Chapter Five

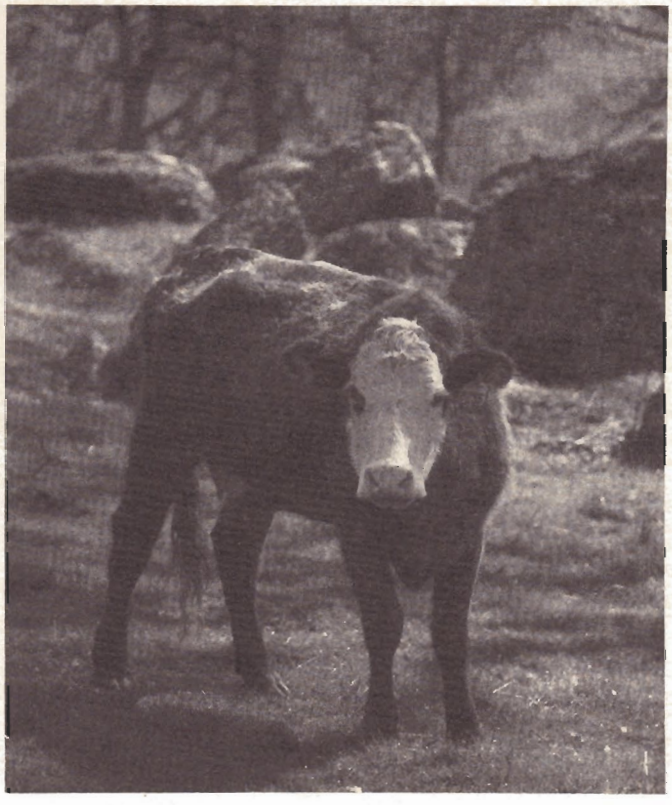
Livestock and Grazing Management

Primary authors: Mel George, Univ. of California, Davis; William Frost, Univ. of California, Eldorado Co.; Neil McDougald, Univ. of California, Madera Co.; J. Michael Connor, Univ. of California, Sierra Foothill Res. and Ext. Center; James Bartolome, Univ. of California, Berkeley; Richard Standiford, Univ. of California, Berkeley; John Maas, Univ. of California, Davis; Robert Timm, Univ. of California Hopland Res. and Ext. Center

Livestock grazing is the dominant land use of California's hardwood rangelands. Livestock graze on approximately two-thirds of all hardwood rangelands in the state. These guidelines provide an overview of the livestock enterprise on hardwood rangelands. Livestock grazing is a complex topic that includes principles of agronomy, plant ecology, animal nutrition, and animal health. The main thrust of this chapter is on cattle production, the dominant livestock product on hardwood rangelands. For information on sheep and other livestock enterprises, as well as related information on the range livestock operation, refer to the reference section in the Appendix, or contact your local Cooperative Extension Farm Advisor

Annual Forage Productivity on Hardwood Rangelands

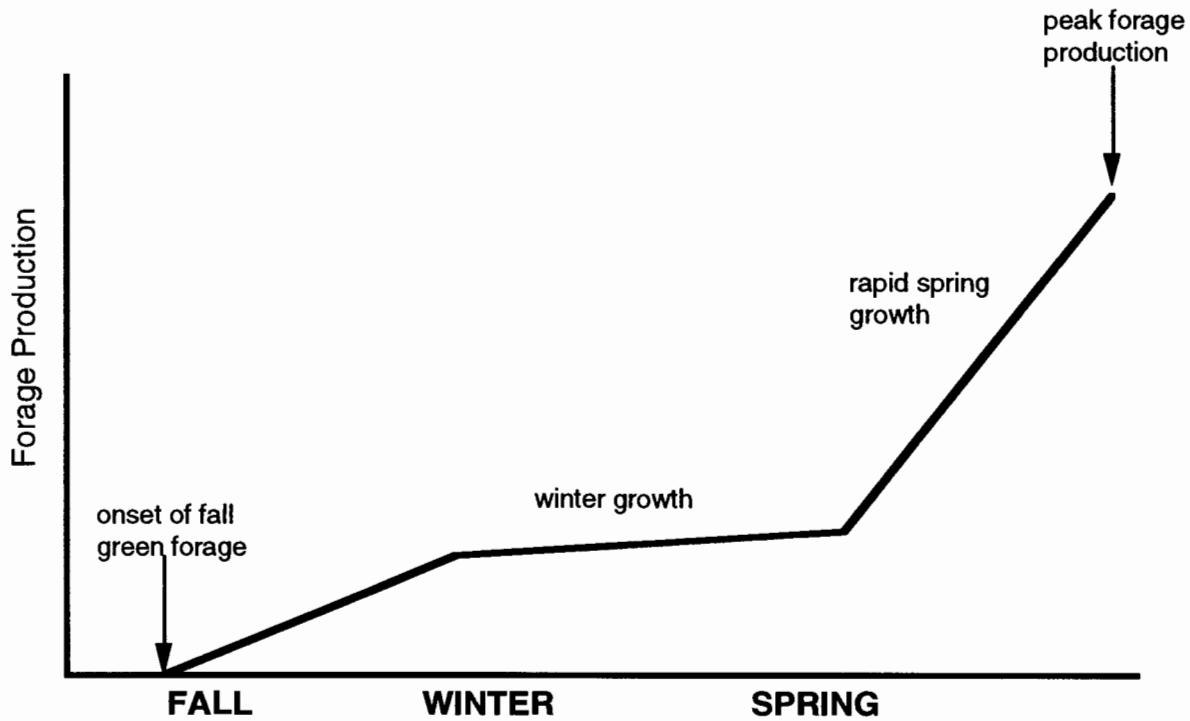
Development of a livestock grazing enterprise on hardwood rangelands depends on annual and seasonal forage production. There are four distinct forage growth phases in the annual grasslands found on hardwood rangelands. These are: 1) onset of fall green forage season; 2) winter growth; 3) rapid spring growth, and 4) peak forage production. Management decisions are guided by these patterns. Four factors have been shown to control seasonal forage productivity and species composition, namely: precipitation; temperature; soil characteristics; and plant residue on the site (residual dry matter or mulch).



Weather Influences

Figure 5-1 shows a generalized forage growth curve for California's hardwood rangelands. The new fall growing season begins when rains start the germination of seed stored in the soil. Young annual plants then grow rapidly if temperatures are warm, but more slowly if it is cool. Little growth occurs when winter temperatures are low. Rapid spring growth commences with warming conditions in late winter or early spring, and continues until soil moisture is exhausted. Peak standing crop occurs at the point where soil moisture limits growth or when plants are mature.

Figure 5-1. Typical pattern of seasonal forage growth on California's hardwood rangelands.



The new fall growing season has been shown to occur following the first fall rains that exceed 1 inch during a 1-week period. This may occur at any time from September 15 until January 1. Early false breaks may occur in summer or early fall, in which case emerged plants may not survive until the true break. Filaree, which has a long taproot, is one of the few annual plants that may survive a false break.

Depending on fall rains and temperatures, forage species composition is usually established by December 1. In dry years, filaree usually dominates, while grass dominates in high rainfall years. Early rains coupled with evenly spaced, adequate rainfall generally produce clover years.

The period of low winter forage growth occurs as fall ends and is the result of cooling temperatures, shorter days, and lower light levels. The winter growth period is short when the season breaks late. This occurs when there is almost no new growth apparent in the fall. However, forage production is greater in mild winters.

Rapid spring growth begins as temperatures warm in the spring and days lengthen. Normally this period occurs between February 15 and March 15 when average weekly temperatures exceed 45 degrees F. The length of rapid spring growth varies from a month in dry southern regions to more than three months in wetter coastal regions.

Maximum forage production occurs at the end of rapid spring growth (peak standing crop). This date can vary from April 1 in the southern San Joaquin Valley to May 25 on the north coast. Late arrival of peak standing crop requires adequate rains in April or early May. The date of peak standing crop on the same site varies widely among years and according to species composition. In years of filaree dominance, peak standing crop will be earlier than in years of grass dominance.

Moisture from summer thunderstorms, although not important for plant growth, leaches nutrients from dry standing forage, and may speed decomposition. Standing residual dry matter frequently shatters into ground litter.

Site Influences

Available moisture depends on rainfall, soil depth, soil texture, aspect, and topography. Most annual plants depend primarily on moisture in the top foot of soil, although filaree and summer annual forbs use water at greater depths.

Heavier clay soils, commonly found on swale areas, hold moisture and conserve it for plant use between widely spaced rains, resulting in a longer rapid-growth period. Upland slopes are drier due to high runoff and lighter-textured soils. South-facing slopes dry faster than north-facing slopes, resulting in different forage production levels.

Hardwood rangeland soil fertility varies tremendously. Nitrogen is the most limiting nutrient, but phosphorus and sulfur can also be limiting. Fertilization with these limiting elements can substantially improve forage productivity. Soil pH varies considerably and influences legume species composition. Acidic soils tend to occur in high rainfall areas of hardwood rangelands, whereas alkaline soils tend to occur in drier areas.

Residue and Grazing Influences

Management of residue, the dry forage component remaining at the end of the dry season, governs forage productivity and composition. Residue, acting as a mulch, influences plant germination and soil organic matter. UC Leaflet 21327, "Guidelines for Residue Management on Annual Range", helps managers determine minimum residue standards. These vary from 200 pounds of dry matter per acre in the southern California to 1250 pounds per acre on steep north coast slopes.

Low fall residue levels encourage higher proportions of silver hairgrass, little qualcinggrass, nitgrass, broadleaf filaree, burclover, redstem filaree, and clover. High fall residue levels encourage dominance by slender wildoats, soft chess, wild oats, and ripgut brome.

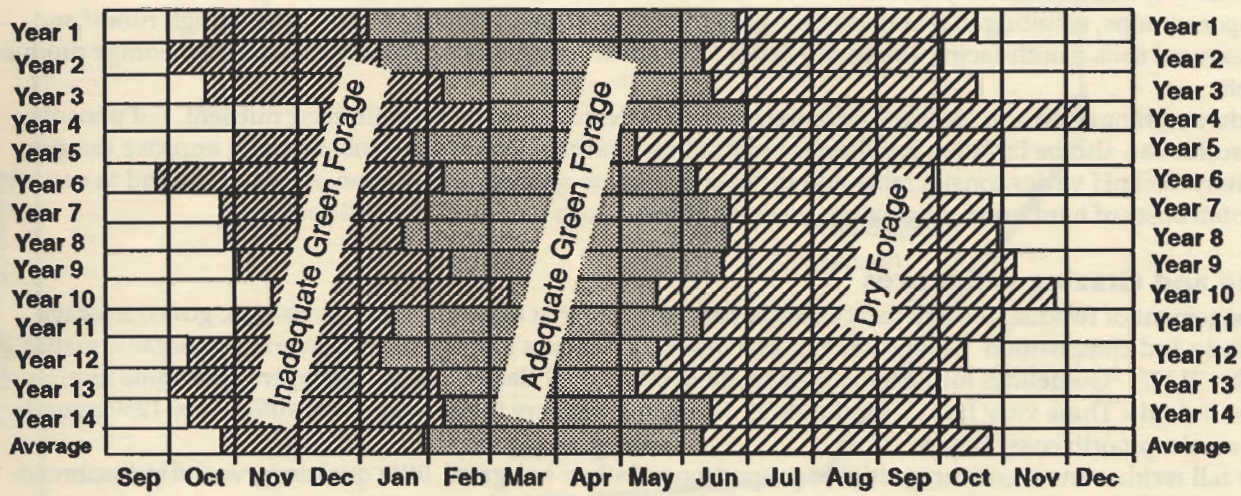
Shading understory forbs with high residue levels result in grass dominance, particularly in an ungrazed situation. Grazing increases forb and legume dominance by opening the canopy. On a moderately-utilized range, livestock do not graze heavily enough to make complete use of available forage, resulting in a patchwork of grasses and forbs.

Seasonal Forage Influences on Animal Performance

Seasonal forage productivity affects livestock weight gains. Cattle that graze in the fall following seed germination may lose weight. This period is called the inadequate green forage season. The onset and length of this period depends on weather conditions. During a dry or cold fall and winter, green forage production will be poor and supplemental feeding may be necessary to maintain cattle performance. A warm fall with adequate precipitation will result in greater forage production and animal performance will improve. Dry residual forage from the previous growing season is commonly available in the fall to provide energy to livestock, but is low in protein and other vital nutrients. The inadequate green forage contains adequate energy, protein, phosphorus, and vitamin A on a dry matter basis. However, livestock are unable to consume enough forage to meet their nutritional needs due to either the high water content of the forage, or simply a lack of available forage.

Animal performance improves during the rapid spring growth period in late winter or early spring. This period is called the adequate green forage season. Forage is usually nutritionally adequate for livestock growth, maintenance and gestation. Peak standing crop occurs when soil moisture limits growth or when plants are mature. Rapid spring growth is followed by the summer dry season, when the forage is a fair energy source but is low in protein, phosphorus, carotene and other important nutrients. Since livestock performance on hardwood rangelands during this summer dry season may be poor, managers commonly provide supplements, transport livestock to high elevation meadows, or use irrigated pasture. Figure 5-2 graphically shows the annual variation that occurs in the timing of these seasons.

Figure 5-2. Example of variation in length of time of the inadequate green season, adequate green season, and dry season at the San Joaquin Experimental Range over a 14-year period.

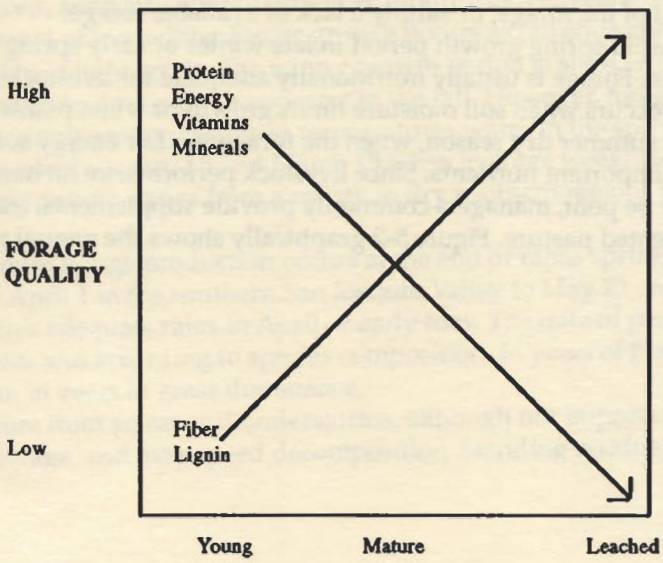


Seasonal Forage Quality

Matching the nutrient demands of livestock and the nutrients supplied by range forage comprises a real balancing act for a considerable portion of each year. Range forage quality varies with species, season, location or elevation, and improvement practices. Hardwood rangeland forage is optimal for livestock growth and production for only a short period of the year, although with management, livestock can graze for extended periods on hardwood rangelands. Early in the season, forage may be of high nutrient content, but nutrients are soluble and may not be efficiently utilized by the livestock's rumen microflora, essential for digestion. Late in the season, high fiber content limits nutrient ingestion and use.

Measures of forage quality such as protein, energy, vitamins, and minerals follow a declining trend as the season progresses (Figure 5-3). Conversely, measures of low quality such as fiber and lignin increase as forage plants mature.

Figure 5-3. General relationship of forage quality to the stage of plant growth.



Stage of Plant Growth

The four nutritional factors of most concern to hardwood rangeland livestock managers are protein, energy, carotene (the precursor of vitamin A), and phosphorus. Forage may also be deficient in copper. High molybdenum aggravates copper deficiency. Potassium and zinc may be deficient in mature weathered forage. Other minerals such as selenium may be found in deficient or toxic levels in localized areas of the state.

Nutrient content changes as plants develop. Stages of plant development (vegetative, flowering, mature, dry, etc) can be visually identified and are good indicators of forage quality. Generally, anything that retards the rate of plant development, such as moisture, slight stress, or grazing, will foster higher nutrient status. Anything that advances the rate of development, for example, extra water or nitrogen, allows greater structural development and reduces nutrient quality (but increases yield). Complete information on seasonal forage relationships are available from UC Cooperative Extension Farm Advisors.

Forage Alternatives for Hardwood Rangeland

Because of this seasonal variability in forage productivity and quality on hardwood rangelands, complementary forages and feed sources must be provided. A hardwood rangeland ranch plan that thoroughly assesses potential forage sources and grazing management can identify the most cost effective means of meeting animal performance objectives (see references at end of this chapter). The following seasonal forage and grazing management practices can provide solutions to limitations in forage production, quality, and utilization that affect animal production per acre.

Season 1 (onset of green season, fall) — The timing and amount of forage productivity is highly variable and may require feed from other sources to provide adequate dry matter or protein. Protein supplements are commonly used. The management options described below can be used individually or in combination with each other to produce complementary forage sources, depending on cost effectiveness.

1-1. Supplemental irrigation of annual ryegrass, winter cereals, or subterranean clover for early fall green feed.
1-2. Development of summer dormant perennials such as perlagrass, hardinggrass, Berber or Palestine orchardgrass for early fall green feed.
1-3. Stay on summer pasture until annual range can be used. However, cold weather may restrict this option.
1-4. Fall or winter grazing of alfalfa fields.
1-5. Provide protein and energy supplements and graze unused dry residue from previous season.
1-6. Feed hay.

Season 2 (winter season) — Following fall growth, cold winter weather stagnates forage productivity. Although protein supplementation may be unnecessary, inadequate dry matter intake may require feeding of hay. Complementary forages to improve winter feed are shown below:

2-1. Nitrogen fertilization of annual range can increase winter feed.
2-2. Properly managed annual legumes increase winter forage productivity.
2-3. Items 1-1, 1-2, 1-4, and 1-5 above can also provide feed during this season.

Season 3 (rapid spring growth, adequate green season) — Forage production on hardwood rangelands during the spring season is usually not limiting. The time of warming temperatures and the amount and timing of spring rains largely determine the length of this season.

3-1. Items 1-2, 2-1, and 2-2 above can increase feed during this period.
3-2. The development of cool season irrigated pasture can provide high quality feed during this period.
3-3. Production of winter cereals or ryegrass can provide extra feed or hay during this season.

Season 4 (dry season, inadequate dry) — The dry season starts as soon as soil moisture is depleted following the end of the rainy season. The dry feed is low in protein. The following complementary forages or strategies can provide summer grazing.

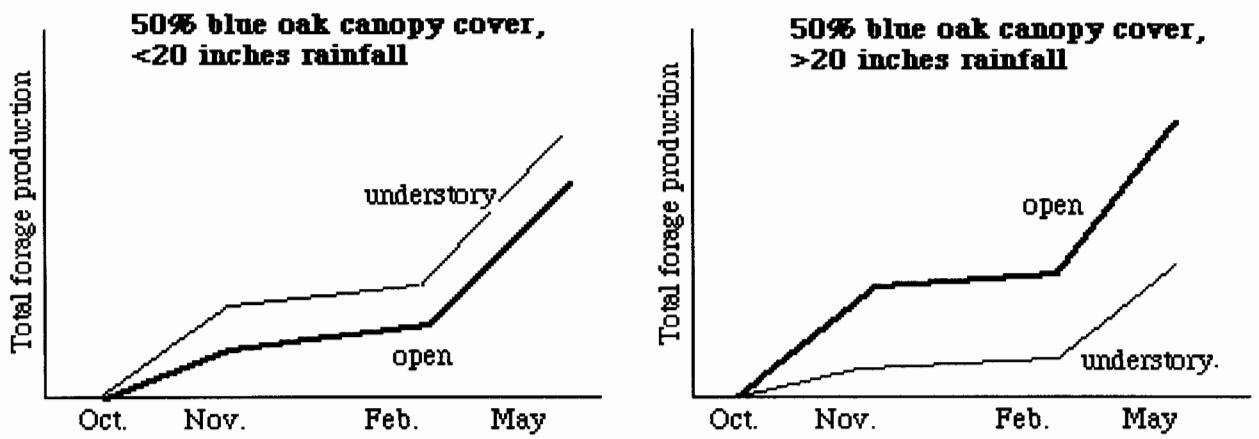
4-1. Item 3-2 above. Rotation of livestock from dry range to irrigated pasture can be a cost effective method of providing adequate protein and dry matter in summer.
4-2. Transport livestock to high elevation range and mountain meadows where feasible. Grazing management of these forage sources should follow established guidelines for perennial range and pastures.
4-3. Sudangrass for pasture or hay production.
4-4. Annual legumes such as rose clover, lana vetch, and annual medics can raise the quality of dry feed for all or part of the summer season.
4-5. Crop residue such as winter cereal stubble can provide dry matter. Shattered grain may improve the quality of this feed source.

Oaks and Forage Production

The oak canopy has an effect on forage production, composition, and quality that varies around the state depending on precipitation, soil, elevation, oak species, and amount of oak canopy cover. Oaks compete with the forage understory for both sunlight and moisture, and alter the nutrient status of the site because of the deep-rooting of oaks and nutrient cycling from litter fall.

Oak removal was historically recommended as a means of increasing forage production on hardwood rangelands. For the deciduous blue oak, most studies have demonstrated increased forage production following tree removal on areas previously containing over 25% canopy cover and receiving over 20 inches of rain. Conversely, where there is less than 20 inches of rain, areas with low blue oak canopy (less than 25 percent cover) consistently had higher forage yields than adjacent open areas. In areas with blue oak canopy between 25 to 60 percent, the canopy effect on forage production varied (Table 5-1). Figure 5-4 shows how moderate blue oak canopy (50%) affects seasonal forage production in different rainfall areas of the state.

Figure 5-4. The effect of 50 percent blue oak canopy cover on seasonal forage production compared with open annual grasslands in two rainfall zones.



In evergreen live oak stands, with leaves that shade forage growth during the winter and early spring months, the few studies which have been carried out show a larger competitive effect of oaks on forage production (Table 5-1). In general, live oak stands with over 25 percent canopy cover will have lower forage growth than cleared areas. One study in the Southern Sierra Nevada foothills, however, showed that in drought years, live oak shading helped conserve soil moisture, resulting in higher forage production than on open sites.

Table 5-1. The effect of oak canopy on hardwood rangeland forage production (note: a "+" indicates forage production is enhanced by oak canopy, a "–" indicates forage production is inhibited by oak canopy, and a "– / +" indicates that the effect is variable in different locations in the state).

Species Group	Canopy Cover	Winter Forage Production	Spring Forage Production
Live oaks	Scattered (<10% cover)	– / +	– / +
	Sparse (10 - 25% cover)	– / +	– / +
	Moderate (25 - 60% cover)	–	–
	Dense (over 60% cover)	–	–
Deciduous oaks	Scattered (<10% cover)	+	+
	Sparse (10 - 25% cover)	+	+
	Moderate (25 - 60% cover)	– / +	– / +
	Dense (over 60% cover)	–	–

The increase in forage production beneath blue oak canopies, or in areas previously beneath blue oak canopies, is attributed, in part, to increased soil fertility due to leaf fall and decomposition. Enhanced soil fertility also improved forage quality beneath blue oaks or where blue oaks were removed. However, since the nutrient input from leaf litter ceases after tree removal, forage production increases will be temporary, until soil fertility gradually declines to similar levels as adjacent open areas. Long term studies have found it may take 15 years for this nutrient effect from oak cover to dissipate after tree removal.

Oak canopies also have an effect on forage species composition. Studies have found that understories of both blue and live oak stands favor later successional herbaceous species such as wild oats, soft chess and ripgut brome. Clovers, annual fescues, filaree, soft chess, and foxtail fescue account for more of the total herbage biomass in open areas than under oak canopy.

In general, managers of livestock enterprises on hardwood rangelands should consider the following general guidelines when managing their oaks:

- There is little or no value in removing blue oaks in areas with less than 20 inches of annual precipitation;
- On areas with over 20 inches of rainfall, thinning oaks where the canopy exceeds 50 percent will have the greatest effect on forage production;
- In areas thinned for forage enhancement, residual tree canopies of 25 to 35 percent are able to maintain soil fertility, retain some components of wildlife habitat, and minimize erosion processes; and
- Tree removal activities should always be planned considering all values of the trees, including wildlife habitat, soil stability, etc. in addition to the possible forage production benefits.

Grazing Management in Hardwood Rangelands

On hardwood rangelands, forage species production and composition, livestock diet preferences, stocking rate and distribution, kind and class of stock, season of use, and range improvement practices influence animal performance and the profitability of the livestock enterprise. The relationship of each of these factors enter into the development of a grazing management strategy for hardwood rangelands.

Livestock Diet Selection and Grazing Behavior

In general, cattle tend to prefer diets that are higher in protein and lower in fiber than that contained in the available forage. Protein in the diet can become limiting before energy content, especially for young stock and lactating cows. This is one of the main reasons why performance of these classes of cattle declines sharply when the forage matures.

Studies at the Sierra Foothill Research and Extension Center, near Marysville, show that organic matter intake and digestibility was greatest in April and early May. Protein consumed was greatest in March. Each of these indicators of forage quality reached their peak during the period of rapid spring growth, and were at a minimum during the summer or fall dry season.

Unpalatable plants do not necessarily have poor nutritive value, but are of low value because they generally are not selected. It is possible to minimize the effects of selective grazing by forcing uniform use during particular seasons, but the animals may not perform quite as well. Where grazing is not forced, livestock will select the most palatable plants first.

Cattle grazing can be divided into three activities: grazing, ruminating and idling. Typically grazing starts at sunrise or a little before, and lasts for two hours. Then, there is a brief period of idling, followed by ruminating and then a longer period of idling. The total time spent on this first cycle is typically about four hours. Four or five shorter cycles (grazing-ruminating-idling) follow through the remainder of the daylight hours, with at least one grazing cycle after sunset.

Time spent grazing is about 8 hours per day, but there are variations in daily duration of grazing due to breed and forage conditions. Hunger will not drive an animal to graze beyond 10 hours per day. Under poor forage conditions, time actually spent grazing may change little, but time spent looking for food can increase from a normal of around 3 hours up to 5 hours. Time spent ruminating is heavily influenced by the fiber content of the forage.

The mechanical task of harvesting the daily requirement of forage is formidable. Under optimum pasture conditions (3 - 5 inches of green forage), the animal must take about 80 bites per minute to harvest 200 pounds of green material in an 8 hour day. Where the number of bites falls to 40 per minute, the intake will be about 44 to 55 pounds of green material per day, which is scarcely enough for maintenance. During the dry season, high fiber content slows rumination, which suppresses intake.

Stocking Rate

Stocking rate is the number of specific kinds and classes of animals grazing a unit of land for a specified period of time. It is usually expressed as animal unit months (AUM) per acre or the reciprocal, acres per AUM. An animal unit is usually defined as one mature (1000 lb) cow. An animal unit month is the amount of feed or forage required by one animal unit for one month to maintain its weight.

Deciding stocking rate is the most important grazing management decision, influencing the health or condition of vegetation, livestock and wildlife. Improper stocking rates result in wasted forage or overstocked range that sooner or later reduces economic return. Incorrect stocking rate may cause other range or livestock management practices to be ineffective, and management goals will not be reached.

Carrying (grazing) capacity is defined as the total number of animals which may be sustained on a given area year after year without damage to vegetation or related resources. Although actual stocking rates vary considerably between years due to annual forage fluctuations, grazing capacity is generally considered to be the average number of animals an area will sustain over time. Ranches are usually bought and sold on the basis of grazing capacity.

There are many ways to estimate stocking rate and carrying capacity. Modern USDA Natural Resource Conservation Service (NRCS) Soil Surveys report forage production and/or stocking rate for poor, average and favorable years. Stocking guides have also been developed based on slope, canopy cover, distance to water and other factors.

Animal performance is influenced by stocking rate. Research at the San Joaquin Experimental Range sug-

gested that moderate grazing gave the most efficient cattle production, while maintaining satisfactory herbage production. Close grazing reduced range forage production in subsequent years as well as efficiency of cattle production. The effects of gazing intensity were apparent in winter forage growth and in mature herbage yield. Grazing intensity effects on spring plant vigor were not apparent. Differences in grazing during the current season partially obscured the effects of past grazing use. However, differences in forage yield and composition were still apparent in the spring.

Livestock Distribution

Slope, distance to water, forage production, forage composition, forage nutritional value, and pests are important factors affecting livestock distribution on hardwood rangelands. Studies at the San Joaquin Experimental Range have shown that livestock spend much more time grazing the highest producing swale sites than the less productive slopes, although this varies by period of forage growth and maturity. From the time the cows are placed in the pasture until the start of rapid forage growth in late March, average cow distribution on swales remains constant and about equal to distribution on slopes. During April and May, when forage is growing rapidly on swales and has matured on other land classes, swales receive heavier livestock use than rocky, brushy slopes. As forage matures and dries in June, cow distribution in swales decreases sharply and increases markedly on slopes. Even though forage on swales has been closely grazed, the cows may continue to spend considerable time regrazing these areas. As the forage matures and dries, cows spend less time grazing south slopes and more time on north slopes. When rains start the new forage growth in winter, use of north slopes decreases, and use of south slopes increases.

Grazing Practices

While most ranches on hardwood rangelands are subdivided into a few to several pastures, intensive control of grazing is seldom practiced. Seasonal or year-long continuous grazing of different hardwood rangeland pastures is traditional. Hardwood rangeland grazing management currently emphasizes maintenance of adequate residue and efficient utilization of forage to encourage desired forage species and adequate soil protection.

Although annual plants do not survive from year to year, their management influences productivity the following year. Light to moderate grazing intensities, leaving moderate amounts of dry forage residue in the fall, tends to result in more desired forage species the following growing season and increased forage levels in January. Research has shown that excessive grazing, with very low amounts of dry residue, tended to produce less desirable forage species with lower total production the following year. Leaving too much residue also results in less total forage production the following year than moderate residue levels.

Specialized grazing management systems adapted to hardwood rangelands have not been widely used nor have they been the subject of extensive research. Some evidence from the literature supports year-long grazing rather than a three pasture deferred rotation, where a different pasture was used during each third of the grazing season. In the 1980s, a small number of ranchers began to subdivide their pastures and rotationally graze. Several changes in ranch productivity have been observed in controlled grazing case studies. Increased stocking rate has resulted in increased total animal productivity, reduced hay feeding during fall and winter, less dependence on hay feeding during drought, reduced weed populations, and reduced predator losses. Additional information on these specialized grazing systems is available from the local office of your Cooperative Extension Farm Advisor, or the Natural Resource Conservation Service.

Nutrient Requirements of Beef Cows

One of the main factors in planning a cow herd supplementation program is the cow's nutritional requirements. Table 5-2 gives the estimated requirements for a 1000 pound beef cow for five periods of production. The nutrients which should be considered as potentially deficient on hardwood rangelands are energy, protein, phosphorus, magnesium, sodium chloride, certain trace minerals and vitamin A. Table 5-3 below shows some general symptoms for deficiencies of the various nutritional elements.

Table 5-2. Nutrient requirements for a 1000 lb. beef cow

Nutrients	Stage of Production				
	Period 1	Period 2	Period 3	Period 4	Period 5
	Calving (45 days)	Breeding (45 days)	Early Gestation (90 days)	Mid Gestation (90 days)	Late Gestation (90 days)
Dry Matter (lbs/day)	20.6	21	19.5	18.1	19.6
Protein (lbs/day)	2.5	2.6	2	1.3	1.6
Energy - Total digestible nutrients (lbs/day)	13.8	14	11.5	8.8	10.5
Calcium (g/day)	36	38	25	15	23
Phosphorus (g/day)	25	27	20	15	18
Vitamin A (1000s IU/day)	37	38	36	25	31

Energy: Energy is the most important nutritional factor to consider for beef cows for several reasons. It is the nutritional factor most commonly lacking due to the shortage of forage. Were it not for energy requirements, a beef cow's nutrients could be met by 2 to 4 pounds of total feed per day. Insufficient energy intake may occur when cattle are forced to graze deficient dry forage in the fall or inadequate green season.

Protein: Protein is most likely to be deficient in the summer and fall when dry forage is plentiful but green forage is not adequate. Supplemental protein for wintering cows is usually the largest annual cost in maintaining a cow. Supplements such as cottonseed or safflower oil meal, and alfalfa hay are primary sources. Urea is a non-protein compound which ruminants may convert to protein with varying degrees of efficiency. Use of liquid supplements and blocks has increased drastically in recent years. Presently, urea has a low to moderate value for cattle on dry range when it replaces protein in a natural protein supplement. Proper management procedures are important when urea is fed to prevent ammonia toxicity and to enhance urea utilization. Special concern needs to be given to dry livestock ranges on years with heavy acorn crops. Feeding urea may result in loss of cattle due to uremic poisoning.

Calcium: Calcium deficiency is not a serious problem in most livestock diets. Calcium is seldom deficient in California forage.

Phosphorus: Phosphorus may be borderline to definitely deficient in diets during summer, fall and winter periods. Feeding with high protein and liquid supplements usually supplies adequate phosphorus to supplement native forage.

Salt: Salt should always be accessible for livestock to use as needed in loose pack or block form. Placing salt away from water is a common practice for improving livestock distribution and improving range utilization.

Magnesium: Under California conditions, grass tetany or hypomagnesemic tetany, often occurs. It is a major problem, especially in lactating cows grazing lush, rapidly growing pastures fertilized with high levels of nitrogen during cool foggy seasons. Grass tetany can be prevented by providing supplemental magnesium.

Trace Minerals: Deficiencies of trace minerals such as copper, iodine and selenium exist in many areas of California. It may be desirable to provide a trace mineralized salt mix as a precautionary measure if there is any reason

to suspect a deficiency. Selenium deficiencies are concentrated in northern (especially northeastern) California. In these selenium deficient areas, it can be administered as an injection or as a pellet placed in the reticulum. Selenium provided in supplement blocks has generally not proved effective.

Vitamin A: Vitamin A deficiencies may occur in beef cow herds. A cow stores up several months supply in her liver during the adequate green feed period, but this supply can be rapidly depleted in a lactating cow. Vitamin A deficiencies may also occur in fall calves during dry years or in young cows. Supplemental vitamin A may be needed.

Potassium: Generally, forages contain more potassium than required by beef cows. However, potassium concentration decreases with advancing maturity of forage and can be reduced further by leaching. Potassium deficiency results in decreased feed intake, decreased milk yield, reduced weight gain and muscular weakness.

Table 5-3. Symptoms of nutritional deficiencies of livestock on hardwood rangelands

Energy Deficiency	Protein Deficiency	Calcium Deficiency	Phosphorus Deficiency	Salt Deficiency	Selenium Deficiency	Vitamin A Deficiency
Retarded growth and loss of body weight	Reduced appetite	Poor Growth	Decreased appetite	Licking and chewing various objects	White muscle disease	Watery eyes
Delayed sexual maturity and poor conception	Reduced growth rate in fetus and calf	Depletion of calcium	Chewing wood, bones and hair	Loss of appetite	Retained placentas	Night blindness
Shortened lactation period and decline in milk yield	Loss of weight	Swollen, tender joints	Low blood phosphorus	Unthrifty appearance	Reduced gains	Scouring
Lowered resistance to disease and parasites	Inadequate intake of other nutrients	Arched back	Stiff joints and lameness	Rough haircoat	Unthriftiness	Respiratory infection
Increased mortality by toxic plants	Delayed or irregular heat	Stiffness	Decreased milk production	Decreased milk production	Diarrhea	Poor conception
	Poor conception rate	Deformed legs	Failure to show heat	Reduced gains		Abortion-shortened gestation period
	Reduced milk production	Fractures	Poor conception rates	Lack of coordination		Birth of dead, weak or blind calves
				Weakness		Retained placentas
				Death		Uncoordinated calves

Range Supplementation of Beef Cows

Supplementation means making up the difference in quality between what range forage provides and what cattle need. It does not mean substituting purchased feed for range forage. A supplement program is designed to enhance utilization of the total diet, and requires knowledge about which nutrients are deficient, the degree of deficiency, and the cost of alternative supplemental feeds.

Frequency of Supplementation: Cattle do not require daily supplementation. Research has shown that it makes no difference whether the supplement is fed at a given rate each day, tri-weekly, or bi-weekly. However, the animals should receive the same amount of supplementation on a weekly basis, regardless of feeding interval. Even if the cows are not fed daily, they should be observed as often as necessary, especially during the pre- and post-calving season.

Forms of Supplements: Dry roughages, alfalfa, grass, or grain hay can be used but should be analyzed to determine nutritive value. Quality hays properly supplemented often result in a satisfactory supplemental feeding program.

Dry supplements may be furnished as meals, blocks or cubes. Blocks and cubes have the advantage that they may be fed on the ground whereas meals require the use of a feeder. Intake of meals can be successfully controlled by the use of salt. Hardness of the food supplement has also been used successfully to limit intake.

Molasses or other feed by-products, such as corn steep liquor or ammoniated whey, are the principle ingredients of liquid supplements. Liquid supplements are easily handled and dispensed by liquid feed companies.

Animal Health Issues on Hardwood Rangelands

A variety of animal health issues affects the livestock enterprise on California's hardwood rangelands. You should contact your local veterinarian or CE Livestock Farm Advisor to evaluate specific concerns you might have about livestock health. Shown below are several important health concerns that are specific to livestock enterprises on hardwood rangelands.

Acorn Calves

The acorn calf syndrome is characterized by deformed calves born to cows that received inadequate nutrition during pregnancy. The condition is not directly caused by eating too many acorns, but is more commonly seen in cattle feeding on hardwood rangelands than in other grazing areas of the state.

Acorn calves suffer various types of deformities. Most commonly, the long leg bones (humerus and femur) are short and bent at the joints. The calves may be "knuckled over" at the joints and appear bow-legged. They may be weak and uncoordinated, making it difficult for them to stand alone and nurse. The head may be short with an undershot jaw, giving a "bull-dog" appearance, or an abnormally long, narrow, pointed jaw.

Acorn calves are often born alive, but are likely to die soon under natural range conditions. If assisted in nursing, many calves will survive. However, this is economically impractical. Most surviving acorn calves will not grow efficiently, and tend to be chronic bloaters, resulting in early death or extreme inefficiency in the feedlot.

Researchers have concluded that this syndrome is not inherited, and is also not directly caused by consumption of acorns. However, high levels of acorn consumption may be an indirect factor in the syndrome, affecting utilization or metabolism of other feeds.

The most likely cause of the abnormalities seen in acorn calves is inadequate nutrition to the mother cow during the third to sixth month of gestation. The exact nutrient deficiencies causing the syndrome are not known, but it is probably the result of reduced availability of a combination of nutrients which may include protein and vitamins A, B-complex and D. Protein is certainly implicated because acorns are low in digestible protein, and protein supplementation of cattle consuming substantial amounts of acorns has been shown to improve their efficiency considerably.

Cow herds can be affected dramatically. Some herds reported up to a 20% incidence of acorn calves during a recent drought year. Once the problem shows up in the herd, little can be done since the nutritional deficiencies that were the cause occurred three to six months earlier during pregnancy.

This syndrome can be prevented by following basic herd nutrition practices as discussed above. Acorn calves usually appear in herds confined for long periods on dry annual range with low forage availability and lack of green feed. First-calf heifers are especially susceptible, probably because of their increased nutrient requirements. If animals cannot be rotated to pastures with better feed conditions, then supplemental feeding of pregnant cows and heifers can be used to prevent acorn calf disease.

Oak Products as Livestock Forage

Oak trees can provide a valuable source of forage to livestock in the form of both leaves and acorns (mast), especially during summer and early fall when the annual forage is dry and sometimes in short supply. A study in

Mendocino County showed that up to 55 percent of the total mid-summer diet of individual cattle was acorns and oak leaves. Oak products made up 28% of sheep diets during the same period.

Acorns contain high levels of energy, but are low in digestible protein, vitamin A, phosphorus, and calcium. These nutrients (except calcium) are also low in annual range forage during the dry season. However, acorns are undependable as forage because production varies annually. Supplemental feed, especially protein supplements, improves animal performance under such conditions.

Oak Poisoning

Although oak products can be a valuable supplement to herbaceous forage, health problems will result if cattle are forced to eat too much of these products because of lack of other feed sources. This is because of the poor balance of nutrients in acorns and the high levels of tannins in acorns and oak leaves. Acorn calf syndrome is a possible health problem, and oak poisoning can have disastrous effects under certain conditions.

Oak poisoning in cattle is caused by consumption of unusually high levels of oak products. This results in high concentration of tannins in the blood, which is toxic to the kidneys and liver. In 1986, several thousand cattle died in two Northern California counties following a severe late spring snow storm. Range feed was particularly short that spring, and the snow knocked millions of new oak buds off the trees and covered most of the ground feed that was present. Hungry cattle consumed the fresh buds, resulting in toxic levels of tannins in the blood. Similar effects have been reported in various parts of the country when oak leaves are prematurely shed after wind or hail, and forage is limiting.

Poisoning from oak buds or other products, while disastrous when it happens, occurs rarely. Managers can protect against it by providing supplemental feed immediately if natural forage is short and a storm results in unusual amounts of oak buds or leaves on the ground. Managers might also want to provide short-term supplemental feed allowing hungry cattle to feed on an inadequate forage supply.

Anaplasmosis

Anaplasmosis is an infectious disease which can cause severe anemia in cattle, sometimes resulting in death or, in pregnant cows, abortion. It is not unique to hardwood rangelands, but it is quite common in such locations because of the high concentration of ticks and other vectors on these lands, and because deer and other wild animals typically found in these areas serve as reservoirs for the disease.

Anaplasmosis is caused by a rickettsial organism called *Anaplasma marginale*. (Rickettsiae are intermediate in size and biology between viruses and bacteria.) Anaplasmosis occurs when *A. marginale* infects a susceptible animal and causes severe anemia due to the destruction of red blood cells, resulting in illness or death in the animal.

Cattle of all ages are susceptible to infection by *A. marginale*. However, the age of the infected animal determines the severity of any clinical disease. When cattle less than one year of age are infected, they will not show any signs of disease. They will become carriers of the organism and develop an immunity which will be protective against the clinical disease. Cattle infected between 12 and 24 months of age have an increasing risk of becoming ill. All infected cattle over two years of age become ill, and approximately 50% will die if not treated. Once infected, the cattle tend to be carriers of *A. marginale* for many years. These animals can serve as a source of infection for other cattle.

The disease agent is spread by ticks and biting flies which carry infected blood from a carrier animal to a susceptible animal. Ticks are unique biological vectors in that they carry *A. marginale* in their tissues and can infect cattle when feeding at subsequent molts or stages of their life cycles. The disease is also spread by humans through the use of dehorning and ear tagging tools, castration instruments, needles, and implanting devices that are not sterilized frequently.

The disease results in severe anemia, manifested as lack of appetite, muscle weakness, and depression. The blood appears thin and watery, and the mucous membranes are pale. The latter is most easily noticed in the lips and around the eyes. On exertion, animals often show signs of respiratory distress. Cows may abort in late pregnancy, and the disease may cause temporary infertility in bulls. A definite diagnosis can be made by a veterinarian from a blood sample from cattle suspected of having the disease. Several different control strategies have been proposed, and your veterinarian can suggest the most appropriate one for you.

The effect of anaplasmosis on a herd, and thus the appropriate protection program for that herd, is dependent on its geographic location within California. In areas such as the Central Valley, there is very little tick activity and cattle do not become infected. Groups of cattle in such areas are not carriers of the organism, do not develop the

disease, but are quite susceptible to infection. If adult cattle such as these are taken to a locale where *A. marginale* is common, they can become infected and can experience heavy losses due to anaplasmosis. These cattle should be protected with a vaccine well before the time they are taken into high risk areas (check with your veterinarian).

In areas with high rates of infection with *A. marginale*, such as portions of the Coast range, almost all cattle are infected early in life. They do not develop any signs of disease, and are carriers of the organism for life. Cattle losses do not commonly occur in these herds unless outside, susceptible cattle are brought in. This occurs commonly with purchased bulls or replacement cows and, therefore, these introduced cattle should be vaccinated well before being shipped into the area. Resident cattle in these locations do not require routine vaccination.

In other locations, including some foothill areas where there is some tick activity and a moderate level of exposure, a significant number of cattle will reach two years of age before they become infected. These susceptible cattle, with herd mates who are infected carriers, can become infected and will develop the anemic condition that can result in illness or death. In herds such as this, it is common to vaccinate all animals since it is impractical to determine which are susceptible and which are carriers. In these herds, older animals are vaccinated with the killed vaccine and young animals are vaccinated with a modified live vaccine.

Since this disease is complicated by many factors, including significant differences among some small local areas within larger regions, it is important to discuss any prevention programs with your veterinarian.

Foothill Abortion

Foothill abortion results in major calf crop reductions in cow herds grazing on hardwood rangelands. The disease, also known as epizootic bovine abortion (EBA), occurs when susceptible cows are exposed by a tick bite, resulting in abortion of the fetus three to four months later, or the birth of a weak calf.

The exact organism responsible for this disease has not been isolated, and thus a preventative vaccine has not yet been developed. UC veterinarians have determined that the soft-shelled pajaroello tick is the carrier of the EBA-causing organism. This tick is common in hardwood rangeland habitats, living in the soil in dry areas around trees, brush, and rock outcroppings. It is less common in more open pastures, although the tick may remain for many years in areas previously cleared of brush. The tick is not found in wet locations.

The pajaroello tick feeds on the blood of cattle, deer, and humans. Since it feeds briefly, and then drops off, they are seldom seen on cattle. The tick is most active on hardwood rangelands during warm, dry weather, and feeds from May to October.

If a pregnant cow is infected through a tick bite, her developing fetus shows the disease effects. Only fetuses under six months gestation are susceptible. Affected fetuses are aborted in late term or born as weak, premature or near-or full-term calves. These calves usually die under range conditions. It is not uncommon for a 40 to 50 percent abortion rate in first-calf heifers. Abortions may occur in groups ("abortion storms"), in which many cows or heifers abort during a short time period. These events may be brought on by some kind of stress, such as extremely cold weather, driving or trucking over a long distance, or inadequate nutrition. Non-pregnant cows exposed through tick feeding become immune to the disease for an unknown period. Periodic re-exposure may be necessary for continued immunity.

Calves that have been aborted due to EBA will exhibit the following symptoms: abortion after 6 to 9 months of pregnancy; large, fluid-filled belly; enlarged lymph nodes; and small hemorrhages in the white part of the eye. Calves born premature because of EBA are weak and smaller than usual.

No vaccine or cure is available, but management recommendations have been developed to reduce disease incidence. These are designed to develop a natural immunity in the cow or heifer by encouraging tick feeding prior to pregnancy or after six months of gestation, or by keeping pregnant cows out of tick-infested pastures before their sixth month of pregnancy. The recommendations are:

1. Locate tick infested pastures. This can be accomplished by checking ranch records to see where cattle were three to four months prior to EBA-caused abortion. Also, sampling procedures have been developed using dry ice to attract ticks.

2. Purposely place sexually mature heifers in known tick areas prior to breeding. The weather should be at least 70 degrees or warmer for at least a few hours during the day at the time of exposure.

3. Place cows or heifers in known tick areas after their sixth month of pregnancy to gain or maintain an active immunity.

4. Keep pregnant cows out of tick infested pastures before their sixth month of pregnancy. Open valley pastures, treeless hay meadows, and irrigated pastures should be safe.

5. Keep cows or heifers that have aborted since these may be especially valuable because of their immunity.

6. Buy replacement cattle from EBA-affected ranches.

Predator Management on Hardwood Rangelands

Hardwood rangelands provide excellent habitat for a variety of wildlife species, including predators such as coyotes, mountain lions, bears, and other carnivores. These predators may attack, kill, and feed on livestock. It is important to note, however, that predators also rely on a host of other wildlife species as sources of food as well.

Preventing and controlling such conflicts between humans, livestock, and predators requires a degree of understanding of the biology and behavior of the predator species, as well as a concerted effort on the part of the land owners or livestock manager. Although landowners can take certain actions to prevent or reduce predation, the services and expertise of a predator control specialist are often required to solve problems.

Predator Biology and Damage Characteristics

Accurate determination of the predator responsible for damage to livestock is an essential first step in preventing further damage. In many cases, close investigation of the evidence of predation in the field helps to identify the species responsible. Detailed descriptions are found in the books listed in the reference section. Predators do have some positive value, by reducing rodents which consume oak regeneration, such as ground squirrels or pocket gophers.

Coyotes: The coyote, a small to medium-sized canid, is responsible for a majority of the predation to sheep, goats, and occasionally to calves. They are found in a wide variety of habitats, and can live in close proximity to humans. Coyotes form mated pairs, breed from January to March, and give birth to pups from mid-March through May, depending on locality. Pups remain with their parents until fall, and then disperse to find mates and establish their own territories. Some are not territorial, but wander nomadically over fairly large areas.

Although the percentage of coyotes that attack and kill livestock is not known, they can inflict serious losses. Small prey such as poultry, young lambs, kids, and pigs are killed with a single bite to the head, neck, or back, and may be carried away without a trace. Multiple sheep and goats may be killed in a single episode, although coyotes only feed upon one, usually consuming muscle or internal organs. Calves are often attacked at the flank, hindquarter, or legs, although newborn calves may be attacked at the throat. Cows attacked while giving birth have severe injuries to the genital organs and hindquarters.

Domestic Dogs: Free-roaming dogs are a serious cause of predation on hardwood rangelands near human dwellings, where dogs are often permitted to roam unsupervised. Many dogs, even well-trained family pets, have a natural inclination to chase livestock. It is not unusual for domestic dogs to join with other dogs in attacking and seriously injuring livestock. The California Department of Food and Agriculture permits livestock owners to receive monetary compensation from the owners of the dogs responsible.

Dogs do not usually feed on livestock they have killed. The carcasses show multiple attack sites on the body and appear mutilated. A dog attack is typically "messy" as compared with a coyote attack. True feral dogs kill for food, and more closely resemble coyote attacks. When a group of dogs attack livestock, they may do so during daylight, they may bark, and be less wary of humans.

Mountain Lions: The incidence of mountain lion attacks on livestock has risen dramatically in recent years, most likely due to increasing lion populations. Lions are seen on hardwood rangelands where they were not present a decade or two ago. Because of their size and capabilities, lions will attack, kill, and feed on various types of livestock, including adult sheep, goats, and cattle.

Mountain lions kill with a single bite, typically to the back of the neck or head, often breaking the necks of the livestock. Larger prey such as cattle or horses may be attacked by lions leaping on their shoulders and biting the neck. Claw marks on the neck, back, and shoulders are evidence of lion attacks. Lions will drag the carcasses to a more secluded location for feeding, and may attempt to cover the carcass by scratching up soil or vegetation.

Although multiple prey may be killed by lions in a single episode, they usually feed on only one carcass. They consume considerably more of an individual carcass than coyotes.

Bears: Because of their omnivorous food habits, bears are commonly found in hardwood rangelands, where they may kill livestock, as well as feeding heavily on acorns and other plant products. They can kill adult cattle and horses, but seem to prefer sheep, goats, calves, and pigs. They may kill multiple livestock when they encounter them on their bedgrounds at night. Bears kill with a bite to the neck and shoulders and may break the neck or back with blows from their paws. Claw marks are often seen on the neck, back, and shoulders of prey. Bears may drag their prey to a secluded location and feed extensively until the whole carcass is consumed, except the hide. Bear droppings and bedding sites are commonly found near the location of the feeding.

Foxes and Bobcats: Because of their small size, these animals usually feed only on lambs and kids and rarely become serious predators. Fox attacks resemble those of coyotes, although tooth punctures are smaller and more closely spaced. It may require multiple bites to subdue their prey. Bobcats usually attack lambs or kids with a bite towards the top of the head. Tooth size and spacing, and claw marks on the carcass, help identify the bobcat. Bobcats may attempt to cover their prey following feeding.

Predator Damage Prevention and Control

Livestock Management: Predation can be reduced by using pastures that have less history of predator problems. Some predators avoid areas of high human activity, so keeping young lambs and kids near to barns, houses or other areas of high human use can be effective. Herding livestock also reduces predation due to human presence.Since coyote predation is often highest during times when the pups are born and being fed, changing lambing, kidding, and calving seasons can help reduce predation. Confining livestock during birthing can also reduce predation. Carrion should be removed from pastures to reduce predator problems.

Exclusion: Various fence designs can protect livestock from predators. Standard woven-wire fencing can exclude coyotes and dogs, or direct their movements in more predictable ways. High tensile, electric fences are also useful. It is more difficult to exclude mountain lions and bears with conventional fence designs, and costs of predator-proof fencing may be prohibitive.

Frightening: Lights, sounds, and other stimuli have been attempted to keep predators from entering pastures with livestock. They have short lived effectiveness, as predators eventually adapt to this stimuli. A strobe-siren device recently developed by USDA shows promise. Chemical repellants for the most part have not been effective. Guard dogs have been used to frighten off predators with mixed success.

Lethal Control: Removal of the predator is often necessary. The landowner may be able to control domestic dogs or coyotes, but larger predators such as bears or mountain lions require a depredation permit issued by the California Department of Fish and Game. Bear, lion, and often coyote control activities are conducted by trained animal damage control specialists, available through cooperatively-funded programs in most counties in California. Check with your local County Agricultural Commissioner or the Department of Fish and Game to see what is available in your area. Specific information on traps and other control methods is also available.

Ranch Management Planning Tools

Developing ranch plans for livestock on hardwood rangelands is a complex and involved process. This chapter has illustrated some of the forage production, grazing, and livestock management considerations that are applicable to operations on hardwood rangelands. It is necessary to conduct detailed planning and analysis, which is beyond the scope of this book. The UC Cooperative Extension Range Program can provide several tools that can help in range planning. These tools are used in Ranch Planning, Grazing Management, and Range Nutrition short courses offered throughout the state with the local Farm Advisors. Some of the specific tools that are presented in these educational materials are discussed below. A complete list of materials available and the address for ordering these are given in the references section.

Calendar of Operations

A calendar of operations chronologically describes the activities in a livestock enterprise. On hardwood rangelands, the calendar starts by listing the timing of activities during the livestock reproductive year. Adding in herd health activities, nutrition, marketing, pasture management, and other production activities will complete the calendar. A completed calendar should include all activities that result in expenditures and income. The calendar can be used for planning and review. It is particularly useful for identifying potential time or labor conflicts when considering new enterprises.

Stock Flows

A stock flow is simply a calendar of livestock inventory, usually by month. Typically, the number of each kind and class of animal is listed at the beginning of each month. This listing can be used to estimate feed demand and to predict numbers of animals to be marketed.

Feed Flow

A feed flow is a calendar of forage and feed availability. It should show feed sources for each month of the year. It will also show when and how much hay or other supplements will be fed during the year. A pasture worksheet is often used to develop feed flows. Comparing feed flows and stock flows allows the manager to estimate periods of forage shortfalls.

Grazing Plans

A grazing plan can be useful if the ranch has many pastures or other forage sources. It is particularly useful for planning rotational grazing. A chart is used to plan what herd will be in what pasture on what day. The chart is also used to record actual grazing locations so that deviations from the plan can be monitored and adjustments made as needed.