432,824	394	Wyoming	349,390	192

Source: U.S. Fish and Wildlife Service

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 2: What is happening to grasslands in the US?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

The history of loss and degradation of grassland resources in the US can be attributed to several factors. The first, and most obvious of which, is the shear loss of grassland area experienced over the last 150 years. Driven largely by cyclic expansions of agriculture, the US has converted over 330 million acres of grasslands to other land uses. The most productive grassland systems have typically experienced a disproportionate loss, with some grassland types now only being represented in small reserves. Other grassland types remain relatively well represented, but the degraded ecological condition across much of what remains limits the economic and biological benefits these lands can provide. The ecological status of many existing grassland systems are heavily influenced at the local level by combinations of habitat fragmentation, undesirable habitat changes due to fire exclusion, declining range condition due to improper grazing management, and loss of habitat values due to the spread of invasive and non-native plants. Further complications arise from demographic trends related to changes in land ownership.

General grassland trends and ownership characteristics

Grassland area remaining

Accurate estimates of current grassland remaining in the US are difficult and elusive due to major differences in definitions of land cover and land use among the agencies responsible for collecting and reporting such information. The Major Land Use (MLU) data includes both private and federal land, except it also includes derived and/or non-native seeded pastures used primarily for grazing livestock. Thus, for states with relatively large areas in pasture the MLU acres clearly over-estimate the area of remaining native grasslands and under-estimate the proportion of potential grasslands remaining. Conversely, the NRI data includes only non-federal rangelands and for states with significant portions of grasslands under federal ownership would under-estimate the area of remaining native grasslands. Additionally, for all states, the acres currently reported as rangeland by the NRI include significant acreage that was not included in the range category in previous reports. Therefore, it is likely that the NRI rangeland acres

represent a slight over-estimate of remaining grasslands, particularly for states with small amounts of federal lands.

Figure 2.1 and Table 2.1 compare the potential grassland acres to the 1997 acres reported for "grassland pasture and range" from the Major Land Use (MLU) reports and the 1997 acres reported for "non-federal rangelands" from the NRI for the 22 western states. Despite the discrepancies among the data, it is clear from Figure 2.1 and Table 2.1 that there are very little remnant native grasslands remaining in the states of Arkansas, Iowa, Louisiana, Minnesota, and Missouri. All of the other western states still have significant acreage of native grasslands remaining, most of which is under private ownership.

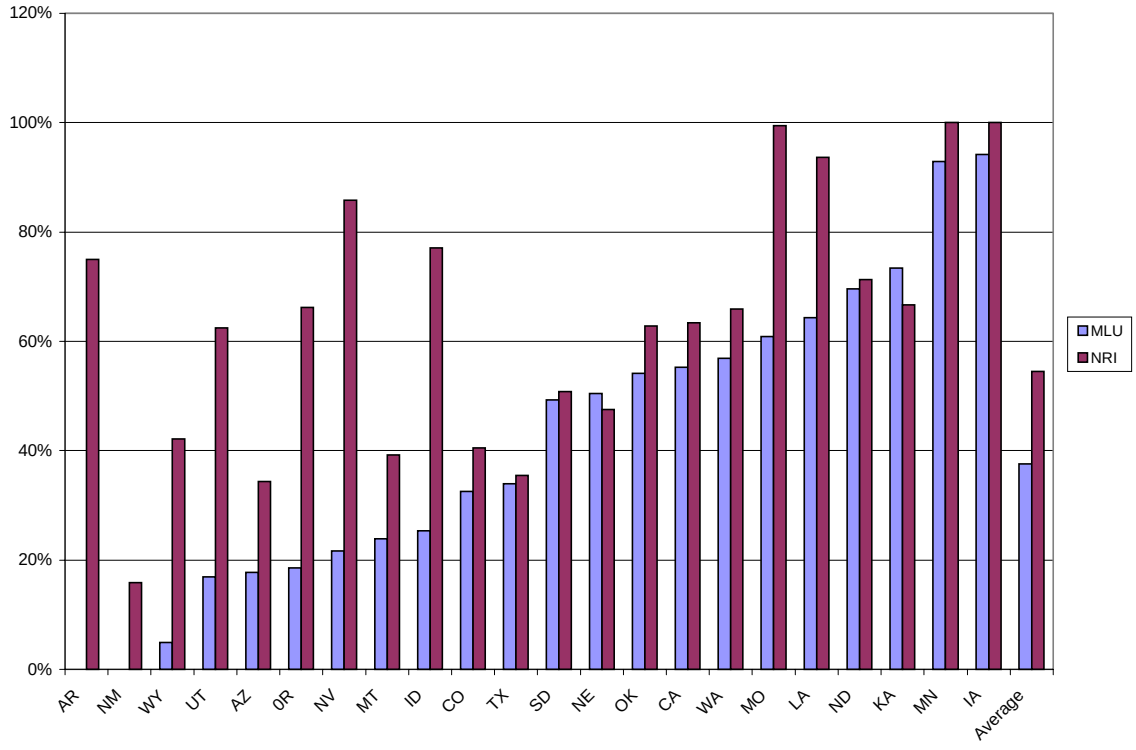

Figure 2. 1. Percent of potential grasslands lost as indicated by 1997 Major Land Use (MLU) report of grassland pasture and range and National Resources Inventory (NRI) report of non-federal rangelands for the 22 western states.

The National Resource Inventory (NRI) reports indicate significant decreases in "pastureland and rangeland" over the 15 years between 1982 and 1997 for the 22 western states. The 1997 MLU reports include 551 million acres of "grassland pasture and range" in the 22 states west of the Mississippi River. This is about 10 percent less than was reported for the same area in 1945.

Similarly, the US Census of Agriculture reports that "other pasture and rangeland" in the states west of the Mississippi River decreased from 415.6 to 380.4 million acres between 1978 and 1997. The Census of Agriculture statistics also excludes public lands, but only include those lands considered to be farms (i.e., greater than $1000 annual revenue).

Characterization of grasslands ownership

*Trends in the number and size of grazing based enterprises***. –** One of the interesting statistics that is available from the Census of Agriculture is the number of farms represented by acreage in other pastureland and rangeland (Table 2.2). For the 22 States examined, 370,068 farms had acreage in other pastureland and rangeland. This is down from the 406,657 farms reporting other pastureland and rangeland in 1978, a percentage change of –9.00. Number of acres in other pastureland and rangeland varied by state, with many of the western states having fewer farms but more acreage per farm. Texas not only had the most acreage in other pastureland and rangeland, but also had the most number of farms represented. Oklahoma, Kansas, Missouri and Nebraska were among the leaders in the number of farms reporting acreage in other pastureland and rangeland, none of which were leaders in the total number of acres reported. A general decline in the number of farms reporting acreage in other pastureland and rangeland occurred between 1978 and 1997.

Current ownership characterization- The 1997 Agricultural Census for the 22 western states indicates that approximately 75% of the pasture and rangeland is in farms (or ranches) with $50,000 or more in annual product sales plus government payments (Figure 2.2) are classified as primarily beef cattle operations (Figure 2.3) and have operators whose primary occupation is farming (ranching) (Figure 2.4).

Approximately 80% of the pasture and rangeland in the 22 western states is in farms (ranches) whose owners are either sole proprietorships, partnerships, or family-held corporations (Figure 2.5) and are operated by persons over 45 years of age (Figure 2.6). Approximately 90% of the pasture and rangeland is in farms (ranches) containing 6,000 or more acres (Figure 2.7) and having operators who own either all or part of the land they operate (Figure 2.8).

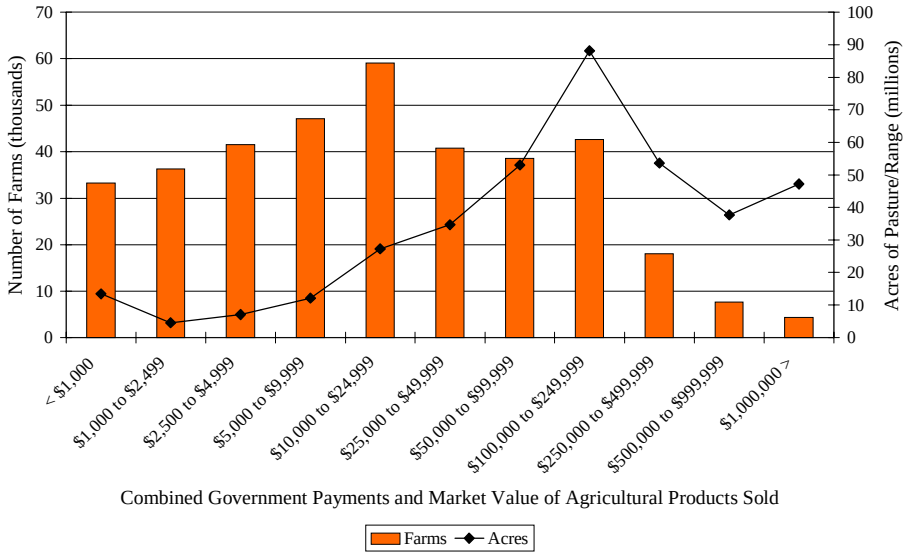

Figure 2. 2. Number of farms and acreage of pasture and range by annual product sales plus government payments category for the 22 states west of the Mississippi. (Source USDA Census of Agriculture, 1997).

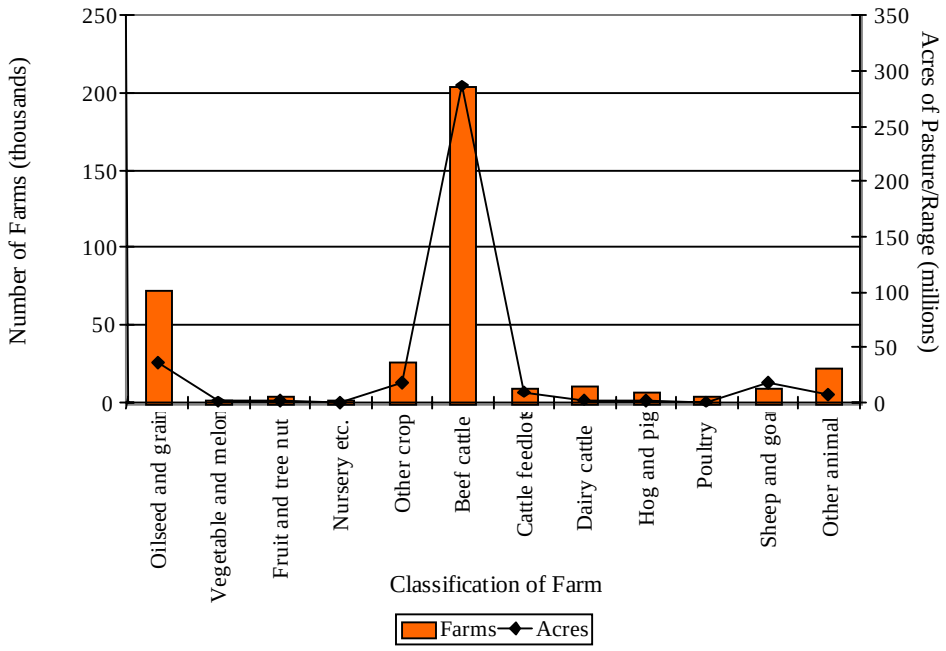

Figure 2. 3. Number of farms and acreage of pasture and range by classification of agricultural operations for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

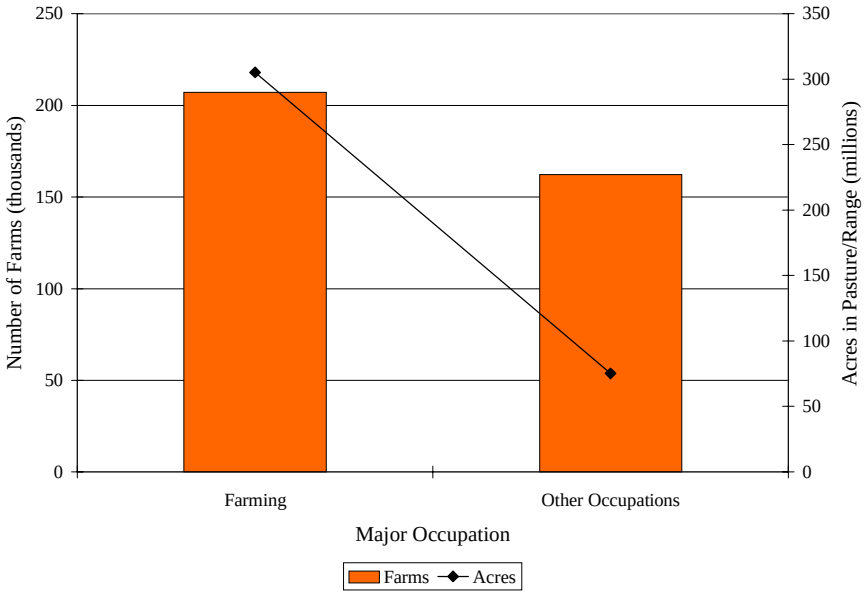

Figure 2. 4. Number of farms and acreage of pasture and range by major occupation category for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

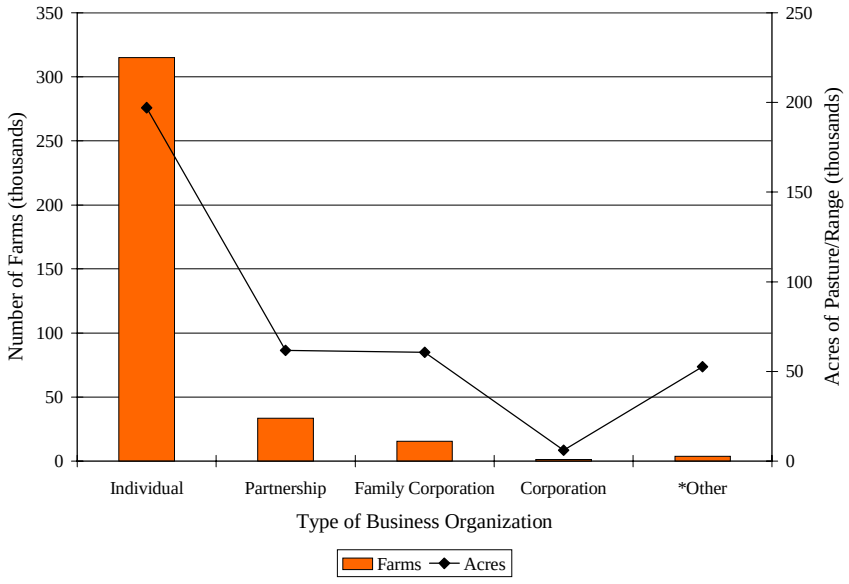

Figure 2. 5. Number of farms and acreage of pasture and range by type of business organization for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

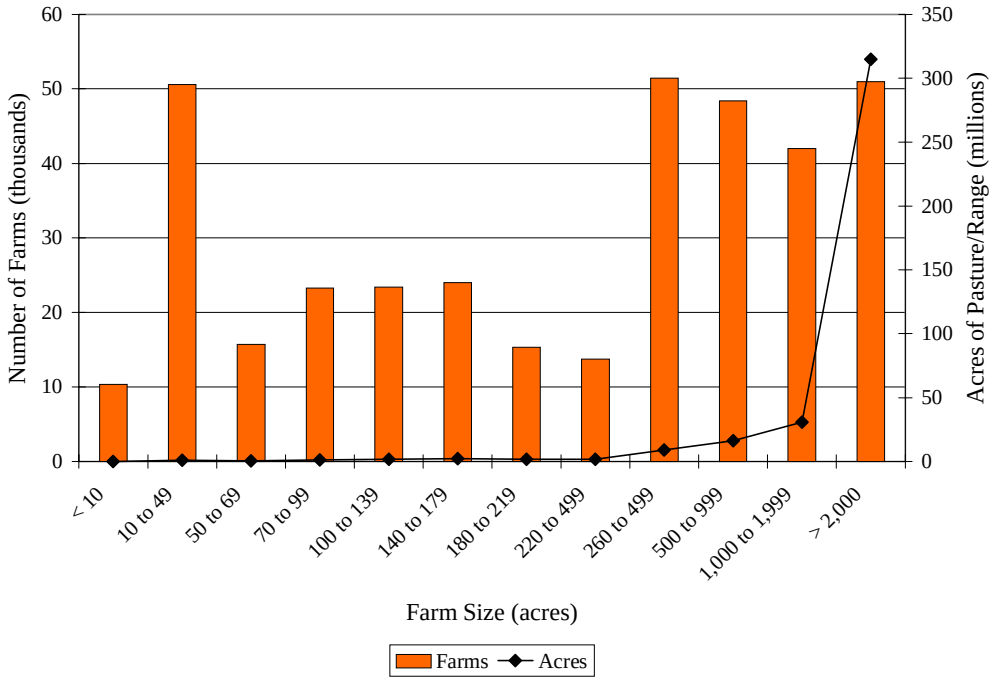

Figure 2. 6. Number of farms and acreage of pasture and range by size of farm for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

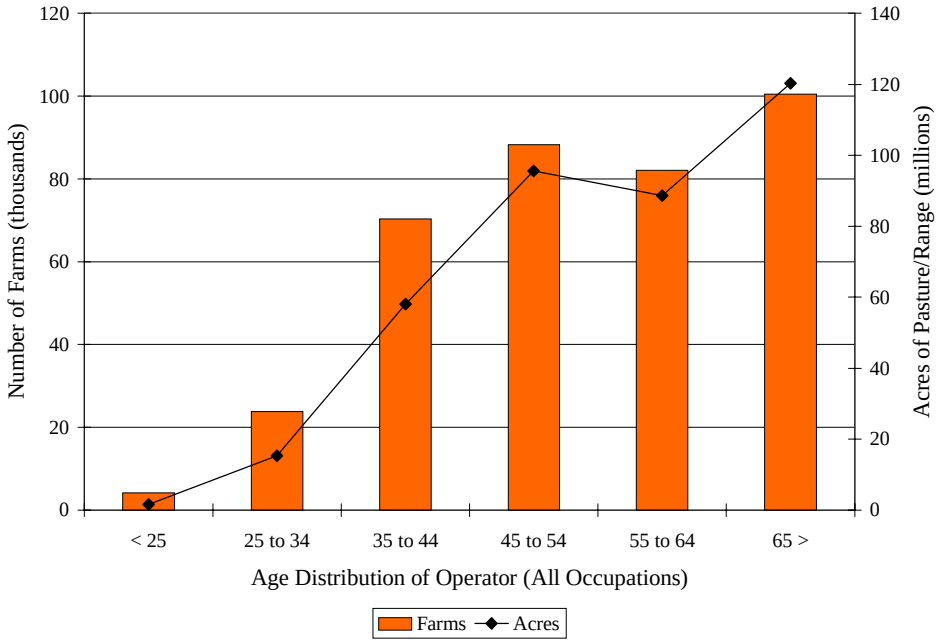

Figure 2. 7. Number of farms and acreage of pasture and range by age distribution of operator for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

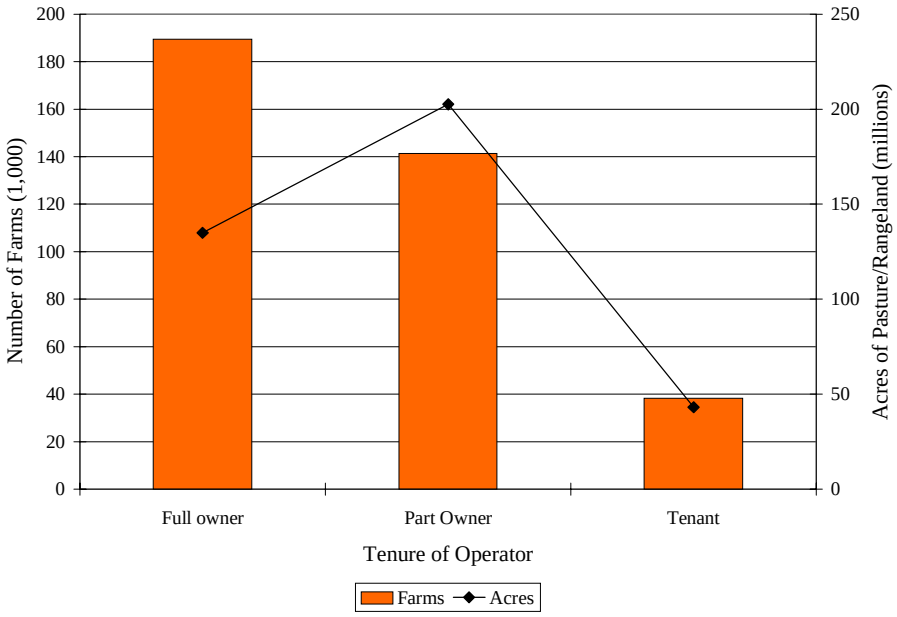

Figure 2. 8. Number of farms and acreage of pasture and range by tenure of operator for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

Detailed grassland trends for Colorado, Idaho, Montana, North Dakota, South Dakota and Texas

In previous sections, it was established that approximately 50% of pre-settlement grasslands in the US have been converted to other land uses. While almost all parts of the US have experienced some loss of native grasslands, it is those states in the Central Plains that have sustained the largest losses. Within the Central Plains, the degree to which native grasslands have been lost increases from west to east. Some of the more easterly states have lost greater than 90% of their original grasslands (e.g., Minnesota and Iowa). Other States in the Central Plains yet retain a substantial portion of their original grasslands managed as pastureland and rangeland. Private farmers and ranchers manage most of these lands. In this section, we examine some of the economic and ecological trends in six such states: Colorado, Idaho, Montana, North Dakota, South Dakota and Texas. For these states, state-level summaries for farm and ranch ownership are in Table 2.3.

Colorado

Colorado's grasslands extended across approximately 41.34 million acres prior to settlement, about 64% of which was shortgrass prairie (Table 1.3, Figure 1.5). Colorado's native grasslands

once accounted for approximately 21% of all shortgrass prairie in the US. Non-federal ownerships occupy about 61% of Colorado's 66.62 million acres of total land surface. Most federal ownerships are in the western half of the state – including most of Colorado's Western Grasslands. Most of the Colorado's remaining Central Plains' grasslands, including substantial acreage of short- and mixed-grass prairie, are in non-federal ownerships in the eastern one-half of the state (Figures 1.2 and 1.6).

Present status

As of 1997, approximately 25.79 million acres of Colorado's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Colorado's nonfederal grazinglands, about 95% are native rangelands (NRI 2000, Table 2.4). These non-federal rangelands represent about 37% of the state's total land base, and approximately 61% of all non-federal rural land in the state (Figure 2.9). Private farms and ranches account for about 80% of all non-federal rural lands in the state; and the accounting of grazinglands on private farms and ranches represents approximately 77% of that reported for all non-federal grazinglands in the state (Tables 2.3 and 2.4). Grazinglands on farms and ranches account for 19.9 million acres, representing 61% of Colorado's total farm and ranch acreage and roughly 30% of the state's total land area.

Recent land use trends.

In the 15 years prior to 1997, Colorado lost about 1.35 million acres of its non-federal native rangeland (~5%), about 22% of which was transferred to federal ownership (Table 2.4). Of the remaining 1,052,900 acres, roughly 60% was converted to cultivated crops, with an additional 166,600 acres being lost to urban expansion. While urban expansion only accounted for about 10% of rangeland conversion, conversion of rangelands accounted for about 41% of the urban expansion.

About 870,100 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 12% of which was transferred from federal ownership. Discounting federal lands, roughly 34% of this "new" native rangeland came from cultivated croplands; another 19% came from lands that were formerly classified as non-native pastures, while the remainder came largely from lands formerly classified as forestland. When considering the net change over the 15-year period, the result was a reduction of 479,500 acres of native rangeland in Colorado.

Regional distribution

The 29 Colorado counties east of the eastern edge of the Rockies contain one of the largest single remaining expanses of southern shortgrass prairie. The total grazinglands on farms and ranches in these counties exceeds 14.3 million acres, and represents roughly 70% of total farm and ranch grazinglands in the state (USDA Census of Agriculture). When all non-federal ownerships are considered, the major river drainages in eastern Colorado hold about 17.9 million acres of grazinglands, again representing approximately 70% of the total non-federal grazinglands in the state (Table 2.5 and Figure 2.10a).

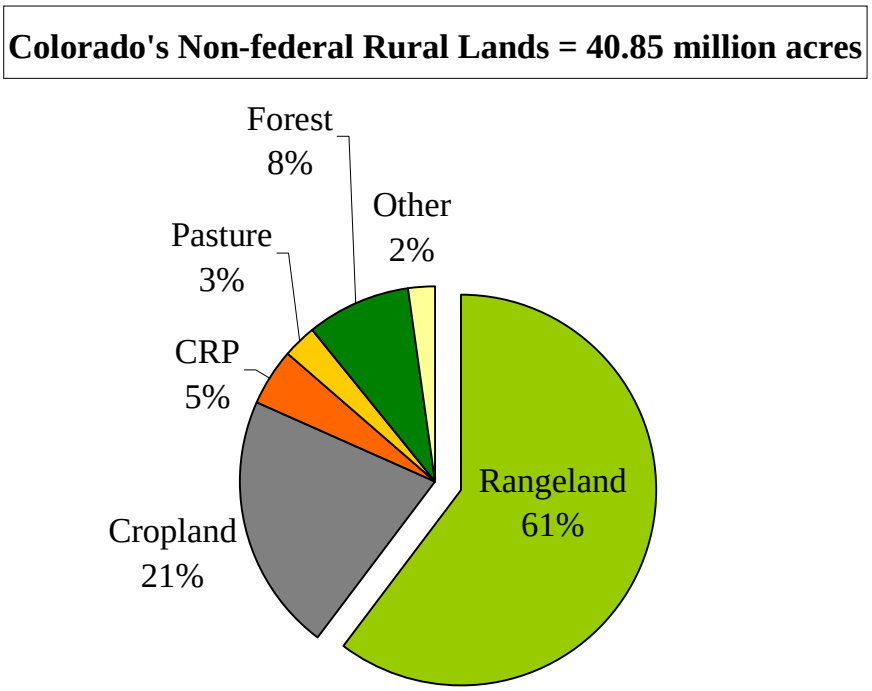

Figure 2. 9. Major land use classes for non-federal rural lands in Colorado, 1997 (Source: NRI, *Revised 2000).*

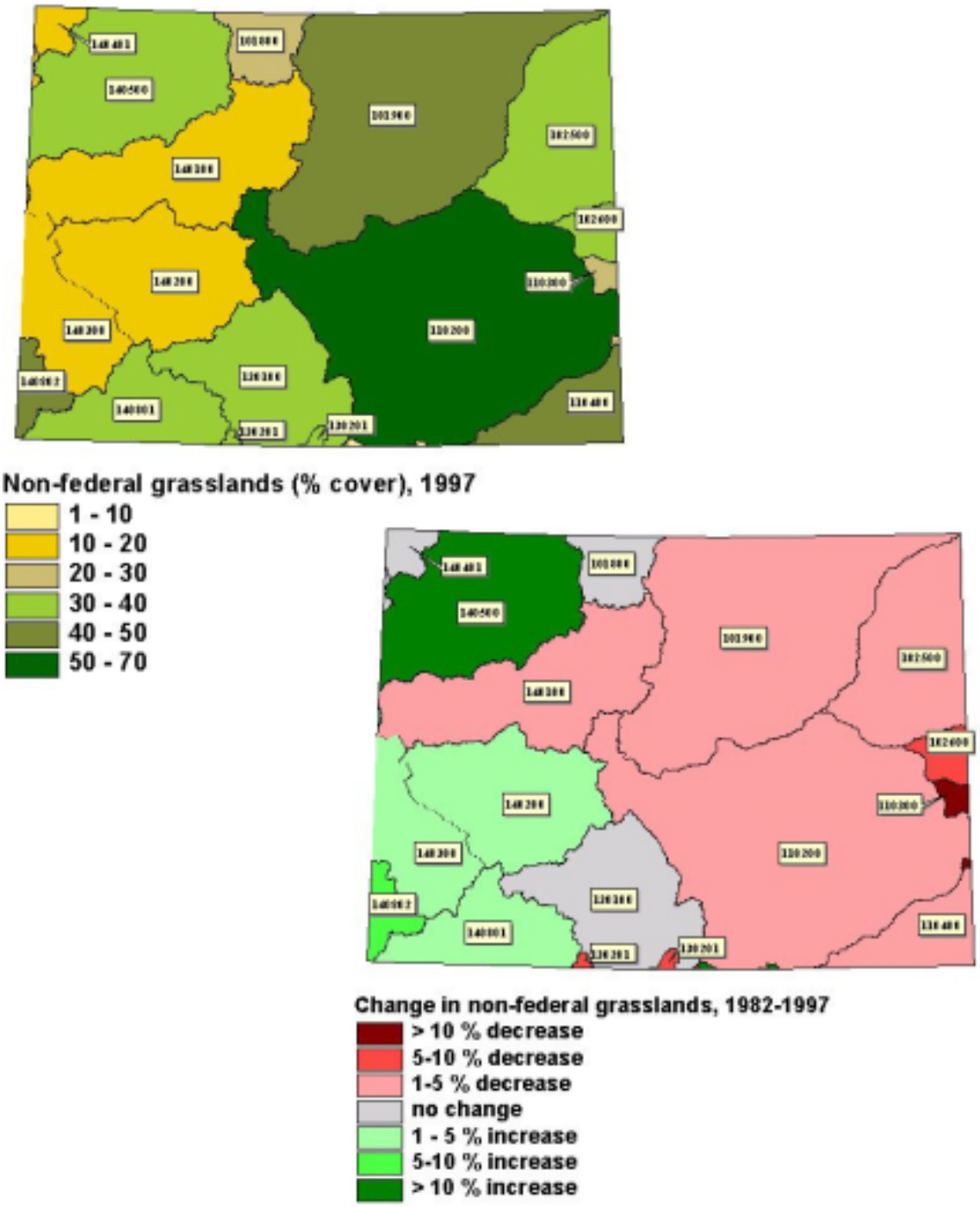

Figure 2. 10. For Colorado, (a) percent Land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE:** *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.3.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

From 1982 to 1997, those watersheds draining the short- and mixed-grass prairies of eastern Colorado experienced a cumulative loss of about 713,700 acres of grazinglands, representing a 3.8% net loss (Table 2.3). The greatest losses were in the South Platte and Upper Arkansas River drainages (Figure 2.10b). Meanwhile, those watersheds draining the Western grasslands experienced a cumulative gain of 280,500 acres of grazinglands, representing a 3.7% net gain. At the scale of large watersheds, the only substantial net loss of non-federal grazinglands across Colorado's Western Grasslands appeared in the Colorado Headwaters.

Trends in farm and ranch enterprises

According to the US Census of Agriculture, the total area of grazinglands on farms and ranches in Colorado declined by 5.9% from 1982 to 1997, while the number of grazingland based enterprises increased by about 9% (Table 2.3). The resulting change was a 13.7% decrease in average size of operation. These trends varied across the state according to the differences in the cumulative landowner response to economic pressures, demographics, and agricultural policies (see Chapter 3).

The actual rate at which grasslands were lost, gained, or experience a change in ownership is apparent at different scales of resolution. For example, between 1982 and 1997 the statewide change in non-federal grazinglands in Colorado suggests a net loss of only 1.6% (Table 2.4). When viewed in the perspective of changes across large river basins (Figure 2.10), it is apparent that most losses were generally focused in those basins east of the Continental Divide and in the Colorado Headwater basin (along the Interstate-70). However, when similar data are viewed at the county level, the variability among counties yields a different perspective. For example, in the Arkansas River basin, the adjacent counties of Pueblo and Las Animas experienced somewhat different fates with respect to grasslands. From 1982 to 1997, Pueblo County lost over 160,000 acres of grazinglands, while experiencing a 26% increase in the number of farms and ranches with grazinglands – the result was a 36% loss in average ownership size. In contrast, neighboring Las Animas County increased its grazinglands on farms and ranches by over 54,000 acres while remaining relatively stable in ownership numbers. Statewide and basin-level averages tend to mask these local dynamics[6].

[6] Because the county-level statistics from the USDA Census of Agriculture are somewhat variable in their reporting area, comparisons among years for individual counties are not as reliable as the cumulative statistics for the state or multi-county sub-regions.

Ecological status and trends

The continued loss of shortgrass prairie is among the most pressing ecological issues for native grasslands in Colorado. Based on remote sensing data, about 11.2 million acres of native short- and mixed-grass prairie remains in eastern Colorado; approximately 19% of which occurs on state and federal lands (EDAW 2000). This figure represents about 41% of the pre-settlement coverage by these grassland types. While much of this shortgrass prairie remains, much of what remains is of a different character and productivity than that which has been converted to cropland. Nevertheless, the remaining shortgrass prairie in Colorado continues to support important native plant and animal communities.

Many of the populations of endemic grassland birds that are typical of shortgrass prairies have shown declining trends. According to breeding bird surveys, grassland birds exhibiting the greatest declines in Colorado include Cassin's sparrow and the lark bunting (Table 1.12). Cassin's sparrow, for example, is threatened by continued degradation and loss of grassland habitats with a shrub component (Ruth 2000). In Colorado, Cassin's sparrows appear to have declined by an average of about 5.4% per year from 1966-1999 (Table 1.12). This is a more rapid decline than that documented for any other state in the species range.

As was discussed in previous sections, a substantial component of the loss of plant and animal diversity in short- and mixed-grass prairies may be related to declining prairie dog populations. A 2000 survey of prairie dog colonies in the grasslands of eastern Colorado established a database that included 5001 colonies across 314,114 acres (EDAW 2000). Of these, the 2000 field survey results suggest that about 52% were active, 28% were inactive or absent, and 20% were unknown. Once adjusted for sampling procedures, they estimated a minimum of 3,069 active colonies covered approximately 214,570 acres across the former range of the species in eastern Colorado. Active colony sizes ranged from 0.04 to 4,129 acres; with 92% of the colonies being <200 acres in size. The 214 prairie dog colonies >200 acres accounted for approximately 50% of the total known area in the state. Overall, these figures suggest that known prairie dog colonies in Colorado may occupy <3% of their current potential habitat, and <1% of their pre-settlement habitat. Also of interest was the fact that the rate of habitat occupancy (% of potential habitat with active towns) on private lands was virtually the same as that on public lands.

Idaho

Idaho's native grassland coverage extended across approximately 28.36 million acres prior to settlement, about 90% of which was Great Basin Shrub or Shrub/Steppe (Table 1.3, Figure 1.5). Relatively large areas of Great Basin Shrub and Shrub/Steppe remain intact across southern Idaho, much of this being under control of the BLM, Department of Defense, and other federal agencies. The one grassland type in Idaho that once occurred largely on private and other non-federal lands is the Palouse Prairie (a local subdivision of Great Plains Grasslands). Approximately 2.72 million acres of Palouse Prairie once occupied a landscape in west-central Idaho that has been converted largely to cultivated cropland.

Present status

As of 1997, approximately 7.82 million acres of Idaho's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Idaho's nonfederal grazinglands, about 83% are native rangelands (Table 2.6). These non-federal rangelands represent about 12% of the state's total land base, and approximately 35% of all non-federal rural land in the state (Figure 2.11). Grazinglands on private farms and ranches account for about 58% of all non-federal grazinglands in the state (NRI 2000, USDA 1997, Tables 2.3 and 2.6). Farm and ranch grazinglands cover about 4.6 million acres, representing 39% of Idaho's total farm and ranch acreage, and roughly 8.6% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Idaho lost about 396,200 acres of its non-federal native rangeland (~6 %), about 41% of which was transferred to federal ownership (Table 2.6). Of the remaining 232,400 acres, roughly 32% was placed under cultivation, with an additional 23,200 acres being lost to urban expansion. From 1982 to 1997, Idaho's urban areas increased by 94% (206,400 acres). In all, about 23,200 acres of native rangeland and 40,900 acres of pastureland were lost to urban expansion during this period.

About 271,700 acres that were not classified as non-federal native rangeland in 1982 were reclassified as non-federal native rangelands by 1997; most of which (64%) was native rangeland transferred from federal ownership. Discounting federal lands, roughly 32% of this "new" native rangeland came from cultivated croplands; another 21% came from lands that were formerly classified as non-native pastures, while the remainder came largely from lands formerly classified as forestland (29%). When considering the net change over the 15-year period, the result was a

reduction of 124,500 acres of native rangeland on non-federal lands in Idaho. However, considering the fact that, statewide, over 190,000 acres was lost simply by transfer to federal lands (Table 2.4), it is difficult to determine from these figures whether or not the cumulative loss of grazinglands was significant over that period. In fact, the Major Land Use (MLU) classifications, that do include federal lands, suggest a statewide net gain of some 758,000 acres of grazinglands during that same period (Table 1.7). While the statewide total of 21.2 million acres of grazinglands according to MLU does represent a long-term decline of 4.6 million acres from its peak in 1954 (records are from 1945 to 1997), the most recent trends seems to suggest an increase of 3.7% from the 20.4 million acres of grassland pasture and range in 1982 (Table 1.7).

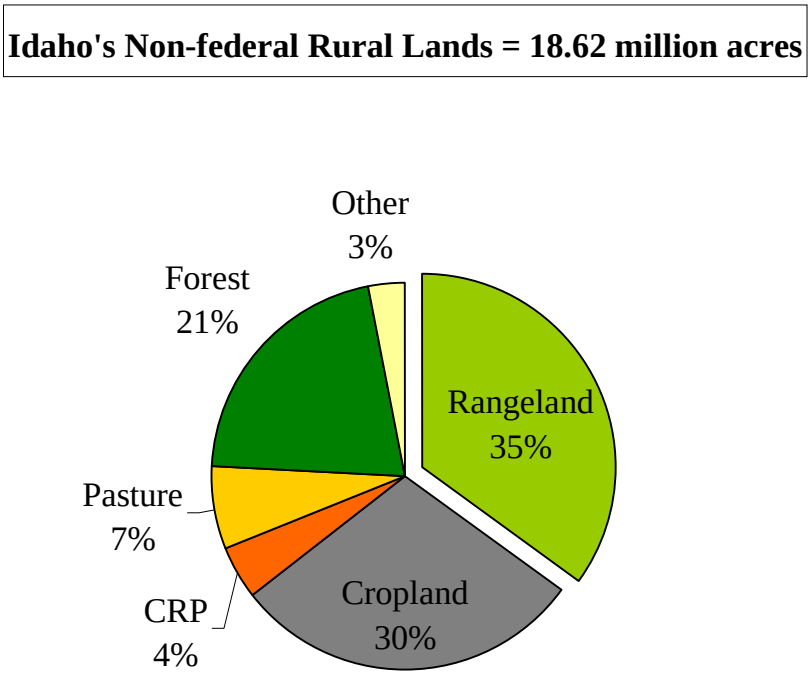

Figure 2. 11. Major land use classes for non-federal rural lands in Idaho, 1997 (Source: NRI, *Revised 2000).*

Regional distribution

The major concentration of Idaho's existing non-federal grazinglands are in the Great Basin Shrub/Steppe grassland types of the southern portion of the state (Figures 1.5 and 2.12a). These concentrations coincide with the Upper Snake and Lower Snake-Boise River drainages that together hold approximately 76% of Idaho's non-federal grazinglands (Table 2.5).

From 1982 to 1997, those watersheds draining Great Basin Shrub/Steppes of southern Idaho experienced a cumulative loss of 129,500 acres of non-federal grazinglands, representing a 1.9% net loss (Table 2.7 and Figure 2.12b). Again, given the overall figures, including federal land transfers, it is difficult to determine whether or not substantial acreages of non-federal grazinglands were actually lost. It is apparent, however, that river basins in the non-federal landscapes of west-central Idaho are now only sparsely covered by grazinglands – these areas once being dominated by the Palouse Prairie ecosystem.

Trends in farm and ranch enterprises

According to USDA Agricultural census data, Idaho's grasslands declined by 24.4% in the 15-year period from 1982 to 1997 (Table 2.1). Meanwhile, the number of grazingland based enterprises decreased by 3.4%, while decreasing in average size by 21.8% (Table 2.1).

Ecological status and trends

Idaho has the least non-federal grasslands of the 6 states highlighted in this report. Almost all of Idaho's Palouse Prairie has been converted to cropland, or is in such a degraded condition that it is not likely to provide much of its former ecological function. The remaining patches of Palouse Prairie are highly fragmented. Much of the grazing lands in the former area of Palouse Prairie have suffered from combinations of fire exclusion and overgrazing, resulting in invasion by cheatgrass (*Bromus tecturum*), a non-native annual grass of little ecological value, and marginal grazing value.

Most existing grasslands in Idaho are in the Great Basin Shrub/Steppe regions in the Snake River drainages. In its native condition, the vegetation of this arid region is often characterized by sagebrush (*Artemesia* spp.) dominated rangelands with varying levels of perennial bunchgrasses such as crested wheatgrass (*Agropyron* spp.) and Idaho fescue (*Festuca Idahoensis*). Elk and mule deer are economically valuable wildlife resources in this area; and these and other species depend upon maintenance of good rangeland conditions for their habitat needs.

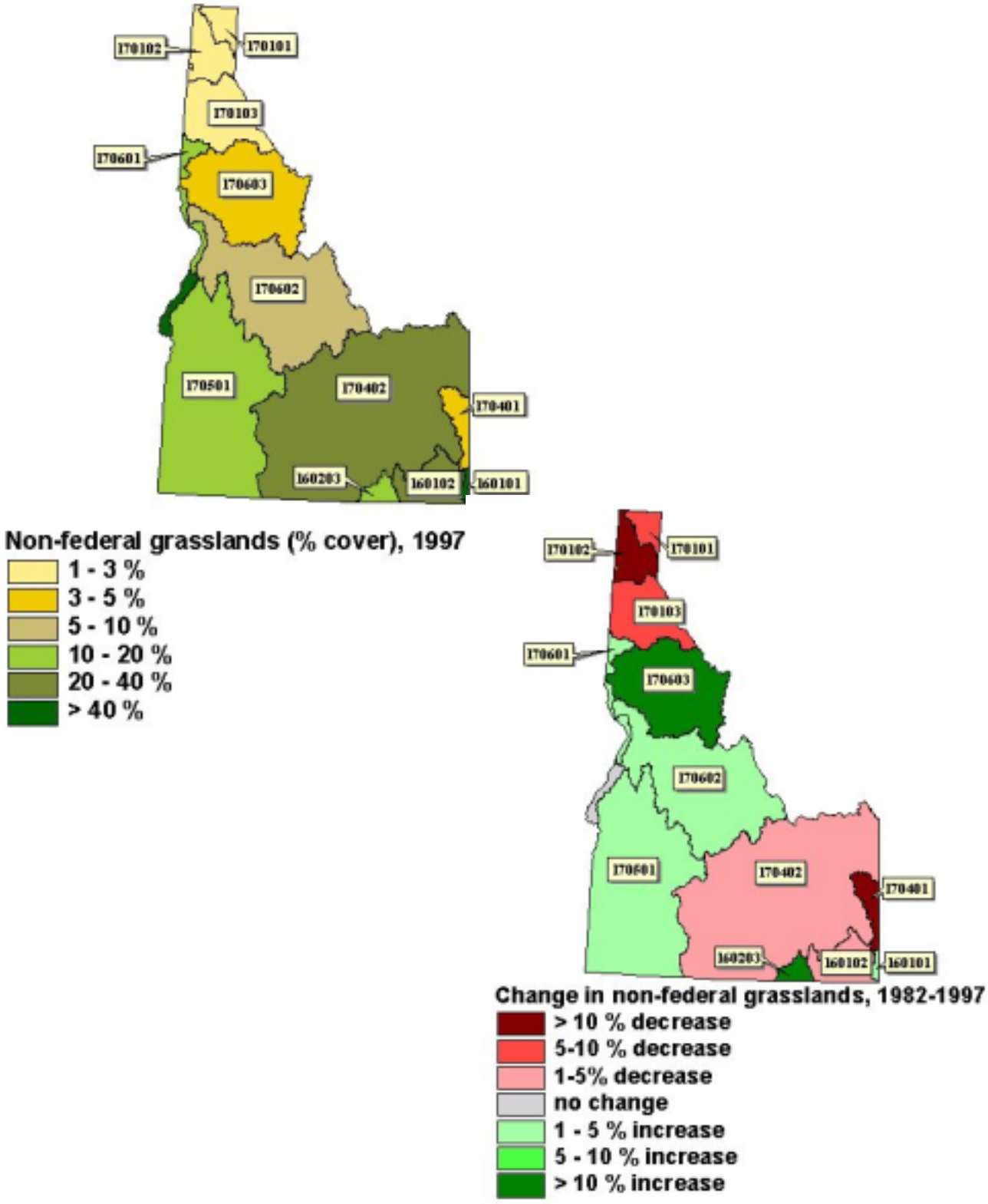

Figure 2. 12. For Idaho, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages**. NOTE:** *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.5.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Fire suppression and spread of exotic grasses are the major ecological issues on the Shrub Steppe habitats that remain as native grassland. In much of this area, fire exclusion and/or improper fire management, combined with overgrazing, has modified much of the shrub steppe vegetation. On many areas, former land management practices have resulted in reduced cover by native crested wheatgrass and Idaho fescue. As a result, cheatgrass and other invasive grasses tend to increase on these habitats, resulting in further ecological degradation. Other invasive weeds such as yellow starthistle, spotted knapweed, and rush skeletonweed are increasing rapidly on grasslands in southern Idaho. These species are not only detrimental to native wildlife habitats, but they reduce the overall usable plant productivity of these rangelands, and are arguably becoming the most alarming environmental issue in the state's grasslands.

The loss and degradation of sagebrush habitats in southern Idaho has contributed to the decline of sage grouse populations – an endemic to these habitats (Connelly *et al.* 2000). Breeding habitats for sage grouse have declined by at least 17-47% (Connelly and Braun 1997). If the effects of habitat loss, habitat fragmentation, and, habitat alterations cannot be managed, then this species may continue to decline in southern Idaho.

Montana

Montana's native grasslands extended across approximately 60.47 million acres prior to settlement, about 65% of which was shortgrass prairie (Table 1.3, Figure 1.5). Montana's grasslands once accounted for approximately 31% of all shortgrass prairie in the US – the largest concentration of any state. Other major pre-settlement grassland types included northern mixed-grass prairie (6.78 million acres), and Great Basin grasslands (11.16 million acres). About 30% of Montana's 94.11 million acres remain in federal ownership (Table 2.1); this located primarily in the forested regions of the Rocky Mountains and the Great Basin in the western third of the state (Figures 1.2 and 1.6).

Present status

As of 1997, approximately 40.19 million acres of Montana's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Montana's nonfederal grazinglands, about 91% are native rangelands (Table 2.8). These non-federal rangelands represent about 39% of the state's total land base, and approximately 57% of all non-federal rural land in the state (Figure 2.13). Farming and ranching enterprises account for about 90% of all non-federal rural lands in the state; and the grazinglands on private farms and ranches account for about 94% of all non-federal grazinglands in the state (Tables 2.3 and 2.8). Grazinglands on farms and ranches account for 38 million acres, representing 65% of Montana's total farm and ranch acreage, and roughly 40% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Montana lost about 1.55 million acres of its non-federal native rangeland (~4%), only about 2% of which was transferred to federal ownership (Table 2.8). Of the remaining 1,510,600 acres, about 48% was under cultivation by 1997. This figure is likely an underestimate of rangeland loss, given the fact that, another 145,000 acres of land that was classified as rangeland in 1982 was in the CRP in 1997. This suggests that some conversions of rangelands to cultivated cropland after 1982 were soon followed by entry of that land into a CRP contract. This further implies that one out of every 6 acres of rangeland converted to cultivated crops was subsequently judged as marginal cropland, and deferred under the CRP. About 52,900 acres of rangeland was lost to urban expansion.

About 472,500 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 37% of which was transferred from federal ownership. Discounting federal lands, roughly 25% of this "new" native rangeland came from lands that were formerly classified as non-native pastures, and another 10% came from cultivated croplands. When considering the net change over the 15-year period, the result was a net reduction of 1,077,200 acres of native rangeland on non-federal lands in Montana. Given that, over this same period, there was an overall net loss of 2,356,000 acres of grazinglands when federal lands are also included (4.9% loss according to MLU estimates, Table 1.7), it appears likely that there was a substantial loss of non-federal grazinglands in Montana.

Regional distribution

The major concentration of Montana's existing non-federal grazinglands is in the shortgrass prairie grassland type in the east-central portion of the state (Figure 2.14a). The non-federal grazinglands in the 8 river basins roughly corresponding to the pre-settlement distribution of shortgrass prairie account for almost 61% of Montana's non-federal grazinglands (Figure 1.5 compared with Figure 2.14a). All but one of those river basins lost grazinglands from 1982 to 1997 (Figure 2.14b). The cumulative net loss across the shortgrass prairie region was over 500,000 acres during this period. However, the loss of native rangelands during this period was likely higher due to the increase of 368,400 acres of introduced pastureland (Table 2.8). This suggests a substantial loss of remaining shortgrass prairie, most of which appears to be converted to cultivated cropland.

The most substantial losses of non-federal grazinglands were in the Marias River Basin and Milk Watershed adjacent to the northern boundaries of the state. Statewide, only a single major drainage experienced a substantial net increase in non-federal grazinglands – that drainage being the Missouri

Headwaters in the extreme southwestern portion of the state.

Trends in farm and ranch enterprises

The total area of non-federal grazinglands on farms and ranches in Montana declined by 7% from 1982 to 1997, while the number of operations decreased by about 5.3% (Table 2.3). The result was an 11.7% decrease in the average grazingland-based farm and ranch operation.

Ecological status and trends

The majority of Montana continues to support native grasslands, and these grasslands support a varied wildlife resource. Montana continues to support the largest remaining expanses of shortgrass prairie in the US. However, because of recent conversions, the biological resources of shortgrass prairie in Montana may be at risk. Habitat fragmentation and the spread of invasive plants are locally important ecological issues in Montana.

Many of Montana's scenic rural areas are rapidly becoming developed, especially in the Great Basin grasslands of the Bitterroot Valley, Paradise Valley, and Gallatin Valley south of Bozeman. This ex-urban development has resulted in ownership fragmentation and shifts away from traditional land uses. The predictable result is habitat fragmentation, exotic plant introductions, and a related loss of much functional wildlife habitat.

According to US Fish and Wildlife Service estimates, Montana holds approximately 10% of the occupied habitat for black-tailed prairie dogs. The currently occupied 66,420 acres is about 1% of the former occupied habitat for the species (US Fish and Wildlife Service 2000). While this represents a substantial decline, the opportunities for gaining occupied habitat may be greater in Montana than elsewhere in the species range, simply due to the acreage of shortgrass prairie remaining.

Montana's breeding grassland bird fauna is the second richest of any other state (Table 1.12). Endemic grassland birds have not shown significant declines in Montana. In fact, 3 species – the ferruginous hawk, Sprague's pipit, and lark bunting – have shown promising significant increases during the period of 1966-1999 in the Breeding Bird Surveys in Montana (Table 1.12). Of these, the lark bunting has been declining elsewhere in its range.

As in other Western states, habitat degradation due to the spread of invasive plants is of concern across Montana's grasslands. In addition to ecological consequences, unchecked exotic plant invasions on

native grasslands can have severe economic effects. For example, after arriving in Montana in 1920, spotted knapweed spread to over 4.7 million acres by 1988 (Invasive Plants Handbook, http://www.denix.osd.mil). The economic loss from spotted knapweed in Montana is now estimated at $42 million annually. Losses to leafy spurge infestations in Montana cost ranchers $2.2 million.

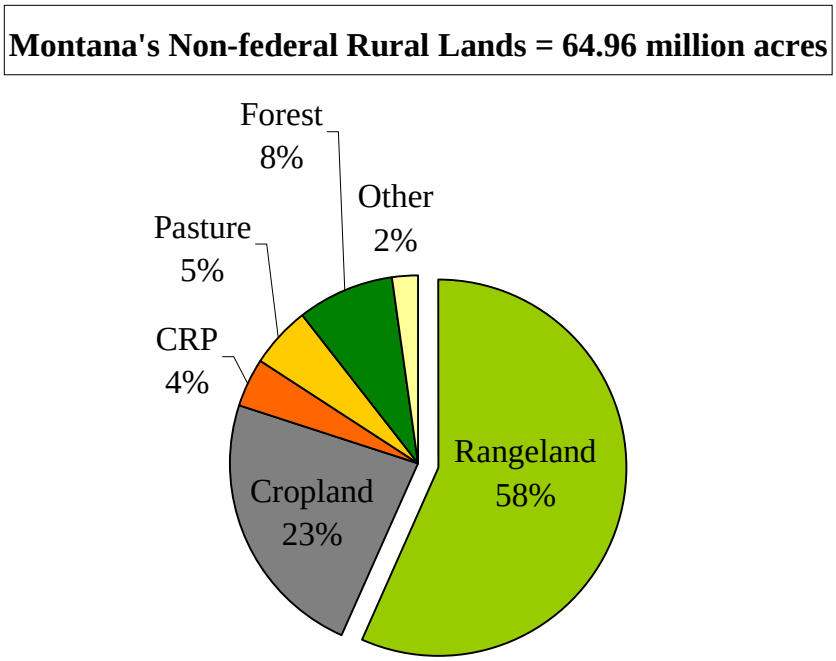

Figure 2. 13. Major land use classes for non-federal rural lands in Montana, 1997 (Source: NRI, *Revised 2000*).

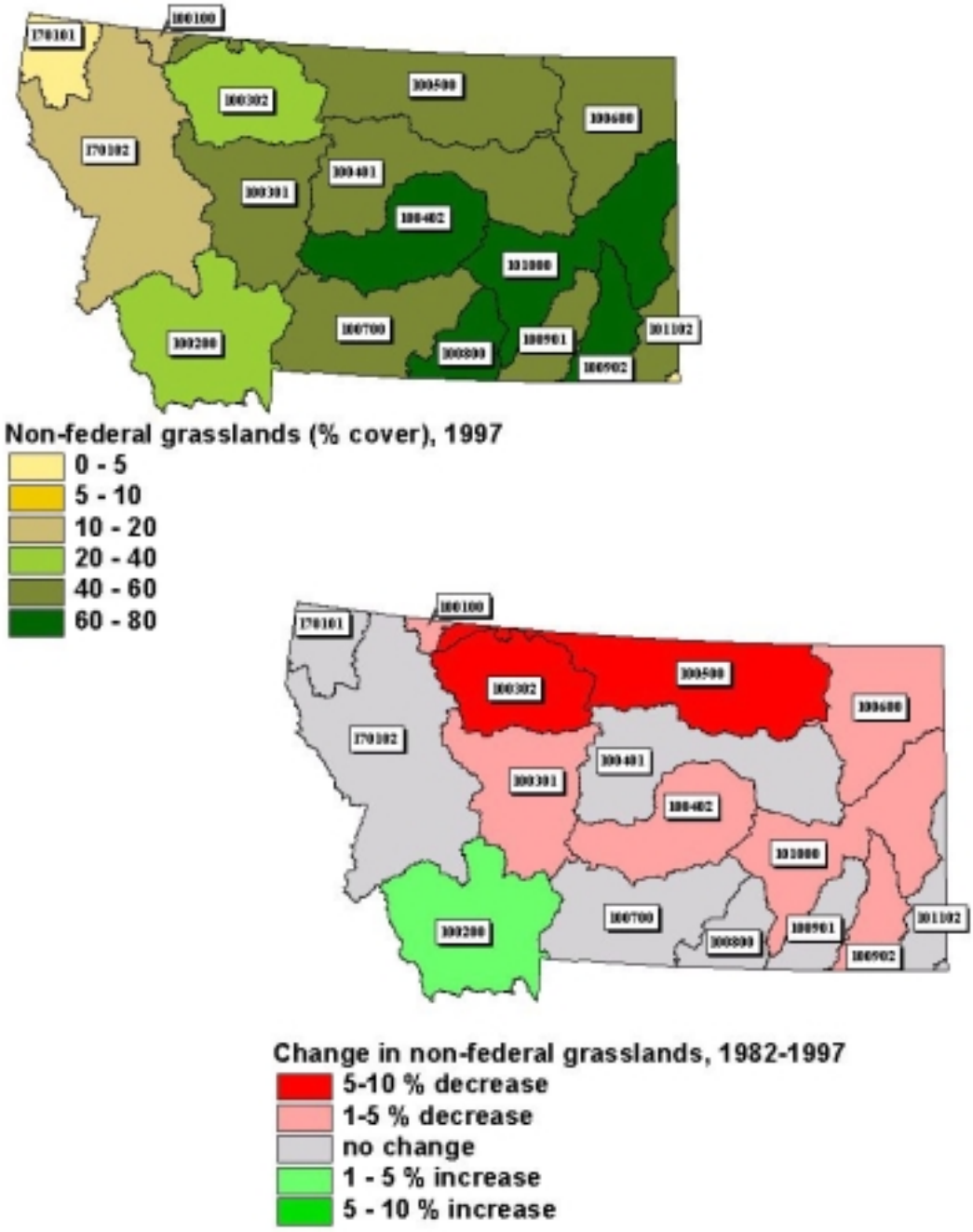

Figure 2. 14. For Montana, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE**: *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.7.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

North Dakota

North Dakota's native grasslands extended across approximately 37.31 million acres prior to settlement, about 88% of which was northern mixed-grass prairie (Table 1.3, Figure 1.5). North Dakota's grasslands once accounted for approximately 35% of all northern mixed-grass prairie in the US – second only to South Dakota. Other major pre-settlement grassland types included about 3.3 million acres of tallgrass prairie adjacent to the state's eastern border with Minnesota. Only 3.8% of North Dakota's 45.25 million acres remain in federal ownership, much of which is National Grasslands along the western border with Montana.

Present status

As of 1997, approximately 11.81 million acres of North Dakota's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of North Dakota's non-federal grazinglands, about 90% are native rangelands (Table 2.10). These non-federal rangelands represent about 23% of the state's total land base, and approximately 26% of all non-federal rural land in the state (Figure 2.15). The grazinglands reported for on private farms and ranches account for about 91% of all non-federal grazinglands in the state (Tables 2.3 and 2.10). Grazinglands on farms and ranches account for 10.8 million acres, some 26% of North Dakota's non-federal rural lands.

Recent land use trends

In the 15 years prior to 1997, North Dakota lost about 1.1 million acres of its non-federal native rangeland (~9.5%), only about 2% of which was transferred to federal ownership (Table 2.8, Figure 2.15b). Of that native rangeland loss, about 70% was a conversion to cropland, 46% being under cultivation by 1997. In all, about 1.16 million acres of North Dakota's non-federal grazinglands (including pastureland) were converted to cropland between 1982 and 1997. In the mean time, about 2.8 million acres were deferred from crop production under the CRP. This implies that about 41% of the acreage that was deferred from cropping under CRP in North Dakota may have simply been replaced by breaking-out grazinglands, the majority of which (64%) were native rangelands. This dynamic begs the question of to whether or not conversions of native grasslands to croplands were indirectly accelerated by the deferments of the CRP.

Urban expansion in North Dakota increased urban lands by only 19%, being relatively stagnant in comparison to other states. A little more than 16,000 acres of North Dakota's grazinglands were converted to urban use from 1982 to 1997.

About 293,400 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 –

only about 3% of which was transferred from federal ownership. Roughly 50% of this "new" native rangeland came from lands that were formerly classified as cropland. Another 31% came from non-native pastures. When considering the change over the 15-year period, the result was a net reduction of 791,800 acres of native rangeland on non-federal lands in North Dakota.

Regional distribution

North Dakota's existing non-federal grazinglands increase along the transition from the northeast to the southwest (Figure 2.16a). The former tallgrass prairies along the eastern portion of the state have experienced the greatest losses – the non-federal grazinglands in those areas now covering less than 10% of the land. The largest concentrations of nonfederal grazinglands are in the southwestern portion of the state where substantial acreage of northern mixed-grass prairie remains.

From 1982 to 1997, all 12 major watersheds (hydrologic units) in North Dakota experienced a net loss in grazinglands (Figure 2.16b). On a percentage basis, the loss of grazinglands uniformly followed the same gradient of grazingland cover. In other words, those drainages with the least to lose lost the most. In the 2 Red River drainages in the easternmost part of the state, for example, the total acreage of grazingland represents less than 5% of North Dakota's total; but, the Red River basin coincides with most of the area formerly dominated by tallgrass prairie. Over 102,000 acres in the Red River basin was recently converted from grazinglands to other land use, primarily cropland. This represents a loss of almost 20% of the grazinglands of the tallgrass prairie in North Dakota. One of the largest concentrated losses of grazinglands was in the Lake Oahe drainage in the south-central portion of the state where over 185,000 acres of grazingands were recently converted to croplands.

Trends in farm and ranch enterprises

The total area of grazinglands on farms and ranches recorded by the USDA Census of Agriculture actually increased by 6% from 1982 to 1997. However, when compared with the 1978 census, the area of grazinglands appears to have decreased by 4%. The number of farms and ranches with grazinglands declined by about 7%. The result was a 14% increase in the average area of grazinglands on farms and ranches.

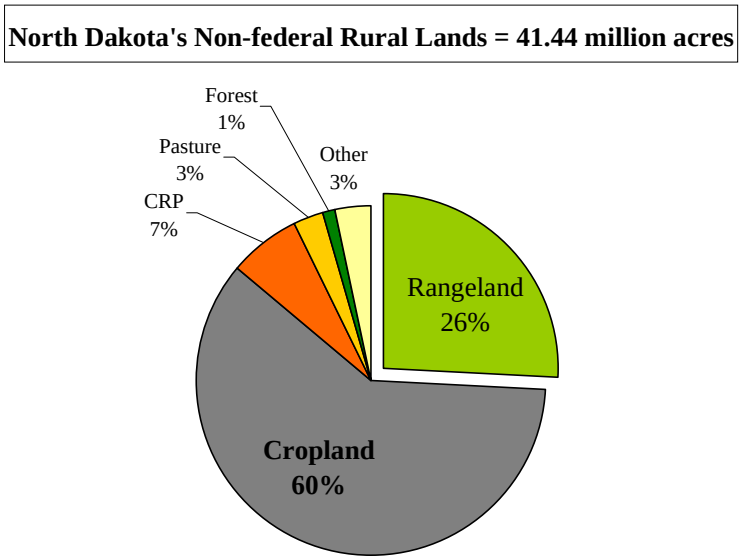

Figure 2. 15a. Major land use classes for non-federal rural lands in North Dakota, 1997 (Source: NRI, *Revised 2000*).

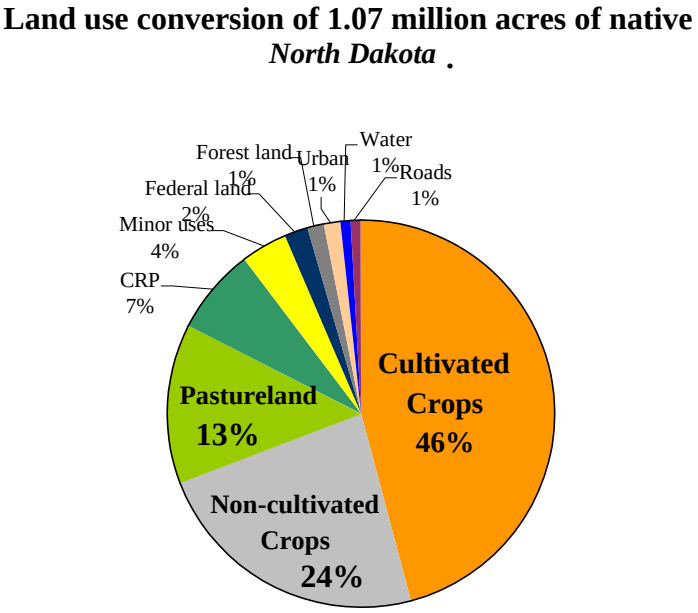

Figure 2. 15b. Land use conversion of non-federal native rangelands in North Dakota, 1982-1997

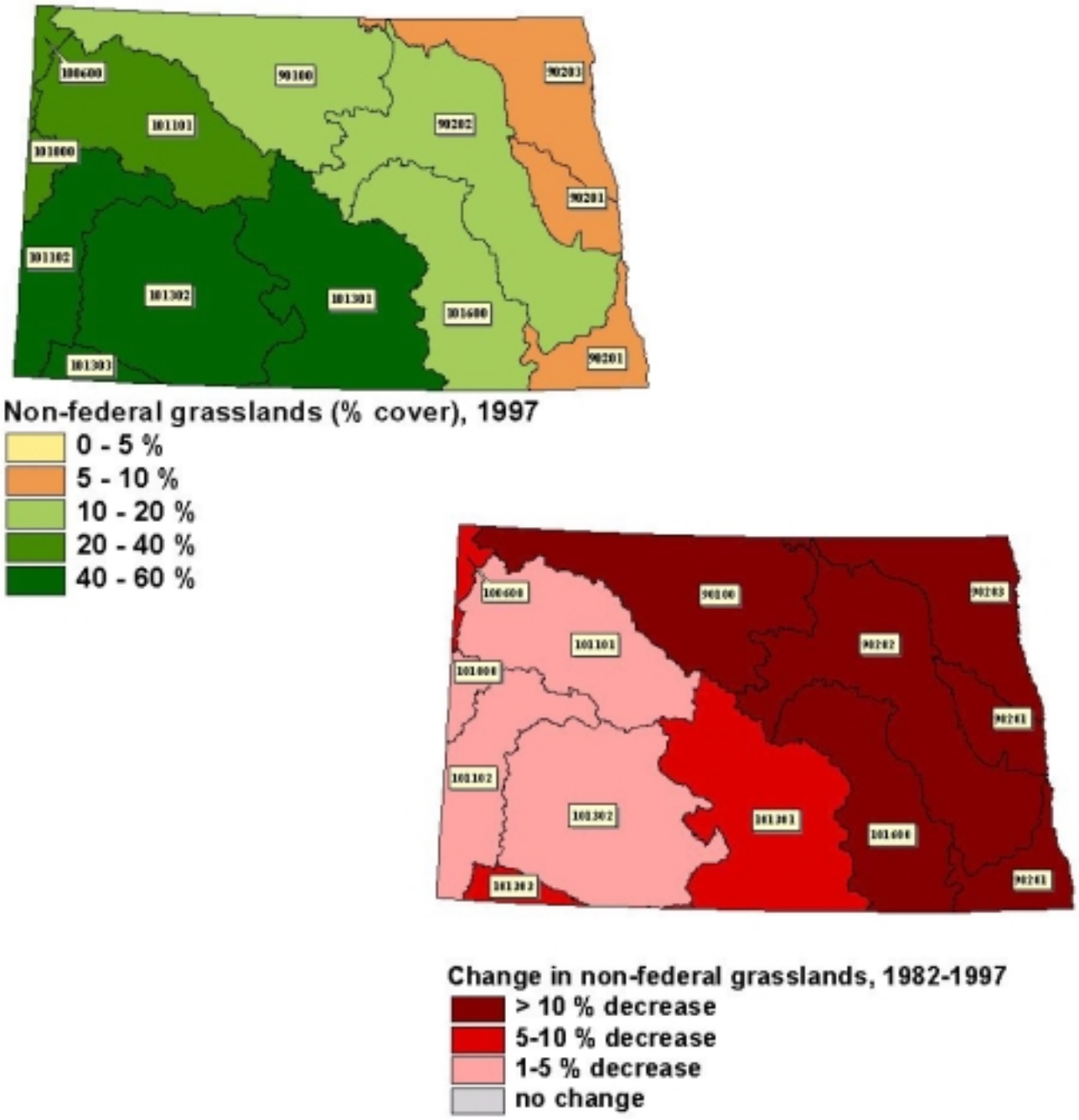

Figure 2. 16. For North Dakota, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE: *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.9***. (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Ecological status and trends

As North Dakota has recently continued to lose grasslands throughout the state, many grassland-associated species will likely continue a trend downward. In general, the most recent grassland losses have been concentrated in the eastern and northeastern half of the state (Figure 2.16). These losses are concentrated in the prairie pothole region, an area of extreme importance for the waterfowl resource of North America. As such, one of the most pressing grassland issues in North Dakota is the continued loss and degradation of these complex grassland and wetland landscapes. Within the US, North Dakota has the largest area of this prairie pothole region.

The prairie pothole region produces about 50-80% of North America's supply of major species of ducks; and is the primary production area for ducks in the Central and Mississippi flyways (Batt *et al.* 1989, Smith 1995). During the 10 years between 1986 and 1995, the prairie pothole region supported an annual average of approximately 15 million breeding ducks – although subject to some annual variability due to drought conditions, these numbers were about 16% lower than the 40 year average from 1955-1995 (Smith 1995). Nesting success in the prairie potholes of North and South Dakota is often too low to maintain stable populations for several species; including mallards, northern pintails, gadwalls, northern shovelers and blue-wing teal (Shaffer and Newton 1995). The cause of these declines is complex, but is ultimately associated with the conversion of grasslands to cultivated croplands and the other land use changes associated with intensively managed agricultural landscapes.

Predation is the major factor leading to waterfowl nesting failures in the prairie potholes (Sovada *et al.* 2001). This predation appears to be a direct result of land use conversions of grassland to cultivated cropland. Predation on waterfowl increases as the proportion of grassland in a prairie landscape decreases, such that waterfowl nesting success in the prairie pothole region is correlated with the amount of grassland remaining in the landscape (Greenwood *et al.* 1995). Because of this, the protection and restoration of grasslands in this part of North Dakota, and in other portions of the prairie pothole region, is probably the highest priority action needed for stabilizing waterfowl production in North America (Sovada *et al.* 2001). While the trend data for species other than waterfowl are not as readily available, it is safe to assume that many of the other species that depend on the grassland—wetland complex of the prairie potholes of North Dakota are impacted similar to waterfowl.

The grasslands of North Dakota are also important areas for breeding populations of several endemic grassland birds. One species in particular, Baird's sparrow has the peak of its breeding distribution in

North Dakota (Dechant *et al.* 2001). Native prairie is optimal breeding habitat for Baird's sparrow. During the period from 1966 to 1999, Breeding Bird Survey records indicate that Baird's sparrow experienced one of the most drastic declines of any endemic grassland bird in the US; decreasing at an average rate of 3.4% per year (Table 1.11). This species seems to depend upon large expanses of native prairie with minimal shrub cover (Dechant *et al.* 2001). This species also suffers from the vegetative conditions resulting from a lack of periodic fire (Madden *et al.* 1999). Using Baird's sparrow as an indicator species, it appears that the condition of North Dakota's native grasslands may not only be suffering from an overall loss in grassland area, but also from increased fragmentation and habitat changes resulting from fire exclusion.

The spread of non-native invasive plants has reduced the habitat capability of much of North Dakota's remaining grasslands. For example, leafy spurge (*Euphorbia esula*), an aggressive rangeland invader, now occupies several million acres in North Dakota and elsewhere in the northern Great Plains. When a grassland area becomes infested with leafy spurge it has reduced wildlife habitat values and loses native plant diversity. In addition, livestock forage consumption is negatively impacted. When grasslands are fragmented by other land uses and subjected to unmanaged grazing, they are more likely to become infested by leafy spurge, or one or more of several other invasive plants. In addition to the ecological damage caused by invasive plants, the economic damage can be substantial. For leafy spurge alone, the cost in terms of production losses, control expenses, and other impacts to the economy exceeds $144 million per year in the Dakotas, Montana and Wyoming (USDA/APHIS 2000). Well-managed, and un-fragmented, grassland systems are less likely to incur these costs.

South Dakota

South Dakota's native grasslands extended across approximately 44.51 million acres prior to settlement, about 82% of which was northern mixed-grass prairie (Table 1.3, Figure 1.5). South Dakota's grasslands once accounted for approximately 38% of all northern mixed-grass prairie in the US – the largest concentration of any state. Other major pre-settlement grassland types included about 7.39 million acres of tallgrass prairie adjacent to the state's eastern border with Minnesota and Iowa. Only 6.3% of South Dakota's 49.36 million acres are under federal ownership, much of which is National Grasslands in the western portion of the state.

Present status

As of 1997, approximately 23.98 million acres of South Dakota's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of South Dakota's non-federal grazinglands,

about 91% are native rangelands (Table 2.12). These non-federal rangelands represent about 44% of the state's total land base, and approximately 49% of all non-federal rural land in the state (Figure 2.17). The grazinglands reported on private farms and ranches account for about 98% of all non-federal grazinglands in the state (Tables 2.3 and 2.12). Grazinglands on farms and ranches account for 23.59 million acres, representing 57% of South Dakota's non-federal rural lands. According to preliminary results from a remote sensing analysis, South Dakota's native grasslands currently occupy approximately 18.9 million acres, representing about 38% of the state (Smith *et al.* Unpublished data from South Dakota GAP Analysis Project).

Recent land use trends

In the 15 years prior to 1997, South Dakota lost about 1.23 million acres of its non-federal native rangeland (~5.3%), only about 3% of which was transferred to federal ownership (Table 2.10). Of that native rangeland loss, about 68% was a conversion to cropland, 46% (632.2 acres) being under cultivation by 1997. This pattern was almost identical in scale to the overall loss and conversion of native rangelands in North Dakota. In all, about 1.82 million acres of South Dakota's non-federal grazinglands (including pastureland) were converted to cropland (including non-cultivated cropland) between 1982 and 1997. In the mean time, about 1.69 million acres were deferred from crop production under the CRP. The conversion of grazinglands to cultivated croplands offset about 74% of the acreage that was deferred under CRP during this period – over half of those grazinglands were in native rangeland in 1982. As was the case with North Dakota, this suggests that some of the conservation benefits derived from CRP deferments may have been offset by sod-busting of range and pastureland.

South Dakota experienced only a 4.4% net decline in cultivated cropland over the period of 1982 to 1997; this being somewhat different than the national average of 13.2% (NRI 2000). In fact, in the 5 years from 1982 to 1987, South Dakota was the only state in the nation to have a substantial increase in cultivated cropland (494,000 acre increase). In comparison, Montana – a state with a similar acreage of cultivated cropland in 1982 – reduced cultivated croplands by about 777,000 acres between 1982-87. . Urban lands in South Dakota increased moderately (105,300 acre increase) representing a 44% expansion from 1982.

About 142,700 acres of South Dakota that was not rangeland in 1982 was reclassified as native rangeland by 1997 – only about 6% of which was transferred from federal ownership. About 26% of this "new" native rangeland came from cropland, and 37% came from lands formerly in non-native pasture. When considering change from 1982 to 1997, the net result was a reduction of 1,089,000 acres of native rangeland on non-federal lands in South Dakota.

Regional distribution

South Dakota's existing non-federal grazinglands increase along the transition from the eastern to western portion of the state (Figure 2.18a). The previous tallgrass prairies along the eastern portion of the state have experienced the greatest losses – the non-federal grazinglands in those areas now covering less than 20% of the land. The largest concentrations of nonfederal grazinglands are in the western portion of the state where substantial acreage of northern mixed-grass prairie remains.

From 1982 to 1997, all 14 major watersheds (hydrologic units) in South Dakota experienced a net loss in grazinglands (Figure 2.18b). The watersheds draining the extreme eastern border of the state had the least cover by grazinglands and experienced the most dramatic recent losses on percentage basis. This is of importance as this area along the western extreme of the tallgrass prairies, very few of which remain. In the 4 basins roughly coinciding with the former range of tallgrass prairie, experienced a loss of grazinglands of about 271,500 acres in the period from 1982 to 1997. This represents a loss of 16.7% of the grazinglands of the tallgrass prairie in South Dakota. One of the largest concentrated losses of grazinglands in South Dakota was in the James River Basin of the east-central portion of the state. Over 500,000 acres of grazinglands were converted to other uses in the James River Basin – this represents a 14.5% loss of grazinglands and accounts for over 30% of the entire loss of grazinglands for the state.

Trends in farm and ranch enterprises

In South Dakota, the total area of grazinglands on farms and ranches recorded by the USDA Census of Agriculture remained relatively stable from 1982 to 1997 (Table 2.1). However, when compared with the 1978 census, the area of grazinglands appears to have decreased by 2.5%. The number of South Dakota's grazingland-based farms and ranches declined by about 8.7% during 1982-1997. The overall result was a 10.5% increase in the average area of grazinglands on farms and ranches.

Ecological status and trends

While South Dakota has experienced recent losses in grassland area across the state, it is the tallgrass prairies and mixed-grass prairies in the eastern portion of the state that received the most concentrated conversions of grasslands. The shortgrass prairies in the western portion of the state remain relatively intact. While comparing figure 2.15a to figure 2.18a, it is apparent that grasslands remaining in South Dakota are somewhat greater than those in North Dakota, both states have experienced very similar patterns of recent land use conversions (Figures 2.15b and 2.18b).

Much of the recent losses in South Dakota's grasslands correspond regionally to the southern tip of the prairie pothole region of the eastern one-third of the state. The conversion of this grassland—wetland complex to cultivated croplands has the same negative impacts on waterfowl and associated biological resources as have been experienced in North Dakota (see previous section on North Dakota).

The black-tailed prairie dog historically occupied the western three-fourths of South Dakota (Hall and Kelson 1959:364-366), accounting for about 8% of the species range in the US. South Dakota currently holds approximately 147,000 acres of occupied habitat, accounting for about 22% of the currently occupied habitat in the US (US Fish and Wildlife Service 2000). Although the occupied habitat in South Dakota has declined by as much as 92% from historic levels, the state's current grassland area occupied by prairie dogs represents a significant proportion of the remaining prairie dog population in the US. From this perspective, the conservation of South Dakota's remaining prairie habitats is of national interest.

The chestnut-collared longspur is an endemic grassland bird with much of its breeding habitat in the short- and mixed-grass prairies of central South Dakota. Optimal breeding habitat for this species includes level to rolling mixed-grass and shortgrass uplands with sparse shrubby cover; and in drier habitats, they prefer moist lowlands (Dechant *et al.* 2000). In general, their habitats are enhanced by periodic fire. According to Breeding Bird Surveys, the populations of chestnut collared longspurs in South Dakota declined by about 7.1% per year in the period from 1966 to 1999 (Table 1.12). Range wide, most of the specie's decline appears to have occurred during the 20 year period from 1980 to 1999. These declines likely reflect the results of an overall decrease in its prairie habitat combined with degradation in the condition of existing habitat.

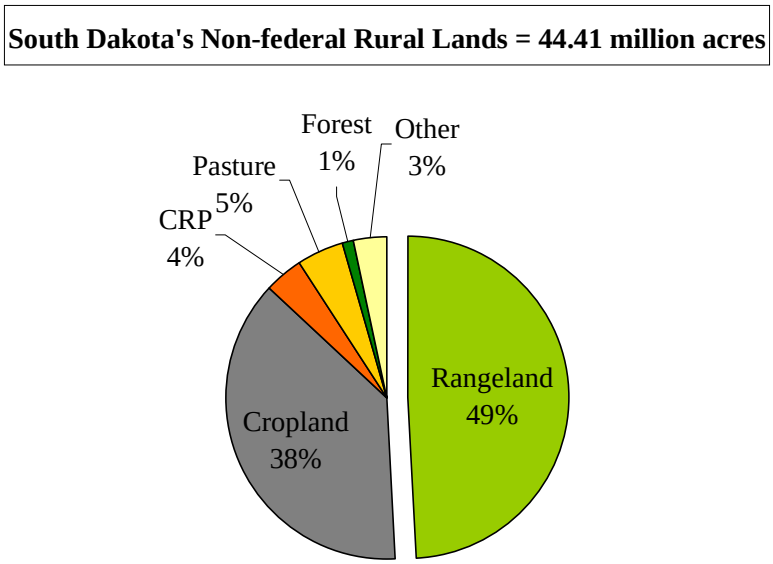

Figure 2. 17a. Major land use classes for non-federal rural lands in South Dakota, 1997 (Source: NRI, Revised 2000).

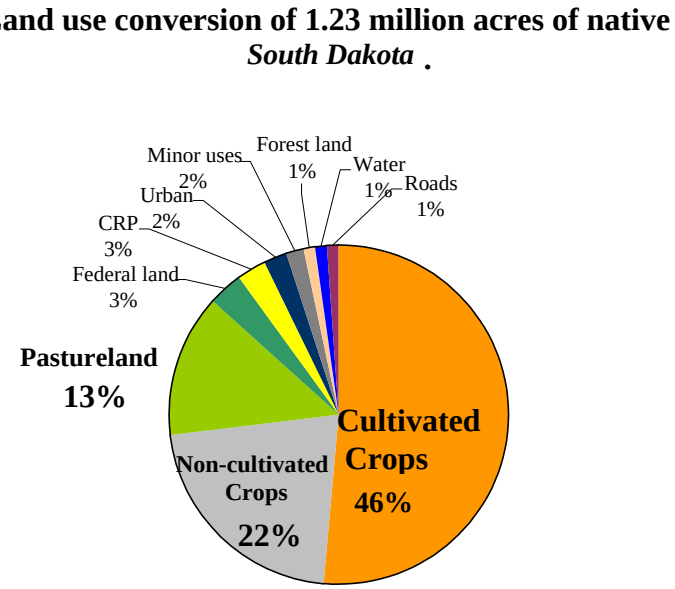

Figure 2. 17b. Major land use classes for non-federal rural lands in South Dakota, 1997 (Source: NRI, Revised 2000).

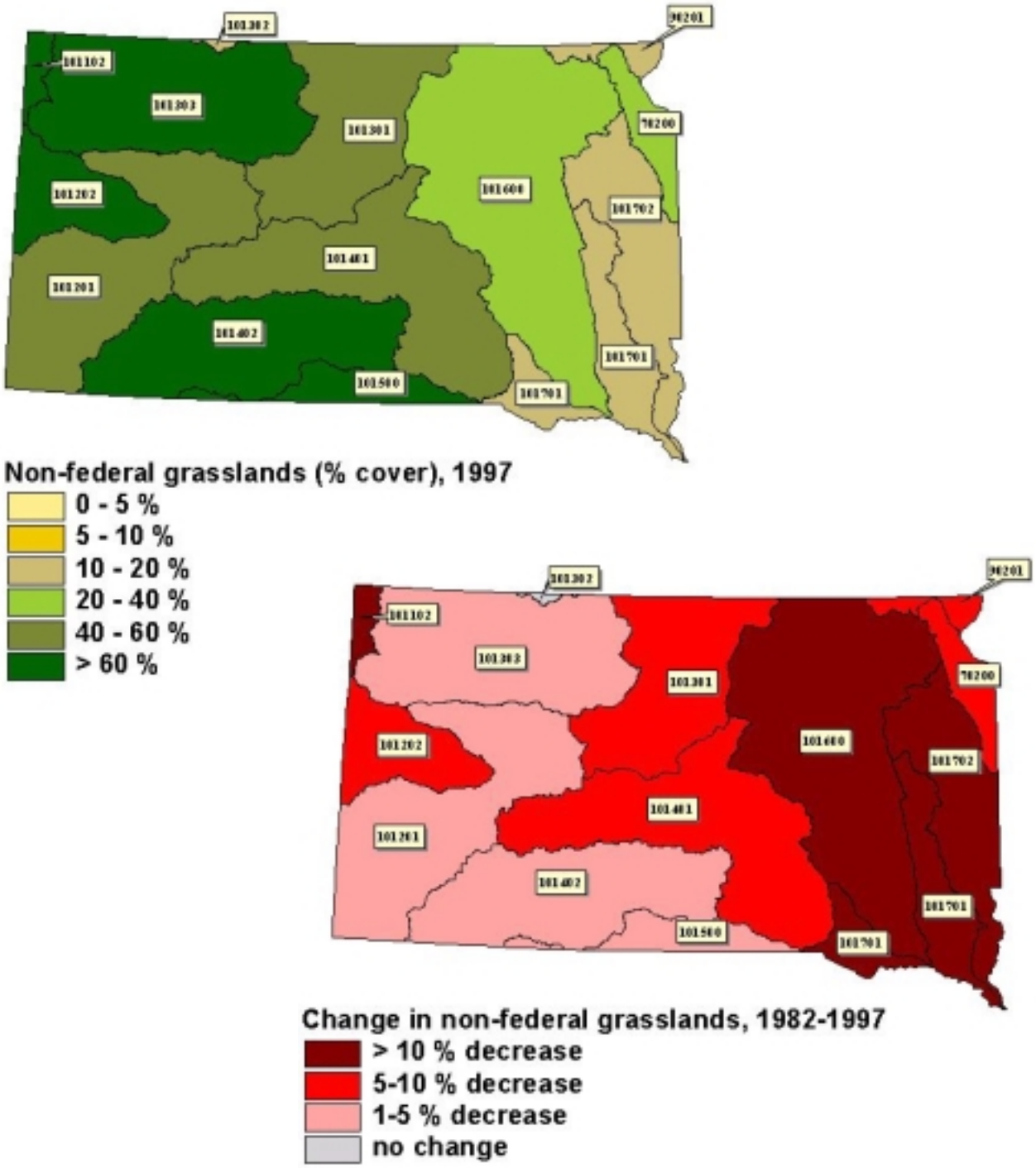

Figure 2. 18. For South Dakota, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. NOTE: *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.9.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Texas

Texas' native grasslands extended across approximately 148.3 million acres prior to settlement (Table 1.3 and Figure 1.5). Texas' grasslands once accounted for almost 17% of the entire US pre-settlement grassland coverage. Texas' pre-settlement grasslands represented 11 different grassland types, representing the majority of the nation's post oak savanna, coastal prairie, and desert savanna grassland types (Figure 1.5). Central Plains grassland types once accounted for approximately 84.52 million acres in Texas; and Western Grassland types covered approximately 63.81 million acres of the state. All grassland types of the Central Plains are represented in Texas, as well as 5 of the 9 Western Grassland types (Figure 1.5).

Federal lands in Texas account for roughly 4% of the total land area, and are concentrated in the forested regions in the eastern part of the state. Federal landholdings in grassland regions include Fort Hood in Central Texas, Big Bend National Park in West Texas and scattered parcels of National grasslands in north-central Texas and the Panhandle.

Present status

As of 1997, approximately 111.66 million acres of Texas' non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Texas' nonfederal grazinglands, about 86% are native rangelands (Table 2.14). These non-federal rangelands represent about 56% of the state's total land base, and approximately 62% of all non-federal rural land in the state (Figure 2.19). The grazinglands on private farms and ranches account for about 77% of all non-federal grazinglands in the state (Tables 2.3 and 2.14). According to the USDA Census of Agriculture, grazinglands on commercial farm and ranch enterprises account for 86 million acres, and roughly 50% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Texas lost about 3.6 million acres of its non-federal native rangeland (~4%), about 99,600 acres of which were transferred to federal ownership (Table 2.14). Of that native rangeland loss, about 27% was converted to cultivated cropland; about 26% was converted to non-native pasture; and about 23% was lost to urban expansion (Table 2.14). In all, about 1.59 million acres of Texas' grazinglands (including pastureland) were converted to cultivated cropland between 1982 and 1997. In the mean time, about 3.91 million acres were deferred from crop production under the CRP. The conversion of grazinglands to cultivated croplands offset about 41% of the acreage that was deferred under CRP during this period – about 62% of those grazinglands were in native rangeland in 1982.

About 3.01 million acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 37% of which was transferred from federal ownership. Roughly 45% of this "new" native rangeland came from lands that were under cultivation in 1982; and about 46% was previously classified as non-native pastures. When considering the net change over the 15-year period, the result was a net reduction of only 598,200 acres of native rangeland. During this same period there was a 19% decrease in cultivated croplands in Texas.

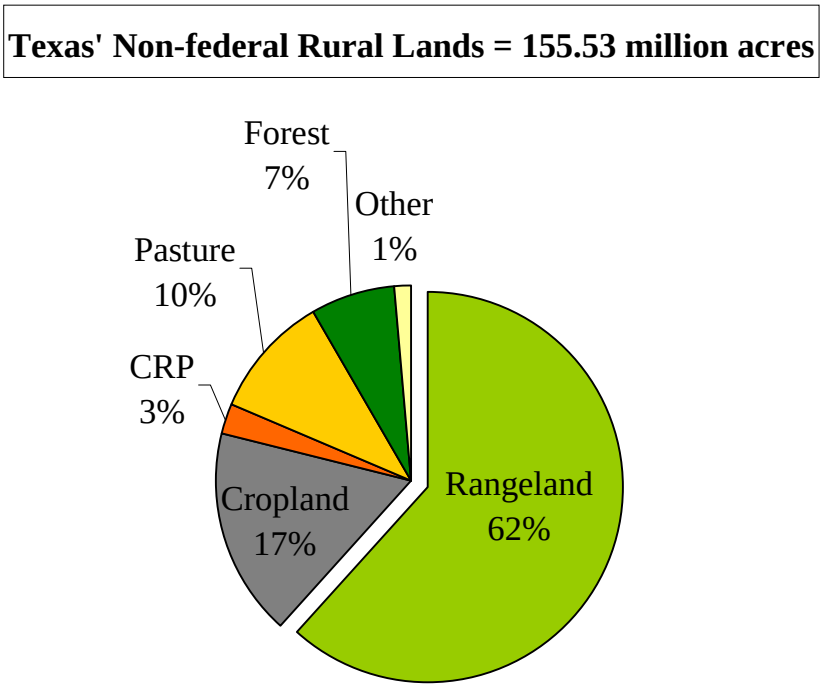

Figure 2. 19. Major land use classes for non-federal rural lands in Texas, 1997 (Source: NRI, *Revised 2000*).

Regional distribution

The major concentration of Texas' existing non-federal grazinglands are in West Texas and along the Rio Grande Valley in South Texas (Figure 2.20a). Other substantial concentrations are in the shortgrass prairies of the southern plains (upper panhandle), and in the savannas of central and south-central Texas.

Overall, the coverage by grazinglands in Texas is shifting from the more populated eastern portions of the state to the less populated areas to the west and north (Figure 2.20a). From 1982 to 1997, the regions experiencing the greatest declines in grazinglands were in the eastern portion of the state, including the Blackland Prairies and Post Oak Savanna grassland types (Figure 2.20b). Other areas that experienced declining grazingland acreage in Texas included the extreme southern portions of the state, the grasslands of central Texas and the shortgrass prairie region in the panhandle. The only areas experiencing a substantial increase in grazinglands were the Red-Pease, Brazos Headwaters, and Red-Lake Texoma Basins in north Texas; and the San Bernard Coastal, Lavaca River, and Guadalupe River Basins along the central Texas coast (Figure 2.20b, Table 2.15).

Trends in farm and ranch enterprises

The total area of non-federal grazinglands on farms and ranches in Texas remained relatively stable when considering the 1982 versus the 1997 Census of Agriculture (Table 2.1). The number of grazingland-based farm and ranch enterprises increased by 8.2% during this period. The result was a 7.6% decrease in the average grazingland-based farm and ranch operation. However, the most dramatic changes in farm and ranch enterprises seem to have occurred more recently. When comparing the size class distributions of Texas' farm and ranches in the 5-year period from 1992 to 1997, it is apparent that most counties in Texas experienced dramatic increases in the smaller operations (i.e., those <500 acres). About 55% of Texas counties experience losses in mid-sized ownerships (500-2000 acres), and 48% of the counties gained numbers of larger ownerships (those >2000 acres). The net effect over that 5-year period was a decline in average ownership size in 74% of Texas' counties; as well as a polarization of ownership sizes (Wilkins *et al.* 2000). In other words, Texas is losing mid-sized (500-2000 acre) farm and ranch enterprises while gaining in both smaller and larger ownerships.

Ecological status and trends

The grasslands of Texas cover the most area, and are the most ecologically diverse of any state in the nation. Thus, the ecological status of grasslands in Texas is highly variable depending upon the region of the state. Those areas of the state having received the greatest recent losses in grassland area correspond with the Blackland Prairies, Post Oak Savannas and the Savannas of the Edwards plateau (Figure 2.20b).

These are the same areas that have received the most recent ownership fragmentation pressures (Wilkins *et al.* 2000).

In addition to cropland conversions, native grasslands in Texas have been adversely impacted by urban expansion, ownership and habitat fragmentation, conversions to introduced pasture grasses, and the long-term changes in habitats that result from fire exclusion and improper grazing management. As a result, much of the state's existing native grasslands have been invaded by woody vegetation – both native and non-native. In fact, in many areas of the state, the invasion and increase in woody vegetation is likely reducing surface and underground water yields (Bednarz *et al.* 2000). The management of woody vegetation for wildlife needs, livestock production, and water yield is an issue of major ecological importance in Texas.

In Texas, as in other states, the trends of endemic grassland species have tended to reflect the overall loss and/or degradation of native grassland habitats. One of the most evident species in this regard is the federally endangered Attwater's prairie chicken, endemic to the Coastal Prairie. Approximately 6 million acres of Coastal Prairie once supported a healthy population of prairie chickens (Campbell 1995). Since 1930, conversion to rice cultivation, urban sprawl, introduction of improved pasture grasses, and declining range conditions associated with continuous grazing has reduced the suitable habitat for this species to about 200,000 acres – approximately 3% of its former range (Campbell 1995). On those grasslands remaining in the Coastal Prairie, the invasion of native woody species such as mesquite (*Prosopis glandulosa*) and huisache (*Acacia farnesiana*); and introduced invaders such as Chinese tallowtree (*Sapium sebiferum*) and Macartney rose (*Rosa bracteata*), have changed the structure and function of the habitat such that it no longer supports many of the wildlife species endemic to the area, including the Attwater's prairie chicken.

The same general trends have led to the demise of other grassland endemics elsewhere in the state. For example, in the savanna grasslands of the Edwards Plateau of central Texas, fire exclusion, overgrazing, and broad-scale brush control efforts have contributed to the development of habitats that no longer support populations of the Endangered black-capped vireo (Campbell 1995). Worsening this situation is the increase of nest parasitism from brown-headed cowbirds associated with grain fields and concentrated livestock operations. For this, and other species, managers have determined that selective control of juniper, combined with prescribed fire, and rotational grazing management, harvest management of white-tailed deer, and cowbird trapping can result in local recovery (Armstrong 2000).

Elsewhere in Texas, the trends are similar to those examples given above. The species involved tend to vary from one grassland type to another; but the overall dynamics related to combinations of ownership fragmentation, land use changes, heavy continuous grazing, fire exclusion, and the introduction of non-native species (including Brazilian fire ants) has resulted in habitat modifications across vast areas of former grasslands. At times the reaction to these habitat changes have taken the form of large-scale brush eradication projects followed by the establishment of non-native grasses. In many cases, these actions have actually worsened the habitat conditions for many native species. Owing to the fact that most of Texas is privately owned and much of the state remains in native rangelands (about 62%, Figure 2.18), the future of much of the state's biological resources will depend upon how native grasslands are managed from this point forward. The most successful management actions seem to be those that mimic natural processes, and focus on restoring native habitats.

Summary

Chapter 1 provided arguments supporting the contention that grasslands were historically and are currently of great ecological and economic importance to the United States. Chapter 2 focused on the ecological status and land use trends of grasslands in the United States. Information regarding the historical extent and distribution of grasslands relative to their current status were explored and grassland ownership patterns were discussed at the national level. These features of US grasslands were then explored for 6 important and distinct grassland states: Colorado, Idaho, Montana, North Dakota, South Dakota and Texas. Chapter 3 will further explore the similarities and distinctions between the drivers of grassland use and change in the United States, in the 6 focus states, and in 17 case studies of particular counties within these focus states.

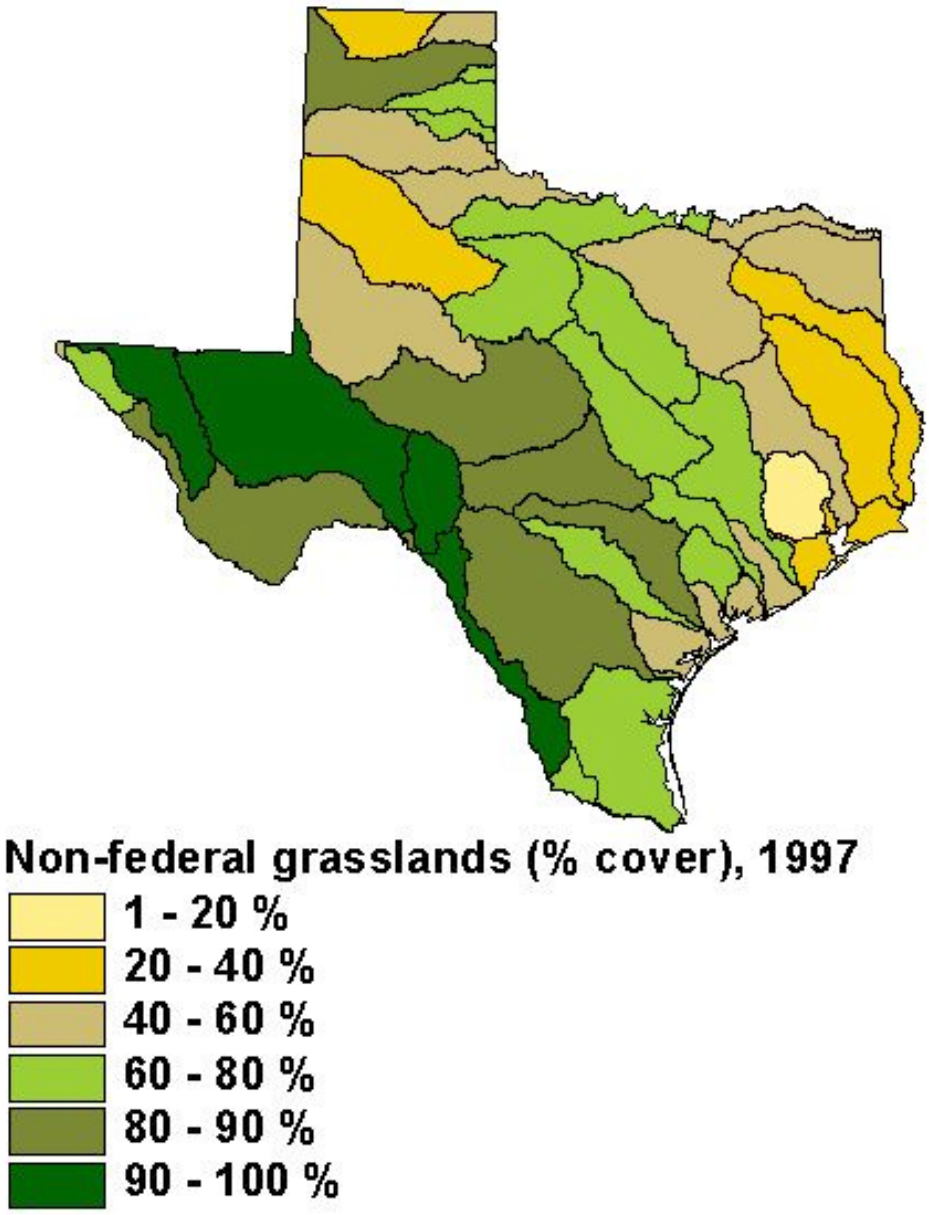

Figure 2. 20a. For Texas, percent Land cover by non-federal rangeland and pasture. Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

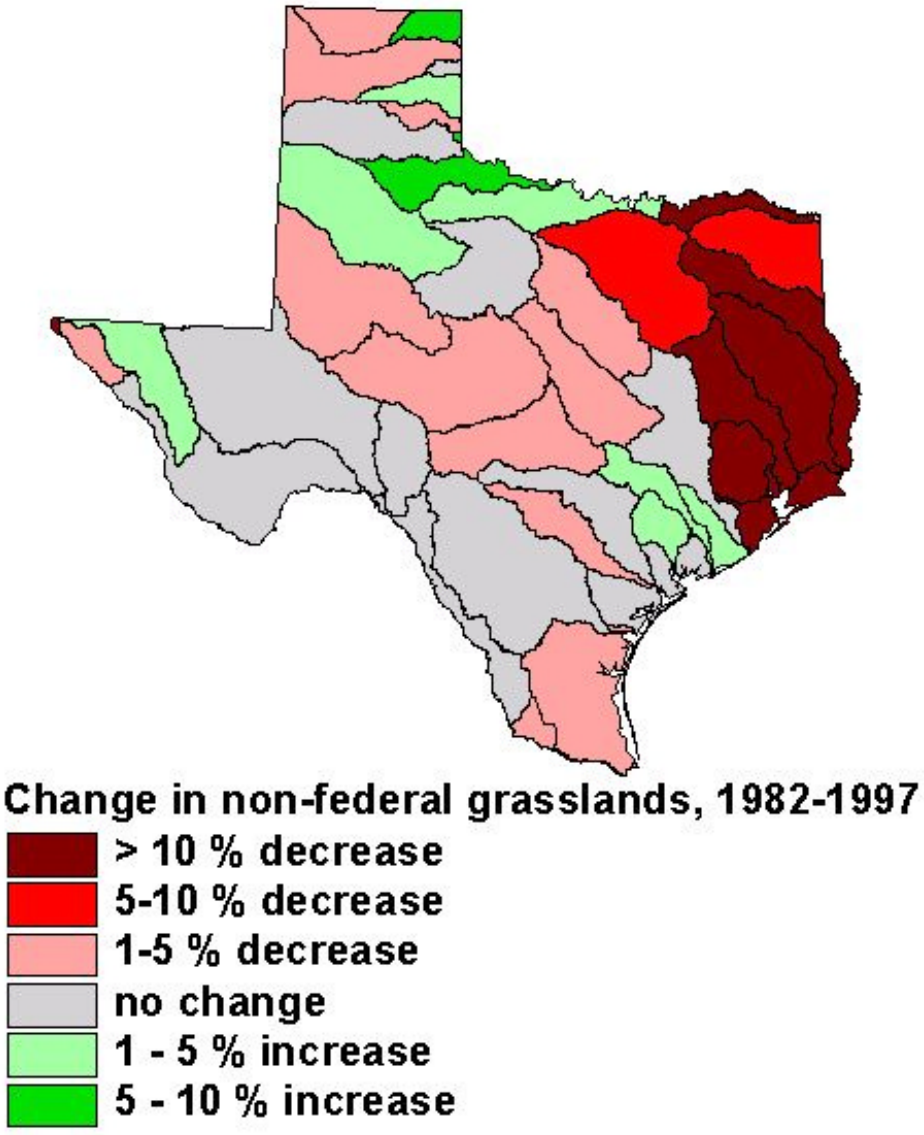

Figure 2. 20b. For Texas, change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Figure 2. 20c. River basin boundaries and Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.13.

Table 2.1. Acres of potential grasslands compared to 1997 estimates of grassland pasture and range from MLU and non-federal rangeland from NRI for the 22 western states.

State	AZ	AR	CA	CO	ID	IA	KA	LA	MN	MO	MT	NE	NV	NM
						……1,000,000 acres……								
Potential Grasslands (Table 1.3)	49.26	0.16	49.96	41.34	28.36	25.45	47.18	4.43	21.86	15.36	60.47	44.05	59.07	47.55
Grassland Pasture and Range (MLU-1997)	40.51	2.01	22.34	27.87	21.17	1.48	12.56	1.58	1.54	6.01	46.04	21.83	46.28	52.19
Non-Federal Rangeland (NRI-1997)	32.32	0.04	18.27	24.57	6.50	0.00	15.73	0.28	0.00	0.09	36.75	23.09	8.37	39.99
Potential acres lost (less GPR - MLU)	8.75	0.00	27.62	13.47	7.19	23.97	34.62	2.85	20.32	9.35	14.43	22.22	12.79	0.00
% of Potential lost (GPR - MLU)	18%	0%	55%	33%	25%	94%	73%	64%	93%	61%	24%	50%	22%	0%
Potential acres lost (less NFR - NRI)	16.94	0.12	31.69	16.77	21.86	25.45	31.45	4.15	21.86	15.27	23.72	20.96	50.70	7.56
% of Potential lost (NFR - NRI)	34%	75%	63%	41%	77%	100%	67%	94%	100%	99%	39%	48%	86%	16%

Table 2.1 (Continued). Acres of potential grasslands compared to 1997 estimates of grassland pasture and range from MLU and non-federal rangeland from NRI for the 22 western states.

State	ND	OK	0R	SD	TX	UT	WA	WY	Total
					.....1,000,000 acres.....				
Potential Grasslands (Table 1.3)	37.31	37.76	27.51	44.51	148.53	28.59	17.18	47.21	833.10
Grassland Pasture and Range (MLU-1997)	11.33	17.31	22.40	22.59	98.06	23.74	7.41	44.87	551.12
Non-Federal Rangeland (NRI-1997)	10.69	14.03	9.29	21.88	95.74	10.73	5.86	27.30	401.52
Potential acres lost (less GPR - MLU)	25.98	20.45	5.11	21.92	50.47	4.85	9.77	2.34	331.98
% of Potential lost (GPR - MLU)	70%	54%	19%	49%	34%	17%	57%	5%	38%
Potential acres lost (less NFR - NRI)	26.62	23.73	18.22	22.63	52.79	17.86	11.32	19.91	481.58
% of Potential lost (NFR - NRI)	71%	63%	66%	51%	36%	62%	66%	42%	55%

Table 2.2. Number of farms reporting acreage in other pastureland and rangeland[1], by State, according to the US Census of Agriculture, 1978 to 1997.

	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 2.3. State-level summaries of farms and ranches holding grazinglands (i.e., pastureland/rangeland) according to Census of Agriculture, 1978-1997.

						% change	
State	1997	1992	1987	1982	1978	1978-97	1982-97
Colorado							
Total Area (ac)	19,943,701	21,314,825	21,173,673	21,194,052	22,725,732	-12.2	-5.9
No. Operations	12,952	11,949	11,875	11,872	12,685	2.1	9.1
Avg Size (ac)	1540	1784	1783	1785	1792	-14.1	-13.7
Idaho							
Total Area (ac)	4,589,326	5,811,794	5,528,460	6,074,020	6,748,908	-32.0	-24.4
No. Operations	6,517	6,247	6,923	6,744	7,076	-7.9	-3.4
Avg Size (ac)	704	930	799	901	954	-26.2	-21.8
Montana							
Total Area (ac)	37,974,463	39,294,203	39,459,291	40,811,816	42,357,296	-10.3	-7.0
No. Operations	13,941	13,129	13,675	13,237	14,230	-2.0	5.3
Avg Size (ac)	2724	2993	2886	3083	2977	-8.5	-11.7
North Dakota							
Total Area (ac)	10,375,089	10,284,485	10,206,220	9,783,849	10,808,961	-4.0	6.0
No. Operations	14,541	14,565	16,025	15,644	19,285	-24.6	-7.1
Avg Size (ac)	714	706	637	625	560	27.3	14.1
South Dakota							
Total Area (ac)	23,588,662	23,946,525	23,069,181	23,392,939	24,183,243	-2.5	0.8
No. Operations	16,858	17,326	17,957	18,474	20,392	-17.3	-8.7
Avg Size (ac)	1399	1382	1285	1266	1186	18.0	10.5
Texas							
Total Area (ac)	86,073,441	87,798,825	86,802,117	86,068,315	87,337,112	-1.4	0.0
No. Operations	84,875	78,805	83,251	78,443	78,178	8.6	8.2
Avg Size (ac)	1014	1114	1043	1097	1117	-9.2	-7.6

Table 2.4. Changes in land cover/use between 1982 and 1997, Colorado.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated cropland	6,619.8	342	206.6	262.7	0.0	43.8	89.6	5.3	1.5	0.6	11.6	1,831.5	9,415.0
Non-cultivated Cropland	229.7	705.4	128.6	53.6	1.0	15.4	21.3	0.9	2.2	0.3	25.0	5.1	1,188.5
Pastureland	45.0	85.7	819.1	147.3	3.8	10.9	34.8	0.8	1.0	0.0	7.3	9.0	1,164.7
Rangeland	632.1	38.2	33.4	23,704.0	42.8	73.6	166.6	12.6	5.5	3.8	296.7	44.3	25,053.6
Forest land	0.7	1.4	4.3	252.5	3,358.1	17.8	79.9	2.0	0.5	1.0	38.8	0.0	3,757.0
Minor land use	15.4	4.8	2.3	34.9	0.6	790.3	12.9	0.8	0.6	0.0	13.4	0.0	876.0
Urban build-up	0.0	0.0	0.0	0.0	0.0	0.0	772.7	0.0	0.0	0.0	0.0	0.0	772.7
Rural transportation	3.5	0.4	0.0	6.7	1.1	0.6	2.1	449.4	0.0	0.0	0.0	0.0	463.8
Small water	0.7	1.0	0.1	2.3	0.2	0.0	0.0	0.0	136.2	0.0	0.0	0.0	140.5
Census water	1.2	0.5	0.0	8.6	0.0	0.0	0.0	0.0	0.0	175.6	0.0	0.0	185.9
Federal land	19.3	22.7	16.6	101.5	34.1	11.6	0.0	0.0	0.0	0.0	23,401.0	0.0	23,606.8
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	7,567.4	1,202.1	1,211.0	24,574.1	3,441.7	964.0	1,179.9	471.8	147.5	181.3	23,793.8	1,889.9	66,624.5

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 25,053.6 and the 1997 total was 24,574.1, with 23,704 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.5. NRI pastureland and rangeland in Colorado (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
101800 North Platte	372	369	369	369	-0.8
101900 South Platte	5303	5133	5058	5058	-4.6
102500 Republican	2062	2017	2010	1992	-3.4
102600 Smoky Hill	223	218	205	211	-5.3
110200 Upper Arkansas	10125	9791	9745	9786	-3.4
110300 Middle Arkansas	87	71	71	71	-18.6
110400 Upper Cimarron	833	806	785	801	-3.8
110800 Upper Canadian	2	2	2	2	11.8
130100 Rio Grande Headwaters	1629	1618	1612	1618	-0.7
130201 Upper Rio Grande	53	49	49	49	-7.6
140100 Colorado Headwaters	1053	1095	1041	1038	-1.4
140200 Gunnison	895	895	909	920	2.8
140300 Upper Colorado-Dolores	484	461	487	504	4.3
140401 The Green River Basin	67	67	67	67	0.0
140500 White-Yampa	1803	1853	2002	2022	12.2
140600 Lower Green	8	8	8	8	0.0
140801 Upper San Juan	920	933	942	945	2.7
140802 Lower San Juan	302	305	304	326	8.0
Total	26,218	25,689	25,664	25,785	-1.7

Table 2.6. Changes in land cover/use between 1982 and 1997, Idaho.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	3,889.0	406.3	162.9	30.9	1.5	34.1	77.2	3.2	0.2	0.0	90.9	705.4	5,401.6
Non-cultivated Cropland	344.4	450.3	89.5	8.1	7.1	9.2	17.1	1.1	0.6	0.0	24.7	36.5	988.6
Pastureland	146.9	58.6	955.9	20.7	0.0	14.2	40.9	1.6	1.3	0.0	26.8	11.9	1,278.8
Rangeland	74.3	24.6	40.5	6,228.8	24.8	12.3	23.2	3.7	1.7	0.0	163.8	27.3	6,625.0
Forest land	1.1	3.7	13.2	28.0	3,740.1	12.9	38.6	2.7	3.2	2.3	148.9	0.4	3,995.1
Minor land use	14.6	1.3	4.6	6.8	7.7	454.4	7.6	0.0	0.0	0.0	1.5	3.1	501.6
Urban build-up	0.1	0.0	0.0	0.0	0.0	0.0	218.8	0.0	0.0	0.0	0.0	0.0	218.9
Rural transportation	3.2	0.3	1.9	2.1	4.4	0.2	1.8	317.4	0.0	0.0	0.0	0.0	331.3
Small water	0.8	1.0	0.8	0.1	0.1	0.0	0.0	0.0	72.9	0.0	0.0	0.0	75.7
Census water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	469.4	0.0	0.0	469.4
Federal land	66.9	29.9	45.5	175.0	162.1	15.2	0.0	0.0	0.0	0.0	33,106.7	0.0	33,601.5
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	4,541.3	976.0	1,314.8	6,500.5	3,947.8	552.5	425.2	329.7	79.9	471.7	33,563.3	784.8	53,487.5

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 6,625.0 and the 1997 total was 6,500.5, with 6,228.8 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.7. NRI pastureland and rangeland in Idaho (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
160101 Upper Bear	60	61	63	63	4.3
160102 Lower Bear	476	470	464	466	-2.2
160203 Great Salt Lake Basin	49	49	49	58	18.1
170101 Kootenai River Basin	14	11	15	13	-5.2
170102 Pend Oreille River Basin	32	38	33	27	-13.9
170103 Spokane River Basin	88	80	73	82	-6.8
170401 Snake Headwaters	47	38	37	37	-21.7
170402 Upper Snake	3749	3619	3578	3575	-4.6
170501 Middle Snake - Boise	2325	2400	2401	2379	2.3
170502 Middle Snake - Powder	178	178	178	178	0.2
170601 Lower Snake	108	103	103	110	1.2
170602 Salmon River Basin	535	538	542	559	4.5
170603 Clearwater River Basin	243	246	281	269	10.9
Total	7,904	7,830	7,816	7,815	-1.1

Table 2.8. Changes in land cover/use between 1982 and 1997, Montana.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	10,974.3	686.2	379.2	28.1	0.0	76.8	17.8	5.9	1.8	0.7	1.6	2,429.3	14,601.7
Non-cultivated Cropland	501.3	1,589.0	324.9	42.8	0.0	18.9	12.9	1.6	0.7	0.0	1.1	101.9	2,595.1
Pastureland	284.3	181.0	2,424.5	73.8	16.1	24.2	24.4	2.2	1.3	0.0	3.5	38.8	3,074.1
Rangeland	721.3	160.4	283.3	36,278.4	91.5	35.1	52.9	13.8	7.3	0.0	38.2	145.0	37,827.2
Forest land	0.0	0.4	4.8	86	5,260.6	1.9	28.1	3.9	0.7	0.0	41.2	0.0	5,427.6
Minor land use	4.8	3.0	6.4	39.5	27.7	1,275.5	8.8	0.0	0.0	0.0	5.4	5.6	1,376.7
Urban build-up	0.0	0.0	0.0	0.0	0.0	0.0	217.6	0.0	0.0	0.0	0.0	0.0	217.6
Rural Transportation	3.6	2.1	2.5	7.9	0.9	1.5	0.8	641.6	0.0	0.0	0.0	0.1	661.0
Small water	6.1	3.2	1.6	19.5	1.8	0.2	0.0	0.0	262.0	0.0	0.0	0.0	294.4
Census water	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	755.1	0.0	0.0	761.1
Federal land	31.0	18.5	15.3	174.9	32.2	2.9	0.0	0.0	0.0	0.0	26,998.7	0.0	27,273.5
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	12,526.7	2,643.8	3,442.5	36,750.9	5,430.8	1,443.0	363.3	669.0	273.8	755.8	27,089.7	2,720.7	94,110.0

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 37,827.2 and the 1997 total was 36,750.9, with 36,278.4 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.9. NRI pastureland and rangeland in Montana (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit		1982	1987	1992	1997	1982-97
		(1,000 acres)				(% change)
100100	Saskatchewan	66	64	64	64	-2.9
100200	Missouri Headwaters	2987	2981	3050	3065	2.6
100301	Upper Missouri	3209	3202	3179	3154	-1.7
100302	The Marias River Basin	2071	1986	1946	1914	-7.6
100401	Fort Peck Lake	3699	3593	3617	3679	-0.5
100402	The Musselshell River Basin	4185	4179	4138	4090	-2.3
100500	Milk	4228	4060	4006	3985	-5.7
100600	Missouri-Poplar	2709	2686	2670	2618	-3.3
100700	Upper Yellowstone	3667	3702	3714	3646	-0.6
100800	Big Horn	1728	1732	1735	1740	0.7
100901	The Tongue River Basin	1382	1361	1373	1377	-0.3
100902	The Powder River Basin	1773	1726	1774	1744	-1.6
101000	Lower Yellowstone	5902	5872	5880	5842	-1.0
101102	The Little Missouri River Basin	1246	1219	1230	1237	-0.7
101202	The Belle Fourche River Basin	0	0	0	0	0.0
170402	Upper Snake	0	0	0	0	0.0
170101	The Kootenai River Basin	95	98	90	94	-0.9
170102	The Pend Oreille River Basin	1956	1972	1923	1944	-0.6
Total		40,901	40,432	40,389	40,193	-1.7

Table 2.10 Changes in land cover/use between 1982 and 1997, North Dakota.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	21,157.2	977.5	122.7	49.4	0.0	97.8	19.4	14.2	5.7	26.8	45.4	2,566.4	25,082.5
Non-cultivated Cropland	805.8	799.2	108.5	97.2	0.0	16.7	3.2	0.3	3.0	0.0	2.5	119.6	1,956.0
Pastureland	285.2	130.2	740.9	92.0	0.0	10.0	2.7	2.6	3.1	0.0	0.5	22.5	1,289.7
Rangeland	491.6	253.0	141.4	10,396.0	15.1	39.6	14.0	8.8	10.2	10.7	21.5	79.3	11,481.2
Forest land	7.8	0.0	5.0	7.2	436.3	1.5	1.7	0.8	0.2	0.0	0.7	0.0	461.2
Minor land use	57.1	22.9	8.5	25.9	2.2	1,197.7	1.4	0.0	0.0	16.0	0.5	13.9	1,346.1
Urban build-up	0.3	0.0	0.0	0.0	0.0	0.0	219.1	0.0	0.0	0.0	0.0	0.0	219.4
Rural Transportation	5.9	0.1	0.6	4.3	0.3	0.0	0.1	703.5	0.0	0.0	0.0	0.0	714.8
Small water	6.4	0.1	1.2	7.6	0.3	0.0	0.0	0.0	179.9	0.0	0.2	0.0	195.7
Census water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	776.4	0.0	0.0	776.4
Federal land	3.4	0.2	0.0	9.8	0.0	0.0	0.0	0.0	0.0	0.0	1,713.7	0.6	1,727.7
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	22,820.7	2,183.2	1,128.8	10,689.4	454.2	1,363.3	261.6	730.2	202.1	829.9	1,785.0	2,802.3	45,250.7

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.11. NRI pastureland and rangeland in North Dakota (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit		1982	1987	1992	1997	1982-97 (% change)
			(1,000 acres)			
090100	Souris	1227	1154	1133	1059	-13.7
090201	Upper Red	285	229	230	215	-24.6
090202	Devils Lake-Sheyenne	951	897	882	839	-11.8
090203	Lower Red	244	223	214	212	-13.1
100600	Missouri-Poplar	115	109	109	106	-7.6
101000	Lower Yellowstone	104	104	102	102	-2.2
101101	Lake Sakakawea	1650	1618	1610	1569	-4.9
101102	The Little Missouri River Basin	1290	1261	1260	1263	-2.1
101301	Lake Oahe	2844	2701	2700	2658	-6.5
101302	The Cannonball - Heart - and Knife River Basins	2935	2825	2836	2790	-4.9
101303	The Grand and Moreau River Basins	278	269	264	262	-5.7
101600	James	849	787	772	745	-12.2
Total		12,771	12,175	12,111	11,818	-7.5

Table 2.12. Changes in land cover/use between 1982 and 1997, South Dakota.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	12,065.40	1,091.20	237.9	18.9	0	50.4	48.3	9.3	2.6	4.4	29.3	1,439.40	14,997.10
Non-cultivated Cropland	970.5	724.4	94.8	18	0	9.4	5.6	1.8	0.6	1.6	10.9	112.9	1,950.50
Pastureland	618	306.3	1,597.50	53.1	1.5	12	12.7	2.4	0.5	0.2	10.3	96.4	2,710.90
Rangeland	632.2	266.7	170	21,733.70	13.8	22.3	25.6	13.3	13.2	0.6	40.1	34.2	22,965.70
Forest land	1.2	1.4	0	16.6	491.5	3.1	10.3	0.8	0	0	1.8	0	526.7
Minor land use	45.9	4.7	7.4	16.4	3.7	1,385.80	2	0.6	0	0	5.9	3	1,475.40
Urban build-up	0	0	0	0	0	0	242	0	0	0	0	0	242
Rural Transportation	3.1	0.8	0.3	5.4	0.7	0.1	1.1	583.9	0	0	0	0	595.4
Small water	2.1	1.4	0.3	5.1	0.2	0	0	0	190.6	0	0	0	199.7
Census water	0.2	0	0	0	0	0	0	0	0	664.9	0	0	665.1
Federal land	1.4	1.5	0	9.2	6.9	0.9	0	0	0	0	3,009.60	0	3,029.50
CRP	0	0	0	0	0	0	0	0	0	0	0	0	0
1997 total	14,340.00	2,398.40	2,108.20	21,876.40	518.3	1,484.00	347.6	612.1	207.5	671.7	3,107.90	1,685.90	49,358.00

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.13. NRI pastureland and rangeland in South Dakota (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit		1982	1987	1992	1997	1982-97 (% change)
			(1,000 acres)			
070200	Minnesota	340	324	317	310	-8.8
090201	Upper Red	84	76	73	76	-9.9
101102	The Little Missouri River Basin	337	338	326	301	-10.8
101201	The Cheyenne River Basin	3805	3731	3691	3693	-2.9
101202	The Belle Fourche River Basin	1392	1384	1338	1321	-5.1
101301	Lake Oahe	2322	2204	2168	2163	-6.9
101302	The Cannonball - Heart - and Knife River Basins	10	10	10	10	0.0
101303	The Grand and Moreau River Basins	4636	4558	4531	4464	-3.7
101401	Fort Randall Reservoir	3503	3365	3301	3238	-7.6
101402	The White River Basin	3655	3623	3583	3593	-1.7
101500	Niobrara	803	789	788	777	-3.2
101600	James	3587	3241	3131	3067	-14.5
101701	Lewis and Clark Lake	544	478	466	451	-17.1
101702	The Big Sioux River Basin	660	579	556	519	-21.3
Total		25,677	24,699	24,279	23,985	-6.6

Table 2.14. Changes in land cover/use between 1982 and 1997, Texas.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	24,445.3	233.0	2,009.9	1,356.8	68.9	135.0	479.1	11.9	31.7	25.2	36.7	3,674.3	32,507.8
Non-cultivated Cropland	236.3	271.8	159.6	52.1	11.9	10.0	35.5	0.8	2.2	0.9	3.3	30.4	814.8
Pastureland	608.6	60.2	12,469.4	1,389.9	1,644.5	157.6	556.3	25.4	60.5	69.4	12.5	53.1	17,107.4
Rangeland	984.3	41.2	924.4	92,729.7	36.6	319.5	838.6	44.5	76.8	107.4	99.6	140.3	96,342.9
Forest land	3.2	0.0	294.2	6.5	8,978.8	53.5	253.0	13.5	26.8	3.4	5.1	0.0	9,638.0
Minor land use	42.0	1.4	38.7	158.9	48.8	1,534.4	58.3	0.8	0.7	0.1	4.7	7.4	1,896.2
Urban build-up	0.2	0.0	0.0	0.0	0.0	0.0	4,615.1	0.0	0.0	0.0	0.0	0.0	4,615.3
Rural Transportation	6.5	0.1	5.4	24.6	0.4	0.1	12.5	1,621.6	0.0	0.0	0.0	0.0	1,671.2
Small water	3.5	0.2	9.0	19.5	6.3	0.0	0.1	0.0	701.3	0.0	0.1	0.0	740.0
Census water	0.1	0.0	2.8	6.2	0.0	1.0	0.0	0.0	0.0	2939.0	0.0	0.0	2,949.1
Federal land	0.0	0.0	1.0	0.5	19.8	0.0	0.0	0.0	0.0	0.0	2,747.9	0.0	2,769.2
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	26,330.0	607.9	15,914.4	95,744.7	10,816.0	2,211.1	6,848.5	1,718.5	900.0	3,145.4	2,909.9	3,905.5	171,051.9

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.15. NRI pastureland and rangeland in Texas (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97 (% change)
			(1,000 acres)		
110901 Middle Canadian	3940	3898	3879	3866	-1.9
110902 Lower Canadian	34	34	34	34	0.0
111001 The Beaver River Basin	719	697	695	706	-1.8
111002 Lower Beaver	565	565	566	600	6.1
111201 The Prairie Dog Town Fork Red River Basin	2069	2056	2050	2086	0.8
111202 The Salt Fork Red River Basin	602	597	581	591	-1.8
111203 The North Fork Red River Basin	880	852	859	892	1.3
111301 Red-Pease	1650	1643	1664	1742	5.6
111302 Red-Lake Texoma	2962	2922	2908	2999	1.3
111303 The Washita River Basin	216	215	215	218	0.6
111401 Red-Little	764	715	692	636	-16.7
111402 Red-Saline	0	0	0	3	0.0
111403 Big Cypress-Sulphur	1864	1802	1765	1727	-7.4
120100 Sabine	1793	1722	1603	1492	-16.8
120200 Neches	1678	1522	1482	1313	-21.7
120301 Upper Trinity	4549	4490	4346	4315	-5.2
120302 Lower Trinity	2082	2046	2008	1854	-11.0
120401 The San Jacinto River Basin	524	485	444	405	-22.7
120402 Galveston Bay-Sabine Lake	642	606	622	570	-11.2
120500 Brazos Headwaters	2559	2542	2550	2609	2.0
120601 Middle Brazos-Clear Fork	3183	3198	3191	3210	0.9
120602 Middle Brazos-Bosque	3472	3438	3414	3434	-1.1
120701 Lower Brazos	3639	3678	3676	3668	0.8
120702 The Little River Basin	3114	3069	3094	3068	-1.5
120800 Upper Colorado	4687	4662	4645	4632	-1.2
120901 Middle Colorado-Concho	8056	7998	7979	7955	-1.3

Table 2.15 (continued). NRI pastureland and rangeland in Texas (6-digit hydrologic units) and percentage change from 1982 to 1997.

120902	Middle Colorado-Llano	4766	4721	4701	4666	-2.1
120903	Lower Colorado	1305	1300	1277	1319	1.1
120904	San Bernard Coastal	592	624	633	602	1.6
121001	The Lavaca River Basin	925	952	964	971	4.9
121002	The Guadalupe River Basin	3165	3155	3166	3183	0.5
121003	The San Antonio River Basin	1775	1736	1707	1705	-3.9
121004	Central Texas Coastal	1776	1778	1775	1768	-0.4
121101	The Nueces River Basin	9369	9344	9335	9439	0.7
121102	Southwestern Texas Coastal	4354	4353	4263	4277	-1.8
130301	Rio Grande-Caballo	37	33	31	30	-18.9
130401	Rio Grande-Fort Quitman	879	873	862	856	-2.6
130402	Rio Grande-Amistad	7161	7161	7110	7111	-0.7
130403	The Devils River Basin	2631	2631	2631	2631	0.0
130500	Rio Grande Closed Basins	3420	3444	3488	3486	1.9
130700	Lower Pecos	11442	11411	11375	11408	-0.3
130800	Rio Grande-Falcon	3054	3055	3055	3043	-0.4
130900	Lower Rio Grande	561	549	549	543	-3.1
Total		11,3450	11,2567	11,1884	11,1659	-1.6

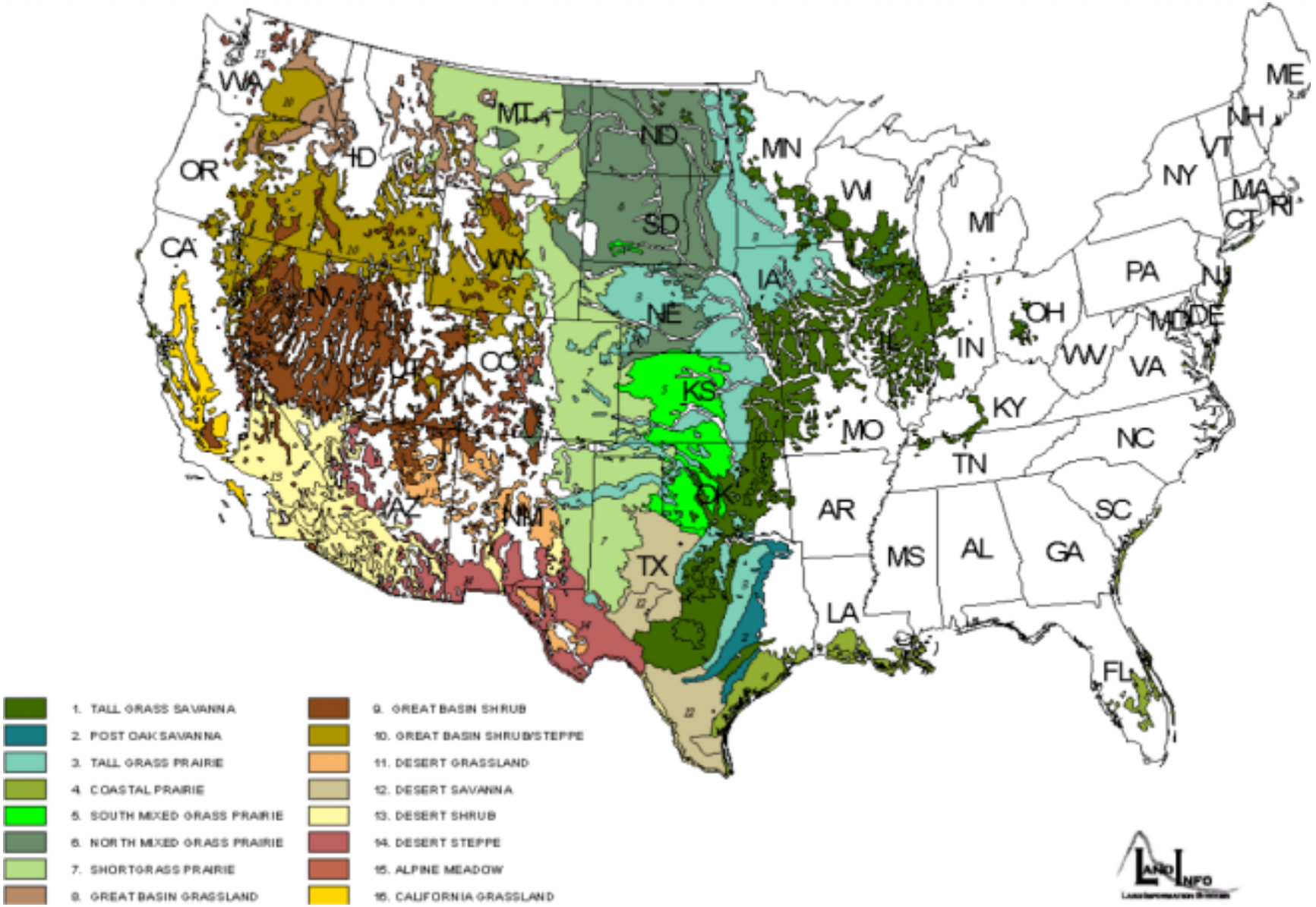

Figure 1.5. Coverage by pre-settlement grassland in the contiguous US. ***Included from Chapter 1 as a reference.***

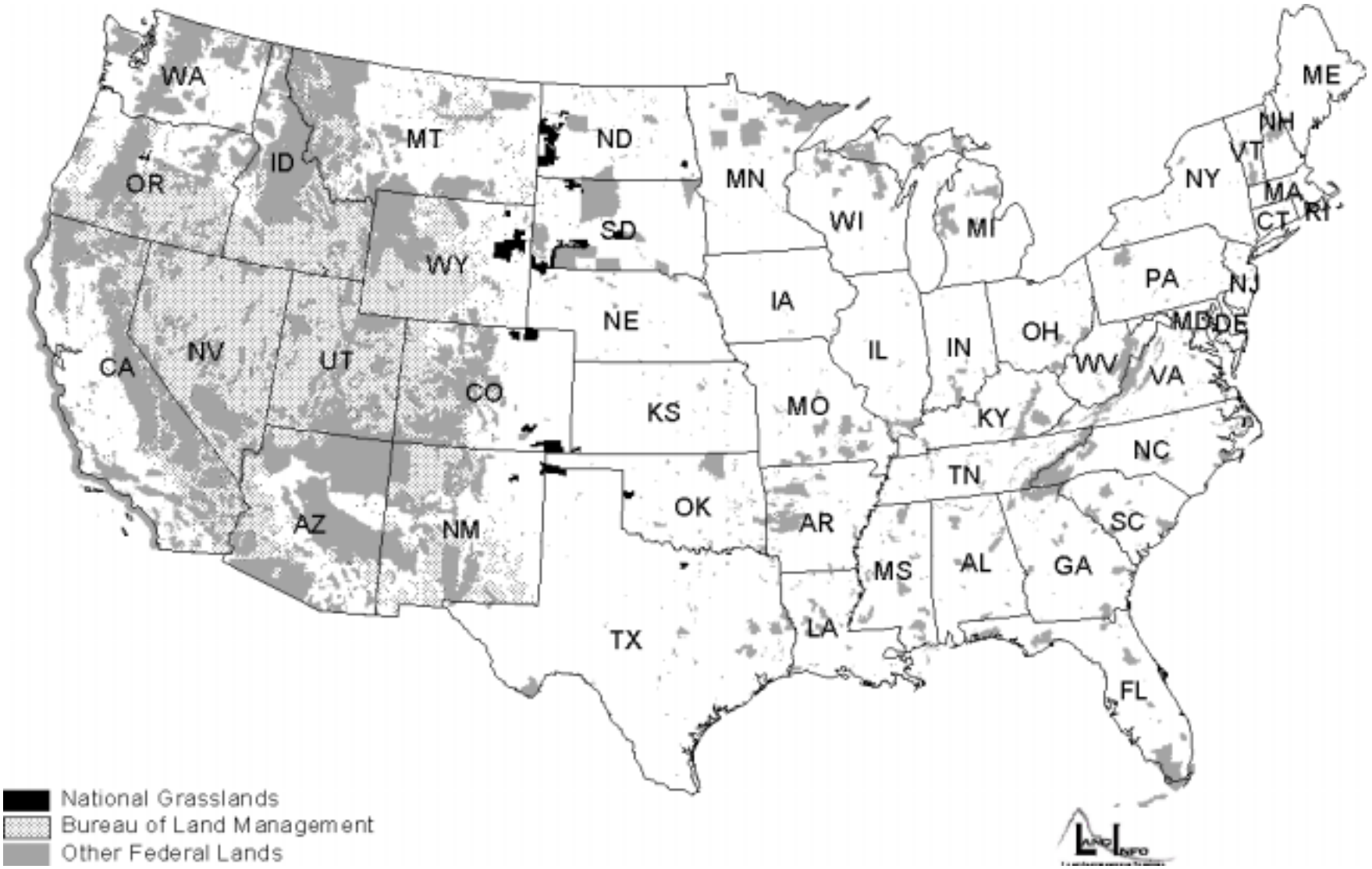

Figure 1.6. Federal ownership of lands in the contiguous US. ***Included from Chapter 1 as a reference.***

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 3: What is driving the changes in grassland use in the US?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Factors broadly influencing grassland use

Human population

Pressure from growth in human population and the resulting demand for housing, businesses, roads, schools, utilities, etc. is an ever-increasing threat to traditional use of grasslands. During the past decade, 9 of the 12 fastest growing states in the US were in the West with growth rates of more than 20% (Table 3.1). Overall, the 22 states west of the Mississippi River gained more than 16.5 million people between 1990 and 2000; a 17.3% increase. This overall growth was achieved in spite of the fact that 9 Great Plains states grew by less than 10% including North Dakota, which grew by less than 1%.

Personal income

One factor that can be an important contributor to population growth pressure is economic opportunity. One measure of relative economic well being is per capita personal income. In 1999 per capita personal income in the US averaged $28,542 and has been increasing at about 5% per year since 1995. Only 5 of the 22 states west of the Mississippi River had per capita incomes higher than the US average in 1999, but 12 of the states had average growth rates of 5% or greater during the 1995 –1999 period (Table 3.2).

The current and continued economic prosperity enjoyed by most sectors of the US economy allow people to consider the purchase of second homes and vacation homes in desirable rural areas. These people enter the market for farm and ranch land because of the lifestyle it provides, not for the potential profits from ranching. As a result, land prices are bid higher than returns to ranching would imply, creating a sell out opportunity for ranchers and a more difficult situation in which to continue to ranch. In addition, prosperity is driving an increase in the average size of houses and of lots. Not only are high amenity areas under population growth pressure, but the land and resource demands of each individual are also increasing.

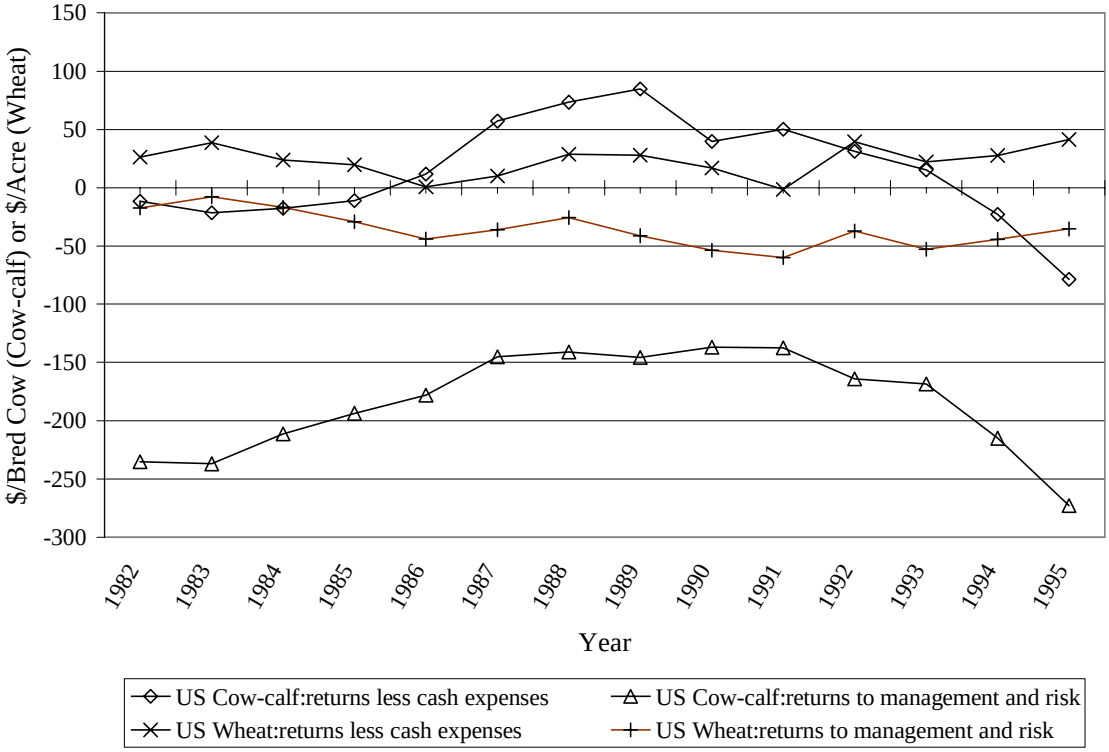

Figure 3. 1. Returns to management and risk and returns less cash expenses for cow-calf ($/bred cow) and wheat ($/acre) enterprises without including direct government commodity payments, United States.

Economics of ranching vs. cropping

While several commodities compete with range livestock for resources, wheat farming is probably one of the more common competitors in the west because of the marginal quality land that typically passes between the two enterprises. Though cyclical in nature, cow-calf enterprise returns-less-cash-expenses were below wheat returns-less-cash-expenses in 8 out of the 14 years from 1982 to 1995 (Figure 3.1), not accounting for government commodity payments that may have been received (ERS/USDA). When overhead costs were accounted for, returns to management and risk for cow-calf operators were considerably below the same returns for wheat producers (Figure 3.1). Hired labor, the opportunity cost of unpaid labor, capital recovery cost of machinery and equipment, taxes and insurance were all higher costs for cow-calf producers compared to wheat producers. Conversely, the opportunity cost of land was higher for wheat producers.

Government policy

In general, the policy of the federal government has been to support production agriculture in the US, through either protection from competition or subsidization of production. The protection policies have generally involved the use of tariffs, import taxes and quotas to shield US agricultural production from foreign competition. Subsidization takes many forms including: product price and producer income support, disaster (drought / flood) relief grants and/or low interest loans, and subsidized input costs like crop insurance, utilities, transportation and soil and water conservation practices. In many cases, a result (albeit unintended) of these agricultural support policies has been, and is, to provide incentives for private landowners to convert grasslands to crop production and/or to thwart, or at least delay, the re-conversion of croplands back to grass. These incentives are provided anytime policies or programs are the cause of a piece of land being more profitable to the landowner if used as cropland in lieu of grazing land.

For example, in the Northern Great Plains the 1999 ERS/USDA soybean cost and returns data estimate average annual operating costs of $66.52/acre; overhead costs of $135.04/acre, which includes opportunity costs for owner labor and land; and an average yield of 40 bu/acre. With an estimated average sale price of approximately $4.00/bu (Aurora Co. South Dakota FSA/USDA office), the soybean enterprise would average a loss of $41.56/acre. With a USDA Commodity Credit Corporation loan rate of $4.92/bu, however, the average producer could expect to collect an additional $0.92/bu as a Loan Deficiency Payment, which would result in the average soybean enterprise producing a loss of only $4.76/acre over all costs and a net return of $130.28/acre over operating costs. For the same year, ERS/USDA indicates that the average Northern Great Plains cow-calf enterprise would have returned a loss of $46.67/acre (assuming an average stocking rate of 9 acres/bred cow), when considering all costs and a net return of only $6.76/acre over operating costs.

In addition to qualifying for Loan Deficiency Payments, cropland is eligible for subsidized crop insurance and/or disaster payments that are significantly more effective in reducing negative financial impacts due to crop production losses compared to livestock production losses. Thus, due to the government support programs, keeping, or converting, land in crops can be both more profitable and less risky than producing livestock on grassland.

Federal estate tax

The Federal Estate Tax, also known as "inheritance tax" or "death tax," is an excise tax levied at death upon the estate of all US resident decedents. The rate of the Federal Estate Tax is computed on a graduated scale, beginning at 37%. In 2001, a credit, called the Unified Credit, is permitted against every estate equal to the estate tax on an estate valued at $675,000. The Unified Credit is scheduled to increase to $1 million through 2006 ($700,000 in 2002 and 2003, $850,000 in 2004, $950,000 in 2005 and $1 million in 2006). If a couple engages in estate planning and creates a "Bypass Trust" or "Credit Shelter Trust" as a part of their wills, they can effectively shelter one Unified Credit each, or $1.35 million in 2001, from the Federal Estate Tax to be levied against their decedents.

A bill to rescind the inheritance tax is currently pending in Congress. Although agriculturists appear to be largely in favor of such a change in policy, it would have an uncertain effect on pastureland and grassland conversion. Currently, producers of sufficient size that are subject to the inheritance tax can avoid a large proportion of it by ensuring their lands will remain in agriculture through a perpetual agricultural conservation easement. If concerned parties retain the right to convert the land in question to higher "value" uses, they will remain subject to the tax. The current tax structure may tie the decision to preserve pasturelands and grasslands or convert them to the current generation. However, the tax can only be considered at fault for land conversion when estate planning is inadequate. Pasturelands and grasslands passed on to heirs in the absence of an inheritance tax are as likely to be converted as any other land with its development rights intact.

As more and more farmers and ranchers approach traditional retirement age, the choice to sell the ranch to the highest bidder or maintain the land in agriculture forever (often at a significant economic cost) is often forced due to our inheritance tax structure. If landowners do not plan to keep the land in agriculture through appropriate estate planning, the tax bill heirs will bear on the land assessed at the "highest and best" use can often provide the impetus for converting the land to residential or commercial uses.

Non-agricultural demand for land

Per acre sale prices of agricultural lands in the western US increased by 66% between 1990 and 2000 (USDA-NASS), indicating a significant increase in the demand for land. Sale prices for

pasture and cropland for 1997 and 2000 for the states west of the Mississippi River are shown in Table 3.3. For this period, prices for both pasture and cropland increased by approximately 10%. However, for the same period cropland rental rates increased only 7% and pastureland rental rates increased by less than 5%. Since rental rates are considered the more accurate indicator of "value in use," these data indicate that forces outside production agriculture are fueling the increased demand for agricultural land, especially pastureland.

Further evidence of the non-agriculture demand for land in the western states can be seen in a comparison of rental rates to selling prices for 2000 (Table 3.4). Cropland annual rental rates averaged $79.38 per acre across the 18 western states reported and the rental rate averaged 5.77% of the sale price. Assuming an 8% capitalization rate, the $79.38 rental rate would indicate that agriculturists (crop producers) could justify a sale (purchase) price of only $992 compared to the $1,480 actual average (Table 3.4). This indicates that the value of cropland for crop production accounts for only 67% of its average sales price in 2000.

A similar comparison for pastureland shows an average annual rental rate of $12.14 per acre across the 12 states reported with the rental rate representing only 3.3% of the sale price. With the 8% capitalization rate livestock, producers could justify a purchase price of only $152 instead of the $481 average (Table 3.4). This indicates that the average value of pastureland for livestock production accounts for only 32% of its average sales price in 2000.

Another indicator that non-agricultural interests are driving the market for agricultural land can be seen in the comparisons of crop and pastureland sales price ratios to crop and pastureland rental rate ratios. On average, pastureland rental rates were only 27% of cropland rates (Table 3.4). However, pastureland sale prices averaged 43% of cropland sale prices. In other words, this data indicates that the average acre of cropland rented had a "value in use" of almost 4 times the "value in use" of the average acre of pastureland rented. However, in the market for agricultural land, cropland was valued just over 2 times greater than pastureland. Again, these differences in ratios indicate that the majority of the demand for pastureland sales is not stemming from livestock producers desiring to purchase more grazing lands.

It is likely that these lands are facing increasing demand for x-urban, rural residential uses. Currently, there are more Americans in their late 30s and early 40s than any other age. This group will remain the modal age category as they move into their 50s, 60s and 70s. They will live

longer, retire younger, be wealthier and be more active than previous generations. This group of people is likely to increase the demand for second homes and ranchettes in high amenity rural areas.

Telecommunications. – Recent innovations in telecommunications has effectively separated job location from the decision of where to live. As a result, people can increasingly have their cake and eat it too; have a high paying city job, but live in an aesthetically desirable, high amenity rural area. Internet broadband, video conferencing, e-commerce, and cellular technology are facilitating a new type of rural resident, not unlike rural electrification did in the early to mid 20th century.

Factors influencing grassland use in Colorado, Idaho, Montana, North Dakota, South Dakota and Texas

Colorado

Human population

Population growth and income are principal correlates with pastureland and grassland loss in Colorado. Reaching 4.3 million residents in the most recent census, Colorado was the third fastest growing state (30.6%) in the US and one of eight states growing by more than 1 million residents between 1990 and 2000. Population growth is driven by three factors in Colorado: 1) a highly educated workforce has resulted in growth in the communications, manufacturing, business services, air transportation, and regional services fields; 2) the rise of second homes in resort communities; 3) the arrival of greater numbers of retirees. All three of the factors are expected to spur continued growth in Colorado in the foreseeable future.

Population and growth in Colorado is not evenly distributed across the state. Eleven of Colorado's 63 counties had populations greater than 100,000 residents in 1998. These eleven counties experienced an average growth rate of 28.7% from 1990-98. All are located in the "Front Range" within view of the Rocky Mountains to the west. The remaining 52 counties in Colorado had populations of fewer than 45,000 people and their average annual growth rate for the period was 21.8%. In Colorado there are 16 rural counties (population <5,000) and they had an average growth rate of 14.8%.

Personal income

Colorado is the fifth wealthiest and second most educated state in the US. More than 1 in 3 Coloradoans holds a university degree and the state's average wage in 1999 was $31,546 (US $28,542). However, the distribution of Colorado's wealth and education is highly unequal. For example, Pitkin County (where Aspen is located) is traditionally among the wealthiest counties in the US ($59,000 average personal income, 1998). The San Luis Valley region of the state has maintained an average income of roughly ¼ that of Pitkin County for at least a half century (13,000-20,000 average personal income, 1998). Front Range incomes are higher on average than the rest of the state, comprising about 82% of total income and about 75% of total population.

The number and proportion of Coloradoans employed in agriculture is slowly declining. In the agriculturally dependent and grassland dominated Eastern Plains, incomes are lower on average (approximately $22,000 average personal income, 1998) than the rest of the state. Average incomes in the agricultural sector are second lowest (to retail) in the state. The interface between the urban Front Range and the rural Eastern Plains increasingly creates scenarios where the "best and highest use" of pasturelands and grazinglands is in x-urban residential development. In some, formerly rural, markets, average housing prices have outstripped increases in average personal income by as much as 150% in recent years, indicating that urbanites are purchasing land and building homes in formerly rural areas.

Non-agricultural demand for land

Colorado agricultural lands are being converted to urban uses, 35-acre ranchettes, other low-density uses and public open lands purchases. Precise estimates of land converted to low-density x-urban development are not readily available. However, the increase in the number of farm and ranch operations and the decrease in the average size of these operations provide evidence of this conversion of working agricultural operations to "lifestyle" farms. The amount of Colorado land in urban uses is increasing at a rate of 28,000 acres per year (Obermann *et al.*, 2000).

State and local efforts at agricultural land preservation

In part due to the state's current affluence, Coloradoans have invested hundreds of millions of dollars toward land preservation over the past decade. Coloradoans created the statewide Great Outdoors Colorado Land Trust (GOCO) and the residents of more than 25 counties and municipalities have taxed themselves to preserve public attributes of undeveloped or agricultural

lands, often in partnership with land trusts. Through the donation or purchase of conservation easements or outright purchase, approximately 660,000 acres of Colorado private lands have been permanently preserved from residential or commercial development in cooperation with some 37 local, state, regional and national land trusts (CCLT in State of Colorado, 2000). Some of these trust lands were historically and will remain in some type of agriculture. Others were not suitable for agriculture or may be converted from agriculture to some low intensity use, including grassland (e.g., parks, wildlife refuges, open space buffers). In addition, more stringent growth management and planning at the state level appears likely in the near future and a prairie dog protection easement program is anticipated.

Colorado case study 1: Weld County

Weld County can be considered illustrative of the many forces of change present in rural Colorado communities that are resulting in the conversion of pasturelands and grasslands into more intensive uses. The issues present in Weld County are quite similar to the forces of change in Pueblo and Adams Counties. These latter two counties together experienced a loss of more than 225 thousand acres (about 15% of total state losses) in pasturelands and grasslands since 1982.

Weld County is located in the South Platte River Basin in the northeastern section of the I-25 corridor and provides the northern border of the Denver Metropolitan region. Weld County is 2.5 million acres in total area, with more than 2 million acres of private land and about one half of the remainder is Pawnee National Grasslands. Data indicate that Weld County experienced a moderate drop in its substantial grassland acreage since 1982, from approximately 973 thousand to 952 thousand acres.

In terms of agribusiness income ($390 million, 1997) and sales (2.9 billion, 1997), Weld County is the most important agricultural county in Colorado and among the most important in the US. The county has deep roots in animal agriculture, having significant beef, sheep, dairy and hog industries within its borders. Typical of agriculturally oriented economies, per capita income in Weld is well below the state average and increased from $18,500 in 1994 to just under $22,000 in 1998.

Weld County experienced a 37% growth in population over the past decade. This growth is concentrated along its western and southern borders, providing housing for Ft. Collins, Boulder and Denver commuters. Weld County land in farms declined to 1.9 million acres in 1997 compared to 2.1 million acres in 1992 and 1987. The number of farms and ranches has stayed relatively constant at about 2,950, but the median operation size (153 acres) was substantially below the county mean (647 acres). More than one third of Weld county operations had agricultural sales in excess of $50 thousand in 1997, while more than one third had sales of less than $10 thousand. These data potentially imply that working operations are being combined into fewer, even larger operations and/or other farms and ranches are subdividing into rural residential properties.

Colorado case study 2: Routt County

Routt County is illustrative of the forces of change in communities with high levels of natural amenities and a high proportion of public lands within their boundaries. These counties are broadly in transition from ranching communities to outdoor recreation based economies driven by tourism, second homes buyers and retirees. Park and Custer Counties, which combined for a loss of 180 thousand acres of pastureland and grassland since 1982, are facing broadly similar issues to Routt County.

Routt County is located in the Yampa River Basin in northwest Colorado and is home to the city of Steamboat Springs and the famous ski area of the same name. Routt County and the surrounding region have long traditions in the sheep and beef cattle industries. Agriculture constitutes a relatively small proportion of total economic activity (3.7% of employment, 0.8% of total income), although agricultural sales were a nontrivial $30 million in 1997. Increasingly, farm and ranch lands in Routt County contribute directly and indirectly to the local economy through consumptive (e.g., elk and deer hunting and trout fishing) and nonconsumptive use (e.g, hiking, backpacking, mountain biking, river rafting) outdoor recreation.

Routt County's average personal income was $31,795, or about 5% above Colorado state average and about 1/3 higher than a more typical agriculture-based community in 1998. Routt County's population grew by almost 40% to 19,690 over the past decade, not atypical of mountain and other high amenity communities in Colorado and the West.

Routt County's 1.5 million acres are approximately equal parts public and private lands. Not withstanding the significant efforts of private land trusts, almost 90 thousand acres of pastureland and grassland were lost in the county since 1982. In 1997, Routt County had 438 farms and ranches on 576 thousand acres; 76 more farms and ranches on 23 thousand fewer acres since 1982. The average size agricultural property decreased by 367 acres to 1,316 over the period. However, the number of properties of greater than 500 acres remained constant and constituted approximately 40% of all agricultural operations in the county in 1997. The number of operations of between 10 and 500 acres increased over the period. Interestingly, approximately 40% of all operations report sales of less than $10 thousand in 1997, implying that many Routt County farms and ranches are "lifestyle" or "hobby" farms.

As farm size decreases, wildlife habitat, open space, water catchment, and biodiversity benefits of pasturelands and grasslands can be expected to diminish as well. Whether the likely increase in lifestyle farms increases or decreases the amount and quality of grassland recovered from pastureland and cropland depends upon the quality of land stewardship practiced by lifestyle farmers relative to the former owners. Unmanaged land is likely to result in problems with invasive weeds and incomplete recovery of native grasslands. Leased land is likely to take on the characteristics of the lessee's management practices. Proper management of lifestyle farms could improve the stock of grassland notwithstanding the unambiguously negative impact of diminished parcel size.

Idaho

Human population

One of the issues driving changes in land use in Idaho is population growth. The population of Idaho in 2000 was close to 1.3 million people. Since 1990, only 2 of 44 counties lost population. Boise County had a 90.1% increase in population and Teton county witnessed a 74.4% increase. Nineteen counties had over a 20% population increase. Much of the population increase has occurred in counties that have easy access to one of the three interstates that run through the state. Per capita income in metropolitan areas outgrew per capita income in non-metropolitan areas by almost 10% from 1982 to 1998.

Land use and land in farms

Approximately 40% of Idaho's land base is considered rangeland. Most of this land is under federal management, with 35% of Idaho's federal lands under Bureau of Land Management jurisdiction and the 61% managed by the US Forest Service (Idaho State Profile). According to NRI statistics, 7.8 million acres of grasslands are in private ownership. The majority of these acres lie in the southern portion of the state.

From 1982 to 1997, farm numbers in Idaho declined 9.71%, from 24,714 to 22,314 farms, according to the Census of Agriculture. Average farm size during this period declined slightly from 563 acres to 530 acres.

The number of farms reporting pasture and rangeland declined from 6,923 in 1982 to 6,517 in 1997 (Figure 3.2), while the number of acres in pasture and rangeland declined 27% (6.07 million acres to 4.59 million acres) between 1982 and 1997 according to the US Census of Agriculture. From 1982 to 1997, 34 of the 44 counties in Idaho declined in pasture and rangeland. The NRI places 1997 rangeland acreage in Idaho at 6.50 million acres, considerably more than the Census of Agriculture estimate, but down 1.88% than the 1982 NRI estimate of 6.62 million acres. The difference between the Census and NRI estimates can be attributed to definitional differences as well as sampling and survey techniques.

An analysis of 1997 Agricultural Census data for all counties in Idaho shows an inverse correlation between the number of acres in pasture and rangeland and the level of government farm payments, but no relationship with net farm income. The dispersion of rangelands, both federal and private, among areas suited for farming throughout much of the state has probably resulted in these correlations not being as significant as in the other states examined.

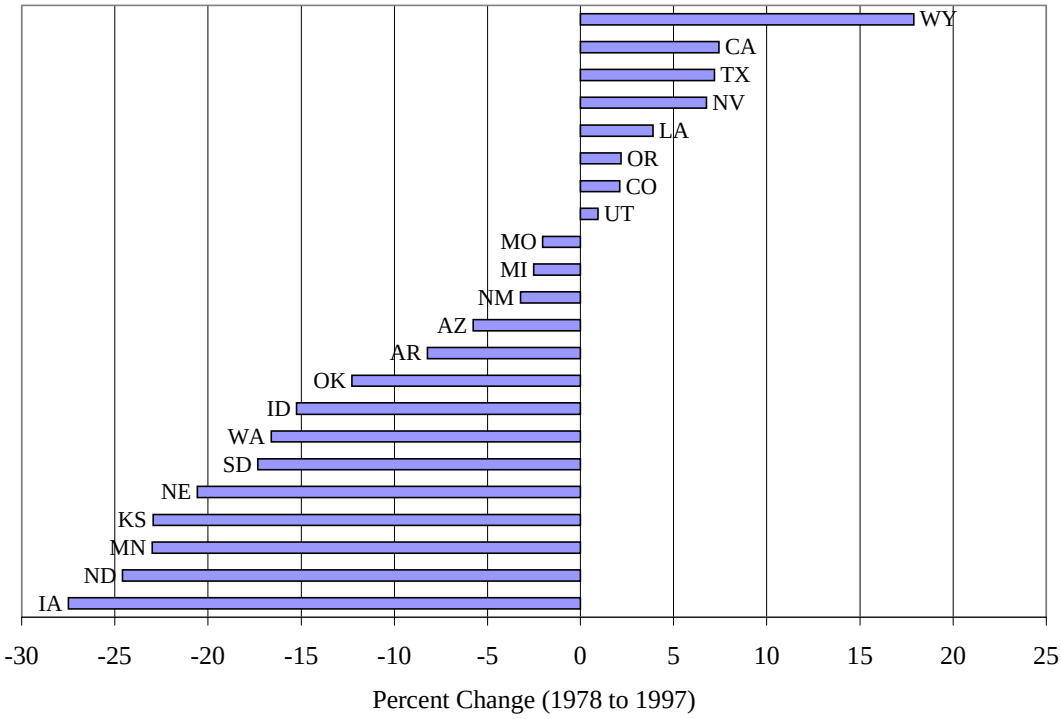

Figure 3. 2. Percent change in the number of farms reporting acreage in other pastureland and rangeland for each of the 22 contiguous states west of the Mississippi River as determined by US Census of Agriculture inventory estimates, 1978 to 1997. Sources: USDC/BC various years, USDA/NASS 1997**.**

According to the NRI data, the most significant rangeland areas are in the Lower Bear (#160102), the Upper Snake (#170402) and the Middle Snake-Boise (#170501) (see Figure 2.11). One county from each area was used for closer analysis. On a hydrologic unit basis, NRI statistics must be interpreted cautiously because of the increased measurement error. Trends are, therefore, more reliable than the actual acreage estimates.

Idaho case study 1: Lower Bear Watershed and Bear Lake County

The Lower Bear Watershed extends into Northeastern Utah, but has 383,700 acres of rangeland and 82,000 acres of pastureland in Idaho. According to the NRI, the 383,700 acres of rangeland in 1997 was down 6.6% from the 409,200 acres that were classified as rangeland in 1982. More than 13,000 of the lost rangeland acres are now non-cultivated cropland, 7,300 acres are classified under CRP land, and 500 acres went into urban development during this 15 year period. While the size of the individual parcels involved in these interchanges is uncertain, the decrease in biodiversity from fragmenting and changing the structure of these rangelands is assuredly diminished.

Bear Lake County is located in the southeastern portion of Idaho and borders Utah and Wyoming. The extreme western edge of the county is located in the Upper Bear hydrologic unit. Just over 50% of the land in the county is under private ownership and 46.5% is under federal management, mainly US Forest Service. The population of Bear Lake County grew 5.4% between 1990 and 2000, when it reached a population of 6,411. The majority (76%) of employed residents work in Bear Lake County. The average farm size in 1997 was 541 acres, down 17% from 1982. The median farm size in 1997 was 239. The decline in farm size has also been accompanied by a decline in the percentage of rangeland relative to cropland—from an average of 55% in rangeland to 41% in rangeland. The recreational amenities this area affords, and the close proximity to a large population center (Salt Lake City, Utah), will continue to place pressure on ranchers to transfer rangelands to uses with a higher economic return (i.e., development and recreation).

Idaho case study 2: Upper Snake Watershed and Twin Falls County

The Upper Snake Watershed extends slightly into Wyoming, Utah and Nevada, but is mainly located in southeastern and south central Idaho. According to the NRI, this watershed contains more rangeland and pastureland acreage than any other watershed in Idaho, with almost 3 million acres of rangeland and 575,400 acres of pastureland. From 1982 to 1997, rangeland declined 4.5% (3.14 to 3.00 million acres), while pastureland increased 3.7% (608,200 to 575,400 acres). From 1982 to 1997, 61,100 acres of rangeland and 92,100 acres of pastureland went into cultivated cropland. Almost 3,700 acres of rangeland and 12,800 acres of pastureland went into urban development, while 160,500 acres of rangeland and pastureland reverted to federal control. During this time, 44,600 acres of cropland and pastureland were converted to rangeland.

Twin Falls County is located on the western edge of the Upper Snake Basin. The county is comprised of just over 1.2 million acres. More than one half (52%) of the county is under federal management, principally the Bureau of Land Management. The population of Twin Falls County grew 20% from 1990 to 2000 to the current population of 64,284, constituting the fourth largest county population in Idaho. The majority of residents work within the county. Zoning laws have limited urban development throughout the countryside by restricting home lots to a minimum of 40 or 160 acres, depending upon the distance from the urban area. While these zoning

regulations have helped preserve the aesthetic value of the land, the impact on rangeland health and biodiversity is uncertain at best.

During the 1970s and into the early 1990s, rangeland acreage was converted to cultivated land (sugar beets, potatoes, alfalfa and small grains) on the west and south ends of Twin Falls County. Deep wells were used to irrigate the land. Little of this conversion is occurring today. This county is typical of many in Southern Idaho where large amounts of rangeland acreage have been brought into crop production by legislation that has allowed farmers to drill wells for irrigation purposes. While this has been a benefit to the economy of Idaho, the impact on rangeland biodiversity, especially on private lands, have been detrimental and has lead to conflicts between threatened wildlife species (e.g., sage grouse) and farming interests.

Idaho case study 3: Middle Snake-Boise Watershed and Boise County

The Middle Snake-Boise Watershed is located in the southwestern portion of Idaho. More than 2.1 million acres of private rangeland and 264,000 acres of pastureland are located in this watershed, according to the NRI. Rangeland and pastureland acreage actually increased by 2% and 5%, respectively, from 1982 to 1997. The increase in rangeland occurred mainly from conversion of federal land to private ownership. Increases in pastureland resulted from cropland conversion. Had it not been for the conversion of federal lands, rangeland would have decreased over the period, since 18,400 acres went into urban development and 13,300 acres went into cropland. Urban land in this area increased from 76,700 acres in 1982 to 168,700 acres in 1997.

Boise County is located in the Middle Snake-Boise hydrologic unit in the west-central portion of the state. Boise County borders Ada County, which contains Boise City, the largest metropolitan area in Idaho. Boise County has just over 1.2 million acres. Just over 75% of the county is under federal management. Approximately 200,000 acres (16.4%) are privately owned. The county population was 6,670 people in 2000, which was an increase of 90.1% from 1990. Over 38% of the work force commutes outside the county, primarily to Ada County. According to the Census of Agriculture, the average farm size decreased from 1,089 acres in 1982 to 583 acres in 1997. The median farm size in 1997 was 175 acres. Although the average farm size has decreased substantially in the past two decades, the number of farmers has increased from 73 to 78 and the number of farms reporting pasture and rangeland acreage has increased from 30 to 40. Boise County is typical of the impact population growth, accompanied by increases in per capita

income, have upon the surrounding rangeland areas. Boise County is truly becoming a bedroom community of Ada County and the surrounding area. The decline in average farm size not only fragments rangelands but the management of the remaining countryside is often not as conducive to rangeland health and biodiversity.

Montana

Human population

The 2000 Census places Montana's population at 902,195 people, with a population density of 6.2 people per square mile. Montana experienced a 12.9% growth in population from 1990 to 2000, with 33 of 56 counties experiencing a population increase during this time. Most of the growth in population occurred in the western portion of the state, while the decline in population mainly occurred in the eastern and north central portion of the state. For example, Ravalli County in the southwestern part of the state experienced a 44% increase in population, while Garfield County in east-central Montana experienced a 20% decline. Non-metropolitan per capita income grew from 10,203 in 1982 to 19,902 in 1998. The gap between metropolitan and non-metropolitan per capita income grew 11% from 1982 to 1998.

Land use and land in farms

The number of farms in Montana grew from 23,570 in 1982 to 24,279 in 1997, while the average farm size decreased slightly from 2,568 to 2,414 acres. According to the Census of Agriculture, 57% of the farms had pasture and rangeland acreage, up 1% from 1982 (Figure 3.2).

According to the Census of Agriculture, Montana experienced a 3.72% decline in pasture and rangeland acreage from 1982 to 1997 (40.8 million to 39.3 million acres), with 36 of 56 counties experiencing a decrease. Some of the largest decreases occurred in the western portion of the state. NRI statistics place 1997 rangeland acreage at 36.8 million acres, down 2.85% from the 37.8 million acres in 1982.

All but one of Montana's hydrologic watersheds experienced declines in rangeland acreage from 1982 to 1997, while the majority experienced increases in pastureland units. All major watersheds also witnessed decreases in cropland acreage, largely due to an increase in acreage enrolled in the CRP. Three watershed units, Lower Yellowstone (#101000), Milk (#100500) and the Missouri Headwaters (#100200) will be more closely scrutinized in this report. On a

hydrologic unit basis, NRI statistics must be interpreted cautiously because of the increased measurement error. Trends are, therefore, more reliable than the actual acreage estimates.

Montana case study 1: Lower Yellowstone Watershed and Rosebud County

The Lower Yellowstone Watershed covers an 8.5 million acre area that flows from south-central Montana northeast to the North Dakota border (Figure 2.13). This watershed contains the greatest amount of rangeland acreage (5.6 million acres) in Montana. From 1982 to 1997, the watershed experienced less than a 1% decline in rangeland and a 6.8% decline in pastureland. While the total acreage in rangeland was basically constant, the acreage comprising the rangeland base did change somewhat. Some 18,400 rangeland acres went into cultivated cropland, 33,200 acres into uncultivated cropland, 9,800 acres into pastureland, and 10,700 rangeland acres ended up being classified under the CRP. During this time period, 9,500 acres of cultivated cropland and 10,000 acres of pastureland were converted back into rangeland. Additional acreage from various land uses, including federal land and small waterways, were also reclassified as rangeland. Cultivated cropland decreased 19% from 1982 to 1997, with most of this acreage going to the CRP, uncultivated cropland, and pastureland. Urban area increased 78%, from 8,200 to 14,600 acres, with 2,600 of those acres coming from rangeland.

Rosebud County is located in the southern portion of the Lower Yellowstone Watershed. Rosebud is the fourth largest county in Montana with over 3.2 million acres. The county population decreased to 9,383 in 2000 from 10,505 in 1990. Most of the farmland acreage is in winter wheat, other spring wheat, or barley. Some acreage is planted in corn, sugar beets and dry beans. Rosebud ranks fifth in Montana in hay production with over 85,000 acres harvested in 1999. The January 1, 2000 cattle inventory was 85,000 head; the fifth largest in Montana. The average farm size decreased 13.5% to 7,406 acres from 1982 to 1997. The median farm size was 1,788 acres in 1997. The number of farms in Rosebud County increased almost 3% from 1982 to 1997, to 362 farms, while the number of farms reporting pasture and rangeland acreage increased 10%. Census of Agriculture estimates placed pasture and rangeland acreage at 2.2 million acres in 1997, or 86% of total farmland acreage. The Agricultural Census reported a 15% decrease in pasture and rangeland acreage from 1982 to 1997, though county personnel (along with NRI statistics) had difficulty justifying this large of decline. County personnel indicate that several ranches along the Yellowstone River were purchased by out-of-state interests, and are still being operated as working ranches and farms, but are being valued for their wildlife and other

amenities. This county typifies many areas where population growth is declining or stagnant, most acreage considered valuable for cropland has already been plowed, and acreage is being purchased by outside interests for a piece of rural life. This type of area may be a prime candidate for conservation easements to maintain the vast rangelands in existence before demands from outside interests put pressure on converting rangelands to other uses.

Montana case study 2: Milk Watershed and Hill County

The Milk Watershed is located in the north-central portion of Montana. Just over 3.70 million acres of rangeland are located in this watershed. Rangeland acreage dropped 6.6% (down from 3.97 million acres) between 1982 and 1997; the most precipitous decline in Montana. The majority of lost acreage (235,800 acres) was converted to cultivated cropland, pastureland (52,700 acres) and CRP acreage (32,700 acres). An additional 24,800 acres of uncultivated cropland, 4,900 acres of pastureland and 35,500 acres of federal land was reclassified as rangeland during this period. Cultivated crop acreage declined 10.7% from 1982 to 1997, and acreage devoted to urban development increased 54%, from 10,500 acres to 16,200 acres.

Hill County is located in the northern center of the state and borders Canada. The county population was 16,673 in 2000, down 5.6% from 1992. Most of the farm acreage in Hill County is planted to some type of wheat or barley. The county ranks first in Montana in other spring wheat with 11.5 million acres planted in 1999. Over 25,000 acres of hay was harvested in 1999, mainly to support a cattle inventory of 28,700 head. The number of farms in Hill County increased from 675 to 692 from 1982 to 1997, while the number of farms reporting pasture and grazing land declined from 323 to 297. The average farm size declined 7.6% to 2,374 acres, with a median farm size of 1,519 acres. According to the Census of Agriculture, Hill County experienced a 13% decrease in pasture and rangeland acres between 1982 ando 1997. This, again, is higher than the decline in rangeland that can be justified by the NRI data, but still substantiates a decline in rangeland acreage. This area is typical of many counties that are agricultural based and has rangeland acreage that can be converted to marginal cropland. When the agricultural economy is depressed and government programs, such as the CRP, provide incentives to convert rangeland to farmland, it is only natural that some farmers will take advantage of these programs to supplement their farm income. While less than 10% of rangeland acreage in the Milk Watershed was converted to other agricultural uses, the increased fragmentation and loss of biodiversity can be significant.

Montana case study 3: Missouri Headwaters Watershed and Beaverhead County

The Missouri Headwaters Watershed is located in the southwestern portion of Montana. Just less than 2.6 million acres of rangeland and 468,000 acres of pastureland are located within this watershed. While rangeland acreage was essentially the same in 1982 and 1997, acreage actually increased by almost 15% from 1982 to 1992 before decreasing again between 1992 and 1997. From 1982 to 1997, 48,000 acres were diverted from rangeland to pastureland, 30,100 acres became forested lands, and 16,300 acres of rangeland went into urban development. Almost 17,000 pastureland acres were reclassified to rangeland during these 15 years and 96,000 acres previously under federal ownership were reclassified as private rangelands. Urban development increased 153% during this period, going from 13,300 to 33,600 acres, most of it coming out of rangeland.

Beaverhead County is located in the far southwest corner of Montana and covers over 3.5 million acres. County population increased 9% from 1990 to its population of 9,202 in 2000. Beaverhead ranks first in Montana for beef cattle production and hay acres harvested, and ranks fifth for sheep production. Some small grains and potatoes are also grown. The number of farms increased from 342 to 360 and the number of farms reporting pasture and rangeland increased from 238 to 248 between 1982 and 1997. However, average farm size decreased from 4,522 to 3,200 acres during this same time period, with the median farm size of 863 acres in 1997. According to the Census of Agriculture, there were just over 1 million acres of pasture and rangeland reported in 1997; a 17% decrease from what was reported in 1982. This decrease could not be substantiated by county personnel nor by the NRI statistics for the watershed that Beaverhead County is a part of. This area, though, is representative of many mountain valleys that were traditionally cattle/rangeland based economies but are beginning to see pressure from outside interests for development because of the natural amenities of the area. Fragmentation and destruction of the natural biodiversity can quickly follow.

North Dakota

Human population

According to Census 2000 data, North Dakota is the second least populated (Wyoming has the lowest population) and grew the least (0.5%) over the past decade among the 22 western states (Table 3.1). An examination of county Census data indicate that only 6 of North Dakota's 53

counties actually gained population during the 1990 to 2000 period and 15 counties lost more than 15% of their population over the decade.

Land use and land in farms

NRI statewide data for North Dakota indicate that range and pastureland declined by almost 1 million acres (8%) between 1982 and 1997 (Table 2.15). This change was accompanied by a decline in cropland of about 2 million acres and an increase of 2.8 million acres in CRP land. The implication in these statistics is that over 775,000 acres of range and pastureland were converted to cropland during this period.

A correlation analysis of 1997 Census of Agriculture data for all counties in North Dakota shows that counties with the largest portions of their agricultural land in the "pasture" and/or "range" category are significantly more likely to receive lower total government payments, have lower net cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger numbers of beef cattle and larger land holdings than counties with less pasture and rangeland.

North Dakota case study 1: Dickey County

Dickey County is located in the southeastern part of North Dakota in the James Hydrologic Unit (#101600, Table 2.9 and Figure 2.15). About one-half of the county can be characterized as "Prairie Pothole". The county lost 5.7% of its population between 1990 and 2000. The county's economy is based primarily on agriculture and the average per capita personal income in the county in 1998 was about 9% below the state average and about 24% below the US average.

The county reported 15% fewer farms in the 1997 Census of Agriculture than in 1982, including a 6% reduction in the number of farms reporting pasture and/or rangeland acreage. As a result of the reduction in farm numbers, size of the average farm increased by 11% during the 15- year period. During this period range and pastureland acreage remained at about 17% of total land in farms; approximately 100,000 acres. According to reports from county Farm Service Association (FSA) personnel (Dickey Co. ND, FSA/USDA) this trend is continuing. However, wetter than normal conditions have caused many of the potholes to remain filled with water and create discontinuities in much of the cropland. As a result, increases in CRP acres of about 3.5% of the

county's 1997 cropland acres have been observed since the early 1990s (from approximately 42,000 acres in 1997 to about 76,000 in 2000).

North Dakota case study 2: Stutsman County

Stutsman County is also located in the James Hydrologic unit, about 50 miles north of Dickey County. Most of the county can be characterized as "Prairie Pothole". The county's economy is largely agricultural based and the average per capita personal income in the county in 1998 was about 4% above the state average and about 13% below the US average. The county lost 1.5% of its population between 1990 and 2000.

The county reported 14% fewer farms in 1997 than in 1982. However, the average size farm increased by more than 10% and 9.6% fewer farms reported pasture and/or rangeland acreage by 1997. During this period range and pastureland acreage remained at about 17% of total land in farms; approximately 215,000 acres. According to reports from county FSA personnel (Stutsman Co. ND, FSA/USDA) this trend has continued since 1997, except that more than 2,800 acres of formerly unplowed grassland was broken into cropland in 2000. However, the county FSA also reported that, like Dickey County, due to wetter than normal conditions, there has been a significant increase in CRP acres since the early 1990s (from approximately 139,000 in 1997 to about 189,000 in 2000).

North Dakota case study 3: Mountrail County

Mountrail County is in northwest North Dakota in the Lake Sakakawea Hydrologic Unit (#101101, Table 2.9 and Figure 2.15). Like the other North Dakota counties highlighted in this report Mountrail is largely characterized as "Prairie Pothole" country. The county's economy is largely agricultural based and the average per capita personal income in the county in 1998 was about 8% below the state average and about 23% below the US average. The county lost 5.6% of its population between 1990 and 2000.

The county reported 14% fewer and 15% larger average size farms in the 1997 Census of Agriculture than in 1982. The number of farms reporting pasture and/or rangeland acreage diminished by 6% by 1997. During this period, range and pastureland acreage increased from about 25% to about 30% of total land in farms; approximately 301,000 acres in 1997. According to reports from county FSA (Mountrail Co. ND, FSA/USDA) and Agricultural Extension

(Mountrail Co. ND, Cooperative Extension Service) personnel, this trend is continuing with small increases in the acreage devoted to grazing land an/or forage production. Since 1997, CRP acreage has been reduced by about one-third due to expiring contracts and the landowners inability to obtain renewal contracts. County officials estimate that about one-third of the acreage coming out of CRP since 1997 has reverted to cropland and about two-thirds to grazing land. Rapidly increasing demand for access rights to land for hunting is beginning to influence owners to maintain and/or create more wildlife habitat on their land.

South Dakota

Human population

South Dakota is the third least populated among the 22 western states. Due to significant population growth on its eastern and western sides the state managed an overall 8.5% increase from 1990 to 2000. However, the population of the state's rural interior continued to erode. Poor economic performance in agricultural production plus a lack of employment alternatives led to population declines in 30 of South Dakota's 66 counties and 9 lost more than 10%.

Land use and land in farms

NRI State-wide data for South Dakota indicate that range and pastureland declined by about 1.7 million acres (7%) between 1982 and 1997 (Table 2.10). This change was accompanied by a decline of only 0.2 million acres in cropland and an increase of 1.7 million acres in CRP land. The implication is that about 1.5 million acres of range and pastureland were converted to cropland during this period.

A correlation analysis of 1997 Census of Agriculture data for all counties in South Dakota shows that counties with the largest portions of their agricultural land in the "pasture" and/or "range" category are significantly more likely to receive lower total government payments, have lower net cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger numbers of beef cattle and larger land holdings than counties with less pasture and rangeland.

South Dakota case study 1: Aurora County

Aurora County is located in southeastern South Dakota and includes land in both the James and Fort Randall Reservoir Hydrologic Units (#101600 and #101401, Table 2.9 and Figure 2.17). The economy is largely agriculturally based. Average per capita personal income in the county in 1998 was about 19% below the state average and about 29% below the US average. The county lost 2.5% of its population in the decade between 1990 and 2000.

Aurora County reported 12% fewer farms in the 1997 Census of Agriculture than in 1982. During this period cropland acreage (including CRP land) remained at about 66% (approximately 226,000 acres) of total land in farms. However, according to county FSA records (Aurora Co. SD, FSA/USDA), cropland increased by about 3% (more than 6,600 acres) from 1996 through 2000, due to plowing up previously uncultivated grasslands. County officials also noted that non-resident ownership of rural land is increasing in the county. Most of the agricultural land, however, is being incorporated into other local farms through rent or lease arrangements. County officials also note an increased interest in management practices that maintain or improve the wildlife habitat and hunting potential of the land.

South Dakota case study 2: Hyde County

Hyde County is about 50 miles northeast of Aurora County and lies primarily in the Fort Randall Reservoir Hydrologic Unit. The county's economy is also primarily dependent on agriculture. County average per capita personal income was about 6.6% below the state average and about 18% below the US average in 1998. The county lost 1.5% of its population between 1990 and 2000.

While total farm numbers declined by only 3% between 1982 and 1997, according the Census of Agricultural, farms with range and/or pastureland declined by 13%. During this period the proportion of total farmland made up of range and pastureland declined from 65% to 58% (a loss of approximately 9,000 acres).

According to county FSA records (Hyde Co. SD, FSA/USDA), this trend is continuing as cropland in the county increased by more than 5% (several thousand acres) between 1997 and 2000 due to breaking out previously unplowed rangeland. According to county officials, the continued conversion of grassland to cropland is largely due to federal government program

incentives. Landowners find it more profitable to convert the land to cropping primarily since it is then eligible for government support including loan deficiency payments and subsidized crop insurance.

South Dakota case study 3: Jones County

Jones County is in central South Dakota and is primarily situated in the Fort Randall Reservoir Hydrologic Unit. The county's economy is also primarily agriculturally based and county average per capita personal income was about 1% above the state average and about 11% below the US average in 1998. The county lost 9.9% of its population between 1990 and 2000.

The county reported 8.6% fewer, but 19% larger average size farms in the 1997 Census of Agricultural than in 1982. During this period range and pastureland acreage remained at about 60% of total land in farms (approximately 356,000 acres).

According to reports from County FSA Office personnel (Jones Co. SD, FSA/USDA) this trend is continuing with little or no breaking of grassland sod into cropland during the last several years. Farm size is continuing to increase with land consolidation via leasing. One factor contributing to the maintenance of grazing lands in the county is the significant increase in use of the land for hunting and the consequent interest in maintaining wildlife habitat.

Texas

Human population

Texas' population is the second largest in the US; second only to California. Texas grew a whopping 22.8% during the decade between 1990 and 2000. However, 66 of its counties (26%) experienced no or negative growth. Most of the population decreases were in counties in the northwestern portion of the state and consisted primarily of counties with economies based largely on agriculture.

Land use and land in farms

A correlation analysis of 1997 Census of Agricultural data for all counties in Texas shows that counties with the largest portions of their agricultural land in the "pasture" and/or "range" category are significantly more likely to receive lower total government payments, have lower net

cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger land holdings than counties with less pasture and rangeland.

During the years 1995 –1999 the statewide average per acre median price for rural land in Texas was $677 and the average annual increase was 7.8% (Real Estate Center). Most of this demand originated from non-agricultural interests as prices notably exceeded the productive value of the land. For example, in many parts of Texas, wildlife based enterprises, primarily lease-hunting, are generating more net income per acre of rangeland than livestock production. Fortunately, ranchers in these areas have learned to manage both their livestock and wildlife enterprises so that they are largely complementary. This kind of complementary land use activity may offer one of the best hopes for providing the economic viability necessary to sustain the ranching industry in many other parts of the US in the future.

Texas case study 1: Cottle County

Cottle County is located in the Rolling Plains Land Resource Region and is in the Red-Pease Hydrologic Unit (#111301 Table 2.13 and Figures 2.19c). It is representative of one of the few areas in Texas that experienced an increase in grassland area of more than 5% between 1982 and 1997. The county is also representative of a region of the state where the economy is primarily dependent on agriculture and, consequently, suffers from low incomes and declining employment opportunities because of prolonged poor performance in the agriculture sector. County average per capita income was 26% below the state average and 29% below the US average in 1998. The county lost 15.3% of its population between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in Cottle and surrounding counties averaged $243 and exhibited an average annual increase of only 2% (Real Estate Center). The relatively depressed land market was a reflection of both the depressed agricultural economy and the lack of demand for other uses of land in this area.

The county reported 4% fewer, but 8% larger, farms in the 1997 Census of Agricultural than in 1982. By 1997, the number of farms reporting range and/or pastureland increased by almost 16%. During this period, the proportion of total farmland made up of range and pastureland increased

from 63% to 73% (approximately 60,000 acres increase). Cotton acreage is reportedly declining significantly. According to reports from county FSA (Cottle Co. TX, FSA/USDA) personnel, the trend in farm consolidation has continued during the past 4 years along with prolonged drought conditions and low commodity prices.

Texas case study 2: McCulloch County

McCulloch County encompasses the geographic center of the state and is a transition area containing typical Edwards Plateau rangelands in its southern half and Rolling Plains mixed range and cropland in its northern half. It lies in the Middle Colorado – Llano Hydrologic Unit (#120902, Table 2.13 and Figure 2.19c). It is representative of one of several areas in Texas that experienced a decrease of less than 5% in grassland area between 1982 and 1997.

The county's economy is primarily agriculturally based, although it is more diversified than the economy of Cottle County. Wildlife based enterprises, especially lease-hunting , are an important and growing land use alternative for McCulloch County. The county average per capita personal income was 29% below the state average in 1998 and 33% below the US average. The county lost 6.5% of its population between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in McCulloch and surrounding counties averaged $709 and exhibited an average annual increase of 9.8% (Real Estate Center). Since climatic and economic conditions for production agriculture were poor over the period, above average land prices must be reflective of demand from non-agricultural interests, primarily wildlife-based recreation.

The county reported 5% more farms in the 1997 Agricultural Census than in 1982 and the number of farms reporting range and/or pastureland increased by almost 20%. During this period, the proportion of total farmland made up of range and pastureland dropped from 76% to 73% (an approximate 50,000 acre loss).

According to reports from county Agricultural Extension (McCulloch Co. TX, Agricultural Extension Service) personnel, the trend toward more but smaller rural land holdings has continued during the past 4 years. This trend has been fuelled primarily by land purchases by people living outside the county with interests in wildlife-based recreation. In addition, some of

the land is being taken completely out of agricultural production in cases where wildlife breeding and other land use goals may preclude agricultural enterprises. Such uses are, however, generally compatible with maintaining good rangeland habitat. County Agricultural Extension personnel also report that more cropland would have been taken out of production during the past 3 to 5 years had it not been for the financial support of government programs, particularly the subsidized crop insurance.

Texas case study 3: Wise County

Wise County is located in North Central Texas in the Upper Trinity Hydrologic Unit (#120301, Table 2.13 and Figures 2.19c). It is representative of one of several areas in Texas that experienced a decrease of more than 5% in grassland area between 1982 and 1997. It is also representative of several areas in Texas that are within convenient commuting distance of a major growth center along the rapidly developing I-35 corridor. Average per capita personal income in the county in 1998 was about 17% below the state average and about 21% below the US average. The population of Wise County grew by 47% between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in Wise and surrounding counties averaged $ 1,830 and exhibited an average annual increase of 15.8% (Real Estate Center). The median tract size sold in Wise County during this period (57 acres) was less than half of the statewide average.

The county reported 33% more farms in the 1997 Census of Agriculture than in 1982 and the number of farms reporting range and/or pastureland increased by 14%. Average farm size in the county declined from 260 acres in 1982 to 198 acres in 1997. Despite these large increases in the number and decreases in size of farms, range and pastureland decreased by only about 10,000 acres during this period according to the 1997 Census of Agriculture. This is clearly a case of where the primary damage to grasslands from population growth is fragmentation into smaller and smaller units.

According to reports from county Agricultural Extension (Wise Co. TX, Agricultural Extension Service) personnel, the trend toward more but smaller rural land holdings has continued during the past 4 years. The trend is fuelled primarily by land purchases by persons seeking x-urban

homesites and "ranchettes" (homesites with 3 to 30 acres and facilities for keeping a horse(s) and/or a few livestock or a small orchard).

Summary

Chapter 3 explored a number of the potential drivers of land use change in the United States with special focus on grasslands. Six broad anthropogenic influences on the extent of grasslands were delineated:

1. Population growth;
2. Affluence and increases in personal income;
3. Relatively low economic returns to agricultural compared to alternative land uses;
4. Incentives favoring cropping over livestock grazing created by federal policies;
5. Non-agricultural demand for rural lands; and
6. Advances in rural telecommunications and its implications for employment opportunity.

The observed influences of these drivers of land use change were illustrated using a variety of case studies from across the 22 state focus region. These 17 brief case studies from Colorado, Idaho, Montana, North Dakota, South Dakota and Texas brought forward the diversity of local situations with regard to rangeland and grassland loss, highlighting the potentially distinct implications of federal grassland protection policies at the local level.

Table 3.1. Resident population in 1990 and 2000, numerical and percent change in resident population 1990 to 2000 of the 22 states west of the Mississippi River ranked by percent change.

US Rank	State	Population		Changes in Population	
		1990	2000	Number	Percent
1	Nevada	1,201,833	1,998,257	796,424	66.27
2	Arizona	3,665,228	5,130,632	1,465,404	39.98
3	Colorado	3,294,394	4,301,261	1,006,867	30.56
4	Utah	1,722,850	2,233,169	510,319	29.62
5	Idaho	1,006,749	1,293,953	287,204	28.53
8	Texas	16,986,510	20,851,820	3,865,310	22.76
10	Washington	4,866,692	5,894,121	1,027,429	21.11
11	Oregon	2,842,321	3,421,399	579,078	20.37
12	New Mexico	1,515,069	1,819,046	303,977	20.06
18	California	29,760,021	33,871,648	4,111,627	13.82
19	Arkansas	2,350,725	2,673,400	322,675	13.73
20	Montana	799,065	902,195	103,130	12.91
21	Minnesota	4,375,099	4,919,479	544,380	12.44
26	Oklahoma	3,145,585	3,450,654	305,069	9.7
30	Missouri	5,117,073	5,595,211	478,138	9.34
32	Wyoming	453,588	493,782	40,194	8.86
35	Kansas	2,477,574	2,688,418	210,844	8.51
36	South Dakota	696,004	754,844	58,840	8.45
37	Nebraska	1,578,385	1,711,263	132,878	8.42
40	Louisiana	4,219,973	4,468,976	249,003	5.9
43	Iowa	2,776,755	2,926,324	149,569	5.39
50	North Dakota	638,800	642,200	3,400	0.53

Source: US Department of Commerce Bureau of the Census, Census 2000.

Table 3.2. Per capita personal income, for states west of the Mississippi River, 1995–99

State	Dollars					% Change			
	1995	1996	1997	1998	1999	95-96	96-97	97-98	98-99
Colorado	24,865	26,231	27,950	29,860	31,546	5.5	6.6	6.8	5.6
Nevada	25,808	27,142	28,201	29,806	31,022	5.2	3.9	5.7	4.1
Minnesota	24,583	26,267	27,548	29,503	30,793	6.9	4.9	7.1	4.4
Washington	23,878	25,287	26,817	28,632	30,392	5.9	6.1	6.8	6.1
California	24,496	25,563	26,759	28,280	29,910	4.4	4.7	5.7	5.8
Nebraska	22,196	24,045	24,590	25,861	27,049	8.3	2.3	5.2	4.6
Oregon	22,668	23,649	24,845	25,958	27,023	4.3	5.1	4.5	4.1
Texas	21,526	22,557	24,242	25,803	26,858	4.8	7.5	6.4	4.1
Kansas	21,899	23,121	24,355	25,687	26,824	5.6	5.3	5.5	4.4
Wyoming	21,514	22,098	23,820	24,927	26,396	2.7	7.8	4.6	5.9
Missouri	22,094	23,099	24,252	25,403	26,376	4.5	5.0	4.7	3.8
Iowa	21,181	22,713	23,798	24,844	25,617	7.2	4.8	4.4	3.1
Arizona	20,634	21,611	22,781	24,133	25,189	4.7	5.4	5.9	4.4
South Dakota	19,848	21,736	22,275	23,797	25,045	9.5	2.5	6.8	5.2
North Dakota	19,084	21,166	20,798	22,767	23,313	11.0	-1.7	9.5	2.4
Utah	18,858	19,955	21,156	22,294	23,288	5.8	6.0	5.4	4.5
Oklahoma	19,394	20,151	21,106	22,199	22,953	3.9	4.7	5.2	3.4
Louisiana	19,541	20,254	21,209	22,352	22,847	3.6	4.7	5.4	2.2
Idaho	19,630	20,353	20,830	21,923	22,835	3.7	2.3	5.2	4.2
Arkansas	18,546	19,442	20,229	21,260	22,244	4.8	4.0	5.1	4.6
Montana	18,764	19,383	20,167	21,324	22,019	3.3	4.0	5.7	3.3
New Mexico	18,852	19,478	20,233	21,178	21,853	3.3	3.9	4.7	3.2

Source: USDC – Bureau of Economic Analysis

Table 3.3. Average cropland and pastureland sale prices and percent change in sale prices, 1997 and 2000, for states west of the Mississippi River.

State	Cropland Price 1997 ($/acre)	Cropland Price 2000 ($/acre)	% Change in Cropland Price 1997 – 2000	Pastureland Price 1997 ($/acre)	Pastureland Price 2000 ($/acre)	% Change in Pastureland Price 1997 – 2000
AZ	3,700	4,300	16.22	300	360	20.00
AR	968	1,080	11.57	890	1,000	12.36
CA	5,080	5,960	17.32	1,100	1,000	(9.09)
CO	772	852	10.36	320	345	7.81
ID	900	1,170	30.00	640	850	32.81
IA	1,700	1,890	11.18	615	650	5.69
KS	649	666	2.62	365	375	2.74
LA	1,080	1,110	2.78	1,210	1,150	(4.96)
MN	1,090	1,270	16.51	360	410	13.89
MO	1,040	1,250	20.19	660	790	19.70
MT	458	458	0.00	190	205	7.89
NE	1,020	1,110	8.82	200	230	15.00
NV	1,700	1,900	11.76	220	270	22.73
NM	1,330	1,370	3.01	150	150	0.00
ND	427	425	(0.47)	141	155	9.93
OK	553	548	(0.90)	361	415	14.96
OR	928	1,020	9.91	400	405	1.25
SD	456	510	11.84	155	190	22.58
TX	674	770	14.24	510	570	11.76
UT	2,300	2,740	19.13	395	420	6.33
WA	1,340	1,340	0	550	490	(10.91)
WY	744	815	9.54	150	160	6.67
Average	1,314.05	1,479.73	10.26	449.18	481.36	9.51
Average % change in annual rental rates 1997-2000			7.03			4.90

Source: USDA- NASS

Table 3.4. Average pastureland and cropland annual rental rates and comparisons of rental rates to sale prices between pasture and cropland, 2000, for the states west of the Mississippi River.

State	Pastureland Sale Price as % of Cropland Sale Price	Annual Cropland Rent ($/acre)	Annual Cropland Rent as % of Cropland Sale Price	Annual Pastureland Rent ($/acre)	Annual Pastureland Rent as % of Pastureland Sale Price	Pastureland Rent as % of Cropland Rent
AZ	8.11	135.00	3.14	-*	-	-
AR	91.94	50.00	4.63	-	-	-
CA	21.65	300.00	5.03	-	-	-
CO	41.45	-	12.80	-	-	-
ID	71.11	120.00	10.26	-	-	-
IA	36.18	115.00	6.08	29.00	4.46	25.22
KS	56.24	35.50	5.33	12.80	3.41	36.06
LA	112.04	51.90	4.68	14.00	1.22	26.97
MN	33.03	77.90	6.13	17.50	4.27	22.46
MO	63.46	60.00	4.80	20.00	2.53	33.33
MT	41.48	17.30	3.78	4.80	2.34	27.75
NE	19.61	66.00	5.95	11.30	4.91	17.12
NV	12.94	-	-	-	-	-
NM	11.28	-	-	2.00	1.33	-
ND	33.02	35.50	8.35	9.50	6.13	26.76
OK	65.28	26.00	4.74	7.80	1.88	30.00
OR	43.10	67.00	6.57	-	-	-
SD	33.99	39.80	7.80	11.00	5.79	27.64
TX	75.67	21.00	2.73	6.00	1.05	28.57
UT	17.17	51.00	1.86	-	-	-
WA	41.04	160.00	11.94	-	-	-
WY	20.16	-	44.00	-	-	-
Average	43.18	79.38	5.77	12.14	3.28	27.44

*- indicates insufficient data

Source: USDA- NASS

Table 3.5. Number of farms reporting acreage in other pastureland and rangeland[1], by state, according to the US Census of Agriculture, 1978 to 1997.

State	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 4: Summary and Conclusions

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Vast expanses of prairies, savannas, and steppes once dominated much of the current arable land in the US. These were grasslands, the largest vegetation formation in North America. During settlement and subsequent development, these grasslands represented a substantial ecological resource that sustained a large portion of the US economy. Through time, the ecological and economic functions of these lands have changed. The root causes of these changes are almost as diverse as the affected lands. Much of the historical grassland area has been converted to other land use – perhaps irreversibly. Much of what remains is degraded to the point that it is no longer capable of supporting the same level or variety of ecological and economic services. However, many natural grassland systems are resilient and they may realize much of their ecological and economic potential subsequent to recovery and restoration efforts.

In sum, the current literature and research regarding grasslands support the following conclusions and recommendations.

- Grasslands provide important ecological functions and services. They include nutrient cycling, carbon sequestration, watershed, wildlife habitat and source of biodiversity. All are dramatically reduced with the conversion of grasslands to other land uses.

- Grasslands are economically important. They are a major source of forage for livestock, particularly beef cattle, provide a source of high quality water, are the basis for wildlife-based recreational activities, and provide untold benefits in open space and scenic amenities among other benefits.

- Most of the historical and remnant grasslands are under private ownership, necessitating the explicit inclusion of landowners in any policy solution to future grassland protection and stewardship.

- Grasslands once accounted for about half of the landmass of the 48 contiguous United States. Largely, they had been converted to other land uses by 1950, primarily cropland.

- Over the last 50 years grasslands have continued to disappear, but conversion to land uses other than cropland have become much more prevalent.

- Grassland types on private lands vary considerably in their historic loss rates. Historically, the earliest and most extreme grassland losses tend to be concentrated in those grassland types most conducive to cropland conversion (e.g., tallgrass prairies). Most recently, grassland types that tend to convert to marginal croplands have faced considerable losses (e.g., mixed- and shortgrass prairies).

- Significant amounts of former cropland have been converted back to use as grazing lands; albeit with significantly reduced ecological function compared to unconverted grasslands.

- Conversion of grasslands to other land cover and/or poor grazing management on some of the remaining grasslands has resulted in significant losses in wildlife habitat and biodiversity.

- Despite an overall decrease in the rate of grassland losses over the last 50 years, some groups of wildlife species (e.g., grassland birds and prairie dog associates) appear to be decreasing at a rate faster than the decrease in grassland area.

- Several government policies and programs supporting agriculture have, and do yet, provide significant economic incentives for private landowners to convert grassland to cropland and/or retain marginal cropland instead of converting it back to grassland.

- Rapid population growth coupled with increasing wealth, advancing communications technology, and other socio-economic factors are dramatically increasing the demand for fragmenting grasslands and/or converting them into urban and ex-urban residential, recreational and industrial developments. Relatively low returns to farming and/or ranching activities on grasslands provide the potential for a ready supply of convertible lands to meet these increasing developmental demands.

- In many areas, continuing economic and population growth will result in increasing grassland fragmentation and loss unless government policy provides mechanisms and financial incentives to facilitate grassland retention and/ or restoration (e.g., conservation easements).

- In many areas, retention and/or restoration of grasslands under private ownership could be enhanced by revising government policies to ensure that they do not provide incentives to retain as cropland those lands that might otherwise be restored to grassland or convert grassland to cropland. Further, programs could be expanded that provide incentives to retain or restore native wildlife habitat and encourage wildlife-based land use enterprises (e.g., USDA-NRCS – EQIP).

This report provides an overview of the historical importance of grasslands in the United States from an economic and biological perspective (Chapter 1). This overview is followed by an assessment of the recent trends in US grasslands and related resources (Chapter 2). Chapter 3 addresses the forces of change in the ecological and economic status of US grasslands. Finally, Chapter 4 briefly points to the lessons learned in the previous three chapters and suggests potential courses of action to address these lessons. The objectives of this report are to inform and improve the quality of public discourse and decision-making surrounding issues of US grasslands. This report is submitted in the hopes of achieving these important objectives.

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Appendix A

Land Use Definitions

Major Land Use Statistics

Grassland pasture and range is defined in the Major Land Use reports as (Vesterby and Krupa 2001, p. 39):

> …all open land used primarily for pasture and grazing, including shrub and brush land types of pasture, grazing land with sagebrush and scattered mesquite, and all tame and native grasses, legumes, and other forage used for pasture or grazing.

Grassland pasture and range differ from cropland pasture in that the latter is assumed to be in long-term rotation or could be cropped without additional improvement. Vesterby and Krupa (2001) state that grassland pasture and range is not always distinguishable from other types of pasture and range. Grassland pasture and range also is distinguished in the MLU reports from forest-use land grazed. Forest-use land grazed "consists mainly of forest, brush-grown pasture, arid woodlands, and other areas within forested areas that have grass or other forage growth" (Vesterby and Krupa 2001, p. 41).

National Resource Inventory

Under the NRI, land used for livestock grazing can be categorized as cropland, pastureland, rangeland or forestland. Grazing land is classified as cropland if it is in a rotation with row or close-grown crops. Forestland is often used for grazing by livestock, but is differentiated from rangeland or pastureland by type of surface cover. According to the Summary Report 1997 National Resources Inventory (USDA/NASS 2000, p. 83-84),

> [forest land is a] *Land cover/use* category that is at least 10% stocked by single – stemmed woody species of any size that will be at lease 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cut over forest or abandoned farmland) and not currently developed for nonforest use. Ten percent stocked, when viewed from a vertical direction, equates to an aerial canopy of leaves and branches of 25% or greater.

Pastureland is defined in the Summary Report 1997 National Resources Inventory (USDA/NASS

2000, p. 86) as,

> [a] *Land cover/use* category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding, or renovation, and control of grazing. For the NRI, this includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether or not it is being grazed by livestock.

Conversely, rangeland is defined in the Summary Report 1997 National Resources Inventory (USDA/NASS 2000, p. 87) as,

> [a] *Land cover/use* category on which that climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheat grass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.

Census of Agriculture

Three types of "pastureland" are included in the census estimates. These definitions are quite similar to those used by the MLU estimates. The category used in this report is "other pastureland and rangeland" and is defined by the Census of Agriculture (USDA/NASS 2000) as any pastureland not included in cropland and woodland pasture. Cropland used for pasture or grazing includes land that could be used for crops without additional improvement, or cropland that is used for rotational pasture. Woodland includes "natural or planted woodlots or timber tracts, cutover and deforested land with young growth which has or will have value for wood products" (USDA/NASS 1997). Land covered by sagebrush or mesquite is considered to be other pastureland and rangeland.