TECHNICAL NOTES

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Review of Ecological Studies of Vegetation Growth in California Annual Rangelands.

Introduction

This report presents several studies which investigated California annual range ecology. Since emphasis was placed on research involving yield measurements to aid future SCS range site classification, this is not a comprehensive review of all known information. Considerable work has been done to relate herbaceous growth and composition to variations in annual weather, geographic location, and soil parameters. Seasonal changes in community structure and documentation of plant succession (primary and secondary) have also received limited study. Reports of broad scope serve well to introduce other research dealing with such specific subject areas.

General Ecology

One of the earliest reports describing the extent and nature of California annual ranges was by Talbot, Biswell, and Hormay (1939). Climate, vegetation, mapped distribution of annual rangelands in general, and specific information on the composition and yield in areas of the southern San Joaquin Valley were presented. They studied grazed and ungrazed areas to measure fluctuations between years of species and yield. By using the product of cover and height as an index to herbage volume, they indirectly estimated a nearly 200 fold difference in production between two consecutive years. This publication, certainly a landmark in the field of annual range ecology, exhibits keen interpretive insight and research quality. In another report on the general ecology of California foothill ranges, Biswell (1956) further separated vegetative communities and described the influences of climate, soil type, and management practices on the vegetation.

Climate and Weather Patterns

Major (1963) presents a method for evaluating plant growth in relation to precipitation, evapotranspiration, and soil water holding capacity. The intent of the paper is to develop an index of plant growth which is universally applicable, but specific examples from California illustrate the boom and bust nature of seasonal plant growth in the Mediterranean annual climate. Several interesting conclusions about water availability and plant utilization throughout the year are drawn. Murphy (1970) used multiple regression to correlate peak yield with effective rainfall totals at various dates through the growing season at the University of California Hopland Field Station in Mendocino County. Rainfall through the third week in November was most significantly correlated with peak yield for the 16 years of data examined, and useful as an index of green season production 70 percent of the time. Rainfall through May 31 was found to be an unreliable indicator of peak yield, and interestingly both the highest and lowest yielding years (3,400 and 900 pounds/acre, respectively) had the same rainfall which was only 67 percent of normal. The study site was a deep loam, and long term average rainfall was about 36 inches and production about 2,000 pounds/acre.

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Hufstader (1976) concluded that rainfall influenced the growth of the dominant species in a stand, but temperatures had no cumulative effect. Subdominant species were thought to be influenced by competition for light and variation in timing of germination rather than rainfall. The study spanned only a single growing season (1972 - 1973) and peak standing crops (interpreted from graphs) were 3,800 pounds/acre on north and 3,100 pounds/acre on south aspects in the south coastal mountains near Los Angeles.

Duncan and Woodmansee (1975) using 34 years of yield data at the San Joaquin Experimental Range (Central Sierra Nevada Foothills) attempted to correlate production with rainfall in "important" months. Contrary to the findings of Murphy (1970), yield was not found related to early season rainfall in this area. They indicate that good yielding years had rainfall well distributed throughout the year, both in the fall for germination and early growth and in the spring when evapotranspiration was high. In my opinion, differences in both climatic regime and soil type between the study areas could have influvenced the results. The soils at the San Joaquin location are of granitic origin and generally coarser and less fertile than at Hopland. Sully (1978) sheds some light on the climatic differences between geographical locations in the state. Using data from both the Hopland Field Station and San Joaquin Experimental Range as well as the U.C. Sierra Foothill Range near Marysville, Yuba County, he calculated correlations between peak yields and rainfall, ambient, and soil temperatures. At the two northerly locations he found yield to be correlated with early season rainfall, but at San Joaquin Experimental Range, weather patterns fluctuated too widely to allow predictive correlations. Ambient temperatures were not useful in predicting peak yield, but soil temperatures were found to be somewhat indicative of production.

Another study of the influences of weather on annual vegetation was published by Pitt and Heady (1978). Using 18 years of data at Hopland, they investigated the interactions of temperature and rainfall through the season on growth, cover, and species composition. Early season precipitation was again found most influential on peak yield and also composition, because spring rainfall was largely superfluous to growth due to adequate soil moisture reserves. Temperature and precipitation patterns were highly interactive since cloud cover influences air temperature. Broadleaved forbs such as filaree and clovers were favored by mild autumn weather and the proportions of annual grasses were influenced by freezing and frost heaving.

Evans, Kay and Young (1975) reported a study of forage growth in relation to microenvironment and range improvement at the Sierra Foothill Range Field Station. Herbicidal weed control and reseeding were the principal treatments, and production was followed over the three growing seasons (1970 - 1972). They reported the principal soil as the Sobrante series and sampled both north and south slopes. Although the three year average yield was higher on the north slope (2,800 pounds/acre) than south slopes (2,250 pounds/acre), fluctuations between years were high and inconsistent. The forage growth remained low through mid-March (less than 750 pounds/acre) but accelerated rapidly after this due to warmer temperatures. Years with high late spring moisture resulted in the highest yields in this experiment.

Geographic and Edaphic Effects

A few studies were found to address the changes in annual vegetation as a function of geographic location or soil type. One publication reported yields in a variety of locations in California but was mainly concerned with the influences of late summer mulch residues (Bartolome, Stroud and Heady, 1980). Intensive vegetation sampling over a 3 to 5 year period provided yield and composition data which was modified by mulch treatments. North coastal sites had the highest rainfall, greatest amount of perennial grass cover, and reached greatest yield at heaviest mulch levels (1,000 pounds/acre). Locations in the center of the state with intermediate amounts of rainfall (15 - 40 inches) grew the most forage at intermediate mulch levels (750 pounds/acre) and supported predominantly soft chess and broadleaf filaree. Southern locations west of Bakersfield with less than 10 inches of rainfall showed no consistent relationship between mulch and production. In this report, the soil texture at each study site was given, although without series classification, and average productions over the study period as a function of mulch treatment were graphed. Although carefully designed and thoroughly sampled as this research was, the small number of sample locations makes extrapolation to other areas of the state of questionable accuracy (J. Bartolome, pers. comm.).

Janes (1969) also looked at variations in composition and yield on a north-south transect of the coast ranges between Humboldt and Kern Counties in the spring of 1968. Because the phenology of the annual grasses varies from north to south, sampling at stand maturity began in April in the south and ended in June near the Oregon border. Only sites with several years of protection from fire or grazing were studied. Sampling was intensive and some interesting correlations between species composition and average rainfall per location were drawn. Each site was tied to a named soil series from a known reference.

McNaughton (1968) examined edaphic and slope exposure effects on species composition and yield of serpentine and sandstone soils on Jasper Ridge at Stanford University. Significant differences in both vegetation parameters were found between soil types when averaged over exposures, and exposure resulted in differential yields on sandstone but not serpentine. Droughty southwest exposures yielded about half (2,700 pounds/acre) that of mesic north-easterly aspects (5,200 pounds/acre) in the single growing season (1965 - 1966) studied. Serpentine had greater species diversity (more natives) and produced less than half (1,700 pounds/acre) the yield of sandstone soils (4,400 pounds/acre) on the average.

Studies of Plant Succession and Seasonal Dynamics

Publications by Burcham (1957 and 1975) describing the patterns of historical vegetation changes in California have been mentioned. The more recent report lists typical dominant annual species found in the central coast and Sierra Nevada foothill ranges and reviews the influences of climate and grazing on the vegetation. An interesting chronological sequence is developed which denotes the rates of invasion and historical periods of dominance of various exotic herbaceous annual plants. The indicated sequences of invasion and increase to dominance of certain species in a historical timeframe is likened to decreasing seral stages of a successional sequence.

White (1966) reported the successional changes on abandoned farmland over a 27 year period in Carmel Valley, Monterey County. Annual grasses ripgut brome, soft chess, and wild oats dominated the area and were equated to "climax" species. Perennial herbs and woody vegetation were slow to colonize the area, at least compared to old field succession in the eastern U.S.A.

Heady (1956) indicates there are three types of vegetation change in annual grasslands, within a season, between seasons, and in relation to grazing. The last factor influences plant composition and yield, and the report lists the main plants indicative of levels of range condition (successional stage) in relation to grazing pressure. In another publication, the seasonal changes in the annual vegetation were followed on three study sites representing ungrazed, moderately, and heavily grazed treatments (Heady, 1958). Five growing seasons were followed, exhibiting fluctuations between and within years that are thoroughly described. This excellent report correlates both environmental parameters (soils, weather, climate) and management practices (grazing, seeding, fertilization, fire) with vegetation change, developing information from both experimental study and review of available literature.

Ratliff and Heady (1962) intensively studied the changes in weight and structure of an annual grass community in the spring of 1960 at Tilden Park near Berkeley. By clipping at weekly intervals from March through August, weight gains to maturity and losses afterward, and the differences between species in the stand were examined. Some species were found to mature earlier and lose weight faster and sooner than others, especially bur clover and filaree. Community weights stabilized in early May and peaked about May 21 at 5,760 pounds/acre. Weight loss occurred rapidly after May 28, going down 23 percent by June 5 and 45 percent by August 20. They acknowledge that the dates of peak maturity and subsequent weight loss will vary with weather patterns annually, but the important point is that the timing of sampling can greatly influence measured composition and yield. Hufstader (1978) also reports great differences between species in timing of maximum growth rates and phenological development, and within species on different slope exposures, as determined by sampling at various dates through the season.

Miscellaneous Ecological Studies

Some additional publications on various topics were encountered which could possibly be of future use. These will be mentioned only briefly. Williams (1963) studied plant morphology and canopy development in single and two species mixtures of three annual clovers commonly seeded for range improvement in an attempt to quantify competition for light. In another study, the influences of a wild herbivore (meadow mice) at high and low population densities were quantified and shown to affect forage production (Batzli and Pitelka, 1970). Finally, Bartolome (1979) followed germination and seedling establishment for a number of common annual range plants in an effort to distinguish the effectiveness and adaptability of various reproductive strategies.

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