Managing Pinyon-Juniper Ecosytems as Nut Groves:

A Path to Sustainable Management

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Abstract

Pinyon trees are the dominant overstory species on more than 36 million acres of land in the southwestern United States. Once considered weeds by rangeland ecologists and removed by the millions from the best growing sites in the Southwest between 1950 and 1980, pinyons are now recognized as critical elements of healthy pinyon-juniper ecosystems. However, a century of fire suppression and overgrazing created abnormally dense thickets of pinyon trees on sites that were unaffected by mid-20th century pinyon clearing programs. A prolonged drought during the 1990s increased the vulnerability of these trees to insect attacks, leading to the death of large numbers of pinyon trees in Colorado, New Mexico, and Arizona during the early 2000s. These dead trees, as well as the remaining live pinyon trees, are at extreme risk from wildfires.

The Bureau of Land Management and the U.S. Forest Service are now faced with the necessity of restoring vast acreages of pinyon-juniper woodlands to conditions less conducive to large-scale intensive fires. In order to achieve this objective, this report argues that the two agencies should seriously consider actively managing these ecosystems for pinyon nut production. We develop our argument based on a review of the literature on pinyon-juniper ecosystem management, together with data obtained through phone interviews with land managers, scientists, extension agents, and pinyon nut buyers. Although our study emphasizes the pinyon nut harvest in Colorado, the spatial and temporal variability of the pinyon nut crop required us to examine the workings of the pinyon nut industry at regional and international scales.

The data indicate that the pinyon nut industry continues to thrive in the American Southwest, despite the loss of large acreages of the most productive nutbearing trees during the conversion era from the early 1950s to the early 1980s. Additionally, although competition from pine nuts imported from China and countries in the Mediterranean is strong, the likelihood is high that demand for American pinyon nuts will continue to expand for the foreseeable future. The ecological and archeological literature indicates that managing pinyon-juniper ecosystems for nut production is highly compatible with multiple use forest management, and in the long term would likely greatly reduce the incidence of high intensity fires. Additionally, many of the recommended best management practices for enhancing pinyon nut production can be easily incorporated into on-going ecosystem restoration programs.

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Introduction

Pinyon-juniper woodlands cover more than 36 million acres of the southwestern United States and intermontane West (Shaw et al. 2005). As reflected in their name, the dominant overstory species in these woodlands are pinyon pine trees (one or more species of six species) and juniper shrubs (one or more species of four main species). The species of juniper and pinyon present and the particular mix of species vary depending on factors such as latitude and longitude, elevation, annual precipitation, topography, and soil and air temperature. In Colorado, where pinyon-juniper woodlands cover 4.8 million acres and make up 22 percent of the state's forests (see figure 1), the common or Colorado pinyon (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) are the dominant overstory species. The majority of Colorado's pinyon-juniper woodlands--75 percent--are managed by the Bureau of Land Management; the rest are mostly on state or private land (Benson and Green 1987).

Once considered weeds by rangeland ecologists and removed by the millions from the best growing sites in the Southwest between 1950 and 1980, pinyons are now recognized as foundation species in pinyon-juniper ecosystems. Foundation species provide core ecological structures and functions, stabilizing local environmental conditions in ways that permit numerous other species to thrive (Sthultz et al. 2007). Removal or death of a large percentage of a foundation species population leads to rapid loss of biodiversity and serious negative impacts on the ecosystem's overall health.

Large numbers of pinyon trees in Colorado and neighboring states died during the severe and prolonged drought conditions that occurred in the Southwest during the1990s. The mortality rate worsened between 2001 and 2004 as many trees that were weakened from prolonged

moisture stress succumbed to the Ips bark beetle (*Ips confusus* (LeConte)). High intensity wildfires in the tinder dry forests diminished the pinyon population even further. Between 2000 and 2005, the combination of drought, insects, fire, and disease killed more than 50 percent of the pinyon in parts of southwestern Colorado and northern Arizona. The presence of the resulting large amounts of dead wood on the landscape increases the likelihood of widespread and high intensity fires at a time when very low moisture conditions combined with very hot summer temperatures are likely to become more frequent (Breshears et al. 2005).

In the past decade, the Bureau of Land Management and the U.S. Forest Service have formed collaborative partnerships with each other and with other forest stakeholders to reduce the amount of easily flammable woody material and decrease the risk of high intensity fires. These programs seek to restore the Southwest's forested ecosystems to tree densities and canopy coverages typical of the region prior to the late 19th century. Restoration efforts include harvesting dead and dying trees, hydro-mowing, hand-thinning, prescribed burning, spraying mature pinyon with pesticides to prevent the spread of bark beetles, and replanting to native understory vegetation. However, with costs as high as $1085 an acre, restoration is expensive (Lynch and Mackes 2003). Additionally, many firms are reluctant to bid on restoration contracts, due to the lack of profitable uses and milling infrastructure for the small diameter wood (i.e., logs under 12 inches in diameter) being removed (Lynch and Mackes 2003).

In 2003, the Colorado State Forest Service, Colorado State University, the U.S. Forest Service, the Bureau of Land Management, and the Forest Products Lab created the Colorado Wood Utilization and Marketing Program to overcome technological, knowledge, and market barriers to the profitable use of small diameter timber and to promote other activities that help agencies generate revenues to pay for restoration. The Bureau of Land Management is

particularly interested in finding ways to offset the costs of treating the 650,000 acres of its pinyon-juniper woodlands that require restoration. In fall 2006, the Colorado Wood Utilization and Marketing Program asked the Institute for Culture and Ecology to analyze the feasibility of expanding BLM's commercial nontimber forest product sales program as a means of enhancing land management revenues. Nontimber forest products are tree and forest understory products, such as boughs, roots, bark, berries, grasses, moss, fungi, and seeds. Transplants, seeds, roots, and evergreen boughs are just a few of the many nontimber forest products harvested in Colorado (Spero and Fleming 2002).

For many nontimber forest products, little scientific literature is available on sustainable management techniques, harvesting practices and impacts, or market dynamics. However, a small body of scientific knowledge has developed on the biology of pinyon nut production, traditional use of pinyon nuts among humans inhabiting the Southwest, and the role of birds and small mammals in pinyon nut dispersal. Since our project budget was too small to conduct extensive primary data collection, we selected pinyon nut harvesting as a case example to examine the challenges and opportunities for expanding nontimber forest product economic opportunities on BLM managed lands in southern and western Colorado. The case illustrates how active management of Colorado's pinyon-juniper woodlands for seed production could facilitate the restoration of healthy forest ecosystems over the course of the next century. The variability of the pinyon crop over time and space requires a management approach that takes into account a centuries-long time horizon as well as the wide range of socio-ecological conditions in the entire area over which pinyon trees grow. Due to the difficulty of obtaining information about pinyon harvesting and markets in Colorado without conducting intensive

fieldwork, our report focuses on pinyon nut use, management, and trade in the Southwest as a whole, and integrates information specific to Colorado where possible.

Part I – Methods

We relied upon a combination of secondary and primary data sources to develop this case study. The secondary data sources we used included scientific journal articles, books, and technical reports as well as newspaper and popular journal articles, government agency memos, and planning documents. To gather primary data, we interviewed key informants, analyzed BLM and Forest Service product sales databases and international trade databases, and reviewed websites of pinyon nut buyers, brokers, wholesalers, and retailers. We interviewed 33 key informants by telephone; interviews were 30 to 45 minutes in length. Key informants were chosen on the basis of their likely knowledge about pinyon nut harvesting, processing, marketing, regulatory policies or land management issues. Topics covered in the interviews varied depending on the background of the informant, but touched on one or more of the following areas:

- Value of Colorado's pinyon crop to various user groups
- Pinyon nut harvest regulations and policies
- Issues and concerns about pinyon management and regulatory practices on BLM managed lands
- Structure and dynamics of the domestic and international pinyon markets and how those have changed over time
- Suggestions or recommendations for enhancing pinyon nut production on BLM managed lands

Part II -- Pinyon Ecology and Biology

Colorado pinyon (*Pinus edulis*) and singleleaf pinyon (*Pinus monophylla*) are the most widely distributed of the pinyon species found in the American Southwest and Great Basin (see figures 2 and 3). Although both species thrive in cool, semi-arid environments, Colorado pinyon requires more moisture and is distributed across large portions of Colorado, New Mexico, Utah, and northern Arizona (Evans 1988). It typically grows in areas where precipitation ranges between 10 to 15 inches, which in the recent past has typically occurred at elevations between 5200 feet and 9000 feet (Anderson 2002). It is most abundant at elevations between 7000 to 7900 feet (Anderson 2002). In Colorado, the Colorado pinyon is distributed along the eastern slopes of the Front Range from the city of Colorado Springs south to the New Mexico border, in the canyon and mesa country in the Four Corners area, and north of Grand Junction along the far western border adjoining Utah.

Singleleaf pinyon is found primarily in Nevada, western Utah, and parts of northern Arizona (Zouhar 2001). It is a drought- and cold-tolerant species that grows in areas where the average precipitation is between 8 to 18 inches and elevations are between 3200 to 9200 feet (Meeuwig et al. 1990). The single-leaf pinyon generally grows in association with Utah juniper (Meeuwig et al. 1990). A hybrid of singleleaf pinyon and Colorado pinyon occurs in central Utah and southern Utah where the ranges of the two species overlap (Lanner 1981).

All species of pinyons have large, wingless, heavy seeds, commonly called pine nuts. The seeds are too heavy for the wind to disperse, and they fall to the ground when released from the cones in which they develop. Pinyon trees depend on numerous vertebrates, such as pack rats, squirrels, chipmunks, jays, and humans, to disperse their seeds across the landscape (Lanner

1981). Scientists have identified three species of jays--scrub jay (*Aphelocoma californica*), Steller's jay (*Cyanocitta stelleri*) and pinyon jay (*Gymnorhinus cyanocephalus*) as well as the Clark's nutcracker (*Nucifraga columbiana*)-- as the most important dispersers of pinyon seeds to sites where trees are likely to regenerate (Gottfried et al. 1995; Lanner 1981). These birds cache enormous numbers of pinyon seeds in the fall and return to eat the cached seeds in the spring. Inevitably, a significant number of seeds remain uneaten every year. The cache sites trap moisture and protect the seeds from the wind and cold, providing micro-environments that permit the seeds to survive long enough to grow into seedlings. Rodents, particularly pack rats, also gather and store pinyon seeds in their middens.

Pinyon-juniper ecosystems exhibit the mosaic pattern of vegetation types and structures typical of semi-arid environments with extreme variability in the spatial and temporal distribution of precipitation. In some areas pinyon-juniper systems occur as a tree-centered or woodland phase, where micro-site environmental conditions and understory vegetation are heavily influenced by large relatively dense patches of trees (West 1999). Elsewhere pinyon-juniper systems occur as a savanna phase, in which large open spaces covered by low shrubs, grasses, and forbs dominate the landscape, with only an occasional tree or small patches of trees scattered here and there (West 1999).

Uneven-aged stands with variable tree structure and understory biomass are characteristic of all pinyon-juniper ecosystems (Pieper 1993). Old growth stands are structurally more complex than younger stands in the tree layer but support fewer understory grasses and shrubs (Bowns 1999). The number of pinyon trees per acre in pinyon-juniper woodlands varies from one or two to several hundred (Ronco 1990).

Pinyon pines are low bushy trees with a multiple branching structure and widespread crown. Mature Colorado pinyon reach heights ranging from 10 to 50 feet and diameters of 6 to 30 inches (Ronco 1990). Mature singleleaf pinyon are somewhat smaller, typically reaching less than 40 feet in height (Zouhar 2001) and less than 20 inches in diameter (Meeuwig et al. 1990). Both species have extensive lateral root systems that permit them to acquire water and nutrients from some distance away from the tree's primary stem (Evans 1988). As a result, the ground surrounding a pinyon tree or a cluster of pinyon trees typically has only a sparse cover of grasses and forbs within the lateral root zone.

Both Colorado pinyon and singleleaf pinyon are very slow growing and long-lived. Moisture is the key factor limiting the growth rate, distribution, and density of both species (Gottfried 1987). If protected from fire and left to grow, dominant pinyons often live 400 to 500 years (Anderson 2002; Everett 1986), and a few pinyon trees have lived as long as 800 to 1000 years (Ronco 1987).

Wild singleleaf pinyon trees rarely bear cones before they reach 35 years of age and generally do not produce commercially viable quantities of seeds until the age of 100 (Meeuwig et al. 1990). Colorado pinyon matures somewhat faster, often bearing cones by the age of 25 (Ronco 1990). Maximum seed production for singleleaf pinyon occurs when a tree is between 160 and 200 years old; the maximum seed production age for Colorado pinyon has not yet been determined but is likely similar (Evans 1988, Meeuwig et al. 1990).

Botanically, pinyon cones are fruits, and pine nuts are seeds rather than nuts. Like other fruits, pinyon cones absorb carbohydrates and nitrogen from the rest of the tree in order to produce seeds. The tree's structural growth slows significantly when it is producing fruit (Fisher et al. 1988). Bumper seed crops occur when many pinyon trees across a large area produce

mature cones with viable seeds during the same year (Gottfried et al. 1995). Large-scale climatic events that create moisture stress, such as an unusually dry summer, initiate bumper crops by triggering the growth of cone primordia in trees dispersed over large areas (Gottfried et al. 1995).[1]

Pinyon trees exhibit the masting reproductive behavior characteristic of many nut and fruit trees (Fisher 1993). Masting is a phenomenon in which a large number of individual trees in a species population produce large seed crops at the same time (Sork 1983). Masting is common in species which rely on vertebrates to disperse their seeds, as the production of large numbers of seeds in a season enhances the likelihood that seed predators will become satiated and that a substantial number of seeds will survive long enough to germinate (Sork 1983). Masting behavior is also positively correlated with higher variability in rainfall (Kelly and Sork 2002). During prolonged periods of drought, pinyon trees divert the water and nutrients that would normally go into reproduction to maintaining vegetation structures needed to survive (Zouhar 2001, Meeuwig et al. 1990).

The onset of cone formation is influenced primarily by the tree's size, rather than its age, and seed production is positively correlated to the surface area of the tree's crown (Fisher et al. 1988). However, the more cones the tree produces, the less energy it has to produce wood (Fisher et al. 1988). Studies by researchers at the Mora Research Center in New Mexico indicate that levels of nitrogen and amino acids, particularly arginine, are also positively correlated with the number of cones produced (Fisher et al. 1988).

A pinyon tree needs three successive growing seasons to produce seeds once primordial growth begins (Little 1977). Buds form in August after a triggering event (Ronco 1990;

[1] A primordium (plural, primordia) is an organ or a part of a biological organism in its most rudimentary form or stage of development.

Meeuwig 1990), and then go dormant for the winter. The cones form from flowers produced during the following spring. Paradoxically, a dry summer will lead to an above average flower crop the following spring, and if conditions are right, an above average cone drop in the fall (Fisher et al. 1988). Pinyons produce fewer cones if temperatures during the late summer are very hot and more cones if temperatures are cooler (Fisher 1993).

Once formed, cones will produce seeds the following spring if moisture and temperature conditions are favorable. The seeds grow over the summer, and the cones release them in the fall, from late September to early November for singleleaf pinyon and from mid-September to late October for Colorado pinyon (Meeuwig et al. 1990, Ronco 1990). However, a very dry spring can delay seed production until the following year. A bumper cone crop occurs the year after three successive years of highly favorable conditions (Little 1977). A series of very dry hot years, such as occurred during Colorado's drought during the 1990s, can lead to many successive years without a bumper crop.

Colorado pinyon produces 10 to 20 seeds per cone and about 1900 seeds per pound; singleleaf pinyon, which has larger seeds, produces 2 to 60 seeds per cone with an average of 900 seeds per pound (Meeuwig et al. 1990, Ronco 1990). In a good year, a productive singleleaf pinyon can produce about 11 pounds of seeds, while a productive Colorado pinyon may produce more than 20 pounds of seeds (Meeuwig et al. 1990; Ronco 1990). Pinyon nut buyers and pickers often refer to Colorado pinyon seeds as "hard shell" pinyon because their shells are too hard to be easily be cracked by hand. Singleleaf pinyon shells can easily be cracked by pressing the seed between the thumb and forefinger, and buyers and pickers refer to it as "soft shell" pinyon.

Both Colorado pinyon and singleleaf pinyon seedlings require shade and moisture to survive and do not thrive in large openings or grasslands (Little 1977). The seedlings of both species grow very slowly, adding only 2 to 6 inches to their height each year, depending on environmental conditions (Little 1977; Meeuwig et al. 1990). Diameter growth is also slow and is heavily influenced by the moisture supply available, with faster growth rates in sites with more moisture and slower growth rates in droughty soils (Meeuwig et al. 1990; Ronco 1990).

Several types of insects, fungi, and other organisms negatively affect individual pinyon trees and, in some situations, large populations of pinyon. The Ips bark beetle (*Ips confusus*), for example, kills pinyon trees weakened by other insects, fungi, or fire (Meeuwig et al. 1990). Dwarf mistletoe (*Arceuthobium divaricatum*) and pinyon needle scale (*Matsucoccus acalyptus*) , are both widespread among pinyon populations. Although they don't kill pinyon trees, they weaken them so that they are more susceptible to the Ips and other insects (Meeuwig et al. 1990). Other pathogens attack the cones, reducing the number of viable seeds produced (Meeuwig et al. 1990; Little 1977). Gall midge (*Pinyonia edulicola*) larvae can do considerable damage during the first year of cone growth, while pine cone moth caterpillars (*Eucosma bobana*) and pinyon cone beetles (*Conophtorus edulis*) attack during the second year of cone growth (Little 1977).

Fire can easily kill or damage pinyon trees, which are thin-barked, but the extent to which fires cause significant damage or death is closely linked to stand structure and fire intensity (Meeuwig et al. 1990). Fire frequency and intensity is higher in areas where understory vegetation is thick and in places where trees are still closely spaced (Zouhar 2001, Anderson 2002).

Pinyon seed production varies greatly from tree to tree, year to year, and place to place because of the pinyon's lengthy and multi-stage fruiting cycle and the many opportunities for the

cycle to be affected by factors such as weather conditions and insect predation (Keeley and Zedler 1998). Singleleaf pinyon is less variable in seed production than the Colorado pinyon, with large seed crops occurring every two to three years (Zouhar 2001). Colorado pinyon has a somewhat longer and more erratic cycle, with large seed crops occurring every three to seven years (Fisher et al. 1988, Ronco 1990). For each species, bigger and more frequent crops occur on better sites where conditions are optimum for the species rather than at the limits of its range (Ronco 1990, Meeuwig et al. 1990).

Although the extent and location of pinyon seed crops varies greatly from year to year, it is quite possible to predict what a crop will be like in advance. Pickers and buyers who know the distribution of pinyon trees with terminal buds, first-year cones, and second-year cones, as well as local and regional weather conditions and the distribution and intensity of pinyon predator activity, can predict seed production fairly accurately two years in advance, and even more accurately one year in advance. Commercial concentrations of seed producing trees of both species can be found somewhere within the species' range even in off-cycle years, and complete crop failures are rare (Meeuwig et al. 1990; Ronco 1990). Because the pinyon crop is variable in time and space it is not amenable to management or research based on the assumptions of a stable equilibrium model. However, although crops are variable, they are not unpredictable and management approaches that take into account their variability are both feasible and necessary.

Part III -- Changing Views of Pinyon over Time

Humans around the world have long valued pine trees for the many products and services they provide: fuel wood, construction material for shelters and fencing, resin for glues and medicines, edible and highly nutritious seeds, branches for shade, and habitat and food for birds

and mammals. Pine nuts, which have been a part of human diets for millennia, are an exceptionally nutritious plant food high in fat, protein, and carbohydrates (see table 1). Unlike most plant foods, the protein in pinyon nuts includes all 20 amino acids, making it nutritionally complete (USDA Agricultural Research Service 2006).

Table 2 compares the nutritive value of an ounce of Colorado pinyon nuts with the equivalent amount of butter and beefsteak. An ounce of pinyon nuts has more than 8 times the calories of lean beefsteak, but still has a significant amount protein (14.3 percent). Figure 4 illustrates how the lipid content of pinyon nuts differs from butter and beefsteak. Although pinyon nuts have a much higher percent of fat ounce per ounce than lean beefsteak, a much smaller percent of that fat (16 percent versus 45 percent) consists of saturated fats. Pinyon nuts are considerably lower in fat content than butter (61 percent versus 100 percent), and a large percent of the fats in pinyon nuts consists of the unsaturated fats that are associated with a lower risk of heart attacks.

Both Colorado and singleleaf pinyon nuts are rich in vitamins including thiamin, niacin, riboflavin, and folate; they also are a good source of minerals, notably manganese, magnesium, copper, zinc, potassium, and iron (USDA Agricultural Research Service 2006). Colorado pinyon nuts have more protein, fat, and calories than singleleaf pinyon, but fewer carbohydrates (Lopez-Mata 2001). The higher fat to carbohydrate ratio of Coloradon pinyon nut gives it a more buttery texture and a less starchy taste (Zouhar 2001).

Humans have eaten pine nuts since the Paleolithic and very likely since the emergence of *Homo sapiens* as a species. Archeologists have found fragments of Italian stone pine (*P. pinea*) cones in human settlements in Spain that date back 50,000 years (Fady et al. 2004). Peoples of the Mediterranean region have cultivated the stone pine, which is native to that region, for at

least 6000 years (Wikipedia 2007). Cultures in northern China, Mongolia, Korea, eastern Russia, the central Himalayas, the Near East, southern Europe, and North America have used pine nuts for food for millennia (Bakels and Jacomet 2003, Ciesla 1998, Haldane 1993).

In the American Southwest, archeologists have documented human use of limber pine (*Pinus flexilis*) and singleleaf pinyon nuts for food at least as far back as 7500 years ago (Rhode and Madsen 1998) (see Table 3 for a timeline of pinyon use and management in the Southwest from 7500 BC to present). Over the next seven millennia, dozens of Native American societies thrived for long periods in this environment of scarce and erratic precipitation by incorporating the nutritious and often abundant pinyon nut into their diet (Lanner 1981). The highly nutritious, portable, and long-lasting pinyon nuts were an especially important plant food among the hunting and gathering cultures of the Colorado Plateau and Great Basin (Bettinger 1991, Steward 1937, Murphy and Murphy 1979, Plog 1979). Pinyon nuts provided calories and protein to these foragers on an everyday basis, but more importantly, caches of nuts--often stored for several years at a time--enabled them to make it through the inevitable lean seasons and years (Fowler 1979).

Around 1700 years ago, the Washoe and Owens Valley Paiute, whose territories included the pinyon-rich zone in the Sierras along what is now the California-Nevada border, developed the social organization and technology needed to harvest and process green pinyon cones in large quantities (Bettinger 1991). Harvesting pinyon nuts from green cones and roasting them in large numbers to preserve them for long periods provided a reliable long-term food supply that made a more sedentarized life possible for the Washoe and Owens Valley Paiute (Bettinger 1991). The Anasazi, who occupied what is now the Four-Corners region between roughly 1200 BC to 1200 and who were the ancestors of present-day Pueblo farmers in New Mexico and Arizona, also

consumed pinyon nuts for food (Nabhan et al. 2004). The pinyon nut's complete protein content may have provided the Anasazi with amino acids otherwise lacking in a diet based primarily on corn, beans, and squash. The Ute, proto-Navajo, and proto-Apache peoples who moved into the Colorado Plateau several hundred years after the collapse of the Anasazi culture in the 1300s incorporated pinyon nuts as a major component of their food-gathering strategies (Nabhan et al. 2004). Although less dependent on pinyon than the Ute, Navaho, and Apache for food, the Pueblo peoples who now occupy territory in northern New Mexico and Arizona have long supplemented their diet of cultivated corn, beans, and squash with pinyon nuts, as did their Anasazi ancestors (Bodine 1979).

For Native American societies in the Southwest and Great Basin, the pinyon nut was, and still is, an important food. It was also a cultural symbol representing life, health, and social unity (Lanner 1981). The pine nut harvest was a time when the various bands of the Great Basin cultures, such as the Utes, Paiutes, Shoshone, and Washoe came together in the pinyon groves to gather the annual crop before winter (Fowler 1979). It was also an important seasonal event among the Navajo, the Pueblos, Jicarilla Apache, and other cultures south of the Great Basin (Lanner 1981). For many of these groups, the fall pinyon harvest continues to be a way to reaffirm and solidify kinship ties.

Besides pinyon nuts, Native Americans in the Southwest and Great Basin used many products derived from pinyon trees, including wood for fuel and resin for medicines and glue, (Lanner 1981). In situations of intense population pressure, the demand for wood among the Pueblo farming cultures exceeded the pinyon's capacity to regenerate (Nabhan et al. 2004). Farmers were much less dependent on pinyon nuts for food than their hunter-gatherer neighbors to the north, east, and west, and it is likely that it was easier for them to overlook the impact of

wood harvesting on nut production until it was too late. For many years, archeologists believed that the collapse of the Anasazi was linked to widespread deforestation of pinyon-juniper woodlands, caused in part by climate change and in part by extensive tree cutting. However, recent evidence suggests that the decline in the availability of wild foods high in protein and essential amino acids--wild birds, game, and pinyon nuts--linked to the dwindling of Colorado pinyon populations, may have been an equally important factor in the Anasazi's withdrawal from the Colorado Plateau. (Ciesla 1998)

The Hispanos who moved into northern New Mexico and southern Colorado following the Spanish Conquest in the 1600s quickly learned to value the pinyon tree, which resembled the Italian stone pine (*Pinus pinea)* of their homeland. Hispanos' preferred firewood was the hot-burning, aromatic pinyon, and as a result they intensively harvested pinyon trees near their settlements for fuel (Raish 2004). Additionally, they used pinyon extensively as supports for homes and stores constructed out of adobe, as well as for fencing (Raish 2004). However, Hispanos also incorporated pinyon nuts into their New World cultural traditions. The rapid and extensive integration of pinyon nuts into Hispano culture is quite likely due to the important role of the stone pine in Spanish culture. By the 1600s, Spaniards had for centuries been tending domesticated stone pines in their native land, and pine nuts were an important supplement in most Spaniards' diets. Although less reliant on pinyon nuts than the indigenous peoples they pushed out, Hispanos still considered pinyon nuts an important food. Additionally, pinyon nuts were imbued with cultural meaning for Hispanos. The widespread practice of gathering and shelling pinyon nuts communally, as well as gifting nuts at important social occasions, served to maintain and strengthen social ties within Hispano families and communities. This practice continues to this day.

From the 1850s, a new and much larger wave of immigrants, mostly of northern European descent, moved into the Southwest. For most of these newcomers, pinyon nuts were neither an important source of food nor a symbol of cultural unity. Although a welcome snack, pinyon nuts were not a key dietary component for most Anglo inhabitants, whose fast transportation networks and intensive ranching and farming operations provided them with ready and year-round access to other foods. Instead, they viewed pinyon pines as important primarily for their wood, which they used in vast quantities to build houses and stores, fuel steam engines, and make railroad ties and mine supports (Lanner 1981). By the 1880s, the Southwest's new residents had denuded many areas that once had supported extensive pinyon groves, opening up those spaces to colonization by grasses and other understory species (Lanner 1981). However, as described in the next section, the arrival of large numbers of immigrants from southern Europe into the nation's cities at the beginning of the 20th century sparked the development of a nation-wide pinyon nut market.

In the early 1900s, the demand for pinyon wood for fuel and building materials decreased significantly with the introduction of the diesel engine and the decline in the construction of new mines and railroad lines (Lanner 1981). Over the next several decades, pinyon trees and juniper shrubs slowly re-colonized areas cleared in the preceding decades. By the 1950s, pinyon-juniper woodlands had re-established themselves in many areas that had been denuded of trees during the late 1800 and early 1900s (Lanner 1981). Using photos taken during the 1880s as a baseline for normal range conditions, range ecologists and foresters during the immediate post-World War II era concluded that pinyon and juniper were invasive species jeopardizing the grasslands that provided critical forage for the Southwest's cattle industry (Lanner 1981).

Beginning in the 1950s, federal and state public land management agencies embarked on a massive campaign to eliminate pinyon trees and juniper shrubs on millions of acres in the states of Arizona, Colorado, Nevada, New Mexico, and Utah (Lanner 1981). The BLM cleared more than 700,000 acres of pinyon-juniper woodland in the Colorado Plateau (see Table 4), including at least 161,327 acres in Colorado (P-J Woodlands 2006). Although the percentage of converted land relative to the total acreage of pinyon-juniper is small, efforts to remove pinyon targeted trees growing on flatter ground with deep soils and relatively high soil moisture (Little 1993). Pinyon trees in such sites tend to be the most prolific nut-bearers, and it is thus likely that efforts to convert woodlands to grasslands destroyed a disproportionately high percentage of the most productive seed-bearers.

In the mid-1970s, under threat of lawsuits from environmental groups and Native Americans concerned about the negative environmental and cultural impacts of the federal conversion program, the BLM and the Forest Service scaled back their efforts to transform pinyon-juniper woodlands into grasslands (Lanner 1981). At the same time, the use of wood to heat homes increased suddenly with the 1973 oil crisis and the subsequent rise in oil and natural gas prices (Kline 1993). As the number of people seeking firewood from public lands increased, BLM and Forest Service interest in maintaining a sustainable supply of pinyon trees grew (Kline 1993).

Large amounts of federal and state funding became available in the 1980s to study pinyon-juniper ecosystems (Gottfried and Severson 1994), whose variability defies efforts to apply conventional equilibrium models of rangeland and timber management. These studies indicate that the question of pinyon-juniper expansion is complex. In some areas that were grasslands a hundred years ago, pinyons are merely recolonizing areas cleared of trees in the

1800s and 1900s (West 1999). In other areas the numbers and density of pinyons are considerably higher than they would have been without the prolonged intensive grazing that eliminated the grass layer and reduced fire frequency (Lanner and van Devener 1998). Recent ecological studies show that pinyon trees are valuable ecosystem components and highlight the need for management strategies that lower the risk of high intensity fires, while retaining healthy tree and shrub components (Gottfried 2004, Zouhar 2001). Ecologists anticipate that if the current global warming trend continues, Colorado pinyon and singleleaf pinyon populations are likely to shift northward as well as upward in elevation (Saunders et al. 2006).

Part IV – Harvesting, Processing, and Storage

Light and small but dense in calories and essential proteins, pine nuts were an ideal trade item in the days before motorized transportation. Remains of pine nuts in a Late Bronze Age shipwreck discovered off the coast of south Turkey in 1982 (Haldane 1993), indicate that pine nuts have been traded in the Mediterranean region since at least the 14th century BC. Roman soldiers and administrators occupying Western Europe from before 50 AD until 250 AD imported pine nuts from their native land for use in burial rites (Bakels and Jacomet 2003). In North America, pinyon nuts were also a trade item. The Zuni, for example, obtained pinyon nuts through trading with the Navajo, and Hispano communities traded pinyon to the Tewa in the Rio Grande (Ackerly 1993).

A brief history of commercial harvest in the U.S.

Large-scale commercial harvesting of pinyon nuts in the United States dates back to the early 20th century, when traders on Indian reservations in the Southwest began shipping large

quantities of pinyon nuts to eastern seaboard cities to satisfy the demand for pine nuts among recent southern European and Near Eastern immigrants (Little 1977). Eventually the domestic market for pinyon nuts expanded to include other cities, such as Chicago and Los Angeles. Seeds from both singleleaf pinyon and Colorado pinyon entered the national market at this time. Despite the extra effort needed to crack the harder-shelled Colorado pinyon seeds, the southern European immigrants, who were the primary consumers during the early 1900s, preferred them over the softer-shelled but starchier singleleaf pinyon seeds (Little 1993). This preference is likely linked to the Colorado pinyon seed's close resemblance in texture and flavor to Italian stone pine seeds.

By the 1930s, dealers in the Southwest were shipping out 1 to 2 million pounds of pinyon nuts every year (Little 1977). In a bumper crop year, the harvest could be several times higher than in an average year. In 1936, when an extraordinarily large pinyon crop occurred, traders shipped out roughly 8 million pounds (Little 1977). Pickers, most of whom were Navajos or Hispanos, received 10 cents a pound during the late 1930s (Little 1977). A skilled picker can pick between 10 to 20 pounds a day, and an income of $1.00 to $2.00 per day would have been good pay for the time. Pine nuts sold for 25 cents a pound on the retail market.

Following World War II, the supply of pinyon nuts entering national markets declined abruptly. Buyers experienced difficulties in obtaining an adequate supply of pinyon nuts because of a labor shortage as many Navajo pickers shifted into other occupations and also because a prolonged drought during the 1950s caused crops to be very poor in a series of years. (Betancourt et al. 1993). By the 1960s, the supply of pinyon nuts was further reduced as a consequence of federal pinyon-juniper removal programs that cleared many nut-bearing trees (Little 1993). Despite the multiple factors negatively affecting the supply of pinyon nuts during

the 1950s, substantial harvests continued to take place into the early 1960s. The Bureau of Indian Affairs estimated that 2.5 million pounds were harvested in New Mexico and Arizona in 1960 (Woodruff 1967). Most of the Colorado pinyon at that time was shipped to New York distributors (Woodruff 1967).

In the 1970s and 1980s, growing consumer interest in health foods and wild-harvested foods led to increased demand for pinyon nuts. Many new buyers entered the pinyon market during this period. In the mid-1970s, the U.S. re-opened trade relations with China, and with pinyon prices high because of chronic labor shortages, U.S. pinyon dealers and brokers soon began importing pine nuts from China (Little 1993). However, the demand for pinyon continues to remain strong, and buyers have little difficulty getting a good price for their product.

Harvesting areas

The commercial pinyon nut harvest takes place primarily in two regions of the Southwest, one corresponding with the geographic distribution of Colorado pinyon and the other with the distribution of singleleaf pinyon. The Colorado pinyon nut harvest takes place primarily in northern New Mexico, northern Arizona, southern Utah, and southern Colorado. For much of the 20th century, commercially viable seed crops were relatively frequent in southwestern Colorado and a sufficient number of skilled Navajo pickers was available to gather pinyon nuts in that area. In the pinyon harvesting grounds located along the front range of the Rockies in northern New Mexico and southeastern Colorado, Hispanos and Jicarilla Apache were the main commercial harvesters. However, they were (and are) much fewer in number than Navajo harvesters, and they tend to bring in smaller quantities than Navajo pickers. Most of the nuts picked by Hispano and Jicarilla were sold in the local roadside stands that were, and continue to

be, a regular feature of northern New Mexican and southeastern Colorado villages and towns. Navajo pickers tended to sell their pinyon nuts to large-scale brokers, often based at local trading posts, who then shipped them to local and distant wholesalers and retailers. Ethnic differentiation in the quantities of pinyon picked and points of first sale continues to this day. Navajo pickers still pick pinyon nuts in southern Colorado, primarily in the Four Corners area. Likewise, the Jicarilla and Hispanos still harvest pinyon nuts along the southern portion of Colorado's Front Range.

During the recent drought from 1993 to 2004, no bumper crops of Colorado pinyon occurred across its range. Colorado was particularly hard hit by the drought, and even localized crops were quite small. As a result, for the past 15 years only a very small portion of the Southwest's commercial Colorado pinyon crop has originated in Colorado. According to key informants, the pinyon nut harvest in Colorado has always been less important than that in New Mexico and Arizona. However, the most recent drought resulted in an unusually prolonged period during which no large crops at all occurred in Colorado, and over time most pickers and buyers ceased to include Colorado in their picking or purchasing circuits. In 2005, Colorado experienced a bumper pinyon crop for the first time since 1992, attracting many recreational and commercial pickers into the woods. Although the number of seeds produced per tree was very high, pickers found that an unusually high percent of the shells was empty (Sluis 2005).

The pinyon-juniper woodlands in eastern Nevada and western Utah are the center of the singleleaf pinyon seed harvest. Commercial picking is concentrated in the mountains along the border of the two states but also extends into the pinyon-juniper woodlands of southwestern Utah and eastern California. As discussed in the previous section, the foraging economies of the Paiute, Shoshone, Washoe, and other Great Basin societies depended upon the annual singleleaf

pinyon harvest. The Western Shoshone, Washoe, and Paiute continue to participate in the harvest of singleleaf pinyon seeds, both for home consumption and for commercial exchange. However, crews of Latino pickers now harvest the bulk of the commercial singleleaf pinyon harvest.

Prior to the 1990s, many pinyon nut buyers concentrated on either the Colorado pinyon harvest or the singleleaf pinyon harvest, and relatively few participated in both. However, with the recent drought and the shortfall in Colorado pinyon supplies over an 11-year period, many buyers and brokers who formerly specialized in Colorado pinyon nuts now include singleleaf pinyon in their operations. Many also distribute imported pine nuts.

Harvesting

Pinyon nut harvesting takes place in the early fall. However, for many pinyon nut gatherers, harvesting is an activity that begins as much as two years before the cones are ready to release their seeds. During the spring, buyers and harvesters scout the countryside, looking for concentrations of pinyon trees heavily laden with maturing cones. Some buyers rent planes and helicopters to scout out areas with commercially viable cone crops. During the fall harvest season, pickers and buyers also keep their eyes open for places where a large number of trees bear first-year cones that may mature the following fall if suitable moisture and temperature conditions occur the next spring and summer. Pickers and buyers are always thinking in terms of the pinyon's multi-year fruiting cycle and the phases associated with that cycle. They must also think regionally, as well as locally, since the location of commercially viable concentrations of pinyon nuts shifts across the landscape from year to year.

Pickers gather pine nuts in several ways. Some, including many who pick commercially, harvest green cones still on the tree. Most birds and mammals cannot easily open the tightly

closed scales of the green cones. However, pinyon jays and Clark's nutcrackers are able to extract seeds from green cones, so pickers who wish to compete successfully need to be at the harvesting sites as soon as possible after the cones have ripened. Once the cones turn brown, their scales open up, exposing the seeds to the elements and seed-eating mammals and birds. Seeds in the opened cones eventually fall to the ground, a process that a strong wind, rain, or snow storm will accelerate. Once the seeds are scattered on the ground, birds and small mammals quickly consume them, making the harvest less profitable for human gatherers.

Green cone pickers use ladders to climb the trees to remove cones when they are still green and haven't yet released their seeds. Green cone pickers also use a hooked pole to pull down branches far enough to where they can remove the cones from the tree. Harvesting the resinous green cones is sticky, difficult work and very time-consuming.

Brown cone, or "dry picking" takes place a little later in the season once the cones have dried, but have not yet released their seeds or fallen to the ground. The seeds can be removed from the brown cones by hitting the cones over a blanket or screen to catch the seeds. Brown cones are easier to harvest, but the chances are greater that other seed predators will have removed a large portion of the seeds.

Pickers who aren't picking commercially, as well as some commercial pickers, often gather seeds directly from the ground, particularly in bumper crop years when seeds are so abundant that birds and mammals are unable to gather most of the seeds before human harvesters arrive. Some pickers rake or sweep up the seeds, and then run them through a screen to sift the seeds from the litter (Little 1993). Others pickers gather seeds from packrat middens, a practice which is more efficient than picking up individual seeds that have fallen to the ground and less messy than picking green cones. However, seeds from middens are more likely to have rodent

fecal matter on the shells, which increases the risk of spreading rodent-borne diseases, such as hanta virus.

Very few pickers use mechanical harvesters like those used to harvest pistachios and walnuts. Most commercial nut harvesting machines are designed to shake the trees and to operate on relatively flat land and in groves where trees are grown at regular spacings (Mexal 1993). Pinyon trees have shallow lateral root systems, and the likelihood of damaging a tree when mechanically shaking it is high (Mexal 1993). Additionally, most pinyon trees are irregularly spaced, and many grow on slopes too steep for the use of most types of mechanical harvesters to be practical (Mexal 1993). Lastly, prices of the most commonly used types of mechanical harvesters--in excess of $100,000--are prohibitive for most pickers and buyers. One broker we talked with had experimented with using a portable harvesting machine developed for harvesting other types of tree nuts. This machine creates a vacuum to suck loose nuts into a carrying bag. However, the resinous cones tend to gum up the machine and the broker found that it was faster to pick by hand.

Processing Pinyon Nuts

Pinyon nuts require several processing steps before they are ready to eat. The amount of initial processing that goes into readying the nuts for the market or home use depends on whether the pickers gathered green cones, brown cones, fallen seeds, or seeds taken from rodent caches. It also depends on whether the nuts are destined to be sold unshelled or shelled. In larger-scale picking operations, harvesters process the cones at the picking site.

- ***Green cones***: Green cones must first be dried either in a drying machine or in the sun to release the brackets that hold in the seeds. Once the green cones are sufficiently dry, the processing is the same as for brown cones.

- ***Brown cones***: Brown cones are shaken to release the nuts, often by using a tumbling machine equipped with screens sized so that the nuts will fall through into one area and the cones through another. Once the seeds have been extracted, they are sorted by machine or by hand to remove empty shells and poor quality seeds. After extracting the nuts, most commercial operators dry the nuts to reduce their moisture content, a process which greatly prolongs their shelf life. The dried nuts are then run through a milling station to remove the kernel from its hard outer shell.
- ***Seeds from rodent caches:*** Seeds gathered from the ground or from rodent middens must be thoroughly washed while still in the shell before they can be processed further.

Some dealers and brokers soak the unshelled pinyon nuts in brine, and sell them either raw or toasted. For small-scale or home consumption, buyers recommend using a mallet or rolling pin to remove pinyon nut shells (Benner 1988).

Pinyon nut storage

All types of pinyon nuts are best stored in a cool, dry environment. Fresh unshelled pinyon nuts will maintain their flavor and texture for a year or more if kept dry and refrigerated at temperatures between -5 to +2°C (Ciesla 1998). Because of their high fat content, fresh shelled pinyon nuts can become rancid in a matter of days or weeks, depending on the temperature and humidity (Ciesla 1998). If dried to the point where all or most of their moisture is eliminated, both shelled and unshelled nuts will keep much longer. Unshelled nuts will keep for three years or more if dried and stored in very dry, cool conditions (Woodruff 1967). A buyer or broker can count on shrinkage of roughly 20 percent for nuts stored over several months (Little 1977).

Part V - Pinyon Nut Products

An evening of internet surfing reveals the existence of many products based partially or entirely on pinyon nuts. A description of some of the major products produced from pinyon nuts, as well as products that pinyon nuts are not yet used for, but for which market potential exists, is provided below.

1) Pinyon nuts – whole or pieces

- **Human food**: The bulk of the Southwest's pinyon nuts are sold as whole nuts for human consumption. Pinyon nuts are sold fresh and dried, shelled and unshelled, and raw and roasted. Some pinyon nut sellers soak unshelled nuts in brine to give them a salty taste; others sell shelled nuts coated with chiles or chocolate. Whole nuts and pieces are incorporated into candies, cookies, and sauces, such as pesto. Whole pinyon nuts are also used as garnishes on cooked foods, such as rice and pasta dishes, or on raw foods, such as salads.

  When eaten as a snack food, the flavors and textures of Colorado pinyon and singleleaf pinyon nuts are readily distinguishable from each other and from the flavors and textures of the three major types of imported pine nuts. Used as an ingredient in confections and sauces, however, few consumers can detect the difference between different varieties of pine nuts. Since the price of pinyon nuts is generally much higher than that of imported pine nut varieties, the bulk of the pinyon harvest goes into high-end snack food and regional specialty food markets.

- **Pet food**: Some pet supply stores offer pinyon nuts in pet food mixes or as a stand-alone product. Small nuts are sold as feed for small parrot-like species such as lovebirds or finches; medium sized nuts are suggested for parrots, cockatoos and macaws. Larger

fresh shelled and unshelled pinyon nuts are marketed as treats for pet squirrels, chinchillas, and other small rodents.

- **Ecosystem restoration and landscaping**: A small market in pinyon seeds has long existed for the nursery and landscaping market. In the past decade, federal and state initiatives to restore native ecosystems have created an expanding market for pinyon seeds suitable for growing seedlings destined for landscaping or restoration projects.

2) Pinyon oil: Although pinyon nut oil is rarely seen in the contemporary United States, pine nut oil is commonly used for cooking and as a medicinal agent in the Mediterranean, Russia, and Korea (Sharashkin and Gold 2004). Manufacturers of beauty, wood finishing, and leather care products include pine nut oil in some products (Sharashkin and Gold 2004). In 2005, pine nut oil received an additional boost in the health products market when Lipid Nutrition began selling PinnoThin, an appetite suppressant based on oils from the Korean pine nut. The active ingredient in PinnoThin is pinolenic acid, one of the major fatty acids found in Korean pine nuts. Pinolenic acid prompts the release of cholecystokin, a hormone that regulates the production of appetite suppressing enzymes in the pancreas (Tuttle 2007). Pinolenic acid may also have other health benefits, such as reducing blood pressure and cholesterol levels (Tuttle 2007). Seeds from both Colorado pinyon and singleleaf pinyon contain pinolenic acid, as well as a variety of other fatty acids known to have health promoting qualities.

3) Pinyon flour – Many Native American cultures made flour from pinyon nuts by parching them thoroughly to remove any moisture, and then grinding them into a coarse meal or flour. Pinyon flour is also a by-product of the pinyon oil manufacturing process. Pinyon meal and flour are used to make many of the same products that can be made with other types of flour. Pine nut

meal can be mixed with water and prepared as a mush or gruel, similar to oatmeal. It makes very nutritious soups, and serves as a thickening agent for sauces. Very finely ground pine nut flour is used to make pastries, pancakes, and other culinary preparations calling for flour.

4) Pinyon picking experiences: Over the past two decades, a strong market for wild food gathering and slow food experiences has emerged in many industrialized countries, including the United States. We did not find any of these types of activities taking place around the pinyon nut harvest in the Southwest. However, a recent rural economic development effort in the pine nut producing region of Korea provides a model for structuring a similar effort around the pinyon industry in the Southwest.

In Korea, pine nuts are a traditional ingredient in a number of Korean dishes, including juk jaht, a gruel made from rice and pine nuts and served to children, the elderly, and the sick. Juk jaht is viewed as a fortifying food because of the medicinal and nutritional properties of pine nuts. To capitalize on this tradition, the Korean forest villages of Pocheon Gidongsanchon and Gapyeong Bandibul recently initiated a fee-for-service program in which visitors can participate for a day in the annual pine nut harvest from September to November (Information Network Village Central Council 2002). Gapyeong County, where these pine nut experiences take place, produces 40 percent of Korea's pine nut harvest. Interested visitors can also tour local pine nut processing sites, assist with cracking and shelling pine nuts in the plants, and learn how to prepare dishes made with pine nuts. The pine nut experience is one of a linked set of "temple" or "slow" food experiences offered through a national network of rural villages. The program's purpose is to provide rural residents with income earning opportunities based on traditional

farming and foraging activities. The villages also sponsor an annual "Miss Pine Nut" festival as a form of public relations and marketing for their pine nut products.

Part VI – Pine Nut Commerce

Global commerce in pine nuts

Seeds from three types of pines--the stone pine (*P. pinea*), Korean pine (*P. koraiensis*), and Chilgoza pine (*P. gerardiana*)--have been widely traded in international markets for many years (Food and Agricultural Organization (FAO) 1995). Siberian pine seeds (*Pinus sibiric*a) have recently entered international markets in large quantities as well (Sarashkin and Gold 2004). Stone pine nuts that enter the international market are harvested primarily from domesticated trees; nuts from the other species of pines are mostly harvested from wild trees (Ciesla 1998). Table 5 provides information about source countries and size of nuts for six types of pine nuts traded on international markets.

China, which produces and exports seeds of the Korean pine, is the world's largest exporter of pine nuts. However, a substantial percentage of China's pine nut exports originate in Mongolia, Korea and Russia (Marsanta Bulletin 2006). These countries ship unshelled pine nuts to China, where they are dried and shelled by hand (Marsanta Foods Limited 2006).

Spain, Portugal, and Italy have for many decades been the primary exporters of seeds from the stone pine, which grows throughout the Mediterranean basin (Ciesla 1998). Turkey emerged as a strong competitor in the stone pine market during the 1990s. The Turkish government invested heavily in improving existing plantations of Italian stone pine in state-owned forests and providing economic development assistance to villagers in pine nut producing regions (Melekber 2004). However, despite increased export production Turkey remains a net

importer of pine nuts. Most of its imported pine nuts come from China, Pakistan,and Afghanistan (Melekber 2004).

Afghanistan, Pakistan, and India export seeds from the Chilgoza pine, which grows in mountainous areas of those countries, as well as in Tibet (Ciesla 1998). In Afghanistan, the Chilgoza pine is cultivated for its nuts, but elsewhere its nuts are harvested from wild trees. Until the 1980s, Siberian pine nuts were used and traded primarily within Russia. However, when trade relations between China and the United States improved, Siberian pine nuts harvested in Russia and processed in China began to enter the international market in large quantities. Recent studies indicating that Siberian pine oil is an appetite suppressant have sparked additional interest on the international market for Siberian pine nuts (Sharashkin and Gold 2004).

For all practical purposes, pinyon nuts are not traded in international markets: exports from the United States all varieties of shelled and in-shell pine nuts are so low that the Foreign Agricultural Service does not include them in its export tracking database (USDA,FAS 2007). The U.S. exports small quantities of prepared pine nut products, mostly to Canada, Singapore, and Mexico (see Tables 6 and 7). U.S. trade data lumps all pine nuts into one category, and therefore it cannot be used to determine what percentage of the value or quantity of pine nut product exports are derived from pinyon nuts.

Prices and demand for pine nuts in countries that import or export pine nuts are influenced by natural and political events taking place in major exporting countries. For example, in 2006, the Mongolian government refused to issue export permits on 3000 metric tons of pine nuts in an effort to force pine nut traders to pay an export tax on their product, driving world pine nut prices to an abnormally high level (Marsanta Foods Limited 2006). Pine nut crops in Asia and Europe follow a cyclical pattern similar to that of pinyon nut crops. The

Chilgoza pine has a commercial crop roughly every 5 years (Melekber 2004). Italian stone pine seed production also fluctuates, but cultivators have dampened its cycle through centuries of genetic selection aimed at producing prolific and frequent seed bearing trees (Fady et al. 2004). A poor seed crop of Korean pine increases demand for Italian stone pine and Chilgoza pine seeds, as evidenced by the increase in imports to the U.S. from Spain, Portugal, Pakistan, and Turkey during years when imports from China are substantially lower than normal (see Figures 5a and 5b). Prices of imported pine nuts in the United States can rise significantly if insufficient product is available from regions other than China to make up the shortfall. Poor crops of Italian stone pine and Chilgoza pine tend to have less impact than Chinese imports on pine nut prices in the United States because they represent a much smaller percentage of total supply on the market.

Pine nut imports to the United States: Sources, quantities, values[2]

China (including Hong Kong) is by far the single biggest exporter of pine nuts, in-shell and shelled, to the United States.[3] From 1989 to 2006, China accounted for 84 percent of the total quantity of in-shell pine nut imports to the U.S. (see Tables 8 and 9). Portugal accounted for 5.3 percent of the in-shell imports, and Turkey for another 5 percent. Afghanistan, Pakistan, South Korea, and Spain contributed the bulk of the rest of the in-shell imports. China's contribution to shelled pine nut imports was even greater – 92 percent of the total quantity brought in to the United States (see Tables 10 and 11). Spain was the next largest importer of shelled pine nuts (2 percent), followed by Portugal (1.9 percent), Pakistan (1.8 percent), and Turkey (1.6 percent).

[2] Analysis based on import and export data from the USDA Foreign Agricultural Statistics on-line database.
[3] However, it is likely that a significant portion of the pine nut imports from China originate in Mongolia, Korea, and Russia.

Annual total imports of in-shell pine nuts have risen fairly steadily over the past 17 years. They increased from an average of 1086 metric tons between 1989 and 1992 to 4024 metric tons between 2003 and 2006--roughly a fourfold increase. The total value of in-shell imports rose from an average of $9.8 million per year between 1989 and 1992 to $39 million per year between 2003 and 2006. The annual average value of shelled pine nut imports during this same period increased only very slightly, from $9300/metric ton to $9750/metric ton.

Domestic pinyon nut harvest: Estimates of annual production

The USDA Economic Research Service tracks the production and value of a number of tree fruit and nut crops, such as pistachios, walnuts, almonds, chestnuts, and pecans, harvested in the United States (USDA,ERS 2007). Many state governments have similar economic research programs for tracking the production and value of commercial domesticated tree crops within their state's boundaries. No analogous tracking systems exist for pinyon nuts, making it difficult to assess the size and value of pinyon nut harvests within individual states or the United States as a whole.

According to pinyon nut dealers interviewed during this study, in years with a bumper crop of Colorado pinyon nuts, total harvest is somewhere between 5 and 7 million pounds. Since 1990, only two bumper crops have occurred for Colorado pinyon, one in 1992 and the other in 2005. In other years, barring widespread drought, the total harvest for Colorado pinyon is likely in the neighborhood of 1-2 million pounds.

Both the BLM and the U.S. Forest Service have systems for tracking the revenues they generate through the sale of pinyon nut harvesting permits, sales contracts, and leases. However,

field offices for both agencies are seriously understaffed, and it is probable that their systems record only a portion of the commercial harvest taking place on BLM and national forest lands. In Nevada and parts of Utah a lease system is used to allocate pinyon harvesting rights. In those areas, buyers are supposed to report at the end of the season the quantity of pinyon nuts actually harvested. Based on buyer reports of their harvests, the Nevada BLM estimated that 461,500 pounds came off commercial leases in 2004 (Frazier 2006). At a retail price of $10 per pound for unshelled pinyon nuts, the value from those parcels was approximately $4.6 million. In 2005, a poor year for singleleaf pinyon in Nevada, BLM managers in Nevada reported that buyers had taken an estimated 64,000 pounds off leases on Nevada BLM lands (Frazier 2006). U.S. Forest Service managers estimated the harvest on their pinyon leases at 262,000 pounds (Frazier 2006). At a retail price of $10 per pound, the value from Forest Service and BLM leases combined was $3.26 million..

BLM and U.S. Forest Service offices in Colorado, New Mexico, Arizona, and the eastern part of Utah use a permit system rather than a lease system, and they do not at present require pickers to report the amounts they harvest. Consequently, it is difficult to estimate how many pounds of Colorado pinyon nuts were harvested on BLM and Forest Service lands.

Pinyon nut prices

Pinyon nuts are among the most expensive nuts on the U.S. market and are consistently two or three times more expensive than pine nuts imported from China (see Table 12). In recent years, the retail price for singleleaf pinyon nuts has hovered around $9 per pound, with unroasted nuts in the shell selling at between $8 and $11 per pound. Colorado pinyon nuts are more expensive, typically retailing at $15 per pound when sold unroasted in the shell, and rising to

more than $30 per pound when supplies are extremely scarce. In most years, the price paid to pickers varies between $5 and $9 per pound, but it may drop below that in bumper crop years. Buyers attribute the high price of pinyon nuts to a severe and chronic shortage of labor for harvesting the nuts and the limited use of machines to harvest and process the nuts.

Most agricultural commodity markets are relatively inelastic in that they can only absorb so much production in any given year. Prices of most agricultural commodities, on the other hand, are very elastic, so that if the supply decreases or increases dramatically so will the price. The pine nut market is just the opposite (Sharashkin and Gold 2004). It is elastic in terms of quantity, absorbing as many nuts as are available in any year, and inelastic regarding prices, so that the price drops only slightly even with a dramatic increase in quantity available. This price inelasticity reflects the fact that pine nuts have no good substitutes, and so pine nut consumers continue to buy as many as are available even when the price is very high. Market elasticity and price inelasticity are even more pronounced for pinyon nuts than for imported pine nuts, most likely because of the shortage of harvesters and the cultural significance of the pinyon nut among many of the primary consumers.

Participants in the pinyon supply chain

Getting pinyon nuts from the woods to the market requires the participation of numerous people, including pickers, buyers, brokers, and distributors. Pickers (also called harvesters and gatherers) operate at the point in the supply chain where the nuts move out of the trees into human hands. Sometimes pickers sell their harvest directly to the end user, typically at roadside stands or, more recently, over the internet, but more often they sell or trade their harvest to buyers. Buyers market the pine nuts they purchase in a variety of ways, including selling directly

to the end users or to wholesalers (also known as distributors) who then sell the product to end users. Buyers fall into two major categories: independent buyers who purchase pine nuts with their own money and contract buyers who buy on commission for a third party, known as a broker or dealer, who supplies funds for purchasing nuts. Contract buyers typically are paid a fixed amount per pound of pinyon nuts delivered to the broker. As is the case with many nontimber forest products industries, roles at the forest end of the pinyon nut supply chain are often fluid: pickers sometimes work as buyers and buyers sometimes act as brokers if they have the capital and if it is economically advantageous for them to do so. Our study gathered data primarily on the roles and characteristics of pickers and buyers, and we did not examine in-depth the roles and characteristics of brokers, distributors, and other participants further along the pinyon nut supply chain.

Pickers

The harvesting workforce is strongly differentiated along ethnic lines and according to the species harvested. Navajos are the major commercial pickers of pinyon nuts harvested in southwestern Colorado, northwestern New Mexico, and northern Arizona. Hispanos and Jicarilla Apache are the major commercial pickers of pinyon nuts in south-central Colorado and northern New Mexico. Latinos from Mexico and Central America dominate the pinyon nut harvest in Nevada and Utah. Western Shoshone and Paiutes also gather singleleaf pinyon nuts commercially. Members of other Native American groups, such as the Zuni, Hopi, Pueblos, and Ute also harvest pinyon nuts, but the extent to which they participate in the commercial harvest is unknown.

Navajos often harvest as families, and they have a reputation for being the most skilled pinyon nut pickers. One buyer in northern New Mexico said, “Most commercial pickers will pick

five pounds where a Navajo will pick 30 pounds. They've got a system in place. Know-how is a big part of doing well in the business." A buyer in northern New Mexico said, "The only people who pick commercially are Navajos. The Pueblo and Hispanics will pick 5-10 lbs for themselves to roast at home and eat. The Navajos will go out for weeks on end--camping--and will come in with 80 pounds or more."

For the Navajo, Western Shoshone, and Paiute – and likely other Native American pickers – the pinyon harvest is a sacred activity, even when the nuts are harvested for commercial exchange. Most Navajos, for example, give an offering and say a blessing as part of the harvesting ritual (Tanner and Greiser 1993).

Buyers

Most pickers sell their nuts to buyers, who buy up large quantities of nuts which they then sell to the end users from their own shop or to local and national wholesalers or retailers. With the introduction of the internet, many buyers now sell directly to individuals through web-based catalogs. Many buyers are not formally licensed, and it is difficult to accurately estimate the number active in the pinyon market. Most buyers are based in New Mexico, long the center of the pinyon trade.

Traders are a special category of buyers, and have a different type of relationship with pickers than other types of buyers. In the 1800s, trading posts were established across much of Indian country in the Southwest as places where Native Americans could exchange wild-harvested products, crafts, and other items for cash or goods difficult to obtain in the local economy, such as flour, oil, manufactured clothes, household appliances, and tools. Native Americans also exchanged pinyon nuts, along with other wild harvested products, and it was nuts

from trading posts that made possible the development of a national pinyon market in the early 1900s.

In bumper crop years, when prices paid to pickers are low, many pickers sell their nuts along the roadside rather than taking them in to a buyer. This cuts out the middleman, and increases the price they receive for their harvest. If the picker has a family network to draw on, the amount he can sell from a roadside stand is substantial. One buyer said, “One Hispano I know, his whole family picks. And every year he sells from 5,000 to 8,000 pounds out of roadside stands, depending on the crop.” However, selling by the roadside takes energy and time, and in poor crop years when prices paid to pickers are high, pickers are more likely to work through a buyer rather than selling directly to consumers.

During the 1990s, the pinyon industry went through a period of major restructuring in the wake of the expansion in imported pine nuts from China and prolonged drought in the eastern portions of the Southwest. Prior to the drought, Colorado pinyon nuts from New Mexico and northern Arizona formed the backbone of the domestic pinyon nut sector. A small number of firms, mostly businesses that existed in the 1940s when demand for domestic pinyon nuts was high, dominated the market. Smaller, newer firms had difficulty breaking into the market. The singleleaf pinyon sector at the time was also difficult for newcomers to break into because several older firms controlled the bulk of the harvest. After several successive years of very poor Colorado pinyon crops during the 1990s, owners of many of the older firms specializing in Colorado pinyon retired or shifted into other business activities. Many of the remaining buyers, as well as new firms entering the market, turned to the singleleaf pinyon harvest to fill their orders.

The role of a buyer is not an easy one. They often have little control over the prices they pay pickers, but as the main interface between pickers and buying companies, they have to deal face-to-face with picker frustrations when the prices paid to pickers drops. Additionally, buyers who lease lands to ensure that they will have an adequate supply of nuts bear considerable financial risk.

Brokers

Brokers (also known as dealers) participate at the next level up the supply chain. Brokers may work on behalf of the big nut distributing companies, such as Diamond Nut. Others work on behalf of smaller retail operations, such as fruit and vegetable stands, specialty shops, and natural food stores. Collectively the smaller operations buy as much of the supply as the big companies, but typically they are much more vulnerable to price fluctuations. An outside observer of the pinyon industry said, “Dealers have to find nuts. Then they have to figure out how much to bid and where to bid. Dealers have to deal with a lot of risk. What if the crop doesn’t pan out?”

Tensions among participants in the pinyon nut supply chain

Historically the terms of trade in the domestic pinyon market have favored the small number of large-scale nut distributing companies that purchased a substantial portion of the harvest each year (Tanner and Greiser 1993). In small crop years, demand is high and pickers are able to command good prices for their product throughout the season. However, harvesting effort and costs are substantial in such years relative to the amount that a picker can harvest, so the overall profit for the picker is not large. In bumper crop years, as soon as the distributing

companies stockpile enough they stop buying from the buyers. However, pickers continue to bring in nuts to the buyers.

Most buyers work with a limited supply of capital, and cannot afford to stockpile large amounts of high-priced pinyon nuts. Banks won't give buyers loans to purchase pinyon nuts on the basis of their pinyon nut stockpiles as collateral. This differs from other tree nut commodity markets, where banks will provide loans based on crop estimates and stockpiled product (Tanner and Greiser 1993). Once distributors stop putting in orders for pinyon nuts, buyers have to drop the price they pay to pickers in order to conserve their buying funds. If the price drops low enough, pickers stop harvesting, leaving a large portion of the crop untouched. As the season wears on, and the distributor's stocks become low, the companies begin buying again. Meanwhile, picker-buyer relations have deteriorated as pickers become angry and frustrated with the buyers for not buying their nuts at a good price. Additionally, the quality of the nuts on the market deteriorates as winter weather moves in.

One long-time buyer points out that a consequence of this cycle is that there are never enough pinyon nuts to support a year-round market (Tanner and Greiser 1993). He suggests that a minimum floor price set by the states would dampen this cycle, resulting in more pinyon nuts being harvested in bumper crop years. If the states would simultaneously provide guarantees on loans to buyers in bumper years as they do for other masting tree crops, buyers could build up stocks to supply the market during years when crops are poor (Tanner and Greiser 1993). Pinyon storage itself does not carry a lot of risk, as properly "cured" pinyon nuts will store safely for 5-6 years (Tanner and Greiser 1993).

Primary markets for pinyon nuts

Pinyon nuts are sold locally and nationally. The local market (i.e., throughout the Southwest) is primarily for raw, unshelled nuts, while demand on the national market is for roasted unshelled nuts. Within the Southwest, subregional differences exist in pinyon nut preferences. People in Nevada and Utah prefer singleleaf pinyon nuts, which are twice as large as Colorado pinyon nuts and less sweet. People in New Mexico, Arizona, and Colorado, who are used to eating Colorado pinyon, find singleleaf pinyon nuts too mealy in texture and less tasty. The prolonged shortage of Colorado pinyon nuts during the past 10 years has prompted buyers to experiment with roasting and aging singleleaf pinyon nuts to give them a flavor and texture more similar to Colorado pinyon. Many pinyon distributors sell raw and value-added pinyon nut products, such as pinyon coffee and candies, to customers in cities along the eastern seaboard and on the West Coast.

One of the buyers we talked with was from a family who started out in the 1960s harvesting singleleaf pinyon nuts in Nevada and Utah. Over time, they shifted into brokering singleleaf pinyon. His firm sells most of their product in Utah, which is the single biggest market for singleleaf pinyon. The pinyon market there is heavily tied into the fall and winter holidays – Thanksgiving, Christmas, and New Year's. For many Utah families, serving pinyon nuts is a holiday tradition, and the market is strong from mid-October through New Year. After the New Year celebrations, sales drop to almost nothing until the next fall.

Market potential

The market of pine nuts and pine nut products in the U.S. has room for considerable expansion. Most imported pine nuts are sold as raw or roasted whole nuts for use in ingredients

in candies, pastries, and ethnic dishes, while pinyon nuts are more likely to be sold as a snack food. Whether made with imported pine nuts or native pinyon nuts, products such as pine nut oil, pine nut flour, pine nut milk, and pine nut coffee exist and are used extensively in some cultures (for example, pine nut oil in Russia, pine nut gruel in Korea, pine nut flour among the Navajo). Expanding these markets within the United States would require increasing the percentage of pinyon nut crops that reaches the market and implementing a strong marketing effort focused on increasing consumer awareness of both the range of pinyon products available and their nutritional benefits.

Pine nuts, including pinyon nuts, face competition from a variety of nuts grown in the United States, such as pecans, pistachios, chestnuts, and walnuts (Sharashkin and Gold 2004). However, the flavors and textures of Colorado pinyon and singleleaf pinyon nuts are sufficiently distinctive from other nuts that demand has remained strong despite their high price per pound compared to other types of U.S. grown nuts and the much less expensive imported pine nuts. One buyer said, “Colorado pinyon is the best of the best in terms of flavor, size and texture. It’s way above what you find in California, Mexico, or Europe. The Mexican pine nut shell is 3-5 times as strong, and you need a hammer to break them. China has a lot of pine nuts and they are great for cooking with but not so good to eat plain. And if you cook with our pinyon, the flavor is a lot better.”

Future of the pine nut industry

The outlook for the pine nut industry over the next ten years is generally optimistic. Demand on the domestic market for pinyon nuts is strong. It’s likely to grow with the move toward slow foods, heritage foods, and locally-produced foods, even if the price continues to

remain higher than prices of other pine nuts. The markets for pinyon nuts will likely continue to be in specialty foods and other niche markets as long as the price of imported pine nuts, especially those from China, remains low. Three factors, however, could change the trajectory of pinyon nuts on the domestic market. First, imported pine nuts may lose some of their competitive advantage over pinyon nuts if current rates of logging in China and Russia continue and the supply of nuts from those areas declines (Sharashkin and Gold 2004). Second, the supply of pine nuts available from China and Russia is likely to fall, and the prices of pine nuts imported are likely to rise as domestic markets and distributing networks in those countries expand. This is happening in Russia (Sharashkin and Gold 2004). Third, labor costs in China are likely to rise as that country's economic growth continues. Similarly, relatively inexpensive stone pine nuts from Turkey may also become more expensive if that country enters the European Union. Fourth, depending on how U.S. immigration policy changes over the next few years, the supply of labor for harvesting pinyon in the Southwest may expand as more immigrants from Mexico and Central America seek work in the United States.

Part VII – Policies and Laws

Reserved rights and customary claims to gathering sites on public lands

Native American reserved rights and customary claims to pinyon gathering sites overlay other policies, laws, and regulations governing pinyon nut harvesting on public lands throughout the Southwest. The Utes' rights to pinyon nuts are covered under the Bernot Agreement of 1873, in which the Southern Mountain Ute, the Ute Mountain Ute, and the Northern Ute retained hunting, fishing, and gathering rights over a large portion of western Colorado. Members of these three societies continue to exercise their gathering rights to pinyon nuts, but there is no data readily accessible on how much or where they do so. Numerous other Native American societies

have customary claims to pinyon nut harvesting in Colorado. At a minimum, efforts to expand commercial pinyon harvesting programs on BLM lands in Colorado would require consultation with the following Native American groups, and very likely others as well:

Southern Ute
Ute Mountain Ute
Northern Ute
Jicarilla Apache
Hopi
Navajo
Southern Cheyenne
Southern Arapaho
Pawnee
Pueblos in northern New Mexico

The continued cultural importance of pinyon nuts in modern-day Native American societies in the Southwest is exemplified in Public Law 100-225, which created the El Malpais National Monument in 1987. Title V of that law includes a provision requiring that monument managers "assure nonexclusive access to the Monument and Conservation area by the Indian people for traditional cultural and religious purposes, *including the harvesting of pine nuts* (italics added). In Nevada, the Western Shoshone (Newe), a federally unrecognized tribe, has been fighting for decades to have their claims over pinyon harvesting areas formally recognized (Clemmer 1985).

Federal resource access policies

Five federal agencies have management responsibility over large areas covered with pinyon-juniper forests in the Southwest: the Bureau of Land Management, the U.S. Forest Service, the National Park Service, the Bureau of Indian Affairs, and the Department of Defense. Much of this land is potentially open to pinyon harvesting, depending on whether the harvester intends to sell the nuts commercially, keep them for future household consumption, give them as

gifts, exchange them for other goods and services, or consume them on the spot. The policies for Department of Defense lands differ for each military reservation, as do policies for lands administered by the Bureau of Indian Affairs. Given the large number of military and Indian reservations in the Southwest, describing those policies is beyond the scope of this report. Some variation exists in policies and regulations for pinyon harvesting on national forests, BLM managed lands, and national parks. However, the rules are sufficiently generalized that they can be summarized for each land management category.

National Parks – Harvesting plant resources, including pinyon nuts, for use elsewhere is generally prohibited in national parks (Antypas et al. 2002). However, in many national parks visitors can sample small amounts of fruits, berries, nuts, and mushrooms of species not considered threatened or endangered. Native Americans can exercise subsistence and religious harvesting rights in national parks if such rights are protected by treaties. The American Indian Religious Freedom Act (42 USC 1996) further protects the rights of Native Americans to harvest culturally sacred plants on all federal lands, including in national parks, irrespective of the existence of a treaty. In some national parks, such as the Great Basin National Park, any visitor can gather pinyon nuts for personal, non-commercial use (Great Basin National Park, no date). The Great Basin National Park limits personal use gathering to 25 pounds per household per year.

Bureau of Land Management and U.S. Forest Service

Cross-agency collaboration

Unlike the National Park Service, whose management mandate is primarily protectionist, the BLM and the U.S. Forest Service have similar dual mandates: to manage resources sustainably while providing access to those resources for commercial exchange and household consumption. The two agencies operated largely independently of each other for most of the 20th century and continue to operate under distinct management authorities. Since the 1990s, when federal agencies adopted ecosystem management as a guiding principle for the planning and implementation of resource management, the two agencies have increasingly coordinated with each other to ensure consistency in the rules governing access to resources on adjoining BLM and Forest Service lands. In the pinyon nut world, this move toward coordinated management has resulted in fairly similar regulations across much of the Southwest.

Categories of harvesting and types of permits

Both the BLM and the Forest Service assign harvesting activities to one of three categories--incidental use, personal use, or commercial use--according to the amounts harvested and whether and how much of the product is harvested for commercial exchange. In many areas, the following rules apply.

- **Incidental use**: Incidental use is the harvesting of pinyon nuts for personal consumption or gift exchange that takes place on the spot or later that day. Neither agency typically requires a permit for incidental use.
- **Personal use (non-commercial)**: Personal use is the harvesting of relatively small amounts of pinyon nuts, where the harvester does not intend to sell the product. The amount varies from as little as 25 pounds per year on BLM and Forest Service lands in

Nevada and western Utah (i.e., singleleaf pinyon country) to 75 pounds per year on most BLM and Forest Service lands in Colorado and northern New Mexico (i.e., Colorado pinyon country). Neither agency charges a fee or requires a written permit for harvesting activities that fall within the definition of personal use.

- **"Commercial" permits**: Commercial use permits are issued for amounts exceeding the personal use limit, even if the nuts are not intended for commercial exchange. Permit prices vary slightly across the region. For example, in Nevada and Utah, BLM field offices charge 25 cents per pound for commercial permits, with a minimum charge of $10. In Colorado, BLM field offices and national forests charge 20 cents per pound for commercial permits, with a minimum charge of $20.[4] A commercial permit from a BLM office in Nevada or western Utah authorizes the holder to remove pine nuts from the geographic area designated on the permit. Other commercial pickers cannot pick pinyon nuts in an area already permitted out. However, individuals and families picking for personal use may harvest in areas for which commercial permits have been issued. Permit holders are required to record the quantity of nuts they harvest and must turn those records over to the BLM within 15 days of completing the picking operation. In theory, a similar set of rules applies to commercial pinyon harvesting on BLM lands in Colorado. However, BLM field offices in Colorado receive very few requests for commercial pinyon nut permits and for all practical purposes do not regulate the commercial harvest. Key informants at the Colorado field offices believe that some unpermitted commercial

[4] Most national forests and BLM offices in Colorado have been combined under "service first" offices, known as public lands centers. To maintain consistency for forest users, agency offices have adopted similar pricing structures for nontimber forest products, including pinyon nuts.

harvesting takes place most years in many parts of Colorado but that the scale of harvesting is insufficiently large and competition insufficiently intense to warrant additional enforcement.

Sealed Bid Permits

Some BLM and Forest Service offices use sealed bid auctions to allocate access to commercial pinyon nut harvesting sites. The BLM began using sealed bid auctions for pinyon harvesting sites in its Nevada field offices during the mid-1990s when Colorado pinyon supplies became scarce and demand for singleleaf pinyon increased. Most BLM field offices and Forest Service ranger districts in Nevada and western Utah with singleleaf pinyon crops now use a combination of sealed bid auctions and “walk-in” commercial permits. Auctions are used in areas where intense competition exists for commercial harvest, and where a competitive bid system will result in higher revenues. Any commercial units that are not sold via the bid process are available for "walk-in" permits. The permit, however, uses the same form and contract stipulations whether bid or walk in. Another important change since the mid-1990s is that BLM field offices in Nevada have closed some areas to commercial harvest at the request of Native American groups with traditional claims to those sites.

Harvest permit data

Neither the BLM or Forest Service provide publicly available tabulations of the numbers of pinyon nut permits they issue or the revenues that they receive from the sale of such permits and leases each year. However, we were able to obtain standard commercial permit data from the BLM for the states of Arizona, Colorado, Nevada, New Mexico, and Utah from the agency’s science center (Watson 2007). In addition, we had access to email reports from BLM offices in

Nevada and Utah regarding the number and value of pinyon nut harvesting auctions in 2006 (Page 2006; Podborny 2006).

Pinyon permit data from the Forest Service are more complicated and time-consuming to obtain since permit data for special forest products are apparently not housed in a centralized location and each region must be approached separately. Due to time and budget constraints, we limited our search for pinyon nut permit data to national forests located in Colorado. However, we were cautioned that permit data likely represents only a fraction of the actual commercial harvesting taking place on national forests (Thinnes 2007).

Very few people obtain commercial permits to harvest pinyon nuts on national forests in Colorado. Only two national forests in Colorado – the Rio Grande and the San Juan – issued commercial permits for pinyon nuts between 2003 and 2006 (see table 13). The vast majority of permitted activity took place on the Rio Grande National Forest. Staff members interviewed on these forests indicated that much better pinyon nut gathering areas are located on adjacent lower-elevation land administered by the BLM or the state of Colorado.

The BLM provided a database containing data on commercial permits sold for seeds and cones for the states of Arizona, Colorado, Nevada, New Mexico, and Utah from 1998 to 2006 (BLM Science Center 2007). As with the national forest permit data, the number of permits issued by BLM offices for pinyon nut harvesting likely represents only a small percent of the commercial activity taking place (Watson 2007). BLM offices in Colorado, New Mexico, and Arizona lumped together sales of seeds and cones of all species. It is thus impossible to determine how much of the permitted activity in seeds and cones taking place on BLM lands in these three states revolves around pinyon nuts. Our interviews with BLM field staff in Colorado,

however, indicated that the number of commercial and personal use permits issued for pinyon nut harvesting each year in that state is very small (see table 14).

Some of the BLM offices in Nevada and Utah distinguished between pinyon nuts and other types of seeds when issuing permits. The data indicate that demand for pinyon nut permits fluctuates significantly from year to year--from a low of no permits purchased in 2001, 2002, and 2003 to a high of 62 permits in 2005. The total revenue from pinyon nut permits issued by the BLM in Nevada and Utah from 1998 to 2006 was $31,889. In addition, BLM offices in these two states held auctions for some pinyon nut sites. In 2006, the only year for which auction data was readily available, BLM offices in Nevada and Utah awarded 17 singleleaf pinyon permits by sealed bid auction to seven different buyers (see table 15). The BLM received $33,052 for these permits.

Differences in receipt retention policies

One key difference between the BLM and the Forest Service with respect to their sales of nontimber forest products is that beginning in 2006, a large percentage of the Forest Service's receipts from the sale of such products remains in the ranger districts where the products are sold.[5] These funds must be used to administer the ranger districts' nontimber forest product programs, including funding any required environmental assessments or impact statements associated with the sales program, enforcement, inventories and monitoring, and efforts to improve product yields and quality. It is too early to determine whether retaining receipts locally will improve the quality and availability of pinyon nut crops on national forest lands. BLM's authority to retain receipts from the sales of any products is limited to retaining 50 percent, all of

[5] Prior to 2006, receipts from sales of nontimber forest products were sent to the general treasury, and monies for managing nontimber forest products either had to come out of congressional appropriations or, more commonly, from Knutsen-Vandenberg Act funds if the funded activities fell within the realm of reforestation.

which must go toward road maintenance and repairs. The Nevada field offices, however, typically retain between 20 and 30 percent of their receipts from pinyon nut sales, and none of this money can be spent on administering the pinyon nut program. One BLM manager pointed out that retaining receipts for program administration carries with it a risk that local administrators might abuse the system by selling more product than is sustainable over the long term.

Concerns over pinyon nut programs

Given our project's short timeframe and small budget, the number and types of stakeholders we could feasibly interview was limited. It is therefore difficult to develop a comprehensive understanding of the aspects of pinyon nut management that are of concern to a broad range of stakeholders. Based on interviews with a small number of dealers we identified four areas of concern among that set of stakeholders. Additional work is needed to develop a more comprehensive list that includes input from more individuals and a much broader set of stakeholders.

1) Land managers' unfamiliarity with pinyon nut management

A challenge several dealers mentioned was that BLM and Forest Service managers lacked familiarity with pinyon ecology and seed production. Frequent turnover in personnel have contributed to this problem. One dealer said, "We just start to get people in there who know something about pinyon, and then there is a big change in personnel. And the new people who come know nothing about pinyon." He described the practical negative consequences of this unfamiliarity on the economic viability of commercial harvest operations:

> The BLM and Forest Service need to do studies so they know where the pinyon nut crops are. Pinyon trees grow at 6,000 to 7,500 feet. The maps are there and the knowledge is there. They could drive around and fly through to find out where the pinyon crops are.
>
> Some government officials make bid areas that are very small--20 miles by 40 miles. But a bid area needs to be bigger than that. Sometimes the production is at the high elevations, up at 7,500 feet. And sometimes it is down at 6,500 feet. Just because you have pinyon trees in an area doesn't mean that the whole area has nut production.

All of the dealers spoke bitterly about the negative and long-lasting ecological impacts of the federal government's decades-long policy of ripping out pinyon trees to make pasture lands. They, as well as a number of the agency foresters we interviewed, felt that the negative attitude toward pinyon was still widespread among the land management agencies and constituted a major barrier to sustainable pinyon management.

2) Balancing Native American claims and commercial harvester needs

One long-time buyer expressed a concern about the BLM's relatively recent policy of setting aside large areas of pinyon grounds for Native American use. His concern was not that areas had been set aside for the tribes, but that the overall amount of land area in set-asides was such that it placed the commercial harvest in jeopardy. He suggested that in establishing future set-asides, it would be helpful to bring together all the stakeholders to work out a system that could work for everyone.

3) Road access

A third concern expressed by most of the dealers we interviewed was that the most recent round of road closures and off-road vehicle restrictions was going to make it difficult and costly

for pickers to make a living since many of the more productive trees are in remote, less well-roaded areas.

4) Federal agencies' lack of knowledge of the value of pinyon nuts

Several dealers attributed land managers' persistence in giving little priority to pinyon nut management to their lack of understanding of the market value of pinyon nuts harvested on the lands they administered. The lack of understanding was in turn linked to their inability to track the actual quantities of pinyon nuts coming off the land. One dealer said, "The biggest obstacle to protecting pinyon adequately [i.e., protecting it from being chipped up or removed indiscriminately in fuels management projects] is BLM's lack of understanding of the value of the resource." Another dealer pointed out that this didn't mean that the land management agencies shouldn't thin out the existing pinyon stands, but rather that they needed to understand how to select productive nut bearing leave trees and what spacings work best for creating healthy and productive pinyon-juniper ecosystems.

State lands

State lands in all of the southwestern states are another source of pinyon nuts. Regulations governing access to these lands vary by state and by the type of management regime governing particular parcels of state-owned lands. We did not have the time to examine state policies outside of Colorado. In Colorado it is possible to lease lands for commercial pinyon harvesting, but no one has ever requested such a lease. One state land manager in Colorado said,

> We would consider permitting for any commercial harvest. For pinyon nuts it wouldn't have to be any different than doing a commercial lease for grass seeds, which we've leased out. The Forest Service handles all of our timber program, but this would be more like grass seeds, so we would handle it ourselves. We'd have to see how big a harvest there was and make a deal with the lessor and the harvester. We'd handle it as a temporary permission for harvesting on the land under grazing lease.

In southern Colorado, people do pick pinyon nuts on state lands, but not on a commercial scale.

Private Lands

We did not have the time or resources to determine the importance to the overall pinyon market of pinyon groves located on private land. Several of the dealers we interviewed said that private landowners are often reluctant to allow pinyon harvesting on their lands. Some of the reluctance is linked to the widespread perception among ranchers that pinyon trees are worthless weeds; others are concerned about liability if a picker gets hurt while harvesting on their land.

State economic development policies

Economic development policies designed to support the pinyon nut industry are virtually non-existent. New Mexico is the only southwestern state that has actively sought to encourage pinyon nut harvesting and marketing. In 1987, the New Mexico state legislature passed the Pinyon Nut Act (NMSA 1978 Sec. 25-10-1 to 25-10-5 (1987)) to support the development of the state's pinyon industry. The act made it illegal for anyone to label and sell pine nuts from species other than pinyon as pinyon nuts. The law also requires that products labeled as pinyon products actually include pinyon nuts as ingredients. The following species are considered pinyon under this law:

P. cembroides	Mexican pinyon
P. culminicola	Potosi pinyon
P. discolor	Border pinyon
P. edulis	Colorado pinyon
P. johannis	Johann's pinyon
P. monophylla	Singleleaf pinyon
P. orizabensis	Orizaba pinyon
*P. quadrifoli*a	Parry pinyon
P. remota	Texas pinyon or papershell pinyon

The Pinon Act sought to create a policy environment that would allow local pinyon nut products to compete with imported pine nuts through branding themselves as distinct from their imported competitors. The law includes provisions for the New Mexico Department of Agriculture to examine the purchase and sales records of pinyon sellers to determine whether their products actually include pinyon nuts. The Pinon Act also established a genetic research program for pinyon nuts. New Mexico State University was charged with carrying out this program, which was to include:

- Developing seed sources for faster growing pinyon trees, identifying ways to limit pinyon diseases, conducting a nutritional analysis of pinyon nuts,
- Developing methods for storing shelled and unshelled pinyon nuts
- Conducting a market study to identify market opportunities for New Mexico's pinyon crop
- Researching technology for harvesting and shelling pinyons

The New Mexico state legislature provided funding for these activities in the first few years after the Pinon Act's passage, but since the mid-1990s, both the labeling regulations and research program have not been funded. Key informants attributed the lack of funding to a change in the composition of the legislative body in 1994.

VIII -- Managing for Pinyon Nuts

The notion of managing pinyon-juniper ecosystems for large-scale nut production is neither new nor far-fetched. In the Mediterranean region, humans have managed stone pine (*Pinus pinea)* for its edible nuts for at least 6000 years (Wikipedia 2007). In Spain, Portugal, and Italy, stone pine stands under cultivation today are thinned and treated against insects to enhance

seed production (Calama and Montero 2007). Chinese scientists have recently completed an applied research project to identify harvesting guidelines for managing Korean pines for timber and nut production simultaneously (Shen 2003). In North America, peoples in California, the Great Basin, and the Colorado Plateau nurtured prolific nut bearing groves by raking litter and duff away from nut-bearing trees to protect them from fire, weeding vegetation from around pinyon trees to decrease moisture competition, pruning away lower branches to reduce the risk of fire and enhance nut production, and selecting trees past their nut-bearing years for fuelwood (Anderson 2002, Litzinger 2003, Nabhan et al. 2004: 20).

The idea of managing pinyon-juniper woodlands for nut production is not new to federal land management agencies in the Southwest. In 1941, Elbert Little, a dendrologist with the U.S. Forest Service, produced a botanical note entitled "Managing Woodlands for Pinon Nuts" (Little 1993). In the post-World War II housing and ranching boom, wood and livestock forage production won out over nut production. Fifty years later, Little, joined by other scientists, once again suggested that federal and state land management agencies manage pinyon-juniper ecosystems for nut production. A prolonged drought, a series of intensive wildfire seasons, and widespread and chronic disinvestment in federal land management diverted the attention of managers once again as they sought instead to patch up the holes in the existing management systems. Now with global warming and potentially catastrophic climate change looming before us, we suggest that the time is here for land managers to finally take Little's suggestions seriously.

A pinyon-juniper ecosystems management approach that has pinyon nut production at its core must be able to deal with the following realities of pinyon biology, ecology, and culture.

1. Variability

A key characteristic of pinyon trees, and especially Colorado pinyon, is the variability in their seed production over time and space. One key informant, a horticulturalist who has studied pinyon trees for three decades summarizes the management "problem" this presents: "It's cyclical *and not neatly cyclical*." From a policy standpoint, this suggests the need to construct policies predicated on a cyclical and not neatly cyclical reproductive strategy. One anthropologist sums up what this means in practice:

> "…given the fluctuations in nut production…it would be unwise for us to consider, in any fashion, policies that would assign collecting rights to specific groups and populations in specific areas. Those groups would simply follow the boom and bust cycles of the pinons in those areas that they are assigned. It would be far better for us to allow harvesting of all areas that are available and productive in any one year." (Ackerly 1991:64).

Unfortunately, managing natural resources by fixing people (and their collecting rights) in time and space is precisely how land managers in industrialized societies are trained to operate (McLain, in press). Indeed, fixing people in time and place is the fundamental principle that underlies virtually all social and natural resource management realms. But unless we can figure out how to allocate harvesting rights in ways that are shaped around the nature of the resource itself, rather than on what is administratively efficient in the short run, it is probable that 30 years from now we will find that our pinyon-juniper ecosystems continue to degrade. This leads to the second key reality of managing pinyon-juniper ecosytems; the need to move beyond the two management myths that have dominated natural resource management in the Southwest for the past century.

2. Moving beyond myth

Litzinger (2003) sums up two management myths that must be overcome if we are to move beyond a band-aid approach to managing pinyon-juniper ecosystems and restore those ecosystems to a long-term healthy state. The first is that pinyon nuts are a sporadic resource with commercial potential only in mast years, and that therefore it is not worth including nut production as a high management priority. This view fails to acknowledge the potential yield of pinyon seed crops over a long period. Moreover, it denies that to a significant degree, pinyons *are* the heart of the ecosystem: if the pinyons do poorly, so will a large number of mammals, birds, insects, reptiles, and plants. One Hispano picker summed this up by saying, "With the pinyon crop you can see the pulse of the forest. The year after the pinyon, you should see the mice. Then the coyotes. Then the raptors. It comes in a huge pulse, and it all goes back to the pinyon."

The second and related management myth is that pinyon-juniper woodlands aren't a productive use of the land (Litzinger 2003). This is the myth that underlaid the 50-year effort to eradicate pinyon from the most productive pinyon-growing sites in the landscape and replace them with non-native grasses. Fortunately, this myth lost some of its power in the wake of ecological studies that clearly demonstrate the negative consequences of manipulating the pinyon-juniper environment to achieve short-term economic objectives. As the number increases of land managers trained in non-equilibrium ecology who understand the critical role that pinyon trees play in pinyon-juniper ecosystems, the prospects are good that future management actions will be more regionally appropriate and more likely to be sustainable over the long term.

3) Humans as a positive force in pinyon-juniper ecosystems

The pinyon nut has a very special place in dozens of cultural systems of the Southwest, just as it does in the ecological system. Indeed, it is quite possible that the relationship is reciprocal; as long as humans and pinyon trees have coexisted in the Southwest, their lives have been intertwined. Given what ecologists now know about the positive roles that humans have played in fostering the development and spread of treed landscapes in the African Sahel, it is possible that pinyon-juniper ecosystems are also anthropogenic (human derived) systems. If so, the long-term health of these systems may depend upon the continued involvement of humans in harvesting and dispersing pinyon seeds, as well as upon nurturing actions by humans that enable pinyon seedlings to survive and mature trees to expand their production of viable seeds.

The cultural significances of the pinyon tree in general and the pinyon nut in particular must be taken into account if viable approaches to managing pinyon-juniper ecosystems are to be implemented. In the case of the pinyon, this means recognizing not merely use rights formalized through treaties, but also acknowledging the importance of customary claims to pinyon nuts that many peoples have developed over time in many parts of the Southwest. It may well also mean that encouraging pinyon nut harvesting (and associated stewardship behaviors that enable pinyons to thrive), whether for household consumption or commercial exchange, is the best course of action that land managers could take.

Management strategies

Managing pinyon juniper ecosystems sustainably requires treating a significant portion of pinyon forests as nut orchards rather than as rangelands (Lanner 1993). The first step in developing such orchards is to identify mixed aged stands of pinyons located on flat ground

with deep soils. Such sites have the best potential for becoming productive nut orchards in a relatively short time.

Ideally, these sites would be managed using horticultural techniques such as irrigation, fertilization, pest management, and plant breeding and propagation techniques aimed at developing rapidly maturing trees that produce frequent and prolific crops of large, thin-shelled nuts. Developing and implementing these techniques would require establishing a research and extension program encompassing a variety of topics including pinyon genetics, selective breeding for an array of desired qualities, crop storage, shelling technology, and marketing. However, federal and state agencies currently do not have the capacity to implement such an intensive management approach, nor are they likely to in the foreseeable future. The following best management practices thus focus on how managers can achieve pinyon nut production objectives within the existing management and research context.

Selective thinning - Very densely spaced stands of pinyons do not provide room for the trees to develop free-spreading crowns capable of producing large quantities of nuts (Little 1977; Fisher 1993). Judicious thinning in such stands can enhance nut production, but results are likely to be most effective in mixed aged stands on highly productive growing sites. When thinning for nut production, the objective is to select the best nut producers as leave trees. Pinyon trees with large spreading crowns and lots of old cones on the grounds are typically the most prolific nutbearers (Mexal 1993).

Pruning lower branches - Pruning the lower branches of a pinyon tree decreases the risk of fire damage and makes trees less susceptible to infections and pests that affect cone crops.

Weeding or clearing away shrubs - Judicious weeding of large shrubs that form fuel ladders decreases the risk of fire damage and makes trees less susceptible to infections and pests that affect cone crops. .

Fertilization - The addition of fertilizer, particularly nitrate nitrogen, stimulates cone production (Fisher and Montano 1977). However, applying chemical fertilizer would likely be too costly, too labor intensive, ecologically questionable, and certainly politically contentious. However, future research might investigate whether the presence of a limited number of domesticated livestock and their manure in pinyon-juniper woodlands positively affects pinyon cone production. Evidence from Africa indicates that domesticated livestock can play an important role in fertilizing trees and crops in semi-arid environments.

Irrigation - Increasing the amount of water available to pinyon trees can also enhance nut production. However, the construction of elaborate irrigation systems is not a very practical alternative in a region experiencing chronic water shortages and conflicts over management activities that involve significant sub-surface disturbance. Horticulturalists have suggested the use of very shallow ditching techniques that direct small but critical amounts of water to individual trees as a low-cost, low impact alternative. Indigenous water diversion systems in use for centuries on the Colorado Plateau could serve as models for such low-impact pinyon irrigation systems.

Managing for nut production: a range of benefits

Including pinyon nut production as a goal of management for pinyon-juniper ecosystems is compatible with a variety of other management objectives. Thinning stands of pinyon, for example, would simultaneously provide fuelwood or wood chips while creating environmental conditions favorable to increased nut production by the pinyon trees left on site. Smaller pinyons could also be thinned out for Christmas trees and transplants (Fisher and Montano 1977). Another argument in favor of managing pinyon juniper ecosystems for nut production is that doing so would provide a very wide range of benefits, ranging from ecological to economic to cultural (see Table 15).

Part IX - Moving Forward

Integrating local and traditional ecological knowledge with scientific management - Limited scientific information exists on how indigenous peoples of the Southwest manipulated native plants, including pinyon pines. It is likely that sedentary peoples, such as the Pueblo, Hopi, and Zuni, manipulated pinyon-juniper woodlands since they would have needed construction materials, fuels and pinyon nuts (Litzinger 2003). A substantial body of literature has recently emerged on how scientific knowledge and traditional ecological knowledge can complement each other (Charnley et al. in press, Moller et al. 2004). A first step in understanding how to manage for healthy pinyon-juniper ecosystems is to develop partnerships with the Native American societies likely to have developed relevant ecological knowledge for producing and maintaining numerous pinyon nut groves dispersed across the landscape.

Regional pinyon nut crop forecasting – From 1938 to 1948, every year Forest Service rangers in the Southwest identified nut crop locations and estimated the size of the crops in each harvesting site. They distributed this information to pinyon nut traders as a mimeographed report (Little 1993). With the transportation and communication systems we have today, it should be feasible to set up a similar forecasting system and to circulate the information broadly and inexpensively by posting the information on National Forest and BLM field office websites. Ideally, the information would also be posted to a centralized and jointly managed website devoted to pinyon nut harvesting and management. Eventually the website could be expanded to include other landowners, such as state land offices and private landowners.

Participatory inventory and monitoring – Many pinyon nut pickers and buyers have difficulty obtaining information from land managers about the location of nut bearing trees and their age and yield characteristics. At the same time, land managers lack information about the extent and impacts of pinyon harvesting on the lands they administer. Participatory inventory and monitoring systems involving partnerships between land management agencies, harvesters, and other interested stakeholders could help fill these information gaps. Such systems have been used successfully in a variety of natural resource management contexts in the United States and Canada (Pilz et al. 2006).

In the pinyon nut sector, participatory inventory and management programs could address questions of interest to pickers, dealers, and land managers alike:

How much area is in pinyon?
How many trees are pinyons?
What age classes are they and where?
What are their cone bearing qualities?
What are their seed yields?
Where are there concentrations of high-yield nut bearing trees?
How have seed yields varied with climatic conditions over time?
What impacts, if any, have harvesting efforts had on yields?

The centralized website used to post regional crop forecasts could serve as the distribution venue for the information obtained through such an effort. Data on the impacts of various harvesting practices could also be collected and made available. Over the long term, gathering and disseminating this type of information has the potential to improve the viability of both the household consumption and commercial pinyon nut sectors. It would also provide land managers with a much better understanding of the overall reproductive health of pinyon populations, and could help identify areas where management interventions might be useful to deal with insect epidemics. In short, putting into place such a tracking system could help all interested stakeholders “read the pulse” of the pinyon-juniper ecosystem.

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Tables

Table 1 -- Nutritive value of pine nuts from five pine species

Scientific name	Common name	Protein (%)	Fat (%)	Carbohydrate (%)	Fiber (%)	Ash (%)	Moisture (%)
P. edulis	Colorado pinyon	14.3	61	18.1	1.1	2.7	3.0
P. monophylla	Singleleaf pinyon	9.5	23	54	1.1	2.4	10.2
P. pinea	Italian stone pine	34	48	6.5	1.4	-	-
P. sibirica	Siberian pine	17	60-64	12	-	-	-
P. gerardiana	Korean pine	17-18	65-67	12	4.8	2.2	4.4

Note: Figures are approximate and based on shelled nuts; dashes indicate no data available.
Source: Lopez-Mata 2001: 608.

Table 2 – Nutritional value of one ounce of *Pinus edulis* nuts, butter, and beef steak

	Calories	% Protein	% Carbohydrate	% Fat
Colorado pinyon nut[a]	178	14.3	18.1	61
Butter	204	0.0	0.0	100.0
Lean beefsteak	21	81.1	0.0	18.9

Sources: Lopez-Mata 2001: 608; USDA, Agricultural Research Service 2006.

Table 3 - Timeline of Pinyon Use and Management in the Southwest

Time period	Pinyon use, management and ecological impacts of other land use activities
~ 4000 BC	Earliest evidence of humans eating pinyon nuts in the Southwest.
Pre-1600s	Native American societies in the Southwest rely on pinyon for food, fuel, medicine, building materials, and other uses; pinyon nut and tree is an important cultural element as well as a food. Sedentarized village populations harvest pinyon trees intensively for building materials and firewood; possibly contributing to collapse of Anasazi civilization in the 1300s.
1600s – 1850s	Hispanos establish settlements in New Mexico and parts of Colorado and Arizona; pinyon nuts integrated into Hispano diet and cultural traditions. Introduction of domesticated cattle, sheep, and goats and extensive grazing. Pinyon trees cut down for firewood, building materials, fencing, mine supports, and smelting operations.
1840s-1920s	Euroamericans and European immigrants begin moving into the Southwest; numbers accelerate rapidly in 1870s. Pinyon trees cut down for railroad ties, mine supports, smelting operations, fuelwood, and fencing. Sheep and cattle herds expand; intense grazing through much of the Southwest.
1900 – 1940	National trade in pinyon nuts develops with large volumes sent annually to New York, Los Angeles, and Chicago. U.S. Forest Service funds research on pinyon nut production in Arizona (1930s and early 1940s).
1950s-1970s	Range ecologists, foresters, and ranchers view pinyon trees as invasive species. Large scale clearing of mature pinyon takes place on public lands to convert woodlands to grasslands. Decline the numbers of pinyon nut harvesters as new economic opportunities open up to Navajos. Poor pinyon crops through the 1950s due to severe drought conditions. Domestic demand for pinyon nuts declines.
1970s – 1980s	During 1970s oil crises, the demand for pinyon firewood expands. Public agencies reduce pinyon clearing efforts. Domestic market for pinyon nuts expands. U.S. Forest Service funds research on pinyon-juniper woodlands. China begins to export pine nuts to the U.S. in the 1980s.
1990s - 2004	Prolonged drought in Colorado, New Mexico, and Arizona. Poor commercial harvests for Colorado pinyon (*Pinus Edulis).* Pinyon die-off across the region. Pinenuts from China imported to U.S. on large scale. U.S. demand for pine nuts remains strong.

Table 4 - BLM Efforts to Convert Pinyon Juniper to Grasslands (1950-2002)

State	Total known acres treated	Total known and estimated acres treated
Arizona	143,066	148,207
Colorado	161,327	165,184
New Mexico	56,294	59,965
Utah	339,575	352,363
Total	**700,262**	**722,719**

Source: P-J Wood 2006.

Table 5 -- Characteristics of 6 Varieties of Pine Nuts

Species – Latin name	Common names	Main producing countries[a]	Size of seeds
Pinus gerardiana	Chilgoza pine	Afghanistan Pakistan Northern India	> 20 mm[b]
Pinus koraiensis	Korean or red pine	China Korea Mongolia Russia	12-16 mm[c]
Pinus pinea	Stone pine, Italian stone pine	Spain Portugal Italy Turkey	15-20 mm[b]
Pinus sibirica	Siberian pine, Russian cedar	Russia	10 mm[c]
Pinus edulis Engelm.	Pinyon, Colorado pinyon, common pinyon, nut pine, two-needle pinyon, two-leaf pinyon	United States - Colorado - New Mexico - Arizona - Utah	10-15 mm[b]
Pinus monophylla Torr. & Frem.	Pinyon, singleleaf pinyon, one-leaf pine, nut pine	United States - Nevada - Utah	15-20mm[b]

Sources: [a]Ciesla 1998, [b]Earle 2007, [c]Missouri Botanical Garden 1999.

Table 6 - Value of prepared pine nut products exported from the U.S. (1989-2006)	
Country	**Total ($US)**
Canada	69,005
Singapore	51,908
Mexico	50,383
Bermuda	20,868
Ecuador	16,277
Republic of Korea	14,644
Leeward-Windward Islands	7,892
Russian Federation	3,288
Costa Rica	3,177
French Pacific Islands	2,592
TOTAL	**240,034**

Source: USDA, Foreign Agricultural Service 2007.

Table 7 - Quantity of prepared pine nut products exported from the U.S. (1989-2006)	
Country	**Total (Metric Tons)**
Bermuda	2
Canada	22.8
Costa Rica	0.2
Ecuador	5.2
Republic of Korea	5.3
Mexico	16
Russian Federation	0.2
Leeward-Windward Islands	4.5
French Pacific Islands	0.3
Singapore	7.8
Total	**64.4**

Source: USDA, Foreign Agricultural Service 2007.

Table 8 - Value of In-Shell Pine Nut Imports to the U.S. (1989-2006)	
Country	**Value ($US)**
China	6,007,491
Portugal	277,641
Pakistan	265,242
Turkey	250,051
Afghanistan	94,430
Spain	69,504
Bolivia	53,196
Korea	44,162
Italy	23,359
Netherlands	18,689
Russian Federation	5,550
New Zealand	2,086
Total	**7,111,401**

Note: China import data include Republic of China and Hong Kong imports
Source: USDA, Foreign Agricultural Service 2007.

Table 9 - Value of Shelled Pine Nut Imports to the U.S. (1989-2006)	
Country	**Value ($US)**
China	337,308,735
Spain	13,215,160
Portugal	11,942,458
Turkey	9,597,974
Pakistan	7,723,783
Switzerland	816,127
France	378,600
Taiwan	247,678
Netherlands	241,968
United Kingdom	219,855
Italy	191,305
Macau	181,284
Japan	174,208
Russian Federation	162,301
Brazil	156,105
Mexico	37,485
Canada	33,295
Lebanon	9,990
Colombia	8,415
Total	**382,646,726**

Note: China import data include Republic of China and Hong Kong imports.
Source: USDA, Foreign Agricultural Service 2007.

Table 10 - In-Shell Pine Nut Imports to the U.S. (1989-2006)	
Country	**Metric Tons**
China	3332.3
Portugal	211.4
Turkey	199.3
Afghanistan	85.7
Pakistan	44.3
Republic of Korea	40.1
Spain	19.2
Bolivia	15.6
Netherlands	10.8
Italy	4.8
Russian Federation	3
New Zealand	0.2
Total	3966.7

Note: China import data include Republic of China and Hong Kong imports
Source: USDA, Foreign Agricultural Service 2007.

Table 11- Shelled Pine Nut Imports to the U.S. (1989-2006)	
Country	**Metric Tons**
China	41,244.4
Spain	916.6
Portugal	870
Pakistan	807.7
Turkey	734.9
Switzerland	93.5
Taiwan	30.4
France	29.3
United Kingdom	25.3
Macau	25
Netherlands	15.2
India	15
Brazil	14.7
Japan	13.7
Russian Federation	12.9
Italy	10.1
Canada	5.1
Mexico	5
Lebanon	1.5
Columbia	1
Total	**44,871**

Note: China import data include Republic of China and Hong Kong imports
Source: USDA, Foreign Agricultural Service 2007.

Table 12 - Spot Prices for Pine Nuts, including Pinyon Nuts on April 27, 2007

Product	Source	Price (dollars per pound	Type of Seller
Pine nuts, whole, raw, shelled, organic	not given	28.44	Gourmet food supplier, retail/wholesale
Pine nuts, whole, raw, shelled	not given	15.90	Natural food supplier, wholesale
Pine nuts, whole, raw, shelled, organic	not given	13.99	Nut supplier, retail/wholesale
Pine nuts, whole, raw, shelled	not given	13.99	Gourmet food supplier, retail/wholesale
Pine nuts, whole, raw, shelled	not given	13.90	Nut supplier (Diamond), retail/wholesale
Pine nuts, whole, raw, shelled	China	12.10	Health food site, retail
Pine nuts, whole, raw, shelled	not given	11.99	Nut supplier, retail/wholesale
Pine nuts, whole, raw, shelled - kosher	not given	11.99	Fine foods, retail/wholesale
Pine nuts, whole, raw, shelled	not given	11.99	Nut supplier, retail/wholesale
Pine nuts, whole, raw, shelled	China	8.69	Nut supplier, wholesale
Pinyon nuts, hard shell, raw, in shell	Southwest	25.00	Regional foods, retail
Pinyon nuts, soft shell, raw, whole, in shell	Southwest	11.00	Pinyon nut business
Pinyon nuts, roasted, salted, shelled	Southwest	30.40	Regional foods, retail
Pinyon nuts, hard shell, roasted, salted, in shell	Southwest	24.95	Pinyon nut business; food services supplier also retail
Pinyon nuts, whole, roasted in shell	Southwest	17.77	Jerky company, retail/wholesale
Pinyon nuts, hard shell, roasted, salted, in shell	Southwest	15.95	Pinyon nut business
Pine nuts, raw, in shell (parrot food)	not given	5.97	Pet food store, retail

Source: Information obtained from an internet search of pinyon nut business websites. 2007, April 27.

Table 13 - Commercial Pinyon Nut Permits Issued on National Forests in Colorado (2003-2006)				
Year	**National Forest**	**Quantity (lbs)**	**Value ($)**	**Number of permits**
2003	Rio Grande	110	110	5
2004	Rio Grande	640	640	32
2005	Rio Grande	310	310	15
2006	Rio Grande	60	60	3
2006	San Juan	11	22	1
	Total	**1131**	**1142**	**56**

Source: Thinnes 2007.

Table 14 – Demand for Pinyon Permits on BLM-Administered Lands in Colorado

Location	Personal use	Commercial use
White River Field Office	Much personal use in good years, but typically pickers do not get permits	No demand for commercial permits; commercial picking likely occurs but limited
Royal Gorge Field Office	Much personal use in good years, but typically pickers do not get permits	Very few requests for commercial permits; commercial picking likely occurs but limited
Grand Junction Field Office	Very few requests for personal use permits; personal use picking likely occurs in good years	Very few requests for permits, don't know whether commercial picking takes place
Glenwood Springs Field Office	No requests for personal use permits in recent years	No requests in recent years
Uncompaghre Field Office	Much personal use in good years, but typically pickers do not get permits	Very few requests for permits, not aware of any commercial harvest in area
San Juan Public Lands Center	Much personal use in good years, but typically pickers do not get permits	Not much demand for commercial permits. People do sell pinyon nuts from roadside stands in the area, but source of pinyon is unknown
San Luis Valley Public Lands Center	Much personal use in good years, but typically pickers do not get permits	No requests for commercial use permits; don't know whether any of the harvesting on BLM lands is commercial
La Jara Field Office	Uncertain whether much personal use harvesting takes place	Occasional requests for commercial use permits
Saguache Field Office	Much personal use in good years, but typically pickers do not get permits	No commercial permits issued in recent years
Del Norte Field Office	Much personal use in good years, but typically pickers do not get permits	No commercial permits issued in recent years

Source: Phone interviews with field office employees, March 2007.

Table 15 - Bids on singleleaf pinyon harvesting units on BLM lands in Nevada and Utah (2006)			
Location	**Bidder**	**Quantity sold (lbs)**	**Value ($)**
Nevada			
BLM			
Battle Mtn	B1	4,000	1,000
Ely	B1	4,000	1,000
Ely	B1	4,000	1,000
Battle Mtn	B2	4,000	1,000
Ely	B2	4,000	1,000
Elko	B3	10,000	2,500
Elko	B3	10,000	2,500
Elko	B4	4,000	1,000
Ely	B4	4,000	1,000
Ely	B4	6,000	1,500
Ely	B4	4,000	1,000
Ely	B5	5,000	1,250
Ely	B5	4,000	1,000
	Nevada Total	**67,000**	**16,750**
Utah BLM			
Cedar City	B6	36,017	9,004
Cedar City	B6	21,137	5,284
Cedar City	B6	5,053	1,263
Cedar City	B7	3,000	750
	Utah Total	**65,207**	**16,302**
	Nevada/Utah Total	**132,207**	**33,052**

Sources: Page 2006, Podborny 2006.

Table 15 - Benefits from Managing Pinyon-Juniper Ecosystems for Nut Production	
Ecological	Food for wildlife, birds, and insects Habitat and shelter for wildlife, birds, and insects Nesting sites for birds Enhancement of biodiversity Soil stabilization Increases in water infiltration rates
Cultural	Maintenance of cultural traditions Recreation and enjoyment (hunting, hiking, nature walks, gathering nuts) Physical well-being (opportunities to exercise) Strengthening kinship networks (nut harvesting brings families together) Fostering of positive human relationships with nature Maintenance of religious and ceremonial traditions Production of ecological knowledge Spiritual well-being
Economic	Wood Forage Nuts Transplants Boughs Christmas trees Resins

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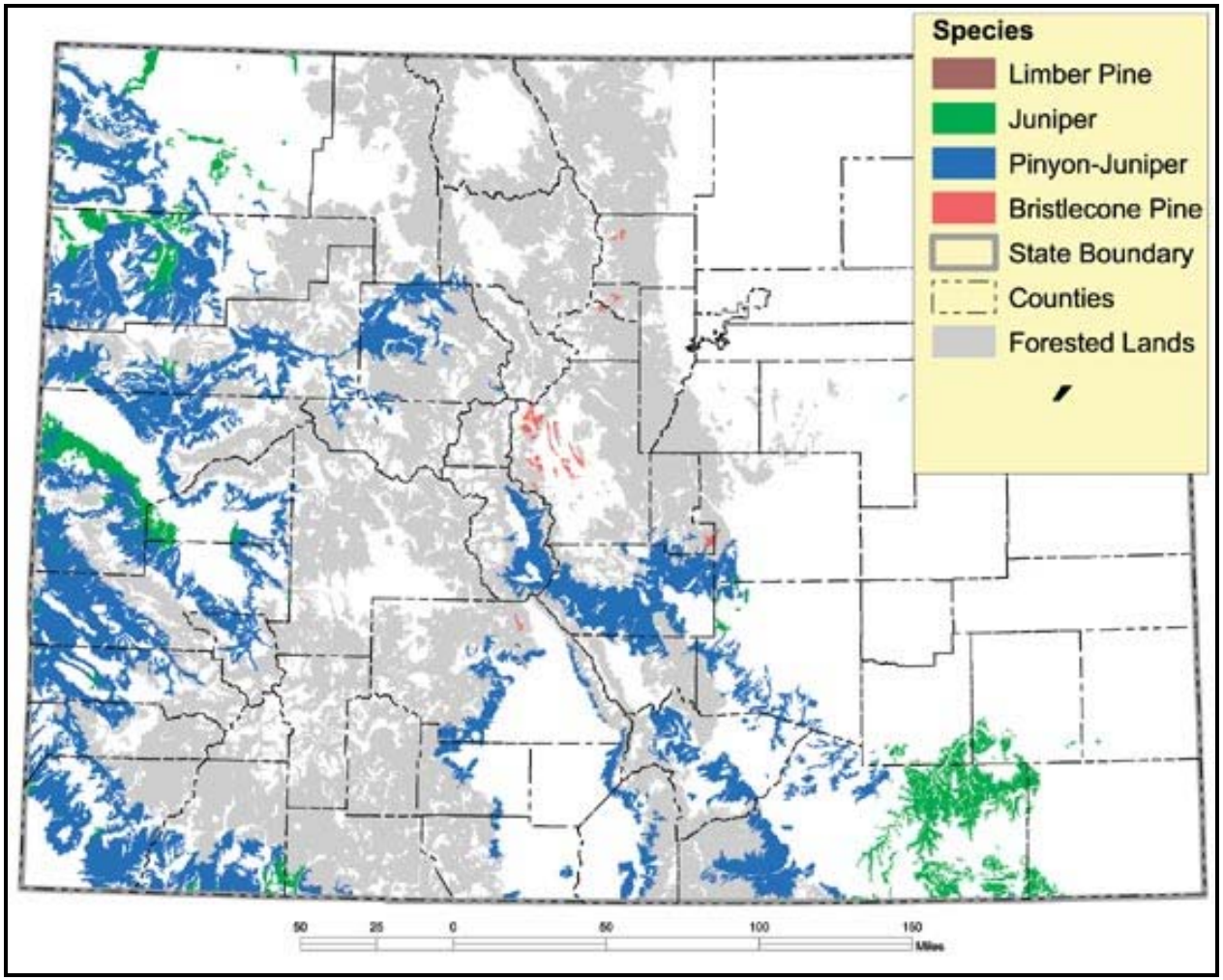
Figures

Figure 1 - Distribution of Forest Ecotypes in Colorado

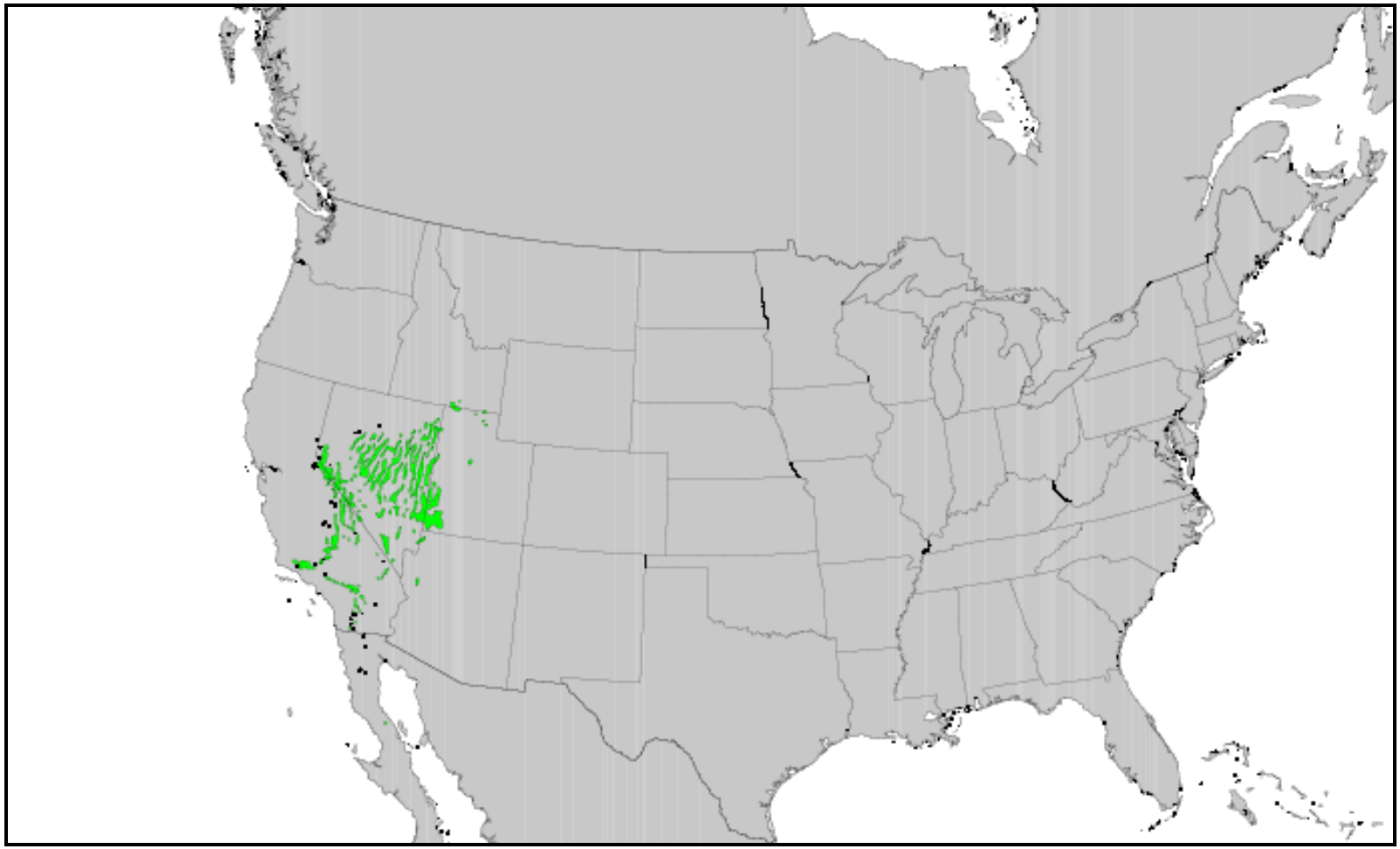


Source: Colorado State Forest Service. 2002.

Figure 2: Range of Colorado pinyon

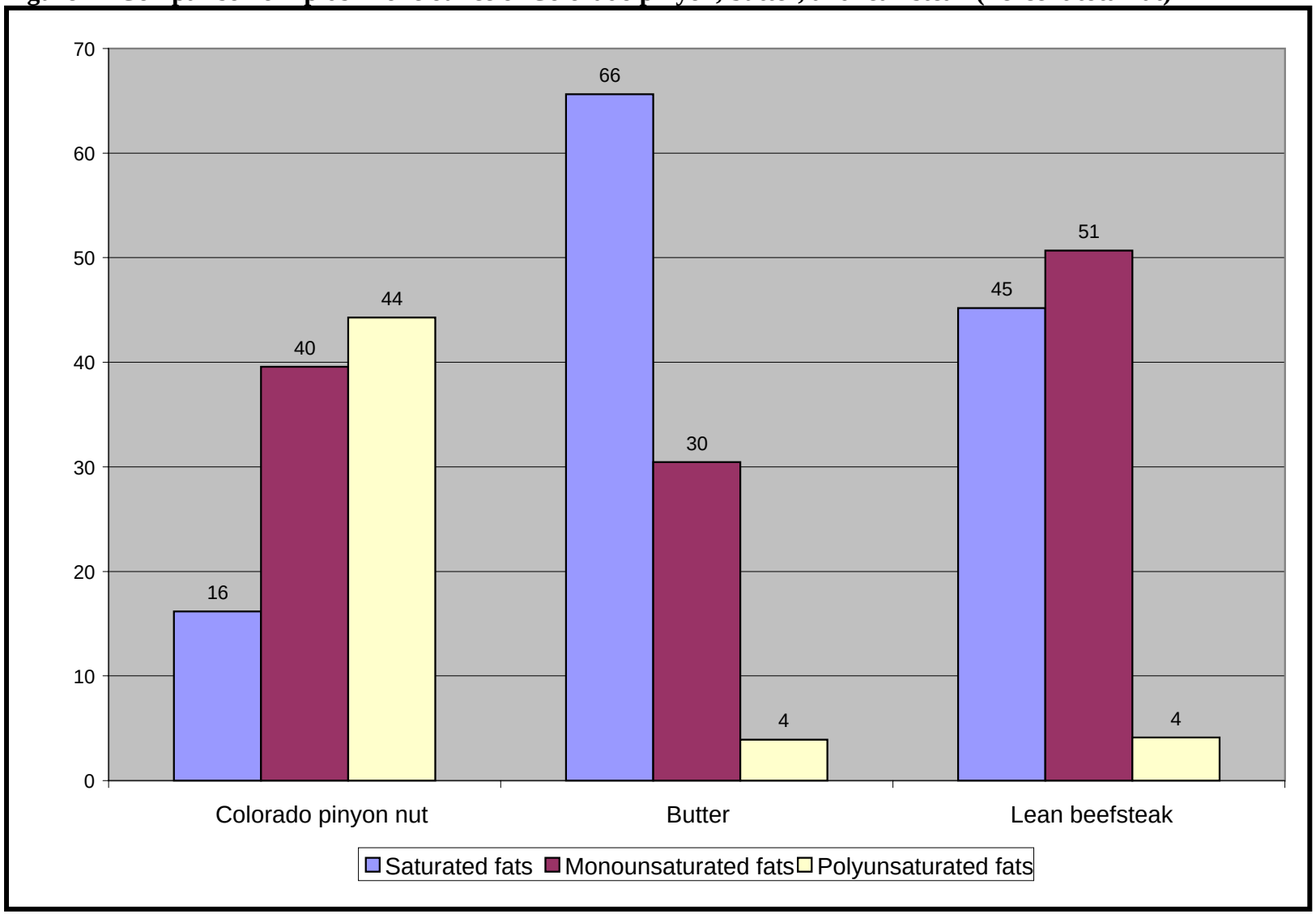
Source: U.S. Department of the Interior, U.S. Geological Survey 2006.

Figure 3: Range of singleleaf pinyon



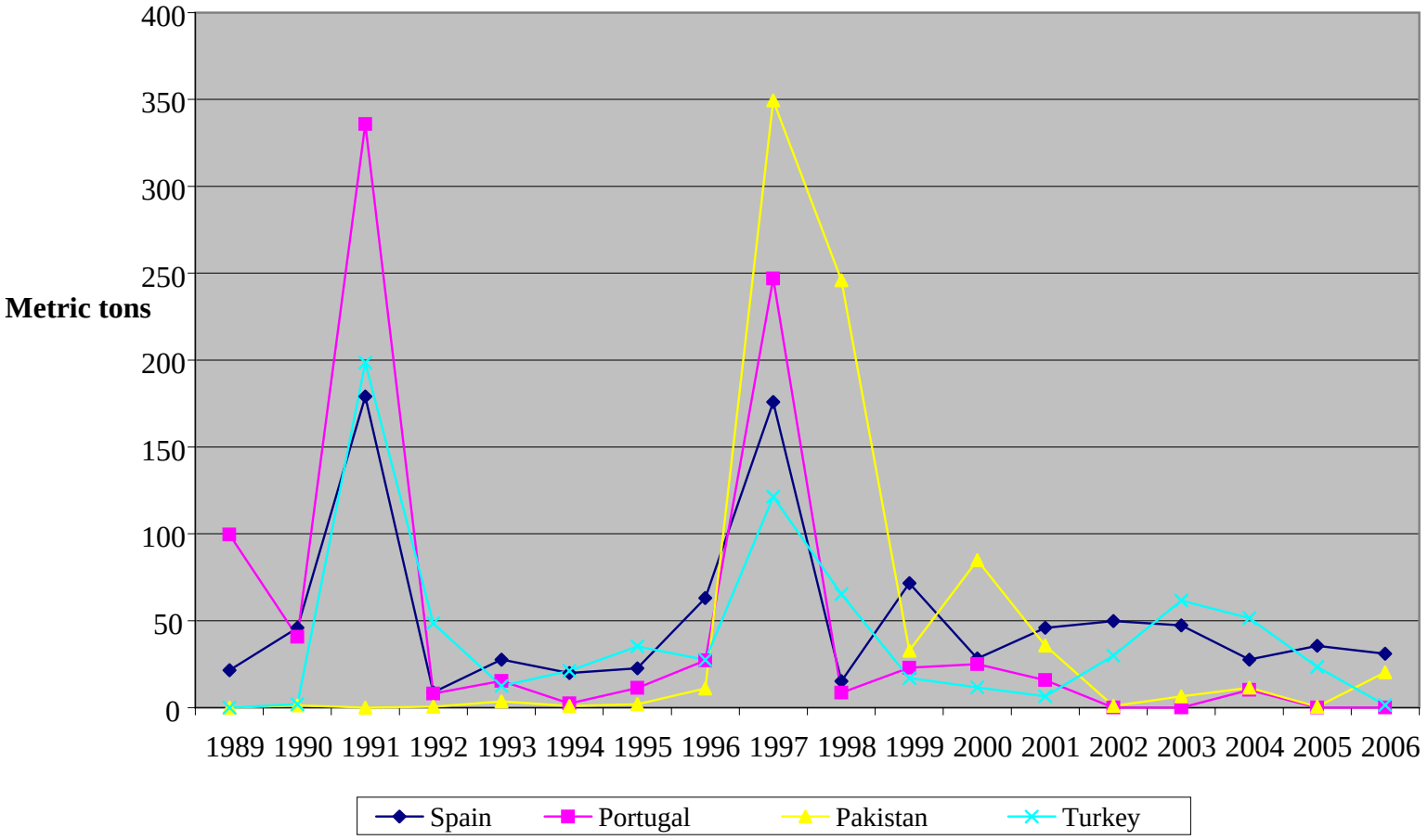
Source: U.S. Department of the Interior, U.S. Geological Survey 2006.

Figure 4 - Comparison of lipids in one ounce of Colorado pinyon, butter, and lean steak (Percent total fat)



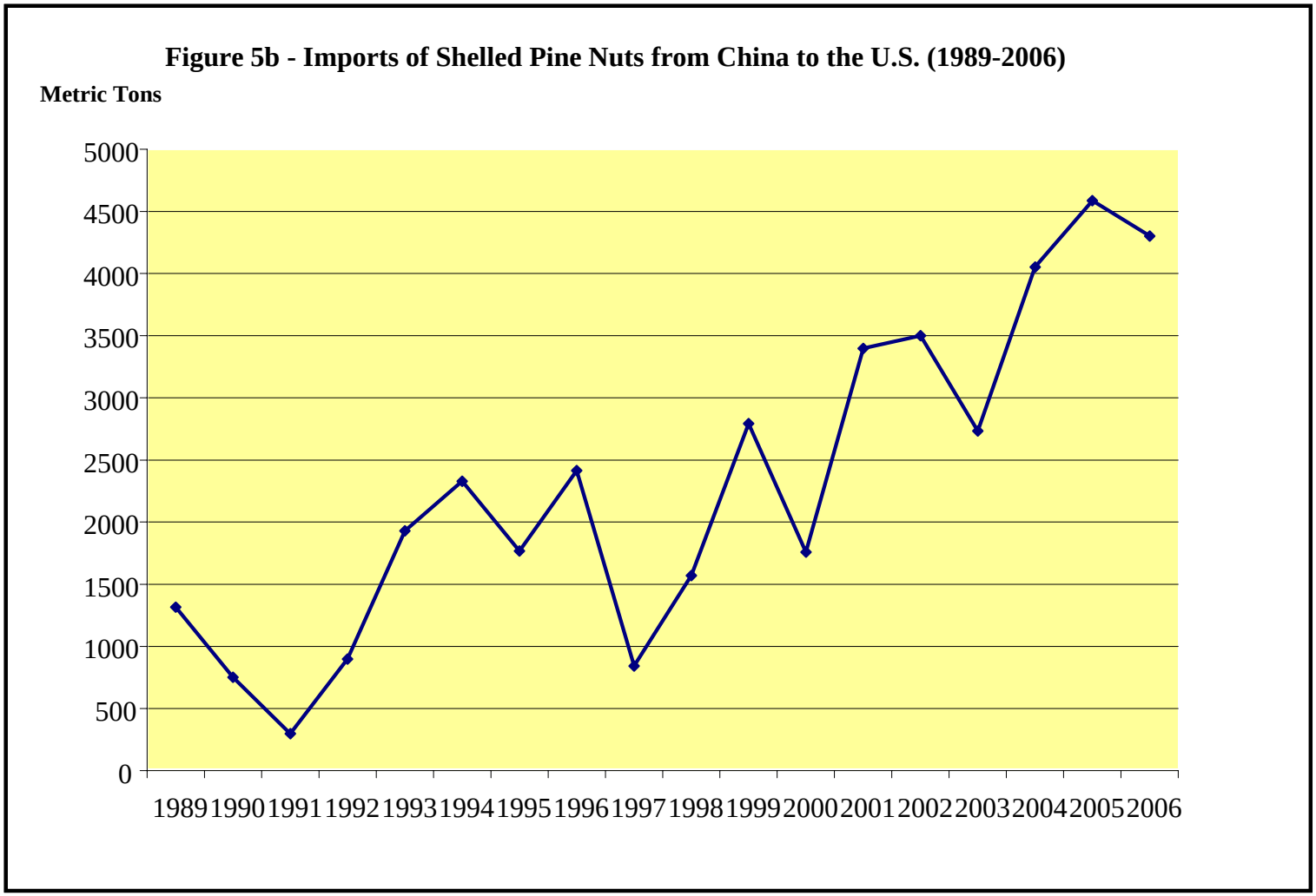
Source: USDA, Agricultural Research Service. 2006.

Figure 5a - Pine Nut Imports to the US (1989-2006) for Spain, Portugal, Pakistan, and Turkey



Source: USDA, Foreign Agricultural Service 2007.

Figure 5b - Imports of Shelled Pine Nuts from China to the U.S. (1989-2006)



Note: China import data include Republic of China and Hong Kong imports
Source: USDA, Foreign Agricultural Service (FAS). 2007.

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Appendix A – List of Interviewees

Categories of People Interviewed
Pinyon nut brokers
Singleleaf pinyon dealer and field buyer
Colorado pinyon dealer and field buyer
Colorado pinyon dealer and field buyer
Pinyon nut buyers
Value-added pinyon nut products manufacturer
Food services supplier
On-line retailer (sideline)
Pickers
Hispano picker -- household consumption
Native seeds/seedling suppliers
Native seeds supplier
Native live plants supplier
Research/Extension
Agricultural economist
Horticuluralist
Forest extension agent
Independent researcher
Land management – field office technical staff
White River (BLM) – Forester
Royal Gorge (BLM) - Forester
San Juan Public Lands Center – Forester with BLM
San Juan Public Lands Center – Forester with San Juan NF
Colorado State Lands – Northwest District Manager
Colorado State Lands – South District Manager
Land management – field office, front desk staff
White River (BLM)
Royal Gorge (BLM)
Grand Junction (BLM)
Glenwood Springs (BLM)
Uncompahgre (BLM)
San Luis Public Lands Center (BLM and FS)
Saguache (BLM)
Del Norte (BLM)
La Jara (BLM)
San Juan Public Lands Center (BLM and FS)
Land management – regional or state-level professional staff
Tribal liaison officer (Forest Service)
Botanist (Forest Service)
Forester (Forest Service)
Natural resource specialist (Bureau of Land Management)

Appendix B -- Profiles of Brokers and Buyers

Pinyon nut brokers[a]	
James	Pinyon nut buyer; organizes field crews on ground; markets mostly to small-scale retail stores in Utah; based in Texas; grew up in the pinyon business, does internet sales (retail and wholesale)
Sheila	Buys pinyon nuts direct from harvesters and from traders, sells roasted pinyon nuts and other food products, makes buying visits to reservations
Edward	Bought pinyon direct from harvesters for about ten years, mostly sold product wholesale, recently shifted into another occupation due to long hours required to make a profit in the pinyon industry.
Pinyon nut buyers	
Howard	Manufactures and sells pinyon value-added products; buys fresh pinyon direct from harvesters; based in New Mexico; business in operation since mid-1990s; does retail and wholesale; storefront and internet sales
Ralph	Supplies pinyon nuts and imported pine nuts to restaurants in west coast cities; buys direct from harvester and in quantity from traders, started in the pinyon business in the 1980s, one of first buyers to deal heavily in imported pine nuts from China; based in New Mexico, occasionally buys in the field, also deals in teas and coffee and runs a coffee shop
Dale	Specializes in pinyon nuts harvested in New Mexico, does on-line sales only, set up business about 10 years ago as a sideline to his firm's work in marketing, sells roasted pinyon only, sales around the United States, primarily retail , based in New Mexico, obtains product from suppliers

[a] Names have been changed to protect the individuals'anonymity.

Appendix C -- Picking and Processing Pinyon Nuts

THE "NUTTING" PROCESS

If you are going to gather the still unopened cones of the pinyon pine, you will need gloves to protect you from the pitch that covers the cones, heavy duty footgear, a light ladder and sacks. You can lay the ladder against the tree, climb and pick only the cones from the tree. Breaking off the limbs is unnecessary and destroys the capability of the tree to be productive.

Another method is to try and knock the nuts from the cones after the cones are more ripened. In this case you would want to lay a tarp under the tree, place the ladder against the tree, and knock against the cones to shake the nuts loose. They can then be gathered from the tarp on the ground.

Pinyon branches and cones are very pitchy. Sap can be removed from hands and clothes with solvents such as cooking oil or alcohol. When picking the cones before they open, you can leave them in the sacks, placing them in the sun for several days. Take the time to turn the sacks daily to give even heating to the cones. When the cones are dried and opened, you can shake the sacks, dislodging the nuts from the cones. Another method is to lay the cones on canvas in the sun and use a shovel to turn the cones until dried.

In order to have clean pinenuts, the Indians would use wicker trays to throw the nuts into the air and let the wind carry away the broken cone scale and bracts. You can do the same, or use a screen or wire mesh of 1/2-inch spacing to separate the nuts from the waste materials

THE FINAL PRODUCT

The basic reason for gathering, drying, shaking and cleaning, of course, is to produce a pinyon nut suitable for eating. They are nutritionally good to eat as is, without further enhancement. But, their flavor may be improved in a number of ways. One is to soak the nuts in brine water, then toast them in an open pan in the oven at a moderate temperature.

Another way is to wash them in cold water, salt them, and put in a covered roasting pan. Steam them in a moderate oven for 15 to 20 minutes, remove the cover, and stir until completely dry.

Native Americans would grind some of the nuts into a paste that could be eaten either cold or warmed. This was done after the outer seedcoats were removed by rolling them over a metate with a hulling stone.

Adapted from: United States Department of the Interior, Bureau of Land Management, Carson City Field Office.Nevada State Office. Picking pinyon nuts. http://www.nv.blm.gov/carson/Public_Room/Pub_Pinyon_Pinenuts.htm [Accessed May 15, 2007]