techniques for successfully growing these crops. For example, one of the biggest problems requiring remedial action was the preleaching of excessive salts from the planting sites. We also learned that it was better to plant larger, more vigorous, healthier, and hardier nursery stock than might be required for a less harsh environment.

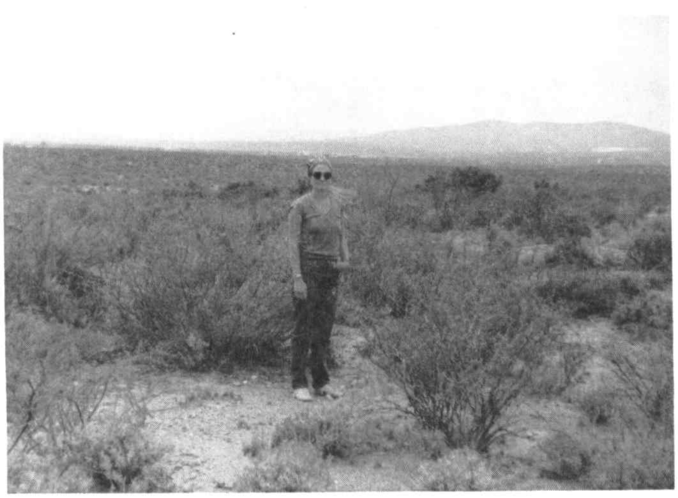
There is also hope for the future in new genetic research to develop new hybrid species with higher salt tolerances and other characteristics which will enable the plant to grow in these harsh environments. Even though mine wastes may never become the "bread baskets" of America, the potential to produce commercial food crops warrants further research and development. Research is also needed to determine the utilitarian values of some new species and new markets need to be developed for commercial uses.

In southern Arizona the present species composition of native plants is far different from that which dominated the landscape a century ago. The ecosystems that exist today have been forever altered by man and nature. Nothing is static. So long as prudent judgement is used in the selection of species for mine waste revegetation, no species should be automatically exempted. Who knows, the exotics of today may become the natives of tomorrow.

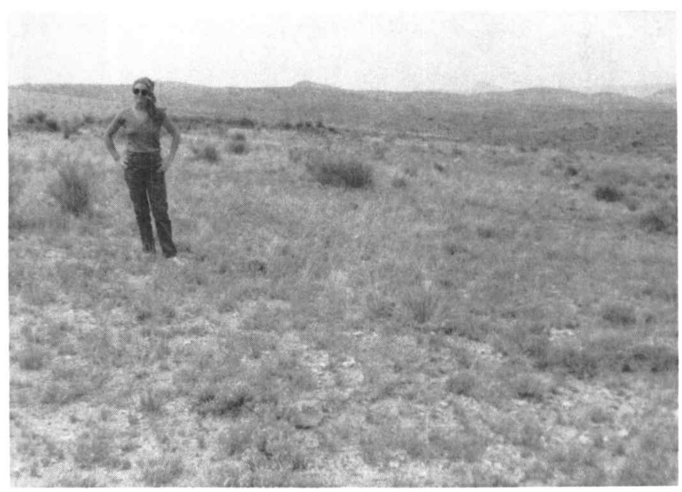
Biomass Distribution at Grassland and Shrubland Sites

Jerry R. Cox, Gary W. Frasier, and Kenneth G. Renard

The only permanent water sources in the Upper San Pedro Valley Basin prior to 1850 were associated with a meandering stream along the valley floor. At that time, upland vegetation was dominated by perennial grasses. A permanent water source was developed near Tombstone, Ariz., about 1875, and livestock populations dramatically increased between 1860 and 1885. Livestock grazing decreased with distance from these permanent water sources, and in time, the upland grasslands near water were dominated by shrubs. While uplands where permanent drinking water was unavailable remained as perennial grasslands.



Shrubland area.



Grassland area.

As perennial grass populations decreased and perennial shrub populations increased, ranchers used rails, cables, plows, disks, and chains to reduce shrub competition. In most instances the treated areas were sown with seeds of native and introduced perennial grasses. In wet summers the seed would germinate and produce plants, but with poor range management practices the plants did not persist and treated areas were eventually redominated by shrubs.

The failure of perennial grasses to persist or adequately compete for moisture and nutrients with shrubs has resulted in these general beliefs: (1) a greater amount of aboveground biomass accumulates after brush invasion, (2) a greater amount of below-ground biomass accumulates after brush invasion, (3) shrub roots are at greater depths within the soil profile, and (4) shrubs produce more fine roots, or

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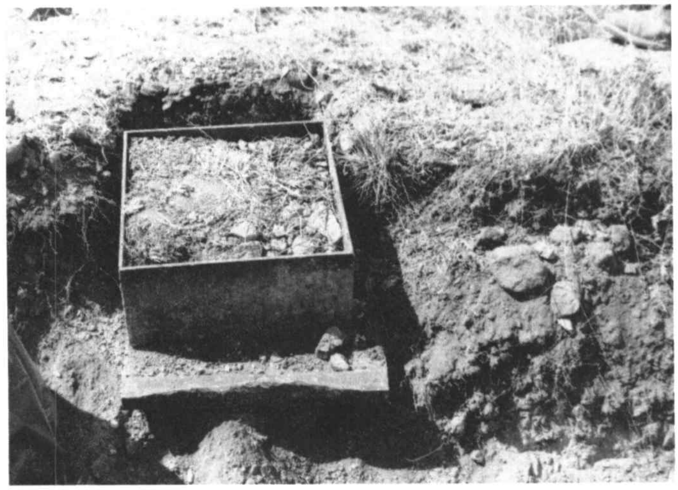
non-woody roots, to extract water and nutrients. Fine roots are the primary organs involved with the uptake of water and nutrients. Other studies of arid and semiarid grasslands and shrublands suggest that most fine roots grow near the soil surface. The purpose of this study was to determine the validity of these general beliefs on similar soils in southeastern Arizona.

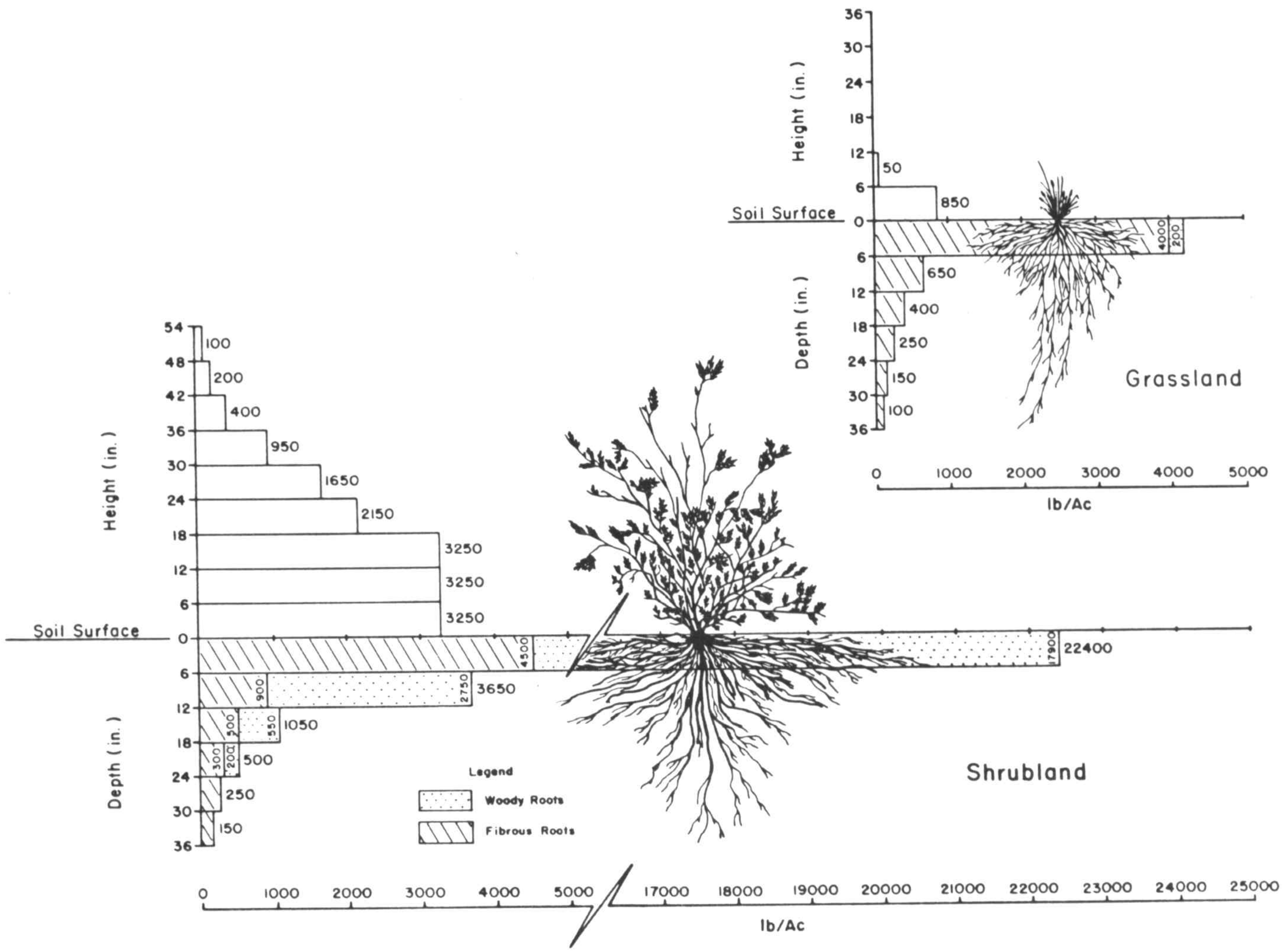
A study site in a shrubland and in a grassland near Tombstone were selected. Neither site had been grazed in 20 years and rainfall, infiltration rates, and the physical soil properties of the sites were similar. The soil profile at each site was vertically sampled to determine the amount and distribution of shoots and roots at 6-inch intervals in August 1983. The time of sampling was selected to coincide with peak standing crop and drying of the soil profile following the summer thunderstorm season.

Shrubs and grasses were cut at the soil surface and vertically divided into 6-inch increments. The roots were washed from the soil for each sample and separated into either woody roots, those with a covering of bark, or fine (fibrous) roots. The shoot (aboveground material) and root biomass was determined by weighing following 7 days of oven drying.



Sampling of Soil Profile for roots.

The mean aboveground and belowground biomass distribution values derived from 8 sampling locations at each site are presented below. Total above-ground biomass at the shrubland was 17 times greater than at the grassland. More



Distribution and quantity of aboveground and root biomass.

than 50% of the above-ground biomass was equally distributed in the lower three 6-inch (0 to 18 inch) levels at the shrubland while more than 90% of the total was 6 inches or below at the grassland. The greater accumulation of above-ground biomass at the shrubland does not necessarily imply a greater potential for growth, but rather that shrub biomass breaks down slowly while grass biomass breaks down rapidly.

We did not find roots at either site below 36 inches, and this would suggest that the rooting profile is similar at both sites. However, a caliche hardpan was present between 24 and 36 inches at both sites. Such hardpans limit rooting depth and more woody roots may be distributed deeper in the soil profile when hardpans are not present.

Total belowground biomass at the shrubland was almost 5 times greater than at the grassland. At the shrubland 80% of the total root biomass was woody at the 0 to 6 inch level, 75% between 6 and 12 inches, 50% between 12 and 18 inches, and 40% between 18 and 24 inches. Woody roots were not found below 24 inches at the shrubland site. At the grassland, only 5% of the total root biomass was woody between 0 and 6 inches, and woody roots were not found below 6 inches at the grassland site.

The common belief that shrubs produce more fine or fibrous roots was not verified; and in fact, the amount of distribution of fine roots was similar at both sites. Approximately 70% of the total fine root biomass was between 0 and 6 inches, and 80% between 0 and 12 inches at both sites. This indicates that perennial grasses and shrubs compete for the same resource at the same levels within the soil profile.

The data should not be used in broad extrapolations relating to the productivity of semiarid grasslands and shrublands. The data does, however, provide an indication of potential biomass distribution changes that can occur when semiarid grasslands become semiarid shrublands.

The grassland and shrubland sites sampled in this study have not been grazed by domestic livestock for 20 years. Outside the exclosures grasses are not invading the shrubland but shrubs are invading the grassland. In a recent article, West shows that some shrubland sites will not return to their prior grassland condition if grazing is discontinued. If, in addition to the grazing, the shrub competition is reduced, Cox et al. showed that semiarid grasslands will return.

Ranchers who wish to improve grass production on their rangelands with mechanical and chemical brush control should answer the following questions: (1) Will I fence the treated area and manage it separately from untreated portions of the same pasture?, (2) Can I afford to completely rest the treated areas for 2 or more years?, and (3) Will I set stocking rates based on the perennial forage produced in the driest summer? If these questions can be answered positively, the range improvement practice, whatever it may be, will likely be successful. However, if one or more of these questions are answered negatively, the practice will fail because of management rather than the treatment. If a failure occurs the rancher can expect reinvasion by shrubs, accelerated erosion, and a direct dollar loss.

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Guide to Scientists, Institutions

An Information Guide to Range Science: a new comprehensive profile of scientists and institutions involved in range research consolidates information on the field of range science in a useful format. Its purpose is to facilitate communication among scientists and students in this multidisciplinary field and provide a useful reference guide for undergraduate and graduate students wishing to enter the field of range science. Universities with range programs and scientists are indexed by country, as well as by range specialty.

The book, published by the College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow 83843, is available for $6.50 plus $1.00 for U.S. postage; $1.50 outside U.S. Contact Ronald Robberecht or Student Chapter, SRM, Idaho Section, Department of Range Resources, University of Idaho.

Tractor Safety Film Now Available

Kubota Tractor Corp.'s recently produced safety film, "Safety Begins With You," focuses attention on the essential practice of sound tractor safety habits in the agricultural community.

In the film, three common tractor accidents are dramatized, demonstrating how novices and experienced tractor operators are equally likely to ignore safety precautions. Along with showing the causes of the accidents depicted, the film cautions viewers about other types of common operator errors which often lead to injury. The film is available for purchase through Kubota Tractor Corp., 550 West Artesia Blvd., Comptom, Calif. 90220.