

9. Key Resource Management Topics

The following section offers brief overviews of several topics that are highly relevant to current and future forest management. The issues addressed in this section have been discussed throughout the assessment; however, this section offers a more detailed analysis of their potential impact on the socioeconomic environment surrounding the Kaibab National Forest (KNF). Forest planners from Arizona's six national forests identified these topics as being key to forest management. Although each topic can affect forests in distinct and varied ways and extents, it represents an issue of common concern to national forests and communities throughout the state. Where relevant, issues have been separated to identify their impact on the local, state, and national level.

9.1 Forest health

Maintaining and improving overall forest and ecosystem health is an important goal of the USFS. However, forest health is a complex and wide-ranging concept, and its exact meaning can be difficult to define. At the national level, the Forest Service has identified four key threats to the health of the nation's forests and grasslands:

- Fire and fuels,
- Invasive species,
- Loss of open space, and
- Unmanaged recreation. (USDA Forest Service 2005j)

Each of these threats, along with the trends associated with them and the implications for managing forest and grassland health, will be considered.

Fire and Fuels

Nationally, fire on NFS lands has been a subject of considerable attention. The Federal Wildland Fire Management Policy estimates that during the pre-industrial period (1500-1800), an average of 145 million acres burned annually in what is now the contiguous United States. Today, an average of about 14 million acres burn on both federal and non-federal lands. Nonetheless, wildland fire regimes and fire-management practices are a major concern for a wide variety of forest stakeholders, including Forest Service staff, recreational users, tribes, and neighboring communities. The White House Healthy Forests initiative describes 190 million acres of national forest land as dangerously susceptible to wildfires, and it states that ponderosa pine density is now fifteen times greater than it was 100 years ago (Office of the President 2002). Federal and state fire-management agencies have reported fires on over more than 5 million acres in five of the last ten fire seasons. During the 2000 fire season, these agencies reported 8,422,237 acres of wildland fire, a record in the more than forty years for which the National Interagency Fire Season has compiled data (NIFC 2005). These numbers pale in comparison to the fires experienced in the western United States before modern fire suppression techniques.

In the area of what is now Arizona, prior to Euro-American settlement in the 1800s, tree densities in ponderosa pine forests were maintained by two natural processes: competitive exclusion of tree seedlings by understory grasses and low intensity surface fires (Belsky and Blumenthal 1997). Large ponderosa pine trees (more than eighteen-inches in diameter) historically dominated the high-elevation forests. Historically, fires burned throughout the ponderosa pine ecosystems every two to ten years at low elevations and less frequently, and with more intensity, at higher elevations (Swetnam and Baisan 1996). Fire frequency began to decrease with the settlement of Euro-Americans and the removal of herbaceous

undergrowth by grazing livestock. Nevertheless, the last few fire seasons have provided several examples illustrating the costs, financial and otherwise, associated with the large wildland fires which continue to break out in Arizona. The Rodeo-Chediski fire of 2002, for instance, spread across over 450,000 acres of land, including over 170,000 acres of the Tonto and Apache-Sitgreaves National Forests. The costs associated with this fire surpassed \$40 million (USFS 2003d).

On the local level, the KNF, like any dryland forest or grassland, is itself no stranger to wildfires. Due in part to precipitation, an elevation change of almost 5,000 feet, and unique soil types, the KNF supports a rich variety of flora and fauna and, thus, fire regimes. Vegetation within the forest varies by elevation and exposure.

Table 42. Plant Community Types and Principle Plant Species in the KNF

Alpine forest	Ponderosa-pine forest	Piñon-juniper woodland	Mountain grassland
	Ponderosa pine Gambles oak Douglas fir sagebrush	Colorado piñon Utah juniper One-seed juniper cliffrose	Mountain Timothy Arizona fescue Mountain muhly Pine dropseed Black dropseed Needlegrass Mountain Brome Arizona wheatgrass Kentucky bluegrass

Source: Lowe 1964

The four predominant plant communities within the forest are alpine forest, ponderosa pine forest, piñon-juniper woodland, and mountain grassland (Lowe 1972). The ponderosa pine forests are typically homogeneous stands of ponderosa pine (*Pinus ponderosa*). Piñon-juniper woodland, one of the simplest plant communities in the state, covers an extensive area below the ponderosa pine forest and is typically observed at elevations of 5,500 to 7,000 feet. The mountain grassland occurs in very small unique areas, which are the natural openings on canyon bottoms or on ridge tops within the coniferous forests. These grassland areas are not suitable for tree growth due to unique soil types which have a high rate of moisture evaporation.

In 1998, the Williams Ranger District of the Kaibab NF began planning a ponderosa pine forest health restoration demonstration area that intended to apply thinning and prescribed fire treatments to these forests in order to restore more natural processes in the ponderosa pine ecosystem. The 1000-acre demonstration area is located east of Williams (USFS 2005m). In addition to the effects of fire on the pines, the study also addresses the effect of prescribed fire on fifty-four species of cavity-nesting birds endemic to the area (USFS 2004k).

The KNF suffered significant damage from infestations of western pine beetles in 2002-2003, registering piñon-juniper mortality on almost 160,000 acres and ponderosa pine damage on over 65,000 acres (USFS 2004d). Ongoing experiments in the forest are exploring the connection between bark beetle infestation and wildfire frequency and behavior.

Historical accounts of the Kaibab Forest often describe it as, “much more open and park-like than it is today,” with forest overstories composed of widely spaced trees growing in both even-aged and uneven-aged stands and understories made up of grasses, forbs, and low shrubs (Cooper 1960, Belsky and Blumenthal 1997). Today old-growth ponderosa pine forests are rare, and many large ponderosa pines have been removed by intensive logging (Noss, LaRoe, and Scott 1995). Through a combination of

grazing, logging, and fire suppression, the density of ponderosa pines within the KNF has risen from an estimated fifty-six trees per acre in 1881 to approximately 851 trees per acre in 1990 (GAO 1999c).

Elsewhere, increases in tree density like these have led to well-documented negative effects, including decreases in understory herbaceous cover and diversity, major changes in hydrological processes, decreased resistance to disease and insect infestation, and an alteration of fire regimes (Covington and Moore 1994, Allen et al. 2002, Belsky and Blumenthal 1997, Laughlin et al. 2004). Large, stand-replacing fires are increasing in number, size, and severity and now threaten many of the remaining ponderosa pine forests in the region (Allen et al. 2002). The effects of such severe fires in local forests and elsewhere have included short-term amplification of erosion and flooding (Allen et al. 2002).

The White House's initiative calls for aggressive thinning projects in Arizona and places much of the blame for the recent Rodeo-Chediski fire and other regional fires on overly dense forests and "nuisance" litigation (Office of the President 2002). Nationally, some researchers echo this claim, blaming environmentalists for creating an environment for apocalyptic wildfires while others join environmentalists in arguing that thinning projects that remove larger trees may actually increase the frequency and/or intensity of fires (Segee and Taylor 2002, Omi and Martinson 2002). On the local level, other citizen groups argue against what they consider a preoccupation with fuel-reduction projects at the expense of other protection efforts, such as a recent postponement of a project to protect Anderson Mesa (Eilperin 2004). Litigation has undeniably delayed, prevented, or changed some fuel-reduction projects. In the Kaibab area, for example, The Grand Canyon Partnership Assessment Project, which was scuttled by litigation in 2001, was replaced by smaller projects. However, several studies at the national and local scale have shown that the impact and scope of litigation on national forest logging plans has been substantially overstated (Cortner et al. 2003, Carter 2003).

It is important to note, though, that wildland fire has also proven to be a useful management tool in many areas. For example, the wilderness areas associated with the Gila National Forest in New Mexico now make extensive use of fire as a wilderness management tool, utilizing prescribed fire and naturally-ignited "wildland fire use" projects to help meet management objectives on more than 175,000 acres in 2003 (Madrid, pers. comm.).

Generally, wildland fire behavior is determined by several factors, including climate and weather conditions and the type, distribution, and abundance of fuels. Because other elements are difficult or impossible for managers to control, management efforts generally focus on changing the likelihood of ignition and the behavior of fires by modifying fuels. For a fire to ignite and burn, fine fuels must be abundant, and fuel moisture must be low (Wright and Bailey 1982, Wink and Wright 1973). However, the chemical and structural properties of fuels also greatly influence a fire's behavior. Particularly abundant or combustible fuels result in fires that are more intense and are more likely to show extreme behaviors, such as spotting firewhirls; crowning; and long, fast runs (Pyne 1997). Intense fires can threaten species and landscapes that are better adapted to slow-burning, low-intensity fires, such as some ponderosa pine forests, and extreme fire behavior can make cultural resources and developed areas more difficult to protect. Heavy surface fuels, such as thick needle layers, can result in long-burning, low-intensity fires while dry grasses are consumed very quickly. Understory shrubs and small trees can act as ladders, carrying surface fires into the crowns of trees (Graham, McCaffrey, and Jain 2004). The most common strategies for managing wildland fire are mechanical treatments¹, controlled fire treatments (used here to include both prescribed and natural-ignition "wildland fire use" fires), and direct suppression of fires.

Managers often also attempt to control human-caused ignitions. As of September 2004, more than 3,260 large, non-prescribed fires had been reported in Arizona and New Mexico. Humans caused 1,308 of these, affecting more than 62,000 acres (CLIMAS 2004, Sept.). Increases in human-ignited fires are likely due at

¹ Although mechanical treatments and fire use projects generally have the common goal of altering fuels to reduce fire intensity, they are discussed separately here because risks and benefits of each are substantially different. Many policies implicitly or explicitly favor one method over the other.

least in part to the increased population of the counties surrounding the national forests (discussed further later in this section). With increased population come increases in visitors and in potential ignition sources, including campfires, debris burning, and faulty vehicle exhaust (USFS 1999a). Increased population density also puts added pressure on forest staff to prevent or immediately contain wildland fires. Data for Arizona show that almost 130,000 homes (housing more than 300,000 residents) are at risk from fires (Morehouse 2001). In the wildland-urban interface, where human developments meet often highly flammable wildlands, fire on public lands can be a major concern for neighbors on private lands.

The focus of fire policy in Arizona is now shifting from fire suppression to fire management (CNF 2003b). The protection of life and property is always the first priority; however, forests also aim to protect and improve overall ecosystem health through fire-management practices. The 2001 Federal Wildland Fire Management Policy states that “the role of wildland fire as an essential ecological process and natural change agent” should be incorporated into the planning process (NIFC 2003). In addition, the more recent Healthy Forests Initiative has also emphasized that the “real solution to catastrophic wildfires is to address their causes by reducing fuel hazards and returning our forests and rangelands to healthy conditions” (Office of the President 2002).

One of the more controversial topics to come out of fire management in recent years is the use of post-fire “salvage” logging to extract some economic gain from burnt areas. Although salvage logging is generally considered to “rescue” any remaining economic value from the affected trees, recent reports have questioned the efficacy and benefits to the national forests of such enterprises. Forest Service documents suggest, for example, that such logging further disrupts the landscape, increasing soil erosion and disturbing wildlife, and can actually increase the likelihood of another fire (USFS 2003d, USFS 1999a).

Invasive species

The view held by some that ecosystem health has declined since the arrival of Europeans on the North American continent is linked in large part to a reduction in biodiversity; the falling population numbers of native species; and a concomitant explosion in non-native, invasive species (Ecological Restoration Institute 2005). Native species populations have fallen drastically under pressure from changing land uses and habitat fragmentation, but invasions of non-native species have been identified as the second greatest cause of species extinction (Vitousek et al. 1997). Pimentel, Zuniga, and Morrison (2005) estimate that approximately 50,000 alien-invasive species have been introduced into the United States, costing an estimated \$120 billion per year (including both damages and control efforts). Furthermore, nearly half of the species federally listed as threatened or endangered are in jeopardy primarily because of competition with or predation by non-native species.

Nationwide, invasive species affect forest ecosystems to the detriment of biological diversity, forest health, forest productivity, soil and water quality, and socioeconomic values (Chornesky et al. 2005). Researchers estimate that the roughly 360 non-native insect species that have invaded U.S. forests cost about \$2.1 billion per year in the loss of forest products alone. A similar amount is lost to non-native plant pathogens (Pimentel, Zuniga, and Morrison 2005).

In the Southwest regional scale, the 2002 bark beetle infestation in Arizona and New Mexico caused significant damage. The infestation was likely the result of a combination of factors, including drought and high tree density. This outbreak killed millions of Ponderosa pine and piñon trees, and mortality, which reached up to 90% at a few localized sites, was highly visible in some areas. 2003 brought an increase in juniper and Arizona cypress mortality, which was also partially attributed to bark beetle infestations (USFS 2004o). Statewide, the round-headed pine beetle actually decreased its impact area from 11,120 acres in 2002 to 4,530 acres in 2003. Almost all of the 2003 round-headed pine beetle damage occurred within the Coronado National Forest. Within the KNF, primary damage to the tree

population was caused by Ips beetle activity, which affected more than 64,000 acres of ponderosa pine and over 158,000 acres of piñon.

In the Southwest Region, annual grasses from Europe were unintentionally introduced through grazing and have changed fire regimes, increasing fire frequency, intensity, and extent (D'Antonio and Vitousek 1992). Likewise, invasions of cheatgrass (*Bromus tectorum*) and Lehman lovegrass (*Eragrostis lehmanniana*) in grassland ecosystems increase fire frequency and intensity. This can be particularly problematic when these invasions occur adjacent to dense forests that are susceptible to wildfire (Chornesky et al. 2005). In the spring and early of summer of 2005, above-average winter rains led to significant accumulations of grass and weeds in desert environments, which then carried several large human-ignited fires through desert ecosystems (Johnson 2005, Meahl 2005, Becerra and Pierson 2005). These ecosystems are normally characterized by high concentrations of succulents, which evolved with little or no fire and are poorly adapted to withstand it (D'Antonio and Vitousek 1992). Many non-native plant species also reduce forage quality. Forage losses due to invasive weed species have been estimated at nearly \$1 billion per year (Pimentel, Zuniga, and Morrison 2005). In the region just south of the Kaibab, invasive grass species have become a substantial problem. According to the USFS (2005d), 187,500 acres in the Prescott, Tonto, and Coconino forests suffer from invasive weeds, such as Dalmatian toadflax (*Linaria genistifolia*), which poses a substantial threat to native plant and animal populations. Recent decisions include projects intended to reduce the infestation of various species of invasive weeds through 14,000 acres of manual removal, 18,000 acres of mechanical removal, 14,000 acres of cultural removal and revegetation, 16,000 acres of biological removal, and 57,000 acres of herbicidal treatments with limited spray zones established within a mile of communities, recreation and scenic sights, and trailheads.

Invasive species threaten a wide variety of forest resources and uses, including both recreational and extractive uses. Chornesky and others (2005) suggest three complementary strategies for controlling non-native species invasions on forested lands:

- Prevent harmful new introductions by identifying and impeding pathways for invasive species introduction and spread,
- Detect and eradicate of invaders that elude prevention, and
- Engage in long-term management of well-established invasive species.

The U.S. Bureau of Entomology and Plant Quarantine, Forest Health Protection, part of the U.S. Department of Agriculture, provides technical assistance on forest health issues and focuses much of its attention on non-native insects, pathogens, and plants (USFS 2005q). Forest Health Protection provides a variety of services aimed at lessening the impacts of these invasive species, including management, monitoring, technology development, pesticide use guidance, and technical assistance programs. A joint project of the University of Georgia and the USDA, available at <http://www.invasives.org>, provides detailed information on a wide variety of invasive weeds, diseases, insects, and other species. The Forest Service has also developed the National Strategy and Implementation Plan for Invasive Species Management, which aims to “reduce, minimize, or eliminate the potential for introduction, establishment, spread, and impact of invasive species across all landscapes and ownerships” (USFS 2004o).

Loss of Open Space

Changing patterns in demography and land use (discussed in more detail in the following section) are leading to a loss of open spaces in U.S. landscapes. In the western United States, “exurbanization,” the shift of populations to semi-rural areas outside suburban areas, is a major contributor to this phenomenon. Much of the rapid growth currently sweeping the Rocky Mountain States is occurring outside of metropolitan areas on land that was previously used for grazing, agriculture, private forestry, and/or

recreation (Esparza and Carruthers 2000). The USFS has identified this fragmentation of forests and grasslands as a major threat to ecosystem health (USFS 2004n). Vitousek and others (1997) describe land transformation (including transformation of natural ecosystems to row-crop agriculture, urban and industrial areas, and pastureland) as, “the primary driving force in the loss of biological diversity worldwide.”

The negative effects of these changes are wide ranging and also include local and global climate changes, air pollution, sediment and nutrient runoff, the destruction of aquatic ecosystems, and a reduction in opportunities for outdoor recreation (Vitousek et al. 1997). The FS notes that, although the loss of open space through residential and commercial development generally increases land values and taxes, it also increases the cost of providing social services to local communities and undermines traditional and rural land uses (USFS 2004n).

A study of exurbanization in southern Arizona described how city- and county-level planning can inadvertently encourage exurban development by increasing the cost and complexity of residential development within the city limits and by promoting low-density development through zoning designations (Esparza and Carruthers 2000).

Increased Recreation at National Forests

In its Agricultural Fact Book, the USDA identifies the Forest Service as supplying more recreational activities than any other federal program. Given a rising involvement in wilderness recreation, the continuing availability of such opportunities is increasingly important (Cordell et al. 1999). Sixty years ago, public use of the national forests was limited, with only 600,000 visitor days in the state of Arizona. By twenty years ago, however, visitor days had increased to nearly fifteen million, making the national forests the main recreational resource in the Southwest (Baker et al. 1988). Today, the National Forest System is an impressive source of outdoor recreation, education, and involvement. Nationwide, more than 200 million recreational visits are logged annually, and the national forests provide 50% of the nation’s forested trail area and 60% of skiing opportunities (USDA 2002). In 1996, almost half of all hunters used public lands and one-third of hunting days occurred entirely or in part on public lands (Flather, Brady, and Knowles 1999). In addition, activities such as rock climbing have greatly increased in popularity although the inherent risks have caused park officials to consider special use fees to cover added ranger responsibilities surrounding climbing-related injuries (Cordell et al. 1999). In the KNF alone, there are between 400,000-700,000 visits each year, including 3,800-9,000 wilderness visits (Kocis et al. 2001a), making tourism (whether to the Kaibab, or, more commonly, to Grand Canyon National Park) one of the single most vital economic factors to the communities surrounding the forest.

In Arizona, access to recreational activities on federal- and state-protected land in Arizona is important and valuable. Over the past half-century, the demand for such outdoor experiences has grown tremendously nationwide. This change can be attributed to several trends, including an increase in leisure time and discretionary income and a greater appreciation for nature in response to growing urbanization (Clawson 1985). About 45% of registered Arizona voters frequently or occasionally go hiking while 40% go picnicking or animal watching. Whether fishing, off-roading, boating, hunting, visiting archeological sites, mountain biking, or horse riding, it is clear that a substantial portion of Arizona residents make use of the National Forest System at one point or another (Merrill 1998). For example, 93% of respondents in a Forest Service report on the Heber-Overgaard area of the Apache-Sitgreaves National Forests agreed that the availability of public lands for recreational activity was at least somewhat important, and nearly all of the respondents felt hiking should be allowed within reasonable parameters. 87% of the respondents even felt that off-road vehicles should have access to forests with only limited restrictions (USFS 1999a).

Several factors have influenced the rise of tourism in the Kaibab area since the inception of the forest. Along with national increases in tourism and outdoor recreation, proximity of the Kaibab to Grand

Canyon National Park is likely a major factor. Few people visited the area for recreation prior to the 1900s due to the rough travel and primitive accommodations. Tourism increased dramatically around the turn of the century with the development of the Grand Canyon Railway in 1901. This railway allowed tourists to travel to the area more quickly and in relative comfort. By the 1920s, sightseers were taking trips to the area to view the Grand Canyon in rapidly increasing numbers (Putt 1995). Many forest rangers were aware of the tourism in the area and committed themselves to public safety and convenience, installing interpretive signs and building trails and scenic roads. However, the problem of inadequate recreational areas persisted, and forest roadsides were frequently lined with campers. The most popular roadside sites deteriorated from overuse and were often lined with trash. This prompted Forest Service officials to develop centralized camping sites with trashcans at the sites (Putt 1995). By the 1930s, the number of visitors to the area had doubled and forest officials were developing many new recreational opportunities for visitors including reservoirs for canoeing and fishing (Baker et al. 1988).

Today, within the KNF, there are nine developed campgrounds. Despite the fact that water is not abundant within the forest, several man-made lakes near Williams provide water-related recreation as well as irrigation and drinking water to the area. Dogtown Lake is the largest reservoir in the area and Cataract Lake (a preferred area for bird watching) is the smallest. Fishing is currently permitted at all of the lakes within the forest boundaries, and campgrounds are available on each shore.

Given the rapid increases in Arizona's population, overcrowding may eventually be a growing challenge for the Kaibab NF; however, according to NVUM data, overcrowding does not seem to be a major issue for the KNF at present. Nearly 53% of the wilderness visitors interviewed in the 2003 NVUM survey stated that there seemed to be "hardly anyone else" present, and only 35% of visitors using developed overnight sites thought that overcrowding was "more of a problem than not," all of which reflects considerable progress from the early recreation history in the forest (Kocis et al. 2001a).

Nationally, a related issue that has drawn some attention recently is the use of recreation fees for public lands. Some users feel that such fees amount to double taxation, adding costs on top of the money donated in taxes, and that these fees discourage lower-income individuals from accessing the park. These arguments echo the ideas of Frederick Law Olmstead, the designer of New York's Central Park and an instrumental voice in the formation of America's national parks. For Olmstead, public open spaces oiled the gears of democracy by bringing disparate classes together. Nevertheless, fees remain relatively low, and studies have shown that the primary cost-incurring activities involved with visits to public lands are those related to travel and lodging (Grewell 2004). However, given that in 2001 nearly 87% of the wilderness visitors to the KNF were Caucasian (in a state with a 25% non-white population), the question of how fees might affect diversity on the public lands system merits some discussion (Kocis et al. 2001a).

9.2 Land and water resources

Previous sections have provided substantial information on recent demographic changes within the area surrounding Kaibab NF. Here, the focus is not on the quantitative nature of demographic change but on the qualitative characteristics of change likely to affect forest management.

Arizona is among the fastest growing states. The population in Arizona increased by more than a factor of four over the 1950-1995 period, and the demographic data within this report show that this trend exhibits no immediate signs of slowing. Some researchers predict another doubling in population between now and 2040 (Peart 1995). Also, older Americans, an increasing part of the population (one in eight people in the U.S. is now over 65 as opposed to one in twenty-five 100 years ago), are moving to the warmer climates of the south and west (Alig et al. 2003). As noted throughout this report, Arizona is also becoming increasingly "exurban" (that is, residences are spreading further from metropolitan areas and becoming more widely spaced), and the popularity of many outdoor recreation activities continues to rise. Previous descriptions in this assessment have shown how, as a result of these developments, many forests

are seeing a growing trend toward recreational use and “ecosystem services” (i.e., the management of public lands to provide services such as improved water quality, wildlife habitat, and clean air to surrounding communities) and away from extractive uses such as mining, logging, and grazing. Availability of land and water is a growing concern for Arizona’s rapidly expanding urban areas. Although national forests in the state are affected by urban growth to different extents, each will need to consider its role as a provider of open space and healthy watersheds. Livestock grazing, changes involving state trust lands, the increased utilization of forests’ water resources, and roadless area rules were identified by forest planners as points of particular interest.

Grazing

Livestock grazing has a long history in Arizona. The prominence of grazing in this area dates back to the middle of the 18th century, when Spanish explorers transported livestock into the region by way of Mexico (Allen 1989). Formal ranching began in the late 1800s following the Civil War and the widespread suppression of the local indigenous populations (Sheridan 1995). The U.S. government’s primary interest was in land acquisition until the 1850s. The distribution of lands to Anglo settlers began in earnest with the Homestead Act of 1862. Over the century following the Civil War (1865-1965), there was a 600% increase in the number of cattle in the western states. However, this transition was by no means linear. For example, the 1880s saw an immense boom in livestock numbers. Nearly a million head of cattle were reported in Arizona by the end of that decade, up from about 38,000 in 1870. However, a combination of environmental and economic pressures soon decimated the herds (and the range, which was devastatingly overgrazed by the mid-1890s), and by the end of that century, an estimated 50-75% of southern Arizona’s cattle had perished (Sheridan 1995).

Sheep and cattle grazing in the Kaibab area can be traced back to the establishment of the Beale Road wagon trail, completed in 1859 under the supervision of Lieutenant E.F. Beale. Ranchers used the Beale Road frequently during the early 1860s to drive their herds between New Mexico and California. Most areas that supported grass and sedge production were stocked with cattle and sheep (Belsky and Blumenthal 1997). Drought conditions in west Texas made Kaibab’s grass-covered hillsides, “a natural attraction for ranchers” (Fuchs 1952). Ranchers could legally graze their herds on any land outside of Indian reservations without any hindrance from the government. As in much of the Southwest, overstocking became a serious problem in the Kaibab area in the 1880s and 1890s, and sheep and cattle began consuming more grass than the forest could produce each year (Putt 1995). By the turn of the 20th century, livestock were having visible negative effects on grasslands and forests. Grazing by the domestic livestock removed grasses that had historically helped maintain cool ground fires and, as a consequence, the open “park-like” forests that were present prior to settlement became dense stands. Grazing further influenced the area by reducing fire frequencies, compacting soils, reducing water infiltration rates, and increasing erosion (Beymer and Klopatek 1992).

The establishment of forest reserves in Arizona during the late 1800s appeared to threaten ranching in the state. A report submitted by Gifford Pinchot in 1900, however, changed the fate of grazing rights on federal lands. In his report, Pinchot stated that livestock grazing was compatible with the major objectives for establishing forest reserves and was essential to the economy of the region. Based on Pinchot’s findings, the government began implementing the use of fees for grazing of private livestock on public land as early as 1901 (Putt 1995). As a consequence, when the Forest Service was established in 1905, they inherited the problems caused by decades of overgrazing. For this reason, a main focus of the Forest Service during the early years of operation was to work with ranchers to control existing herds and reduce any conflicts on the land. By the 1920s, however, continued damage by livestock was interfering with the range improvement programs initiated by the FS. As early as 1910, studies of range conditions were being conducted which indicated that overgrazing was seriously impacting the growth of ponderosa pine

(Putt 1995). Such conditions forced the Forest Service to impose a strict range improvement program in 1925, sharply reducing the number of livestock grazing permits issued within the Kaibab forest.

Nationally, in 1906, the Forest Service implemented the practice of collecting fees for grazing private livestock on public land. The amount of FS land devoted to livestock grazing has been stable over the past three decades, as has been the amount of BLM land (USFS 2000a). However, some studies have suggested that changes in land use will result in a decrease of grazing land in the Pacific and Rocky Mountain Assessment Regions (Mitchell 2000). At present, nearly 167 million acres of BLM land and 95 million acres of Forest Service land are allotted to fee-based grazing rights, the latter accounting for 65% of the entire National Forest System. Livestock graze over 90% of federal lands in the eleven Western States (Carter 2003). The forage grazed on this land accounts for about 2% of the beef-cattle feed in the continental U.S. and financially supports one-tenth of Western livestock producers, whose grazing fees continue to be charged based on the formula initiated by the Public Rangelands Improvement Act of 1978 (PRIA) (Cody 2001). The grazing leases provided by the Forest Service account for nearly one-quarter of the grazing land utilized by Arizona ranchers, and most Arizona ranching operations rely on one or more federal or state grazing permits (Ruyle et al. 2000).

The PRIA began the fee formula for the FS and the BLM on an experimental basis, but following continuing presidential and congressional support, it has remained the standard. Grazing fees have become controversial in part because the fee has increased only marginally from its inception and has not kept pace with the market rates. In 2002, for example, the grazing fee remained \$1.35 per AUM² on federal land, while the USDA estimated the average rate for grazing leases on non-irrigated private land among sixteen western states at \$13.50 per AUM (NASS 2003). Some citizen groups assert that this leads to disproportionate financial output by the Forest Service in the interests of grazing (Coalition 2001). In Arizona, for example, conservation groups note that the FS recently spent nearly \$250,000 to establish and maintain cattle fences and borders for land that generates only \$7,000 per year in grazing revenue as part of an attempt to protect Apache Trout and other threatened fish in livestock-impacted watersheds (Wolff 1999). Many groups also argue that livestock ranching interferes with other uses of the national forests

The National Forest System contains much of the summer range and a portion of the year-round grazing in the area, and as such, regional administrators help determine the success of southwestern livestock industries. However, ecological impacts of ranching, including the persecution of “problem animals,” the alteration of fire regimes, impacts to water supplies and riparian areas, introductions of exotic weeds, and the construction of fences and roads, can bring it into conflict with other uses (Freilich et al. 2003). Some argue that a balanced relationship between livestock grazers, environmentalists, and the Forest Service is important, even critical, given the continuing decline of grassland ecosystems, even critical (Baker et al. 1988).

Many proponents of ranching point to the social and economic benefits of rural lifestyles, arguing, for example, that “the best way to preserve the open spaces, arid ecosystems, and diverse biota of the Southwest is to keep rural people on the land” (Brown and McDonald 1995). Thus, ranching on public and private lands may also be seen as a viable method of limiting urban sprawl and promoting the economic independence and cultural uniqueness of rural communities.

State Trust land reform

The practice of allocating public lands for various beneficiaries in Arizona dates back to the founding of the territory in 1863. The current system of managing these lands, referred to as State Trust lands, was

² One AUM is defined as the amount of forage required by an animal unit (the equivalent of one 1,000 pound cow and her suckling calf) for a one-month period. Thus, the total number of AUMs is equal to the number of animal units multiplied by the number of months they are on the range.

established with the Arizona State Land Department in 1915. Since that time, the department has worked actively to manage these lands to help fund schools and other public institutions. In addition to original allotments granted by the federal government through Territorial and State Enabling Acts, the State Selection Board was allowed to select various lands throughout Arizona sufficient to ensure future financial support for selected beneficiaries. The selection of lands for state acquisition was completed in 1982 although most land selections were made between 1915 and 1960. Federal laws prohibited acquiring mineral lands or agricultural areas previously claimed by homesteaders, so the Selection Board chose lands with the greatest grazing potential. As a result, the majority of land selected between 1915 and 1960 was in central and southeastern Arizona with some additional “checkerboard” parcels near railroads in the north central portion of the state. Since that time, land exchanges have led to relocation of limited trust lands in western desert areas toward the region surrounding Phoenix and Tucson as well as western Yavapai County (AZSLD 2005).

Since its inception, the State Land Department has been granted authority over all trust lands as well as the natural products they provide. This authority over trust land is central to the AZSLD’s primary mission of maximizing revenues for its beneficiaries, a role that distinguishes it from other agencies charged with management of public lands (national parks, national forests, state parks, and the like). As of 2005, the AZSLD manages land holdings for fourteen beneficiaries, the most prominent of which is the K-12 public school system. The public schools currently hold 87.4% of State Trust lands. The vast majority of Arizona trust lands currently are intended solely for livestock grazing. However, the Urban Lands Act, passed by the state legislature in 1981, has allowed the State Land Department to capitalize on the increased value of trust lands surrounding the state’s rapidly growing municipalities. As a result, the department’s urban lands lease and sale program has become the largest revenue producer for the trust (AZSLD 2005).

Pressure for reform of the State Trust land system has been fed in recent decades by a relative scarcity of private developable land in areas that are continuing to experience massive population growth. Although various kinds of reforms have been proposed, the variety of stakeholders involved makes resolution a challenge. The competing interests involved include city and town governments and political lobbies representing educators, environmentalists, grazing interests, and homebuilders. Several cities throughout the state are striving to work with builders in order to ensure a sufficient supply of land for future housing. At the same time, educators would like to collect as much money as possible from the sale of trust lands in order to supplement limited financial support from the state legislature. Finally, environmentalists and ranchers have an interest in preserving lands for their conservation value and existing grazing rights. Despite continued efforts to reach a compromise among these interests, a number of proposed reform plans have thus far failed to pass from committee in the Arizona State Legislature (Nintzel 2005, Davis 2004).

At issue is the process by which the AZSLD takes advantage of increased land values for educational funding while still preserving sensitive areas for conservation in the face of increasing urbanization. Policy makers suggest that the impasse over proposed reforms for the State Trust Land System can be broken down into the following key issues, all of which have been viewed as “deal breakers” by one or more of the interested parties: 1) the amount of land available to be set aside for conservation; 2) open, competitive auctioning for grazing leases; 3) federal and state land exchanges; and 4) the composition of the State Trust Land Board (Sherwood and McKinnon 2005, Nintzel 2005, Riske 2005).

Legislators have balked at proposals favored by organizations such as the Sonoran Institute and Grand Canyon Trust that call for protection of nearly 700,000 of the state’s 9.3 million acres of Trust Land. Meanwhile, the Arizona Preserve Initiative, a measure that would allow the state to match payments from local jurisdictions to buy state land that qualified for open-space preservation, has been delayed by legal challenges to its constitutionality. Similarly, legal court challenges to State Trust Land reform have been posed by groups seeking to overturn the Arizona Supreme Court’s decision in 2001 that allows non-ranchers to bid on state grazing leases as well as a 1990 Supreme Court ruling which prohibits the state

from swapping parcels with federal agencies and/or private speculators. Finally, comprehensive reform of Arizona's State Trust Land system has also been held up by the education lobby's insistence that any reforms should be approved by a newly composed Board of Trustees charged with overseeing the management and disposal of trust lands (Sherwood 2005, Nintzel 2004).

These and other challenges have been addressed by various proposals for reform submitted by state lawmakers. As recently as October 2004, a coalition seeking the overhaul of state land management was "pronounced dead" after the facilitator resigned in the wake of failed attempts to pass a measure through the legislature. Still, Governor Napolitano, along with a number of state senators and representatives, remains committed to Trust land reform and aims to present voters with a reform package by the 2006 general election. Whatever the outcome, it should be noted that the ultimate resolution of these issues will likely have a significant impact on national forests in Arizona given the extent and value of State Trust lands in close proximity to forest boundaries (Davis 2004, Riske 2005). More information on the management of State Trust Lands by the Arizona State Land Department is available online at <http://www.land.state.az.us/>.

Water

The U.S. uses a lot of water, and the primary uses are not always obvious to the general public. Even though per capita public consumption of water resources has increased by 400% over the past century, less than one-tenth of total freshwater removal is utilized in the areas most often considered under "primary water use": domestic and private use. The judicious use of water resources is particularly important in the West, and water is an immediate and everyday concern to Arizona residents. The National Forest System in the state is central to the question of water resources. Although USFS lands account for only 14% of the total land area, those lands contain 40% of the region's water resources (Baker et al. 1988). In fact, national forests and grasslands function as the largest provider of water in the continental U.S., containing nearly 10 million acres of wetland and riparian areas and the headwaters of 15% of the nation's supply of water. These resources, valued at billions of dollars, supply water to more than 60 million people and provide opportunities for recreation, preservation, and employment (Schuster and Krebs 2003).

Regionally, below-average precipitation over the past several years has once again brought water to the forefront of natural resource management concerns. According to the U.S. Geological Survey, the period following 1999 is the driest in the hundred years that the Colorado River has been monitored. That river supplies 25 million people in seven states with water (USGS 2004, CRWUA 2005, Pontius 1997). In Arizona in particular, low rainfall has led to periodic drops in water levels in nearly all the primary reservoirs. Statewide, although Lake Mohave and Lake Havasu raised their levels by 1% and 3% respectively over the second half of 2004, other reservoirs dropped precipitously. The Salt River system dropped 8% against the maximum storage level, and Lyman Reservoir dropped 16%. By early 2005, both Mohave and Havasu had already returned to the previous, lower levels. Above average rains last winter, however, have had a profound effect upon Arizona's primary reservoirs with four at over 90% capacity and nearly all at higher levels than the year before. Two of the watersheds surrounding the greater Kaibab area show the discrepancies within the state. The Verde River System was up to 99% of capacity by May of 2005 although it had returned to 90% by June, while the Lake Powell reservoir further north remained at between 35-43% of capacity, well below its average. The capricious nature of Southwest precipitation is one of the aspects that make management of water resources particularly difficult in this region (CLIMAS, September 2004-June 2005).

Much of the previous years' water worries can be attributed to below-average precipitation starting in October 2003. Below-average snow-pack in Payson, Arizona, has caused that community, and many others like it, to implement programs aimed at conserving water. The Salt River Project Board of Directors, which instituted cutbacks in residential, agricultural, and municipal use for 2005, has taken

similar precautions. That was the third straight year such methods were implemented (CLIMAS, September 2004; CLIMAS, February 2005).

Although the Kaibab Forest stays relatively cool and receives a large amount of precipitation, surface water is uncommon because of the porous nature of the Kaibab limestone which caps much of the plateau. The lack of obvious surface water has led some to refer to it as “the green desert” (Martin 1985). The majority of the forest soils are shallow and susceptible to erosion. Since reliable water sources are scarce in the area, water has been a controlling factor in the establishment of transportation routes and settlement (Putt 1995). While the government has contracted research organizations to investigate the possibilities of developing a water pipe across the Coconino Plateau which would transport water from Lake Powell and the Grand Canyon Dam as far south as Phoenix, these plans have not translated into any large-scale action to date (Heffernon and Muro 2001).

Watershed pollution also remains a concern in the region. In 1993, Pinto Creek suffered environmental damage from a breach in containment at a tailing waste levee. Acid drainage and other chemical byproducts of the mining industry also pose dangers to recreational and fishing activities on public lands (Peart 1995).

Active management of the water resources on public and private lands is a complex and multifaceted endeavor. Considering the value of water resources on forest service lands, continuing such management activities while working in partnership with tribal and other nongovernmental agencies is, in the words of Schuster and Krebs (2003), “simply good business.”

9.3 Forest access and travel

Earlier chapters discussed forest access and travel, focusing on the transportation characteristics of communities surrounding the Kaibab National Forest. This section provides a detailed assessment of recent interpretations of the Roadless Rule and current trends in OHV use—two internal access issues that are of particular concern to many forest planners and that are likely to have a significant impact on future forest planning.

Roadless areas in the National Forests

The larger roadless areas in national forests have long received different treatment than more developed areas. Through Roadless Area Review and Evaluation (RARE) studies, these areas have been inventoried and their wilderness characteristics considered for potential designation as wilderness under the Wilderness Act of 1964 (Baldwin 2004). The National Wilderness Preservation System is comprised of federal lands, “where the earth and its community of life are untrammelled by man, where man himself is a visitor and does not remain” (16 USC 1131 et seq.). Wilderness areas are designated only by Congress and are generally protected from commercial enterprises, road construction, mechanical vehicles, and structural development.

Roadless areas provide a variety of social and ecological benefits, and these unfragmented lands have become even more important as unprotected areas are increasingly developed and converted to urban uses. Among other benefits, they provide clean sources of drinking water and help prevent downstream flooding, protect threatened and endangered species, provide a wide variety of recreation opportunities, and serve as barriers against invasions of nonnative species. The KNF includes approximately 53,000 acres of inventoried roadless areas (IRAs) (USFS 2001c).

In 2001, the Forest Service published a final rule that prohibited several activities in IRAs. These activities were prohibited because they threatened to diminish the areas’ suitability as designated wilderness (USFS 2001b). With significant exceptions, road construction and reconstruction and timber

cutting were prohibited in IRAs. Implementation of this rule was administratively delayed, then enjoined, by two separate Federal District Courts and remains enjoined under appeal (Baldwin 2004). Subsequently, a new rule was adopted by the USDA on May 5th, 2005 that provides individual states with significant flexibility in managing IRAs by allowing governors to petition the Secretary of Agriculture to create special, state-specific rules (USFS 2004g). According to a report from the nonpartisan Congressional Research Service, the new rule suggests that IRAs “would be presumed available for a variety of uses, including timber harvests, subject to unit-by-unit planning processes” (Baldwin 2004).

Off Highway Vehicle (OHV) access

Historically, recreational use of the forests was non-motorized except on major forest roads. Beginning in the 1980s, however, the use of motorized recreational vehicles significantly increased (USFS 1999a). Currently, 1.1 million Arizonans, slightly more than 20% of the state’s residents, identify themselves as motorized trail users (USFS 2003a, Arizona State Parks 2004). The popularity of OHVs creates yet another challenge to the FS’s commitment towards balancing recreational use and forest health. OHV use can provide substantial economic advantages to the surrounding communities. According to Silberman (2003), OHV users spent a combined \$580.3 million in 2002 in Coconino, Yavapai, and Mohave Counties alone, representing \$28.9 million in state tax revenue. However, a number of studies have shown that OHV use also poses a threat to resources through trail deterioration, vegetation damage, reduced air and water quality, noise pollution, wildlife disruption, and social conflicts arising between different groups of recreational users such as hikers or bikers.

This, combined with the increased problems caused by illegal use, makes managing OHVs a topic of importance to the forests (Stokowski and LaPointe 2000, Bluewater Network 1999). In response, the KNF and four other Arizona national forests initiated a five-forest amendment for OHV travel. Still in the early stages at the time of this assessment, the Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto National Forests adopted a Draft Environmental Impact Statement (DEIS) that proposes limitations and/or restrictions on cross-country travel by OHV users on lands managed by the five forests. Several issues need to be resolved before these amendments can be adopted into existing forest plans, among them the feasibility of enforcing new OHV restrictions and the right of entry for individuals into certain areas for the purposes of cultural practices, fuelwood gathering, or retrieval of big game (USFS 2003a, USFS 2003c, Arizona State Parks 2004). Only the Coronado NF is not a party to the proposed amendment, having previously established forest rules regarding cross-country travel. Contrary to existing regulations in the KNF and other forests in Arizona, areas within the Coronado are considered closed unless otherwise posted. This has effectively prohibited the cross-country travel by OHVs that the five-forest amendment currently seeks to address.

A review of the FS-wide policy regarding OHV travel is also taking place at the national level. The draft national OHV policy, published in July 2004, would require forests to designate a system of roads and trails for OHV use. This process will likely require a considerable amount of time, personnel, and financial resources to complete (Roth, pers. comm.).

10. Summary of Key Findings and Recommendations

The communities surrounding the Kaibab National Forest (KNF) have undergone substantial social and economic changes over the past twenty years. The purpose of this assessment has been to illustrate some of the more dramatic trends in key indicators and discuss their likely implications for future forest planning and management.

Among the most noteworthy trends in the area of assessment is a significant increase in population over the past two decades. Data show that overall population within the five counties surrounding the KNF increased by 134 percent between 1980 and 2000 with the strongest growth occurring in Washington, Mohave, and Yavapai Counties. Within this overall increase, growth in the retirement-age population and an upsurge in individuals of multiple race and Hispanic origin were particularly strong. Along with increases in population, the area witnessed a substantial growth in housing, including homes intended for seasonal use. Together, these trends warrant careful consideration by forest planners. Ultimately, a larger and more diverse population suggests not only an increased number of potential forest users but also a change in the level and nature of interaction between the KNF and surrounding communities.

The economies of northern Arizona and southern Utah are also likely to have a substantial impact on future planning and management of the KNF. Data suggest that economic growth in the region has been relatively strong, supported in part by strong gains in total part- and full-time employment in Washington and Yavapai Counties. The most significant economic gains between 1990 and 2000 were reported for the construction, wholesale trade, and finance and real estate sectors. Despite significant increases in per capita and family income and decreasing rates of poverty, data show that each of the counties within the area of assessment remain economically limited when compared to statewide figures over the same period. Meanwhile, recent indicators of dependence on natural resources have shown mixed results. As a whole, the area of assessment experienced a decline in income from wood products and processing and a relatively slight increase in income from special forest products and processing between 1990 and 2000. Over the same period, four of the five counties within the area of assessment reported strong gains in tourism employment. Although activities such as ranching and timber harvesting continue to play an important role in rural areas, recent years have seen a continued shift away from extractive industries and toward a regional economy that is increasingly dependent on the construction, real estate, and service sectors supporting growing urban populations. When combined with ongoing demographic changes, such factors are likely to have a direct impact on the KNF's role within the local and state economy.

A review of county comprehensive plans and long-range policies has demonstrated the importance of both travel patterns and land use characteristics surrounding the KNF. Though road conditions have generally improved over the last several decades, research shows that expansion of regional road networks has not kept pace with travel demands arising as a result of population and industry growth. Furthermore, previous transportation planning has not always been implemented in a way that supports long-range land use plans. Such plans reveal that the preservation of open space, the sustainable use of natural resources, and the use of public lands are of growing importance to regional planning authorities, government agencies, environmental advocates, and community residents. Increasing land values, the cost of infrastructure development, and limited water supplies are among the numerous factors that have made policy formation increasingly contentious in recent decades. The KNF has an opportunity to play an important role in the resolution of current and future transportation and land use issues by promoting sustainable regional planning policies, informing local stakeholders of the environmental and economic impacts of transportation and land use alternatives, and effectively involving surrounding communities in forest planning and management.

Concurrent with trends in the regional economy, there has been a measurable shift away from extractive uses of national forests. This trend is supported by national surveys showing continued declines in timber harvesting as well as recent data on KNF that suggest a ninety percent decrease in sawtimber permits on

forest lands between 1990 and 2000. These same reports point toward a substantial increase in recreational uses of national forests in general and the KNF in particular. Data suggest that a significant increase in the use of OHVs is a primary reason for the Forest Service's growing concern over unmanaged recreation. These trends are consistent with the recent expansion of communities with high levels of natural resource amenities and signal a shift in the perceived role of forest lands. The KNF has the opportunity to incorporate these data on changing forest users and uses into future forest plan revisions and management priorities.

Although the incorporation of "special places" into forest management plans is a relatively new phenomenon, the KNF has designated nearly 150 natural, cultural, and recreation sites within forest boundaries. Forest archeologists and recreation staff have also cooperated with leaders of regional Native American tribes to identify and protect sites throughout northern Arizona that are considered special for their cultural and spiritual values. Recent events such as the proposed expansion of the Arizona Snowbowl and proposed developments near the Grand Canyon have highlighted the importance of "special places" as a key factor in forest planning and community relations. In the future, the KNF should continue to seek public input in identifying special places and planning for their protection.

Regional trends and Forest Service planning regulations have influenced the relationships between the KNF and surrounding communities. In particular, the protection of wildlife, prevention of forest fire, sustainable management of area watersheds, and the provisional land use policy have involved a diverse array of stakeholders. In recent years, growing attention has been paid to these issues given the general public's expectation for adequate participation in decisions affecting public land management. Although such relationships are inherently unique and dynamic, specific frameworks for monitoring and improving community-forest interaction may aid future KNF management objectives.

Finally, data suggest that a number of natural resource issues will continue to influence future management alternatives of the Kaibab NF. The control of invasive species, management of fire and fuels, preservation of open space, and protection of regional biodiversity each carries important implications for future forest plans. Although an exhaustive analysis of these issues is beyond the scope of this assessment, research shows that each will be significantly impacted by ongoing socioeconomic trends.

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Appendix A. Industry Sectors for IMPLAN Data Analysis

Income from wood products and processing	
NAICS Sector	
133	Logging camps and logging contractors
134	Sawmills and planing mills
135	Hardwood dimension and flooring mills
136	Special product sawmills
137	Millwork
138	Wood kitchen cabinets
139	Veneer and plywood
140	Structural wood members
141	Wood containers
142	Wood pallets and skids
144	Prefabricated wood buildings
145	Wood preserving
146	Reconstituted wood products
147	Wood products, N.E.C.
148	Wood household furniture
152	Wood T.V. and radio cabinets
154	Wood office furniture
157	Wood partitions and fixtures
161	Pulp mills
162	Paper Mills-Except Building Paper
163	Paperboard Mills
164	Paperboard containers and boxes
165	Paper Coated & Laminated Packaging
166	Paper Coated & Laminated N.E.C.
168	Bags-Paper
169	Die-Cut paper and Board
170	Sanitary Paper Products
171	Envelopes
172	Stationary Products
173	Converted Paper Products N.E.C.

Income from special forest products and processing	
NAICS Sector	
22	Forest products
24	Forestry products
26	Agricultural-Forestry-Fishery Services

Tourism employment*	
NAICS Sector	
Retail	
449	General Merchandise Stores
450	Food Stores
451	Automotive Dealers and Service Stations
452	Apparel & Accessory Stores
455	Miscellaneous Retail
Restaurant / Bar	
454	Eating and drinking
Lodging	
463	Hotels and lodging places
477	Automobile Rental and Leasing
Amusements	
486	Commercial Sports Except Racing
487	Racing and Track Operations
488	Amusement and Recreation Services
489	Membership Sports and Recreation Clubs

* Discounted according to the Travel Industry Association of America Tourism Economic Impact Model (TEIM). TEIM attributes the following percentages of gross sales to tourism: lodging (95%), restaurant/bar (23.62%), retail (10.91%), and amusements (6.43%).

Source: Arizona Tourism Statistical Report 2003, Arizona Office of Tourism (AZOT)

Appendix B. Indirect Economic Effects of Forest-Related Products in the Kaibab National Forest

Output, Value Added and Employment

July 26, 2005

Base Year: 2002

Industry	Industry		Employee	Proprietor	Other Property	Indirect	Total
	Output*	Employment	Compensation*	Income*	Income*	Business Tax*	Value Added*
1 11 Ag, Forestry, Fish & Hunting	230.600	2,235.375	15.833	5.137	15.900	6.520	43.390
19 21 Mining	172.418	1,404.143	52.761	-9.431	39.485	7.320	90.135
30 22 Utilities	202.274	718.374	40.040	3.561	60.178	19.090	122.868
33 23 Construction	2,634.775	25,593.155	694.942	188.214	94.962	11.618	989.736
46 31-33 Manufacturing	1,973.479	11,319.464	433.326	42.200	214.726	14.581	704.833
390 42 Wholesale Trade	459.634	4,579.295	173.356	10.531	72.285	76.601	332.773
391 48-49 Transportation & Warehousing	881.053	7,494.879	293.531	40.504	61.145	26.401	421.582
401 44-45 Retail trade	1,782.286	33,349.889	701.171	109.194	268.206	262.330	1,340.901
413 51 Information	450.487	2,978.384	93.431	12.600	73.770	15.569	195.369
425 52 Finance & insurance	637.100	5,006.611	152.326	21.934	162.090	13.215	349.566
431 53 Real estate & rental	820.562	9,368.800	78.688	75.869	308.281	76.498	539.336
437 54 Professional- scientific & tech svcs	541.361	7,896.817	184.640	147.434	53.954	6.844	392.871
451 55 Management of companies	37.940	437.241	15.677	0.724	7.335	0.389	24.124
452 56 Administrative & waste services	398.085	8,568.749	145.054	31.076	35.971	8.101	220.202
461 61 Educational svcs	111.677	2,919.097	60.158	-0.494	1.997	0.740	62.400
464 62 Health & social services	1,674.821	24,568.317	773.300	102.106	98.098	12.629	986.133
475 71 Arts- entertainment & recreation	245.661	4,799.122	72.321	16.235	20.855	13.596	123.006
479 72 Accommodation & food services	1,043.385	26,494.988	352.332	22.458	98.773	60.014	533.577
482 81 Other services	725.485	15,169.352	255.355	65.672	14.490	9.554	345.071
495 92 Government & non NAICs	3,062.439	33,130.598	1,450.911	0.000	1,096.817	140.940	2,688.669
Totals	18,085.522	228,032.651	6,039.154	885.525	2,799.317	782.549	10,506.544

*Millions of dollars