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Insects, like taxes and the poor, are always with us. Some insects, however, are more noticeable than others, and ranchers are beginning to notice some little black bugs feeding on their range grasses. In fact, some acreages are so badly infested that the grasses have died. These little "fellers" (3/16 inch) are busy year round sucking grass juices, eventually severely injuring the plant. When an infested range is overgrazed or hit with drought, the plants have no chance to recover and the grass stands may be wiped out.

Utah State University scientists are busy obtaining as much information as possible about the life cycle, means of spread, scope of infestation, and methods of managing and controlling the insect. Read more about grass bugs starting on the next page. Now what do grass bugs have to do with our cover picture? Nothing really — just thought you also might enjoy this scene so typical of Utah's mountains.

Photo by Robert Fleischer
Problems with range grasses?

Look for black grass bugs!

B. AUSTIN HAWS, DON D. DWYER, and MAX G. ANDERSON

Ranchers and range specialists in Utah and in surrounding states have noticed and reported whitish or yellowish spots of grass in their ranges. Sometimes all the grass on a range appears to be completely dry or dead.

Various reasons for these losses of range grasses have been proposed, such as early freezing, droughts, and sometimes insect injury. Undoubtedly, all of these factors have, singly or in combination, sometimes contributed to range grass losses.

With grazing costs and other feeding and production costs rising, many in the livestock industry are saying that if range grass losses continue, substantial changes will have to come about in cattle feeding and management if they are to continue in the livestock business.

In the fall of 1971 the efforts of many individuals and groups, who had been trying to get help to solve some of the problems of range grass losses, were coordinated in a range insect research project supported by the Utah Experiment Station. Later, in July of 1972, the Agricultural Research Service of the U.S. Department of Agriculture joined the research efforts by adding $20,000 to the Black Grass Bug Project.

Four major lines of research have been undertaken. Some objectives of each line of research are listed:

- **Taxonomic studies.** Collect and identify black grass bugs and determine their relative abundance and distribution in Utah. Collect and evaluate other range pests and their potential roles as harmful or beneficial range insects. Develop a range insect collection at Utah State University.

- **Biological studies.** Determine the life cycles and seasonal histories of black grass bugs. Prepare reports showing where they come from; where they are all year; how they develop, feed, and move from one range to another; their "enemies"; and their reactions to climatological and other environmental factors.

- **Plant studies (grasses) as related to black grass bugs.** Determine the general nature of insect injury to grasses (local, systemic, mechanical, physiological) and to specific plant structures (top growth, roots, reproductive parts). Calculate the economics of range grass losses [how much grass bugs eat—their "AUMS" (animal units per month)] and quantify changes in grass production and quality (nutritional value and digestibility) when grasses are protected from insects. Evaluate differences in resistance of grass varieties to insect attack.

- **Studies of management and control of range pests.** Develop systems and principles to be utilized in integrating methods for reducing grass losses, through proper establishment and management of ranges for the maximum benefit of domestic animals, wildlife and beneficial insects. Develop acceptable uses of grass varieties, grazing fertilizers, burning and pesticides to reduce range grass losses.

![Figure 1. A female black grass bug deposits her eggs in a grass stem. Note the ovipositor (egg laying organ) protruding from the middle of the abdomen.](image-url)
WHAT ARE BLACK GRASS BUGS?

Black grass bugs are about 3/16 inch long. They have bulging eyes and whitish buff margins of color around their wings and light markings on their head.

Several kinds of black grass bugs have been identified in Utah; but they are all commonly called black grass bugs. Not very much is known about these different species. Our preliminary observations indicate that certain species seem to be more prevalent in certain areas and types of ranges than in others.

The predominant species studied in 1972 was Labops hesperius (figure 2a). This species appeared to constitute the major problem in Utah.

Many ranges in the state, however, have not yet been examined for black grass bugs or the injury they cause to grasses.

Figure 2b shows a male and female Labops hirtus, found in substantial numbers in ranges near the Duck Creek Ranger Station, in the Fish Lake area and in some of the northeastern ranges of Utah. So far this species has commonly occurred in native grasses and wet meadows. Very little is known about its biology or its total distribution in the state.

A third species (figure 2c), Labops utahensis, has been collected most frequently in the northern and central areas of the state. Its relative numbers and distribution in the state, however, are not well known.

Note this "bug" is much larger than the other black grass bugs. It is frequently found on Giant Wild Rye and is reported to be a pest of crested wheatgrass in Nevada.
Figures 2a, b, and c show that males are usually more slender than females and often have the membranous tips of their wings bent or broken off (figure 2a), because of mating activity. The females have an egg-laying organ or ovipositor located in the posterior midline of the abdomen (figure 1).

Several species of a much larger “black grass bug” of the genus *Irriisia* have also been identified (figure 2d). Little is known about the biology and the average damage done by these larger grass bugs in Utah, but they do enormous damage to giant wildrye (*Elymus cinereus*), and it has been reported that they severely injure crested wheatgrass (*Agropyron desertorum*) in Nevada.

Considerable work remains to be done in determining how the various species are similar or different in their locations and in what they do on range grasses. Most of the information given in this article about black grass bugs applies to observations gathered concerning *Labops hesperius*.

**THE WHERE AND HOW OF BLACK GRASS BUGS**

Apparently, no one knows for sure where the grass bugs originated. When our research project began, some people were saying that grass bugs mostly favored ranges with introduced grasses and not native range grasses. Our observations indicate that the grass bugs are sometimes present in great numbers in the native grass ranges.

At this time, we believe adult black grass bugs move from native grasses on to introduced grasses such as crestedwheat. Just how black grass bugs spread from one range or field to another is not known for certain. They may walk. Some may fly or hitchhike on cars that drive through infested grasses. The bugs may be carried through the digestive systems of livestock or wild animals that eat the grass or other plants that contain eggs. They may be carried as eggs laid in non-grass plants (such as asters, dandelions, clovers, or yarrow) by those who pick and discard these plants as “wild flowers.” If range grasses were clipped and hauled off for hay, eggs in the grass could be distributed this way.

Bugs in general fly only if they have four well-developed wings. We have not seen grass bugs fly. Assuming that a second pair of membranous wings is necessary for flight, however, males and females of different species of black grass bugs vary in their potential for flight.

For example, the female of *Labops hesperius* (on the left in figure 3) has a front pair of wings, but only a vestigial second pair of wings. Preliminary observations indicate that a few of these females do have larger second wings and may fly. The males and females of *Labops hirtus* generally have short “non-flying” types of second wings, although a few individuals of each sex seem to have both pairs of wings well-developed. The wing situation of *Labops utahensis* seems to be about the same as that of *hesperius*. Male and female specimens of *Irriisia* that have been examined have had four well-developed wings.

Ranges heavily infested with grass bugs are sometimes located within a few hundred yards of ranges that have grasses and vegetation of the same age and general conditions yet are not infested. Our present impression, therefore, is that unless the bugs have some help, as just explained, their spread is relatively slow. Relatively slow movement is also suggested by an agency report that the black grass bugs did not reappear for several years in a range where ultra low-volume malathion had been applied.

Eggs are laid in several different places such as in green or dry grass stems, at the base of leaves and in several non-grass plants (figure 4). After the eggs are laid, the embryos inside continue to develop so that by late fall or winter, some body structures can be seen through the egg covering.

When the eggs are laid depends on the location of the ranges and climatological conditions. In the lower valleys and warmer regions the eggs probably are laid in May or June, while they may not be laid until July or August or later in the cooler climate of the higher elevations.

Female *Labops hesperius* have been observed punching holes in dry grass stems with their beak. The female steps forward, inserts her ovipositor...
Grass bugs found along the road to Bryce Canyon were observed feeding when the air temperature was 22°F and snow was present. At the same time the temperature in the grass root crowns measured 44-47°F.

**WHAT DO GRASS BUGS DO**

Grass bugs have piercing, sucking mouth parts, sometimes called a beak. Plants they attack develop yellow or whitish, irregular spots or patches in the leaves, and eventually the leaves dry and die. They do not cut notches or chew holes (figure 6).

**DAMAGE LEAVES**

Black grass bugs usually feed with their head pointing to the ground. The bugs run up and down the stems and leaves, usually starting at the pointed tips of the leaf, and feed rather systematically toward the wider parts of the leaf. Yellow spots begin to appear as the insects feed. The injury appears to be restricted to the feeding area. If the insects die or are removed from grass after they have fed and if there is adequate moisture, the top growth of the plants recovers and the new grass seems to develop in its usual manner.

In a few small feeding trials, the two or three nymphs (as shown in figure 5) placed on a single blade of crested wheatgrass turned the blade of grass yellow or white in 4 to 6 days.

**Figure 4.** Left—Grass stem with a crack made when black grass bug eggs were laid. Dark spots are egg caps. Right—Grass stem with black grass bugs inside. Hatching nymphs leave the egg through egg cap on the left.

into the hole she punched and lays her eggs (figure 1). This is one way black grass bugs lay their eggs, but there may be others. As many as 44 eggs may be found in the ovaries of one female. As a general average, approximately 10 eggs are found together in a grass stem and these appear to have been laid by one female. Several female grass bugs sometimes seem attracted to a certain stem for egg laying. We have observed 125 or more eggs in a single stem of grass.

Present evidence indicates that the eggs require a “cold treatment” before they will hatch. How cold and for how long is not known. Eggs collected in the fall will hatch in about 6 or 7 days at room temperature after being stored for about a month at 40°F. On the basis of our incomplete information, we believe that black grass bug eggs overwinter as eggs in the stems and leaves of grass and other plants previously mentioned. However, eggs may hatch in the fall or during warm periods in the winter. The resultant nymphs may be able to survive in the grass crowns and debris if the snow and cold weather return after the eggs have hatched. This sort of process could explain why second and third instar nymphs were found feeding on crested wheatgrass March 16, 1972, a few days after the snow pack melted, in the Bryce Canyon area.

The time required for an egg to hatch and develop into a mature adult is from 40 to 60 days. So far we can identify only one generation per season in Utah.

Temperature or a combination of factors seem to influence the insects considerably as to whether they are up on the plants feeding or down in the crowns of the grass and the debris.

**Figure 5.** Black grass bug egg, nymphs and adult. Egg left, nymphal instars 1 to 5 middle, adult right. Nymphs shed their “skins” between each stage of growth. Eggs are about 3/64 of an inch. Adults are about 3/16 of an inch. In the alcohol preservative these nymphs have shrunk.
In fields of crested wheatgrass heavily infested with black grass bugs, if the leaves are not all killed, they seem to be stunted and very few reproductive structures develop (figure 7). We are not sure this is due to the grass bug injury. Sometimes the damage is less blatant, but even mildly injured grasses may be less nutritious and digestible.

Grass in ranges heavily infested with grass bugs may "house" 800 to 1,000 grass bugs in a single clump of grass. Their damage potential is obviously enormous. The bugs are sometimes so numerous there seems to be no place for all of them to rest on the plant.

**REDUCE ROOT RESERVES**

In the Bryce Canyon area, crested wheatgrass root samples were taken early in the season, when the grass bugs infestations were low, and again later in the fall after the grass bugs had fed on the grass all season. Preliminary observations indicate that severe grass bug injury to top growth may be critical to grass survival.

In one intermediate wheatgrass range near Tropic Reservoir observed in 1972, the grass bugs had killed the top growth of the plants during the growing season. However, new grass grew after the adult insects died and the rains came. Later, however, cattle were allowed to graze the new top growth closely, thus preventing the plant from manufacturing and storing adequate root reserves.

In another range in the same area, the grass plants appeared to have died after severe damage by grass bugs, when there was insufficient soil moisture to prevent dessication and death of the plants. The amount of precipitation seems critical in determining what happens to range grasses after they have been severely injured by grass bugs.

When grass plant tops are seriously damaged continuously year after year, and root structure and reserves decrease, the effects of drought, exposure of the roots by run off, and the heaving action of freezing may contribute to the eventual loss of grass stands. Figure 8 shows the present condition of two ranges near Tropic Reservoir with a history of several years of severe infestation by grass bugs. Large bare spots are developing in the range, and dead "stubs" of plants are present in many areas.

The 1973 experiments will help determine more precisely what happens to root reserves and to root development under completely protected conditions as compared with those left exposed to heavy insect damage.

**MANAGEMENT AND CONTROL**

One or a combination of methods of control or management may eventually offer acceptable solutions to this range insect problem. For example, grass bug populations have varied considerably in pastures next to each other where seeding methods differed. Grass varieties differed in susceptibility to grass bug injury. Some ranchers have reported fewer grass bugs after infested fields were grazed heavily. Some reports have indicated...
Figure 8. Ranges, that have been heavily infested with black grass bugs such as this one (left) in Blubber Creek, southern Utah, contain many plants with poor top growth and crowns protruding excessively from the soil. Hundred of "bugs" per plant were found in this grass (right) in Whiteman Bench. Black grass bugs spend considerable time in soil cracks and crowns of the grass.

excellent control of the grass bugs with low dosages of short-residual pesticides.

Information gathered over the next few years about each of these alternatives of control should provide a basis for the development of a sound pest management program. Long term, adequate control or management of range pests has to be based on the effects on all important parts of the ecosystem. For example, many case histories show that improper use of the wrong pesticides has resulted in the development of a pest more detrimental to the crop and more difficult to control than the original target insect species.

The person who manages or owns a rangeland heavily infested with grass bugs must, however, immediately take some kind of action, whether he has research data to back him up or not. Ideally, he needs a clear panorama of all major facts needed to act for the maximum benefit of all who may be concerned with range management. In the real world, he can only decide what to do on the basis of the best information we have.

Obviously, the loss of range grasses is not just a "bug" problem. Before an acceptable set of solutions can be

Figure 9. Wheatgrass plants heavily infested by black grass bugs appear to have been heavily grazed by sheep or cattle. Underneath the soil, the roots are few. (All of the above photographs by William P. Nye.)
put together, the "facts" about all the other aspects of range grass management (seeding methods, grazing, etc.) need to be collected and integrated.

**TODAY'S ALTERNATIVES**

*Chemical control.* Two guiding principles may help if chemicals are to be applied for controlling grass bugs. First, apply insecticides after the eggs have stopped hatching and before the new adults can begin to lay eggs. The limited information on hand now indicates the proper time to apply insecticides may be as the nymphs develop into adults. Studies by others indicate adults start laying eggs about 10 days after they reach the adult stage.

The time black grass bugs hatch and mature to adults varies at different altitudes. Continuous field examinations are necessary from the time snow melts until the older nymphs are found if one wishes to protect his range against black grass bugs. Adults appear to die "naturally" after they have mated and laid their eggs in the late summer or fall.

Field tests of several pesticides now approved for use on ranges are being planned for 1973. We do not have experimental data from our area upon which to base control recommendations. Much of the experimental data from other areas is not applicable in Utah. Different ranges may need to be treated differently.

*Clearing and seeding range land.* Some ranges observed in 1972 were interseeded in chained pinyon juniper areas, where sagebrush and other shrubs and native plants were not completely removed. These areas had very good grass stands and relatively few black grass bugs. These particular types of ranges appeared to provide good habitat for many animals, such as lizards, snakes, birds, as well as for spiders and other insect-eating arthropods. In nearby monocultural ranges black grass bugs were abundant.

*Use of grass varieties.* Perry Plummer, Project Leader at the Intermountain Forest and Range Experiment Station, Ephraim, reports that grass variety plots there have showed considerable differences in coloration. Light green and yellowish white colors in 1972 were at least partially associated with differences in insect injury.

Mixtures of grass species planted in various experimental plots around the state have existed for many years. Grasses that have survived in some of these mixtures appear to be some of the same species that were observed in the Ephraim planting to be least infested by grass bugs during 1972.

A collection of 37 native and introduced grasses, mostly Agropyrons and Elymus, indicates that all of them show injury believed to be that of the grass bugs. Grass bugs were found in the ranges where the grasses were collected and they were observed feeding on some but not all of the grasses.

Studies have been initiated to define the possibilities of utilizing different growth patterns and resistance qualities of range grasses to reduce losses to insects.

Much more information is needed concerning the differences in grass bug injury to grasses and the significance of this injury on survival of grass ranges through the years.

*Grazing, rotation and management.* Some livestock producers in the Alton area of southern Utah believe that they have had fewer grass bugs in the spring where the infested ranges have been grazed and most of the dry leaves and stems removed from the previous fall. It seems logical that fall grazing may reduce the number of eggs in a pasture and thereby reduce the number of grass bugs present the following year if the eggs do not survive the trip through an animal's digestive system.

Dried cow manure collected from pastures heavily infested with grass bugs early in the season and later grazed by cattle is being examined to determine if live eggs can be found.

Certain rotation programs need to be reexamined to determine if systems designed to rest the plants and build up root reserves favor outbreaks of black grass bugs.

Studies have been initiated to try to develop grazing plans that can help decrease the grass bug population by destroying their eggs, while avoiding detrimental effects of removing the dry grass that might result in overwintering injury to the grasses or in soil erosion.

What we have seen on the ranges and learned this past year warrants the prediction that range grasses can be protected and that production and quality of range forages can thus be increased economically.

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**WILDLIFE NOTES**

There's no chivalry in the winter woods. When deer are yardsed in deep snow and forage is scarce, fawns of the year often starve because they can't reach a steadily heightening browse line.

Archibald Rutledge, a grand outdoors writer, noted that wild turkeys look black when they're approaching, and silver-grey when retreating. Don't move! The wild gobbler's eyesight is binocular-sharp.

Snowy owls, visiting the United States during midwinter, are day-flyers and frequenters of open country. Therefore they collect occasional pheasants and cottontail rabbits, but rarely enjoy a grouse dinner.

Among flowers that bloom in the fall, there is witch hazel—which breaks out in tiny, plastic clusters of yellow bloom just about the time first frosts are blighting the north woods.
Infectious calf diarrhea, or neonatal calf diarrhea syndrome (scours), has been recognized as a complex, serious disease of calves for many years. The incidence varies considerably by season, by year, and from herd to herd. Calf diarrhea occurs in all breeds of cattle and has caused considerable mortality in beef as well as high milk producing dairy breeds. It has been estimated that up to 25 percent of all calves die before they reach 2 months of age, usually within 10 days of birth, and most often as a result of calf scours.

The precise cause of "calf scours" defies complete description, but the condition is assumed due to a great variety of known, and some unknown, factors.

**INFECTIOUS CAUSES**

Several bacteria can cause diarrhea in calves. Among these bacterial species, virulent *E. coli*, one of the major offenders, has been recognized for 75 years.

In recent years other bacteria have been found in diarrhetic conditions of calves: *Clostridium perfringens*, serotypes of Salmonella species of Chlamydia, Arizona, Providence, Pseudomonas, Klebsiella, Enterococci and Proteus. Predisposing factors, such as stress induced by adverse environment, or a poor nutritional status may contribute to the severity or the actual occurrence of the disease symptoms.

Several viruses can also cause diarrhea in calves. As early as 1943, a virus isolated from sick calves was reported to cause severe fever, diarrhea, and pneumonia in that sequence, when it was introduced into young, healthy calves.

Since that time, viral agents including adeno, herpes, picorna, myxo and reo viruses have been associated with scurging conditions of young calves.

Viruses, like bacteria, are influenced by predisposing factors. These phenomena are poorly understood. In some cases a synergistic action between virus and *E. coli* takes place, and reducing the numbers of *E. coli* in the small intestine will help control the disease.

Attempts to classify cases of calf diarrhea on the basis of virological and bacteriological findings have not been satisfactory.

**CLINICAL SIGNS**

Clinical signs of infectious calf diarrhea can vary widely. The calves usually do not appear sick at birth. A rapid and weak heart beat may be the first recognizable sign. A slight transient increase in body temperature is followed by a normal or sub-normal temperature. Death may occur before diarrhea actually develops. In other calves, a diarrhea with watery or pasty feces may develop and continue for several days. Most of these cases begin within a day or two of birth.

Calves that escape such an early attack, may develop a diarrhea at 4 to 20 days of age.
LESIONS — TISSUE CHANGES

The lesions are often variable and depend largely on the duration of illness prior to death and to some degree on the specific agents present. Dehydration is the most general and constant finding. The gross appearance of the stomach, liver, and intestines are rapidly altered by postmortem changes. The enteritis is usually a mild catarhal inflammation, but sometimes a marked hemorrhagic or hyperemic inflammation of the inner lining parts of the intestine are apparent, along with gas accumulation.

TREATMENT AND PREVENTION

Beef herd managers should maintain a closed herd during the calving season. The geographic location of the calving area on the farm should be changed periodically. Newborn calves should be protected from extremely adverse weather, and sick calves should be isolated if possible.

Drastic changes in respiration, nutrition, and excretion are required of a calf at birth. Failure to accommodate readily to the new environment plus exposure to pathogenic bacteria and viruses often overwhelm the newborn animal.

Immediate and thorough treatment may save a high percentage of animals during less than severe outbreaks. The most beneficial procedure is to preserve or restore the fluid electrolyte and blood pH balance. This is extremely important because death from calf scours often ensues due to chemical alteration of body tissue fluids rather than from toxemia or other direct effects of the infectious agents. Milk feeding should be discontinued and temporarily replaced with small quantities of highly digestible protein such as beef bouillon.

Antibiotics should be used with discretion, and should be directed at specific infectious agents.

Disease prevention by proper housing and management of calves deserves considerable attention. In general, segregation into single calf units that are clean, dry, and properly ventilated is a beneficial procedure. It is extremely important that all utensils used for feed, milk and water be absolutely clean.

Calves at birth have a major deficiency of gamma (α) globulin (a blood protein). This protein can inactivate or destroy disease causing agents. It requires 3 to 4 weeks for a calf to manufacture its own globulin, which is a vital part of any animal’s disease fighting mechanism.

Nature has compensated partly for this deficiency in newborn calves by providing the mother with a colostrum which contains many of the disease fighting materials.

Colostrum should therefore be provided for all newborn calves. Calves must receive this during their first few hours of life if it is to be of the desired value.

Since there is a difference in the gamma globulin content of colostrum from individual cows, attempts have been made to improve the quality of the colostrum by “vaccinating” pregnant cows with specific viruses and/or bacteria found in scouring calves. The colostrum from these vaccinated cows should then protect the newborn calf during its first critical weeks of life. Work on this approach has not progressed to a point allowing recommendations.

FOUR KEYS TO PESTICIDE SAFETY

READ THE LABEL ON EACH PESTICIDE CONTAINER BEFORE EACH USE. Follow instructions, heed all cautions and warnings. Why read the label each time? Because the chemical nature of pesticides and their uses vary greatly. You should refresh your mind each time on the material’s specific uses.

APPLY PESTICIDES ONLY AS DIRECTED. Apply them only to the crops specified, in amounts specified and at times specified in label instructions, or by your agricultural authorities.

STORE PESTICIDES IN THEIR ORIGINAL, LABELED CONTAINERS. Keep them out of the reach of children and irresponsible people. They cannot be properly identified unless they are in original labeled containers. Lock pesticides in a shed away from feed, seed, and other farm supplies.

DISPOSE OF EMPTY CONTAINERS SAFELY. It is almost impossible to remove all material from a container. “Empty” containers contain small amounts of pesticides which could harm children or animals who might get into them. It is best to dispose of empty containers by burying them at least 18 inches deep in an isolated area provided for this purpose away from water supplies.

MARCH 1973
To most Utahns a rabbit is a rabbit, is a varmint. To a scientist, however, that rabbit could be a hare, and to the sportsman it could provide the justification for a day in the field.

Whatever your viewpoint, Utah provides ample opportunities to learn about the Leporidae, the rabbit family, since some of its most interesting and unusual members live in the state. For example, the smallest rabbit, the pigmy rabbit (Sylvilagus idahoensis), which weighs less than a pound, inhabits deserts in western Utah. At the other end of the scale, the white-tailed jackrabbit (Lepus townsendii), actually a hare — weighs up to 10 pounds and occurs in sagebrush plateau areas. A close relative of the rabbits, the pika (Ochotona princeps), is an unusual mammal that looks more like a guinea pig. It frequents rocky slopes above the tree line in Utah.

**HARES AND RABBITS**

Distinguishing rabbits from hares can be difficult. Hares are larger and heavier with longer ears and legs. They are found in more open habitats and generally have larger home ranges than rabbits. Some species of hares turn white in winter, while rabbits retain the same colored coat all year.

Hares and rabbits reproduce differently as well. Female hares, called does, may have as many as four or five litters each season, with two to eight young in each litter. The young are born with their eyes open, are completely furred, and can care for themselves within a few days. The doe returns each day to nurse the young but does not care for them in any other way.

Young rabbits, on the other hand, are born blind, naked and helpless. The female rabbit cares for the young in a nest made of grass and fur until they are weaned. Like hares, rabbits may have several litters in a year and are thus capable of rapid increases in numbers.

Both rabbits and hares are important prey for several mammalian and avian predators. Coyotes, foxes, bobcats, weasels and many species of hawks and owls are included among the prime predators. Predation may play a significant role in population dynamics of predators as well as prey.
species. For example, populations of jackrabbits (*Lepus californicus*) in the Great Basin have been found to fluctuate widely over an approximate 7-year period. Their chief predator, the coyote (*Canis latrans*), fluctuates similarly but lags behind the jackrabbit population slightly. There is evidence that the jackrabbit density affects coyote litter sizes and the percentage of females breeding. Similar relationships have been determined or implicated for other species of lagomorphs.

**THE SNOWSHOE HARE**

Perhaps the least familiar of Utah’s hares is the snowshoe hare (*Lepus americanus*). Snowshoes derive their name from their large hind feet, which allow them to travel effectively over deep snow. The feet are heavily furred and have long toes, to prevent them from sinking in the snow. Snowshoe hares are found in the mountains of the state, primarily in areas with coniferous cover there.

Its abundance makes the snowshoe hare a significant game resource over most of its range. It is considered a game species in 16 of the 24 states in which it occurs, and is hunted in all the provinces of Canada. Only in Newfoundland, where about a million hares are harvested annually, the market value of the meat was approximately $1.25 million dollars in 1970. Hares are more important game meat-producers than even moose and caribou there.

In the western states, the snowshoe hare has received much less attention. Only four of the ten states in which the hares occur, protect the animal in any way. Utah has no closed season on snowshoes and yet the resource is utilized very lightly. This is largely because the public lacks awareness of and information about the species.

**SNOWSHOE HARE RESEARCH**

Research on snowshoe hares in Cache National Forest by the Department of Wildlife Science and the Ecology Center of Utah State University is assessing their resource potential in Utah. Sound management of such a natural resource requires a knowledge of both the renewal rate of the resource and its total magnitude. The reproductive potential of the hares and their population density are therefore basic information in devising careful biological management.

During the breeding season, which begins in late March and extends into
August, hares are collected for examination of their reproductive tracts in order to determine the breeding characteristics of the population. By counting and aging embryos, the average litter size and the number of litters produced annually can be determined. These data are combined with survival rates for the adults, to give the actual reproductive output of an average female in the population for the entire breeding season.

The density of hares in a given area is determined by live trapping and tagging animals for recapture or by removing animals by snaring. Using more than one method of estimation permits comparison of the results and promotes accuracy in estimating the population density. Extrapolating the density levels over the areas of the state that provide suitable habitat will yield rough population estimates for Utah’s public lands.

**SOME KNOWNS AND UNKNOWNS**

Densities of well over 150 snowshoes per square mile have been recorded in the mountains of Colorado and Utah. Their abundance is closely related to the coniferous forest types and distribution is therefore somewhat patchy in the mountainous habitat. The snowshoes’ abundance in the Rockies compares favorably with that in the central parts of its Canadian range.

The populations in the Rocky Mountains are similar in reproductive capabilities to populations further to the North. Up to three litters may be produced in a summer by a female although the average as a whole is somewhat lower. Litter size varies from two to nine offspring per litter, averaging about 4.5 young per litter. Thus an average female can produce over 10 young per year if she lives through the whole summer.

Accounts from hunters and trappers indicate possible periodic scarcities of hares in this area, but regular fluctuations, as seen in other parts of the species range, are doubtful. The intriguing question is why Utah’s pop-
An Australian research team has developed equipment to check how much benefit grazing animals get from the pasture they are eating. The equipment is a breakthrough for animal nutrition researchers. It will enable them to test animals under normal conditions, outside laboratories and confined areas. It also will help eliminate errors caused by changes in animal biochemistry when they are handled or confined. The technique was developed by a research team of scientists at the Department of Biochemistry and Nutrition in the Faculty of Rural Science at the University of New England at Armidale, New South Wales.

In the past, scientists have been able to make many detailed studies on housed animals. The lack of suitable equipment prevented similar studies on animals grazing in open pasture. Although these studies have been important to nutritional research, the confinement and handling of some animals, particularly sheep, caused temporary changes in their body chemistry which affected samples taken from them. The Australian research team has developed instruments that can be mounted on the backs of animals and take samples from the stomach and blood continuously or at predetermined times. They used radioactive tracer techniques to examine in details the use animals made of the feed they ate.

Three different instruments to take samples from the blood and stomach were developed. They were simple, robust, inexpensive, and consistently reliable. All were based on clockwork mechanisms.

One is an apparatus that withdraws a sample of ruminal fluid from the stomach continuously at a constant rate. It consists of a syringe attached to a clock assembly. The flow rate into the syringe can be changed by altering the size of the mainspring winder spindle. A sampling probe in the animal's rumen are attached to the syringe by a polythene tube. The whole mechanism and syringe are bolted in a weatherproof plastic box and carried in a pocket in a harness worn by the animal.

A similar instrument withdraws blood at a predetermined time by attaching the syringe plunger to the alarm spindle on the clock mechanism. The catheter inserted in the animal's jugular vein contains heparin to overcome clotting. Withdrawal of a 20 milliliters (ml) (two-thirds of a fluid ounce) sample of blood may be prolonged for about 3 hours. At longer periods a blood clot may form at the catheter tip, causing blockage. However, withdrawal periods of about 1½ hours have been used repeatedly with success.

The third instrument, for taking a continuous sample of blood, is more complicated and involves two syringes. Both syringes were connected by rack and pinion drives to the one clockwork mechanism. One rack slowly withdraws the plunger of one syringe, taking an 18 ml (five-eighths of a fluid ounce) blood sample over 15 hours.

The other depresses the second plunger, forcing a steady flow of heparin into the animal through the sampling period.

The blood was withdrawn from the animal through a catheter in the jugular vein. The polythene catheter passed through a metal Y-piece. This gave access for a thinner tube from the heparin syringe which passed into the catheter and continued the length of it to within 1 millimeter (.04 inch) of the tip inside the vein.

Researchers report that once animals are accustomed to the equipment they appear to graze normally during its use; observers saw no unusual behavior.
Economists and businessmen are optimistic about 1973. Consensus forecasts call for a real growth rate of 5.5 to 6 percent, a rate of inflation of around 3.5 percent, and an unemployment average of 5 percent. What does this mean for farmers and agricultural firms? There may be some renewed pressure on costs in 1973. But more importantly, it indicates a continued strong demand for food and other agricultural products.

Measured by employment, the United States has changed from an agricultural economy, to an industrial economy, to a service economy. Of the total civilian work force of 82 million, about 62 percent are now employed in service occupations, in wholesale and retail trade, and by government agencies. About 4 percent are employed in farming and 34 percent in manufacturing, mining, construction, transportation, and utilities.

Consumers are in a spending mood. Per capita disposable income after taxes has never been so high. Here is the record for the U.S. since 1965, according to the Commerce Department:

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Capita Disposable Income, U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>$2,436</td>
</tr>
<tr>
<td>1966</td>
<td>2,604</td>
</tr>
<tr>
<td>1967</td>
<td>2,749</td>
</tr>
<tr>
<td>1968</td>
<td>2,945</td>
</tr>
<tr>
<td>1969</td>
<td>$3,130</td>
</tr>
<tr>
<td>1970</td>
<td>3,366</td>
</tr>
<tr>
<td>1971</td>
<td>3,596</td>
</tr>
<tr>
<td>1972</td>
<td>3,954</td>
</tr>
</tbody>
</table>

The number of farms in Utah in January was down to 12,600, 400 fewer than a year earlier. Total net income per farm in Utah is up. According to the latest U.S.D.A. reports, Utah farmers had an average net income of $4,042 in 1969, $4,516 in 1970, and $4,658 in 1971. Utah's neighbors fared much better, however. Farmers on the average realized net incomes of $8,412 in Idaho, $7,171 in Wyoming, $7,827 in Colorado, $10,437 in New Mexico, $34,616 in Arizona, and $10,993 in Nevada. The U.S. average was $5,581.

Current prices for raw wool in the world export market are the highest since early 1951. Declining production and expanded consumption have resulted in heavy demand for wool since mid-1972. Japanese buyers have increased their purchases, as have European dealers.

According to the Statistical Reporting Service, Utah turkey growers plan to raise 4,100,000 turkeys in 1973, a 5 percent increase over last year.

The price of farm real estate nationally is expected to increase during the coming year by about 8 percent, the same as for the past year.

Demand for farm loans will likely increase even though the cost of credit will probably remain relatively high. Indications are that fiscal and monetary policies will cause interest rates to remain at about or slightly above current levels well into 1973.
Silage for fattening cattle

JOHN BUTCHER and HOWARD LLOYD

Silage has been increasingly popular in Utah during the past few years. High yields, 30 tons or more per acre on a wet basis, are reported for corn silage. This would be 8 to 10 tons per acre on a dry matter basis, which is a higher yield than commonly expected from alfalfa or other field forage.

The results of two corn silage feeding trials are given in table 1. The diets without corn silage were approximately 59 percent rolled barley, 30 percent dried beet pulp pellets, 6 percent chopped alfalfa and straw and 5 percent protein, vitamin, mineral and stilbestrol pellets. When the silage was added it was substituted for the chopped hay and straw and beet pulp. The cattle in trial I were balanced numbers of Holstein and Hereford steers, while trial II included only Hereford heifers.

These trials definitely indicated the merit of corn silage in cattle fattening diets. A notable observation, especially in trial I, was the complementary effect of the corn silage in getting the animals to consume the diet more readily and with less wastage, which led to a saving of almost a pound of feed per pound of grain.

It should be emphasized that this silage was well preserved and had very limited spoilage.

Feeding stilbestrol has been banned since these experiments, therefore, the feed requirements may be greater now, but the relative comparisons are expected to remain valid.

The Ogden Area Beef Feeders furnished the cattle and feed that made these experiments possible. Bruce Russell and J. Medina helped collect and used part of these data for M.S. theses.

Table 1. Silage feeding experiments at USU with individually fed cattle

<table>
<thead>
<tr>
<th># of animals</th>
<th>Trial I</th>
<th>Trial II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement averages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial wt (lb)</td>
<td>720</td>
<td>563</td>
</tr>
<tr>
<td>End wt (lb)</td>
<td>1158</td>
<td>897</td>
</tr>
<tr>
<td>Daily feed main trial (lb)**</td>
<td>22.9</td>
<td>18.7</td>
</tr>
<tr>
<td>Daily grain main trial (lb)**</td>
<td>2.88</td>
<td>2.02</td>
</tr>
<tr>
<td>Daily grain total trial (lb)**</td>
<td>2.56</td>
<td>1.95</td>
</tr>
<tr>
<td>Feed conversion main trial</td>
<td>8.05</td>
<td>9.25</td>
</tr>
<tr>
<td>Feed conversion total trial**</td>
<td>8.57</td>
<td>9.23</td>
</tr>
<tr>
<td>Carcass wt (lb)</td>
<td>674</td>
<td>521</td>
</tr>
<tr>
<td>Ribeye area (sq in)</td>
<td>11.5</td>
<td>11.9</td>
</tr>
<tr>
<td>Back fat (in)</td>
<td>0.31</td>
<td>0.45</td>
</tr>
<tr>
<td>Carcass conformation</td>
<td>6.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Carcass grade***</td>
<td>6.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Cutability %</td>
<td>51</td>
<td>53</td>
</tr>
</tbody>
</table>

*Corn silage at air dry equivalent. In the first trial the silage was constant, but the second trial started with approximately 36% silage and was reduced to 12% at the final stages of fattening.
**Includes approximately 25 days of initial adjustment.
***5=choice, 6=choice minus, and 7=good plus.

DEMAND FOR BEEF WAY UP

The demand for beef is up sharply. Consumers are eating more than ever, despite higher prices. Prices will remain high until supply catches up with demand, if it can. When consumers earn more money, they improve the quality of their diets, and this generally means more beef. As can be seen from the following U.S.D.A. figures, per capita consumption of beef is up 33 percent since 1962:

<table>
<thead>
<tr>
<th>Per Capita Consumption of Beef, Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962............. 88.8</td>
</tr>
<tr>
<td>1963............. 94.5</td>
</tr>
<tr>
<td>1964............. 99.9</td>
</tr>
<tr>
<td>1965............. 99.5</td>
</tr>
<tr>
<td>1966............. 104.2</td>
</tr>
<tr>
<td>1967............. 106.5</td>
</tr>
<tr>
<td>1968.............109.7</td>
</tr>
<tr>
<td>1969.............110.8</td>
</tr>
<tr>
<td>1970.............113.7</td>
</tr>
<tr>
<td>1971.............113.3</td>
</tr>
<tr>
<td>1972.............115.5</td>
</tr>
<tr>
<td>1973.............118.0</td>
</tr>
</tbody>
</table>
Certain avian species are known to deposit their eggs into active nests of different species, after which they abandon them to the care of the foster parents. To the biologist, this is known as parasitic nesting. A nasty and inferior practice by human standards, it is perfectly natural and biologically "moral" in avian society. Parasitic nesting is most common among certain members of the duck family, cuckoo birds, cowbirds, pheasants, weaverbirds, and honeyguides.

During a cooperative waterfowl study conducted by Utah Division of Wildlife Resources and the Utah Cooperative Wildlife Research Unit at Utah State University, researchers located several parasitic nests. Two mallard nests were parasitized by pheasants and a shoveler nest was parasitized by a cinnamon teal. Each of the nests was marked to facilitate subsequent evaluation of the success of the nests. As fate would have it, one mallard-pheasant nest and the shoveler-cinnamon teal nest were destroyed by marsh predators. The one mallard-pheasant nest that survived nature's forces produced six pheasant chicks and eight mallard ducklings for the mallard hen mother to manage (figure 1).

Several questions developed from these observations. One of them centers on the number of eggs. The average clutch size for a mallard is 10 eggs and that of a pheasant is 12 eggs. Then why were there only 14 rather than 20 to 22 eggs in this nest? The answer depends upon birds being divided among two types of layers: determinate birds that stop after laying a certain number of eggs; and indeterminate birds that continue to lay until a definite number of eggs have accumulated in the nest. Pheasants and ducks are indeterminate layers. If eggs are added or removed from their nests during egg laying, it influences the total number of eggs they ultimately will lay. Biologists believe that indeterminate type birds are clued by the way the eggs in the nest push against the abdominal surface of the hen. When the proper number of eggs exerts the critical pressure, a signal is relayed to the endocrine glands. Egg laying stops, and a secretion of a prolactin-type hormone initiates incubation behavior.

Another question, what happens to pheasant chicks that have a mallard mother? Obviously, since a pheasant does not have webbed feet, it cannot take to water. Due to this physiological barrier and many behavioral mechanisms, the pheasant chicks will not be able to rally to the mallard hen's call, nor will they be able to cross bodies of water during their feeding activity. However, the pheasant chicks are not entirely doomed after the loss of their foster mother and brood mates. With a little luck, the pheasant chicks may survive in the habitat surrounding the nest site, since a mallard normally builds its nest in semi-dry to dry areas, rather than over water. These areas undoubtedly can provide an adequate nutritional supply of insect and seed material, not to mention sufficient cover and protection from inclement weather conditions. This postulate is further supported by the fact that successful pheasant nests are often discovered in similar habitat.

While parasitic nesting is not considered uncommon, many people are surprised to learn of this phenomenon, especially with a species as familiar as the pheasant. The biologist, realizing that parasitism occurs commonly among particular avian species, anxiously waits a chance to observe this fascinating phenomenon at some point in his own career.

LARRY B. DALTON and SCOTT M. STENQUIST are a Graduate Student of Utah Cooperative Research Unit in the Department of Wildlife Resources. SCOTT M. STENQUIST is a Graduate Student in the Department of Wildlife Resources.
SNOWSHOE HARES
(Continued from page 14)
ulations remain fairly stable while comparable groups fluctuate widely. Disease is probably not a major factor in hare demographics, since they are nearly free of any parasites. Discontinuity of the habitat in Utah may regulate increases in hares over large areas. Another possibility is that the variety of predators in the state affects their abundance. These questions can only be answered by additional research.

In the meantime, the increasing demands for all kinds of outdoor recreation in Utah should enhance snowshoe hares as a resource. To date, they have been apparently properly managed by default, but information from studies of their biology will facilitate future careful use. Besides being a good target for the hunter’s shotgun or rifle, the snowshoe is good eating too. Why not give the snowshoe a try? Here is one recipe that may make the effort worthwhile.

Snowshoe hare — Clean the hare in the field; skin and wash it well at home. Cut the animal in half (along the backbone). If desired, marinate in buttermilk marinade, described below.

Rub with salt and brush with melted butter (margarine will burn). Wrap legs with bacon strips. Roast in moderate (325°F) oven, basting often, until tender, about 1 hour. To make gravy: cook pan drippings with water or bouillon broth and thicken by stirring in ½ cup of sour cream that has been mixed (cold) with corn starch. Serve with potato dumplings, red cabbage and cranberry sauce.

Serves 2-3 persons.

Buttermilk marinade — This will reduce the “gamey flavor” of most game animals. Make enough to cover meat. Basic recipe: add two bay leaves, several lemon slices and six each of pepper corns and dried juniper berries to one quart of buttermilk. Allow meat to stand in marinade for 24 to 48 hours at 40°F. Remove, wash briefly and dry before cooking.

MARCH 1973
Livestock Poisoning

Wayne Binns and Eugene H. Cronin

Over the years, numerous cases of plant poisoning in livestock have been misdiagnosed and many thousands of dollars have been spent treating animals for diseases that did not exist. Whenever sick animals are examined by a competent veterinarian and the diagnosis is not specific, the possibility of poisoning by plants should be investigated. Information pertaining to poisonous plants and their effects on animals may be obtained from the Utah Agricultural Extension Service or the USDA, ARS, Poisonous Plant Research Laboratory, Utah State University, Logan, Utah.

Some poisonous plants will cause signs of poisoning and/or death within minutes after ingestion. In other cases, clinical signs of toxicosis may not be manifested for 3 to 4 months. Occasionally, plant poisoning may not be suspected until a carcinogenic-type growth is found in specific organs during postmortem examinations, or when deformed offspring are born, or when young animals do not grow and develop normally.

To identify the toxic agents in poisonous plants, the chemical analysis must be very exacting and detailed. Errors that frequently have resulted from hasty conclusions based on inaccurate chemical analysis, have then been perpetuated in the literature. Actually, the chemical agent must be purified, chemically characterized, and tested for its physio-pathological effects on susceptible experimental animals before it can rightfully be incriminated as a toxic principle in a poisonous plant.

Traditionally, most stockmen associate disease conditions in animals with infectious agents, heredity or nutritional deficiencies. In reality, research has shown that many symptoms of sub-lethal plant poisoning in livestock closely resemble many infectious, hereditary and nutritional diseases. For example, physical retardation may be caused by certain antemembolite factors in specific plants.

The diagnosis of plant poisoning in animals is not an easy or precise procedure. Any case of sudden illness or death with no apparent cause is commonly considered to be a poisoning. This may not always be correct. When a large number of animals are suddenly affected, however, a suspicion of poisoning is justified until it has been proven otherwise.

Clinical signs induced by ingestion of poisonous plants may include: (1) acute death; (2) transitory illness; (3) general body weakness; (4) disturbance of central nervous, vascular, and endocrine systems; (5) photosensitization; (6) frequent urination; (7) diarrhea; (8) bloating; (9) chronic debilitation and death; (10) embryonic death; (11) fetal death; (12) abortion; (13) extensive liver necrosis and/or cirrhosis; (14) edema and/or ascites; (15) tumor growths in tissue; (16) congenital deformities; (17) metabolic deficiencies; and (18) physical injury.

No general set of clinical signs per se irrefutably provide all the information necessary to make a diagnosis of plant poisonings. A careful description of the toxic signs coupled with information pertaining to available plants provides a meaningful basis for a tentative diagnosis. Information essential to a poisonous plant diagnosis is:

1. The type of feed and site grazed, availability of water, and prevailing management practices before illness occurred.
2. Specific identification and relative abundance of all known poisonous plants available to the animals.
3. Amount and stage of growth of the various poisonous plants being grazed.
4. The toxicity and palatability of the plants in relation to their stage of growth.
5. Time from ingestion of plants until onset of toxic signs.
6. Species, age and sex of animals affected.
7. Clinical signs of toxic reactions.
8. Chemical analysis of plants.
9. Careful evaluation of all the information relative to the etiology of the disease. This evaluation must be made by technically trained individuals with experience in poisoning of livestock by plants.

Often, no specific gross lesions are found during post-mortem examinations of animals dying suddenly from plant poisoning. This is not the case in infectious diseases. Usually, plant poisoning does not start out as an inflammatory reaction. The first insult to the body is a chemical change within the cells. This in turn disturbs the function of the cells, which results in disfunction of an organ. Organ impairment, if not fatal, is followed by clinical signs of a toxic reaction, and later by gross and histopathological lesions.

Wayne Binns is Director of the Poisonous Plant Research Lab, Agricultural Research Service.
Eugene H. Cronin is a Plant Physiologist in the Department of Botany.
One question frequently asked is, "Why do animals eat poisonous plants?" Despite many studies, the complete answer has not been obtained. Many poisonous plants such as poison hemlock are unpalatable to livestock and are eaten only when palatable forage is not available. Rain, melting snow, or heavy dew may enhance the palatability of some poisonous plants. The feed intake of thirsty animals is reduced until their thirst has been quenched, but then, they will become ravenously hungry and eat large quantities of most any plant that is available, including some of the most nonpalatable poisonous plants. Other poisonous plants such as lupine, horsebrush, death camas may be readily eaten only at certain stages of growth. Some, including locoweed, black nightshade, birds foot trefoil are readily eaten at any stage of growth or when mixed with hay. Poisonous plants, such as milk vetch, larkspur and halogeton, are highly palatable to livestock, and when these plants are abundant even in small areas, losses will occur.

The most common reason for animals eating poisonous plants is the total lack of sufficient palatable forage. Another common cause, especially with cattle, is seldom recognized as significant by the livestockmen. This is the change in the palatability and nutrients of grass-type plants after they reach maturity. A live plant is never static. When grasses and grasslike plants reach maturity, usually just before the peak of flowering, their metabolic processes slow down, with consequent decreases in plant palatability and in nutrients—proteins, sugars, minerals and vitamins. Close observation has shown that at this time cattle will start eating the leaves from some forbs, especially succulent forbs, and browse-type (woody) plants. As the grass-type plants continue to decrease in palatability and nutritive value, the animals will eat more and more forbs and browse-type plants including the leaves, twigs and stems of many trees and shrub-type plants.

As their food preferences change, the animals also utilize more normally nonpalatable plants, some of which may be poisonous. Proper feed supplementation at this time may reduce the animal's deprived appetite in addition to maintaining body weight and providing for continued growth and development. Too frequently, animals are turned on range areas with little attention being given to the amount of palatable, nutritious forage available. When the spring growth of plants has been delayed, forage may be insufficient, and the hungry animals will eat most any plant to keep alive. It is under such conditions that low larkspur, oakbrush and chokecherry poisonings are common.

Some of the common poisonous plants on intermountain ranges, to which cattle and sheep are susceptible at specific times of the grazing season are shown in table 1.

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**Table 1. Type of range animal susceptible to poisonous plants at definite seasons**

<table>
<thead>
<tr>
<th>Poisonous to cattle</th>
<th>Time of year</th>
<th>Poisonous to sheep</th>
<th>Time of year</th>
<th>Poisonous to cattle &amp; sheep</th>
<th>Time of year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber Milk Vetch</td>
<td>Spring</td>
<td>Horsebrush</td>
<td>Spring</td>
<td>Desert Parsley</td>
<td>Spring</td>
</tr>
<tr>
<td>Oak</td>
<td>Spring</td>
<td>Death camus</td>
<td>Spring</td>
<td>Chokecherry</td>
<td>Spring</td>
</tr>
<tr>
<td>Low larkspur</td>
<td>Spring</td>
<td>Rubberweed</td>
<td>Summer</td>
<td>Broomweed</td>
<td>Spring and Summer</td>
</tr>
<tr>
<td>Water hemlock</td>
<td>Spring</td>
<td>Sneezeweed</td>
<td>Summer</td>
<td>Loco</td>
<td>Spring</td>
</tr>
<tr>
<td>Tall larkspur</td>
<td>Early Summer &amp; early fall</td>
<td>Greasewood</td>
<td>Fall</td>
<td>Copperweed</td>
<td>Summer</td>
</tr>
</tbody>
</table>

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**WILDLIFE NOTES**

If you hook a fish in the gill or stomach area and do not wish to keep it, clip the leader off as close to the fish as possible. It will dissolve in a matter of a week to ten days, with no harm to the fish. Otherwise, use a disgorger. You can mortalively wound a fish if you take the hook out improperly or carelessly.

- Snakes probably are unable to detect airborne vibrations. This means that a rattlesnake has never heard its own or another's rattle.

- The male ostrich has several wives. They all lay their eggs in one nest, then leave all the hard work to father. He does all the work of hatching out his large family.

- Ants are capable of lifting 52 times their own weight, which is equal to a man lifting 8,000 pounds.

- In streams containing trout, squawfish and suckers, with squawfish predominating, river otters have been known to content themselves with squawfish.
Mountains and associated "back valleys" of Utah

A. R. Southard and LeMoyne Wilson

The Wasatch Front in Utah includes part of 3 National Forests and is an invaluable source of water, minerals, timber, range, wildlife and recreational space. In addition, the area is aesthetically pleasing to millions of people who annually view this kaleidoscopic scene. Besides those who live in the "back valleys" year-round, the number of "summer" residents is increasing.

The burgeoning population (resident and transient) implies an urgent need for careful planning for the uses of this space and its resources.

By focusing attention on the soil resources of this part of Utah and indicating their major properties and limitations this article tries to clarify factors important in developing viable land use plans for large tracts of land. The soils properties discussed in this article are depth, slope, stoniness, texture, drainage and temperature. These are the essential soil properties that must be considered in general planning.

The information presented is based on a recently completed soils map of Utah. No attempt is made to identify problems that might be encountered in individual fields or on individual ranches. Such detailed information may be obtained from unpublished soil maps and reports available at local Soil Conservation Service offices or from the Utah Agricultural Experiment Station. The accompanying soil map shows the areas and major kinds of soils discussed in this paper.

**Physiography, Relief and Drainage**

The Wasatch Mountains are part of the Middle Rocky Mountains Physiographic Province.¹


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LeMoyne Wilson is an Associate Professor Emeritus in the Department of Soil Science and Biometeorology.

Figure 1. Location of the Wasatch Mountains and associated "back valleys."
The western slopes of the mountains are very steep and remarkably straight, while those on the east are less steep and much more irregular. Generally, the range grades into dissected plateaus toward the east. For a distance of about 35 miles in the vicinity of Salt Lake City and Provo the range was glaciated. The largest glaciers descended westward for a distance of approximately 10 miles to an elevation of about 5,000 feet.

Three major streams, that have their headwaters in the Uinta Mountains, cut through the Wasatch Mountains and discharge into Great Salt Lake. The Weber River emerges at Ogden. The Provo River passes through a canyon to Utah Lake, which drains to Great Salt Lake through the Jordan River. Bear River cuts through the Wellsville Mountains in Northern Cache Valley and drains to the Great Salt Lake. Major streams that have their headwaters in the Wasatch Range are the Logan River, the Blacksmith Fork River and Little Bear River. All of these flow through Cache Valley and drain into the Bear River. The Ogden River joins the Weber River west of Ogden and flows into Great Salt Lake. Most of the numerous smaller streams also drain westward to the Valleys of the Wasatch Front.

**CLIMATE**

The Wasatch Mountains markedly influence their own climate and that of the surrounding valleys. Most of

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**Figure 2. Soils of the Wasatch Mountains and “back valleys.”**

**Legend**

<table>
<thead>
<tr>
<th>Map Symbol</th>
<th>Association Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elwood-Dateman-Baird Hollow Association (Argic Cryoborolls, Pachic Cryoborolls and Cryic Paleborolls).</td>
</tr>
<tr>
<td>22</td>
<td>Holmes-Kovich Association (Typic Argixerolls and Cumulic Haplaquolls).</td>
</tr>
<tr>
<td>23</td>
<td>Horrocks-Bradshaw Association (Typic Argixerolls and Typic Haploxerolls).</td>
</tr>
<tr>
<td>25</td>
<td>Agassiz-Bradshaw Association (Lithic Haploxerolls and Typic Haploxerolls).</td>
</tr>
<tr>
<td>26</td>
<td>Smarts-Bradshaw-Broad Association (Pachic Argixerolls, Typic Argixerolls and Calcic Argixerolls).</td>
</tr>
<tr>
<td>27</td>
<td>Parleys-Kidman-Avon Association (Calcic Argixerolls and Calcic Haploxerolls).</td>
</tr>
</tbody>
</table>
the area's storms approach from the northwest. Generally, precipitation increases with increased elevation, from the west front to the highest elevations. The mean annual precipitation ranges from about 18 to over 40 inches. Much of the precipitation, especially in the higher mountains, comes as snow. Mountain areas with elevations ranging from 8,000 to 11,000 feet are extremely valuable for collecting and storing moisture for use in the valleys below during the summer months. Closely associated with the Wasatch Mountains are a number of relatively small upland valleys locally referred to as "back valleys". These valleys range in elevation from about 5,000 to 6,000 feet.

The climate in the back valleys is generally somewhat cooler and wetter than that of the Wasatch Front valleys. The average annual precipitation at Heber City is 16.3 inches, compared to 14.6 at Provo. The length of the frost free (growing) season is 84 days at Heber compared to 120 days at Provo and 160 days at Ogden. There are also some differences among the climates of the back valleys. For example, the Morgan and Ogden valleys have somewhat longer growing seasons and warmer soil temperatures than do other back valleys.

The upland valleys are used mainly for irrigated farming. Because of their relatively short growing season, irrigated pastures and hay (alfalfa and grass) are the main crops. Dairying, beef cattle and sheep production are the major agricultural pursuits. The surrounding foothills and mountains provide important supplementary grazing.

These upland valleys and the adjacent foothills are, however, increasingly attracting suburban developments.

DESCRIPTION OF THE SOILS

The soils of the area occur in 6 different associations. The Elwood-Date­man-Baird Hollow Association (Argic Cryoborolls, Pachic Cryoborolls and (Cric Paleborolls) are cold soils of the high mountains. Elevations range from about 8,000 to 12,000 feet. The average soil temperature during the summer months at the 20 inch depth is less than 59°F.

The Holmes-Kovich Association (Typic Argixerolls and Cumulic Haploquolls) is located in the back valleys. The elevation of these valleys is from about 5,200 to 6,000 feet.

The soil temperature for the summer months in these soils is somewhat higher than 59°F, but the average annual soil temperature is less than 47°F. These soils are thus too cold except for the more hardy crops such as hay and pasture and some barley and oats.

The other 3 soil associations occur in the adjacent mountains at elevations of about 6,000 to 8,000 feet. The summer soil temperatures are 60°F or more but, as in the back valleys, the annual soil temperatures are less than 47°F.

Descriptions of each of the 6 soil associations follow: Elwood-Date­man-Baird Hollow Association (Argic Cryoborolls, Pachic Cryoborolls and Cric Paleborolls).

This association is located in the higher portions of the Wasatch Mountains. Elevations range from 8,000 to 12,000 feet and the relief is strongly rolling to very steep.

The climate is characterized by cool summers and cold winters, with an average annual precipitation ranging from 25 to over 40 inches. The mean summer soil temperature at a 20-inch depth is less than 59°F. This association consists of about 25 percent El­wood, Hourglass and Sessions soils, 25 percent Date­man, Day­bell and Hail­man soils and 25 percent Baird Hollow and Lucky Star soils, with inclusions of other soils and rock out­crop. The Elwood, Hourglass and Ses­sions soils are mainly deep with hard bedrock below 40 inches. The surface horizon is dark-colored, usually with fine loamy textures. The subsoil is more finely textured than the surface, ranging from fine loamy to clayey, and it usually contains large amounts of gravel and cobbles. The Date­man, Day­bell and Hail­man soils are deep, with dark-colored surface soils more than 16 inches thick. Textures are mainly loamy with varying amounts of gravel and cobbles. The subsoil texture ranges from coarse loamy to fine loamy, usually with a marked increase in gravel and cobbles.

The Baird Hollow and Lucky Star soils are deep with dark-colored surface soils underlain by a light-colored, leached and bleached horizon. Textures are mainly coarse loamy or fine loamy. The finer textured subsoils occur deeper than 24 inches below the surface. Textures are mainly fine loamy, generally with a high content of gravel, cobbles, and stone.

The soils of this association are well drained. Permeability is moderately slow. Runoff is medium to slow and sediment production is moderately low.

The principal vegetation consists of aspen, spruce, and fir with associated grasses, forbs, and shrubs.

Land uses that destroy or disrupt the plant cover of these thick, dark­colored surface soils should be avoided. Otherwise, erosion and sediment production will rapidly accelerate, especially during intense storms. Holmes-Kovich Association (Typic Argixerolls and Cumulic Haploquolls).

This soil association is located in mountain valleys east of Salt Lake City and Provo. The valleys are generally traversed by major streams such as the Provo and Weber rivers. The major areas where these soils occur are in Heber and Kamas valleys.

These soils are usually dry during the summer months unless they are irrigated. The mean annual precipitation ranges from 14 to 25 inches. The average annual soil temperature at the 20-inch depth is slightly less than 47°F. This association consists of about 50 percent Holmes and Manila soils, and 25 percent Kovich and...
Crooked Creek soils with inclusions of other soils.

The Holmes and Manila soils are deep and occur on alluvial fans and terraces. They have dark silty surfaces, and fine loamy or clayey subsoils that are generally gravelly or cobbly.

The Kovich and Crooked Creek soils are poorly drained. They have thick, very dark brown or black surfaces, over strongly mottled subsoils. Textures are fine loamy or clayey. Gravel and cobbles are common below 3 feet in some areas. These soils are on flood plains and low river terraces and they are often affected by a high water table. Use of these soils for permanent structures should be carefully considered. Residences should not be constructed on flood plains, and special precautions are necessary when building on soils with high water tables.

The Holmes and Manila soils are well drained, while the Kovich and Crooked Creek soils are poorly drained. Permeability ranges from medium to slow and runoff is slow to medium and sediment production is low.

The Kovich and Crooked Creek soils are used mainly for meadow hay and pasture, and to some extent for irrigated crop production, but are mainly spring-fall grazing lands. The vegetation in uncultivated areas is oakbrush and sagebrush, with associated grasses and forbs.

Horrocks-Bradshaw Association (Typic Haploxerolls)

This association is widely distributed in the Wasatch Mountains. The soils are on steep to very steep mountain slopes at elevations ranging from about 6,000 to 8,000 feet.

This soil association consists of about 35 percent Horrocks and Yeates Hollow soils, 20 percent Bradshaw and Mud Springs soils and 20 percent Broad and Sheep Creek soils, with inclusions of other soils and Rock Outcrop.

The Horrocks and Yeates Hollow soils are moderately deep to deep. They have dark brown, gravelly or cobbly loamy surface horizons underlain by cobbly, gravelly or very cobbly fine loamy or clayey subsoils. Bedrock occurs below 20 inches.

The Bradshaw and Mud Springs soils are deep or moderately deep. They have dark, gravelly, cobbly or very cobbly, loamy, surface horizons and very cobbly, coarse, loamy subsoils.

The Broad and Sheep Creek soils are deeper than 36 inches. They have dark, gravelly or cobbly, loamy surface horizons and very cobbly or very gravelly, fine, loamy subsoils that are underlain by a layer of soft lime usually at depths ranging from 15 to 36 inches. Fractured limestone or sandstone bedrock occurs below the lime horizon.

The soils are well drained. Permeability is moderate, runoff is moderately rapid and sediment production is medium.

Native vegetation consists of mohogany, oakbrush and associated shrubs, grasses, and forbs. Most of these soils are used for watersheds and grazing.

As moisture storage capacity is related to soil depth, any uses tending to encourage soil removal from areas of this association that have a low water-holding capacity should be avoided.

Agassiz-Bradshaw Association (Lithic Haploxerolls and Typic Haploxerolls)

This association is located in the Wasatch Mountains from northern Cache County southward to the upper drainage of Weber River in Summit County. It is extensive along the steep mountain front east of Cache Valley extending to the south end of the Salt Lake Valley. Elevations range from 5,800 to about 8,000 feet and the relief is steep to very steep.

This soil association consists of about 55 percent Agassiz and Little Pole soils, 20 percent Bradshaw and Mud Springs soils with inclusions of other soils and Rock Outcrop.

The Agassiz and Little Pole soils are less than 20 inches deep and have dark brown, very cobbly, loamy, surface horizons, and very cobbly, fine, loamy subsoils, underlain by fractured bedrock. The Bradshaw and Mud Springs soils are deeper than 36 inches, and have dark brown, gravelly, cobbly or very cobbly, loamy surface horizons and very cobbly, coarse, loamy subsoils.

These soils are well drained. Permeability is moderate, runoff is me-

Figure 3. Heber Valley—a “back valley” in Wasatch County. Heber City in the background.
dium to rapid and sediment production is moderate to low.

The native vegetation is mainly big sagebrush, grasses and forbs on south facing slopes at lower elevations, juniper at higher elevations on south facing slopes and maple or oakbrush at lower elevations. These soils are used mainly for watersheds and range.

These shallow soils must be carefully managed to control erosion and sediment production.

**Smarts-Bradshaw-Broad Association** *(Pachic Argixerolls, Typic Argixerolls and Calcic Argixerolls)*

This soil association is most extensive in Cache, Rich, Weber, Morgan and Summit counties. Elevations range from about 5,200 to 7,500 feet. Most occurrences are on steep to very steep mountain slopes but some gently rolling areas are included.

This soil association consists of about 30 percent Smarts, Henefer and Broadhead soils, 25 percent Bradshaw and Mud Springs soils, 20 percent Broad and Sheep Creek soils, with inclusions of other soils and Rock Outcrop.

The Smarts, Henefer and Broadhead soils are deep and have thick, dark-colored, fine, loamy, surface layers and clayey subsoils that are mainly cobbly or stony to very cobbly or very stony. The Bradshaw and Mud Springs soils are deep and have dark brown, gravelly, cobbly or very cobbly, loamy, surface horizons and very cobbly, coarse, loamy subsoils. The Broad and Sheep Creek soils generally occur on steeper slopes than the other soils in the association. They are moderately deep to deep and have dark brown, gravelly or cobbly, loamy surface horizons, very gravelly or very cobbly, fine, loamy subsoils, underlain by very cobbly, loamy accumulations of soft lime. The lime zone occurs at depths ranging from 15 to 36 inches.

These soils are well drained. Permeability is moderate to moderately slow, runoff is medium to moderately rapid and sediment production is low. The native vegetation consists of oakbrush, maple, mahogany, big sagebrush and associated forbs and grasses. These soils are used mainly for range and watersheds.

**Parleys-Kidman-Avon Association** *(Calcic Argoxerolls and Calcic Haploxerolls)*

These soils are located in the Ogden and Morgan Valleys. They occur mainly on terraces and fans at elevations ranging from about 5,000 to 5,300 feet. The relief is mainly level to gently sloping, however, some areas of moderately sloping alluvial fans are included.

This association consists of about 40 percent Parleys and Timpanogos soils, 20 percent Kidman and Lakewin soils, and 15 percent Avon and Mendon soils, with some inclusions of other soils.

The Parleys and Timpanogos soils are deep, with dark brown, loamy surface horizons, and fine, loamy subsoil horizons underlain by horizons of soft strong lime accumulation.

The Kidman and Lakewin soils are deep, with dark brown, loamy or gravelly loamy, surface soils, and loamy and gravelly loamy subsoil subsoils, underlain with accumulations of soft lime.

The Avon and Mendon soils are deep, with thick, dark gray or black, fine silty surface soils, and fine silty and clayey subsoils, underlain by fine silty and fine loamy, soft lime accumulations.

The soils of this association are mainly well drained. Permeability ranges from rapid to slow, runoff ranges from rapid to slow, and sediment production is moderate to low.

The soils are used mainly for irrigated crop production.

Land uses that destroy the plant cover and expose the thick, dark-colored soil surface to erosion should be avoided. Exposure of the fine-textured subsoils to erosion would greatly increase the danger of these fine sediments polluting the mountain streams.

The soils properties discussed in this paper are depth, slope, stoniness, texture, drainage and temperature. These are the essential soil properties that must be considered in general planning for the 1325 of large tracts of land.

**WILDLIFE NOTES**

Although the silk in a spider’s web seems fragile, it is really one of the strongest materials known. This material will stretch one fifth its length before breaking and possesses a tensile strength exceeding that of steel.

- Beavers can cut down willow trees five inches thick in three minutes.
- Fish with forked tails are the fastest swimmers.
- In some arid regions of the west, the chipmunk has learned to do without water for months at a time. The little animal extracts moisture from succulent green plants and from the starch of seeds.
- The horns of antelope fawns start to grow when the young buck is about ten months old.
- The dragonfly is a creature of the air, never walking. Its legs are used only for catching prey and as landing and perching gear.
- If danger threatens a brood of red squirrels, the mother moves them, one by one, to another nest or temporary hiding place. She grasps each one by the loose skin on its belly, and the younger curls its legs and tail around the mother’s neck. This method enables her to jump from branch to branch with her young.
Sheep grazing in late fall can control big sagebrush on seeded cattle range if the practice is initiated before sagebrush becomes too dense. Results were most promising for the lightest of three densities of big sagebrush; i.e. about $1 \frac{1}{2}$ plants (all sizes) per 100 square feet of area. Sheep had little effect on sagebrush where there were 13 plants per 100 square feet of area and the sheep lost considerable weight. When sheep grazing was discontinued after 6 consecutive years, sagebrush plants increased greatly in size, hence also in potential for producing new plants; this suggests that the practice should be repeated periodically. This method of biological control can greatly reduce the need for costly chemical or mechanical sagebrush control treatments on seeded range, and the sagebrush provides some forage for sheep that is not used by cattle. These results were obtained in a cooperative study by personnel of the Intermountain Forest and Range Experiment Station and Utah State University conducted at the Benmore Experimental Range in southeastern Tooele County, Utah.

Management of rangelands over the past 30 years has often included rehabilitation of depleted, overgrazed ranges as well as vast acreages that were abandoned after dryland farming. A common practice on depleted sagebrush lands has been to remove competitive woody species by plowing followed by drilling or broadcasting seed of adapted grasses. Crested wheatgrass (*Agropyron desertorum*) has been the most successful grass for reseeding throughout the sagebrush zone, and this so-called "miracle grass" appears able to survive indefinitely on semiarid ranges.

Despite its longevity, crested wheatgrass stands are vulnerable to reinvansion by woody species. In the Intermountain region, two of the most common invaders are big sagebrush (*Artemisia tridentata*) and rubber rabbitbrush (*Chrysothamnus nauseosus*). Of these two, big sagebrush is the more competitive with crested wheatgrass.

Sagebrush begins to grow earlier in the spring than rabbitbrush, and its root system develops mainly in the zone also occupied by grass roots (figure 1). Spring cattle grazing, which coincides with the growth period of both crested wheatgrass and sagebrush, gives sagebrush an advantage over grass (figure 2). Photosynthetic and transpiring leaf surface is removed from the grass by grazing so that soil moisture not utilized by the grass is available to the ungrazed sagebrush. In addition, sagebrush plants trap snow which improves soil

Figure 1. Seven-year-old plant of big sagebrush that had well developed lateral roots within the upper foot of soil which is also the main zone for grass roots.

MARCH 1973
moisture in their immediate vicinity and gives them an added advantage (figure 3). Management that rests part of a range from spring grazing helps to improve grass vigor. Nevertheless, in years of substantial spring precipitation, sagebrush seedlings often become established in even the most vigorous grass stands if a seed source is present. Of course, existing sagebrush plants also benefit from the extra moisture. Once the sagebrush plants become established, they compete very successfully with the grass, and in time tend to become dominant on spring-grazed range if some control measures are not used.

The work reported here was done on an area located in the spring-fall zone at an elevation of approximately 5,700 feet. Annual precipitation there averages 12.8 inches, and the soils are mostly clay loams. The existing stands of crested wheatgrass are now 34 years old and still productive except where sagebrush has greatly limited their productivity.

The study involved spring grazing by cattle and fall grazing by sheep on three 100-acre pastures of crested wheatgrass that incorporated three different densities of sagebrush. Each pasture was divided through the middle to facilitate both early and late fall grazing by sheep. Spring grazing by cattle began about April 20 and ended 30 days later to allow for regrowth of grass before depletion of soil moisture. Early fall grazing by sheep usually began the first week of October and continued for a period of about 5 weeks (figure 4). Late fall grazing began early in November and continued until about December 15. In most years snow covered the ground for at least part of the late fall season (figure 5).

The predetermined spring stocking rate varied among the pastures depending upon the amount of forage in each. For the pasture having heaviest sagebrush, it was 3.6 cow-days per acre; in the other two pastures it averaged 6.0 cow-days per acre. Approximately 20 percent of the total cow-days was provided by yearlings and the balance was provided by cows that had calves by their sides. In both fall periods, sheep grazed at a uniform stocking rate of 40 sheep-days per acre in 2 of the 6 years and at 50-sheep days per acre in the other 4 years. All animals were weighed on and off experimental pastures after an overnight shrink in the corral (figure 6).

In addition to the areas grazed by both sheep and cattle, a system of enclosures having takedown fences provided for isolated grazing by each class of stock during the seasons in which they grazed. An adjacent ex-
closure also was totally protected from livestock grazing during the 6-year study.

EFFECTS ON SAGEBRUSH

The greatest effect of sheep grazing on sagebrush was to reduce the size of existing plants rather than completely kill them. Total numbers of plants changed very little during the period of sheep grazing, although a few of the very small plants were eliminated. The decrease in size of plants (figure 5) greatly reduced their capacity to produce flower stalks as compared to plants not grazed by sheep in fall, and this was a deterrent to new plants getting started. Two years after the sheep grazing was ended, the numbers of sagebrush plants over 12 inches in height had increased substantially (table 1). Greatest percentage increases occurred where sheep grazing had previously reduced plant size.

EFFECTS ON ANIMALS

Average daily gain for yearling heifers in early spring over the period of the study was 2.57 pounds per head. Comparable figures for cows and calves grazed with the yearlings were 1.55 and 1.53 pounds per head, respectively.

Crested wheatgrass leaves averaged about 3 1/2 inches in height when cattle entered the pastures in April, and under the level of stocking used, cattle ate the grass about as fast as it grew (figure 2). Following the removal of cattle about May 20, regrowth of grass took place in each year of study, but the amount varied with years. In rare years of below-average winter and spring moisture no spring regrowth will occur after May 20.

Sheep weight gains or losses during fall grazing were related to the amount of sagebrush in each unit. Averages for the 6-year period showed that for the lightest sagebrush density (1 1/2 plants per 100 square feet) sheep about maintained their weight during early fall, but they lost an average of 3.5 pounds per head during late fall. Where there was medium sage-

Figure 4. Upper—at the beginning of early fall grazing, sheep avidly seek new green regrowth of crested wheatgrass in preference to drier regrowth from spring season. Although sheep gained weight in early fall during such years, on the average they about maintained their weights on this area (one and a half sagebrush plants per 100 square feet). Lower—Sheep lost 3.5 pounds each during the same period where sagebrush was dense (13 plants per 100 square feet).

Figure 5. Area to right of fence was grazed only in early spring by cattle, whereas area to left of fence was grazed by cattle in early spring plus sheep in late fall. Sagebrush plants averaged two and a half plants per 100 square feet over this entire unit, but the average was twice that in the areas shown in photo.
brush density (3½ plants per 100 square feet), sheep showed a loss in early fall of 1.6 pounds per head and an additional 5.1 pounds per head loss in late fall. Where sagebrush density was heaviest (13 plants per 100 square feet), sheep lost an average of 3½ pounds per head in early fall and an additional 8 pounds per head in late fall. Sheep tended to lose weight in periods of cold weather. They gained best in years when there was green regrowth of crested wheatgrass in late summer and early fall. Fall regrowth occurred in about half of the years.

Under the Benmore conditions, cattle offer no hope for controlling sagebrush on crested wheatgrass range, except indirectly, i.e. deferment of spring grazing would tend to improve vigor of grass. Observations during several years of cattle grazing in the fall showed that cattle ate only a few flower stalks of big sagebrush. The amount eaten was entirely inadequate to provide any measure of control; this was true even in pastures having the least amount of sagebrush. Furthermore, we observed that a daily protein supplement of ¾ pound soybean meal per cow during both summer and fall did not cause cows to eat sagebrush. Occasionally, in other localities, cattle have been observed eating sagebrush in winter enough to kill some plants. Where this occurs, probably one of two situations exists — either the cattle are concentrated in areas where there is a shortage of other forage, or a more palatable variety of sagebrush is present than occurs at Benmore.

Grazing by sheep in fall will reduce size of sagebrush plants and limit their reproduction. However, the practice should be initiated before sagebrush plants become too numerous. Effective control was maintained in this study where plants averaged about 1½ plants per 100 square feet of area.

Table 1. Percentage increase in numbers of big sagebrush plants over 12 inches high during 6 years of sheep grazing and 2 years later

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<tr>
<td>Cattle, early spring (CS)</td>
<td>17 5 50 42 2 26</td>
<td>50 5 76 10 35</td>
<td>42 5 36 16 40</td>
</tr>
<tr>
<td>Sheep, early fall</td>
<td>-20 28 5 76 10 35</td>
<td>-7 0 40 36 16 40</td>
<td>-20 28 5 76 10 35</td>
</tr>
<tr>
<td>Sheep, late fall</td>
<td>0 29 8 29 -25 61</td>
<td>-25 8 29 -25 61</td>
<td>-25 8 29 -25 61</td>
</tr>
<tr>
<td>Sheep, late fall + (CS)</td>
<td>11 5 0 35 8 38</td>
<td>11 5 0 35 8 38</td>
<td>11 5 0 35 8 38</td>
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No grazing

Slow Moving Vehicle emblem. In most states, S.M.V. is the law. If you drive your farm vehicle on the road, you need S.M.V. protection. Get it. S.M.V. could save your life.
UTAH SCIENCE
Index for Volume 33, 1972

AUTHOR INDEX

Albrecht, Stan L.
Rural development: its dimensions and focus 33(4):115-120

Andersen, Berniece A.
Native plants for gardens 33(2):50-52 (joint author)

Andersen, Jay C.
What is rural development 33(2):60-61

Arave, Clive
Blood will tell 33(4):111-112 (joint author)

Balch, D. F.
Behavioral control of vertebrate pests 33(1):12-13 (joint author)

Bond, Larry K.
To commute or not to commute: a new choice for farm families 33(2):53-54, 68 33(1):7-9 (joint author)

Box, Thadis W.
Ecology, environment, and natural resource scientists—an editorial 33(1):3-4

Brown, Perry J.
Answering questions about tourism—a growing economic development tool 33(1):7-9 (joint author)

Butcher, John E.
Cubed hay gives better gains 33(2):57, 68 (joint author)

Caldwell, Martyn M.
The plant ecology of Utah's desert range lands 33(1):14-15 (joint author)

Campbell, William F.
A research tool for plant scientists—the electron microscope 33(2):40-43, 49 (joint author)

What you've wanted to know about lawns—but were afraid to ask 33(3):88-90

Collier, G. Donald
A legend in danger—prairie dogs 33(1):22-25 (joint author)

Cox, Lois M.
How others see us 33(1):16 (joint author)

Getting answers from Utah's salt desert 33(3):73-74, 84

Cronin, E. H.
Utah's most notorious poisonous weed—controlling tall larkspur 33(2):47-49

Dodge, David E.
New shapes for turkey 33(4):101-102

Draper, Carroll
Logan lagoons good for ducks 33(2):55-57 (joint author)

Gardner, B. Delworth
To commute—or not to commute: a new choice for farm families 33(2):53-54, 68 (joint author)


Gillett, T. A.
Blood will tell 33(4):111-112 (joint author)

Grant, C. V.
Behavioral control of vertebrate pests 33(1):12-13 (joint author)

Hanson, Avin R.
Penstemons for Utah gardens 33(4):130-131 (joint author)

Hancock, H. K.
There is a difference between saying and doing 33(1):5-6

Hanks, R. J.
New irrigation method saves water but, it's expensive 33(3):79-82 (joint author)

Hart, G. E.
The chemistry and geology of Blacksmith Fork—the chemical profile of a stream 33(1):19-21 (joint author)

Hendricks, Deloy G.
Iron deficiency—causes and consequences 33(3):75-78 (joint author)

Pigs help answer questions about human nutrition 33(4):121-122 (joint author)

Holmgren, Arthur H.
Native plants for gardens 33(2):50-52 (joint author)

Hunt, John D.
Answering questions about tourism—a growing economic development tool 33(1):7-9 (joint author)

How others see us 33(1):16 (joint author)

Constraints to expanding the Utah tourist industry 33(2):58-60

Jadhav, S.
Modern treatments retard spoilage of fruit and produce 33(4):104-108, 112 (joint author)

Jensen, Louis A.
Weed control in cities and towns 33(2):44-46

Keller, Jack
New irrigation method saves water but, it's expensive 33(3):79-82 (joint author)

Kimball, S. L.
A research tool for plant scientists—the electron microscope 33(2):40-43, 49 (joint author)

Lamb, R. C.
Genetic improvement of dairy cattle 33(4):113-114

Lanner, Ronald M.
Natural hybridization among the pinyon pines 33(4):109-110, 112

Low, Jessop B.
Logan lagoons good for ducks 33(2):55-57 (joint author)

Mahoney, Arthur
Iron deficiency—causes and consequences 33(3):75-78 (joint author)

Pigs help answer questions about human nutrition 33(4):121-122 (joint author)

Malechek, John C.
Range productivity and economics 33(1):10-11 (joint author)

Matthews, Doyle J.
Utah agriculture is never static—an editorial 33(3):71-72

Nielsen, Darwin B.
Water rights and zoning restrictions 33(3):83-84

Pollard, Leonard H.
Penstemons for Utah gardens 33(4):130-131 (joint author)

Richardson, E. Arlo
Regional climatic planning—guide for Utah 33(1):26-28

Regional climatic planning—guide for Utah 33(2):62-64

Regional climatic planning—guide for Utah 33(3):91-93

Salunkhe, D. K.
Subatmospheric pressure storage of fruits and vegetables 33(1):29-31 (joint author)

Modern treatments retard spoilage of fruit and produce 33(4):104-108, 112 (joint author)

Schomaker, John H.
Answering questions about tourism—a growing economic development tool 33(1):7-9 (joint author)

Seeley, Schuyler D.
Spring frosts and fruit trees—a perennial dilemma 33(4):123-124 (joint author)

Smith, Arthur D.
Range productivity and economics 33(1):10-11 (joint author)

Southard, Alvin R.
The chemistry and geology of Blacksmith Fork—the chemical profile of a stream 33(1):19-21 (joint author)

Soil classification and mapping in Utah—from 1899 to 1972 33(1):32-34 (joint author)

Soils of the Wasatch valleys 33(3):85-88 (joint author)

Spillett, J. Juan
A legend in danger—prairie dogs 33(1):22-25 (joint author)

Stenquist, Norris J.
Cubed hay gives better gains 33(2):57, 68 (joint author)

Tew, Ronald K.
Land type surveys on the Dixie National Forest 33(2):65-67
Thorne, Wynne
Refocusing research to better serve Utah—
an editorial 33(3):71-72

Wadley, Bryce N.
Some sweet cherries resistant to western x-disease 33(4):125-127

Wagner, Frederic H.
Desert Biome Research Program: mapping
an ecosystem 33(1):17-18, 30

Walker, David R.
Spring frosts and fruit trees—a perennial dilemma
33(4):123-124 (joint author)

West, Neil E.
The plant ecology of Utah's desert rangelands
33(1):14-15 (joint author)

Williams, J. S.
The chemistry and geology of Blacksmith Fork—the chemical profile of a stream
33(1):19-21 (joint author)

Wilson, LeMoyne
Soil classification and mapping in Utah—
from 1899 to 1972 33(1):32-34 (joint author)
Soils of the Wasatch valleys 33(3):85-88
(joint author)

Workman, John P.
Range productivity and economics 33(1):10-11 (joint author)

Wu, M. T.
Subatmospheric pressure storage of fruits
and vegetables 33(1):29-31 (joint author)
Modern treatments retard spoilage of fruit
and produce 33(4):104-108, 112 (joint author)

SUBJECT INDEX
Index for Volume 33, 1972

Agriculture
an editorial 33(3):71-72
Alfalfa
cubed hay 33(2):57, 68
weevil 33(4):103
Anemia
iron deficiency 33(3):75-78
Botulism
lagoons for ducks 33(2):55-57
Breeding
dairy cattle 33(4):113-114
sweet cherries 33(4):125-127
Capital
tourism constraint 33(2):58-60
Chemicals
pests and poisons 33(1):12-13
Blacksmith Fork 33(1):19-21
Climate zones
guide for Utah 33(1):26-28
guide for Utah 33(2):62-64
guide for Utah 33(3):91-93
Control
vertebrate pests 33(1):12-13
weeds 33(2):44-46
tall larkspur 33(2):47-49
lawn pests 33(3):88-90
spoilage of fruit & produce 33(4):104-108, 112
Dairy
genetic improvement 33(4):113-114
milk production 33(4):113-114
Dean
Doyle J. Matthews appointed 33(1):6, 13
Diseases
western x 33(4):125-127
Ecology
an editorial 33(1):3-4
plant 33(1):14-15
ecosystem 33(1):17-18, 30
Economics
tourism development 33(1):7-9
range productivity 33(1):10-11
rural population 33(2):53-54, 68
irrigation method 33(3):79-82
rural to urban 33(4):115-120
orchard heating 33(4):123-124
Electron microscope
research tool 33(2):40-43, 49
Environment
an editorial 33(1):3-4
prairie dogs 33(1):22-25
housing developments 33(3):83-84
zoning 33(4):127-129
Financial Report
Agricultural Experiment Station 33(3):94-95

Food
iron deficiency 33(3):75-78
Nutrition and Food Science Center 33(4):100-101
Fruit
subatmospheric pressure storage 33(1):29-31
spring frosts 33(4):123-124
sweet cherries 33(4):125-127
Genetics
blood will tell 33(4):111-112
Health
possible leukemia weapon 33(2):39
swine and human nutritional problems
33(4):121-122
Hybridization
pinyon pines 33(4):109-110, 112
Insects
lawn pests 33(3):88-90
alfalfa weevil 33(4):103
Lawn
fertilizers 33(3):88-90
mowing 33(3):88-90
seeding 33(3):88-90
Livestock
poisonous weed 33(2):47-49
an editorial 33(3):71-72
Maps
soil classification 33(1):32-34
Dixie National Forest 33(2):65-67
Pinyon pines
hybridization 33(4):109-110, 112
Plants
desert rangelands 33(1):14-15
research tool 33(2):40-43, 49
native garden plants 33(2):50-52
penstemons 33(4):130-131
Prairie dogs
predators 33(1):22-25
Produce
subatmospheric pressure storage 33(1):29-31
an editorial 33(3):71-72
spring frosts 33(4):123-124
sweet cherries 33(4):125-127
Range Management
productivity and economics 33(1):10-11
Recreation
saying and doing 33(1):5-6
Research
bacteriology 33(2):39
molecular plant science 33(2):40-43, 49
an editorial 33(4):99-100
Rural
commuting population 33(2):53-54, 68
to urban movement 33(4):115-120
land-use zoning 33(4):127-129
Soil
classification and mapping 33(1):32-34
salt desert 33(3):73-74, 84
Wasatch valleys 33(3):85-88
Tourism
economic development tool 33(1):7-9
how others see us 33(1):16
expansion constraints 33(2):58-60
Trees
bulletin 33(3):95
Turkey
new products 33(4):101-102
Vertebrates
behavioral control 33(1):12-13
Water
desert rangelands 33(1):14-15
Blacksmith Fork 33(1):19-21
Weeds
in cities and towns 33(2):44-46
larkspur 33(2):47-49

32

UTAH SCIENCE