Livestock Management in the American Southwest: Ecology, Society, and Economics
Edited by R. Jemison and C. Raish

Commercial livestock operations in Arizona

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1. INTRODUCTION

Range livestock production, ranching, is a long-established land use in Arizona with origins that trace back to the 16th century Spanish explorations (Allen 1989, see Wildeman and Brock, this volume). Despite major shifts toward urbanization in the state, livestock grazing remains the most widespread use of Arizona rangelands. Through the sale of calves, yearlings, stocker cattle, and culled cows and bulls, cattle ranching accounts for nearly 25% of the agricultural economy in the state. However, based on profit alone, the economic viability of ranching in Arizona is questionable. Because of economic factors related to income production, decisions to remain in the ranching business are not entirely financial. Lifeway considerations have long played an important role in the process.

Much more threatening to the future of ranching in Arizona than pure profit motives is the uncertainty associated with the tenure of public land grazing permits and state land grazing leases. Private ranch lands are impacted through ongoing urbanization and development pressures. These factors, and all of the complexity they entail, will largely decide the future of Arizona ranching.

This chapter describes administrative, regulatory, environmental, economic, and social constraints on ranching in Arizona.

2. PATTERNS OF LAND OWNERSHIP

Arizona ranchers are largely dependent on the use of state and federal land for livestock grazing. The distribution of land and grazed land ownership in Arizona is presented in Figure 1 and Table 1. Federal, state, and Indian lands make up over 80% of the surface area in Arizona. The United States Forest Service (FS), Bureau of Land Management (BLM), and Arizona State Land Department (ASLD) administer 11.6 million ha that are grazed by livestock. These public and state grazing permits and leases account for over 85% of the state's grazing land outside of Indian reservations.

Large blocks of private land used for ranching are primarily associated with historic Spanish or Mexican land grants. Land grants play less of a role in the current ownership and management of rangeland in Arizona than in New Mexico. A few Spanish land grants were made in southern Arizona before Mexico gained its independence in 1821. Mexican land grants were established over much of the grassland in the San Pedro, San Rafael, and Santa Cruz valleys of southeastern Arizona, but by the mid 1800s the Apaches had driven off the Mexican ranchers. Large-scale ranching in Arizona was not re-established until after the Civil War when the Apaches were forced onto reservations. Anglo ranchers started many large ranches in Arizona in the 1880s, often with funding from outside Arizona and usually by controlling access to water (Sheridan 1995).

The federal government acquired its land after much of the more productive land with water was appropriated by private individuals. An Arizona ranch typically comprises a core of private land and grazing allotments on federal and/or state land, all of which are managed as the ranch unit. Although ranchers do not hold fee simple property rights to grazing allotments, in practice these grazing resources are treated as part of the ranch and determine its value when sold or appraised for federal estate taxes. The two primary federal land management agencies are the BLM and the FS. Both agencies manage rangelands for a number of different objectives, and are mandated by law to manage resources for multiple uses, including

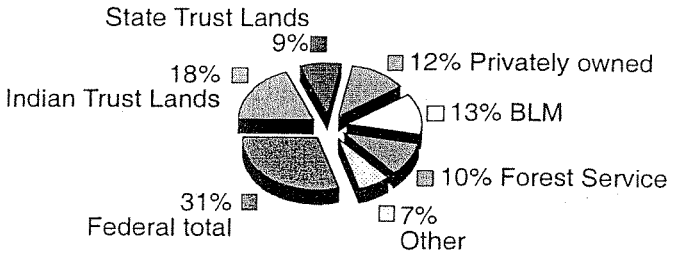


Figure 1. Land ownership in Arizona.

Table 1
Land ownership in Arizona.

	Total area
	m Hectares
Privately owned land	5.2
Bureau of Land Management	5.6
Forest Service	4.5
Other	2.8
Federal total	12.4
Indian Trust Lands	8.1
State Trust Lands	3.8
Total - Land in Arizona	29.5

but not limited to livestock grazing, wildlife habitat, recreation, and watershed values. The non-federal, state-owned grazing land in Arizona is managed by the ASLD with the objective of providing income to Arizona's educational system. These complex administrative boundaries bring with them a mix of regulations and constraints to the management of Arizona ranches.

Grazing lands on Indian reservations in Arizona encompass about 18% of the state. Much of this land is quite arid and grazed by cattle, sheep, horses, and goats. Sheep production on Arizona's reservations is much more important than elsewhere in the state (Ruyle 1991). Much less is known about range management practices on Indian Reservations than on publicly owned grazing land. Ranching on Indian Reservations is often managed through grazing associations with a combination of Tribal and privately owned herds (see Brugge and Gerow, this volume).

3. PROBLEMS WITH RANCHING ON PUBLIC LANDS

The amount and juxtaposition of public and state lands in Arizona has a major influence on ranching operations. Most Arizona cattle ranches depend, to some extent, on federal or state land forage for grazing livestock. Public and state grazing permits and leases account for over 85% of the state's grazing land outside of Indian reservations (Mayes and Archer 1982). To further complicate matters, many ranches rely on some combination of state grazing lease, private lease, and/or federal (FS or BLM) grazing permit. Over one-third of all Arizona ranching operations include a combination of two or more agency-administered grazing allotments, most commonly state and BLM (Figure 2). Nearly another third rely only on state

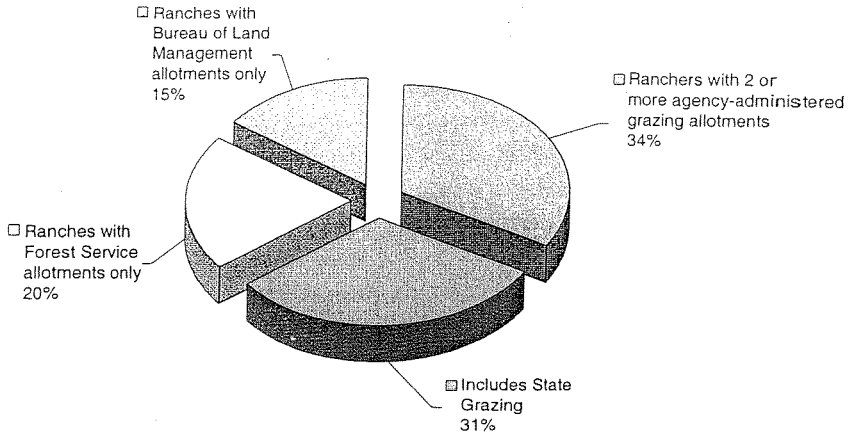


Figure 2. Arizona ranch reliance on state and federal grazing.

permits while 20% have only FS allotments and 15% include only BLM allotments (Mayes and Archer 1982). While these percentages have no doubt varied somewhat since 1982, reliance of Arizona ranches on public and state lands is clear.

Private base property requirements, called commensurate property, to hold grazing permits differ among FS (and even among national forests within the Forest Service region) and BLM. State grazing leases have no base property requirements. Most of the ranches comprising primarily private land are associated with Spanish or Mexican land grants or the alternate sections of private land found in northern Arizona, which were granted to the railroads in the late 1800s to promote western expansion (Sheridan 1995).

The degree to which land status is mixed influences the complexity of ranch management. Regulations, fees, and enforcement of regulations can vary from location to location within the same agency due to line officer discretion. A formal memorandum of understanding is typically prepared to coordinate management planning on ranches with a mix of federal, state, and private holdings. These Coordinated Management Agreements are strictly voluntary, but are often effective in improving communication because they involve various agencies in an effort to improve the management planning process.

Because of the dependence on government grazing permits, livestock grazing is regulated by various agencies. Stocking rates and grazing seasons are defined by the managing agency. Often these requirements are limited by competing uses and values such as recreation or riparian restoration, or by restrictions imposed by the U.S. Fish and Wildlife Service due to the Endangered Species Act (ESA). Physical improvements such as water developments and fencing may also be limited by these and other legislative requirements, such as those of the National Environmental

Policy Act (NEPA) or the National Historic Preservation Act (NHPA). These restrictions may have little regard for the practical aspects or economic viability of the ranch operation.

Costs of grazing on state or public land are also subject to changes and are continually scrutinized by various groups. Many believe that ranchers are paying less than fair market value for grazing fees while others argue that costs associated with grazing public land including the permit value more than make up for the difference (Watts and LaFrance 1994).

Costs associated with public land use due to vandalism, theft, disruption of operations, and other problems increase the cost of doing business for public land ranchers. As the state population increases, the impacts of development, subdivisions, and recreational uses increase costs for all Arizona ranchers. Restriction of management practices such as controlled burning, use of herbicides, seeding exotic plants, and limited predator control further influence ranching.

Requirements of NEPA and ESA have caused agencies to create burdensome processes to follow before range improvement projects or management plans may be approved, often leading to untimely delays or even cancellation of projects intended to benefit the ranching operation or other resource values. Agency actions involving public land grazing permits are also the target of a considerable amount of litigation, draining the agencies' time and money to actively manage grazing allotments.

Other specific resource competition issues that pertain to public land livestock grazing include the implementation of conservative forage utilization restrictions. These may be especially problematic where large populations of elk are present. All of these factors relate to the future status of public land grazing permits. Sentiment to remove or drastically reduce public land grazing, along with stricter interpretation of environmental legislation, and a host of pending legal suits cloud the future of federal grazing permits (Ruyle 1991).

These influences lead to uncertainty as to the long-term tenure status of grazing permits. Because of this uncertainty, some ranchers are reluctant to continue to invest in maintaining necessary physical structures or provide the vigilance required to properly oversee grazing management. As a result it is possible that future infrastructure declines could become important constraints on ranching efficiencies.

Efforts such as those of the Malpai Borderlands Group in southeastern Arizona and southwestern New Mexico and the Diablo Trust in northern Arizona (community action groups composed of land managers, public land users, environmental groups, and interested citizens) to coordinate management of multi-agency lands may be the most promising approach to maintain the viability of public land ranching while protecting open space and reducing habitat fragmentation.

4. ENVIRONMENTAL CHARACTERISTICS AND ARIZONA RANCHING AREAS

Environmental characteristics also have a major influence on range livestock operations. Factors including seasonal precipitation and temperature, soil, and vegetation and topography provide the ecological boundaries within which range livestock production must exist. Because ranching occurs statewide over a diverse landscape, no two ranches are alike in terms of environmental characteristics. Largely based on these differences, the state may be divided into seven general ranching regions, each with certain characteristics that distinguish it from the other six. (For in-depth discussions of major ecological zones and their characteristics, see appropriate chapters of this volume. Also see Kruse and Jemison, this volume, for a discussion of grazing systems.)

5. MAJOR RANCHING AREAS IN ARIZONA

5.1. The Arizona Strip

The Arizona Strip lies north of the Colorado River and west of the Navajo Indian Reservation. Vegetation of the region includes mixed grass plains (largely shortgrass species such as blue grama), cold desert shrub (primarily sagebrush), and pinyon-juniper woodland. Range forage production is typically low to moderate, but highly productive grasslands are present. Ranches are primarily cow-calf operations with fairly low stocking rates.

5.2. The Northern Plateau

This is a region of large plateaus and mesas that extends into some mountains. Essentially it is the lower drainage for the Little Colorado and the Colorado Rivers. Much of this area incorporates parts of the Hopi and Navajo Reservations. Based largely on precipitation, the area may support only widely spaced shrubs, more suitable for sheep and goats, to highly productive shortgrass and bunchgrass grasslands. Other than the sheep and goat production on the reservations (Brugge and Gerow, this volume), ranches are largely cow-calf operations.

5.3. Central Mountains

The central mountain region is a rugged area of the state, with isolated mountain ranges cut by canyons and gorges. The area is characterized by the Mogollon Rim that runs in a discontinuous fashion across most of the state. The area includes open, high-elevation grassland, interior chaparral, pinyon-juniper woodlands, and ponderosa pine forests. This ranching zone includes both stocker and cow-calf

operations. Upper elevations serve as summer allotments whereas juniper-grasslands and chaparral vegetation is often grazed year-long.

5.4. Southeastern Desert

The southeastern portion of the state is a basin and range type of landscape, large sloping plains broken by individual mountain ranges creating a wide variety of vegetation types. These include desert grassland, desert shrubs, Chihuahuan desert shrub, and open woodlands. The area is a major ranching area and primarily supports cow-calf and cow-calf-stocker operations.

5.5. South Central Desert

This hot dry region in south central Arizona is characterized by broad valleys and low mountain ranges. Vegetation includes annual grasses and forbs interspersed among low desert shrubs and cactus, including palo verde and saguaro. Desert grassland communities occur as precipitation and elevation increase. Although the area supports many cow-calf ranches, in the lower country it is probably best suited to stocker operations limited to grazing in the spring months during good precipitation years.

5.6. Western Desert

The western desert area lies mostly below 610 m elevation and is basically a flat plain cut by washes and separated by low rugged hills. Desert shrubs, including creosote, are common. Forage for livestock includes filaree and indian wheat and other little annual plants that grow mainly in the spring. The area supports some cow-calf ranches that utilize the shrubs for browse. Stocker operations are more common here than elsewhere, typically bringing steers on in early spring when wet years dictate.

5.7. Northern Desert

This region is similar to the western desert but is more typical of the Mojave Desert in vegetation. Cow-calf operations are more typical here than further south.

Based largely on broad environmental zones, the state can also be divided into Major Land Resource Areas (MLRAs) characterized by a particular pattern of soils, climate, water resources, and land uses (NRCS 1981). The eight MLRAs in Arizona (Figure 3) roughly define Arizona's major ranching areas (Mayes and Archer 1982, Ruyle 1991). These major environmental divisions are further divided into subresource areas and ultimately into specific ecological sites used as units for management planning. An ecological site, as defined for rangeland, is a distinctive kind of land with specific physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and respond to

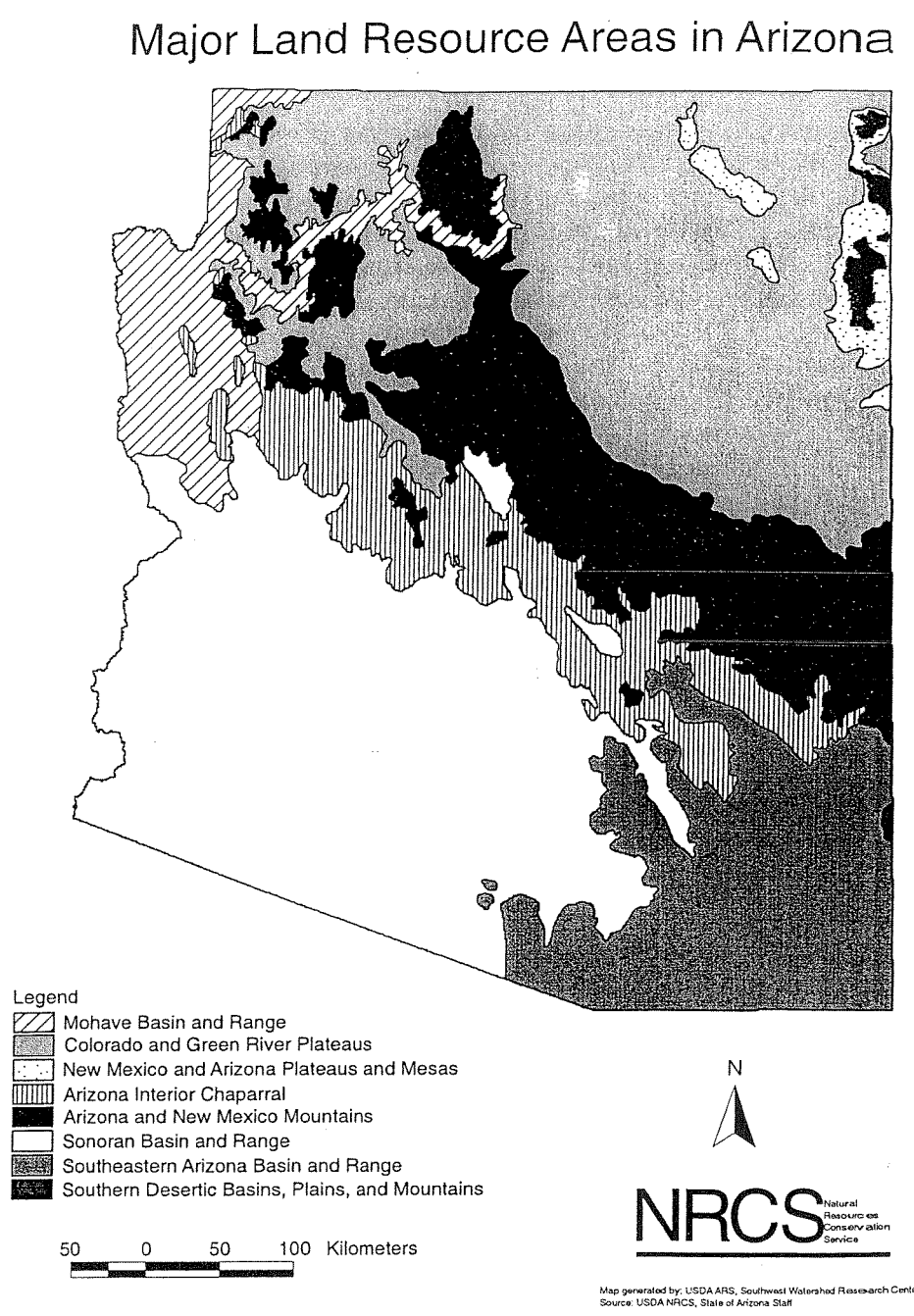


Figure 3. Major land resource areas in Arizona.

management. Ecological sites are described by guides that depict characteristic plant communities and suggested stocking rates for livestock grazing, among other information (NRCS 1981).

From a range livestock management view, ecological sites provide a very useful classification scheme. As an extensive type of agriculture, ranching requires the management of a natural system to achieve the objectives of the rancher (and society). Ecological site descriptions are used as the basis for making generalizations about the response of these natural systems to management. The diversity of Arizona's rangeland is illustrated by the fact that the area of land required to support one cow for a year varies from approximately 7 ha in the most productive regions to over 40 ha in the driest.

6. ORGANIZATION AND MECHANICS OF COW-CALF RANCHES IN ARIZONA

Many factors converge to influence the organization and operation of ranches in Arizona. These include environmental, physical, economical, and cultural factors. Not the least of these factors is the influence of public land management constraints on ranching, which are discussed elsewhere in this chapter.

Because ranching occurs statewide over a diverse landscape, no two ranches are alike in terms of vegetation, soils, rainfall, elevation, topography, land ownership mixes, or other factors. Accordingly, management practices vary significantly from one ranch to another based on differences in management philosophy and ability, physical and ecological characteristics of the rangeland, and economic factors. With few exceptions, perhaps animal identification requirements and minimum vaccination procedures, no industry-wide procedures exist for Arizona ranches. Even yearly variation in rainfall patterns and amounts can call for unique management decisions, unlike previous years or on neighboring ranches.

Estimates of the number of Arizona cattle ranches vary depending on how ranches are defined. Approximately 2,500 farms and ranches were reported to own at least one beef cow during 1995 (Arizona Agricultural Statistics Service 1995). Most operations have fewer than 50 cows, which is consistent with the national average. The majority of breeding cows in Arizona occur on larger ranches with more than 100 cows (Table 2) (Ruyle 1991). Based on these estimates, Arizona's average size cattle ranch has a base herd of approximately 130 cows and a total of 190 animal units. These numbers are down about 17% since 1993 (Ruyle 1991, Arizona Agricultural Statistics Service 1995).

The large majority of ranches in Arizona are cow-calf operations. These operations are typified by a base cow herd, and the animals needed to support them. Cows range in age from those nursing their first calves at 2 to 3 years, to those over

Table 2
Inventory of farms and ranches in Arizona by cow herd size, 1995

Number of ranches	Size of herd
250	50 – 99
580	100 – 499
170	> 500

Source: 1995 Arizona Agricultural Statistics Service

12 years. Decisions to cull cows can be complex and no set decision rules are appropriate. Biological and market considerations must take into account the dynamic aspects associated with the culling decision to increase profits (Tronstad and Gum 1994). The average age of cows in Arizona is somewhere between 5 and 7 years. In a recent survey of Arizona ranches, commissioned by the Grazing Land Valuation Committee (Seperich et al. 1995), cows were reported to comprise 71% of the total animal units on a ranch. The remaining 29% included yearling heifers and steers, 1 to 2 year old heifers, calves, bulls, and horses. Replacement heifers, those animals brought into the herd to replace culled or otherwise lost cows, usually represent approximately 11 to 17% of the total cow numbers. However, inventories show replacement heifers to represent 0 to 13% of the numbers of mature cows (Seperich et al. 1995). Bull-to-cow ratios are typically reported as 1:20 or more on ranches with gentle topography, and 1:15 on rougher, more remote ranches. Again, actual inventories show fewer bulls than these figures would represent (Seperich et al. 1995). Estimated death loss for cows and bulls is respectively 2 and 1%.

Breeding and calving schedules also vary considerably from ranch to ranch. Bulls are often allowed to run with the cow herd year around, with no management-defined breeding period. Calves may be born during any period throughout the year. In practice, however, most cows will breed during flushes of new plant growth in the spring and summer, which tend to produce calves during two primary periods, late winter and late spring. Under these conditions, calving rates are thought to be lower than when breeding seasons are more controlled. Ideal breeding and calving periods often recommended by technical experts are as short as 60 days. Such short breeding periods are not practical or common on the majority of Arizona ranches.

Nutritional constraints, predator losses, and the extensive nature of Arizona ranches influence calving rates or calf crops. No published surveys provide calf crop estimates for Arizona ranches. Some Arizona data exist that report calf crops of only 53% (Unpublished survey data from Le Vinnes for the Cooperative Extension

Service, n.d.). In contrast, Torell and Word (1991) report calf crop averages as high as 87% for some parts of New Mexico. The true Arizona average probably lies somewhere between these values.

7. TECHNOLOGY ADOPTION

The development and adoption of technology by the ranching industry has advanced with mechanical and scientific developments, and with the application of science to management. Ranches have adopted typical mechanical devices such as trucks and telephones as they have become available. More recent technology includes motorized vehicles such as all-terrain vehicles, diesel and solar powered pumps, electric fences, and computers. Animal science advances that have been adopted include genetic technology, improved breeding practices, vaccine use, hormonal implants, nutritional supplementation, and individual animal record keeping, including condition scoring. Development and adoption of range management includes setting stocking rates more in line with long-term carrying capacities, grazing system application, and prescribed burning. Mechanical and chemical brush control and re-seeding continue but primarily on private land.

As discussed previously, Arizona is a mosaic of federal, state, and private ownership, and most Arizona ranches depend to some degree on grazing these lands. Federal and state agencies have grazing regulations and related manuals of technical procedures for the management and monitoring of livestock grazing on these lands. The requirements of these agencies reflect the current state of grazing management technology. Further agency requirements, for example, the on-going effort of the Arizona Department of Environmental Quality to identify Best Management Practices for grazing activities in Arizona, as required by SB 1103 which modified state law, will continue to influence the adoption of grazing management technology.

8. SUITABILITY OF ARIZONA RANGELANDS FOR COMMERCIAL CATTLE RANCHING

The question of whether Arizona rangelands are suitable for commercial cattle ranching has environmental, economic, physical, and sociocultural considerations. Suitability is legally defined for Forest Service purposes by 36 CFRs. 219.3 (Code of Federal Regulations) as follows:

> *Suitability:* The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone. A unit of land may by suitable for a variety of individual or combined management practices.

The Forest Service Range Analysis Handbook for the Southwestern Region additionally defines grazing capability of a land area to be dependent upon the interrelationship of the soils, plants, and animals. Grazing capacity is a function of capability, proper use by livestock, and the level of management that may be applied. Grazing capability classes are assigned to mapping units based on soil stability estimates. Neither BLM nor ASLD have these specific grazing capability or capacity guidelines, but in a sense, make similar considerations on an allotment by allotment basis by taking into account management applications such as forage utilization mapping when making stocking decisions.

The suitability of rangelands for cattle grazing can also be viewed in the broad context of resource sustainability. Ranching is dependent upon the sustainability of livestock grazing as a land use or the continued capacity of the land to produce forage for livestock production (Ruyle 1991). The sustainability of livestock grazing depends upon physical and environmental factors that constrain carrying capacity. But where ranches depend upon public land grazing, societal constraints also apply. A societal carrying capacity takes into account natural resource values other than livestock production (Ruyle 1991). Resource allocation decisions imposed by societal values may override the productive potential of the land itself. For example, as previously discussed, endangered species regulations or decisions to allocate more forage for elk and less for cattle may limit ranching operations.

Environmental constraints to range livestock production correspond to conditions that characterize the previously discussed Major Land Resource Areas. Amount and distribution of precipitation combine with seasonal temperatures and soil potentials to define the forage production capability of specific sites. Rough topography, low levels of forage production due either to poor site potential or increases in woody vegetation at the expense of forage plants, frequent droughts, and scarcity of water are primary factors limiting livestock grazing capacity on Arizona rangelands. Some of these limitations may be corrected by management inputs such as prescribed fire or water development.

Additionally, individual plant species vary with respect to grazing tolerance and plant communities differ in resilience and resistance to disturbances such as drought, fire, and grazing (Westoby et al. 1989). Grazing tolerance, in general, is the relative ability of individual plants to survive grazing. Resilience describes the speed with which a plant community returns to its former state after it has been disturbed. In contrast, resistance is the ability of the community to avoid displacement in the first place. The extent to which these attributes function influences plant community response to various levels of grazing and grazing management.

For example, much of the vegetation described as plains grassland (Brown and Lowe 1994, Engle and Bidwell, this volume) was heavily grazed by livestock for at least 100 years yet remained intact as grasslands. These grassland communities

have been less changed in their aspect by poor livestock grazing management than have the lower elevation desert grasslands (Bahre 1991, Loftin et al., this volume). Lower elevation grasslands responded to overgrazing, in part, through shrub infestations, especially increases in mesquite and reduced production of perennial grasses.

Recent aggregate measures of the ecological conditions on Arizona rangelands indicate steady improvement. The best aggregate measure of ecological condition comes from the National Resources Inventory (NRI) performed every 5 years by the Natural Resources Conservation Service (NRCS) on the nation's non-federal land (NRCS 1997). The NRIs were performed on randomly selected sites on private, Indian Reservation, and Arizona State land, but not on BLM or FS lands. The authors of the 1992 NRI Rangeland Report stress that care should be taken when interpreting the results, because there are many influences affecting range condition and trend over time, so that any one snapshot view could be misleading. However there has been a clear, but slow, positive trend in range condition in Arizona from 1982 to 1992 (Figure 4). The 10-year trend indicates a number of Arizona's vegetation communities are moving slowly toward their biotic potential.

Is ranching appropriate in these areas? Should these rangelands be grazed? The application of ecologically sound management practices will determine the environmental sustainability of livestock grazing on rangelands. Setting proper stocking rates, which are related to management inputs as well as environmental limitations, is arguably the major management decision. A conservatively small number of cows as the base herd, augmented by stocker cattle when conditions warrant, provides flexibility to cope with the vagaries of nature on Arizona rangelands.

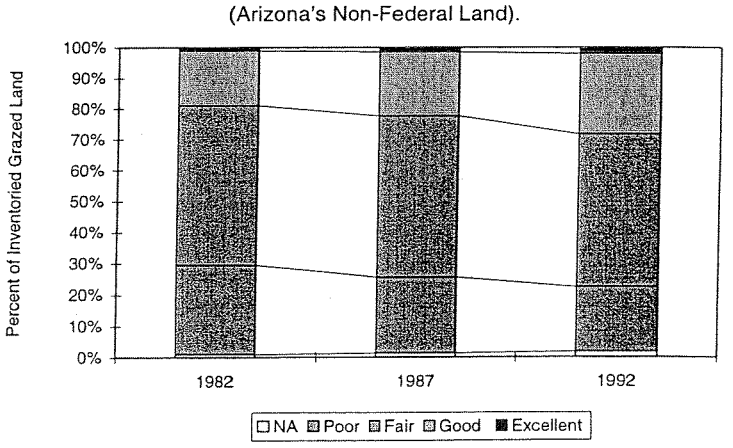


Figure 4. Change in range condition (NRI).

9. RANCHING PROFITABILITY

Ranch profitability is largely determined by productivity, market prices, and production costs. These general factors are influenced by an array of specific factors. For example, ranch productivity in Arizona is greatly affected by range condition, weather, and the number of animal unit months (AUMs) assigned to a grazing permit. Range forage conditions and the resulting nutrition received by beef cows on rangelands largely determine fertility and calf weaning weights. The market price received for calves varies according to the price of corn, availability of grass or pasture elsewhere, livestock numbers, and trade factors. The cost of inputs needed to run a ranch vary from fuel and labor to grazing fees and these expense items influence a ranch's bottom line. All of these factors mentioned, combined with management decisions and ranch size, determine the economic viability of a ranching unit.

9.1. Size of operation

While noting that at least 100 cows are needed to achieve economics of size, Krause (1992) reports that 52% of the beef cows in the U.S. reside in herds with fewer than 100 head. In Arizona, however, Mayes and Archer (1982) report that only 9.2% of Arizona's beef cow production occurs on ranches with less than 100 cows. Arizona Agricultural Statistics Service (1995) data suggest that production on small ranches was probably less in the mid-1990s than in 1982. The number of ranches in all size categories has also declined, reflecting larger ranch units within each size category, while total beef cow numbers for the state have declined (Figure 5).

Given that some costs are fixed (i.e., their cost remains the same whether cow numbers go up or down), economies of size are a major force behind the economic pressures of moving toward larger ranches. For example, we calculated a weighted ranch income (before deducting any operator salary or interest expenses) of $1,391, $20,991, and $25,250 for small (193-229 AUY—Animal Unit Year, which is one cow with or without calf for 1 year), medium (393-644 AUY), and large (706-1,153 AUY) ranch sizes, respectively, from ranch income numbers reported by Seperich et al. (1995). Weighted ranch income figures were calculated by weighting animal units across low (<7AUY/section) (a section of land equals 259 ha), medium (7-11 AUY/section—animal unit year per section, which is one cow with or without calf for 1 year per section or 259 ha of land), and high (>11 AUY/section) animal carrying capacities. The weighted return per AUY is only $1.27, $37.64, and $26.86 for small, medium, and large size ranches, respectively. Although the sample size of ranchers interviewed was very limited (approximately 30 ranches for nine categories reported their practices from 1989 to 1993), the numbers do illustrate that a large ranch can cover the fixed cost of an "operator salary" better than a medium sized ranch even when profit/AUY is lower for a large than medium sized ranch.

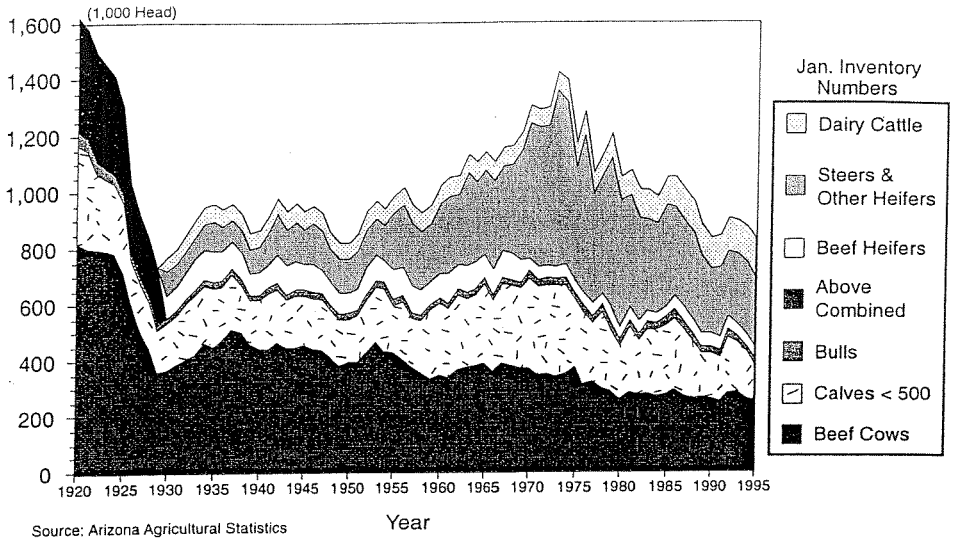


Figure 5. January livestock inventory numbers for Arizona.

Fowler et al. (1994) estimated that direct ranch expenditures in local communities for Arizona ranches averaged $20,680 in 1991. Although small ranches have lower expenditures in the community than large ranches, basic family needs related to food, clothing, vehicle repair, gasoline, and medical expenses still need to be met in order to maintain a viable ranching unit. Small ranches in New Mexico (1-99 AU) averaged expenditures of $11,533 compared to $20,509 for large ranches (351-1000 AU). Even the largest ranch size possible in the small category (i.e., 99 AU) would need over $120/AU in cash return to meet current minimal living expenses. This exceeds virtually all cash flow estimates associated with ranching, including the cost estimates for Arizona ranches from 1980 through 1993 presented later in this chapter. Cost and return estimates presented in Table 3 (found in a subsequent section on "Costs of Production") show that a ranching unit needs to exceed 150 animal units in order to meet minimal family living expenses of $12,000 (i.e., 12,000/$78.50/hd = 153 head). Maynard et al. (1996) report average living expenses for all ranchers in Yavapai County at $18,647. Thus, small sized ranches will likely need at least 50% of their income from off-ranch or non-livestock sources in order to meet basic living expenses, even if they "own" most of the value associated with their ranch and accompanying grazing permit(s).

9.2. Land productivity for Arizona

Figure 5 portrays how January 1 livestock inventory numbers have changed over time since 1920 for all categories of cattle in Arizona. Livestock on the range would

include beef heifers, most bulls and calves less than 227 kg, and all beef cows. Clearly, the number of animal units on the range has declined since 1920 when an estimated 819,000 beef cows were on Arizona's rangelands. After dropping from this peak in 1920 to only 360,000 beef cows in 1929, numbers increased sharply to 510,000 by 1937. Since then, numbers have steadily trended downward by about 4,500 head, or 1% annually, to the beef cow herd of 249,000 reported for 1995. Much of this decline can be attributed to fewer animal units allowed on grazing permits. From 1985 to 1991, Fowler et al. (1994) report that the number of animal units permitted for grazing on all federal lands declined about 3% annually.

Mayes and Archer (1982) report that 45.6, 42.6, and 11.7% of Arizona's ranches have a carrying capacity of <6, 7-12, and >13 AUYs per section, respectively. About one half of Arizona's ranchers have less than 7 AUY/section carrying capacity. Seperich et al. (1995) found the average return for low (<7 AUY/section), medium (7-11 AUY/section), and high (>11 AUY/section) carrying capacity ranches to be $–15.35, $44.53, and $25.73 for each animal unit, respectively. This return does not include any deductions for operator salary or interest expenses on land, improvements, cattle, or short-term loans. This result is counter intuitive since one would expect a higher cash flow per animal unit from ranches with lower input costs or a higher carrying capacity/section. However, they also report small ranch sizes with low carrying capacity have fence resources worth $255,000. This compares with only $130,000 of fence resources, almost half that of the smallest ranches, for their large ranch category. The problems associated with small sample size and inconsistencies in reporting expenditures from one ranch category to the next argue for building ranch budget expenditures up from standard practices rather than from a handful of solicited expenditures. Problems associated with revenues in their study are also evident since the small ranch size with high carrying capacity has no revenue reported from steer calves or yearling steers for the entire 1989 through 1993 period. The paucity of sound cost of production data available for range livestock production in Arizona indicates that contributions to the literature are needed in this area. Cooperation with ranchers in completing detailed questionnaires and resources to complete cost of production budgets will be required for this objective.

9.3. Market fluctuations

Price fluctuations are notorious for beef cattle and Arizona in particular. Figure 6 portrays the relationship between total U.S. cattle numbers and Arizona calf prices. Calf prices are given in 1995 real dollars so that inflation is removed from the annual 1960 through 1995 calf price series. Cattle numbers trended steadily upward from 1930 to their peak in 1976, with a cyclical pattern around this trend as shown. Historically, the cattle cycle has averaged about 11 years. As one would expect, Arizona calf prices generally show an inverse relationship with the cattle inventory cycle. Note that calf prices peaked in 1972 and 1979, near the bottom of

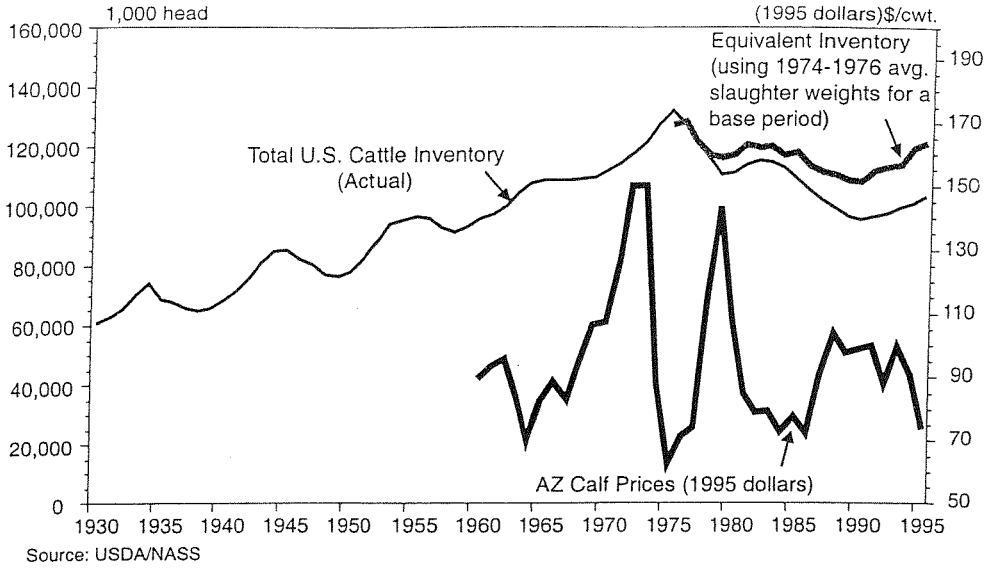


Figure 6. United States cattle numbers and Arizona calf prices.

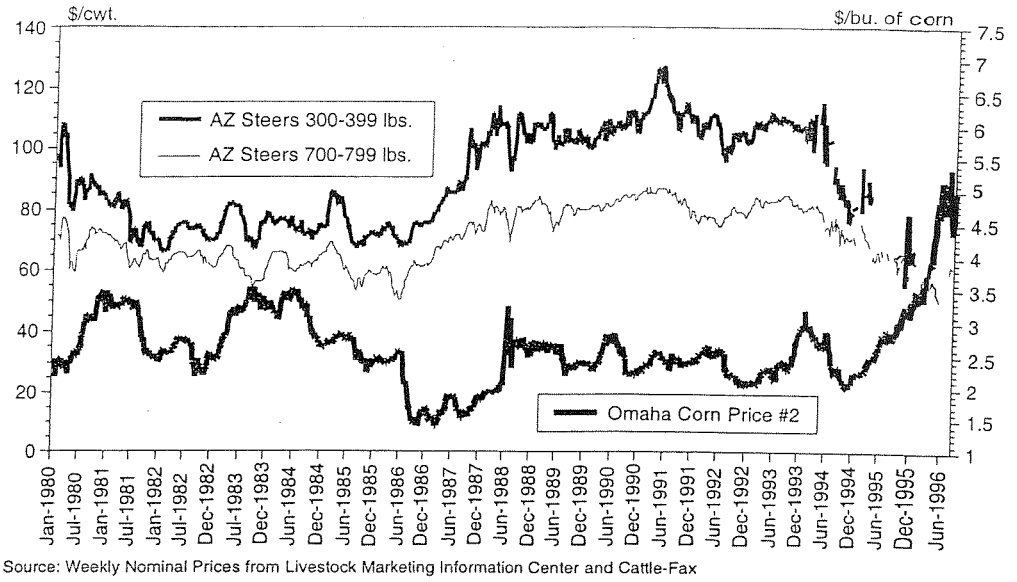
the cattle cycle. Real calf prices (1995 dollars) were $150/cwt. (one cwt. equals 45 kg) in 1972/73 and they fell to only $62/cwt. in 1975. Although this magnitude of price change is huge, the relative magnitude this kind of price change has on cash flow and profitability of an average ranch is even larger. Clearly, ranchers need to budget conservatively in good times so they are not over-extended when prices drop.

Although total cattle numbers have trended down from 1975 to 1995, the amount of actual beef produced or equivalent inventory has not dropped nearly as much. Dressed beef per cow increased 25%, from 204 kg in 1970 to 255 kg in 1995. Heavier carcass weights, feeder imports, and a dramatic drop (72% since 1976) in the slaughter of calves contributed to this increase.

Market prices also fluctuate more for light weight calves than heavier feeders (Figure 7). The price spread between 136-181 kg steers and 318-362 kg steers changes dramatically in relation to the price of corn. Generally, the cost of gain for lightweight calves is less than the price of heavier feeders, resulting in a premium paid for lightweight calves. Corn is the primary feed element for feeder cattle so higher corn prices translate to higher costs of gain. Corn prices were so high in the summer of 1996 that it was cheaper to buy the weight than put it on so the "premium" for 159 vs. 340 kg steer calves was $-1.54/cwt.

9.4. Influence of NAFTA and the 1994 peso devaluation

The North American Free Trade Agreement (NAFTA) did not directly influence



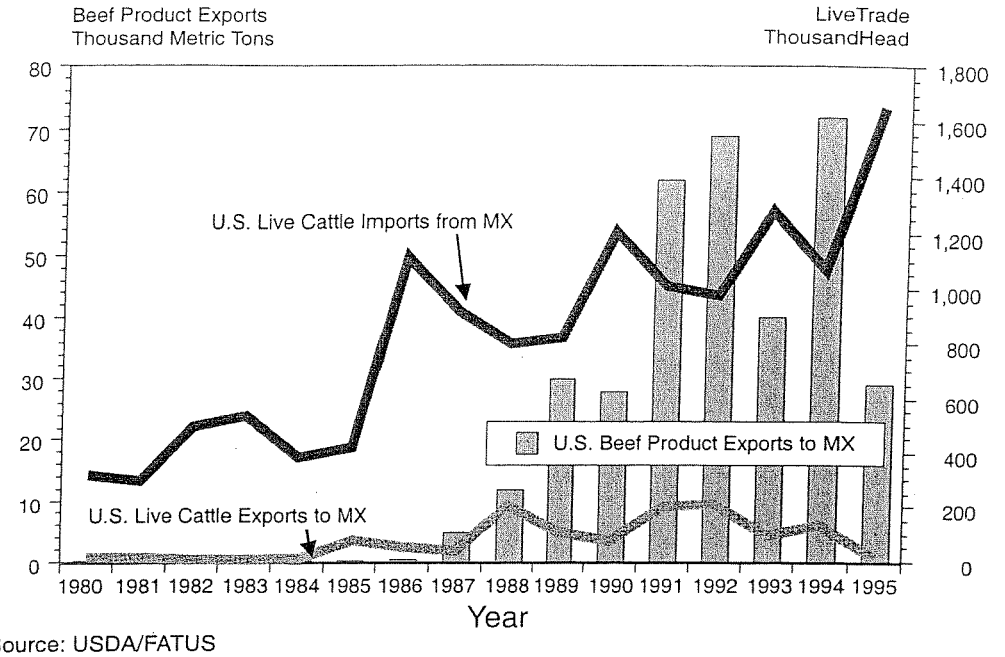
Source: Weekly Nominal Prices from Livestock Marketing Information Center and Cattle-Fax

Figure 7. Relationship between corn and Arizona feeder prices (1bu [bushel] equals 35l).

live cattle trade with Mexico because the only trade restrictions that have applied prior to NAFTA and after 1988 are health requirements by Animal Plant Health and Inspection Service (APHIS) that are still in place. Prior to 1988, an export quota was in place by the United States that had the effect of bunching feeder imports from Mexico during December and January. Trade restrictions on exporting beef products to Mexico were relaxed somewhat in 1987 and continued to be reduced until 1991 when all tariffs on meat products were finally eliminated except for some variety meats. However, in November of 1992 Mexico reinstated tariffs on chilled and frozen beef exports going to Mexico. Subsequently, the export of beef products to Mexico in 1993 were almost cut in half from 1992 (Figure 8).

Live cattle trade with Mexico is dominated by the flow of feeder cattle exports to the U.S. During 1995, nearly 1.38 million feeder cattle were imported from Mexico. A combination of factors related to the 1994 peso devaluation, drought in Mexico, and capital flight resulted in a surge of feeder cattle imports in 1995. In 1996, about 60% of the feeder cattle imports entered through Texas with the remainder entering through Arizona.

The price impact of Mexican feeders coming into the United States market is an issue that has been heatedly debated at times, particularly when United States cattle numbers are at the top of their cycle and feeder prices are depressed. Peel (1996) estimates that on average from 1988 through 1992, Mexican feeder imports



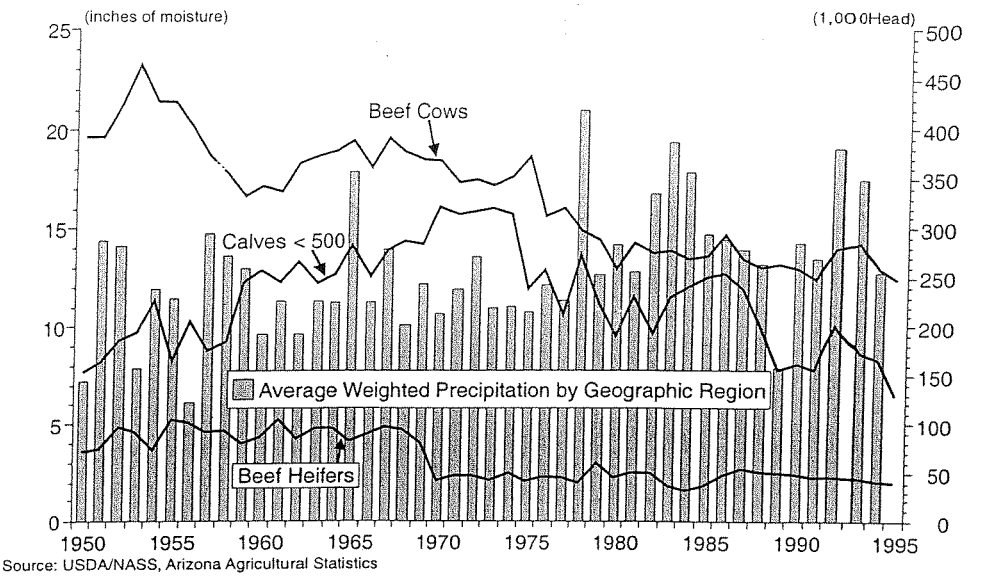
Source: USDA/FATUS

Figure 8. United States livestock and beef product trade with Mexico.

had the greatest impact on 181-227 kg steer prices. Their price was reduced by \$0.44/cwt. or \$1.98/head. Average monthly imports were 87,624 during this period. The highest monthly import level recorded for this period was 336,228 head for December 1986. At this level, the price of 181-227 kg feeder steers was reduced about \$2/cwt. or \$9/head. In general, Peel estimates that a 100,000 head increase in 181-227 kg steers for a month will decrease the U.S. price by \$.70/cwt.

9.5. Weather influences

Beef cow inventories don't fluctuate with moisture and subsequent forage availability nearly as much as the inventory of calves less than 227 kg (Figure 9). Adjusting calf numbers to available forage is generally the most attractive alternative. This is because in years of good precipitation and enhanced forage availability ranchers keep their yearlings rather than sell them and in poor years sell them. Yearlings provide the flexibility to adjust to changing weather conditions. This relationship is reinforced in years when corn prices are high and "excess rangeland forage" is available making heavier yearlings an attractive option. In the case of extreme drought, for counties in or adjoining a declared disaster area, certain federal tax exemptions allow for income from drought sales to be carried over to subsequent years when replacements will be bought. But this leaves the rancher in the



Source: USDA/NASS, Arizona Agricultural Statistics

Figure 9. Arizona precipitation and selected January livestock numbers.

situation of selling replacements when local prices are depressed by the large num ber of cattle for sale and buying replacements when prices are relatively high.

10. COSTS OF PRODUCTION

Estimates of the cost of production for livestock are notoriously difficult to mak because of the fragmented nature of the industry, and diversity in rangeland condi tions and production practices. However, USDA Economic Research Service (ER 1980-1993) does compile an annual cost of production estimate and return for west ern states. As previously discussed, Seperich et al. (1995) conducted a survey o 1989-1993 ranch returns and costs. Approximately 30 ranchers participated in thei study sponsored by the Grazing Land Valuation Committee. Fowler et al. (1994 surveyed western livestock operations in 1992 and also solicited cash receipts an expense data that included information from Arizona ranchers. A total of 4,57 usable responses were received with 277 coming from Arizona. In conducting study of alternative sale weights and market strategies, Gao (1996) built sale rev enues and cost of production estimates for Arizona from feeder prices, feed prices forage availability, and rates of gain and production practices described below. Gao (1996) used ERS annual cost estimates for the west for several of his cost estimate presented in Table 3.

ble 3
imated revenues and expenses for an animal unit year for Arizona, 1980 - 1993 (1993 dollars).

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1980-1993 AVG	1980-1993 SE	1980-1993 COV
VENUES — (1993 dollars)							$/AUY								$/AUY	$/AUY	%
ers	252.13	195.56	182.75	175.62	170.82	165.89	165.17	196.90	206.13	193.15	190.04	187.99	178.10	185.54	188.98	21.81	11.54%
fers	124.49	92.33	90.07	81.29	80.78	79.95	80.60	100.42	106.12	97.99	98.48	98.23	91.20	95.13	94.08	12.13	12.89%
l Cows	67.36	56.48	54.88	55.84	60.80	52.00	54.40	67.36	69.44	70.56	75.68	72.32	67.52	64.80	63.53	7.66	12.06%
TAL REVENUES	443.98	344.37	327.70	312.75	312.40	297.84	300.17	364.67	381.69	361.70	364.20	358.54	336.82	345.46	346.59	38.26	11.04%
RIABLE CASH EXPENSES (1993 dollars)																	
zing Fees (weighted Fed., State, & Private)	51.11	47.47	36.46	29.26	27.20	21.76	23.94	24.77	24.25	26.10	25.62	27.18	25.92	24.99	29.72	8.98	30.23%
tein Supplements	21.81	18.69	18.07	15.83	16.45	14.05	14.30	13.89	15.58	15.76	20.62	19.73	20.20	19.90	17.49	2.69	15.35%
& Minerals	2.69	2.71	2.73	2.68	2.52	2.54	2.55	2.49	2.40	2.40					2.57	0.12	4.76%
& Medicine	9.08	9.11	9.49	9.40	9.43	9.17	9.18	9.06	8.97	9.25	12.86	11.26	13.46	16.67	10.46	2.32	22.15%
stock Hauling	3.70	3.77	3.95	3.85	3.77	3.77	3.57	3.47	3.41	3.48	3.78	4.75	4.57	5.44	3.95	0.58	14.59%
keting	5.03	5.04	5.29	5.24	5.24	5.25	5.21	5.16	5.29	5.34	6.07	5.75	3.02	3.42	5.03	0.82	16.22%
ed Labor	33.55	32.59	31.88	31.40	30.47	29.91	30.50	28.69	29.06	29.04	39.52	39.22	40.13	38.11	33.15	4.25	12.81%
l, Lube, Electricity	27.28	28.03	25.55	23.41	18.86	17.91	14.39	14.15	14.13	15.47	17.33	17.73	15.76	16.16	19.01	4.94	26.00%
hinery & Bld. Repairs	26.04	26.28	27.59	28.07	26.21	26.35	26.11	25.45	25.67	25.50	20.67	20.82	20.72	20.81	24.74	2.71	10.95%
er											4.10	4.04	4.05	3.87	4.01	0.10	2.48%
otal Variable Cash Expenses / AUY	180.29	173.70	161.01	149.15	140.15	130.70	129.75	127.15	128.78	132.35	150.59	150.49	147.82	149.37	146.52	16.64	11.36%
ED CASH EXPENSES (1993 dollars)																	
eral Farm Overhead	40.01	34.34	31.45	28.44	34.93	30.33	38.87	50.10	31.49	31.73	42.52	33.03	32.48	42.85	35.90	6.12	17.04%
es & Insurance	29.37	22.88	22.46	21.81	18.65	17.41	22.74	30.68	31.75	32.03	19.20	16.27	16.06	20.21	22.96	5.72	24.91%
rest	86.64	74.51	73.38	66.38	67.36	59.89	53.01	54.28	62.77	57.82	67.67	54.36	46.14	53.68	62.71	10.77	17.18%
otal Fixed Cash Expenses / AUY	156.02	131.73	127.29	116.63	120.94	107.63	114.62	135.06	126.01	121.59	129.39	103.65	94.68	116.74	121.57	14.99	12.33%
TAL CASH EXPENSES	336.31	305.43	288.29	265.78	261.09	238.33	244.37	262.21	254.79	253.93	279.97	254.14	242.51	266.11	268.09	26.84	10.01%
URN TO NON-CASH FIXED ASSETS AZING PERMIT, MGMT, & RISK / AUY	107.67	38.94	39.40	46.97	51.31	59.51	55.80	102.46	126.91	107.77	84.23	104.39	94.31	79.36	78.50	29.46	37.53%
ED NON-CASH EXPENSES (1993 dollars)																	
ital Replacement	77.37	75.41	79.35	75.57	75.13	70.46	69.44	69.54	69.76	67.92	90.18	86.80	84.15	82.30	76.67	7.08	9.23%
rating Capital	15.74	18.77	14.66	10.96	11.83	8.80	5.68	5.92	7.35	8.32	20.37	13.67	9.18	8.60	11.42	4.62	40.50%
er Nonland Capital	51.85	44.53	40.97	37.02	28.23	25.77	26.14	29.49	31.80	32.88	33.58	34.24	35.10	32.66	34.59	7.20	20.83%
otal Non-Cash Expenses / AUY	144.96	138.71	134.98	123.56	115.19	105.04	101.26	104.95	108.90	109.12	144.13	134.71	128.43	123.56	122.68	15.34	12.50%
AL EXPENSES	481.27	444.15	423.27	389.34	376.28	343.37	345.63	367.16	363.69	363.06	424.11	388.85	370.94	389.67	390.77	39.38	10.08%
URN TO GRAZING PERMIT, MT., & RISK / AUY (1993 dollars)	-37.29	-99.78	-95.58	-76.59	-63.89	-45.53	-45.46	-2.49	18.00	-1.36	-59.90	-30.31	-34.12	-44.20	-44.18	34.20	-77.40%

' is animal unit year, AVG. indicates sample average, SE is the sample standard error, COV is the coefficient of variation or SE/AVG.
enues were obtained from Arizona prices for 181-227 kg steer and heifer calves, and cull cows. Other than grazing fees, cost estimates were obtained from ERS, cost of production estimates for
ern states. Please see text for details of production estimates.

The assumptions used to calculate revenues presented in Table 3 are: (1) The ranch sells 181-227 kg calves in the cash market every fall with steers making up 50% of the calf crop; (2) Heifers weigh 95% of the 204 kg steer weight and 40% of the heifer calves are kept for replacements; (3) Cow fertility is 85% and 5% of the calves are lost at birth, resulting in essentially an 80% calf crop; (4) Replacement heifers count against the total grazing allotment allowed at a rate of 0.7 AUM from the time they are weaned until they calf; (5) Cull cows weigh 454 kg when they are sold and cow death losses are 2.5% annually. The weight category of 181-227 kg calves was chosen because this weight category was found to be the most profitable target weight by Gao (1996) over the 1980-1993 period. Weekly market prices are Arizona specific and from USDA Agricultural Marketing Service (AMS) and Cattle-Fax.

Using the above assumptions, average revenues (1993 dollars) per animal unit year over the 1980-1993 period were $346.59, and $358.54 in 1991. These numbers are very close to the estimate of $338.33/AUY obtained by Fowler et al. (1994) in 1991 for Arizona. Seperich et al. (1995) report a range in annual revenues of $115 to $237 per animal unit, depending on ranch size. For the 1989-1993 period, average revenue for their nine different ranch categories is only $181 per animal unit, about one half of the other two estimates.

In Table 3, grazing expenses are calculated by weighting the proportion of federal, state, and private grazing hectares in the state with federal, state, and private grazing fees (Arizona Agricultural Statistics Service, various years). Under this method, state, private, and federal lands make up 33.4, 9.5, and 57.1%, respectively, of the grazing AUMs in the state (Mayes and Archer 1982). Because the private grazing fee was included for private lands, the grazing expense overstates "cash expenses" paid for grazing. However, no records are available on the amount of grazing that occurs for cash fee, the opportunity cost for private lands is the market grazing fee, and private lands are a small component of the total grazing bill with less than 10% of grazing lands private. Cash grazing expenses are estimated at $29.72/AUY using the above method, and make up 20.2% of total variable cash expenses estimated.

Hired labor is the largest component of variable cash expenses at $33.15/AUY, followed by grazing costs. Total variable cash expenses average $146.52/AUY. Adding fixed cash expenses associated with taxes, insurance, interest, and farm overhead bring total cash expenses to $268.09/AUY. This figure is very close to the $269.65/AUY of operating expenses reported by Fowler et al. (1994) for Arizona. Mark Browning from Farm Credit Services Southwest indicated that operating expenses should be kept in the range of $175 to $225/AUY (late 1990s prices), excluding payments associated with any land debt. Removing interest from the accompanying table brings the cost per AUY down to $205, within the range suggested by Browning (1997). Seperich et al. (1995) found operating expenses (including

interest expenses) to vary from $165.03 to $223.82 per AUY, depending on ranch size and carrying capacity.

The return to non-cash fixed assets, grazing permit(s), management, and risk is calculated at $78.50 for the 1980 to 1993 period. Non-cash fixed assets includes depreciation on capital items and the opportunity cost on capital items that the rancher owns. For example, if a rancher purchased a truck for $10,000 with cash out of his pocket and the truck has depreciated to $8,000 in value in 1 year, the rancher has a depreciation expense of $2,000 and another expense associated with the opportunity cost of his money. That is, the $10,000 used to buy the pick-up truck could be earning interest in a bank or a mutual fund. Assuming the opportunity cost of funds is 10%, the rancher has another $1,000 in expenses associated with "operating capital." Thus, even though the cash expenses associated with the truck were limited to fuel, repairs, license, and insurance, because the truck was paid for in cash, these other costs must be covered by the ranch operation over the long-haul.

11. RANCHER MOTIVES

Economic analysis of the behavior of private firms typically is based on the assumption that the firms wish to maximize profit. With regard to family owned ranches and farms, however, it has been recognized that the profit motive is strongly moderated by other goals and associated motives (Rodewald and Bostwick 1971). If profit is not the primary motivation of livestock grazers, then economic analysis of the consequences of alternative federal grazing policies and management options must be adjusted to this reality.

For family ranchers, a ranch may be both a source of dollar income from the production of livestock and a direct source of individual and family satisfaction. In other words, a ranch may provide both production and consumption outputs. To account for this duality, Smith and Martin (1972) suggested that in the economic analysis of ranches the concept of "satisficing" should replace the profit motive assumption. Satisficing refers to behavior that attempts to satisfy multiple motives or objectives but not necessarily to maximize any one of the objectives. For example, if the ranch is the family's sole source of income, profits must be sufficiently positive to maintain an acceptable economic standard of living. On the other hand, if outside income is available, then it may be used to support the family in their continued operation of the ranch and a lower, perhaps even negative, level of ranch profit is acceptable. The implications of the latter situation could be very significant for the levels of investment in range improvements that are acceptable to the rancher, for rancher reaction to increased grazing fees, and for the social acceptability of livestock grazing as a use of federal rangelands. In the 1960s, a number of

studies were done in Arizona (Martin and Jeffries 1966, Dickerman and Marti 1967, Martin and Gatz 1968) that indicated ranch sale prices were higher tha would be expected based on the rates of return that could be earned even afte taking into account possible tax and land appreciation factors. These findings le Smith and Martin (1972) to examine the goals and attitudes of Arizona ranchers They interviewed 89 ranchers with a survey instrument that included 33 attitudi nal items and various economic variables including a question as to whether or no the rancher would be willing to sell the ranch at the then current prices. Because o the low rates of return for Arizona ranches, those ranchers who responded with a "no" were considered to have motives for ranching other than or in addition to a profit motive. Those who responded with a "yes" were considered to be motivatec primarily by profits. Approximately 72% of the ranchers interviewed said they woulc not sell, indicating that profits were not a primary motivating goal for them.

To identify other motives, they used orthogonal factor analysis to extract 11 fac tors from the 33 attitudinal variables: (1) land fundamentalism, (2) family funda mentalism, (3) rural fundamentalism, (4) resource protection goal, (5) conspicuous consumption/speculative attitude, (6) income satisficing, (7) wealth satisficing (8) agricultural orientation, (9) immobility, (10) local orientation, and (11) local so cial satisficing. Discriminant analysis was then used to determine which factors and variables were most significant in correctly classifying the ranchers as between those who would sell and those who would keep their ranches. The three most important factors were land fundamentalism, conspicuous consumption/specula tive attitude, and rural fundamentalism. These three factors are mostly non-mon etary and show that ranch ownership for these ranchers is a source of consumption outputs, not just profit. Smith and Martin (1972) also found that the expectation that children would go into ranching and the availability of outside income influ enced whether or not ranchers would sell at current prices. At the time of the study, 80% of the ranch owners interviewed had outside jobs or other sources of income. According to a study of the economic characteristics of western ranches, the aver age Arizona ranch family of 3.3 members (Fowler et al. 1994) has 1.6 family mem bers who work off the ranch providing 53 percent of the total family income.

Another study looked at those factors that were important in the decision to con tinue ranching among Colorado ranchers with federal grazing allotments (Bartlett et al. 1989). Among these ranchers, social and attitudinal factors were just as im portant as the perceived ability to get another job and the difficulty of selling the ranch. Difficulty in selling the ranch and social ties were the factors most signifi cant in their association with the decision to remain in ranching. These were fol lowed by job mobility, profit, and family life on the ranch. Further, over half of these ranchers felt that rate of return on investment, one measure of profitability, "was of little or no importance" (Bartlett et al. 1989, p. 455).

It seems clear that multiple motives led most of the ranchers described in these studies to continue ranching despite low rates of economic return. These studies show that during the period between 1970 and 1991 ranchers had non-economic values and obtained social and psychological benefits from ranch ownership that offset the economic disadvantages of ranch operation. There are a number of factors that make it difficult to determine the more complex layers of non-economic values of Arizona ranchers. As members of an occupational group, ranchers are scattered, isolated, and sometimes resentful of outside interference. Persistent independence has caused many Arizona ranchers to resist governmental regulation and investigation, a factor that compromises the ability of government agencies to collect reliable data concerning rancher attitudes and values. In recent years, the individuals that participate in the economic activity of cattle raising have become increasingly diverse in background and attitudes, making it difficult to categorize them as members of a coherent occupational group or to determine their group non-economic values.

From the late 19th century through the 1960s, however, there are abundant source materials from which the non-economic values of ranchers can be determined. These sources include personal recollections of ranchers, minutes of professional association meetings, and publications of business and women's auxiliary organizations. Writers of reminiscences from the early part of this period often stated their perception that they were part of a disappearing way of life. They had witnessed the radical changes that took place as modern ranching with fencing and permit systems gradually replaced open range ranching. Many expressed a deep regret for the replacement of old-style ranch life by the "rapid development of the nation's resources in behalf of so-called progress" (Sharp 1974, p. 154). To document what they believed was a disappearing ranch culture, these writers described with great detail the family life, social activities, and daily work routines of humble homesteads with only a few head of cattle as well as large commercial ranches that ran 10,000 to 30,000 head.

The early recollections may be divided into three major groups: the writings of cowboys who worked for large cattle companies, writings of ranchers on owner-operated ranches, and writings by ranch women (both ranch wives and women ranch operators). Reminiscences of absentee ranch owners or wealthy outside cattle investors are rare and are not included here. Although all three types of recollections share general values, the writers in each group value different aspects of ranch life.

Cowboy narratives, (Benton 1943, Herron 1965, Moore 1965, 1974, Axford 1969, Sharp 1974, 1985, Durham 1992) describe the working operations of very large corporately-owned cattle companies, including the Cananea, the Chiricahua, the Erie, the San Simon Canal and Cattle Company, and the Aztec Land and Cattle Company. This group of writers value the adventure and freedom that the life of a

cowboy offered, the excitement of working enormous herds of cattle on the v unfenced rangelands, the comradeship of fellow cowboys, and the beauty of t land and its utility for stock ranching. Many of these writers, such as Sharp (197 who admiringly described the country as open, immense, and entirely owned two big companies, expressed a surprising degree of loyalty to efficiently operat large company ranches. The appeal of the cowboy life to others (Benton 19 Chrisman 1969) centered more in the freedom of movement and the variety of wo ing situations provided by the itinerant occupation. Herron (Chrisman 1969), w worked and lived in Mexico as a cattle-buyer, valued the interest of learning a other culture and language. In general, cowboy writers expressed a strong wo ethic, particularly taking pride in their knowledge of specific skills and in th ability to perform dangerous activities unknown to the vast majority of the popu tion. These writers also placed high value on humor, practical jokes, and the abili to meet hardship without complaint. Less prevalent in this set of narratives a sentiments of attachment to one particular location.

The second group of writers consists of ranch owners Ellison (1981), Flieger (199 Hislop (1965), Irvin (1984), Munk (1905, 1920), Rockfellow (1955), and Siebold (198 In contrast to cowboy writers, the owners expressed strong attachment to one pa ticular location, specifically to their ranch or homestead. They felt strong ties to th local community and its economy and were reluctant to relocate elsewhere. Amo the early writers were several individuals who had adequate financial resourc and business skills that enabled them to put together very large ranches. Althou they shared many values with non-ranching rural residents, these men perceiv of themselves as an exclusive and superior group, the aristocrats of the rural co munity. Many of them were economically and politically powerful and well co nected in the territorial capitol. J. A. Munk (1905), an easterner who caught th western fever, was the first president of the Arizona Cattle Growers Association. photographer and author of two books, Munk collected "Arizoniana" for 35 yea and donated his collection of 12,000 rare volumes to the Southwest Museum i Los Angeles.

More recent writings of ranch owners Flieger (1991), Cofer (n.d.), Hughes (1980 and Duncklee (1994) describe considerable hardship caused by low or negative r turns of ranch operations and the need to supplement ranch income with oth types of work. Yet these writers value ranching lifeways to such a degree that the expect their children to continue in the occupation and forego monetary opportun ties in other fields. This group of writers most closely expresses the attitudes tha Smith and Martin (1972) identify as "land fundamentalism" and "rural fundamen talism." They believe that ranching provides a higher state of total well-being tha any alternative mode of making a living. They value ranch ownership because permits them to feel closer to the earth. They value the ranch as a beneficial plac to raise children that instills rural values preferable to those derived from urba

life. They express strong ties to their local area, believe that agricultural occupations are superior to urban occupations, and respect the knowledge of the elder generation of ranchers, despite, or perhaps because of, their lack of formal education (also see Eastman et al., this volume).

Women writers, whether ranch operators (Bourne 1969, Wilbur-Cruce 1987), or

The publications of the organizations that represent the interests of the cattle industry provide the second category of documents for determining the non-economic values of Arizona ranchers. These documents include the publications of livestock associations, women's auxiliary organizations, and historical organizations. In 1903, members of the various local livestock associations that had been active during the late 19th century met in Tucson to form the first territorial association. The Arizona Cattlegrowers Association and local associations became powerful organizations. During the period prior to World War II, the publications of the association expressed the concerns and interests of ranchers as a group more directly because at that time Arizona's cattle industry had greater cohesiveness and political clout. The various cattlegrowers associations served as protective institutions attempting to maintain rangeland holdings for exclusive or primary use by members.

During the first two decades of its operation, the Arizona Cattle Growers Association published the full minutes of its annual meetings, including the discussions that led to resolutions. Discussions at the meetings focused on occupational education (dissemination of veterinary and nutritional information), reorganization of the cattle industry into a "modern" business activity, and representation of cattle grower interests with federal and state agencies. At the meetings, ranchers discussed controlling or eliminating sheep driveways, cooperating with the Forest Service on issuance of permits, reducing railroad rates, continuing the Biological Survey predator and rodent control program, preventing unauthorized cattle importation from Mexico into Arizona Territory, providing additional police control against rustling, and recording brands in a more systematic manner. Resolutions stressed cooperation with public agencies in writing grazing bills and stated the Association's preference for creation of a permit system to control excessive grazing on the public range.

Association minutes also reveal that members wanted to promote a public image of ranchers as "small-holders." Discussions stressed the democratic nature of the cattle industry and the democratic values of ranchers. The Forest Service supported these democratic values with a policy that gave preference in grazing permits to homesteaders and owners of small herds of livestock. At several Cattlegrowers meetings, Forest Rangers stated that support for "the small man making a living for his family" was a "fundamental principle" of their agency.

During the 1920s, the Association began publishing The Weekly Market Report and the Arizona Cattle Growers' Newsletter to supplement the minutes of annual meetings. By September 1945, the amount of economic information and ranch news had become so large that the Association initiated the Cattlelog as its official magazine. In addition to professional articles on livestock breeding, disease, nutrition, and marketing, the Cattlelog included several monthly feature articles that addressed the political and social interests of Arizona ranchers. "The American Way"

appealed to patriotic and religious sentiments, with articles by nationally famous writers such as Norman Vincent Peale and DeWitt Emery, president of the National Small Businessmen's Association. Following World War II, articles stressed the contribution of ranchers to the war effort, and during the Cold War articles, strongly critical of both fascism and communism, described Russia's economic failings.

Another standard feature in the Cattlelog was a monthly biography of a pioneer rancher. As an occupational group, ranchers expressed an unusual degree of interest in "old-timers" in the industry, in the history of ranching, and in their position as pioneer leaders in the territory and state. This high degree of occupational pride was influential in the establishment of organizations such as the Pioneer Historical Society and in a proliferation of small county organizations devoted to the preservation of pioneer and ranch history. The Arizona National Livestock Show produced a series of Ranch Histories as a project of the Arizona Living Stockmen Hall of Fame. The series, which honors pioneer cattlemen and provides detailed information on individual ranches, features ranch histories written by ranchers themselves. This series expresses the industry's high value for ranching lifeways and respect for individual pioneer ranchers. The sense of loyalty and pride within the cattle industry appears to be stronger than that of other industries, such as mining or farming, that have made equal or greater contributions to the economy and development of Arizona.

Finally, the Cowbelles, an organization of ranch wives and women ranchers founded in Douglas in 1939, became another voice expressing the attitudes and values of Arizona ranchers. The group evolved from a club devoted to providing social activities for isolated ranch women and their families into a national organization of ranch women promoting and supporting the cattle industry. In 1952 the Cowbelles became an auxiliary of the American National Cattlemen's Association. After the 1962 creation of the Arizona Beef Council, the Cowbelles worked with the state beef council "to promote the welfare of the livestock industry."

12. IMPACT OF PAST RESEARCH ON RANCH MANAGEMENT IN ARIZONA

When outlining the current state of knowledge about livestock management issues and the need for more research, should consideration be given to the impact of past research? How much of what is known has been applied? What determines which technology gets applied? Answers to such questions could help select research problems to focus on from the large set of potential research problems. In general, the impact from economic and range management research in Arizona has not been

documented. Although there is reason to think that while research has had an impact, there is still much room for improvement.

Economic research on range issues in Arizona, as in much of the West, has not significantly helped ranchers make better decisions. Torell and Tanaka (1990, p. 47) note that in the west:

> the biggest contribution economists could make would not be by increasing the complexity of their economic models but rather in providing answers to very basic questions dealing with the economics of alternative management options. Western livestock producers continue to make management decisions based on little if any direction from the agricultural economics profession as to economic feasibility.

Part of the problem is that providing answers to very basic questions is not likely to lead to tenure or advancement in research universities. A related issue is that there simply are not many economists working on ranching issues, and of those that do, the focus is on high profile regional or national policy issues such as grazing fees on public lands. As noted earlier, Arizona ranches are diverse. Supporting decision making at the ranch scale is prohibitively labor intensive. For economic research to have a greater impact on ranch management practices it will have to be integrated into ongoing rangeland science research to a greater extent than in the past.

Spreadsheet tools have been developed and are available to interested ranchers for a number of common ranch management issues through the National Cattleman's Association, Cattle FAX, and the Arizona Ranchers' Management Guide (1993). Some of the larger, more sophisticated ranchers have developed their own tools or purchased accounting tools to help assess the economic feasibility of alternative management options, but the proportion of ranchers doing so has not been documented.

Similarly, the economic costs and benefits of many range improvements are not well understood. Although there has been some success in developing improved range management technology, the adoption and overall technical and economic impact has not been documented. Collecting data on application of mechanical devices or animal science would be arduous. On the other hand, because so much of Arizona's grazed land is public land, it is possible to document, if not in great detail, the stocking rate and rotation system of much of the grazed land in Arizona, as ranchers must file management plans for their allotments. However, because the land is administered by several agencies with different objectives, that documentation is not consistent and to date no one has compiled the information from all of the agencies across the state. Efforts are made within each county to facilitate coordinated planning in areas where grazed land falls under multiple jurisdictions, and such efforts could be systematically documented across the state to assess the adoption of grazing systems. In some areas it would also be possible to assess the response of vegetation to different management systems, since a number of sites have been monitored for 5 to 20 years.

13. RANGE RESEARCH INSTITUTIONS IN ARIZONA

There are a number of facilities in Arizona with a long history of rangeland research. The world's first experimental range, the Santa Rita Experimental Range (SRER), was established in 1903 in southern Arizona by a precursor to the Forest Service (Martin and Reynolds 1973, Medina 1996). Many studies on diverse topics from grazing rotations to wildlife have been researched there under the management of the Forest Service. Now managed by the University of Arizona, the SRER has ongoing experiments on grazing systems, exotic plant species, small watersheds, fire, and wildlife. In addition to studies on the SRER, the School of Renewable Natural Resources at the University of Arizona has a research program with emphasis on range management, monitoring methods, revegetation, and ecological processes on rangelands.

At Arizona State University, rangeland research is conducted as part of the Environmental Resources Program. Research areas include rangeland and forest response to fire, improved rangeland monitoring methods, planning issues, rangeland wildlife issues, riparian area management, rangeland ecology, invasive species, and brush management.

In northern Arizona, there is a multi-state effort to address environmental problems on the Colorado Plateau, called the Colorado Plateau Forum, including livestock management issues based at Northern Arizona University (NAU). Most of the research on range issues is related to forested conditions in northern Arizona. Also located on the NAU campus, the Flagstaff Laboratory of the Forest Service's Rocky Mountain Research Station has performed much research on multiple use issues including the use of wooded areas for grazing. The Rocky Mountain Research Station was responsible for research on the SRER before that was turned over to the University of Arizona, but it is best known for research conducted on the Beaver Creek Watershed, relating to the hydrological responses to a number of management practices on forest lands, and especially reseeding and timber management methods (Baker and Ffolliott 1997).

The Bureau of Land Management, while not a research institution, encourages research on the land it manages, particularly the San Pedro Riparian National Conservation Area, which is of interest because the San Pedro is one of the few free-flowing rivers in Arizona. The San Pedro has extremely rich biodiversity, with important recreational uses, including birding and tourism, which have grown after the exclusion of cattle from the riparian area. The BLM also manages the Empire Ranch, near Sonoita in southeasern Arizona, which is intended to demonstrate how multiple uses, including ranching, can be accommodated on a grassland ecosystem.

Arizona also contains several specialized research areas. The Southwest Watershed Research Center of the Agricultural Research Service manages the Walnut

Gulch Experimental Watershed near Tombstone, Arizona. An extensive database c rainfall, runoff, and sediment movement has been accumulated since 1959, an numerous publications and simulation models have been developed using thes data (Southwest Watershed Research Center 1997). The Appleton Whittell Researc Ranch Sanctuary near Elgin, Arizona, managed by the National Audubon Society has been used to study the response of vegetation and wildlife after removing cattl from a high plains grassland (National Audubon Society 1996).

Also in southeastern Arizona, as well as southwestern New Mexico, the Malpa Borderlands Group is trying out new institutional relationships. Ranchers are work ing cooperatively with conservation groups to develop and implement better man agement practices with the aim of preserving both open space and ranching as a way of life. Although not a research project per se, the Malpai Borderlands Group is collecting data on the effects of management and has attracted national attention for its attempts to improve relations between environmental groups and ranchers, especially to promote the increased use of prescribed burning.

To build on the ongoing efforts in southern Arizona, the Natural Resources Conservation Service has proposed "Project 41" for Major Land Resource Area (MLRA) 41, Southeastern Arizona Basin and Range. They propose that MLRA 41 become a pilot study area because of its importance as a livestock grazing area, statewide and national interest in the area's resources, and the concentration of research areas in the MLRA. Barker (1996) estimates that of the roughly 300 ranches in MLRA 41, half have coordinated ranch plans in the work lists of the interagency planning groups. Including ranches on private land and those that only use land administered by one agency, perhaps 65% of the ranches have grazing management plans, and 75 to 80% have tried some form of grazing management. Because of significant invasion by woody species, it is unlikely that grazing management systems, by themselves, will permit the ecological restoration of this area, particularly on the semidesert grasslands (MLRA 41-3). Large-scale planning and coordination will be needed to increase the fire frequency to what are thought to be historical rates in this MLRA.

14. THE LINK BETWEEN RESEARCH AND RANCHERS IN ARIZONA

Arizona Cooperative Extension provides basic information to ranchers about past research. The information is generally available in the form of pamphlets, the Arizona Ranchers Management Guide (1993), seminars, and even over the Internet on the Arizona AgNIC World Wide Web site: http://ag.arizona.edu/agnic/range.html. Because of the increasing cost of personnel-dependent services and stagnant public funding for agriculture, new approaches to extension are needed that leverage extension efforts across many ranches.

The Natural Resources Conservation Service is another key player working with ranchers in Arizona. Although in some cases cost-share funding is provided, the NRCS emphasis is on technical assistance in voluntary cooperation with the rancher to develop a Conservation Plan. A planning process is used to relate an inventory of the rancher's resources and problems to his or her objectives, develop several alternatives, and have the rancher select and implement the management system. Monitoring is then performed to evaluate and adjust the plan as necessary. NRCS range conservationists believe that the key is to educate ranchers so that they understand the ecological relationships built into the plan.

One aspect of conservation planning that needs continued research is the development of an inexpensive, science-based means to estimate whether range resources are at risk. One research need is the development of methods to determine range health as suggested by the National Research Council (1994). The concept of Rangeland Health assumes that some easily measured changes can indicate that rangelands are at risk of crossing thresholds beyond which the system cannot be returned to its original state without excessive economic cost. Much research is needed to identify these thresholds and apply related ecological concepts to management of rangelands.

15. FUTURE RESEARCH NEEDS

Although there has been progress in many areas, we still do not have an in-depth understanding of the interrelationships of economic and ecological issues in rangeland management. William E. Martin, who was one of the most active agricultural economists in Arizona to study range issues, was quite clear that the lack of adequate biological data, in a form useful to economists, was a major obstacle to improved understanding of range economics in Arizona, and throughout the west. In surveying the history of range improvement research, he (Martin 1972, p. 133) noted that "a lot of people put in a lot of time trying to understand the economics of range improvement investment. They were relatively unsuccessful in their efforts not because of a lack of economic sophistication, but because the response data relative to improvement practices were almost totally lacking."

In a later article, Bernardo and Conner (1990, p. 33) conclude that "little has been achieved in increasing the availability of experimental data reporting vegetative improvement experiments and the limited transferability of their findings, future prospects for obtaining these data also appear limited."

Most of the cost and return estimates available for ranching are generated with an estimate for a general management input category obtained from a survey. These estimates are acceptable for providing generalizations of the industry but they usually fail to have the detail that is needed to evaluate how costs or revenues will

change if a different or new management practice is implemented. Building a ranc budget by documenting specific production practices and then expensing-out th cost of these practices will impact ranch profitability.

Biological data are often a limiting factor when trying to calculate the economi value of range and herd management issues with dynamic implications. For ex ample, the economic value of weaning calves at an early age during a poor gras year is difficult to calculate because the biological change in subsequent cow fertil ity has never been quantified. Biological issues are also compounded in complexit due to the wide variability in conditions from one year to the next and one ranch t the next ranch.

A myriad of biological data related to endangered species management is cur rently needed to satisfy the complex administrative relationships mandated in th ESA. Many of the administrative guidelines that regulate grazing management or public lands are related to habitat requirements for endangered species. Often thes requirements are only sketchy, based on assumptions or anecdotal data rather thar research. There is much to be learned about habitat requirements of endangerec species and the influence of livestock grazing on these habitats. In order to bette understand the potential impacts of federal rangeland management and grazing policy alternatives on individual ranchers, as well as the industry, research also is needed to determine what associations or relationships may exist between motives, attitudes and specific rancher behavior beyond the sell/not-sell dichotomy. For ex ample, some observers think that ranch infrastructure is declining in Arizona. I this is true, the decline could be associated with low rates of return and the lack of a strong profit motive. Ranchers could be drawing down on their infrastructure assets in order to satisfy their non-economic goals. Whereas, if they were motivated solely by profit, they would be more likely to discontinue their ranching enterprise. Research should be undertaken to measure the existing level of ranch infrastruc ture and trends in that level.

To fully determine the non-economic values of Arizona ranchers, research must focus on the collection of accurate data for both past and current values. This should include three categories of information: (1) solid economic data on bona fide com mercial ranch operations, (2) ranch heritage, and (3) lifeway values. The economic data should include average ranch size, number of employees, contribution to state tax base and to the local economy (from expenditures), level of federal dependency, profitability and percentage of ranches showing profits, ownership patterns (for private, state, and federal land use), and off-ranch income, including percentage of family income supplied by off-ranch employment. The second category should focus on ranch heritage, including the average length of operation of particular ranches (i.e., the number of years a ranch family has lived on one particular ranch),

continuation of ranching as an occupation within particular families (whether on the same ranch or not), level of formal education of ranch operators, and period at which secondary or off-ranch sources of income began.

The third category includes the compilation of a formal inventory of past non-economic values expressed in rancher reminiscences and the other sources presented here dating from the early part of century. A comparison can then be made between the inventory of past non-economic values with an inventory of current values to determine the degree of retention or change. This information would provide an explanation for actions contrary to purely economic values and would provide an evaluation of the degree to which current ranchers still hold to the attitudes described by Smith and Martin (1972) as "ranch fundamentalism," the group of separate but interrelated attitudes about family and rural values and land itself, which lead to the belief that cattle ranching provides a better lifeway and leads to a higher state of total well-being than any alternative mode of making a living.

16. SUMMARY

Ranching in Arizona is under economic pressure and public scrutiny as never before. A number of long-term trends are reducing the number of cattle in Arizona. As urbanization continues and the share of Arizona's economy in ranching drops, ranching is losing political influence. At the same time, the economics of ranching are such that many ranchers can continue ranching only by seeking work off the ranch and, perhaps, by underinvesting in long-term ranch infrastructure. Constraints posed by the dependence of Arizona ranches on public and state lands exacerbate these problems.

Uses of Arizona rangelands, other than for livestock grazing, are increasingly emphasized by an urban population with little tie to the land. Some of these uses, for example urbanization and increased recreational pressures, may negatively impact the value of the land for ranching.

In an attempt to follow the complexity of environmental regulations, state and federal agencies continue to constrain ranching practices. Much of this pressure is aimed toward public land grazing allotments. Resource disputes are quick to be litigated rather than attempting to seek management solutions. This regulatory burden, the uncertainty associated with public and state land grazing allotments, and the marginal economics are taking a toll on Arizona ranches.

On the other hand, ranchers feel strong ties to the land and the ranching lifestyle. There is much evidence that ranchers are willing to accept lower incomes than could be obtained elsewhere in order to live a ranching lifestyle, as well as published accounts reflecting on the value of a ranching lifestyle. With the associated character traits of independence and perseverance, it is likely that many Arizona

ranchers will stay in ranching as long as they can. Also in ranching's favor is the growing realization that the alternative to ranching in many areas is subdivision and the construction of "ranchettes" with the attendant loss of open space and habitat fragmentation. Given the diversity of ranches in Arizona, it is fair to say that although some information is available on ranching costs in Arizona, on the whole, they are not well understood. Nor, in general, do we have good grasp of production relationships, especially how management affects vegetation and how management affects the conversion of vegetation into beef. We have an even weaker grasp on how the activity of ranching provides utility to ranchers, although it is clear that the consumption aspects of ranching are a major motivation for many ranchers. Research is needed on these biological and socio-economic issues and on the possibility of longer term weather forecasting and in particular on the science basis for regulatory decisionmaking.

Ranching will continue in Arizona. Range livestock production is currently the single most important agricultural industry in Arizona. However, because of widespread dependence on state and federal land, the future of Arizona ranching is tied to the administration of these lands. In a strictly environmental sense, some level of livestock grazing is sustainable on most Arizona rangelands. Other considerations, reflecting social priorities, are likely to determine at what level ranching will continue in the state.

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