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**ANNOTATED
B I B L I O G R A P H Y**

Of Research Conducted at
UNIVERSITY OF CALIFORNIA

**SIERRA FOOTHILL
RESEARCH AND EXTENSION CENTER**

During the Period
May 1969 to January 1997

Sierra Foothill Research & Extension Center Publication No. SFREC 9701

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Introduction

We have attempted to include in this bibliography all publications resulting from research conducted at Sierra Foothill Research and Extension Center (SFREC) from May 1, 1969 to June 30, 1996. "Publications" as used here include any printed scholarly report of research or demonstration efforts which can be readily located within the University of California library system. Copies of virtually all references are also on file at SFREC.

I am confident that we have listed all papers reported to us by researchers, and we have located other references that we are aware of. Often papers are published some time after field work at the Center is completed. Occasionally, those publications are not brought to our attention, and some of those papers may have escaped this list.

For ease of searching this bibliography, each of the 318 references has been placed into one of eight broad subject area categories. A few publications are listed in two categories. An authors list provides an alphabetical listing of all authors, with page numbers. We have included an abstract for each reference. Abstracts were taken from the authors' abstract or conclusions, or if none was available, an abstract was provided by our writers.

This bibliography is also available (currently in a slightly earlier version) on the SFREC homepage at <http://ice.ucdavis.edu/ucsfrec/>.

I appreciate the dedicated efforts of those who made this bibliography possible: Noriko Ruxton, primary writer and data entry person; Carol Hollingsworth, initial organization of the data base and data entry; Anna Robertson, data entry and writing, Chris Feddersen, assistance in coordination and writing. I thank Doug McCreary and Jerry Tecklin for draft review, as well as other assistance, and also Glenn Nader and Bill Frost for draft review.

J.M. Connor, Superintendent June 18, 1997
Sierra Foothill Research & Extension Center

Alternate Uses of Rangeland

Donaldson, D.R., J. Hasey, R.M. Sachs, and R.B. Standiford. 1988. Eucalyptus for biomass - short-rotation intensive culture (SRIC). *What's Happening in California Forestry* 15: pp. 1-5.

Biomass farming is similar to farming fruit trees or grapevines, except that wood is the marketable product. Wood for fiber and fuel may be obtained from relatively small diameter trees, which are planted at high densities to give rapid canopy cover and high yields when irrigation and fertilization are optimized. Biomass farming described here has little in common with traditional forestry which harvests trees at 40 to 80 year intervals (depending on tree growth rate and desired processing size). At least 3 harvests are obtained from each root system before trees are replanted. Ref.127\61.54.

Hasey, J., and J.M. Connor. 1990. Eucalyptus shows unexpected cold tolerance. *California Agriculture* 44(2): pp. 25-27.

Although some species of eucalyptus trees in an experimental plantation were damaged in a 1989 cold snap, several species and clones survived temperatures lower than previously thought to be tolerated. The trees are in a low-elevation Sierra foothill test planting used for studies assessing fuelwood growth rates. Eucalyptus are fast-growing hardwood trees used in California for firewood, biomass, and pulpwood, but cold sensitivity is a major limitation determining where they can be grown successfully. Ref.50\61.05.

Hasey, J., M. Connor, and R. Standiford. 1987. Foothill fuelwood plantation. *What's Happening in California Forestry* 14: pp. 1-4.

Foothill and valley landowners are increasingly interested in growing trees as energy crops both commercially or for their own wood stoves. The potential markets for these trees are as firewood, bio-mass for co-generation plants, or as pulpwood chips for lumber companies. One hardwood tree in particular, the Eucalyptus, has performed well in several trials throughout California. Eucalyptus are generally fast growing, tolerant of poor sites and produce energy values comparable to oak wood. Ref.159\61.55.

Hasey, J., R. Standiford, R. Sachs, and M. Connor. 1987. Evaluation of hardwood species for fuelwood. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day*. p. 59-61.

In March 1984 a clonal and seedling plantation of selected Eucalyptus and poplar species was planted at the University of California Sierra Foothill Range Field Station at 575 feet elevation. The main objectives of this six year project are to evaluate survival and growth characteristics and to determine optimum harvest time of hardwood trees as energy crops grown under foothill conditions. Ref.76\61.31.

Hasey, J., R.B. Standiford, J.M. Connor, and R.M. Sachs. 1988. Low-elevation foothill fuelwood plantation. *California Agriculture* 44(2): pp. 21-22.

Early rates of growth during 43 months show that there is considerable promise for the production of large volumes of woody biomass from intensively managed plantations of exotic hardwood species on low elevation foothill rangeland sites. The high uniformity of the clonal blocks of both eucalyptus and hybrid poplars contrasts with the larger variability of the natural seedling stands. The uniformity of the clonal stands may be particularly useful in design of harvesting and processing technology. Ref.56\61.11.

LeBlanc, J.W., J.K. Hasey, R.B. Standiford, J.M. Connor, and R.M. Sachs. 1997. Eucalyptus for low elevation foothill plantations in California. 1997. *West.J.Appl.For.* 12(4): pp. 101-107.

We established a test plantation of selected Eucalyptus and poplar seedlings species and clones on a range site in the Sierra Nevada foothills. The main objectives were to evaluate survival and growth of the various species and clones and to determine a rotation age for intensively managed hardwood trees grown under low elevation foothill conditions. Seedlings and clones of six species of Eucalyptus and one hybrid poplar were grown with short rotation intensive culture techniques for 7 yr. Rotation age, defined as the culmination of mean annual increment, varied from 3 to 6 yr. The best producing clone produced 8 cords of fuelwood per acre per year. The potential for damage from freezing and snow at these elevations is also discussed. Ref.312\64.52.

McCreary, D.D. 1996a. An Agroforestry system for California's hardwood rangelands. Proceedings, Fourth North American Agroforestry Conf., July 23-28, 1995. Boise, ID. pp. 135-137.

This study evaluated the potential of different conifers to grow in conjunction with cattle grazing on California's low elevation hardwood rangelands. After four years, the conifers have had high survival and rapid growth, despite relatively harsh conditions. While there has been some damage from cattle, it has been fairly minor and not a serious threat to field performance. Results suggest that both Monterey and KMX pines show promise for incorporation into an agroforestry system. Ref291\64.27.

Standiford, R.B., D.R. Donaldson, R.M. Sachs, and J.K. Hasey. 1988. Short-rotation intensively cultured woody biomass plantations. California Agriculture 42(6): p. 18.

University of California scientists established research plots in several counties and at UC agricultural field stations to learn what species of hybrid poplars and eucalyptus could be grown on different sites, what management practices were necessary, and what range of growth rates could be expected. Even though these studies have shown that the potential yields from California short-rotation intensive culture are among the best reported anywhere in the world, various factors limit the extent to which plantations can be established at present. Ref.58\61.13.

Beef Cattle Management and Health

Adams, T.E., and B.M. Adams. 1992. Feedlot performance of steers and bulls actively immunized against gonadotropin-releasing hormone. *J. Anim. Sci.* 70: pp. 1691-1698.

Feedlot performance and testicular and pituitary function were assessed in cattle actively immunized against GnRH. Taken together, these data indicate that the GnRH-KLH conjugate is an effective immunogen in steers and bulls, with primary immunization alone as effective as the more conventional multiple-injection regimen. Ref.162\61.46.

Adams, T.E., C.A. Daley, B.M. Adams, and H. Sakurai. 1992. Reproductive function and feedlot performance of beef bulls, steers or bulls actively immunized against GnRH: effect of synovex S. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day: p. 23-30.

The results of this study indicate that vaccination of bull calves against GnRH suppresses testicular development and function. Such treatment also retards expression of secondary sex characteristics such as change in scrotal circumference and masculinity. Although not measured, sex-linked behavioral characteristics, such as aggressiveness, may also be depressed in immunized bulls. Ref.238\63.50.

Adams, T.E., C.A. Daley, B.M. Adams, and H. Sakurai. 1993. Testis function and feedlot performance of bulls actively immunized against gonadotropin-releasing hormone: effect of implants containing progesterone and estradiol benzoate. *J. Anim. Sci.* 71: pp. 811-817.

The effect of implants containing anabolic steroid (Synovex) on testis function, feedlot performance, and carcass traits was evaluated in bulls, steers, and bulls actively immunized against gonadotropin-releasing hormone (GnRH). Immunization, like Synovex, reduced the masculinity of the carcasses of bulls. Taken together, these data indicate that immunization against GnRH may have practical utility as a noninvasive alternative to surgical castration in management of beef cattle. In addition, the residual levels of testosterone secretion in immunized bulls may have anabolic effects that reduce the need for supplementation with exogenous steroids. Ref.86\61.42.

Alexander, G.L. 1988. Development and application of an electronic recording system to measure grazing and rumination in range cattle. M.S. Thesis, Univ. of Calif., Davis. 90 pages.

This study investigates a system that records and transmits information on individual jaw movements of free ranging cattle. The system consists of a jaw movement sensor, a storage-transmitter unit which transmits the information to a receiver and a computer to receive and store the information. The two transmitters gave data that was fairly consistent with that of other studies. Activity times, number of daily chews and chewing rates all fell within reasonable ranges although further adjustments and refinements were required to remove the slight underestimations of grazing and rumination times. There were no extreme variations from day to day, indicating estimates are reliable. Ref.121\63.80.

Alexander, G.L., and J.G. Morris. 1987. Electronic recording of grazing and rumination behavior in range cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 33-40.

A system that records and transmits data concerning times of occurrence of individual jaw movements of free ranging cattle is described. Intake of forage is a major factor in determining the level of production from grazing animals. Profitability may depend to a large part on the grazing animal achieving as high an intake as is possible and so it is important to understand and quantify the factors involved. In this experiment the data are transmitted hourly at a fixed time; records contain the jaw movements for the currently logged hour as well as the previous two hours. Ref.216\63.27.

Allen, L.J., L.W. George, and N.H. Willits. 1995. Effect of penicillin or penicillin and dexamethasone in cattle with infectious bovine keratoconjunctivitis. *J. Am. Vet. Med. Assoc.* 206(8): pp. 1200-1203.

To evaluate the efficacy of penicillin or penicillin and dexamethasone for treatment of infectious bovine keratoconjunctivitis. On the basis of the findings in this controlled study, we suggest that subconjunctival administration of procaine penicillin G, with or without dexamethasone, does not significantly affect the outcome of naturally developing IBK. Under the conditions of our study, the cost of treating affected cattle subconjunctivally with penicillin or with penicillin/dexamethasone combinations may be unjustified. Ref.320\65.01 Baker, D.G., M.L. Bruss, and L.J. Gershwin. 1993. Abomasal interstitial fluid-to-blood concentration gradient of pepsinogen in calves with type-1 and type-2 ostertagiosis. *Am. J. Vet. Res.* 54: pp. 1294-1298.

Angelos, J.A., Dueger, E.L., George, L.W., Carrier, T.K., Mihalyi, J.E., Cosgrove, S.B., and Johnson, J.C. 2000. Efficacy of florfenicol for treatment of naturally occurring infectious bovine keratoconjunctivitis. *J. Am. Vet. Med. Assoc.* 216(1): pp. 62-64.

To determine the efficacy of florfenicol for treatment of calves with naturally occurring bovine infectious keratoconjunctivitis (IBK) in a randomized controlled field trial. Results: Florfenicol administered SC (1 dose) or IM (2 doses 48 hours apart) was effective for treatment of calves with IBK. Corneal ulcers healed by day 20 in 48 of 49 calves (98%) calves treated with florfenicol IM, 39 of 42 (93%) calves treated with florfenicol SC, and 33 of 52 (63%) control calves. 65.09

Baker, D.G., and L.J. Gershwin. 1992. Seasonal patterns of total and *Ostertagia*-specific IgE in grazing cattle. *Vet. Parasitology* 44: pp. 211-221.

Serum samples, collected monthly from January through December 1988 from 10 cows, their calves, and 10 yearling heifers, were used to determine total and *Ostertagia*-specific IgE levels. In addition, serum pepsinogen concentration, fecal egg counts, and body weights were measured. Total and *Ostertagia*-specific IgE levels followed similar seasonal patterns, being generally highest in the spring. Breed and/or sire effects on total IgE levels were observed, with cattle from Angus-cross lines having higher levels than cattle of the other breeds tested. Ref.163\61.47.

Baker, D.G., and L.J. Gershwin. 1993a. Immunoglobulin E and type I hypersensitivity in bovine ostertagiosis. *Vet. Parasitology* 46: pp. 93-102.

A series of experiments were performed to determine whether immunoglobulin E (IgE) and Type I hypersensitivity reactions might be involved in the immune response of cattle to infection with *Ostertagia ostertagi*. When calves were lightly infected, serum IgE levels paralleled worm burdens. However, in heavy infections, both serum and lymph IgE levels were inversely related to burdens of *O. ostertagi*. Increases in mediators, especially histamine and leukotriene (LT) C₄ were detected in tissue or lymph, and were associated with cellular changes indicative of hypersensitivity. Ref.165\61.48.

Baker, D.G., and L.J. Gershwin. 1993b. Inverse relationship between IgE and worm burdens in cattle infected with *Ostertagia ostertagi*. *Vet. Parasitology* 47: pp. 87-97.

Changes in serum total and *Ostertagia*-specific IgE levels, and pepsinogen concentrations were evaluated in 28 Holstein calves naturally or experimentally infected with *Ostertagia ostertagi*. In addition, IgE and pepsinogen concentrations were determined in abomasal lymph. Results showed that (1) lymph IgE responses were inversely correlated with worm burdens, and (2) serum IgE levels were unreliable for predicting worm burdens. Ref.188\62.22.

Baker, D.G., L.J. Gershwin, S.N. Giri, and C. Li. 1993. Cellular and chemical mediators of type 1 hypersensitivity in calves infected with *Ostertagia ostertagi*: histamine, prostaglandin D₂, prostaglandin E₂, and leukotriene C₄. *Internatl. J. Parasitology* 23: pp. 333-339.

Cellular and chemical mediators of type 1 hypersensitivity in calves infected with *Ostertagia ostertagi* include: histamine, prostaglandin D₂, prostaglandin E₂, and leukotriene C₄. Levels were determined in 26 Holstein steers before and after natural or experimental infection with *Ostertagia ostertagi*. Ref.179\62.13.

Baker, D.G., L.J. Gershwin, and D.M. Hyde. 1993. Cellular and chemical mediators of type 1 hypersensitivity in calves infected with *Ostertagia ostertagi*: mast cells and eosinophils. *Internatl. J. Parasitology* 23: pp. 327-332.

Abomasal mucosal mast cell and eosinophil accumulation was morphometrically evaluated in 26 Holstein steers after natural or experimental infection with *Ostertagia ostertagi*. Results showed that following infection, accumulation of mast cells and eosinophils in abomasal tissue was dependent on infection pattern. Eosinophilia was greater in steers with type 1 ostertagiosis, while mastocytosis was more pronounced in steers with type 2 ostertagiosis. Ref.180\62.14.

Baker, D.G., L.J. Gershwin, and T.G. Snider, III. 1991. Celiac trunk cannulation for obtaining abomasal lymph from cattle. *Am. J. Vet. Res.* 52: pp. 1117-1120.

Cannulation of the celiac trunk was surgically performed in 26 Holstein steers. The procedure was successful in 23 (88.5%) of the steers. Twenty-two of the steers were infected either naturally or experimentally with the abomasal nematode, *Ostertagia ostertagi* and/or other gastrointestinal parasites. The remaining 4 steers were not infected. Lymph obtained after surgery was used in various immunologic and biochemical assays. Daily lymph flow rate and total and differential WBC counts were determined after surgery in 4 of the infected and 3 of the noninfected steers. Steers were euthanized for tissue specimen collection 7 days after surgery. Ref.37\60.08.

Baker, D.G., J.L. Stott, and L.J. Gershwin. 1993. Abomasal lymphatic lymphocyte subpopulations in cattle infected with

Ostertagia ostertagi and *Cooperia* sp. Vet. Immunol. Immunopathol. 39: pp. 467-473.

Abomasal lymphatic cannulation was performed on steers naturally or experimentally infected with *Ostertagia ostertagi* and *Cooperia* sp. Abomasal lymphatic lymphocyte subpopulations were evaluated using antibodies specific for bovine mononuclear cell surface antigens, followed by flow cytometric analysis. These findings are compatible with reports of worm-specific antibody synthesis in bovine nematodiasis. Ref.182\62.16.

Baker, N.F. 1980. Protection of livestock against internal parasites by management methods. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 41-43.

It has recently been estimated that losses to the cattle industry as a result of internal parasites exceed 450 million dollars annually. Such a large loss due to disease could well be prevented if all cattle were to be treated monthly with the anthelmintics presently available. Unfortunately, if this were done, the cost to the livestock industry in dollars for drug purchase and labor of administration would exceed the present loss as the result of disease! Thus, where possible we must utilize management practices which do not interfere with maximal productivity, yet minimize exposure to parasitic infection. Ref.197\63.08.

Baker, N.F. 1985. Ivermectin and other controls for internal parasites of cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 1-3.

The reduction of contamination of pastures in California through residual treatment to remove developing worms in the fall, or by single treatment to remove all stages of worms from cattle in summer, will greatly reduce infection rates on pasture in the following winter and spring. Whether or not this single treatment will be adequate to protect against performance losses in all instances during winter and spring has not been determined. Where it is possible to utilize such a treatment, this certainly must be considered the cornerstone to a successful control program. Such programs will require modification when cattle are brought in from other states. Ref.205\63.16.

Baker, N.F., and R.A. Fisk. 1986. Seasonal occurrence of infective nematode larvae in California Sierra foothill pastures grazed by cattle. Am. J. Vet. Res. 47: pp. 1680-1685.

Worm-free Holstein tracer calves were used to assess the seasonal variation in number and course of development of nematode parasites of cattle on an irrigated pasture located in the California Sierra foothills. The most common genera of nematodes found in the abomasum and small intestine were *Ostertagia* and *Cooperia*, respectively. The infective *Ostertagia* larvae on herbage were most numerous in early spring and lowest in summer months. Arrested development of *Ostertagia* occurred in mid-to-late spring. Evidence of seasonal hypobiotic development of *Os venulosum* was found. Ref.26\58.05.

Baker, N.F., R.A. Fisk, R.B. Bushnell, and M.N. Oliver. 1981. Seasonal occurrence of infective nematode larvae on irrigated pasture grazed by cattle in California. Am. J. Vet. Res. 42: pp. 1188-1191.

During the period extending from Dec 1, 1975 to Dec 22, 1976, 3 distinct peaks in the concentration of infective nematode larvae on pasture forage were detected by use of helminth-free tracer calves. Two of these peaks, 1 occurring in the spring and 1 in the fall, consisted mainly of *Ostertagia ostertagi* and *Cooperia* sp. It is concluded that these 2 peaks can be anticipated annually and constitute unsafe periods for grazing. The 3rd peak was comprised largely of *Haemonchus placei* and *Cooperia* sp. It is concluded that this peak occurred as the result of unusual rainfall and reduced evaporation in August. Ref.101\61.66.

Barry, S. 1996. Determining forage diet quality by analyzing fecal matter with near infrared spectroscopy. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 27-30.

A relatively new technique developed by the Department of Range Ecology at Texas A&M University can quickly determine the nutritional status of cattle grazing rangeland or pasture. Cattle manure is analyzed using near infrared reflectance spectroscopy (NIRS). Manure samples have been collected from ranches throughout the Sacramento Valley and Sierra Foothill, etc. and analyzed using the NIRS process. Ref.278\64.14.

Beckett, J.L., J.W. Oltjen, D.J. Drake, R.E. Delmas, H.A. George-McCann, G.A. Nader, and L.C. Forero. 1993. Estimation of the effect of decreasing public land allotment on beef production in northern California. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 5-10.

This study was undertaken to evaluate the effect of reduced public land grazing on cattle ranches in northern California. In particular, the effect of decreasing allotments on forage availability for cattle operations was studied. Two variables were estimated: (1) the decrease in cow-herd size necessary in order to sustain itself on the same amount of supplemental forages currently being fed, and (2) the increase in conserved forage (hay) that would be required to maintain the same number of animals currently in a particular operation. Ref.167\61.49.

Bell, M., Daley, C.A., Berry, S.L., and Adams, T.E. 1996. Pregnancy status and feedlot performance of beef heifers actively immunized against gonadotropin-releasing hormone. *J. Animal Science* 75: pp. 1185-1189.

The contraceptive effect of active immunization against GnRH was evaluated in beef heifers. Crossbred heifers were randomized by breed and weight, and assigned to one of three treatment groups. Group IB were actively immunized against GnRH, heifers in group NB and NN did not receive the anti-GnRH vaccine. Sixteen weeks after primary immunization, bulls of proven fertility were introduced into pens containing Groups IB and NB. Bulls were maintained with heifers for 2 months. Data suggest that immunoneutralization of GnRH may be an effective tool that will reduce the incidence of unintended pregnancy in heifers destined for feedlots. 66.09

Berger, T. 1995. Proportion of males with lower fertility spermatozoa estimated from heterospermic insemination. *Theriogenology* 43: pp. 769-775.

This study was designed to evaluate the proportion of males with spermatozoa detectably less fertile than the spermatozoa from other males. The proportion of pairs in which the males sired equivalent numbers of offspring were 0.42, 0.18, 0.33 and 0.09 for trials with fresh boar semen, liquid-stored boar semen, frozen bull semen and fresh rabbit. The calculated proportion of males with less fertile spermatozoa were 0.36, 0.57, 0.42 and 0.70, respectively. Although these differences in fertility would not be apparent in some management systems, a high proportion of ejaculates had spermatozoa that were detectably less fertile. Ref.134\63.88.

Berger, T. 1996. Fertilization in ungulates. *Animal Reproduction Sci.* 42: pp. 351-360.

The fertilization process is critical for the preservation of mammalian species. The range in sperm fertilizing potential will influence the assay sensitivity required to detect differences in sperm fertilizing potential to determine the most fertile ejaculates. Interaction with the zona pellucida (ZP) and oolemma are two bioassays suggested to assess variation in sperm fertilizing potential. Interaction with receptors on the oolemma appears to contribute to the variation in sperm fertilizing potential observed within fertile populations. Ref.276\64.12.

Connor, J.M., S.L. Berry, C.B. Wilson, and C. Daley. 1988. The effect of pelvic area on calving difficulty in beef heifers. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 10-14.

The present study was undertaken as part of a heifer management trial that involves crossbreeding Hereford heifers with Angus, Gelbvieh and Longhorn sires. The objective of measuring pelvic areas was to ascertain whether pelvic measurements taken at different times had any relationship to the incidence of dystocia. The data collected during the last two years would indicate thus far that selecting heifers based on pelvic area would serve no purpose in preventing dystocia but that selecting bulls (or breeds) that are known to sire calves with low birth weights would result in a lower incidence of dystocia. Ref.222\63.33.

Connor, J.M., C.B. Wilson, J.L. Hull, S.L. Berry, and C.A. Daley. 1989. Results from breeding yearling heifers to bulls of three breeds: 1. Dystocia and calf production measures. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 23-26.

This study evaluated calving ease in first calf heifers for births resulting from mating with Texas Longhorn, Angus or Gelbvieh bulls. We also examined livability and gains of these calves. We concluded that birth weights were lighter for Longhorn cross calves than for Angus or Gelbvieh crosses. Results for dystocia scores were similar: scores for births resulting from Longhorn sires were the lowest. Livability for Longhorn crosses were the highest, but gains to weaning were significantly lower than for the Angus crosses. Ref.231\63.42.

Connor, M. 1992. First calf heifer management. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 11-16.

Several management methods for first-calf heifers which were evaluated at the Sierra Field Station over several years. Sires were selected from several herds representing each of three breeds, Texas Longhorn (L), Angus (A) or Gelbvieh (G). L matings resulted in lower dystocia scores, generally lighter calf birth weights, reduced percentage of heifers

requiring assistance at calving and a larger proportion of live calves at weaning. L cross calves were lighter at weaning. Births of heifer calves resulted in a significantly lower dystocia score and reduced requirement for assistance compared to bull calves. Calving heifers were fed hay at 6 p.m. 58% of the births occurred during the daytime hours (6 a.m. to 5:59 p.m.).Ref.236\63.47.

Daigneault, J., and L.W. George. 1990. Topically applied benzathine cloxacillin for treatment of experimentally induced infectious bovine keratoconjunctivitis. *Am J Vet Res* 50(3): pp. 376-380.

The purposes of the study reported here were to test the efficacy of various dosages of topically administered benzathine cloxacillin for treatment of experimentally induced IBK, and to compare the efficacy of benzathine cloxacillin with that of an approved long-acting oxytetracycline formulation. Ref. 322\65.03

Daley, C. 1991. A three year look at stocking density and rainfall patterns on gain of stocker cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 30-32.

An attempt was made to look at differences in weight gain and dollar return of stocker cattle managed under two levels of stocking over a three year period. High stocking rates returned more dollars per acre in the first two years of this trial although return per head was higher for the low stocking rate groups because of higher gains. The results from 1990-91 indicate that under severe feed conditions a lowered stocking rate is favored economically on either the per head or the per acre basis. Ref.72\61.27.

Daley, C.A. 1992. Synchronization of estrus with MGA (melengestrol acetate) and lutalyse in yearling heifers. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 5-9.

The recent emphasis on value-based marketing and carcass predictability has caused many cow-calf producers to take a second look at estrus (heat) synchronization and artificial insemination (AI) programs. A method for synchronization is discussed. Eighty-six yearlings heifers were fed MGA at 5mg/hd/day for 14 days and received an injection of prostaglandin 17 days after the last day of MGA feeding. 80% of the heifers showed visible estrus, and were inseminated, within four days of the prostaglandin injection. Calving data revealed an 83% conception rate to first service on those heifers that responded to the synchronization. Ref.235\63.46.

Daley, C.A., and T.E. Adams. 1996. Development of a vaccine to prevent pregnancy/cyclicity in heifer calves. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 23-26.

Several studies have been designed to synchronize the recovery of immunized heifers in an attempt to develop management strategies for large groups of heifers where it is difficult to make culling decisions early. In this manner, all heifers could be managed identically until culling decisions are made. Under this management strategy, the immunization procedure would be temporary and recovery of replacement heifers could be synchronized so that this population of females would still calve at two years of age. New vaccine adjuvants are currently being evaluated to determine their usefulness under this type of management scheme. Ref.277\64.13.

Delmas, R.E. 1980. Management of the research herds at the Sierra Field Station. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. p. 29.

At the Sierra Field Station there are approximately 250 commercial Herefords, 60 purebred Polled Herefords, and 60 replacement heifers. All mature cows at the Station are assigned to a research project. The size of the experimental groups range from 10 to 35 head of cows and depend upon the experimental design. Pasture records and individual production records are kept on all cows, calves, and bulls. All animals are weighed a minimum of five times per year. Cows are pregnancy tested each year, and the open cows are culled unless the experimental design states otherwise. Ref.194\63.05.

Delmas, R.E. 1985. Ralgro for replacement heifers. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. p. 23.

Preliminary results from this trial indicate that 1) implanting heifers with Ralgro at 2-4 months of age produces variable results; 2) implanting heifers with Ralgro following weaning showed no beneficial effect; and 3) implanting heifers with Ralgro just prior to the breeding season inhibits sexual maturity (estrus) and lowers the pregnancy rate. Ref.80\61.35.

Drake, D.J., E.R. Atwill, J.M. Connor, and D. Jones. 1997. Prevalence of *Cryptosporidia parvum*, *Giardia duodenalis*, and *Campylobacter jejuni* in beef calves and impacts on preweaning gain and weaning weight. Proc., Western Section, American Society of Animal Science. p. 48.

Three herds of crossbred beef calves were tested for fecal shedding of *Campylobacter jejuni* and protozoal eggs from *Cryptosporidia parvum* and *Giardia duodenalis*. Infection impact on preweaning ADG and adjusted weaning weight

was determined. Fecal grab samples were randomly obtained from calves at 2-3 months of age and again at weaning. Calves were identified as positive or negative for each parasite. Statistical analysis included location and sex effects. Ref.308/64.45.

Dunbar, J.R., J.M. Connor, C.B. Wilson, C.A. Raguse, T.R. Famula, C.A. Daley, and M.R. George. 1988. Bypass protein for growing range calves. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 1-5.

A 114-day supplemental feeding trial involving a total of 144 English-bred steers averaging 496 pounds was conducted to evaluate urea, bypass protein, and urea plus bypass as range supplements. The urea-based supplement appeared not to be as palatable as the bypass and urea plus bypass protein supplements. The major bypass ingredient in the bypass and bypass plus urea supplements was corn gluten meal. Steers consuming the bypass plus urea supplement gained the most weight and returned more dollars over supplement cost. Ref.75\61.30.

Dunbar, J.R., C.A. Daley, J.M. Connor, C.B. Wilson, C.A. Raguse, T.R. Famula, and M.R. George. 1989. Utilization of bypass protein in liquid supplements. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 1-6.

Steers consuming bypass protein supplements gained the most weight and returned more dollars over supplement cost. It is not yet clear what added benefit, if any, the combination of urea and the corn gluten meal may have. Steers in the low stocking density groups (5.33 acres/hd) gained more weight than the high stocking density groups (2.67 acres/hd) across all supplement treatments. As a result, the lower stocking density groups returned more dollars per head. Dollar return per acre favored the high stocking density groups. Variations in overall average daily gains between years may be a reflection of residual dry matter differences. Ref.227\63.38.

Dunbar, J.R., C.A. Daley, J.M. Connor, C.B. Wilson, C.A. Raguse, T.R. Famula, and M.R. George. 1990. Supplements evaluated for wintering range calves. California Agriculture 44(2): pp. 12-15.

In two range feeding trials to evaluate supplemental nitrogen and/or bypass protein source and stocking densities, calves at a low density gained more weight than high density groups. Dollar return during the supplementation phase, however, was highest from high density groups fed a combination of urea and corn gluten meal. Ref.55\61.10.

Dunbar, J.R., J.G. Morris, B.B. Norman, A.J. Jenkins, C.B. Wilson, and J.M. Connor. 1993. Cupric-oxide needles effective as oral copper supplement in cattle. California Agriculture 47(3): pp. 25-26.

This trial illustrates that copper-oxide-wire particles provide an effective and simple method for preventing or treating copper deficiency in cattle. Study results indicate that oral administration of copper-wire particles was effective, cheap, safe, and convenient in preventing or treating copper deficiency. Such a deficiency can retard growth in cattle. Ref.30\62.28.

Dunbar, J.R., B.B. Norman, and W.H. Johnson. 1983. Selenium pellets for cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 31-37.

Selenium deficiency in cattle was originally thought to be a problem primarily confined to northern California. There is now evidence that selenium deficiency is widespread throughout the state. The selenium pellet administered in a single operation, offers a safe, economic, and effective means of preventing selenium deficiency in grazing cattle for a period of two years. During that period, it raises selenium concentrations in the blood and other tissue from deficient to normal levels. Ref.203\63.14.

Dunbar, J., J. Oltjen, M. Sween, M. Connor, H. Johnson, and C. Wilson. 1993. Range supplementation strategies for steers grazing the Sierra foothills of California. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 1-4.

A number of experiments on supplementation of steers under annual range conditions at the UCSFREC have demonstrated that supplements may affect growth, but profit per acre may not always improve. Maximal gain per animal is not always the most important production criterion. The effects of supplements on forage intake are complex in grazing cattle where interactions between grazing, supplement intake, forage availability and conditions may modify normal mechanisms that regulate intake. There is evidence of a positive response in steer weight gain & dollar return/acre when small amounts of energy are fed in the spring. Ref.166\61.49.

Dunbar, J.R., C.B. Wilson, and J.M. Connor. 1987. Range cow nutrition. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 10-18.

In California it is estimated that the cost of maintaining the range beef cow accounts for approximately \$400.00 annually. One of the major ways to increase profitability of the range cow herd is to reduce this cost. Sixty percent of this \$400 represents feeding the cow. Body condition scoring was developed from an Australian method and can be used by anyone working with cattle to assess the fatness or condition of cows, calves, or bulls. It can serve as a

valuable management aid in cattle production. Ref.212\63.23.

Eastman, T.G., L.W. George, D.W. Hird, and M.C. Thurmond. 1998. Combined parenteral and oral administration of oxytetracycline for control of infectious bovine keratoconjunctivitis. J Am. Vet. Med. Assoc. 212(4): pp.560-563.

Combined parenteral and oral administration of oxytetracycline appears to be an effective method of reducing severity of a herd outbreak of IBK and may be superior to treatment of affected animals with procaine penicillin G. Ref 316\64.56

Edmondson, A.J., L.W. George, and T.B. Farver. 1989. Survival analysis for evaluation of corneal ulcer healing times in calves with naturally acquired infectious bovine keratoconjunctivitis. Am J Vet Res 50(6): pp.838-844.

The purpose of the study was to compare 3 methods of calculating the healing time, and to assess the effectiveness of survival analysis for the statistical evaluation of healing times in a clinical trial comparing parenterally administered long-acting oxytetracycline, topically instilled furazolidone and no treatment on the healing rate of corneal ulcers in a natural epizootic of IBK. Ref. 323\65.04

George, L.W. 1990. Antibiotic treatment of infectious Bovine Keratoconjunctivitis. Cornell Vet 80(3) editorial: pp. 229-235.

Infectious keratoconjunctivitis is a widespread, highly contagious ocular disease of cattle that is caused by the gram-negative bacteria *Moxarella bovis*. The clinical signs of IBK include corneal ulceration, edema, opacity and occasionally perforation. Affected cattle may have lowered weight gains and impaired vision which reduces their economic value. Other major losses include direct costs of repetitive drug treatments. Once *M. bovis* is introduced, it spreads rapidly by direct contact or by face flies. In most outbreaks, 80% of yearling calves become infected during the summer. Ref 317\64.57

George, L.W. 1984. Clinical infectious bovine keratoconjunctivitis. The Compendium on Continuing Ed. for the Practicing Vet. S712 Continuing Education Article #12 6(12): pp. S712-S720.

Infectious bovine keratoconjunctivitis (IBK) is a widespread, highly contagious ocular disease of cattle. The incidence of the disease is variable, but in some herds 45% of the calves may develop ocular lesions during a summer. Economic losses in feedlot calves in one or both eyes include 260 day postweaning body weight decreases of 35-47 lbs respectively. The economic significance of IBK is exemplified by the results of surveys in the United States and Australia, where the disease was endemic in the majority of the cattle herds. Ref. 324\65.05

George, L.W., T. Keefe, and J. Daigneault. 1989. Effectiveness of two benzathine cloxacillin formulations for treatment of naturally occurring infectious bovine keratoconjunctivitis. Am J Vet Res 50(7): pp. 1170-1174.

A field study was performed to determine the effectiveness of benzathine cloxacillin for the treatment of infectious bovine keratoconjunctivitis. The study was performed between June and September of 1987. Ref.321\65.02

George, L.W. 1987. Treatment methods for pinkeye in cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. p. 32.

The effectiveness of topically applied furazolidone (NFZ), and subconjunctivally administered penicillin G for the treatment of infectious bovine keratoconjunctivitis (IBK) were compared to that of parenteral and combined parenteral oral therapy with oxytetracycline (OTC). All of the calves were examined 3 times weekly. Calves treated with OTC had the best response to therapy, while those treated with topical NFZ had the poorest response. The response of the calves to the penicillin G was significantly poorer than that observed in the OTC treatment group. Seemingly, OTC is superior to NFZ and penicillin G for the therapy of active IBK. Ref.215\63.26.

George, L.W. 1990. Managing pinkeye in beef cattle. California Agriculture 44(2): pp. 11-12.

Two field studies showed that a widespread pinkeye epidemic in a beef herd can be effectively treated with injections of long-acting oxytetracycline, followed by feeding the antibiotic in the ration. When the disease is less prevalent, injecting affected animals with penicillin or oxytetracycline is effective. Ref.244\63.56.

George, L.W., J. Mihalyi, A. Edmondson, J. Daigneault, G. Kagonyera, N. Willits, and M. Lucas. 1988. Topically applied furazolidone or parenterally administered oxytetracycline for the treatment of infectious bovine keratoconjunctivitis. J Am. Vet. Med. Assoc. 192(10): pp. 1415-1422.

The effectiveness of topically applied furazolidone (FZ) or parenterally administered oxytetracycline (OTC) for treatment of infectious bovine keratoconjunctivitis was determined in a field study between June and August of 1985. Eyes of hereford calves were examined 3 times each week for 7 weeks. Between 1 and 4 weeks after treatment, the

lowest frequency of *Moraxella bovis* isolation was observed in specimens treated from the OTC calves, and the highest frequency was observed in specimens from the untreated calves. During the entire 7 week period, a progressively increased mean minimal inhibitory concentration of FZ (but not OTC) was observed for *M. bovis*. Ref.319\64.59

George, L.W., and J.A. Smith. 1985. Treatment of *Moraxella bovis* infections in calves using a long-acting oxytetracycline formulation. *J. Vet. Pharmacol. Therap.* 8: pp. 55-61.

Studies were undertaken to determine the effectiveness of an oxytetracycline HCl formulation for the prophylaxis and treatment of chronic *Moraxella bovis* ocular infections in calves. Two separate experiments were performed. For the first, calves were separated into two groups and the eyes were infected with *M. bovis*. The eyes of these calves were observed and cultured for 37 consecutive days. The cultures from the five treated calves were negative after the first antibiotic administration and remained so for 14 days. Ref.44\60.30.

George, L.W., W.D. Wilson, J.D. Baggot, and J.E. Mihalyi. 1984. Antibiotic treatment of *Moraxella bovis* infection in cattle. *J. Am. Vet. Med. Assoc.* 185(10): pp. 1206-1209.

An inexpensive, yet effective method for the treatment of cattle with ocular *Moraxella bovis* infections is needed. Some studies indicate that there may be regional differences in the anti-microbial susceptibility tests on *M. bovis*. Such studies also indicate the importance of performing antimicrobial susceptibility tests on *M. bovis* before the treatment of large numbers of infected animals and indicate a need for the development of alternate treatment regimens for cattle with IBK. Ref.318\64.58.

Hull, J.L. 1980. Beef heifers to be bred as yearlings. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 33-37.

Although supplementation of growing heifers may be economically marginal when interpreted solely on the basis of weight gains, other considerations such as presupplemental ADG, increased stocking rate of irrigated pasture, and specific breeding weight and time goals would determine the most appropriate management practice to be used during the growing phase. The data reported here indicate that although irrigated pasture is a very good growing diet, energy supplementation will increase ADG; however, an optimal system of supplementation such as feeding heavily for two weeks followed by no grain for two weeks should be employed. The addition of monensin is also recommended. Ref.195\63.06.

Hull, J.L. 1991. Livestock for irrigated pasture. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 46-47.

All phases of grazing management must be considered to optimize animal production from irrigated pasture. These should include a preventive animal health program, a pasture management plan, an animal management plan and the selection of the type of livestock to be grazed within the overall management system to be the desired objectives. Ref.71\61.26.

Hull, J.L. 1985. Managing beef heifers for early breeding. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* p. 24.

To take advantage of the high productivity and low production cost of an irrigated pasture, the use of high-energy supplements and monensin sodium in the diet of grazing heifers is recommended. Even with their use, however gain has not always been in the recommended range of 1.25 pounds per day or better. Recent studies concerned with the growth and development of replacement beef heifers bred to calve as two-year-olds have shown that protein-energy supplementation for such heifers grazing irrigated pasture will enhance average daily gain over conventional energy supplementation. Ref.79\61.34.

Hull, J.L., R.E. Delmas, and E.J. DePeters. 1984. Protein-energy supplements for beef heifers. *California Agriculture* 38(11-12): pp. 9-10.

Recent studies concerned with the growth and development of replacement beef heifers bred to calve as two-year-olds have shown that protein-energy supplementation for such heifers grazing irrigated pasture will enhance average daily gain over conventional energy supplementation. Variable performance on irrigated pasture led to our investigation of various levels of protein and energy supplementation as a means of increasing average daily gain to produce heifers of adequate breeding weight. Ref.24\60.22.

Hull, J.L., and J.R. Dunbar. 1977. Straw: low-cost feed but not least cost. *California Agriculture* 31(4): pp. 18-19.

Cereal straw can be fed as a major portion of a growing ration with little if any energy available for production. Better growth can be obtained when cottonseed meal rather than urea is used as a nitrogen source to supplement straw. A

least-cost program will result in a least-cost ration for a given set of specifications and feed prices. However, the least-cost ration does not ensure least-cost gain. More work is necessary on feeding cereal straws, especially on factors affecting intake and net energy values. Ref.46\61.10.

Hull, J.L., W.N. Garrett, and J.R. Dunbar. 1978. Rice or barley straw for pregnant beef cows. *California Agriculture* 32(11): pp. 14-15.

Rice straw is palatable and a satisfactory feed for pregnant beef cows, provided protein, mineral, and vitamin requirements are met. Diets containing high levels of barley straw are unpalatable even when supplemented with protein, minerals, and vitamins. They should not be fed to pregnant beef cows unless special precautions are taken to ensure that adequate quantities of nutrients will be consumed. Ref.93\63.63.

Hull, J.L., and C.A. Raguse. 1978a. Irrigated pasture for beef heifers to be bred as yearlings. *J. Anim. Sci.* 46: pp. 878-883.

Irrigated pasture grazing trials were conducted during three grazing seasons (years) to investigate systems for rearing early-breeding replacement beef heifers. Seven-to 8-month-old weaner beef heifers grazing irrigated pasture were supplemented with barley. Supplemental treatments were (1) none, (2) three times per week (MWF), (3) daily (fed weekly-intake limited by salt to be consumed over 7 days) and (4) same amount as (2) and (3) would consume in 2 weeks. Supplementation increased ADG and supplementing for 2 weeks followed by no grain for 2 weeks in general increased ADG more than other supplemental treatments. Ref.64\61.19.

Hull, J.L., and C.A. Raguse. 1978b. Utilizing irrigated pasture for beef heifers to be bred as yearlings. *California Agriculture* 32(7): pp. 6-8.

Many studies have shown irrigated pasture to be a good growing ration. Others have shown better results with grain used to supplement irrigated pasture. In preliminary trials at Davis with beef calves on irrigated pasture, barley, supplemented at the rate of 20 percent of their expected total dry matter intake (approximately 1 kg/day), did not improve gains significantly, but supplementation did permit a marked increase in stocking rate. In conclusion, phases of management, genetics, and nutrition must be considered if rearing replacement heifers, and for early breeding (bred as yearlings to calve as 2-year-olds), and a good preweaning diet is necessary. Ref.94\63.64

Hull, J.L., C.A. Raguse, and R.E. Delmas. 1981. Rumensin supplements for replacement heifers on irrigated pasture. *California Agriculture* 35(3-4): pp. 8-9.

Although supplementation of growing heifers may be economically marginal when evaluated solely on the basis of weight gains, other considerations, such as preweaning average daily gain (ADG), increased pasture stocking rate, and specific breeding weight and time goals, would determine the most appropriate management practice to be used during the growing phase. The data indicate that energy supplementation of irrigated pasture increases ADG. Only heifers with above-average ADG at weaning should be selected as replacements and fed a diet for continued growth to reach 650 pounds by 14 to 15 months of age. Ref.22\60.23.

Hull, J.L., C.A. Raguse, and J.P. Guild. 1972. Supplementation of dry annual range by irrigated pasture. *J. Range Manage.* 25(2): pp. 96-99.

Supplementation of a low protein, high-fiber, dry annual-range forage by irrigated pasture appears feasible. Data indicate that irrigated pasture can be used to increase the amount, or improve the quality, of beef production, and that it can compete economically with cottonseed meal as a supplemental protein source for cattle grazing dry annual-range forage. Ref.9\45.26.

Hull, J.L., C.A. Raguse, J.G. Morris, and R. Delmas. 1974. Feedlot animal waste compared with cottonseed meal as a supplement for pregnant range cows. *J. Range Manage.* 27(3): pp. 192-194.

Three groups of pregnant beef cows grazing dry native annual range were either supplemented with pelleted cottonseed meal (0.90 kg/head daily), a pelleted mixture of 75% feedlot manure-25% barley (ad lib.), or received no supplementation for a period of 84 days. Cows were induced to consume the manure pellet on range by accustoming them to the manure-barley pellet in a preliminary period of feeding in a drylot. A marked response occurred to both supplements as measured by cow weights at calving and weaning weight of the calf. Ref.67\61.22.

Iglesias, T., and J.G. Morris. 1982. Hepatic and plasma concentration of carotene and vitamin A in range cows. *Proc., Western Sec. Amer. Soc. Anim. Sci.* 33: pp. 1-4.

The present study was undertaken to reexamine the necessity to supplement breeding cows with vitamin A under northern Californian range conditions. The results support and reaffirm the conclusion of Hart and Guilbert (1933) that mature breeding stock, under normal range conditions in northern California, can store sufficient vitamin A in their

livers during the green season to meet their demands throughout the year. While a deficiency of vitamin A can have serious economic consequences, the probability of a deficiency occurring appears to be relatively remote. Therefore, vitamin A supplementation as an insurance against a deficiency needs to be supplied on a minimal cost basis. Ref.104\63.48.

Ingram, R., J. Dunbar, B. Willoughby, C. Wilson, and M. Connor. 1988. Body condition scoring beef cows. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 6-9.

Body condition is a more reliable guide for evaluating nutritional status than live weight. Body condition scoring is easy to learn and useful when practiced by the same person in the same herd over several years. Nutrition and reproduction decisions are made with more precision where a body condition scoring system is routinely used. Ref.74\61.29.

Johnson, W.H., B.B. Norman, and J.R. Dunbar. 1979. Selenium improves weight gain of beef calves. California Agriculture 33(3): pp. 14-15.

The objective of these studies was to determine the effects of injections of selenium, vitamin E, and combinations of the two on post-weaning weight gains of beef calves raised in Se-deficient areas. Treatment with Se produced significant increases in weight gain over controls. Improvements ranged from 16% to 59%, with an average of 43% on a trial-by-trial basis. Additions of vitamins E, A, & D to Se produced no significant increase in weight. Treatment with vitamin E alone produced a significant increase in gain over controls in one of three comparisons, but the increase was significantly less than that produced by Se treatments. Ref.48\61.03.

Kaya, H.K., and R.D. Moon. 1978. The nematode *Heterotylenchus autumnalis* and face fly *Musca autumnalis*: a field study in northern California. J. Nematol. 10: pp. 331-341.

Heterotylenchus autumnalis was found in six northern California counties surveyed, and the incidence of nematode infection of face flies ranged from 4.7 to 43.8%. Intensive studies at a cattle ranch in Yuba County showed that population densities of the host and nematode infections were highest in flies from cow pats receiving full sun. Average host population density was 105.7 puparia per pat, and nematode infection averaged 38.6%. Pats in partial sun averaged 13.5 puparia and 13.1% nematode infection. No face fly was recovered from shaded pats. Ref.95\61.62.

Kaya, H.K., R.D. Moon, and P.L. Witt. 1979. Influence of the nematode *Heterotylenchus autumnalis* on the behavior of face fly *Musca autumnalis*. Environ. Entomol. 8: pp. 537-540.

Face flies of both sexes infected with the nematode, visited the faces of cattle and fresh cattle dung. However, female flies greatly outnumbered males at both sources. Generally, infected male flies found on cattle and dung contained young nematodes. In contrast, infected females on cattle contained nematodes of all ages, and most infected females from dung contained older nematodes. The propensity of healthy female flies to visit faces of cattle and dung depended on their gonadotrophic age. The majority of flies with immature eggs were found on cattle while the majority with mature eggs were found on dung. Ref.96\61.63.

Letshwenyo, M. 1996. Efficacy of lasalocid and decoquinate in controlling coccidiosis in beef calves raised in foothill range. M.P.V.M. Thesis, Univ. of Calif., Davis. 27 pages.

Sixty-four Hereford/Shorthorn cross calves, raised under foothill conditions at Sierra Foothill Research and Extension Center, were used in a field trial to determine the efficacy of lasalocid and decoquinate, or remained as non-medicated controls. Fecal Samples were collected and examined at the beginning and end of the study. The overall oocyst shedding rate was lower than those reported in previous studies. The mean body weights per group increased by 5.0%, 5.1%, and 3.0% for the lasalocid, decoquinate, and control groups, respectively. Ref.310\64.48.

Loomis, E.C. 1987. Evaluation of Cooper's ear tag for fly control on cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 19-25.

Cooper's ear tags (Code 20) provided excellent control of horn flies for the period June 9 to September 9, 1986. A cow herd was sprayed with 0.25% Deltax which kept fly populations low for 6-7 weeks, after which the herd was exposed to 1% Warbex dust bags. The dust bags had little effect. None of the treatments was effective against face flies. Ectiban tapes reduced horn fly levels in some cases. Ref.213\63.24.

Maas, J. 1996. Bovine coccidiosis. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 31-33.

In a clinical research trial conducted at the Sierra Foothill Research and Extension Center in 1995, we looked at the effect of prevention of coccidiosis on weaning cattle. Our conclusion was that coccidiosis prevention, in weaned calves that are minimally exposed to coccidia may have important production benefits. Ref.279\64.15.

Morris, J.G. 1980. Assessment of sodium requirements of grazing beef cattle: A review. *J. Anim. Sci.* 50: pp. 145-152.

Although grazing cattle generally freely consume supplemental salt, the necessity of providing sodium additional to that in the feed has almost universally been accepted without evaluation. Techniques proposed for detection of Na inadequacy of cattle are reviewed and it is concluded that parotid salivary Na:K ratio and adrenal histology are the most sensitive indices of Na inadequacy. However, while saliva is a readily sampled body fluid, narrow Na:K ratios are not always associated with production responses to supplemental Na. Ref.65\61.20.

Morris, J.G. 1983. Supplementation of range cattle. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 25-30.

Reviews range cattle nutrient requirements and some supplementation considerations. States Vitamin A liver (100-230 mg/g) and blood plasma (15-31 mg/dl) concentrations for cattle on dry range. Vitamin A levels are probably adequate in cattle on foothill ranges if cows graze green forage for a short period during the year. Phosphorus levels in dry forage are below NRC requirements for lactating cows. Energy and protein are deficient for a considerable portion of the grazing year. In one trial, fed protein and energy was substituted for forage at the rate of 68%. Ref.202\63.13.

Morris, J.G. 1984. Supplementary feeding breeding cows on range. Is it profitable? *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 17-19.

During periods of low feed (energy) intake, the cow reduces her energy expenditure, and additional supplementary feed goes toward an increase in body weight and energy expenditure. When range forage is of good quality (March - May at the Sierra Field Station) energy reserves of cows are restored to similar levels, largely independent of previous levels of supplementation. The results of this experiment to date indicate that when cows are conservatively stocked on cleared foothill range in most years, supplementary feeding is unlikely to be profitable. The study is still in progress. Ref.204\63.15.

Morris, J.G. 1985a. Energy balance of grazing beef cows. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 4-7.

The objective of this study was to measure feed (energy) intake and energy loss by cows grazing on range so energy balance could be calculated. The greatest difference between energy intake and expenditure occurs in the green season when the cows gain in body tissue. These data show the importance of matching the cows' energy expenditure with the availability of forage and the remarkable elasticity of the cow to reduce energy expenditure in periods of low feed availability. Ref.206\63.17.

Morris, J.G. 1985b. Evaluation of feeding value and costs of cattle supplements. *UC Davis Dept. of Animal Sci. and Coop. Ext. Beef Day.* pp. 7-13.

The results of this six-year field experiment involving over 1000 cow years demonstrates that supplementation can increase the productivity of range cows, but the feed cost is greater than the economic return. Although no significant response was obtained in pregnancy percentage to supplementary feeding, the data does indicate that cows of low body weight at calving are the ones most likely to be open. If any supplementary feeding is practiced, these low body weight cows should be the first to receive supplements. While this experiment was conducted over a period of 6 years and encompassed variable seasonal conditions, it was conducted at only one site. Ref.125\63.01.

Morris, J.G. 1989. Range cow management. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 9-11.

The overall objective of a management system for range cows is to maximize net income in relation to the investment in cows, land and other resources. Profitability of the operation depends on the costs of achieving high pregnancy and weaning rates, and high milk production in the cow. Supplementation of the cows increased weaning weight of the calves when comparing them to the non-supplemented group, but caused an even greater increase in costs. Results may differ with a breed of cow with higher milk production or higher stocking rate. Ref.229\63.40.

Morris, J.G., and R.E. Delmas. 1980a. Improving the delivery of supplements to range cattle. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 38-39.

Seasonal variability in supplement consumption by livestock is discussed as are means of measuring consumption in grazing animals. An electronic gate feeder is discussed which provides known amounts of supplement to individual cattle grazing in a group situation with other cattle. Ref.196\63.07.

Morris, J.G., and R.E. Delmas. 1980b. Seasonal variation in the nutritive nature of California range forage for cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 16-20.

A fundamental characteristic of the world's rangelands is the variation in quantity and quality of forage it makes available to grazing animals. This variation results from responses of pasture plants to climatic variables, particularly temperature and rainfall. Data show that the organic matter digestibility and therefore, available energy from annual range forage falls to low levels in the summer-fall period. Thus, the forage ingested by range cattle varies markedly and predictably with the growth cycle of the range plants. Ref.192\63.03.

Morris, J.G., and R.E. Delmas. 1982. Portable self-feeder for supplementing cattle on range. J. Animal Sci. 54(3): pp. 500-503.

A portable self-contained unit which permits supplementation of individual cattle or groups of cattle grazing common range is described. Each unit has four individual feed bunks with an electronic gate that controls entry of cattle to the supplements. When the electronic gates are in continuous operation, they rapidly discharge the lead-sulfuric acid storage batteries. Therefore, a circuit was devised which reduces this demand at all times except when cattle were feeding from the unit. The batteries are recharged by either solar panels or an alternator driven by a small gasoline motor. Ref.28\57.30.

Morris, J.G., R.E. Delmas, and J.L. Hull. 1980. Salt (sodium) supplementation of range beef cows in California. J. Anim. Sci. 51: pp. 722-731.

The need for supplying supplemental salt to beef cows grazing unseeded, partially cleared California range was investigated with two groups of 22 Hereford cows each. Treatments began when the cows had been lactating about 5 months and continued through the subsequent two pregnancies and lactations. One group of cows received supplemental salt *ad libitum*, while the other group received no salt. Groups were alternated between two fields to reduce effect of pasture variation. This experiment demonstrates some limitations of using forage Na alone to predict whether cattle need supplemental salt. Seasonal variation of the Na content in the diet consumed is important, but Na intake from the water supply must be determined as well. Ref.66\61.21.

Morris, J.G., and J.L. Hull. 1980. Effect of stocking rate on liveweight gains. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 21-22.

One hundred and seventeen weaner steers were drenched with Thibenzole, weighed, and divided into four groups by stratified randomization on a body weight basis. The four groups of steers had an initial mean shrunk body weight of about 200 kg. In order to have differential stocking rates, the number of animal per group was varied as the fields were relatively uniform in size. During the trial, individual body weights were taken at weekly intervals on steers corralled and weighed directly from pasture. Our conclusion, for optimal use of foothill range for liveweight gain in steers, high stocking rates for the short period when the forage is of high nutritive value are required. Ref.193\63.04.

Norman, B.B. 1989. Pinkeye (infectious bovine keratoconjunctivitis - IBK). Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 20-22.

This article summarizes infectious bovine keratoconjunctivitis (IBK), treatment, prevention, clinical signs of infection, & management. Ref.230\63.41.

Oltjen, J.W. 1996. Strategic supplementation of range beef cows: split feeding by body condition and stocking rate. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 35-41.

Preliminary results from research aimed at identification of optimal supplementation strategies for range beef cows shows that cows in poorer condition may be supplemented to improve reproductive performance. When body condition dropped below 5.5, cows were supplemented for the next three months. Performance of the cows in the strategic supplementation was improved over those never supplemented, at reduced cost compared to a group always supplemented. Interactions with forage available to graze were observed, and are being explored in further research. Ref.275\64.11.

Oltjen, J.W. 2002. Strategic supplementation of range beef cows: split feeding by body condition and stocking rate. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 18, 2002.

This paper describes five years research aimed at identification of optimal strategies for supplementary feeding of beef cows. Pregnancy rate was not affected by supplement treatment for cows on the moderate stocking rate; however, standard supplementation did increase pregnancy rates for the heavy stocked cows to 88.12% compared to 82.55% and 82.96% for the non-supplemented and strategically supplemented animals, respectively. Calf weights at the weaning averaged about 20 lb greater for cows stocked moderately than for those at the heavy stocking rate for both the non-supplemented and strategically supplemented groups. Stocking rate had little effect on standard supplemented cows. 66.15

Price, E.O. 1985. Bull breeding performance evaluation. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 8-11.

Mating behavior tests provide an opportunity to gain valuable information on the breeding soundness of bulls before they are exposed to females. Many reproductive problems in bulls that would otherwise go unnoticed in routine semen checks can be identified in serving capacity tests. Ref.207\63.18.

Price, E.O. 2002. Fenceline weaning of beef calves. 2002. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 18, 2002.

It was concluded that providing fenceline contact between beef calves and their dams at weaning reduces the negative effects of artificial weaning on calf behavior and growth rate. Although the effects of weaning on calf behavior were relatively short-lived, treatment differences in weight gain established in the days following weaning persisted for at least 10 weeks. Type of housing of totally-separated calves (pasture or dry lot) immediately following weaning and preconditioning calves to hay immediately prior to weaning had only minor effects on their behavioral responses to separation and subsequent weight gain. 66.16

Price, E.O. and R. Borgwardt. 1994. Age-related changes in the sexual performance of Hereford bulls. Appl.Anim.Behav.Sci. 41: pp. 257-261.

Twelve polled Hereford bulls were subjected to annual sexual performance evaluations starting at 12-13 months of age and continuing to 5 years. Significant year effects were obtained for ejaculation frequency, frequency of mounts without ejaculation and the proportion of mounts that culminated in an ejaculation. As yearlings, the subjects exhibited more mounts, fewer ejaculations and a lower ejaculation-to-mount ratio than in years 2 through 5. Increases in mating efficiency between years 2 through 5 were not significant. Some individual year-to-year variation in sexual performance was noted until the bulls reached 4 years of age. Ref.270\64.06.

Price, E.O., C.L. Martinez, and B.L. Coe. 1984. The effects of twinning on mother-offspring behavior in range beef cattle. Applied Anim. Behav. Sci. 13: pp. 309-320.

Methods to increase the productivity of beef cattle include induced twinning and multiple fostering of calves on nurse cows, but little is known about the capacity of cows to rear more than one calf in a rangeland environment. The hypothesis that mother-offspring bonds are weaker with twins than with singles was supported by the fact that mothers bearing twins groomed their offspring less than mothers with singles, and twins were normally found at greater distances from their mothers than singles. Most long-distance cow-calf separations resulted from the cow moving to feed or to obtain water. Ref.271\64.07.

Price, E.O., and S.J.R. Wallach. 1991. Inability to predict the adult sexual performance of bulls by prepuberal sexual behaviors. J. Anim. Sci. 69: pp. 1041-1046.

The objective of this investigation was to determine the extent to which the sexual performance of adult bulls (18 to 24 mo. of age) can be predicted by prepuberal sexual behaviors. Tests were administered to 121 polled Hereford bulls to determine whether adult sexual performance (especially serving capacity or ejaculation rate) was related to mounting of estrous females at 6 mo. of age, age of first ejaculation, frequency of sexual behaviors in heterosexual interactions or the frequency of male-male mounting exhibited in all-male groups. None of the above measures reliably predicted adult serving capacity. We concluded that the sexual behaviors of prepuberal beef bulls were of limited usefulness in predicting adult sexual performance. Ref.272\64.08.

Price, E.O., and S.J.R. Wallach. 1991. Development of sexual and aggressive behaviors in Hereford bulls. J. Anim. Sci. 69: pp. 1019-1027.

This study describes maturation-related changes in the sexual and aggressive behaviors of Hereford bulls. Two groups of 13 and 14 bulls, respectively, were tested for sexual and aggressive behaviors every 3 mo from 3 to 24 mo of age. We conclude that sexual performance data obtained in serving capacity tests administered to yearling bulls before 18 mo of age may underestimate the mating potential of certain individuals. Aggressive behaviors are sufficiently well developed in males by 18 mo of age that prolonged bouts of fighting may reduce the reliability of sexual performance data when testing males in groups. Ref.273\64.09.

Raguse, C.A., J.L. Hull, and R.E. Delmas. 1980. Beef calf production from irrigated pasture, supplements and winter annual range in the Sierra Nevada foothills. Proc., UC Sierra Foothill Range Field Station Beef and Field Day. pp. 5-15.

Animal data were analyzed by computing means and standard deviations for 1) cow weights at breeding, weaning and calving, and at beginning and end of supplementation, and 2) calf weights at birth and weaning (adjusted to 205 days). Using years as replications mean cow and calf weights for the two management systems were compared using the Student's "t" test. An Animal Unit Month (AUM), where used, was defined as one 1000-lb cow. A number of management options used in the study would be useful to part-time farmer-ranchers, especially where family labor and relatively-inexpensive irrigation water are available. Ref.191\63.02.

Raguse, C.A., J.G. Morris, and V.N. Landry. 1989. Correlation of steer average daily gain with diet quality and forage phenology in an improved annual grassland. J. Range Manage. 42: pp. 415-420.

Objectives of this study were to construct a model to describe seasonal changes in steer average daily gain (ADG); to observe changes in nitrogen concentration and in vitro organic matter digestibility related to time of season and ADG; and to relate the phenological progress of maturation of rose clover to ADG, nitrogen concentration and in vitro organic matter digestibility. Ref.85\61.40.

Sainz, R.D. 1993. Value-based marketing of beef cattle. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 11-15.

Current systems for marketing beef cattle and their meat products are changing from average-based to new value-based trading systems. With value-based marketing, cattle will be traded based upon the yield and quality of the usable beef they will produce, rather than their weight alone. The purpose of this paper is to discuss several aspects of value-based marketing of beef with special attention to three questions: 1) Why do we need value-based marketing? 2) how will value-based marketing be implemented? 3) What are the implications for cattle producers? Ref.168\61.49.

Sanchez, M.D. 1983. Energy expenditure and intake in range beef cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 15-16.

In order to improve the productivity of ruminants on pasture it is necessary to have a better understanding of the energy transactions occurring in the animals during the different periods of the production cycle. Up to now the caloric requirements of grazing beef cattle can only be estimated from summations of the energy cost of the different physiological (growth, lactation, pregnancy) and physical (eating, milking, etc.) activities. This present work is directed towards the estimation of the total daily energy expenditure and energy intake of beef cows grazing annual grasslands with different levels of alfalfa supplementation. Ref.201\63.12.

Sanchez, M.D. 1981. Energy expenditure and feed intake of beef cattle grazing annual rangeland. Ph.D. Thesis, Univ. of Calif., Davis. 40 pages.

The energy expenditure (EE) and the feed intake (FI) were measured in beef cows grazing annual rangeland. The cows were divided in three groups that received 0 (group 1), 2 (group 2), and 4 (group 3) kg of alfalfa cubes per day as supplement from August to February. Cows from group 1 had significantly lower EE than cows from groups 2 and 3 in measurements immediately preceding and following calving. Calves from cows in group 3 gained weight faster than calves from the other two groups. Cows from group 3 also had significantly higher total intake of DOM than cows from the other two groups, indicating an additive effect of the supplement. Ref.119\63.90.

Thatcher, E.F., and L.J. Gershwin. 1988. Generation and characterization of murine monoclonal antibodies specific for bovine immunoglobulin E. Vet. Immunol. Immunopathol. 18: pp. 53-66.

Monoclonal antibodies were produced against serum-derived bovine immunoglobulin E (IgE). Culture supernatants of hybridomas were initially screened by enzyme-linked immunosorbent assay (ELISA). Supernatant-derived antibodies were concentrated and further characterized using ELISA, reverse cutaneous anaphylaxis, immunohistochemical staining, and immunoblotting of IgE-containing samples separated by SDS-polyacrylamide gel electrophoresis (PAGE). Eight monoclonal antibodies showed specificity for bovine epsilon immunoglobulin heavy chain. These antibodies will be useful in research applications and in diagnostic assays. Ref.164\63.95.

Wagon, K.A., W.C. Rollins, P.T. Cupps, and F.D. Carroll. 1972. Effects of stress factors on the estrous cycles of beef heifers. J. Animal Sci. 34: pp. 1003-1010.

Similar groups of ungentled range weaner beef heifers were reared separate from other cattle at the University's Davis campus and Range Field Station. While there were considerable differences in the abilities of the observers to detect estrus it was shown that it was possible for a skilled observer, with the aid of a marker animal, to detect a very high percentage of the heats with twice daily observations. Ref.27\45.12.

Williams de Araujo, J., Borgwardt, R.E., Sween, M.L., Yelich, J.V., and Price, E.O. 2003. Incidence of repeat-breeding among Angus bulls (*Bos taurus*) differing in sexual performance. *Applied Animal Behavior Science* 81(2003): pp. 89-98.

The objective of this study was to determine if HP and LP bulls differed in their tendency to repeat-breed individual females. Sexual performance level did not influence mate preferences or the incidence of repeat-breeding during tests. 66.05

Wilson, C.B., J.L. Hull, S.L. Berry, C. Daley, and J.M. Connor. 1989. Results of breeding yearling heifers to bulls of three breeds; 2. Feedlot and carcass performance. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day*. pp. 27-30.

The carcass data indicates the Longhorn crosses will grade equally to the Angus crosses. They may have a slight advantage because of lesser total fat, as their yield grade was approximately one half a yield grade lower. Numbers are small, therefore it is difficult to make a strong conclusion. This trial will have two more years of feedlot and carcass data to be analyzed. Ref.232\63.43.

Wilson, C.B., D.J. Wilson, B.B. Norman, and J.R. Dunbar. 1985. The effects of multiple selenium rumen pellets in feeder cattle. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day*. p. 12.

Administering up to 8 selenium rumen pellets to yearling calves showed no harmful effects to the cattle. The higher blood samples were in the magnitude of 10 less than the toxic levels. All tissue samples were within the safe range except for those from the kidney, which was only 0.3 ppm above the stated safe maximum of 7.6 ppm. There were no animal health problems that could be attributed to selenium levels. There was no significant difference in ADG between groups. Ref.208\63.19.

Wilson, D.J. 1984. The effects of multiple selenium rumen pellets in feeder calves. M. S. Thesis, Univ. of Calif., Davis. 29 pages.

Although some tissue and blood levels were significantly different ($p < 0.05$), no significant differences were observed for measured health and growth parameters for supplemental levels of 2 to 8 rumen selenium pellets per animal. It is unlikely that cattle would accidentally be repelleted more than once or twice under field conditions. Based on our observations in Hereford feeder steers, accidental repelleting as might happen under field conditions would not harm these steers. Ref.25\59.28.

Wilson, D.J., B.B. Norman, D.W. Hird, C.B. Wilson, and M.N. Oliver. 1991. Evaluation of multiple reticulorumen selenium pellets as a health risk in growing Hereford steers. *Am. J. Vet. Res.* 52: pp. 1866-1870.

Five groups of Hereford steer were monitored for 293 days. One group of 3 was not given selenium supplementation; the other 4 groups of 3 steers each were given 2, 4, 6, or 8 reticulorumen selenium pellets. Health, body weight, and blood selenium concentration were monitored during the study. At the finish, steers were slaughtered, and various tissues from the carcasses were analyzed for selenium content. Initial blood selenium concentration did not differ significantly among groups. Analysis did not indicate risk to human beings consuming tissues from these steers. Ref.43\60.07.

Irrigated Pasture Management

Burlando, T.M. 1978. Parasitic nematodes of irrigated pasture; identification, pathogenicity, and control. M.S. Thesis, Univ. of Calif., Davis. 22 pages.

Nematode population and chemical control studies conducted at the University of California Sierra Foothill Range Field Station indicate that during and immediately following periods of prolonged drought nematodes may be a significant limiting factor in the production of irrigated pasture. Neither DBCP, nor DBCP plus subsequent oxamyl sprays, nor oxamyl sprays alone, significantly increased total production of aboveground herbage during a 1-year field trial. Analysis of oxamyl residues in foliage revealed that large amounts of this chemical remained in the foliage 28 days after the last application. Ref.246\63.94.

Erikson, V.A. 2001. The effectiveness of vegetative filter strips in attenuating nutrients, pathogens and sediment of runoff waters from irrigated pastures of the Sierra Foothills. M.S. Thesis, Univ. of Calif., Davis. pp: 23-24.

In California's Sierra Nevada Foothills, flood irrigated pastures are an important source of green forage for livestock during summer months when the surrounding rangelands are dry and dormant. Significant amounts of runoff can be generated from these pastures during irrigation events. Nine plots with one of three randomly applied treatments were developed for this study. It was found with this study that these data do not support the use of vegetative filter strips to attenuate nutrients, microorganisms and sediment from irrigated pastures. 65.22

George, M.R., and C. Shock. 1984. Adaptability of tropical forages to California's central valley. California Agriculture 38(9): pp. 10-12.

A comparison of forage dry matter yield for 20 tropical and cool season forages is presented along with the modified crude fiber and crude protein of 14 tropical and cool season grasses. Perennial warm-season forages offer the advantage of high yields but disadvantages of lower cold tolerance and lower forage quality. Eventual utilization of high-yielding tropical forages will depend upon selection of plant materials with high quality and good low-temperature tolerance. Ref.49\61.04.

George, M.R., C. Wilson, P.B. Sands, R. Ingram, and M. Connor. 1987. Warm season grass trial. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 41-42.

The cool season species commonly used in foothill and valley irrigated pastures are not very productive during the hot summer months. Only dallisgrass, a warm season grass, remains productive during July and August. Warm season grasses, being of tropical origin, have a high optimum temperature for growth and therefore do quite well under hot summer temperatures. The objective of this study is to test several warm season grasses for their adaptability to foothill irrigated pastures during the summer and to determine yield response to adequate and reduced irrigation. Ref.217\63.28.

George, M.R., C.B. Wilson, P.B. Sands, R. Ingram, and J.M. Connor. 1988. Warm season grass trial (A progress report). Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 30-39.

The objective of this study is to test several warm season grasses for their adaptability to foothill irrigated pastures to determine yield response to adequate and reduced irrigation. The irrigation treatments are not reported in this progress report. Seven tables report on dry matter, total yield, protein, ADF, NDR, and ash residue. Ref.225\63.36.

Hull, J.L. 1991. Livestock for irrigated pasture. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 46-47.

All phases of grazing management must be considered to optimize animal production from irrigated pasture. These should include a preventive animal health program, a pasture management plan, an animal management plan and the selection of the type of livestock to be grazed within the overall management system to be the desired objectives. Ref.71\61.26.

Raguse, C.A. 1989. Irrigated pastures: first-year experiences with "controlled grazing". Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 12-19.

This article summarizes first-year experiences with "short duration" grazing with beef cattle on a perennial grass-legume irrigated pasture. Ref.73\61.28.

Raguse, C.A. 1991. Influence of pasture conditions (quality) on livestock performance. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 15-20.

The net effect of pasture maturity, selection, intake, particle breakdown, digestion, absorption, metabolizable energy (ME) content and efficiency of ME utilization for animal production can be summarized as Feeding Value. Animals appear to respond primarily to variations in the amount and maturity of leaf material in the sward, and its distribution in the canopy. Ref.68\61.23.

Raguse, C.A., J.L. Hull, and R.E. Delmas. 1980. Perennial irrigated pasture. III. Beef calf production from irrigated pasture and winter annual range. *Agronomy J.* 72(3): pp. 493-499.

The objective of this study was to compare simple (range-only, yearlong) and complex [improved range and irrigated pasture plus winter supplementation with alfalfa (*Medicago sativa* L.) cubes] systems for beef calf production using a fall calving (Nov-Dec), early summer weaning (May-Jun) reproduction cycle. While total land per cow/calf unit was less for the complex system and total investment higher for the simple system, operating costs, depreciation, and interest were higher for the complex system. It appeared that second and third trimester cow stresses did not adversely affect calf birth weights and ADG. Ref.99\63.68.

Raguse, C.A., and K.L. Taggard. 1990. Management and monitoring of short duration grazing on perennial grass-legume pastures. Proc., Amer. Soc. Agron. Annual Meet., San Antonio, TX. 44: p. 155.

Plant and animal responses under rotational grazing should reflect entry (forage accumulated) and exit (forage utilized) levels as positioned on the theoretical "S" shaped (sigmoid) forage regrowth curve. Botanical composition changes occurred but were not related to grazing level treatments. Forage regrowth monitoring and stocking rate predictions were defined as animal unit days (AUD) per unit height or mass of forage removed. Liveweight gain ha⁻¹ was higher for the more closely grazed treatment, a reflection of higher stocking rates; average daily gains (ADG) did not vary between grazing level treatments. Ref.144\63.76.

Raguse, C.A., and K.L. Taggard. 1991. Irrigated pasture runoff water and its contained nitrate, phosphate and sulfate: preliminary results of water sampling on the SFRFS Haworth experimental pastures. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 35-59.

In 1989, we began to collect water samples and analyze them for nitrate, phosphate, sulfate and chloride content. Simultaneously, we collected samples from the applied water source (irrigation district ditch). While tentative, these samples suggested: similar levels of nitrate and sulfate, with generally higher levels in subsurface than in surface water; very low levels of phosphate, with suggestion of marginally higher levels in surface runoff; detectable increase in ion concentration in runoff following fertilization; and, except for post-fertilization, concentration values of 10 parts per million or lower. Ref.70\61.25.

Raguse, C.A., K.L. Taggard, and J.L. Hull. 1991. An 8-/10 paddock short duration grazing system - results of a 3-year study. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 21-27.

We were able to demonstrate linear (mid) and near-asymptotic (upper) portions of a theoretical sigmoid growth response using both forage height and weight measures. Regarding stocking rate/grazing pressure, we achieved practical upper and lower limits, i.e., pastures such as these should not be grazed harder, nor be permitted to accumulate higher levels of forage mass. Proper grazing management will operate near the low end of the theoretical curve. Equal ADGs between treatments indicated equal forage quality, and the low A-U (accumulation-utilization) treatment increased transfer efficiency. Ref.69\61.24.

Raguse, C.A., K.L. Taggard, J.L. Hull, C.A. Daley, and J.M. Connor. 1989. Short-duration grazing on irrigated pasture. *California Agriculture* 43(4): pp. 4-7.

First-year results are available in a long-term study of the popular short-duration grazing system, also known as controlled or intensive grazing, under way at the UC Sierra Foothill Range Field Station. The 1988 experiment compared two grazing intensities in an eight-paddock rotation with 3-day grazing and 21-day forage regrowth intervals. A stocking rate predictor was developed based on plant height, and a close relationship was found between heifer weight gains per acre and amount of forage removed. Ref.59\61.14.

Taggard, K.L., C.A. Raguse, M.R. George, J.L. Hull, C. Daley, and J.M. Connor. 1990. Update on short-duration grazing study on irrigated pasture. *California Agriculture* 44(2): pp. 8-11.

Two-year results showed similar responses to two levels of pasture accumulation-grazing utilization management. Orchardgrass height and capacitance probe readings were both useful in monitoring forage availability, but stocking rate predictions using grass height were less variable and change in grass height during grazing was more closely related to seasonal liveweight gain. Ref.52\61.07.

Management and Physiology of Hardwood Rangelands

Albin-Smith, T.K., and C.A. Raguse. 1984. Environmental effects of land use and intensive range management: a northern California example. Univ. of Calif. Water Res. Center, Contr. no.187. p. 33.

This paper presents criteria for assessing and mitigating environmental impacts of manipulating foothill rangeland to improve its capacity for livestock grazing. Environmental setting information provides the basis for impact analysis: baseline soil and vegetation types, hydrology, habitat, and land use history of the foothill environment was assessed for sensitivity to range improvements and land use, including vegetation-type conversion, facilities construction, grazing, and irrigation. Ref.23\57.43.

Allen-Diaz, B.H., and B.A. Holzman. 1993. Resampling VTM plots in blue oak cover type series. Report for Forest and Rangeland Resources Assessment Program (FRRAP), Calif.Dept.of Forestry and Fire Protection, July 1993. p. 70.

Understanding recent change within the blue oak woodlands is the focus of this study. The transitional cover types such as Blue oak-Foothill pine/Grass and Blue oak/Buck brush/Grass persist on the landscape due to continuous changes in blue oak communities through time as well as in response to human disturbances such as harvesting and fire suppression. Grazing did not appear to significantly affect overstory vegetation change. Although it is the ecological changes that were of most interest in this study, it is the cultural impacts that will significantly determine the future of the blue oak woodlands in California. Ref.123\62.30.

Barry, S. 1996. Determining forage diet quality by analyzing fecal matter with near infrared spectroscopy. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 27-30.

A relatively new technique developed by the Department of Range Ecology at Texas A&M University can quickly determine the nutritional status of cattle grazing rangeland or pasture. Cattle manure is analyzed using near infrared reflectance spectroscopy (NIRS). Manure samples have been collected from ranches throughout the Sacramento Valley and Sierra Foothill, etc. and analyzed using the NIRS process. Ref.278\64.14.

Bartolome, J.W., and Betts, A. 2001. Effects of RDM levels on annual range composition, production and water quality. Proc., UC Sierra Foothill REC Beef & Range Field Day, April 19, 2001.

Plants grew more rapidly early in the season on plots with the highest RDM, producing significantly more above ground biomass at the end of winter than on the lowest RDM level. By the end of the growing season in May this effect disappeared, and intermediate RDM levels produced the highest above ground biomass. Species richness per plot was significantly lower on the plots with highest RDM levels. *Erodium botrys* (filaree) and *Trifolium hirtum* (rose clover) decreased significantly with the highest RDM level, while *Taeniatherum caput-medusae* (medusahead) increased in cover with higher RDM. These results support the hypothesis that moderate levels of grazing maintain species diversity and enhance forage productivity. 66.10

Bartolome, J.W., and Betts, A. 2001. Prescribed fire for barbed goat grass control.

At SFREC, we have installed twenty-four 8X2 square meters permanent plots, half with goat grass and half without. In June 1999, all 8 plots in the Forbes 13 pasture were burned while the other 16 remained unburned. At peak plant biomass in May 1999 and 2000, we measured species percent cover on all plots. These data indicate that the June 1999 burn was highly effective at reducing goat grass cover in the Forbes plots. Percent cover of goat grass went from 64% in 1999 down to 8% in 2000 in burned plots. On unburned plots, there was a small but non-significant decrease in goat grass cover from 24% to 19%; however, visual observations confirm that on unburned plots, the size of the goat grass patches increased from 1999 to 2000. It appears that the removal of the accumulated dead biomass itself can significantly reduce the numbers of goat grass plants through seed predation and reduce the fitness of any plants that do grow there as well.66.14

Boursier, P.J. 1982. The effect of the application and subsequent removal of ammonium nitrate on the growth and nitrogen-fixing capability of subterranean clover (*Trifolium subterraneum* L.). M. S. Thesis, Univ. of Calif., Davis. 16 pages.

The review of the literature reveals considerable variation in recommendations involving the use of nitrogen fertilizer during the establishment of forage legumes. This study was performed to investigate the effects of the application of NH_4NO_3 and its subsequent removal upon the growth and nitrogen fixation of subterranean clover plants. The experiment was performed twice during different times of the year to determine the effects of variation in total sunlight received. Determinations were made at various times during the experiments for total dry weight, apparent nitrogen fixation, leaf area and reduced nitrogen concentration. Detailed measurements of total daily light intensity were maintained during each experiment. Ref.102\63.82.

Boursier, P.J., C.A. Raguse, and K.L. Taggard. 1989. Growth and nitrogen-fixing responses of subterranean clover to application and subsequent removal of ammonium nitrate. *Crop Sci.* 29: pp. 758-763.

Considerable variation exists in recommendations for the use of N during establishment of forage legumes. Abundant literature documents the inhibition of N₂ fixation by applied N, but few experiments determined the consequences of its subsequent removal. In this study the effects of NH₄NO₃ on the growth and N₂ fixation of subterranean clover were investigated. The results suggest that low to moderate levels of N can be applied to an annual range community containing subterranean clover to attain specific fall-winter growth objectives without the risk of suppressing peak (spring) N₂ fixation. Ref.135\63.75.

Caminos, J., C.A. Raguse, and D.C. Sumner. 1973. Effects of seed aggregation, nutrient availability, and temperature on germination of subterranean clover (*Trifolium subterraneum* L.). *Agronomy J.* 65: pp. 1002-1003.

Germination percentage was increased and emergence was accelerated when two or more subterranean clover seeds were planted in close physical proximity instead of singly. The effect was enhanced when nutrient solution was supplied. The influence of close seed spacing and improved nutrient availability were more pronounced at cool temperatures, they therefore could be of importance to stand establishment from new seedlings in the California annual range when rainfall adequate to permit germination occurs later than normal. Ref.11\57.34.

Campbell, C.G., and B.H. Allen-Diaz. In press. Livestock grazing and riparian habitat water quality: An examination of oak woodland springs in the Sierra foothills of California. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar 19-22, 1996.

Studies have suggested that livestock degrade riparian vegetation and stream channels, produce sediment, pathogen, and nutrient loading as pollutants which may result from grazing on or near streams. This study shows that moderate livestock grazing intensities do not detrimentally affect water quality at springs or ephemeral creeks in the oak woodland of California. Ref.253\64.01.

Connor, J.M. 2001. Prescribed fire impacts on yellow starthistle & medusahead. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 19, 2001.

Transline successfully controls yellow starthistle during the year of application at the field scale as well as the small plot level. Multiple years of treatment are necessary because a seed bank has been established which lasts for several years. Research indicates that at least three years of treatment are necessary, followed by spot treatment to pick up re-invasions. Prescribed burning can effectively serve as at least one year's treatment program. While our conclusions regarding burning for YST control are based on just one year of data, they agree with research done elsewhere. Medusahead, if present in large enough concentrations, may at least partially replace YST that is removed by chemical treatment. Integration of prescribed burning into a treatment program appears to be effective in reducing medusahead populations, and it may discourage medusahead replacement of controlled yellow starthistle. 66.11

Dahlgren, R., Horwath, W.R., and Tate, K.W. 2001. Changes in soil quality due to oak tree removal in California oak woodlands. 2000-2001 Report to M. Theo Kearney Foundation of Soil Science. pp. 12-24

Blue oaks (*Quercus douglasii*) have been shown to create islands of enhanced soil quality and fertility beneath their canopy. This study addresses two important questions concerning islands of soil fertility: Does soil parent material affect the intensity of soil fertility enrichment? What happens to islands of enhanced soil quality and fertility following tree removal? To address these questions, three blue oak woodlands were examined. 66.01

Dahlgren, R., and M.J. Singer. 1991. Nutrient cycling in managed and unmanaged oak woodland-grass ecosystems. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USFS Tech. Rep. PSW-126: pp. 337-341.

The influence of oak trees and grazing on nutrient cycling in oak woodland-grass ecosystems was examined at the Sierra Foothill Range Field Station in the northern-Sierra Nevada foothills of California. Nutrient concentrations in ecosystem waterflows (precipitation, canopy throughfall, and soil solutions) were monitored in a non-managed natural area and in an adjacent grazed area. Grazing increased soil solution concentrations of chloride and sodium, but had no effect on major nutrient levels. When comparing between oak and non-oak sites, the oak sites had enhanced soil solution concentrations and decreased levels of sodium. Ref.150\61.43.

Dahlgren, R., and M. Singer. 1993. Biogeochemistry in oak woodlands of the Sierra foothills. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 29-30.

Our study has focused on nutrient cycling; the movement of nutrients in, out of, and within the ecosystem. The flow of nutrients through the oak woodland ecosystem has been studied for a four year period in the Schubert Watershed. Fluxes of nutrients in ecosystem waterflows (precipitation, canopy throughfall, soil solutions and stream water), plant uptake, and litterfall were monitored. Removal of Oaks leads to a loss of nutrients from the ecosystem. Ref.171\61.49.

Dahlgren, R.A., and M.J. Singer. 1994. Nutrient cycling in managed and non-managed oak woodland-grass ecosystems. Rep. to Integrated Hardwood Range Management Program. 91 pages.

This research project examining oak woodland nutrient cycling shows that oak trees play a major role in maintaining the nutrient status of these ecosystems. Each year, a typical blue oak will return approximately 1, 0.1, 2, and 0.8 kg of nitrogen, phosphorus, calcium and potassium, respectively, to the soil surface in the form of litterfall (e.g. leaves, twigs and acorns) and canopy throughfall (canopy leaching). While these values may appear low, multiplying by all the oak trees in a watershed results in very large quantities of nutrients. Ref.177\62.11.

Dahlgren, R.A., and M.J. Singer. 1995. Nutrient cycling in grazed and ungrazed oak woodland rangelands. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 27-33.

Oak trees play a critical role in sustaining ecosystem productivity through their role in cycling nutrients to the soil surface, preventing nutrient leaching losses, increasing water infiltration, and attenuating water erosion and stream sediment concentrations. Moderate intensity grazing does not appear to have any serious detrimental effects on nutrient cycling in these oak woodland ecosystems. Oak tree removal will lead to a significant loss of nutrients from these ecosystems leading to a long-term decrease in ecosystem productivity. Careful removal of oaks does not significantly change stream flow patterns or amounts. Ref.241\63.53.

Davidson, E.A., J.F. Eckart, S.C. Hart, and M.K. Firestone. 1989. Direct extraction of microbial biomass nitrogen from forest and grassland soils of California. *Soil Biol. Biochem.* 21: pp. 773-778.

The direct extraction method for estimating microbial biomass-N, which involves chloroform fumigation and extraction without an incubation step, affords the opportunity to analyze soils for which the incubation step is problematic. We tested the direct extraction method on freshly sampled grassland and forest soils of California, which experience seasonal wetting and drying cycles and labile substrate inputs. Ref.295\64.31.

Davidson, E.A., and M.K. Firestone. 1988. Measurement of nitrous oxide dissolved in soil solution. *Soil Sci. Soc. Am. J.* 52: pp. 1201-1203.

Degassing of soil solution as soil water enters springs and streams may be a significant pathway of N_2O release into the atmosphere. A simple method is presented to sample soil solution to include gases dissolved in solution. Small porous cup lysimeters connected to narrow diameter nylon tubing were flushed with N_2 gas; a vacuum was applied with an evacuated serum bottle; and solution and gases were captured in the bottle. Concentrations of N_2O in soil solution of a grassland in central California varied from below ambient to 13 times ambient. At a wet riparian zone site, N_2O in soil solution appeared to be related to NO_3^- concentration, which can be determined from the same soil solution sample. Ref.301\64.37.

Davidson, E.A., D.J. Herman, A. Schuster, and M.K. Firestone. 1993. Cattle grazing and oak trees as factors affecting soil emissions of nitric oxide from an annual grassland. *ASA Special Publication* 55: pp. 109-119.

Range management decisions are driven largely by considerations of animal productivity and land-use regulations, but range management may also impact exchange of trace gases between the biosphere and the atmosphere. The first objective of this work is to determine the effects of grazing and vegetation cover on NO emissions at a study site in the central valley of California. The second objective is to investigate the mechanisms which may explain differences in NO fluxes between grazed and ungrazed plots, between plots under oak canopies and plots in open grassy areas, and between wet and dry seasons. Ref.299\64.35.

Davidson, E.A., J. Stark, and M.K. Firestone. 1990. Microbial production and consumption of nitrate in an annual grassland. *Ecology* 7(5): pp. 1968-1975.

Gross nitrification rates ranged from 12 to 46% of gross mineralization rates during the growing season of annual grasses. Microbial assimilation of NO_3^- occurred at rates similar to previous estimates of plant uptake. Hence two common assumptions, that nitrifying bacteria are poor competitors for NH_4^+ and that microbial immobilization of NO_3^- is insignificant, are not correct for this grassland system. Spatial compartmentalization of sites of production and consumption of inorganic-N, along with diffusional constraints among such microsites, appear to be critical factors affecting N-cycling characteristics of the ecosystem. Ref.296\64.32.

Eckart, J.F., and C.A. Raguse. 1980. Effects of diurnal variation in light and temperature on the acetylene reduction activity (nitrogen fixation) of subterranean clover. *Agronomy J.* 72(3): pp. 519-523.

Singly, or in combination, both light intensity or temperature can limit symbiotic N fixation. The present study determined N fixation response to variation in both light and temperature for an annual range legume which, during its normal growing season, may be subject to growth limiting levels of both environmental factors. The results show that diurnal changes in acetylene reduction by subterranean clover result more from fluctuations in temperature than from diurnal changes in light and suggest that N_2 fixation by root nodules of this species is buffered against shortterm changes in photosynthate supply. Ref.98\63.61.

Ellis, K.W. 1980. Teamwork on the range. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 53-55.

This outline describes the network of departments and people involved in the range livestock programs in Extension. The staff, both specialists and advisors, must continue to work with state and federal agencies who control the decision-making processes connected with these agencies now and in the future as a resource for decision making so that the best multiple use plans can be developed and prevail. Most of all, we must and will continue the close cooperation with those who own, operate, and stock California's rangelands in order to maintain the team effort that has proved beneficial and fruitful. Ref.200\63.11.

Evans, R.A., B.L. Kay, and J.A. Young. 1975. Microenvironment of a dynamic annual community in relation to range improvement. *Hilgardia* 43: pp. 79-102.

Syntheses of microenvironments based on monitoring are needed for understanding complex phenomena of an ecosystem and for establishing benchmark or standard regimes of temperature, light, and soil moisture for laboratory experiments involving seed germination, seedling growth, and other plant responses. These studies, in turn, answer questions about the dynamics of a plant community. The microenvironment was monitored and vegetation was intensively sampled to interpret complex responses of an annual rangeland community to chemical weed control and reseeding. Ref.89\61.57.

Evans, R.A., B.L. Kay, and J.A. Young. 1976. Influence of date of planting on emergence of cultivars of *Trifolium hirtum* All. and *T. subterraneum* L. *J. Range Manage.* 29: pp. 333-337.

Emergence by seven cultivars of rose clover and eight cultivars of subclover was studied in relation to date of planting. Numerous planting dates were used for three growing seasons. Temperature in the seedbed was monitored hourly. The seeded clovers all germinated at the time of the first effective rains. Where seeds were exposed to high soil temperatures, early fall planting generally reduced seedling emergence in cultivars of rose clover, but enhanced or did not affect emergence in subclover. In 2 of the 3 years, seeding after the first rain gave significantly lower emergence. Maximum seedbed temperatures below 10 C allowed only very limited emergence. Ref.19\59.19.

Evans, R.A., J.A. Young, and B.L. Kay. 1974. Germination of winter annual species from a rangeland community treated with paraquat. *Weed Sci.* 22: pp. 185-187.

Three annual plant species, erect plantain, common chickweed, and silver hairgrass are commonly found and may dominate a unique flora on areas sprayed with paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) in cismontane rangelands of California. The basis of this phenomenon is shown to be temperature-related germination requirements, novel seed characteristics, and lack of competition. Weed control-revegetation systems that use paraquat in establishing forage species on rangelands have been developed for arid Intermountain areas of the West and for areas of the Mediterranean climate in cismontane California. Ref.15\59.15.

Firestone, M.K., L.J. Halverson, and D.J. Herman. 1995. Nutrient cycling in managed oak woodland-grass ecosystem. Final Rep. To Integrated Hardwood Range Management Program. Berkeley, Calif. October 2, 1995. 56 pages.

Covering an estimated 3 million hectares statewide, hardwood rangelands support diverse uses in California. These rangelands are used extensively as cattle pasture, so management practices implemented in the interest of cattle production widely affect all users. It is therefore in the interest of all users that an understanding be developed as to how various management practices affect ecosystem sustainability. One aspect of the long-term productivity of these systems is the cycling of nutrients among soil, flora, and fauna. This study investigates the effects of managing this land for cattle production on ecosystem nutrient cycling. Ref.153\63.89.

Firestone, M.K., L.E. Jackson, R.B. Strauss, and E.A. Paul. 1985. Dynamics of nitrogen transformations in a California annual grassland: II. Microbial processes. Proc., Amer. Soc. Agron. Annual Meet. Davis, CA. 43: pp. 155-156.

Competition for $^{15}\text{N-NH}_4^+$ and NO_3^- was quantified in open grassland field cylinders over 24 h periods. During the period of most active plant N uptake, static NO_3^- pools were not detectable and field rates of nitrification (by pool dilution assay) could supply about 1/3 of the plant N uptake. During this period of apparent competition for NO_3^- , denitrification was detectable in field soil only when plants were removed. Uptake of NH_4^+ by microbial biomass was about 4 times that of plant uptake. Ref.107\63.71.

Frost, W.E., J.W. Bartolome, and J.M. Connor. In press. Understory - canopy relationships in oak woodlands and savannas. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar 19-22, 1996.

We summarize available information about the relationships between oak overstory and understory plants. Understory biomass productivity and plant species composition vary considerably in California's oak woodlands and savannas. Factors discussed include geographic location, overstory species composition, overstory density and distribution, and animal utilization. Management implications are summarized for different woodland types around the state. Ref.256\64.01.

George, M.R. 1987. Effect of weather on range forage production. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 1-9.

Weather analysis is a useful tool for determining expected timing of weather and plant growth events and it can be used to assess risk. Knowing when to expect the first germinating rain in fall can help to determine average dates for range seeding as well as the expected date of fall green up. Economic evaluation of range improvement practices frequently requires productivity projections over several years. Weather variability can be factored into those projections by using the probabilities for average and above or below average temperature and moisture conditions as a measure of weather risk. Ref.211\63.22.

George, M.R. 1991. Grazing and land management strategies for hardwood rangelands. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USFS Tech. Rep. PSW-126: pp. 315-319.

Annual rangelands produce 84 percent of California's range forage which is used all year by sedentary ranching operations and seasonally by migratory operations. Environmental policy, energy and water costs may reduce traditional summer forage sources, resulting in increased grazing pressure on hardwood and annual rangelands. However, the landowner's production goals and society's environmental quality goals can still be attained by subdividing the ranch into management units based on the land's productive potential and resource value and by intensifying grazing management. Ref.152\61.43.

George, M.R., Bartolome, J., McDougald, N., Connor, J.M., Vaughn, C., and Markegard, G. 2001. Annual range forage production. ANR Rangeland Management Series Publication 8018: page 9.

California's foothill rangelands make up the primary forage source for the state's range livestock industry (FRAAP 1988). Forage productivity in California's annual rangelands varies greatly from season to season and from year to year. While predicting the productivity of these annual rangelands has been an elusive research objective, analysis of long term forage production data from the San Joaquin Experimental Range (SJER), UC Hopland REC (HREC), and UC Sierra Foothill REC (SFREC) has allowed researchers to describe seasonal and annual variation of the forage resource. 65.17

George, M.R., J.R. Brown, and W.J. Clawson. 1992. Application of nonequilibrium ecology to management of Mediterranean grasslands. J. Range Manage. 45: pp. 436-440.

The state and transition model and the ball and cup analogy are used to organize the vegetation dynamics knowledge base for California's annual-dominated Mediterranean grasslands. These models help identify irreversible transitions and alternate stable states. Mechanisms that facilitate movement between successional stable states are categorized as demographic inertia, seedbank and germination, grazing impacts, establishment and competition, fire feedback, and irreversible changes in soil conditions. Ref.87\61.41.

George, M.R., and L.M. Hall. 1991. Grazing compatible with blue oak regeneration. Report for Forest and Rangeland Resources Assessment Program (FRRAP), Calif. Dept. of Forestry and Fire Protection, August 1991. p. 32.

Cattle have been implicated as a principal cause for poor oak regeneration in California's hardwood rangelands. The effects of stock density and season of grazing was evaluated on blue oak establishment. Seven hundred and twenty blue oak seedlings were planted on ten-foot centers in thirty plots in three annual grassland pastures at the Sierra Field Station. Steers were allowed to graze one plot per week at low, medium, and high stock densities during the months of January, April and July of 1990. It is clear that cattle damage to oak seedlings varies tremendously depending on season of grazing and, to a lesser degree, stock density. Ref.39\60.17.

George, M.R., L. Lasarow, and J. Clawson. 1985. Computerized pasture inventory program. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 13-16.

Many ranchers keep animal or herd performance records but do not keep pasture performance records. The pasture inventory program was developed to provide ranchers with an easy method of keeping pasture records. It includes a tutorial which introduces the concepts of pasture inventory and shows step by step how to use the program. The program is currently being tested at the Sierra Foothill Range Field Station. Newer versions will be documented and released as they are developed to meet the needs of the ranching community. Ref.209\63.20.

George, M.R., Nader, G.A., McDougald, N.K., Connor, J.M., and Frost, W.E. 2001. Annual rangeland forage quality. Univ. of Calif., DANR Publication 8022: page 13.

Matching the nutrient demands of livestock with the nutrients supplied by range forage is a balancing act for a considerable portion of each year. The quality of range forage varies with plant species, season, location, and range improvement practices. Range forage is optimal for only a short period of the year. 65.19

George, M.R., C.A. Raguse, W.J. Clawson, C.B. Wilson, R.L. Willoughby, N.K. McDougald, D.A. Duncan, and A.H. Murphy. 1988. Correlation of degree-days with annual herbage yields and livestock gains. J. Range Manage. 41: pp. 193-197.

On California's winter annual rangelands precipitation controls the beginning and end of the growing season while temperature largely controls seasonal growth rates within the growing season. Post-germination accumulated degree-days (ADD) account for the length of the growing season and variation of daily temperature. Simple correlations of ADD and herbage yield or resultant livestock gains were determined at 5 locations in annual type range in northern California. Degree day values were determined by summing daily degree-days from the beginning of the growing season after germinating rainfall until the clipping or weigh dates. Ref.84\61.39.

Hart, S.C. 1991. Control of decomposition processes and nutrient flow in a California forest and grassland. Ph.D. Thesis, University of California, Berkeley. 226 pages.

This dissertation work focused on two major factors that potentially control decomposition processes and nitrogen release from plant detritus in forests and annual grasslands with Mediterranean-type climates: substrate quality (degradability) and spatial compartmentalization of available carbon and N within the soil profile. Despite a low initial quantity of *Pinus ponderosa* needle litterfall in an old- compared to a nearby young-growth mixed-conifer forest, no difference in decomposition rates was found between litter types when incubated in either stand. The extremely low rates of decomposition in these forests appear to be due to the combined effects of low quality litter and seasonal displacement of warm temperatures from moist conditions in Mediterranean-type climates. Ref.293\64.29.

Hart, S.C., M.K. Firestone, E.A. Paul, and J.L. Smith. 1993. Flow and fate of soil nitrogen in an annual grassland and a young mixed-conifer forest. Soil Biol. Biochem. 25: pp. 431-442.

A comparative study of N dynamics in an annual grassland and a young mixed-conifer forest, that occur on the same soil great group in California, was made by adding small amounts of $^{15}\text{NH}_4^+$ to mineral soils within field microplots and following changes in ^{15}N recoveries in soil and plant pools over 12-16 months. Total ^{15}N recovery was only about 54% 6 months after ^{15}N addition, indicating a high potential for rapid N loss from the surface soil of this forest. Comparison of net changes in litter N and accumulation of ^{15}N during decomposition suggests that N was mineralized from litter concurrently as N was immobilized from the mineral soil in both sites. Ref.298\64.34.

Herman, D.J., Halverson, L. J., and Firestone, M. K. 2003. Nitrogen Dynamics in annual grassland: oak canopy, climate, and microbial population effects. Ecological Applications 13(3): pp. 593-604.

Hardwood rangelands in California, which are commonly used for cattle production, are characterized by an oak overstory and annual grass understory. Our goal was to evaluate how canopies influence nitrogen-cycling processes and how tree removal affected these processes. 66.04

Holmes, T.H., and K.J. Rice. 1996. Patterns of growth and soil-water utilization in some exotic annuals and native perennial bunchgrasses of California. *Annals of Botany Company* 78: pp. 233-243.

We compared exotic cool-season annuals and native perennial bunchgrasses in terms of growth, biomass allocation, rooting distribution, root morphology, and soil water utilization. Exotic cool-season annuals completed their life cycle early in the dry season through rapid growth apparently made possible by a high proportional allocation to shoots in combination with the efficient production of roots of high specific root length. Further, annuals tended to concentrate root growth and soil water utilization in the upper soil profile. In contrast, native perennial bunchgrasses allocated a high proportion of their biomass to the production of a deep root system, which allowed them to continue soil-water utilization well into the dry season and contribute to the formation of a very dry soil profile. Taken together, these contrasting patterns suggest that the invasion of exotic cool-season annuals might have produced a corresponding increase in the amount of water present at depth in the soil profile during the dry season. Ref.307\64.44.

Jackson, L.E., M.K. Firestone, J.P. Schimel, and J.W. Bartolome. 1985. Dynamics of nitrogen transformations in a Californian annual grassland: I. Plant uptake and transfers. *Proc., Amer. Soc. Agron. Ann. Meet.* p. 157.

Uptake of N by annual plants in a natural grassland was greatest in early spring when soil moisture was high. At this time, litter, especially detrital roots, was decomposing at maximum rates (50 kg dry weight/ha/day). Plants took up approximately 1/10 of the NH_4^+ pool. A similar experiment later in the spring indicated that low soil moisture changed rates of plant uptake of NO_3^- and NH_4^+ . Ref.108\63.65.

Jackson, L.E., J.P. Schimel, and M.K. Firestone. 1989. Short-term partitioning of ammonium and nitrate between plants and microbes in an annual grassland. *Soil Biol. Biochem.* 21: pp. 409-415.

We measured short term partitioning of $^{15}\text{NH}_4^+$ and $^{15}\text{NO}_3^-$ into plants and microbes in a California annual grassland. High rates of microbial NO_3^- uptake may have resulted from the occurrence of microsites that were depleted in NH_4^+ . Even though plants competed better for NO_3^- than for NH_4^+ , microbial uptake was a major factor controlling NO_3^- availability to plants. The high rates of NH_4^+ and NO_3^- uptake by plants and microbes clearly demonstrate that the soil N pool bears little relationship to actual N availability. Ref.303\64.39.

Jackson, L.E., R.B. Strauss, M.K. Firestone, and J.W. Bartolome. 1988. Plant and soil nitrogen dynamics in California annual grassland. *Plant and Soil* 110: pp. 9-17.

Seasonal changes in soil water and nitrogen availability were related to the phenology and growth of plants in California annual grassland. Plant accumulation of nitrogen was mainly confined to two short periods of the year: fall and early spring. This suggests inorganic nitrogen flux during the drought period. The "drought escaper" life history characteristics of annual grasses in California annual grassland, however, may prevent plants from utilizing available nitrogen during a large part of the year. Ref.265\64.02.

Jackson, L.E., R.B. Strauss, M.K. Firestone, and J.W. Bartolome. 1990. Influence of tree canopies on grassland productivity and nitrogen dynamics in deciduous oak savanna. *Agriculture, Ecosystems and Environment* 32: pp. 89-105.

In oak and annual grassland savanna in the foothills of the Sierra Nevada, CA, soils under deciduous blue oak canopies have higher nitrogen turnover and inorganic N availability than surrounding open grassland soils. Over 3 years of study, annual above- and below- ground productivity and plant N accumulation in both communities were generally very similar. Although the two areas differ in species composition, rates of seedling establishment, seasonal phenology, and dry weight and N allocation patterns, these differences are not great enough to affect productivity at this site. Even if forage production in the blue oak savanna does not benefit from the presence of oak canopies, soils under oaks harbor a reservoir of soil organic N that could be rapidly lost or redistributed if oaks are removed for management purposes. Ref.302\64.38.

Jinks, A. 2003. From fecal pats to nutrition: Using near-infrared reflectance spectroscopy of feces to determine nutritional diet quality. *Proc., UC Sierra Foothill REC Beef and Range Field Day, April 17, 2003.* pp. 9-11.

Dried fecal samples were analyzed for crude protein, acid detergent fiber (ADF), neutral detergent fiber (NDF), and ash using standard proximate analysis (wet chemistry) procedures. Dry matter was determined at the time of compositing. Dry matter digestibility and digestible organic matter were calculated for comparison to NIRS values. 66.17

Johnson, K.L., and C.A. Raguse. 1985. Comparative effects of repeated cycles of water stress on growth and apparent dinitrogen fixation of Ladino and strawberry clovers. *Crop Sci.* 25(2): pp. 299-306.

Water stress is a major environmental factor limiting growth and symbiotic N_2 fixation of legumes. This study was conducted to determine the effects of repeated short-term cycles of water stress on growth and N_2 fixation of Ladino clover and strawberry clover. In separate experiments, stolons of each species were trained into a calcined,

montmorillonite clay medium, under controlled conditions of ambient air and root temperature, and provided with N-deficient nutrient solution. The results of these experiments indicate that minor, short-term water stresses, if repeated, can result in significant decreases in productivity. Ref.110\63.66.

Kay, B.L. 1969. Hardinggrass and annual legume production in the Sierra foothills. *J. Range Manage.* 22(3): pp. 174-177.

Seeding trials at the Sierra Foothill Range Field Station show that total forage production can be doubled by sowing annual clovers. Also increased were the quantity and quality of winter feed. Winter feed was increased further by planting hardinggrass with the legumes. Results were similar on the two soil types involved. Ref.1\46.15.

Kay, B.L. 1971. Atrazine and simazine increase yield and quality of range forage. *Weed Sci.* 19(4): pp. 370-371.

Application of atrazine to intermediate wheatgrass increased forage yields, plant protein, and nitrate over a 4-year period. Atrazine or simazine applied to a sward of red brome, Arabian grass, and red-stem filaree increased dry-matter yields sixfold and also increased protein and nitrate nitrogen. Nitrate in plants treated with atrazine increased to near-toxic levels for livestock. Ref.5\45.62.

Kay, B.L. 1986. Rose clover - a preferred quail food. *Proc., Joint Mtg. Soc. for Range Mgmt & The Wildlife Soc., Sparks, NV.* 22: pp. 39-41.

Diets of California quail were sampled from 1979 to 1981 during the fall and winter on cleared and seeded foothill ranges on the east side of the Sacramento Valley. Rose clover comprised 43% to 96% of the crop sample by dry weight. It was used both as seed and leaves, and in amounts proportionally greater than its occurrence in the range cover. Quail are highly selective in choosing among the food sources present. Rose clover is clearly a preferred species as it is selected over the many non-seeded resident species which persist after the range clearing. This is not surprising as legumes are well recognized as a preferred food plant. Ref.114\63.86.

Kay, B.L., and R.E. Owen. 1970. Paraquat for range seeding in Cismontane, California. *Weed Sci.* 18(2): pp. 238-244.

A technique was developed for seeding rangelands too steep or too rocky to seed by current methods. Hardinggrass and subclover were established by seeding immediately after spraying the resident vegetation with paraquat. Tested for seeding in sod were single-disk, double-disk, and hoe-type drill openers. No hardinggrass was established without some weed control. Spraying helped establish subclover but was not critical. Prolonged weed control made paraquat superior to cultivation by giving better weed control and a firmer seedbed. Ref.2\45.60.

Kay, B.L., and D.T. Torell. 1970. Curing standing range forage with herbicides. *J. Range Manage.* 23(1): pp. 34-41.

Paraquat applied to standing annual range forage at anthesis of the grasses resulted in standing hay 57 to 77% higher in protein. Crude fiber was decreased and phosphorus increased. Forage production was generally lower with treatment, because the growing season was shorter. Palatability of dry forage was improved. Lambs on treated forage gained more rapidly. No physiological or pathological changes were found in the lambs. Spraying resulted in less grass and more clover in the year following spraying. Ref.3\45.21.

McClaran, M.P., and J.W. Bartolome. 1989. Effect of *Quercus douglasii* (fagaceae) on herbaceous understory along a rainfall gradient. *Madrono* 36(3): pp. 141-153.

Variation in effect of approximately 50% *Quercus douglasii* (blue oak) cover on herbaceous understory biomass and composition was studied along a rainfall gradient between five sites. Biomass and composition were compared between understory and adjacent open grassland at each site to evaluate changes in canopy effect along the gradient. We conclude that variation in canopy effect on biomass resulted from changes in relative production between understory and open grassland, not from differences in relative composition. Ref.274\64.10.

McCreary, D.D. 1989a. 49er fire revegetation activities. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 7-8.

In September, 1988 a fire swept through Western Nevada County, destroying 200 homes and burning over 35,000 acres of land. In terms of property loss, the 49er Fire was one of the most destructive in California history. It was also tremendously damaging to native woody vegetation, which was predominately oak trees. Soon after the fire was extinguished, efforts began to revegetate burned areas. By mid-March, nearly 800 pounds of acorns had been planted. While it is still too early to evaluate the success of Project Acorn in terms of oak tree establishment, the project was certainly successful in educating the public. Ref.228\63.39.

Morris, J.G., and R.E. Delmas. 1980b. Seasonal variation in the nutritive nature of California range forage for cattle. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 16-20.

A fundamental characteristic of the world's rangelands is the variation in quantity and quality of forage it makes available to grazing animals. This variation results from responses of pasture plants to climatic variables, particularly temperature and rainfall. Data show that the organic matter digestibility and therefore, available energy from annual range forage falls to low levels in the summer-fall period. Thus, the forage ingested by range cattle varies markedly and predictably with the growth cycle of the range plants. Ref.192\63.03.

Osman, A. 1974. Response of subclover (*Trifolium subterraneum* L.) to phosphorus as influenced by soil phosphorus adsorption characteristics, mechanical disturbance of the soil profile, temperature and light. Ph.D. Thesis, Univ. of Calif., Davis. 88 pages.

These studies were undertaken to evaluate the phosphorus requirement of subterranean clover grown on the Sobrante-Las Posas soil series and the growth response of the species with variations in light, temperature and soil disturbance. Ref.248\63.97.

Osman, A., C.A. Raguse, and D.C. Sumner. 1977. Growth of subterranean clover in a range soil as affected by microclimate and phosphorus availability. II. Laboratory and phytotron studies. *Agronomy J.* 69: pp. 26-29.

Growth of subterranean clover seedlings on P-deficient soil was studied under controlled temperatures, photoperiod, and light intensities representative of winter in California's annual rangeland, with a phosphorus treatment. Plant weights were significantly affected by P rates only at the 3.0 and 4.5 leaf stages. Total P per plant was a more consistent indicator of P availability than was % P. Shoot:root ratios, nodules per plant, and percent crude protein in shoot and root increased with P availability. Ref.13\57.33.

Raguse, C.A. 1980. Evolution of a pasture-range research program. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 45-50.

This analysis has been written from the point of view of a co-project leader with over fifteen years of research history in the management of irrigated pasture and improved rangelands, principally as used by beef cattle. It includes an accounting of the pasture-range research program available and utilized at SFREC. The previous history and current activities of both the Hopland and Sierra Foothill Range Field Stations support the future projection of these facilities for research, teaching, and public service serving a broad array of societally-important objectives. Ref.198\63.09.

Raguse, C.A. 1987. Vegetation-type conversion at the Sierra station - an historical review. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 43-47.

Vegetation-type conversion may have several objectives, only one of which may be increase of range forage to support livestock production. With concerns about maintenance of environmental quality and wise management of renewable natural resources, complete type conversion has evolved to selective, prescribed manipulation of woody vegetation to maintain the natural mosaic pattern of the landscape. The UC Sierra Field Station's experiences in an ongoing vegetation-type conversion program will aid in development of a more universally acceptable approach to improving livestock production without unduly compromising aesthetic values and natural resources conservation needs. Ref.218\63.29.

Raguse, C.A., G.A. Beall, J.L. Hull, D. McCreary, and C.B. Wilson. 1990. Thirty years of research: an overview. *California Agriculture* 44(2): pp. 4-7.

For the last 30 years, the Sierra Foothill Range Field Station has been an invaluable outdoor laboratory, classroom, and demonstration facility. The station will continue to serve society as research, teaching, and outreach evolve in response to changes in the broad geographical area it represents. Ref.53\61.08.

Raguse, C.A., and R.A. Evans. 1977. Growth of subterranean clover in a range soil as affected by microclimate and phosphorus availability. I. Field studies. *Agronomy J.* 69: pp. 21-25.

The relationships between microenvironment and phosphorus availability were studied. Ridge, furrow, and aspect microsites were established to create variations in light and temperature microenvironments. Phosphorus was applied and subterranean clover sown in rows perpendicular to the microsite ridges, slopes, and furrows. Temperatures were monitored, and plant sampling was done to determine development, plant weight, and %P per plant. Large diurnal temperature differences were associated with microsite treatments and were more pronounced for soil than for air. Ref.12\57.33.

Raguse, C.A., J.L. Hull, and R.E. Delmas. 1980. Beef calf production from irrigated pasture, supplements and winter annual range in the Sierra Nevada foothills. Proc., UC Sierra Foothill Range Field Station Beef and Field Day. pp. 5-15.

Animal data were analyzed by computing means and standard deviations for 1) cow weights at breeding, weaning and calving, and at beginning and end of supplementation, and 2) calf weights at birth and weaning (adjusted to 205 days). Using years as replications mean cow and calf weights for the two management systems were compared using the Student's "t" test. An Animal Unit Month (AUM), where used, was defined as one 1000-lb cow. A number of management options used in the study would be useful to part-time farmer-ranchers, especially where family labor and relatively-inexpensive irrigation water are available. Ref.191\63.02.

Raguse, C.A., J.L. Hull, M.R. George, J.G. Morris, and K.L. Taggard. 1987. Range fertilization: results of a five-year research program. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 26-31.

For the geographic area in our study, plant and animal productivity may be enhanced by either of two fertilization strategies. The first, and probably preferable, is to apply adequate levels of phosphorus and sulfur sufficient to stimulate legume production and symbiotic nitrogen fixation capability. The second strategy is to apply moderate levels of nitrogen together with adequate levels of phosphorus and sulfur, which will both increase plant production and have a somewhat greater effect during the fall and winter seasons. With either strategy, maintenance of effective stocking rates is critical to efficient forage-to-animal transfer and conversion. Ref.214\63.25.

Raguse, C.A., J.L. Hull, M.R. George, J.G. Morris, and K.L. Taggard. 1988. Foothill range management and fertilization improve beef cattle gains. California Agriculture 42(3): pp. 4-8.

Substantial profit resulted from fertilization in a three-year study on foothill range concluded in the early summer of 1985. The work was done at the UC Sierra Foothill Range Field Station east of Marysville near Browns Valley. An earlier report (California Agriculture, May-June 1984) gave details of the experiment and a first-year summary of results. Our final results showed that fertilization with moderate to high levels of phosphorus and sulfur or with combinations of nitrogen, phosphorus, and sulfur was profitable on this cleared and legume-reseeded grassland. Ref.60\61.15.

Raguse, C.A., J.L. Hull, M.B. Jones, J.G. Morris, M.R. George, and K.D. Olson. 1984. Range fertilization in the Sierra Nevada foothills. California Agriculture 38(5-6): pp. 4-6.

A long-term, field-scale foothill range fertilization study began in 1982, to compare nitrogen alone, phosphorus plus sulfur, and combinations of the three elements simultaneously. The phase I period of three years will permit assessment of nitrogen carryover from the first-year application of nitrogen, as well as provide an opportunity for study of the phosphorus-sulfur influence on annual clovers. Ref.63\61.18.

Raguse, C.A., J.L. Hull, M.B. Jones, J.G. Morris, M.R. George, K.D. Olson, K.L. Taggard, and R.E. Delmas. 1984. Range fertilization in northern California - current experiments at the UC Sierra Foothill Range Field Station. Proc., 32nd Annual Calif. Fert. Conf., Fresno, CA. p. 10.

This study compared the average daily gain (ADG) of cattle on fertilized and unfertilized annual range. The application of nitrogen, phosphorus, and sulfur to annual legumes and grasses produced increased ADG. When too much nitrogen was applied, potentially undesirable results included changes in botanical composition (more grasses and non-legume forbs, fewer legumes) and lowered quality of the forage, especially in spring as growth dilution lowers protein content. Where annual legumes such as subclover, rose clover, or bur clover can be established, they may provide a solution to the problem of poor winter forage growth and low quality summer feed. Ref.106\63.73.

Raguse, C.A., J.L. Hull, M.B. Jones, J.G. Morris, M.R. George, K.D. Olson, K.L. Taggard, and R.E. Delmas. 1986. Plant, livestock and economic responses to selective fertilization of Sierra foothill rangeland with nitrogen, phosphorus and sulfur. Range Sci. Rep. No.8, UC Davis Agron. & Rg. Sci. Dept. 8. 11 pages.

Field scale treatments of nitrogen-only, phosphorus plus sulfur, and all three elements together were aerially applied in early October of 1982 on a 520-acre site at the UC Sierra Foothill Range Field Station, and the experiment was conducted for three consecutive years without additional fertility adjustment. Assessment of soil nutrient status was made and climatic data, especially precipitation and temperature, were used as aids in interpretation of results. The best animal gains were from the multiple-element (NPS) and the higher-level PS treatments. Ref.118\63.79.

Raguse, C.A., R. Hull, M.B. Jones, J.G. Morris, M.R. George, and K.L. Taggard. 1985. The Forbes Hill range fertilization experiment. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 17-19.

Normal costs of fertilizer materials and application were recovered in the first grazing season (in a good year) following fall application. Best results were from the multiple-element (NPS) treatments. An extremely important element in recovery of fertilization benefits is the ability to adjust stocking rates to sometimes large seasonal changes in levels of forage production. Stocker steer average daily gains were higher for fertilized fields, indicating significant benefits of fertilization to forage quality. Ref.77\61.32.

Raguse, C.A., M.B. Jones, M.R. George, and K.D. Olson. 1983. Range fertilization studies. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 17-24.

Field fertilizer treatments: Using urea as the N source and a 1:1 mixture of 0-25-0-10S and 0-20-0-12S as P and S sources, NP and S were applied by helicopter on October 5 and 6, 1982, in various combinations and concentrations. Data collected: Animal level - average daily gain; weight gain per animal per grazing period; digestibility and protein content of forage collected by fistulated steers; animal grazing days. Plant level - changes in botanical composition; forage levels prior to each weigh date; NPS content of selected forage samples; observations on legume growth and vigor, including nodulation. Economic analysis and projections. Ref.81\61.36.

Raguse, C.A., J.L. Jones, J.G. Morris, M.R. George, K.D. Olson, K.L. Taggard, and R.E. Delmas. 1986a. Conversion of annual range forage to beef in the Sierra Nevada foothills. Proc., Calif. Plant & Soil Conf., Sacramento, CA. pp. 91-98.

Conversion of plant to animal product in a Mediterranean annual grassland was studied in a type-converted oak woodland, annual-legume-reseeded, lower foothill area of the Sierra Nevada. Major objectives were to assess both short- and long-term biological and economic responses to additions of selected levels and combinations of nitrogen, phosphorus, and sulfur where soils were known to be limiting in all three elements. Seasonal grazing was done by stocker steers. Esophageal-fistulated animals were used to collect forage samples from which treatment and season related changes in quality could be assessed. Ref.116\63.77.

Raguse, C.A., J.L. Jones, J.G. Morris, M.R. George, K.D. Olson, K.L. Taggard, and R.E. Delmas. 1986b. Plant, livestock and economic responses to selective fertilization of annual rangeland with nitrogen, phosphorus and sulfur. Proc., 34th Annual Calif. Fert. Conf., Fresno, CA. pp. 53-60.

Field-scale treatments of nitrogen-only, phosphorus plus sulfur, and all three elements together were aerially applied in early October of 1982 and the experiment was conducted for three consecutive years without additional fertility adjustment. Esophageal-fistulated animals were used to collect forage samples from which treatment and season related changes in quality could be assessed. In addition to data collected for plant and animal levels of the system, an initial assessment of soil nutrient status was made and climatic data, especially precipitation, were used as an aid in interpretation of results. Ref.117\63.74.

Raguse, C.A., J.W. Menke, and D.C. Sumner. 1974. Developmental morphology of seedling subterranean and rose clover leaves. Crop Sci. 14: pp. 333-334.

Ten morphologic stages of leaf development were described for seedling subterranean clover and rose clover. The system is relatively simple to apply and has proved useful in field, greenhouse, and controlled-environment studies that require a rapid, nondestructive means of monitoring growth responses to changes in plant environment. If plant development is slow because of cold or other environmental stress, this index is supplemented with one describing growth from emergence to full expansion of the unifoliate leaf. Ref.16\60.29.

Raguse, C.A., J.G. Morris, and V.N. Landry. 1989. Correlation of steer average daily gain with diet quality and forage phenology in an improved annual grassland. J. Range Manage. 42: pp. 415-420.

Objectives of this study were to construct a model to describe seasonal changes in steer average daily gain (ADG); to observe changes in nitrogen concentration and in vitro organic matter digestibility related to time of season and ADG; and to relate the phenological progress of maturation of rose clover to ADG, nitrogen concentration and in vitro organic matter digestibility. Ref.85\61.40.

Raguse, C.A., and K.L. Taggard. 1979. Growth of subterranean clover in a range soil as affected by microclimate and phosphorus availability. III. Comparative growth of subterranean and rose clovers at cold soil temperatures. *Agronomy J.* 71(4): pp. 523-528.

The biological yield potential of winter annual range legumes is influenced by the timing of rainfall adequate to ensure germination. Three controlled-environment experiments were conducted to compare the seedling growth of rose clover and subterranean clover on a P-deficient soil simulating winter conditions of cold soils and low light. Results suggest that while the practical soil threshold temperature for overall growth is near 5 C, some intraplant growth processes may proceed, but only at adequate availability levels of mineral nutrients. Ref.97\63.69.

Raguse, C.A., K.L. Taggard, and R.E. Delmas. 1983. Irrigation of foothill annual rangeland: a means of augmenting fall/winter forage. In: Hannaway, D.B., ed. *Foothill for food and forests*. Beaverton, OR: Oregon State Univ. Symp. Series No. 2. pp. 345-349.

Winter annual legumes have low fall and early winter forage yields in California's Mediterranean-type climate. A 2-year field study was conducted to determine the effect of late summer irrigation on forage yield potential of subterranean clover, rose clover, and bur clover. Under climatic conditions similar to those in the present experiment, early fall irrigation will ensure vigorous plant growth at temperatures under which maximum root development and nodulation of legumes can occur. This increase in plant material in early fall allows earlier and longer grazing periods, and up to 6,000 to 7,500 kg/ha of high quality forage can be produced. Ref.105\63.72.

Raguse, C.A., K.L. Taggard, J.L. Hull, J.G. Morris, M.R. George, and L.C. Larsen. 1988. Conversion of fertilized annual range forage to beef cattle liveweight gain. *Agronomy J.* 80: pp. 591-598.

A 3-yr field experiment evaluated average daily and total seasonal weight gains of growing beef cattle on fertilized California foothill annual range. Soils were a mixture of four series of alfisols. Differences in ADG due to treatments were largely restricted to the first year and to treatments with N, P, and S or the higher level of PS, but 3-yr trends were not significant. Results indicate that either N, P, and S or a sufficient level of P and S to stimulate production of legume N was required for high forage production. Ref.32\59.27.

Schimel, J.P. 1987. Plant/microbial competition for nitrogen in a California forest and grassland. Ph.D. Thesis, Univ. of Calif., Berkeley. 156 pages.

I examined the role of NH_4^+ vs. NO_3^- , and of spatial compartmentalization in controlling plant/microbial competition for N in annual grassland and mixed conifer forest soils. Control of N-incorporation by the forest floor biota was examined by slurrying samples in ^{15}N containing solutions. NH_4^+ uptake was rapid. An inhibitor of glutamine synthetase, MSX, reduced NH_4^+ uptake, suggesting that a portion of the microbial population was NH_4^+ limited. Ref.292\64.28.

Schimel, J.P., L.E. Jackson, and M.K. Firestone. 1986. Control of nitrification and denitrification in a California annual grassland. *Proc., IV ISME* : pp. 645-649.

We have begun to examine the importance of nitrification and denitrification in an oak-grass savanna in the foothills of the Sierra Nevada in California. In these soils the concentrations of NO_3^- are generally very low. However NO_3^- appears to be quite dynamic; we have found that NO_3^- accumulates rapidly in lab incubations and in field cylinders from which plants are removed. Nitrification may enhance nitrogen availability because grassland plants may compete better for NO_3^- than for NH_4^+ . Ref.300\64.36.

Schimel, J.P., L.E. Jackson, and M.K. Firestone. 1989. Spatial and temporal effects on plant microbial competition for inorganic nitrogen in a California annual grassland. *Soil Biol. Biochem.* 2(8)1: pp. 1059-1066.

The changes in N-dynamics which occur after the start of autumn rains, following an extended summer drought, were examined in a California annual grassland. Competition for NH_4^+ and NO_3^- were assessed in intact soil microcosms periodically watered to stimulate autumn rains. Nitrification benefitted plants by increasing accessible N. Spatial factors were critical in controlling N-dynamics. Microsites free of NH_4^+ were presumably responsible for the extensive microbial NO_3^- uptake. Of the activities measured in the top 9 cm of the soil, the surface 5mm accounted for almost half of mineralization and plant NH_4^+ -uptake, but only 11% of microbial NH_4^+ -uptake. Ref.297\64.33.

Singer, M.J., J. Blackard, and G.L. Huntington. 1980. Plant cover helps control rangeland erosion. *California Agriculture* 34(10): pp. 8-10.

Soil erosion by water is a two-part process. First, the impact of raindrops detaches soil particles from the main mass of soil. Then, water flowing over the soil surface transports this loose soil from the site of detachment. Proper range management can prevent large erosion losses by ensuring that an adequate plant cover exists during the rainy season. This means that grazing pressure must be controlled and that type conversion practices such as mechanical brush removal, burning, and cultivation need to be timed so that the soil is not bare during the rainy periods of the year. Further research is needed to quantify the relationship between soil chemical properties and erodibility. Ref.100\63.70.

Singer, M.J., and R.A. Dahlgren. In press. The role of oak trees in nutrient cycling. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

Many oak woodland ecosystems are grazed and many are being cleared for oak firewood to enhance grazing. Nutrients removed from an ecosystem at rates greater than they can be made available by natural processes such as rock weathering, nitrogen fixation, and atmospheric deposition lead to decreased productivity of the ecosystem. In grassland soils, nutrients leached below the shallow rooting zone of annual grasses are removed from the ecosystem into stream or ground waters. In contrast, the deeply rooted oak trees are able to capture the majority of the nutrients before they are lost from the ecosystem by leaching. Ref.262\64.01.

Smith, T.K. 1978. Land use and intensive range management in the Sierra Nevada foothills -- a contemporary analysis. M.S. Thesis, Univ. of Calif., Davis. 91 pages.

The purpose of this investigation was to examine some range improvement practices commonly used in beef cattle production. The physical & biological environment at UC Sierra Foothill Range Field Station in Yuba county (our model) is representative of approximately nine million acres of Sierra Nevada foothill land. Soil erosion was found to be the major category for prevention efforts, for it can be both a cause and effect of environmental degradation in rangeland. Other categories of impact include direct removal of wildlife habitat through vegetation-type conversion and indirect impacts on the cultural and biological resources. Ref.247\63.96.

Standiford, R., technical coordinator. 1996. Guidelines for managing California's hardwood rangelands. Oakland, CA: Univ. of Calif. DANR Publication 3368. 173 pages.

The purpose of this book is to help landowners and managers of hardwood rangeland properties develop management plans that maintain the profitability of their properties, while at the same time sustaining the ecological values provided by their land. There is no one best management system or one best set of guidelines. These guidelines will lead the reader through a close evaluation of their goals and objectives for their personal lives and their properties, and present a variety of management strategies to achieve these goals and objectives. This book is a revision of *The Preliminary Guidelines for Managing Hardwood Rangelands*, released in 1986 by the University of California. Ref.289\64.25.

Stark, J. 1991. Environmental factors versus ammonia-oxidizer population characteristics as dominant controllers of nitrification in an oak woodland - annual grassland soil. Ph.D. Thesis, Univ. of Calif., Berkeley. 146 pages.

Environmental variables and kinetic characteristics of ammonia-oxidizer populations were examined to determine which factors were most important in controlling seasonal and spatial variation in gross nitrification rates in a California oak woodland-annual grassland soil. Soil NH_4^+ , NO_3^- , moisture, total N and C, and nitrification potential were higher in soils beneath the oak canopies than in open grassy areas between oaks and higher in the 0-1 than 1-9 cm soil layer. Mean soil temperatures and fluctuations in temperature and moisture were higher in open areas. Physiologically distinct ammonia-oxidizer populations coexisted within the oak woodland annual grassland soil. Populations from open sites had temperature optima that were 5 °C higher than those from canopy sites. Michaelis-Menten constants appeared different; however, high variability prevented drawing conclusions about population differences. Ref.294\64.30 .

Sumner, D.C., C.A. Raguse, and K.L. Taggard. 1972. Effects of varying root/shoot temperatures on early growth of subterranean clover. *Crop Sci.* 12: pp. 517-520.

We sought to determine the individual contributions of ambient root and shoot temperatures to rate of plant development, dry matter accumulation, and root/shoot ratio. Subterranean clover was grown from seed in the following chronological sequences: (i) plants were grown at 20 °C from seed to the two-leaf stage; (ii) root, shoot, or overall temperature was then lowered to 10 °C and growth was allowed to progress until the five-leaf stage; and (iii) temperature was returned to 20 °C and growth was continued to the 7- to 10-leaf stage. Shoot ambient temperature appeared to be less important than root ambient temperature as a determinant of growth rate. Ref.10\45.25.

Taggard, K.L., R.E. Delmas, and C.A. Raguse. 1976. Late summer irrigation and establishment of winter annual legumes in a mediterranean-type climate. *Agronomy J.* 68: pp. 674-677.

A 2-year field study was conducted to determine the effects of late summer irrigation on seedling development, forage yield potential, and management problems of subterranean clover, rose clover, and bur clover. By irrigation prior to fall rains, we subjected six successive seedings to higher temperatures and longer fall-growth periods than usual. In the 1972-73 season, rose clover showed the largest differences in growth rates between planting dates. In the 1973-74 season, late-flowering subclover had the fastest growth rate; there were no differences between clovers following late irrigation. Ref.20\55.16.

Tate, K.W. 2003. Ungrazed buffers for filtering runoff. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 20, 2003. pp. 39-41.

The project is being conducted on grazed, irrigated pasture at the UC Sierra Foothill Research and Extension Center near Browns Valley. Study design is completely random with 3 treatments applied to 9 pastures for 3 replicates. Buffer treatments are a 3:1 pasture area (240 m) to buffer area (40m) ratio, and a no buffer control. The 3:1 and 6:1 ratio treatments have buffer widths of 16 and 8m, respectively. Irrigation water is applied to the top of each plot and surface water runoff is collected and measured at the base of each plot. Plots are grazed by beef cattle prior to each irrigation trial. 66.18

Williams, W.A., C.D. Thomsen, and W.L. Graves. 1994. Evaluating dryland legumes and native perennial grasses as plant materials for use in sustainable agriculture systems. Final Report to Univ. of Calif. Sustainable Agric. Res. and Education Program. Dec. 26, 1994. 19 pages.

We evaluated dryland legumes and native perennial grasses for use in pasture, range, vineyard, and farming systems in northern California with respect to adaptability, persistence, weed suppression, and management requirements. Specific components of this project included field trials with dryland legumes at Sierra Foothill REC. Ref.249\63.98.

Wilson, C.B. 1980. Grazing productivity on seeded annual ryegrass in the California foothills. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 51-52.

Increasing the carrying capacities of annual type ranges in the winter has been an important objective in livestock production research in California. By introducing annual ryegrass and supplemental irrigation, carrying capacities of five to six times that of typical winter rangelands were obtained. Cattle were able to gain on the ryegrass in mid-December and early January. Normally, cattle on rangeland in the Sierra foothills do not start gaining weight until mid-February or March. This early high quality feed, therefore, provided a grazing alternative to increase livestock production from a basic range forage system. Ref.199\63.10.

Young, J.A., R.A. Evans, and B.L. Kay. 1970. Germination of cultivars of *Trifolium subterraneum* L. in relation to matric potential. *Agronomy J.* 62: pp. 743-745.

The germination of 11 cultivars of subclover in relation to matric potential was dependent on the texture of the soil substrate. Germination terminated or was virtually zero at minus 5, 8 and 12 bars, respectively, on sand, loam, and clay substrates. Germination on soil beds in the greenhouse was dependent on substrate texture and the amount of seed coverage. In all tests in which germination was more than minimal, variability among the cultivars was marked. Ref.4\45.65.

Young, J.A., R.A. Evans, and B.L. Kay. 1971a. Germination of caryopses of annual grasses in simulated litter. *Agronomy J.* 63: pp. 551-555.

A technique was developed for germinating grass caryopses in simulated litter, without the base of the caryopses in contact with a liquid moisture-supplying substrate. Germination of five annual species of bromegrass and medusahead differed markedly in response to temperature from 10 to 25 C, compared to germination of the same species in petri dishes. The species also differed in their rates of root elongation and root persistence under repeated drying cycles at incubation temperatures from 10 to 25 C. The differences in litter germination may be the basis for dominance of one species over another under specific temperature regimes. Ref.7\45.50.

Young, J.A., R.A. Evans, and B.L. Kay. 1971b. Response of medusahead to paraquat. *J. Range Manage.* 24(1): pp. 41-43.

Medusahead plants from 23 sources were susceptible to paraquat at Davis, California, but resistant to application of this herbicide at Reno or Stead, Nevada. Differences in response were not due to ecotypic variability among the sources. Our purpose was to determine if ecotypic variability in medusahead was the cause of differential response of this species to paraquat application in different areas of western United States. Ref.8\45.49.

Young, J.A., R.A. Evans, and B.L. Kay. 1973. Temperature requirements for seed germination in an annual-type rangeland community. *Agronomy J.* 65: pp. 656-659.

Germination as affected by constant and alternating temperatures was investigated in four species of annual grasses: soft chess, ripgut, slender oat and foxtail fescue; and in their replacement forage species: seven cultivars and one naturalized population of rose clover, hardinggrass, and perlagrass. The annual grasses germinated under a very broad range of temperatures; rose clover cultivars germinated at lower temperatures. Rose clover from a naturalized population had lower germination at low temperatures and higher germination at high temperatures than the seven cultivars tested. Ref.14\59.16.

Young, J.A., R.A. Evans, and B.L. Kay. 1975a. Dispersal and germination dynamics of broadleaf filaree, *Erodium botrys* (Cav.) Bertol. *Agronomy J.* 67: pp. 54-57.

Dispersal, self-burying, and seed germination of the indehiscent fruits of broadleaf filaree were investigated. Field dispersal and laboratory germination in relation to temperature and germination enhancement experiments were conducted. Dormancy can be overcome artificially by soaking fruits in concentrated sulfuric acid or by exposing the seeds to diurnal fluctuations of temperature and relative humidity. Seeds that will imbibe water have an optimum germination at relatively cool temperatures, but considerable germination occurs with warm day temperatures and extreme diurnal fluctuations. Ref.17\59.17.

Young, J.A., R.A. Evans, and B.L. Kay. 1975b. Germination of Italian ryegrass seeds. *Agronomy J.* 67: pp. 386-389.

We studied the germination of seeds of Italian ryegrass under constant and alternating temperatures, and simulated litter as a germination substrate. Italian ryegrass germinated over a wider range of temperatures and at more extreme diurnal fluctuations than did other annual grasses from the same environment. Germination of the naturalized population was highest at both relatively cool nights and warmer days. The limited temperature range at which Italian ryegrass germinates and the inability of roots to resist drying or to regenerate after drying may limit it ecologically. Ref.18\59.18.

Young, J.A., B.L. Kay, and R.A. Evans. 1970. Germination of cultivars of *Trifolium subterraneum* L. *Agronomy J.* 62: pp. 638-641.

Germination of seeds of 11 cultivars of subclover grown in California was depressed by high temperatures and low temperatures, or remained dormant or non-sensitive in relation to incubation temperatures. Non-sensitive cultivars were least responsive to manipulations of the germination environment; while germination of temperature sensitive cultivars was stimulated by treatments such as, activated charcoal substrate, CO₂ enriched atmosphere, inclined plates, or KNO₂ solution. Pellet inoculation of seeds did not stimulate germination except with "Dwalganup". Ref.6\45.64.

Regeneration and Management of California Oaks

Adams, T.E., Jr., and K. Rice. 1988. Evaluation of selected techniques to enhance artificial regeneration of California white oaks. Public Serv. Research and Dissemination Program, 1987-88 Summary Report. p. 2.

This study is stressing the impact of natural agents (excluding large herbivores) on directly-seeded acorns and on nursery transplants at research locations in six counties across the state. After the oak seedlings emerge in the spring, researchers will assess interactions between these seedlings and annual vegetation to develop a model to understand temporal partitioning of soil moisture among competing plant species. By comparing response of oak to varying treatments used to control annuals, effects on oak survival and growth will be determined. Ref.124\61.59.

Adams, T.E., Jr., P.B. Sands, and W.H. Weitkamp. 1988. Artificial regeneration of blue and valley oak in California. Range Sci. Rep. No. 16. UC Davis Agron. & Range Sci. Dept. 16: pp. 1-9.

Suspected elements of poor valley oak and blue oak regeneration are being studied in three regions using artificial regeneration techniques. Plantings of acorns and nursery stock have been made within deer-proof exclosures to examine the impacts of weed competition, fertilization, and small mammals and insects. Results suggest weed control and protection from small mammals and insects will be necessary for successful artificial regeneration of blue and valley oak in many areas of the state. Ref.31\59.30.

Adams, T.E., Jr., P.B. Sands, W.H. Weitkamp, and N.K. McDougald. 1991a. Blue and valley oak seedling establishment on California's hardwood rangelands. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USDA For. Serv. Tech. Rep. PSW-126: pp. 41-47.

Factors contributing to poor establishment of blue oak and valley oak in California oak-grassland savannas were studied in a series of acorn seeding experiments initiated in 1985. Exclusion of large herbivores permitted examination of herbaceous interference and small mammal and insect depredation. With few exceptions, the addition of screen protection to discourage predation significantly enhanced survival and growth. Shade provided by window screen cages is suspected of making an unmeasured positive contribution. Interaction between herbaceous control and protection appears to develop with time. Ref.148\61.43.

Adams, T.E., Jr., P.B. Sands, W.H. Weitkamp, and N.K. McDougald. 1991b. Blue oak seedling regeneration on California rangelands. Proc., IVth International Rangeland Congress, Montpellier, France. April 22-26, 1991. pp. 67-71.

Control of herbs appears essential to achieve adequate emergence and first-year survival of blue oak seedlings. Limited data on long-term survival suggests seedling mortality over time is reduced by herb control. Screens protected seedlings against insects and small mammals. Window screen cages provided the best protection from predation, but they may modify the microenvironment. They provide shade, the effects of which we could not separate from protection. Predation in our studies may have been affected by concentrated planting patterns and characteristics of the exclosures. Ref.149\61.53.

Adams, T.E., Jr., P.B. Sands, W.H. Weitkamp, and N.K. McDougald. 1992. Oak seedling establishment on California rangelands. J. Range Manage. 45: pp. 93-98.

Factors responsible for poor recruitment of blue oak and valley oak need to be determined on California hardwood rangelands so that management strategies for enhancement of recruitment can be developed. To examine selected factors, exclusive of large herbivore impacts, a series of acorn seeding experiments was initiated in 1985 in 6 counties on representative sites. At each site, the experimental treatments were the factorial combination of herbs vs. no herbs and screen protection vs. no protection. With few exceptions, the addition of screen protection discouraged predation and significantly enhanced survival and growth. Ref.158\61.61.

Adams, T.E., Jr., P.B. Sands, W.H. Weitkamp, N.K. McDougald, and J. Bartolome. 1987. Enemies of white oak regeneration in California. Proc., Symp. Multiple-use Mgmt. of Calif. Hardwood Res. USDA Forest Service Tech. Rep. PSW-100. pp. 459-462.

Blue oak and valley oak acorns and nursery stock were planted in six counties during the 1985-1986 growing season, but each plant material was not planted at all sites. Results suggest weed competition was a major cause of poor emergence and survival of seedlings developing from field-planted acorns and survival of transplanted nursery stock. These problems were aggravated by use of a slow release fertilizer placed beneath acorns and transplants. Small mammals and insects were responsible for additional mortality at all locations. Ref.113\61.60.

Adams, T.E., Jr., P.B. Sands, W.H. Weitkamp, and M.E. Stanley. In Press. Oak seedling establishment by artificial regeneration on California rangelands. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

Poor recruitment in many stands of oaks (*Quercus* spp.) on California's rangelands has raised concern about the sustainability of the state's hardwood resource. Studies using spatial and temporal replication were initiated to examine factors suspected of contributing to poor seedling regeneration of blue and valley oaks. Information from these studies will help refine survival curves that can be used in planning oak restoration and mitigation. Ref.147\64.01.

Allen-Diaz, B.H., and B.A. Holzman. 1993. Resampling VTM plots in blue oak cover type series. Report for Forest and Rangeland Resources Assessment Program (FRRAP), Calif.Dept.of Forestry and Fire Protection, July 1993. p. 70.

Understanding recent change within the blue oak woodlands is the focus of this study. The transitional cover types such as Blue oak-Foothill pine/Grass and Blue oak/Buck brush/Grass persist on the landscape due to continuous changes in blue oak communities through time as well as in response to human disturbances such as harvesting and fire suppression. Grazing did not appear to significantly affect overstory vegetation change. Although it is the ecological changes that were of most interest in this study, it is the cultural impacts that will significantly determine the future of the blue oak woodlands in California. Ref.123\62.30.

Bartolome, J.W., and M.P. McClaran. 1985. Blue oak stand age structure. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. p. 26.

Stand age structure, vertical growth rates, fire dates and fire free periods were measured for blue oaks in the Campbell and Koch pastures. The faster vertical growth rates for sprouts compared to seedlings is probably related to the greater success of establishment from sprouts compared to establishment from seedlings because it reduces the period of time that terminal buds are within the reach of browsing deer and livestock. Ref.210\63.21.

Bartolome, J.W., and M.P. McClaran. 1987. Understory forage production in blue oak woodlands. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. p. 56.

Preliminary guidelines for management of hardwood range published by UC Cooperative Extension in 1985 suggest that in areas with more than 20 inches of annual rainfall, tree cover of 50 percent or more suppresses the understory. During this study our results showed location combined with plant species composition offers potential as a useful guide to predict the effects of blue oak canopy removal or retention. Along a rainfall gradient within the blue oak woodland with 50 percent canopy, suppression of understory production occurs above 50 cm rainfall. The canopy has no effect or an enhancement below 50 cm annual precipitation. Ref.220\63.31.

Berman, J., and C. Bledsoe. In press. Effect of forest soil inoculum on Mycorrhizal root development and growth of valley oak seedlings. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

In this study a field experiment and a green house experiment were carried out to assess the effects of mycorrhizal infection on valley oak seedling growth. This information could be a valuable aid in efforts to reintroduce valley oaks to disturbed riparian areas. These studies suggest that forest soil used as inoculum can increase percent mycorrhizal infection on valley oak seedling roots. The effect of mycorrhizal infection on growth should be evaluated in a longer-term study. Ref.251\64.01.

Bledsoe, C. S., and C. S. Milikin. In press. Soil water potentials provide evidence of hydraulic lift and oak root activity in a California blue oak woodland. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

Blue oaks and annual grasses coexist in an environment that appears to be unfavorable toward growth during hot dry summers. To see how the dry summer affects root activity, soil water potential was measured with thermo-couple psychrometers at four depths. Because root uptake decreases soil water potential below 25 cm (evaporation is minimal) and grasses senesce by June, the decreases in soil water potential suggest that oak root activity continues throughout the summer. After sunrise soil water potential decreased rapidly, after sunset soil water potential gradually increased. These patterns occurred between late May and October, when soils were drier, and were observed throughout the soil profile. Ref.252\64.01.

Cheng, X., and Bledsoe, C.S. 2002. Contrasting seasonal patterns of fine root production for blue oaks (*Quercus douglassi*) and annual grasses in California oak woodland. *Plant and Soil* 240: pp. 263-274.

In a blue oak woodland in NE California, we used root ingrowth cores to study seasonal patterns of fine root (<2mm diameter production) (FRP) for annual grasses and blue oaks. At each of 3 sites (river, upland, and hilltop) there were three studies: short term seasonal, a long term cumulative study and a core nutrient enrichment study. 66.02

Connor, J.M., and B.L. Willoughby. In Press. Effect of blue oak canopy on annual forage production. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar 19-22, 1996.

Production of annual forage was compared at four sites under four blue oak canopy levels (0, 25, 50, and 75 percent), over five years. Long-term precipitation averages 28.5 inches. Significant differences in herbaceous forage production occurred among years, with the highest rainfall season being the most productive and the drier years generally being less productive. The effects of canopy cover varied from year to year; canopy significantly depressed forage yield in two of the five years. High rainfall years appeared to favor herbaceous plant growth under the higher canopy levels. Ref.254\64.01.

Dahlgren, R., and M. Singer. 1993. Biogeochemistry in oak woodlands of the Sierra foothills. *Proc., UC Sierra Foothill REC Beef and Range Field Day*. pp. 29-30.

Our study has focused on nutrient cycling; the movement of nutrients in, out of, and within the ecosystem. The flow of nutrients through the oak woodland ecosystem has been studied for a four year period in the Schubert Watershed. Fluxes of nutrients in ecosystem waterflows (precipitation, canopy throughfall, soil solutions and stream water), plant uptake, and litterfall were monitored. Removal of Oaks leads to a loss of nutrients from the ecosystem. Ref.171\61.49.

Dahlgren, R.A., and M.J. Singer. 1994. Nutrient cycling in managed and non-managed oak woodland-grass ecosystems. *Rep. to Integrated Hardwood Range Management Program*. 91 pages.

This research project examining oak woodland nutrient cycling shows that oak trees play a major role in maintaining the nutrient status of these ecosystems. Each year, a typical blue oak will return approximately 1, 0.1, 2, and 0.8 kg of nitrogen, phosphorus, calcium and potassium, respectively, to the soil surface in the form of litterfall (e.g. leaves, twigs and acorns) and canopy throughfall (canopy leaching). While these values may appear low, multiplying by all the oak trees in a watershed results in very large quantities of nutrients. Ref.177\62.11.

Dahlgren, R.A., and M.J. Singer. 1995. Nutrient cycling in grazed and ungrazed oak woodland rangelands. *Proc., UC Sierra Foothill REC Beef and Range Field Day*. pp. 27-33.

Oak trees play a critical role in sustaining ecosystem productivity through their role in cycling nutrients to the soil surface, preventing nutrient leaching losses, increasing water infiltration, and attenuating water erosion and stream sediment concentrations. Moderate intensity grazing does not appear to have any serious detrimental effects on nutrient cycling in these oak woodland ecosystems. Oak tree removal will lead to a significant loss of nutrients from these ecosystems leading to a long-term decrease in ecosystem productivity. Careful removal of oaks does not significantly change stream flow patterns or amounts. Ref.241\63.53.

Epifanio, C.R. 1989. Hydrologic impacts of blue oak harvesting and evaluation of the modified USLE in the northern Sierra Nevada. M. S. Thesis, Univ. of Calif., Davis. 144 pages.

The original objective of this project was the determination of the impacts of vegetation-type conversion and other range management techniques on water yield and water quality from a rangeland watershed. Six years data for rainfall, runoff and sediment yield for two watersheds, S1 and S2, have been reduced, tabulated, placed into a computer database and statistically analyzed. The watersheds were found to be sensitive to rain intensity and amount. Runoff tends to increase linearly with rainfall. In view of the fact that the SCS tolerable annual soil loss limits for the SFRFS are 5 tons per acre per year, none of the watersheds posed serious erosion problems during the study period. Ref.137\62.27.

Frost, W.E., J.W. Bartolome, and J.M. Connor. In press. Understory - canopy relationships in oak woodlands and savannas. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar 19-22, 1996.

We summarize available information about the relationships between oak overstory and understory plants. Understory biomass productivity and plant species composition vary considerably in California's oak woodlands and savannas. Factors discussed include geographic location, overstory species composition, overstory density and distribution, and animal utilization. Management implications are summarized for different woodland types around the state. Ref.256\64.01.

George, M.R., and L.M. Hall. 1991. Grazing compatible with blue oak regeneration. Report for Forest and Rangeland Resources Assessment Program (FRRAP), Calif. Dept. of Forestry and Fire Protection, August 1991. p. 32.

Cattle have been implicated as a principal cause for poor oak regeneration in California's hardwood rangelands. The effects of stock density and season of grazing was evaluated on blue oak establishment. Seven hundred and twenty blue oak seedlings were planted on ten-foot centers in thirty plots in three annual grassland pastures at the Sierra Field Station. Steers were allowed to graze one plot per week at low, medium, and high stock densities during the months of January, April and July of 1990. It is clear that cattle damage to oak seedlings varies tremendously depending on season of grazing and, to a lesser degree, stock density. Ref.39\60.17.

Gordon, D.R., and K.J. Rice. 1993. Competitive effects of grassland annuals on soil water and blue oak (*Quercus douglasii*) seedlings. Ecology 74(1): pp. 68-82.

Four California annual grassland species were used to examine the hypothesis that different plant species have equivalent competitive effects. We investigated the effects of the annuals on soil water availability and the growth responses of blue oak to neighbor-induced water depletion. Neighborhoods of annuals were composed of species from the California annual grassland with differing phenology and morphology that were hypothesized to show non-equivalent competitive effects on both a per-individual-and a per-unit-tissue basis. Ref.190\62.24.

Gordon, D.R., K.J. Rice, and J.M. Welker. 1991. Soil water effects on blue oak seedling establishment. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USDA For. Serv. Tech. Rep. PSW-126: pp. 54-58.

A field experiment was conducted to examine the effects of soil water availability on blue oak seedling establishment. Soil water and plot size, depending on the site, and initial acorn weight and parent tree all influenced oak seedling growth. Survival and height in subsequent growing seasons was dependent on early growth. Soil water availability in the first growing season, therefore, influences both oak seedling establishment and growth in subsequent years. Ref.186\62.20.

Gordon, D.R., J.M. Welker, J.W. Menke, and K.J. Rice. 1989. Competition for soil water between annual plants and blue oak (*Quercus douglasii*) seedlings. Oecologia 79: pp. 533-541.

We examined the competitive effects of two annual species on soil water potential and blue oak seedling growth and water relations. Two densities of the annual grass and one density of the annual forb comprised plant neighborhoods around the oak seedlings grown in 1 m deep boxes. Rates of soil water depletion differed among neighborhoods. These results suggest that the annual species are not equivalent competitors for water: fibrous grass roots had greater competitive effect than did forb tap-roots. Ref.128\61.58.

Hall, L.H.. 1991. The effects of season of grazing and stock density on blue oak (*Quercus douglasii*) regeneration in the sierra foothills of California. M.S. Thesis, Univ. of Calif., Davis.43 pages.

This study investigated the effects of stock density and season of grazing on blue oak establishment. Seven hundred and twenty year- old blue oak seedlings were planted on ten-foot centers in 30 plots in three annual grassland pastures at the Sierra Foothill Range Field Station east of Marysville. Steers were allowed to graze one plot per week at low, medium and high stock densities during the months of January, April, and July. One half of all tree planting spots received a herbicide application prior to planting to eliminate grass competition. Low stock density does not have a significant detrimental effect on oak establishment in winter. Grazing damage and browsing by deer increased dramatically in the spring and summer periods. In summer deer browsing damage in the control plots exceeded cattle damage in the experimental plots. Grazing damage was mainly due to nipping and rarely due to girdling or uprooting. Trampling damage was usually minimal. Herbicide application did not have any effect on the incidence of trampled or grazed trees. Ref.309/ 64.47.

Hall, L.M. 1991. Effects of cattle grazing on planted oak seedlings. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 42-45.

The results of this study indicate that cattle damage oak seedlings at medium and high stock densities particularly in the spring and summer months. At low densities in the winter and spring, however, it is quite possible that oak regeneration and livestock production are not mutually exclusive. The detrimental effects of deer at critical times of the year can be just as significant as cattle damage and should not be underestimated. Further investigations on the seasonal grazing of oak seedlings would help clarify the effect of livestock on oak seedlings. Ref.234\63.45.

Hall, L.M., M.R. George, D.D. McCreary, and T.E. Adams, Jr. 1992. Effects of cattle grazing on blue oak seedling damage and survival. *J. Range Manage.* 45: pp. 503-506.

Cattle grazing has been suggested as a principal cause for poor oak recruitment in California's hardwood rangelands. This study evaluated the effects of stock density and season of grazing on blue oak establishment. In December 1989, seven hundred and twenty blue oak seedlings were planted on 3-m centers in 30 plots in 3 annual grassland pastures. Browsing and trampling damage were estimated at the end of each treatment. Analysis of variance revealed significant differences between seasons but not between control and ungrazed plots within seasons. Damage was greatest during the summer season but there was no difference between grazed plots and those protected from cattle grazing. Ref.178\62.12.

Jackson, L.E., R.B. Strauss, M.K. Firestone, and J.W. Bartolome. 1990. Influence of tree canopies on grassland productivity and nitrogen dynamics in deciduous oak savanna. *Agriculture, Ecosystems and Environment* 32: pp. 89-105.

In oak and annual grassland savanna in the foothills of the Sierra Nevada, CA, soils under deciduous blue oak canopies have higher nitrogen turnover and inorganic N availability than surrounding open grassland soils. Over 3 years of study, annual above- and below- ground productivity and plant N accumulation in both communities were generally very similar. Although the two areas differ in species composition, rates of seedling establishment, seasonal phenology, and dry weight and N allocation patterns, these differences are not great enough to affect productivity at this site. Even if forage production in the blue oak savanna does not benefit from the presence of oak canopies, soils under oaks harbor a reservoir of soil organic N that could be rapidly lost or redistributed if oaks are removed for management purposes. Ref.302\64.38.

Jansen, H.C. 1986. The effect of Blue oak removal on herbaceous production on a foothill site in the northern Sierra Nevada. *Proc., Symp. on Multiple-Use Mgmt. Calif. Hardwood Res. USDA Forest Service Tech. Rep. PSW-100.* pp. 343-350.

The effect on herbaceous production of blue oak canopies of 25, 50, and 75 percent, and the effect of complete removal of such canopies were determined over a 7-year period for a single site in the foothills of the northern Sierra Nevada. Tree covered plots produced 12% less than grassland plots, while cleared plots produced 46% more than tree covered plots. Percentage differences in production were about the same for the middle and end of the growing season, but were considerably less at the beginning of the growing season. Tree canopy, whether present or removed, has no discernable correlation with production due to tree size, stocking and other plot effects. Ref.266\64.03.

Kay, B.L. 1987. Long-term effects of Blue oak removal on forage production, forage quality, soil, and oak regeneration. *Proc., Symp. Multiple-Use Mgmt. of Calif. Hardwood Res. USDA Forest Service Tech. Rep. PSW-100.* pp. 351-357.

Herbaceous forage response to the killing or removal of blue oak trees was measured for 21 years in the north-Sierra foothills of California. Increased herbage was noted in all but three of the first 15 years, but not after the fifteenth year. Forage increases during this 15-year period averaged 66 percent if the roots were killed and 45 percent if only the tops were killed. Naturally occurring grasslands within the area averaged 26% higher forage production than the tree covered areas. Percent increases due to tree removal were the greatest in the driest years. Ref.267\64.03.

Kay, B.L., and O.A. Leonard. 1979. Effect of blue oak removal on herbaceous forage production in the north Sierra foothills. *Proc., Symp. Ecology, Manage.and Util.of Calif.Oaks. Claremont,CA.* pp. 1-5.

Herbaceous forage production beneath blue oak trees increased when the trees were killed. Forage yields were greater in 11 years of the 13 years following treatment averaging 66 percent if the roots were killed and 45 percent if only the tops were killed. Percent increases were greatest in the driest years. Yields when trees and roots were killed > tops only removed > naturally occurring grassland > under live trees. When trees were killed the botanical composition improved and total ground cover increased. Bulk density of soil increased. Ref.21\59.21.

Kloss, S. 2000. Geographic patterns of phenotypic variation in water relation traits in sierran populations of California blue oak. Ph. D Thesis, Univ. of Calif., Berkeley: page148.

This study characterized the distribution of genetic variation in California blue oak populations using a greenhouse experiment, and an experiment that compared the data from the experimental treatments with data collected from the same populations in a common garden and field sites. This study developed understanding of how genetic variability is distributed between and within populations of California blue oaks. Phenotypic variations in water relation traits of six populations of California blue oak were compared. 65.18

Knapp, E.E., Goedde, M.A., and Rice, K.J. 2001. Pollen-limited reproduction in blue oak: implications for wind pollination in fragmented populations. *Oecologia* 128: pp. 48-55.

Human activities are fragmenting forests and woodlands worldwide, but the impact of reduced tree population densities on pollen transfer in wind pollinated trees is poorly understood. In a 4-year study, we evaluated relationships among stand density, pollen availability, and seed production in a thinned and fragmented stand of blue oaks (*Quercus douglasii*). 66.03

Matzner, S., K. Rice, and J. Richards. In press. Comparisons of water stress and stomatal conductance in different size classes of *Quercus douglasii* from different sites. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar 19-22, 1996.

Patterns of water stress and its effect on stomatal conductance were determined for different size classes of *Quercus douglasii* a species which is not regenerating throughout much of its range. Measurements were made on seedlings, saplings and adults at three sites that differed in annual precipitation and temperature extremes. Although differences between size classes, sites, and years were discovered, there was no evidence that blue oaks in regeneration and nonregeneration areas differ in their water relations. Ref.258\64.01.

McClaran, M.P. 1986. Age structure of *Quercus douglasii* in relation to livestock grazing and fire. Ph.D. Thesis, Univ. of Calif., Berkeley. 119 pages.

Blue oak size poorly predicts tree age and is of little value in describing stand age structure. The variation in growth rates among neighboring trees is the main limitation of the predictive ability of tree size. Stand age structure cannot be described by size distribution because they are different. Therefore the validity of earlier predictions of blue oak age structures based on tree size should be questioned. Age structure and size-age relationship results are of possibly equal importance as an injection of evidence into the current political discussion of blue oak regeneration, stating that there is no simple or quick fix solution. Ref.78\63.99.

McClaran, M.P. 1988. Comparison of fire history estimates between open-scarred and intact *Quercus douglasii*. The American Midland Naturalist. 120: pp. 432-435.

Reservation has been expressed regarding relying on samples from trees with open scars to estimate fire history. A greater probability of scarring for open-scarred trees is one reason commonly given for restricting samples. Fire scars in 181 scarred *Quercus douglasii* cross sections were dated from two different stands. Open-scarred trees were twice as likely to scar as intact trees, but the average number of scars per tree were similar. Time since last fire is critical, as scars may heal before sampling. This suggests that fire history estimates will be most affected by sample restriction in areas with long periods of fire suppression. Ref.88\59.34.

McClaran, M.P., and J.W. Bartolome. 1989. Fire-related recruitment in stagnant *Quercus douglasii* populations. Can. J. For. Res. 19: pp. 580-585.

Blue oak age structure, stem analysis, and fire-scar history from more than 500 individuals on two sites in central California, U.S.A., revealed (i) meager tree recruitment since the 1940s and few trees older than 150 years, (ii) increased fire frequency following Anglo-American settlement in 1848 until fire suppression efforts in the 1940s, (iii) a positive association between tree ages and fire dates, and (iv) superior vertical growth to 135 cm of postfire sprouts (trees with ground-level ages within 1 year after fires) on the site with less livestock browsing pressure. Ref.33\59.32.

McClaran, M.P., and J.W. Bartolome. 1989. Effect of *Quercus douglasii* (fagaceae) on herbaceous understory along a rainfall gradient. Madrono 36(3): pp. 141-153.

Variation in effect of approximately 50% *Quercus douglasii* (blue oak) cover on herbaceous understory biomass and composition was studied along a rainfall gradient between five sites. Biomass and composition were compared between understory and adjacent open grassland at each site to evaluate changes in canopy effect along the gradient. We conclude that variation in canopy effect on biomass resulted from changes in relative production between understory and open grassland, not from differences in relative composition. Ref.274\64.10.

McClaran, M.P., and J.W. Bartolome. 1990. Comparison of actual and predicted blue oak age structures. J. Range Manage. 43: pp. 61-63.

There is increasing interest in understanding the role of management on the current lack of blue oak recruitment on California foothill rangelands. Age structure analysis has been suggested to relate when and how much recruitment occurred under past management as an indication of current management effects on recruitment. Previous estimates of blue oak age structure were based on unquantified correlations between age and diameter. Actual age structures were significantly different than age structures predicted from all regression equations at both sites. Ref.35\59.33.

McCreary, D.D. 2001. Prescribed fire impact on oaks. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 19, 2001.

Here at the SFREC we have initiated a project to examine the effects of prescribed fire on oaks. One hundred and fifty blue oak trees within the perimeter of two prescribed burns conducted last summer were tagged and evaluated. The results of these projects suggest that native California oaks are relatively resistant to either prescribed or natural fires and have developed mechanisms to withstand adverse impacts and are able to survive, reproduce and grow. 66.12

McCreary, D.D. 1987. The integrated hardwood range management program. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 57-58.

Hardwoods grow on approximately 20 million acres in California. To date, however, there has been little interest in studying or managing this resource. This is largely because hardwoods have relatively little commercial value. A number of individuals and organizations have recently voiced concerns that the existence of some hardwood species -- especially oaks -- is threatened. In response to growing concerns, the University of California and the California Department of Forestry jointly agreed to support a research and education program aimed at the management, enhancement and protection of the State's hardwood range resources. Ref.221\63.32.

McCreary, D.D. 1988. Artificially regenerating native oaks in California. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 42-44.

In the last decade, a number of studies have investigated the causes of poor regeneration. These include limited soil moisture, acorn predation from deer, birds and rodents, defoliation by insects, and browsing by wild and domestic range animals. This research project demonstrated that with the proper treatment and planting of acorns and seedlings, native oaks in California can be successfully artificially regenerated. If direct seeding of acorns is used, acorns should be collected during September or early October, while they are still on the trees. Ref.226\63.37.

McCreary, D.D. 1989a. 49er fire revegetation activities. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 7-8.

In September, 1988 a fire swept through western Nevada County, destroying 200 homes and burning over 35,000 acres of land. In terms of property loss, the 49er Fire was one of the most destructive in California history. It was also tremendously damaging to native woody vegetation, which was predominately oak trees. Soon after the fire was extinguished, efforts began to revegetate burned areas. By mid-March, nearly 800 pounds of acorns had been planted. While it is still too early to evaluate the success of Project Acorn in terms of oak tree establishment, the project was certainly successful in educating the public. Ref.228\63.39.

McCreary, D.D. 1989b. Field performance of valley oak seedlings under different irrigation regimes. Fourth Workshop on Seedling Physiology and Problems in Oak Planting. Columbus, OH (abstr.). USDA Forest Service Tech. Rep. NC-139: p. 21.

A study was initiated to evaluate the effects of alternative irrigation regimes on valley oak seedling establishment using direct seeded acorns and transplanted container stock. Results indicated that valley oak seedlings can be successfully established by planting either container stock or acorns. Excellent growth and survival can be obtained if the planting area is kept free of weeds, planting spots are pre-augured, and fertilizer tablets are placed below the roots. Frequent irrigation does little to improve field performance. Ref.280\64.16.

McCreary, D. D. 1989c. Emergence and growth of blue and valley oak seedlings as affected by acorn sowing date. Proc., 10th No. American Forest Biol. Workshop, Vancouver, B.C. pp. 200-204.

Blue and valley oak acorns were sown at monthly intervals from November until March. The speed of seedling emergence was directly related to sowing date, with earlier emergence of acorns sown first. Blue oaks initiated shoot growth over a wider time period than valley oaks. The percentage of seedlings produced from acorns was over 90% for both species and all sowing dates, except for blue oaks sown in March. The March sowing also resulted in the latest emergence and smallest height growth for both species. Ref.138\62.25.

McCreary, D.D. 1989d. Regenerating native oaks in California. California Agriculture 43(1): pp. 4-6.

Livestock are frequently blamed for poor regeneration of native oaks in California, but research indicates that other factors are also involved. Conditions favoring natural regeneration may occur only once or twice a century. Artificial regeneration is a practical but currently costly alternative. This research demonstrated that, with proper treatment and planting of acorns and seedlings, California blue and valley oaks can be successfully propagated. Ref.62\61.17.

McCreary, D.D. 1990a. Blue oaks withstand drought. *California Agriculture* 44(2): pp. 15-17.

Many blue oaks in California lost their leaves early in 1987 and 1988 after prolonged periods of low rainfall. A study found that summer defoliation had little short-term effect on growth or survival, suggesting that blue oaks are well adapted to withstand periodic droughts. Ref.54\61.09.

McCreary, D.D. 1990b. Drought defoliation of *Quercus douglasii* in California. *American Nurseryman* 172: pp. 65-66.

I studied blue oak in California's Sierra Nevada foothills to document some of the effects of drought on this species. Because the winter of 1986-87 was exceedingly dry, and there was little precipitation in California from March '87 to August, I set up an experiment in mid-August to determine why the leaves of some blue oaks in this area turn brown in dry conditions and the consequences of early leaf drop. Results suggest that drought-induced summer defoliation of blue oak has little short-term impact on growth or survival. Ref.143\61.67.

McCreary, D.D. 1990c. Native oaks--the next generation. *Fremontia* 18: pp. 44-47.

Artificial regeneration of blue, valley, and Engelmann oak can help supplement natural regeneration in areas where few seedlings are becoming established. Techniques are currently available for successfully growing and outplanting oak seedlings. At present, however, providing sufficient site preparation, maintenance, and protection are costly. The challenge for the future is to develop low-cost techniques which will allow extensive wildland plantings. Ref.142\61.44.

McCreary, D.D. 1990d. Acorn sowing date affects field performance of blue and valley oaks. *Tree Planter Notes* 41(2): pp. 6-9.

Acorns of blue oak and valley oak were sown at monthly intervals from November until March. The earlier acorns were sown, the earlier seedlings emerged. First year and second year height growth and survival were also related to sowing date with the smallest growth and lowest survival for seedlings from the latest sowing. These results suggest that late acorn sowing reduces the chances for successful field establishment. Ref.282\64.18.

McCreary, D.D. 1991a. The effects of drought on California oaks. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp. 40-41.

The results of this study suggest that summer defoliation of blue oaks has little short-term impact on growth, survival, or acorn production. However, it remains to be seen how longer-term drought periods will affect these trees. Perhaps some trees are able to survive a year or two of below normal rainfall but will be killed or damaged by prolonged and repeated droughts. Since many of the trees on hardwood rangelands are a century or more old, however, it's reasonable to assume that the species in general has evolved mechanisms to withstand the adverse impacts of even long-term periodic droughts. This study will continue monitoring for the next few years. Ref.233\63.44.

McCreary, D.D. 1991b. Seasonal growth patterns of blue and valley oak seedlings established on foothill rangelands. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USDA Forest Service Tech. Rep. PSW-126: pp. 36-40.

Blue and valley oak seedlings were planted on a foothill rangeland site in 1987 and 1988. Both species were watered their first year but received no irrigation thereafter. They were evaluated during each subsequent spring and summer for survival, weekly height growth and total year-end height. Seedling survival was extremely high for both species and height growth was rapid and vigorous. The greatest height increment occurred during the second flush. These results suggest that both blue and valley oaks have the capacity to grow rapidly as young seedlings if suitable environmental conditions are maintained. Ref.155\61.43.

McCreary, D.D. 1991c. Artificial regeneration of native oaks in California. Proc., Society of American Foresters National Convention, San Francisco, CA. 91-05: pp. 603-604.

To help develop guidelines for successfully artificially regenerating native California oaks, a variety of research projects have been undertaken at the Sierra Foothill Research and Extension Center, and at the California Department of Forestry and Fire Protection nurseries at Davis and Magalia. These projects have focused on developing practical, low cost techniques for producing, planting and protecting oak seedlings. Hopefully this information will promote greater success in regenerating plantings and help ensure the long-term conservation of these important indigenous species. Ref.283\64.19.

McCreary, D.D. 1993. Regenerating native California oaks. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 25-27.

During the past six years, a number of research projects have been conducted at the SFREC to better understand the causes of poor regeneration of blue and valley oaks in the Northern Sierra region and to develop techniques for artificially regenerating native oaks. These latter projects have demonstrated that oaks can be successfully established on hardwood rangelands if sufficient care is taken to plant, protect, and maintain them. Ref.170\61.49.

McCreary, D.D. 1995. Augering and fertilization stimulate growth of blue oak seedlings planted from acorns but not from containers. *West. J. Appl. For.* 10(4): pp. 133-137.

Blue oak, a widely distributed species in California, is reported to be regenerating poorly in portions of the state. To ensure this species can sustain itself, successful artificial regeneration strategies are needed. Two separate studies evaluated the effects of augering and fertilization on the field performance of direct seeded acorns and 1-year old container seedlings. For all treatments, acorns tended to grow better than transplants. These results suggest that blue oak can be successfully established by planting acorns, and that both augering and fertilization can enhance field performance. Ref.112\63.85.

McCreary, D.D. 1996. The effects of stock type and radicle pruning on blue oak morphology and field performance. *Annales des Sciences Forstieres* 53(2-3): pp. 641-648.

Blue oak acorns were germinated and divided into three groups or stock types. The first group was directly sown in the field; the second was sown in containers and grown for 4 months before outplanting; and the third was grown for a year before outplanting. In addition, each of these groups was further divided into three radical pruning treatments: i) radicles left intact; ii) 2-3mm cut from radicle tip; and iii) radicles pruned back to 1 cm. Results indicated that radicle pruning dramatically altered the morphology of container seedlings, but had almost no effect on field performance. Stock type, however, dramatically influenced field growth and survival, with the directly sown acorns and the 4-month-old seedlings growing far faster than the 1-year-old seedlings. Ref.288\64.24.

McCreary, D.D. 1997. Treeshelters: an alternative for oak regeneration. *Fremontia* 25(1): pp. 26-30.

At the Sierra Foothill Research and Extension Center, we have been testing treeshelters to protect individual seedlings in grazed pastures. Our results indicate that while treeshelters are very effective in protecting oak seedlings from a variety of animals, including livestock, they are not panacea. In some situations, other strategies such as removing livestock at critical times, using other types of protective cages or installing electric fences, may be more appropriate. However, based on the results of our initial trials, treeshelters do appear promising since they not only initially protect seedlings from cattle, but also greatly reduce herbivory from grasshoppers, as well as damage from voles. They also promote much more rapid growth and make it easier to reduce weed competition. Ref.136\64.22.

McCreary, D.D., and Z. Koukoura. 1990. The effects of collection date and pre-storage treatment on the germination of blue oak acorns. *New Forests* 3: pp. 303-310.

Two studies examined the best time to collect acorns and the effect various pre-storage treatments, including soaking and drying, have on germination. Results indicated that acorns can be successfully collected over a fairly wide interval, extending from late August until late October. Acorns from all harvest dates had high germination, as long as they were not allowed to dry out before storage. Drying acorns reduced both the rate and amount of germination. To ensure good seed quality, blue oak acorns should be collected directly from tree branches and placed immediately in cold storage. Ref.281\64.17.

McCreary, D.D., and J. Tecklin. 1993a. Effects of tree shelters and weed control on blue oak growth and survival. Fifth Workshop on Seedling Physiology and Growth Problems in Oak Plantings, Ames, IA (abstr.). USDA Forest Service Gen. Tech. Rep. NC-158: p. 4.

Blue oak is one of several species of native California oaks that is regenerating poorly in some locations. Two of the most important factors limiting both natural recruitment success and field performance of planted seedlings are 1) limited soil moisture induced by competing plants, and 2) browsing or insect defoliation. This study indicated that tree shelters can promote increased survival and height growth of blue oak seedlings. However, shelters had no affect on caliper and consequently the seedlings tended to be tall and spindly. The size of weed control also affected performance, with 4-foot diameter circles best in terms of costs and benefits. Ref.290\64.20.

McCreary, D.D., and J. Tecklin. 1993b. Tree shelters accelerate valley oak restoration on grazed rangelands. *Restoration and Management Notes* 11.2: pp. 152-153.

Most oak restoration plans recommend either excluding cattle from planting areas by building small enclosures or keeping them entirely out of pastures where seedlings have been planted. This past year, we evaluated an alternative approach-using tree shelters to protect individual seedlings in grazed pastures. Our results indicate that tree shelters can effectively protect individual seedlings from cattle, deer and elk. None of the shelters exposed to these animals were seriously damaged or rendered ineffective, although there was evidence of considerable rubbing against them. In addition, seedlings inside tree shelters tended to grow more rapidly than those protected with the other protective covers. We believe this study demonstrates that tree shelters offer a promising option for successfully protecting oak seedlings in areas where livestock browsing currently limits restoration efforts or plans. Ref 285\64.21.

McCreary, D.D., and J. Tecklin. 1993c. Top pruning improves field performance of blue oak seedlings. *Tree Planters' Notes* 44(2): pp. 73-77.

This study indicates that top pruning large blue oak seedlings improves field performance. Although they were initially shorter, pruned seedlings grew faster during the next two seasons, were significantly bigger after 2 years than seedlings from the other stocktypes, and generally appeared more vigorous. This treatment is especially recommended for seedlings that have grown tall and "leggy" and appear to have out-of-balance shoot-root ratios. Top pruning could either be done in the nursery or just before or after field planting. Ref.189\62.23.

McCreary, D.D., and J. Tecklin. 1996. Effects of treeshelters on field performance of oaks in California. Sixth workshop on seedling physiology and growth problems in oak plantings (abst.) USDA Forest Service Gen. Tech. Rep. NC-182: p. 20.

Blue oak and valley oak are two species of native California oaks, endemic to the state, reported to be regenerating poorly in some locations. During the last four years, we have conducted several studies on the growth and survival of these species in treeshelters. These studies indicate that treeshelters show great promise for establishing native oaks on difficult sites in California. They have proved highly effective in protecting seedlings from a variety of animals intent on eating them, and have caused substantial increases in overall growth rates. Ref.284\64.20.

McCreary, D.D., and J. Tecklin. In press. Effects of seedling protectors and weed control on blue oak growth and survival. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar 19-22, 1996.

Two of the most important factors limiting both natural recruitment and field performance of planted blue oak seedlings are 1) limited soil moisture induced by competing plants, and 2) herbivory from insects, rodents or browsing animals. This study compared how treeshelters and screen cages affect the field performance of blue oaks. After 5 years, seedlings protected with treeshelters were significantly taller than those in screen cages. This study suggests that treeshelters are a promising tool for regenerating blue oaks in California, and that providing adequate weed control can greatly improve the field performance of planted seedlings. Ref.259\64.01.

Menke, J.W. 1988. Effect of grazing history and canopy cover on blue oak (*Quercus douglasii*) seedling water stress and survival. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day*. pp. 25-29.

Given the severe water stress that typically occurs in California each late spring, summer and fall, it is likely that regeneration success will be episodic in years with wet springs following good acorn crops. Agroforestry activities will optimally be timed to coincide with these conditions, that is, cages would only be erected on natural seedlings in these favorable years. Our experience with transplanting of older age classes indicates that sapling transplants are even less likely to be successful. Ref.224\63.35.

Milikin, C., C. Bledsoe, and J. Tecklin. In press. Woody root biomass of 40-to 90-year-old blue oaks (*Quercus douglasii*) in western Sierra Nevada foothills. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar 19-22, 1996.

Tree roots extract the nutrients and water that support above ground growth, and they return carbon and nutrients to the soil when they die. Although tree roots are an important component of woodland ecosystems, little information exists about their biomass or distribution. This research examined biomass and spatial distribution of blue oak roots at UC Sierra Foothill Research and Extension Center. Due to the small sample size, these relationships cannot yet be used for predicting belowground biomass. Ref.260\64.01.

Momen, B. 1988. Water relations and drought resistance mechanisms of *Quercus douglasii* (blue oak) and *Q. wislizenii* (interior live oak) seedlings. M. S. Thesis, Univ. of Calif., Davis. 57 pages.

The oak woodland-grass community in California covers about 3.5 million hectares. Water stress effects appear to have their major impact in plant populations during the seedling establishment period because stress develops most rapidly in shallow rooted, young plants. Soil water content, pressure-volume curve analysis, leaf conductance, and morphometric measurements of two oak species were measured during the spring and summer of 1987. Ref.131\63.81.

Momen, B., J.W. Menke, and J.M. Welker. 1992. Tissue water relations *Quercus wislizenii* seedlings: drought resistance in a California evergreen oak. *Acta Oecologica* 13(1): pp. 127-136.

Interior live oak is an evergreen species which is a co-dominant overstory species with *Quercus douglasii* in the northeastern California oak woodlands. In this study we examined the drought resistance characteristics of *Q. wislizenii* seedlings by quantifying the components of tissue water relations, growth parameters and stomatal conditions. Drought stressed seedlings exhibited significant reductions in total, osmotic and turgor potentials as well as decreases in the turgor loss point within two weeks of drought. Ref.187\62.21.

Momen, B., J.W. Menke, J.M. Welker, K.J. Rice, and F.S. Chapin III. 1994. Blue oak regeneration and seedling water relations in four sites within a California oak savannah. *Internatl. J. Plant Sciences* 155: pp. 744-749.

Water relations of transplanted and naturally occurring blue-oak seedlings were studied to examine the effects of site differences with regard to the rates of progressing drought on the current lack of blue-oak establishment in California oak savannas. During the dry season, water status of transplanted seedlings was more favorable at a grazed open site where grass density was minimal but soil and atmospheric drought were most pronounced. In contrast, transplanted seedlings experienced the highest rates of water deficit and senesced earliest at grazed canopy and ungrazed canopy sites, and their water relations were similar at both sites. Naturally occurring seedlings were 3-4 yr. old, and thus their roots might have already extended to deeper soil layers where competition from grass roots was low. Ref.306/64.43.

Norberg, E., J.R. McBride, J. Bertenshaw, A. Mossadegh, and S. Kloss. In press. Ecotypes of Blue oak and their significance for regeneration. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar. 19-22, 1996.

Ecotypic differentiation in blue oak is being studied in common garden experiments at the Hopland and Sierra Nevada Field Station. The purpose of this work is to document ecotypic variation in the species and to relate its significances of these preliminary differences are discussed in terms of seedling establishment and the need for the establishment of seed transfer rules for blue oak. Ref.257/64.01.

Phillips, R.L., N.K. McDougald, and D.D. McCreary. 1995. Blue oak acorns more viable in Madera County than Kern County. *California Agriculture* 49(5): pp. 18-21.

Acorns from native blue oaks growing in Madera and Kern counties were evaluated for quality in this 2-year study. Acorns from Madera County were larger and more of their seedlings emerged from the soil and at a faster rate than acorns from Kern County. Insect infestation and disease in the acorns were not consistent during the study. Ref.287/64.23

Rice, K.J., D.R. Gordon, J.L. Hardison, and J.M. Welker. 1991. Intraspecific phenotypic variation and ecological genetics of blue oak (*Quercus douglasii* Hook. & Arn.). *USDA Forest Service Gen. Tech. Rep.* 126: pp. 59-63.

We examined potential variation in water use efficiency in both mature trees and seedlings of blue oak by measuring the carbon isotope composition of plant tissue collected from populations arrayed along a latitudinal rainfall gradient. Acorns from the mesic site were significantly smaller. While the probability of emergence increased with acorn size in the xeric population, there was no effect of acorn size on emergence in the mesic population. Further, leaf weight responded differently among families to variation in neighborhood composition, suggesting genetic variation for plasticity in leaf morphology. Ref.184/64.40.

Rice, K.J., D.R. Gordon, J.L. Hardison, and J.M. Welker. 1993. Phenotypic variation in seedlings of a "keystone" tree species (*Quercus douglasii*): the interactive effects of acorn source and competitive environment. *Oecologia* 96: pp. 537-547.

We used common garden techniques to examine how genetic variation at regional and local scales affected phenotypic expression in traits affecting oak seedling growth and survival. By varying the species composition of herbaceous neighborhoods into which acorns were planted, the interactive effects of competition and acorn germplasm source on phenotypic expression could also be examined. Probability of seedling emergence increased significantly with acorn size in the xeric population but not in the mesic population. Similarly, the effect of acorn size on seedling leaf area, stem weight, and root weight was also population dependent. Ref.305/64.42.

Rice, K., J. Richards, and S. Matzner. Patterns and process of adaptation in blue oak seedlings. In press. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar. 19-22, 1996.

A series of reciprocal transplant studies initiated at Hopland REC, the Sierra Foothill REC, and the San Joaquin Experimental Range have examined the relative contribution of genetic differentiation and phenotypic plasticity to observable intraspecific variation in blue oak seedling survival, growth and water-use efficiency (WUE). Differences among maternal families in survival and growth are also highly significant and varies among and within sites. This result is further indication of the potential importance of local adaptation in blue oak seedling survival and growth. Ref.261/64.01.

Singer, M.J., and R.A. Dalgren. In press. The role of oak trees in nutrient cycling. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar. 19-22, 1996.

Many oak woodland ecosystems are grazed and many are being cleared for oak firewood to enhance grazing. Nutrients removed from an ecosystem at rates greater than they can be made available by natural processes such as rock weathering, nitrogen fixation, and atmospheric deposition lead to decreased productivity of the ecosystem. In grassland

soils, nutrients leached below the shallow rooting zone of annual grasses are removed from the ecosystem into stream or ground waters. In contrast, the deeply rooted oak trees are able to capture the majority of the nutrients before they are lost from the ecosystem by leaching. Ref.262\64.01.

Singer, M.J., X. Huang, and C. Epifanio. 1990. Selective oak removal does not harm water quality. *California Agriculture* 44(2): pp. 17-18.

Measurements before and after removal of oaks from 14% of a 250-acre watershed indicated small but not statistically significant increases in the runoff/rainfall ratio and no change in nutrient or sediment removal. Careful, selective oak removal appeared to have no harmful effect on water quality. Ref.51\61.06.

Swiecki, T.J., E.A. Bernhardt, and C. Drake. 1994. Factors affecting blue oak sapling recruitment and regeneration. Report for Forest and Rangeland Resources Assessment Program (FRRAP), Calif. Dept. of Forestry and Fire Protection, Dec. 1993: p. 132.

We assessed the status of blue oak regeneration at the stand level and examined effects of environmental and management factors on sapling recruitment at 15 locations distributed throughout the range of blue oak. We used logistic regression to identify management, vegetation, and environmental variables associated with sapling recruitment. Several important conclusions about blue oak sapling recruitment and regeneration can be drawn from this study. These conclusions apply to the current status of regeneration and projections are based on a continuation of current management practices. Ref.173\62.10.

Swiecki, T.J., E.A. Bernhardt, and C. Drake. In press. Factors affecting blue oak sapling recruitment. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

We used logistic regression to identify environmental and management history factors associated with blue oak sapling recruitment for 15 locations distributed throughout the range of blue oak. We developed within-location logistic regression models for six locations, and between-location models and other ecological observations, we propose a conceptual model of blue oak regeneration. Ref.263\64.01.

Tecklin, J., M. Connor, and D. McCreary. In press. Rehabilitation of a blue oak restoration project. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

After attempting to restore blue oaks for two years on 4 acres of formerly oak woodland converted to annual grassland, seedling loss led to two remedial measures. The first effort was to replant acorns and seedlings onto the most unsuccessful planting spots and protect them with four foot plastic tree shelters. In the second remediation, one of 83 matched similar pairs throughout our original planting was retrofitted with a treeshelter, while the other was left unprotected. Our results indicate that failing restoration projects might be dramatically improved by relatively inexpensive means, and that performance of already site selected survivors on difficult sites can be enhanced by retrofitting with tree shelters. Ref.264\64.01

Tecklin, J., Connor, J.M., and McCreary, D.D. 2001. Rehabilitation of an oak planting project on cleared rangeland using tree shelters and grazing; a ten-year saga. USDA Forest Service Gen Tech Rep PSW-GTR-184. 2002: pg 838.

On a 2-hectare site at the Sierra Foothill Research and Extension Center near Marysville, California, 1,440 blue oaks (*Quercus douglassii*) were planted during 1990-91 in an attempt to re-vegetate an oak woodland that had been almost totally cleared for cattle grazing during the 1960's. This paper summarizes a poster that was presented at the Fifth Symposium on Oak Woodlands: Oaks in California's Changing Landscape, October 22-25, 2001, San Diego, California. 66.07

Tecklin, J., and D.D. McCreary. 1993. Dense vegetation may encourage vole damage in young oak plantings. *Restoration and Management Notes* 11(2): p. 153.

This study leads us to believe that increased vegetative cover creates favorable habitat for voles, especially during their periodic population peaks. Range managers have known for some time that intensive grazing reduces vole populations. Restoration of oaks on rangelands, however, has usually begun by fencing off the oaks from cattle or other grazers. This can introduce serious rodent problems. We suggest that grazing, along with adequate tree protection strategies, may play an important role in successful oak regeneration. Ref.286\64.46.

Welker, J.M., D.R. Gordon, and K.J. Rice. 1991. Capture and allocation of nitrogen by *Quercus douglasii* seedlings in competition with annual and perennial grasses. *Oecologia* 87: pp. 459-466.

The spatial overlap of woody plant root systems and that of annual or perennial grasses promotes competition for soil-derived resources. In this study we examined competition for soil nitrogen between blue oak seedlings and either the annual grass or the perennial grass under controlled outdoor conditions. Ref.157\62.19.

Willoughby, B.L. 1988. The effect of blue oak removal on herbaceous production. Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day. pp 22-24.

The effect of tree canopy (0 to 75%) on standing crop was significant for both non-cleared and cleared plots. However, this effect varied by season and was not significant at the beginning of the growing season. Tree canopy effect on standing crop was greater for cleared than non-cleared conditions. Even though there was a significant difference between cleared and non-cleared conditions, there is no significant difference between the three canopy levels on the cleared plots or the non-cleared plots. Ref.223\63.34.

Willoughby, B.L. 1993. Blue oak tree canopy effect on herbaceous forage production. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 31-32.

The objective of this trial is to evaluate differences in herbaceous forage production at four different oak canopy levels - 0, 25, 50, and 75% cover, in the Sierra foothills. The results from the first two years are not conclusive. The 1991 production in all plots except 0% canopy were about one half of the 1992 production which had about average rain fall. The 0% canopy (open space) was about the same yield each year. In 1992 there was about 150 lbs. per acre yield decrease going from the 25% canopy to the 50% to 75%. The 0% canopy was about half way between the 50% and 75% plots or about 200 lbs. per acre less than the 25% canopy cover. These differences are for all four replications. Ref.172\61.49.

Watershed Management/Water Quality

Allen-Diaz, B., Jackson, R.D., and Spencer, M. 1998. Grazing effects on California's oak woodland springs and creeks. 51st Annual Meeting, Society for Range Management, Guadalajara, February 8-12, 1998, Jalisco Mexico. p 2.

Three watersheds at SFREC were studied between 1992 and 1997 to determine the effects of cattle grazing on the vegetation of cold water springs and creeks. Results showed that grazing usually did not change plant community type over time. Although commonly measured variables: species, cover, richness and diversity vary considerably over time with changes in grazing pressure, no threshold was crossed which resulted in a change of community state during the study. This result suggests that spring and creek communities are stable relative to grazing, although classical variables may be more sensitive to detection of grazing impacts and may provide clues to potential lags in ecosystem response to grazing. 65.11

Allen-Diaz, B.H., and Jackson, R.D. 2000. Grazing effects on spring ecosystem vegetation of California's hardwood rangelands. *J. Range Manage.* 53(2): pp. 215-220.

Three spring-creek systems at SFREC from each of the 3 watersheds were randomly assigned to grazing treatments (9 total). Treatments were ungrazed, lightly grazed, and moderately grazed based on degree of use in upland pastures encircling the spring-creek systems. Grazing intensity did not affect total herbaceous cover at spring fed creeks. A year x grazing treatment interaction ($P < 0.05$) was detected for total herbaceous cover at spring-fed creeks. Three years after grazing removal, total herbaceous cover on ungrazed creek plots surpassed cover at moderately grazed and lightly grazed plots. Moderately grazed plot herbaceous cover declined steadily throughout the first 3 years, while lightly grazed plots cover remained relatively stable. With few exceptions, stable plant communities persisted on sites regardless of grazing intensity or cover changes. Total herbaceous cover was sensitive to interannual fluctuations, especially under increased grazing intensities. This attribute renders cover a more useful gauge of ecosystem health than plant composition as the latter may not provide evidence of potentially deleterious grazing x climate interactions until after soil erosion or water table characteristics are seriously, perhaps permanently, altered. 65.14

Atwill, R. 1995. Assessing the risk of surface water contamination of *Cryptosporidium parvum* from beef cattle production: implications for land use restrictions. Proc., UC Sierra Foothill REC Beef and Range Field Day: pp. 15-17.

The critical issue is how would *Cryptosporidium parvum* from calves gain access to surface waters and end up in drinking water supplies. The essential steps must include calves becoming infected and shedding the oocysts in their feces. These oocysts must then enter a surface water supply and remain infective as they journey downstream to water treatment plants and distribution systems. The scientific evidence supporting the claim that cattle are a significant source of *C. parvum* for surface water is incomplete and contradictory in some cases. It is premature at this time to claim that cattle production is a leading source of *C. parvum* in surface water. Ref.239\63.51.

Connor, J. M., and M. Joyce. In press. A model nonpoint source management plan for hardwood rangeland. Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues. San Luis Obispo, CA., Mar. 19-22, 1996.

The state water resources control board has adopted and is beginning to implement the California rangeland water quality management plan (CRWQMP). This plan was initiated by the state's livestock grazing industry as a proactive means for addressing Federal clean water act water quality requirements for California's rangelands. We developed a plan for management of the hardwood rangeland. It's objectives are to guide resource use at the Center and to serve as a practical example for grazing land managers as they write their own plans as suggested by the CRWQM plan. Ref.255\64.01.

Connor, M., and M. Joyce. 1995a. An example of a rangeland NPS management plan. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 18-26.

A rangeland management plan was developed for SFREC which can serve as a model plan for management of non-point source (NPS) water pollution. Plan steps include assessment of the resource (including any pollution sources); selection of practical management alternatives which will achieve the goals; and monitoring to determine whether management activities are effective. Ref.240\63.52.

Connor, M., and M. Joyce. 1995b. Problem assessment on rangeland watersheds. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 36-38.

In order to develop a rangeland management plan, any existing problems have to be identified. It is important to realize that many existing management methods are effectively reducing water pollution. These methods may already adequately meet many Water Quality Control Board requirements, especially if local water bodies are not impaired. There also may be some simple and relatively inexpensive management procedures that can be adopted that can substantially reduce water pollution from a rangeland watershed. Ref.243\63.55.

Davidson, E.A., and M.K. Firestone. 1988. Measurement of nitrous oxide dissolved in soil solution. *Soil Sci. Soc. Am. J* 52: pp. 1201-1203.

Degassing of soil solution as soil water enters springs and streams may be a significant pathway of N₂O release into the atmosphere. A simple method is presented to sample soil solution to include gases dissolved in solution. Small porous cup lysimeters connected to narrow diameter nylon tubing were flushed with N₂ gas; a vacuum was applied with an evacuated serum bottle; and solution and gases were captured in the bottle. Concentrations of N₂O in soil solution of a grassland in central California varied from below ambient to 13 times ambient. At a wet riparian zone site, N₂O in soil solution appeared to be related to NO₃⁻ concentration, which can be determined from the same soil solution sample. Ref.301\64.37.

Diaz, B.A., E. Hammerling, and C. Campbell. 1997. Comparisons of standard water quality sampling with simpler procedures. 1997. *J. Soil and Water Cons.* 53(1): pp. 42-45.

Unfiltered water samples were collected at Sierra Foothill Research and Extension Center to determine whether different holding times and storage methods affected nutrient concentrations. Replicate samples were analyzed within 24 hours per EPA standards, or treated with six different combinations of refrigeration and storage times. Despite federal standards, we found that holding times up to one month and preservation methods including a one-week period at room temperature have no significant effect on chemical parameters measured. Ref.313\64.53

Diaz, B.H., Jackson, R.D., and Fehmi, J.S. 1998. Detecting channel morphology change in California's hardwood rangeland spring ecosystems. *J. Range Manage.* 51(5): pp. 514-518.

Permanent channel cross-sectional transects perpendicular to flow were used to estimate changes in spring and resultant creek channel morphology. Three cattle grazing treatments (none, light and moderate) were applied to 2-5 pastures containing a perennial spring or resultant creek cohort for 5 years. Grazing effects on the total change in channel morphology were not detected, nor did our method detect channel morphology change over the 5 year study period. Ungrazed creeks and streams were observed to change more than grazed springs and creeks although these differences were not statistically significant. Observed but not significant, change over time appears related to rainfall patterns. Permanent channel cross-sections, one of the currently recommended methods for monitoring livestock grazing impacts on stream channels, may not be adequate for detecting channel changes in low-flow spring/creek systems. 65.13

Drake, D.J., E.R. Atwill, J.M. Connor, and D. Jones. 1997. Prevalence of *Cryptosporidia Parvum*, *Giardia Duodenalis*, and *Campylobacter Jejuni* in beef calves and impacts on preweaning gain and weaning weight. *Proc. Western Section, American Society of Animal Science* 48: p. 4.

Three herds of crossbred beef calves were tested for fecal shedding of *Campylobacter jejuni* and protozoal eggs from *Cryptosporidia parvum* and *Giardia duodenalis*. Impact on preweaning ADG and adjusted weaning weight was determined. Fecal grab samples were randomly obtained from calves at 2-3 months of age and again at weaning. Calves were identified as positive(+) or negative(-) for each parasite. Ref. 326A\65.07

Epifanio, C.R. 1989. Hydrologic impacts of blue oak harvesting and evaluation of the modified USLE in the northern Sierra Nevada. M. S. Thesis, Univ. of Calif., Davis. 144 pages.

The original objective of this project was the determination of the impacts of vegetation-type conversion and other range management techniques on water yield and water quality from a rangeland watershed. Six years data for rainfall, runoff and sediment yield for two watersheds, S1 and S2, have been reduced, tabulated, placed into a computer database and statistically analyzed. The watersheds were found to be sensitive to rain intensity and amount. Runoff tends to increase linearly with rainfall. In view of the fact that the SCS tolerable annual soil loss limits for the SFRFS are 5 tons per acre per year, none of the watersheds posed serious erosion problems during the study period. Ref.137\62.27.

Epifanio, C., and M.J. Singer. 1987. Water quality and nutrient aspects of annual rangeland as influenced by range improvement. *Proc., UC Sierra Foothill Range Field Station Beef and Range Field Day.* pp. 48-55.

We have found that sediment and nutrient losses tend to be small for both watersheds studied in the Schubert area. The careful removal of oaks, according to the methods prescribed by the field station, did not have an effect on either runoff or water quality. However, we do not have sufficient data to come to any conclusions about the impact of vegetation removal on sediment yield. Additional years of data will be collected to determine, more conclusively, if type conversion has an effect on water quality. Studies of this kind are, of necessity, long term because of the highly variable precipitation and responses to precipitation. Ref.219\63.30.

Epifanio, C.R., M.J. Singer, and X. Huang. 1991. Hydrologic impacts of oak harvesting and evaluation of the modified universal soil loss equation. Proc., Symp. on Oak Woodlands and Hardwoods Rangeland Mgmt., USFS Tech. Rep. PSW-126 : pp. 221-224.

Two Sierra foothill watersheds were monitored to learn what effects selective oak removal would have on watershed hydrology and water quality. We also used the data to generate sediment rating curves and evaluate the modified universal soil loss equation (MUSLE). Annual sediment rating curves better accounted for the variability in precipitation events from year to year, which may be at least as important as total rainfall, on the amount of runoff and sediment yield. The MUSLE predicted quite accurately when calibrated for these watersheds. Ref.151\61.43.

George, M., and J. Clawson. 1993. Rangeland water quality. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 17-23.

Before 1960, water pollution emphasized control of "point sources"--sewer pipes or industrial waste outlets--where a single discharge point could be identified and corrective action taken to reduce the pollutant load to surface water or groundwater. In recent years increased attention has been focused on "nonpoint" sources of pollution--sources that are diverse and often difficult to identify and control and that may combine to impair water quality. Contributions from nonpoint sources are unavoidable--the natural leaching of chemicals from weathering soils or the fecal coliform bacteria added by wild animal populations. Ref.169\61.49.

Gerlach Jr., J.D. 2003. The impacts of serial land-use changes and biological invasions on soil water resources in California, USA. *J. Arid Environments*: pp. 1-15.

Land-use changes and biological invasions have converted the vegetation of California's Central Valley and surrounding foothills from a mixture perennial forbs and grasses and spring- and summer- flowering annual to vegetation dominated by Eurasian spring-flowering annual thistle that has caused losses of soil moisture resources on invaded sites of 15-25% of mean annual precipitation. A rough preliminary estimate indicates that the value of the lost water may range from 16-75 million dollars per year in the Sacramento River watershed alone. 66.06

Jackson, R.D., and Allen-Diaz, B.H. 2001. Nitrogen dynamics of spring-fed wetland ecosystems of the Sierra Nevada foothills oak woodland. USDA Forest Service Gen Tech Rep PSW-GTR-184. 2002: pp. 119-128

Spring-fed wetlands are small, highly productive, patchy ecosystems nested within the oak woodland/annual grassland matrix of the Sierra Nevada foothills. Seasonal variation in nitrogen cycling parameters are described at the Sierra Foothill Research and Extension Center located at Browns Valley, CA. An abbreviated version of this paper was presented at the Fifth Symposium on Oak Woodlands: Oaks in California's Changing Landscape, October 22-25, 2001, San Diego, California. 66.08

Lewis, D. 1999. Water quality and yield in a California oak woodland watershed: A 17 year study. M.S. Thesis, Univ. of Calif., Davis: p. 110.

Collection and analysis of hydrologic and water chemistry data were performed for 17 years to develop a water balance and calculate nutrient fluxes in a 103 ha oak woodland watershed in the Sierra Nevada foothills of Northern California. This study fills a gap for such information about California oak woodlands and complements other studies from other Mediterranean regions. In addition, analysis of mean monthly $\text{NO}_3\text{-N}$ and suspended solid runoff concentrations provide preliminary water quality data. Ref.327A\65.08.

Lewis, D., Singer, M.J., Dahlgren, R.A., and Tate, K.W. 2000. Hydrology in a California oak woodland watershed; a 17-year study. *J. of Hydrology* 240 (2000): pp. 106-117.

The western foothills of the Sierra Nevada are some of the most rapidly developing lands in California. Use of these lands includes vineyards, retirement and family home construction, livestock grazing, and fuelwood harvesting. These many uses require varying levels of hardwood conversion and oak tree removal that alters the nutrient cycling, wildlife habitat, and hydrology of these watersheds. There is little long term hydrologic data to help determine the impact of these land use changes on water yield or quality. To fill this gap, precipitation and stream flow data were collected for 17 years in a 103 ha California oak woodland watershed, from which oaks were removed from 14% of the land area. 65.21

Lewis, D., Singer, M.J., Tate, and K.W. 2000. Applicability of SCS curve number method for a California oak woodlands watershed. *J. Soil and Water Cons.* 55 (2): pp. 226-230.

The curve number (CN) method developed by the now NRCS for predicting peak runoff from watersheds has not been extensively tested in western regions of the United States. We used a 17 year rainfall and runoff record from a California Oak woodland watershed to compare the accuracy of CN as prescribed in the SCS National Engineering Handbook (NEH-4) with two alternative methods. Each method predicted mean annual peak runoff that was not

significantly different from observed runoff, and correlation between estimated and observed runoff from each of the three methods were statistically significant. However, the highest correlation coefficient showed that only 50% of the variability in the data was accounted for by any of the methods. The NEH-4 method underpredicted maximum flows for the highest flow years. The more conservative Hjelmfelt method more frequently over predicted peak flow. Overprediction provides a measure of safety when using the CN technique. 65.15

McCreary, D.D. 1995. Riparian restoration study. Proc., UC Sierra Foothill REC Beef and Range Field Day. pp. 34-35.

This project was initiated to begin testing several approaches for restoring woody vegetation to areas near a perennial stream at the Sierra Foothill REC that were cleared of woody vegetation approximately 25 years ago. Another principal goal of this project was to develop a demonstration area for conducting field tours for land owners and managers, as well as for the general public, to show people how various riparian restoration approaches work, what kind of growth can be expected from plantings, and what changes in wildlife habitat and stream morphology are likely to result. We will continue to closely monitor this project; no conclusion is available at this time. Ref.242\63.54.

Munn, J.R., Jr., and G.L. Huntington. 1976. A portable rainfall simulator for erodibility and infiltration measurements on rugged terrain. Soil Sci. Soc. Am. J. 40: pp. 622-624.

A portable rainfall simulator for field study of erosion potential and infiltration on mountainous terrain is described. Polyethylene tubes produce 3.2 mm drops which fall 2.5 m onto a 61 by 61 cm plot. The maximum rainfall intensity is 23 cm/hour. A 16% intensity variation across the plot area was measured, but the variation between separate simulated storms was <1% for identical intensity settings. The unit is suited to one man operation on slopes up to 60%. Ref.90\61.64.

Pereira, M., E.R. Atwill, M.R. Crawford, and R.B. Lefebvre. 1998. DNA sequence similarity between California isolates of *Cryptosporidium parvum*. Applied and Environmental Microbiology 64(4): p.14

We evaluated whether nucleic acid amplification using primers specific for *C. parvum* followed by automated DNA sequence analysis of the PCR amplicons could differentiate between California isolates of *Cryptosporidium parvum* obtained from livestock, human, and feral pigs. Almost complete sequence identity existed among the livestock isolates and between the livestock and human isolates. DNA sequences from feral pig isolates differed from livestock and human by 1.0 - 1.2%. The reference sequence obtained by Laxer et al (8) differed from the California isolates of *C.parvum* by 1.8 - 3.2%. These data suggest that DNA sequence of the Laxer amplicon does not allow for differentiation between various strains of *C.parvum* or that our collection of isolates obtained from various hosts from across California were to one strain of *C.parvum*. Ref.325A\65.06.

Singer, M.J., J. Blackard, and G.L. Huntington. 1980. Plant cover helps control rangeland erosion. California Agriculture 34(10): pp. 8-10.

Soil erosion by water is a two-part process. First, the impact of raindrops detaches soil particles from the main mass of soil. Then, water flowing over the soil surface transports this loose soil from the site of detachment. Proper range management can prevent large erosion losses by ensuring that an adequate plant cover exists during the rainy season. This means that grazing pressure must be controlled and that type conversion practices such as mechanical brush removal, burning, and cultivation need to be timed so that the soil is not bare during the rainy periods of the year. Further research is needed to quantify the relationship between soil chemical properties and erodibility. Ref.100\63.70.

Singer, M.J., X. Huang, and C. Epifanio. 1990. Selective oak removal does not harm water quality. California Agriculture 44(2): pp. 17-18.

Measurements before and after removal of oaks from 14% of a 250-acre watershed indicated small but not statistically significant increases in the runoff/rainfall ratio and no change in nutrient or sediment removal. Careful, selective oak removal appeared to have no harmful effect on water quality. Ref.51\61.06.

Singer, M.J., Y. Matsuda, and J. Blackard. 1981. Effect of mulch rate on soil loss by raindrop splash. Soil Sci. Soc. Am.J 45: pp. 107-110.

The effect oat straw has on splash detachment and soil transport was quantified on Auburn clay loam using 50 rainfall simulator events. Raindrops with 3.2 mm diameters were applied from a height of 2.5 m to 30 cm X 30 cm plots at an intensity of 76 mm/hour for 30 minutes. The slope was 9%. There was a linear correlation between the amount of straw cover and the decrease in the amount of soil moved. The amount of interrill flow of water did not decrease, indicating that the reduction in soil loss by interrill flow was actually due to the reduced rain splash detachment. Ref.269\64.05.

Tate, K.W. 2001. Wildfire Impacts on Water Quality. Proc., UC Sierra Foothill REC Beef and Range Field Day, April 19, 2001.

Our sampling was not a designed experiment; rather it was opportunistic sampling to quantify water quality from the TT watershed following wildfire for comparison to water quality data from other watersheds in the area. To provide some perspective on the water quality data collected from TT following the fire, we compare this data to that from 3 small, un-burned rangeland watersheds located within 5 miles of the TT watershed on SFREC. Over 100 water samples were collected each year on each watershed reported in this paper. Significantly higher turbidity readings were realized on the TT watershed compared to all three SFREC watersheds. The high suspended sediment and turbidity at TT compared to SFREC indicates that accelerated erosion and significant transport of ash likely occurred during both years following the fire. The levels of NO₃ and NH₄ in TT stream flow are not remarkable when compared with other rangeland watersheds. 66.13

Tate, K.W., Dahlgren, R., Singer, M.J., Allen-Diaz, B., and Atwill, E.R. 2000. Temporal water quality variability on California rangeland watersheds: Implications for monitoring. 53rd Annual Meeting, Society for Range Management, February 13-18, 2000, Boise, Idaho, 53: pp 40.

Successful water quality monitoring and standards establishment must account for the inherent variability and pattern of nonpoint source pollution transport at several temporal scales. The timing and frequency of sampling from the storm to the annual time scale must be accounted for to develop and achieve effective water quality monitoring for any objective. 65.12

Tate, K.W., Dahlgren, R.A., Singer, M. J., Allen-Diaz, B., and Atwill, E. R. 1999. Timing and frequency of sampling affect accuracy of water-quality monitoring. California Agriculture 53 (6): pp. 44-48.

Monitoring water quality is a major issue on California's rangeland watersheds, and there is limited published data to guide these efforts. We used stream-flow and water-quality data from experimental rangeland watersheds to demonstrate the temporal variability of water quality at the storm, season and annual time scales. The timing and frequency of water sampling from the storm to the annual time scale play an extremely significant role in watershed quality monitoring. Our studies conducted in Northern California suggest that a minimum sampling strategy should include sampling before, during and after storms. Samples must be collected over a period of several years to account for variability among years. 65.10

Tate, K.W., Nader, G.A., Lewis, E.R., and Connor, J.M. 2000. Evaluation of buffers to improve the quality of runoff from irrigated pastures. J. Soil and Water Cons. 55(4): pp 473-478.

Non grazed, vegetated buffer strips are often recommended as best management practices to protect waterbodies from sediments and nutrients in runoff from grazed pastures. The objectives of this study were to characterize levels of nitrate/nitrogen (NO₃), total phosphorus (Total P), and total suspended solids (TSS) in runoff and evaluate the potential water quality improvements from 10m buffer strips on irrigated Sierra Nevada foothill pastures. We found that 15% and 69% of irrigation water applied to sprinkler and flood irrigated pastures became runoff, respectively. There were distinct temporal patterns of constituent concentration in runoff during irrigation events having ramifications for effective water quality monitoring and study design. The 10m buffer did not significantly reduce concentrations and loads of NO₃-N in runoff from sprinkler and flood irrigated pastures. The buffer also failed to reduce Total P concentration under either irrigation schemes, or Total P and TSS load under flood irrigation, and Total P load under flood irrigation. These results reflect the effectiveness of buffers during the first year following buffer establishment. Improved irrigation efficiency to reduce runoff generation is perhaps the most readily acceptable and practical first step for reducing the potential for negative water quality impacts from these systems. 65.16

Wildlife

- Aigner, P.A. 1996. Effects of firewood harvesting on avian abundance and guild structure in a California oak-pine woodland. M.S. Thesis, Northern Arizona University. 117 pages.

This thesis studies the impact of firewood harvesting on the breeding-season bird community in an oak-pine woodland in the foothills of the northern Sierra Nevadas, California, with particular focus on the foraging behavior of species in the foliage-gleaning insectivorous guild. Objectives were to measure population trends of all species after an experimental firewood harvest, and to use concomitant changes in food abundance to assess the importance of interspecific competition for food in structuring the foliage-gleaning guild. Results are consistent with the hypothesis that competition is less likely to be important in structuring communities in variable environments. Ref.268\64.04.

- Aigner, P.A., W.M. Block, and M.L. Morrison. 1997. 1997. Effect of firewood harvesting on birds in a California Oak-Pine woodland. *Journal of Wildlife Mgt.* 62(2): pp. 485-496.

Little is known about the effects of firewood harvesting on wildlife in oak-pine woodlands. We studied the effect of firewood harvesting on population trends of birds during the breeding season in the foothills of the northern Sierra Nevada. We detected population shifts in 14 species (7 year round residents, 4 breeding migrants, 1 migrant, 2 winter residents). Our results indicate that small-scale firewood harvests have minimal negative short-term effects on most of the more common bird species present during the breeding season, but we caution that effects on uncommon species may have gone undetected. Ref.174\64.50.

- Aigner, P.A., J. Tecklin, and C.E. Koehler. 1995. Probable breeding population of the black rail in Yuba County, California. *Western Birds* 26: pp. 157-160.

We report the discovery of a probable breeding population of black rails in two marshes along tributaries of Dry Creek at the University of California Sierra Foothill Research and Extension Center about 24km east of Marysville in the foothills of the Sierra Nevada, Yuba County, and subsequent detections of black rails on two other tributaries of Dry Creek. Ref.237\63.49.

- Aigner, P.A., W.M. Block, and M.L. Morrison. Design recommendations for point counts of birds in California oak-pine woodlands: power, sample size, and count stations versus visits. In press. *Proc., Symp. on Oak Woodlands: Ecology, Management, and Urban Interface Issues*. San Luis Obispo, CA., Mar. 19-22, 1996.

Point count data was used from a 3-year experimental study of the impact of firewood cutting on an oak woodland bird community to make specific recommendations about sampling design and sample sizes necessary to detect environmental impacts on bird density. Optimal allocation and sample size varied depending on the species, parameter of interest, and statistical hypothesis test. Our results can be used to plan future studies when objectives and parameters of interest are clearly defined. Ref.250\64.01.

- Aigner, P.A., W.M. Block, and M.L. Morrison. 1997. 1997. Effect of firewood harvesting on birds in a California Oak-Pine woodland. *Journal of Wildlife Mgt.* 62(2): pp. 485-496.

Little is known about the effects of firewood harvesting on wildlife in oak-pine woodlands. We studied the effect of firewood harvesting on population trends of birds during the breeding season in the foothills of the northern Sierra Nevada. We detected population shifts in 14 species (7 year round residents, 4 breeding migrants, 1 migrant, 2 winter residents). Our results indicate that small-scale firewood harvests have minimal negative short-term effects on most of the more common bird species present during the breeding season, but we caution that effects on uncommon species may have gone undetected. Ref.174\64.50.

- Anderson, J.R., and R.W. Merritt. 1977. The impacts of foraging meadowlarks, *Sturnella neglecta*, on the degradation of cattle dung pads. *J. Applied Ecol.* 14: pp. 355-362.

In 110 hours of observations over four years only the western meadowlark was seen foraging in cattle dung pads. Field examination of dung pads with and without undigested barley seeds (the former from cattle provided a supplemental autumn-winter ration of cottonseed meal and barley), and gizzards of twelve meadow-larks killed during winter, showed that they were foraging in pads for barley seeds, not insects. This appears to be the first report of a bird species utilizing cattle dung pads in pastures as an autumn-winter food source for seeds. Ref.91\63.59.

Block, W.M. 1989. Spatial and temporal patterns of resource use by birds in California oak woodlands. Ph.D. Thesis, Univ. of Calif., Berkeley. 364 pages.

This study concentrated on populations, foraging ecologies, and habitats of birds found at three oak-woodland study areas in California. Data was collected from three breeding and two nonbreeding seasons from 1986 through 1988. Spatial and temporal patterns were examined and investigated. The conclusion is that many species found in oak woodlands have morphological and behavioral traits that allow them to exploit a changing environment. Thus, management of oak woodland birds must be based on detailed information collected across a wide-range of environmental conditions representative of those occurring in oak woodlands. Ref.140\63.84.

Block, W.M., and M.L. Morrison. 1987. Conceptual framework and ecological considerations for the study of birds in oak woodlands. Proc., Symp. Multiple-use Mgmt. of Calif. Hardwood Res. USDA Forest Service Tech. Rep. PSW-100 : pp. 163-173.

The distributions and abundances of birds within oak woodland communities of California are the results of geologic events leading to the formation of the Mediterranean-type ecosystem, and of more recent anthropogenic impacts that have altered the landscape. The principal objective of this framework is to outline aspects of bird biology, ecology and behavior that must be addressed before assessments of habitat quality can be made. Collection of all of these data requires extensive field work to determine temporal and spatial patterns of habitat and resource use. There are no shortcuts for obtaining this information. Ref.122\63.60.

Block, W.M., and M.L. Morrison. 1990. Wildlife diversity of the central Sierra foothills. California Agriculture 44(2): pp. 19-22.

A 3-year study of wildlife-habitat relationships in the oak woodlands of California's Sierra foothills found a wide range of species. This was directly related to the diversity of habitats provided by oak woodlands. We found a wide variety of wildlife, much of which was directly attributable to the vegetative diversity of the central Sierra foothills. No oak woodland at the Sierra Foothill Range Field Station goes unused by wildlife. In the management of oak woodlands, a rich diversity of wildlife can only be ensured by maintenance of the diversity of habitats. Ref.61\61.16.

Block, W.M., M.L. Morrison, J.C. Slaymaker, and G. Jongejan. 1988. Design consideration for the study of amphibians, reptiles, and small mammals in California's oak woodlands: temporal and spatial patterns. In: Management of amphibians, reptiles and small mammals in North America. USDA Forest Service Gen. Tech. Rep. RM-166. pp. 247-253.

Using pitfall traps to sample amphibian, reptile, and small mammal populations, we found pronounced variation within and among study areas, and within and between years in capture rates of all taxa and of many of the species studied. Implications of these results apply both to the design of studies for these animals as well as for their management. Each oak-woodland type contains a unique set of factors that predispose species to use the area for some aspect of their life histories. Management for a species should be based on information that considers the spatial and temporal variability in habitat use to provide for all life requisites. Ref.126\63.78.

Block, W.M., M.L. Morrison, and J. Verner. 1990. Wildlife and oak-woodland interdependency. Fremontia 18: pp. 72-76.

Management of wildlife in oak woodlands requires an ecosystem approach. Oak woodlands consist not only of trees, but also of shrubs, leaf litter, grasses, forbs, downed woody debris, and countless other biotic and abiotic components. These components are interrelated; thus, alteration of one will affect the others. Management must be based on accurate information that details the ecologies of all animals found there and also predicts effects of environmental change on their populations. Ref.141\61.44.

Daly, H.V., K. Hoelmer, and P. Gambino. 1991. Clinal geographic variation in feral honey bees in California, USA. Apidologie 22: pp. 591-609.

Feral honey bees in California are mongrel populations, partially differentiated in morphometrics from managed colonies as well as from European subspecies. Most morphometric variables had low but significant correlations with environmental factors and clinal patterns of spatial autocorrelation with distance. Some measurements of body size exhibited Bergmann's Rule, but the hind legs did not exhibit Allen's Rule. The geographic variation is presumably adaptive and has developed within 138 years in the presence of a large, mobile beekeeping industry. Ref.38\60.20.

Gambino, P., K. Hoelmer, and H.V. Daly. 1990. Nest sites of feral honey bees in California, USA. Apidologie 21: pp. 35-45.

Nest site characteristics are described for 94 honey bee nests in trees, 17 in the ground, and 82 in man-made structures. Nests were in trees of mean diameter 85 cm primarily in live hardwoods, especially oaks. Entrances were mostly single knots or cracks in the main trunk at ground level and up to a mean height of 2.5 m. Most nests in the ground were in treeless areas; half had partially exposed combs, possibly aiding ventilation. Nests in buildings differed from those in trees by having smaller entrances. Compass orientation of comb in natural nest sites was commonly from 145-195 degrees. Ref.34\60.19.

Gorenzel, P., S. Mastrup, and T. Nguyen. 1988. California quail life history calendar. *Outdoor California* (Mar-Apr.): pp. 13-16.

The events described in this natural history calendar are based on more than 2,000 hours of observation since 1981 at the University of California Sierra Foothill Range Field Station in the foothills east of Marysville, Yuba County. The calendar applies best to California quail in the foothills of the central to northern Sierra Nevada. The timing of events at a given location can vary from year to year, depending on rainfall and temperature patterns. The events we describe could occur as much as a month earlier in the more arid southern portions of California and up to a month later in the cooler, more northern portions of quail range. Ref.129\63.62.

Gorenzel, W.P., R.H. Schmidt, and G.A. Giusti. 1993. Want to help wildlife? Start a nest box trail! *Outdoor California* (Jan-Feb): pp. 11-16.

A nest box trail is simply a number of nest boxes, or bird houses, set up at regular, spaced distances from one another. A nest box trail can consist of just a few to hundreds of boxes. The number is limited only by the amount of resources and time you want to commit. Nest boxes can be purchased, but most people build their own. After the boxes are put up, they are inspected periodically through the nesting season to check on the birds. When nesting is finished, the boxes must be cleaned and readied for next year. The rewards of such an undertaking can be significant in many different ways...woodworker, bird watcher, and a person concerned with environmental awareness. Ref.103\64.00.

Lott, D.F., and S. Mastrup. 1985. Dominance relations and the California quail. *Covey Rise* 4: pp. 1-4.

There are usually twenty to twenty-five million California quail in California each year. About two million are harvested. Our research was designed to learn more about California quail sociality, and its relationship to individual reproductive success and to population dynamics. In particular, we wanted to learn about dominance relationships and their effect on feeding behavior and on the number of young an individual produced. We found that all adult males and some young-of-the-year males formed a dominance hierarchy in the winter covey. The rest of the young males, and all of the females, rarely interacted aggressively. The dominance status of males proved to be important: only the highest ranking males got mates in the spring. Ref.111\61.65.

Manweiler, S.A., R.S. Lane, W.M. Block, and M.L. Morrison. 1990. Survey of birds and lizards for ixodid ticks (Acari) and spirochetal infection in northern California. *J. Medical Entomol.* 27: pp. 1011-1015.

A total of 138 birds (24 species) was captured in an oak woodland between December 1988 and June 1989 at the UC Sierra Foothill Range Field Station. Ticks were not found on 71 birds captured between December 1988 and March 1989. Five subadult *Ixodes pacificus* (Cooley & Kohls) were removed from 3 of 67 birds caught between April and June 1989. These three birds, an orange-crowned warbler, a lazuli bunting, and a chipping sparrow, represent new host records for *I. pacificus* in California. Tissues from two ticks and thick blood films prepared from 126 birds tested negative for spirochetes by direct immunofluorescence (DI). Ref.36\60.05.

Mastrup, S.A.N. 1986. Dominance relations and reproduction success in California quail. M.S. Thesis, Univ. of Calif., Davis. 92 pages.

The California quail is a very social animal which at times will form cooperative groups to raise its young. All adult members of both communal brood groups in the study population shared the various brood care duties. Due to either the excellent breeding conditions, or the communal brood care, or both, the survival rate of the young was the highest ever recorded for this quail. This cooperative behavior could have evolved by either inclusive fitness (kinship), or by individual selection via reciprocity. However, until further research is done on the kinship ties (if any) of the participants, our understanding of this system will remain clouded. Ref.115\63.83.

Miscellaneous

Allardice, W.R., R.A. Dahlgren, and M.J. Singer. 1990. Mineralogy and weathering processes in basic metavolcanic "greenstone" in the Sierra Foothill region of Northern California. Amer. Soc. Agron. Annual Meet., San Antonio, TX (Abstr.). p. 459.

Weathering processes were examined in Typic Haploxeralfs formed in upper Jurassic basic metavolcanic greenstone. The objective of our study was to examine the role of weathering processes and soil mineralogy as it pertains to nutrient cycling. Results indicate a weathering sequence of primary chlorite --> vermiculite-chlorite intergrade --> vermiculite and smectite. In the upper soil horizons, the vermiculite appears to be transformed to mica by K enrichment associated with biocycling. In contrast, in the lower portion of the profile where K levels are low, vermiculite weathers to smectite. Ref.139\63.58.

Anderson, J.R., and E.C. Loomis. 1978. Exotic dung beetles in pasture and rangeland ecosystems. California Agriculture 32(2): pp. 31-32.

Because exotic dung beetles rapidly bury cattle dung pads and thereby reduce pest fly breeding sites, they are expected to represent a permanent, self-perpetuating type of pest management. Field releases have shown that three species have successfully overwintered in different parts of the state. Systemic insecticides provided in cattle rations render cattle dung toxic to both native and exotic dung beetles. Ref.47\61.02.

Anderson, J.R., R.W. Merritt, and E.C. Loomis. 1984. The insect-free cattle dropping and its relationship to increased dung fouling of rangeland pastures. J. Econ. Entomol. 77: pp. 133-141.

Natural and experimentally formed dung pads dropped on range in May and early June totally smothered covered forage during the first year. However, the invasion and feeding activity of hundreds of *Aphodius fimetarius* (L.) adults in many such pads, plus annual fall rains, resulted in 70 to 80% decomposition of the pads during the next growing season. Other factors assessed, evaluated, and reviewed were different types of bioassays for assessing dung pad degradation, factors affecting the process and rate of degradation, and the adverse economic impact associated with dung pad fouling, plus the rejection of associated rank growth of forage. Ref.29\57.37.

Bonner, K., and G. Brackley. 1974. Basic inventory of vegetation and soils in the Sierra Foothill Range Station Scott 13 - Scott 14 complex. Term Report for RM 199 Winter Quarter. 29 pages.

This study was conducted during the winter quarter of 1974. Soil depth sampling was accomplished between February 28, and March 12, 1974. Ref.146\63.92.

Kaya, H.K., and R.D. Moon. 1978. The nematode *Heterotylenchus autumnalis* and face fly *Musca autumnalis*: a field study in northern California. J. Nematol. 10: pp. 331-341.

Heterotylenchus autumnalis was found in six northern California counties surveyed, and the incidence of nematode infection of face flies ranged from 4.7 to 43.8%. Intensive studies at a cattle ranch in Yuba County showed that population densities of the host and nematode infections were highest in flies from cow pats receiving full sun. Average host population density was 105.7 puparia per pat, and nematode infection averaged 38.6%. Pats in partial sun averaged 13.5 puparia and 13.1% nematode infection. No face fly was recovered from shaded pats. Ref.95\61.62.

Kaya, H.K., R.D. Moon, and P.L. Witt. 1979. Influence of the nematode *Heterotylenchus autumnalis* on the behavior of face fly *Musca autumnalis*. Environ. Entomol. 8: pp. 537-540.

Face flies of both sexes infected with the nematode, visited the faces of cattle and fresh cattle dung. However, female flies greatly outnumbered males at both sources. Generally, infected male flies found on cattle and dung contained young nematodes. In contrast, infected females on cattle contained nematodes of all ages, and most infected females from dung contained older nematodes. The propensity of healthy female flies to visit faces of cattle and dung depended on their gonadotrophic age. The majority of flies with immature eggs were found on cattle while the majority with mature eggs were found on dung. Ref.96\61.63.

Kouakou, B. 1991. Fate of urushiol (poison oak toxicant) when consumed by dairy goats. M. S. Thesis, Univ. of Calif., Davis. 42 pages.

This study attempts to determine if urushiol and/or its metabolites would be found in the milk, urine, and feces of dairy goats eating poison oak. From the data collected and the procedures used in our initial studies, no urushiol was identified in the urine and the milk. Urushiols were found only in the feces. Based on the finding of this initial research, it is not possible to conclude that urushiol metabolites are not found in the milk or the urine, because the procedures used here were specific for catechol analysis. More specific methodology must be developed to trace the fate of urushiol metabolites in meat and milk. Ref.154\62.26.

Kouakou, B., D. Rampersad, E. Rodriguez, and D.L. Brown. 1992. Dairy goats used to clear poison oak do not transfer toxicant to milk. California Agriculture 46(3): pp. 4-6.

Dairy goats that eat poison oak do not transfer detectable amounts of the toxic principle, urushiol, to the milk or to the urine. Furthermore, this oily, toxic irritant is found in goat manure at less than 9% of its concentration in poison oak leaves. What does all this portend? That farmers using dairy goats to clear poison oak need not worry about contaminating the goats' milk with urushiol. More studies are underway. Ref.154\62.26.

Lane, R.S. 1990. Seasonal activity of two human-biting ticks. California Agriculture 44(2): pp. 23-25.

In northern California, the western black legged tick is considered the primary vector of the spirochete that causes Lyme disease. That tick and the Pacific Coast tick also can be carriers of several other diseases. In one study to learn when humans and other animals are at greatest risk of exposure, adults of both tick species were found to be most abundant during the cooler seasons. Ref.315\64.55.

Lane, R.S., and P.E. LaVoie. 1988. Lyme borreliosis in California. Annals N.Y. Acad. Sci. 539: pp. 192-203.

In the western United States, Lyme borreliosis (LB) was first reported as a distinct clinical entity in 1978 in a hiker bitten by an *Ixodes* tick in Sonoma County, California. Details of four additional cases among northern California residents with onsets between 1977 and 1980 were described in 1983, and since then the number of cases diagnosed from this region has risen steadily. Elsewhere in the Far West, sporadic cases of LB have been reported from Nevada, Oregon, and Utah. Ref.130\61.56.

Lane, R.S., J. Piesman, and W. Burgdorfer. 1991. LYME BORRELIOSIS: Relation of its causative agent to its vectors and hosts in North America and Europe. Annual Rev. Entomol. 36: pp. 587-609.

Changing human land-use patterns during the second half of the twentieth century appear to have provided an environmental mosaic suitable for wildlife and *I. dammini* to thrive in parts of the northeastern and midwestern United States. Critical hosts for the enzootic cycle of *I. dammini*-transmitted *B. burgdorferi* include the white-footed mouse as a host for immature ticks and as a reservoir of the spirochete and white-tailed deer as a host for adult *I. dammini*. The nymphal stage of *I. dammini* seems to be primarily responsible for transmission of the Lyme disease spirochete. Ref.40\60.04.

Merritt, R.W. 1974. The species diversity and abundance of insects inhabiting cattle droppings and their role in the degradation of dung in four different pasture and rangeland ecosystems in the Sierra Nevada foothills of California. Ph.D. Thesis, Univ. of Calif., Davis. 273 pages.

A two-year study at the Sierra Foothill REC consisted of: 1) a quantitative analysis of the differences in diversity and abundance of the insect fauna colonizing and inhabiting diurnally and nocturnally excreted cattle droppings in four different pasture and rangeland ecosystems (cultivated irrigated pasture, natural woodland range, partially cleared woodland range, totally cleared woodland range), and 2) a study of the relationship between the diversity and abundance of insect inhabitants per cowpat and the rate of pat degradation. Ref.160\63.91.

Merritt, R.W., and J.R. Anderson. 1977. The effects of different pasture and rangeland ecosystems on the annual dynamics of insects in cattle droppings. Hilgardia 45(2): pp. 31-71.

Cattle droppings constitute a special microhabitat, including both organisms (biotic communities) and abiotic environment, each influencing the properties of the other. The interacting factors which influence both the diversity and abundance of insect species colonizing dung, and the rate of pat degradation, are summarized. Economic considerations are important criteria determining the type of pasture ecosystems for agricultural purposes. Our study showed that the establishment of totally cleared, dry grassland pastures in California resulted in a general reduction of the indigenous dung insect fauna. Ref.92\63.67.

Rowell, T.E. 1991a. What can we say about social structure? *In*: The development and integration of behaviour. Essays in honour of Robert Hinde. pp. 255-270.

There seems to be general agreement on some hierarchical, nesting system of sociality, although whether the hierarchy is of organization or simply of description is still under discussion. On the whole we can say increasingly little about animal social systems as we move up the hierarchy, to the point of being increasingly doubtful about whether the higher levels exist or not. We have become fairly sophisticated about the lower levels of the hierarchy, largely thanks to Hinde's leadership, and we now accept a degree of complexity and continuity in relationships which would have been unthinkable 30 years ago. Ref.42\60.09.

Rowell, T.E. 1991b. Till death us do part: long-lasting bonds between ewes and their daughters. *Anim. Behav.* 42: pp. 1-2.

Data from 11 ewe-lamb pairs of feral Texan barbado sheep that were followed for more than a year showed that some mothers and daughters maintained strong associations for up to 2 years. The possibility on an extended matrilineal system is suggested by the fact that the ewe flocks were usually led by the oldest ewe present (82% of 139 records). It seems that bonds between mothers and daughters may persist but do not always do so even when both survive. Socio-demographic factors may play a part. Since such different findings lead to fundamentally different predictions about the social organization of sheep, it is important to try to understand how they might arise. Ref.41\60.10.

Rowell, T.E., and C.A. Rowell. 1993. The social organization of feral *Ovis aries* ram groups in the pre-rut period. *Ethology* 95: pp. 213-232.

Primates are described as having peculiarly complex social behaviour when compared with other mammals, but the methods and expectations of primatologists also differ from those of other mammalogists, confounding the comparison. A very simple social organization has been described for sheep. Correlation between the effects of age and rank varied with current demography. Comparison is drawn between monkey and sheep social behaviour, and it is concluded that perceived differences are partly due to differences in the expectations and methods of their respective students. Ref.183\62.17.

Schoeler, G.B., and R.S. Lane. 1993. Efficiency of transovarial transmission of the Lyme disease spirochete, *Borrelia burgdorferi*, in the Western Blacklegged Tick, *Ixodus pacificus* (Acari: Ixodidae). *J. Med. Entomol.* 30(1): pp. 80-86.

The efficiency of transovarial transmission of *Borrelia burgdorferi* was evaluated in *Ixodes pacificus* collected from two areas in northern California where Lyme disease is known to be endemic. In total, 132 of 1,499 replete females examined by direct immunofluorescence were demonstrated to be infected with *B. burgdorferi*. Larvae and eggs from 119 of these females were examined; none was found to contain *B. burgdorferi*. We conclude that transovarial transmission is not efficient for maintaining *B. burgdorferi* in populations of *I. pacificus*, a known vector of that pathogen. Infection with the spirochete does not appear to affect either feeding or reproductive success adversely in females of this tick. Ref.314\64.54.

Tzeng, C.C., and D.L. Brown. 1994. Effects of *in vitro* rumen fluid incubation and pepsin HCL treatment on poison oak urushiol. Joint An. Meet. ADSA/ASAS, Minneapolis, MN (Abstr.) July 11-15, 1994. p. 1.

To determine if urushiol is destroyed or altered by *in vitro* rumen fluid and/or pepsin HCL incubation, poison oak leaf samples of 0.5g were incubated for 24, 48, or 72h with 40 ml phosphate buffer and 10 ml rumen fluid in a CO₂ atmosphere. Neither rumen action alone, nor rumen action plus pepsin HCL could account for the 91% disappearance of urushiol from the GI tract observed in previous investigations. Ref.175\61.50.