87 Dyer's Woad: From Cultivated—To Cursed
WILLIAM A. VARGA AND JOHN O. EVANS
An historic and scientific look at past uses and future controls of an invasive Utah weed.

90 Property Tax Equity Problems in Utah: Part II
W. CRIS LEWIS
The second informative installment which provides credible solutions to our property tax inequities.

94 Tracking Individualistic Chromosomes
STERLING M. ELLSWORTH, THOMAS D. BUNCH, AND STEPHEN R. PAUL
A young scientist's work in cytogenetics; chromosomal anomaly identification and the effects of a translocation in Holstein cattle at USU.

97 Desert Bighorn Sheep—Doomed by a Fly?
THOMAS D. BUNCH, HENRY E. MCCUTCHEON, AND STEPHAN R. PAUL
Desert Bighorn deaths, once attributed to common environmental factors, are now discovered to be caused by a more deadly and insidious invader, the bot fly larvae.

104 Wind Energy
KENNETH G. HUBBARD
Energy potentials from wind use are viewed in terms of site, season and climate variables in Utah.

107 Population Changes in Rural Utah
WILLIAM F. STINNER, MICHAEL B. TONEY, AND STEPHEN KAN
Utah's rural population boom: is it changing the face of the land? How do the migrants and natives feel about this and each other? A survey and discussion.

110 Projects in Progress
LOIS M. COX
This feature heralds things to come. Its brief samplings of ongoing research describe the hows and whys of anticipated results.

* Grateful acknowledgement is given to Studio Vista Publications, London, England, and the British Museum for permission to reproduce the medieval illustrations seen in "Dyer's Woad—From Cultivated to Cursed."
Past glories

Through no fault of its own, Dyer's woad (*Isatis tinctoria*) has fallen from grace with human beings. Well before the Christian era, the plant was valued as a medicinal herb. When the Romans invaded Britain, they were confronted by warriors painted with dye extracted from the Woad (or wad, as it was called in 13th Century England) plant. In the 13th Century, Woad was actually being cultivated in both Continental Europe and England as a source of blue dye.

Indigotine, a chemical which produces the blue coloration, is located in the leaves of Woad. The leaves were hand-picked, crushed, and kneaded into balls before drying. The dried leaves were stored until a need for dye making arose. They were then taken to couching houses where they were ground, piled, sprinkled with water, and allowed to ferment for approximately one month. During this time, an obnoxious odor issued from the pile, and in Sixteenth Century England, Queen Elizabeth forbade any Woad-growing or processing to take place within five miles of any one of her residences.

Fermentation developed the insoluble indigotine, and the material could again be stored until further fermentation was induced to produce as much of the dye powder as was wanted. Cloth would be dipped in a solution made from the powder and hung to dry. As it dried, the cloth took on the blue coloration. Indigo from the Far East eventually replaced Woad, but Woad was still cultivated until 1930 in England.

In the United States, its cultivation was probably limited to Virginia in colonial times.

It is generally accepted that Woad is a native of southeastern Russia and that it spread throughout the eastern hemisphere in pre-historic times. It occurs in the wild and under cultivation in China, Western Tibet, and Afghanistan.
As it appears in spring, Dyer’s woad is a conspicuous, yellow-flowering plant.

Well-timed applications of 2,4-D provide adequate control of Dyer’s woad.

Woad fruits hang like ornaments from umbrella-shaped branches.

Dyer’s woad is invasive and dominant; inhibiting the plant growth around it.

Will it consume our grazing lands?
Shape and growth habits

Woad is a blue-green plant, two- to four-feet tall, and is related to the common mustards. It is biennial, sometimes a winter annual, and occasionally a short-lived perennial. In any case, Woad tends to form a rosette in spring or fall, developing flowers and seeds the next year. Early in the following spring and summer it appears as a conspicuous, yellow-flowering plant and in late summer its stalk is ornamented with winged, black fruits.

Woad leaves are blue-green and slightly pubescent (covered with fine hair). They are of two types: upper leaves (without petioles) that clasp the stalk and lower leaves (with petioles) that do not. All leaves have a cream colored midrib from base to tip. The lower leaves form a rosette in early spring. The large, woody stalks are purplish-blue and topped by a compound panicle (flower cluster) that has an umbrella-like shape. Approximately twenty stalks begin to develop from each rosette in the spring, but usually seven or fewer, mature.

The fruits of Woad are black silicles. They hang like ornaments from the umbrella-shaped branches and may hitch rides in hikers’ pant cuffs, any other passing traffic, or the wind. The fruits are three-fourths inch long and one-fourth inch wide at their widest part.

The large, fleshy taproots of Woad plants may exceed five feet in depth in loose, gravelly soils. Asexual reproduction may occur from this underground root system. In Utah, Woad prefers loose, alkaline, bench soils. In England, it is often located in old lime pits and chalk quarries.

The weed scene

Now, although still doing only what it has always done, Dyer’s woad has entered the ranks of plants we call weeds. In Cache and Box Elder counties, it has even been tagged as noxious. And there are those rangeland experts (Evans and Young, at the University of Nevada/Reno) who warn of its remarkably aggressive ability to displace desirable forage plants.

Woad was first reported in Utah in 1917. Its official recognition came when Bassett Maguire collected a specimen for the USU herbarium in 1932 near the railroad in Perry. In the west, Woad can also be found in northeastern California, southeastern Oregon, Montana, Wyoming, and Idaho. Montana ranchers call it Utah mustard. Idahoans tend to use less polite descriptive terminology (as we do when speaking of their yellow toadflax [butter and eggs plant], which is invading Utah).

Woad is a persistent weed, and its rosette is thought to inhibit the growth of other plants. Its related mustard plants are known to take up to twice as much nitrogen and phosphorous, four times as much potassium, and four times as much water as a well-developed oat plant. Dyer’s woad may be as or more destructive in competitive situations. In northern California’s Scott Valley, Dyer’s woad has been replacing annual grasses which were thought to be the culmination of plant succession in the weed community. On the other hand, on exceptionally steep hillsides where few plants can be counted on for reliable anti-erosion action, total elimination of Woad may be ill-advised.

Young and Evans found a germination depressant in the fruits of Woad. The substance inhibits germination of other mustards and also, to some extent, that of other plants. In many cases, root elongation following germination was stunted in plants adjacent to Woad. The seeds within the fruits of Dyer’s woad contain no inhibitor, and the inhibitor can be removed from the fruits by leaching.

Possible defenses

In northern Utah, Woad can be controlled mechanically or by herbicides. As a biennial, the plants can be removed by digging, hoeing, or plowing while they are in a vegetative state during the initial year of growth. Work at USU has shown that 2,4-D at a rate of 1½ lb/A is effective on ranges if application is repeated and then followed by roguing. In alfalfa fields, metribuzin, at ½ to ¾ lb/A can be used to good effect.

In no case, however, should the herbicide be applied after the Woad plants have started to set seed. Particularly on ranges, an ill-timed application of 2,4-D could not only be a useless expense, it could actually damage the land’s overall productivity. Once Woad is setting seed, it is apparently immune to 2,4-D—its usual environmental associates, however, are generally susceptible at that time of year.

The Four Corners Regional Commission is considering a grant application that would allow establishment of a control demonstration area in northern counties of Utah and southern counties of Idaho. Target areas would be designated, and the above control measures initiated by cooperative effort of individual citizens, farmers, county weed people, and USU personnel.

The program would be designed to demonstrate effective control methods, the importance of timing herbicide application to obtain significant results, and how to recognize the plants at various stages of growth.

ABOUT THE AUTHORS

Bill Varga, Research Associate and co-project leader of Project 427—"Adaptation of Commercial and Native Plants in the Utah Environment." He is on the faculty of the Utah State University Plant Science Department and is based at the Farmington Display Gardens.

John O. Evans, Associate Professor of Plant Science, is leader of Project 743, "Weeds in Agronomic Crops." He is investigating new methods of weed control which include biological management, new tillage implementation, and integrated pest management approaches. Dr. Evans teaches undergraduate and graduate courses in weed science at Utah State University.
In the first installment of this two-part article on property tax administration in Utah, two important problems of equity or fairness were discussed. Both arose because of variation in the ratio of assessed value to market value (i.e., the assessment ratio) within and among counties.

Within a county, variable assessment ratios imply different annual property tax levies on properties with the same market values. The variation in the property tax on comparably priced properties is often 30 to 40 percent.

Because the state program for financing local school districts is based on the level of assessed valuation per student, the variation in assessment ratios has caused an unintended redistribution of more than $3 million each year from counties having above-average assessment ratios to those with below-average ratios.

The revaluation of all property in the state, which began in 1969, was designed to reduce if not eliminate these problems. Because of inflation and less-than-modern assessment administration in some counties, the problems are at least as great now as they were before the revaluation program was started.

Can the property tax system be redesigned so that the magnitude of these problems is reduced? The answer is a resounding yes! A number of improvements can be made, many of which would make the assessment procedure less costly as well as more equitable.

Three ways to improve the equity of local property tax systems are proposed here. The first involves simply publishing all relevant property tax information by address in local newspapers or in reporting booklets. This would cost little, while greatly increasing the information base of all taxpayers. The second alternative involves developing a predictive equation that could be applied to the characteristics of each property on the tax rolls as the assessment is made. The last alternative and, undoubtedly, the most radical, involves a self-assessment scheme. Each property owner would be responsible for valuing his own property for tax purposes. To ensure that such valuations were at least equal to actual market values, the valuation would be construed as a legal offer to sell the property at that valuation.

Publication of property tax data

Regardless of what else might be done, the assessed value and tax levy on all properties in the taxing jurisdiction should be published by owner’s name and address rather than the generally incomprehensible technical property description. These records are a matter of public record anyway, but it is a difficult task to go to the assessor’s office and ferret out the necessary information. Publication, whether in the local newspaper or in some sort of widely distributed reporting booklet, would greatly facilitate increased public awareness of relative tax burdens and inequities. It is my opinion that very few property owners have any idea whether they are being fairly treated with regard to the taxes on their property. Publication of assessed values and taxes would allow each person to compare his tax burden to that of others.

In and of itself, this would not reduce the magnitude of the problem. It would, however, inform many property owners that their tax burdens are too high relative to properties of comparable value in their neighborhood. The resultant increased numbers of protestors and greater pressure on local officials, could result in action to reduce the inconsistencies in the assessment ratios.
Problems in Utah: Part II

Some local government officials can be expected to oppose this recommendation. They would be reluctant to compound their problems now with a large number of irate property owners complaining about their tax levies. These officials would probably argue that the data are already available, although as has been indicated, the time and inconvenience cost to obtain them are high.

A computer model approach to property valuation

Because economic forces constantly change both the average level of real property prices and the relative prices of various parcels, revaluations must be made on a continual basis. The current state program of reassessment at five-year intervals is not adequate in a period of rapidly changing values. In the past five years, the price of a typical residential property probably has increased more than 50 percent. Assessments made only three or four years apart in two counties will not be comparable. For example, the average assessment ratio in Utah counties where revaluation occurred in 1972 is 9.5; in counties where the revaluation was made in 1976, the average is 17.6.

Consider the problem within a county. A home built in 1972 for $30,000 is appraised at that amount for tax purposes. By 1976, its market value is $45,000. In that year, an identical home is constructed at a cost of $45,000. To achieve equity within the county, that house should be appraised at its 1972 value, but it is typically valued at $45,000. The annual property tax will be 50 percent higher for the newer property despite the two having the same market values.

The standard appraisal technique of physical inspection and evaluation of each property makes it too costly to assess all property each year; even the five-year cycle is expensive. There is an alternative, however. One that is relatively inexpensive, could be used to update appraisals as often as each quarter, and would provide uniformly accurate estimates of market value. The basis is an inventory of the characteristics of each property including lot size, structure size, number of bedrooms, neighborhood quality, coupled with a predictive equation. Developing the inventory is straightforward, and, once created would only have to be modified for new structures and changes in existing ones. That information could be obtained at the time that building permits are issued.

The predictive equation can be developed from a set of data on properties sold during a given period. In most areas, properties continually are being bought and sold. The prices represent actual market values and ought to be used in the assessment process regardless of the specific appraisal technique used. Local realtors' associations often collect all relevant data on properties sold through their agencies and, in some cases, publish it for the private use of their group. There is no reason these data could not be made available to the county assessor. Alternatively, a small state tax could be levied on sale of real property, say, $0.50 per $1,000 of value. The tax would not raise much revenue, but it would provide a continual update on market values.

The equation might take the following form:

\[ V = B_0 + B_1X_1 + B_2X_2 + \ldots + B_nX_n \]

where \( V \) is market value, \( X_1, \ldots, X_n \) are the property characteristics, and \( B_0, \ldots, B_n \) are parameters. Using multiple regression techniques, the values of \( B_i \) can be estimated, and then any property can be appraised by substituting the specific characteristics of that property (i.e., the \( X_i \)'s) into the equation. In following periods, the equation can be reestimated using the most current data on property values.
transactions and then all property reappraised by applying the new equation to each parcel. This procedure would require only minutes on a computer.

To show how this might be done, a sample of 108 properties sold in the Logan area in 1976 was used to estimate the following equation:

\[ V = 16,990 + 18.5X_1 - 172X_2 + 5,524X_3 \quad (R^2 = 0.81) \]

where:

- \( V \) = predicted market value
- \( X_1 \) = square feet of finished floor space in the structure
- \( X_2 \) = age of structure
- \( X_3 \) = dummy variable for neighborhood quality

Although this equation is designed only to be indicative, it explains more than 80 percent of the price variation among properties. Assume a new home (\( X_2 = 0 \)) is completed with 1,500 square feet of floor space (\( X_1 = 1500 \) and is located in a "good" neighborhood (\( X_3 = 1 \)). The appraisal is made by evaluating the equation for those values of \( X_1 \), \( X_2 \), and \( X_3 \), i.e.:

\[ V = 16,990 + 18.5(1500) - 172(0) + 5,524(1) \]
\[ V = 50,264. \]

Now, all this probably sounds too simple, and in a sense it is. The actual equation would probably include additional variables such as some or all of those listed earlier. The functional form might be different; for example, the exponential relationship

\[ V = 11X_1^{0.7} \]

might better explain the relationships among the several variables. Nevertheless, even the simple-minded version presented above generates more consistent estimates than those made by an appraiser. For the sample of 108 properties, the coefficient of variation\(^8\) in the ratio of assessed value to market value is 0.196; for the ratio of predicted value to market value the ratio is 0.167. That is, the regression estimate or prediction of market value is more accurate than is the assessor's estimate.

To summarize, the multiple regression approach has the following advantages over the conventional assessment procedure:

- It makes use of actual data on market value.
- It can be updated on a regular basis, at least yearly, to compensate for changes in the average level of real property values and for relative values.
- The cost is low, especially when compared to physical inspection and evaluation of properties.
- It probably would result in "better" or more accurate estimates of market value.

This approach, however, is not understood by local officials, and might therefore be resisted, despite its being conceptually simpler than conventional appraisals of real property. That the technique is being used with success in other parts of the country, suggests that it should be seriously considered for use in Utah.

**Owner-assessment process**

A radical alternative but possibly the most efficient and equitable would be an owner-assessment scheme. Every year each owner of a land parcel would have to set a market value on his property and be taxed on that amount. To insure that owners do not place unrealistically low values on their property, the self-valuation would constitute a legal offer to sell at that price. If a qualified buyer made a valid offer to buy the property at or above the self-assessed value, the owner would have to sell. Alternatively, the owner could either sell or raise his self-valuation to the amount of the offer plus, say, five percent. Under this alternative some might place unrealistically low values on their properties in the hope that no one would notice; if offers were made, the owners would revalue upward until no further offers were forthcoming, or sell if the offering price was sufficiently attractive.

The mechanics of the process might work like this: by January 15 of each year, every property owner would submit his property valuation to the county assessor. These data would be compiled and made widely available to the public during February. Offers to buy at the listed or higher prices could be made during the first two weeks of March. Each owner whose "offer" had been accepted, would have two weeks in which to revalue to at least 105 percent of the offer or sell the property. An updated list of valuations would be published to reflect the revaluations and the offering process repeated. The result should be that most Utah properties would be valued at between 100 and 105 percent of market value. The large variation in assessment ratios that now exists should be eliminated. Market forces would insure that no property is assessed at a significant discount from market value, and the self-assessment process would preclude the possibility of any significant overassessment.

In addition to eliminating disparate assessment ratios, the system would have the following advantages:

- It would reduce greatly the staff and budget for assessment activities. Only a small clerical staff would be needed to insure that all properties were self-assessed and to prepare the reporting booklets.

Property assessments and tax levies, which are a matter of public
Owner-assessed property value:  
So radical it might work?

record, would be more readily available to all citizens.

Adjustments for change in property values would be made accurately each year. Failure of a property owner to fully adjust his assessed value upward would result in offers to buy his property.

The potential problems of "cronyism", bribery, and other types of influence on assessors would be eliminated.

Undoubtedly, the number of property transfers would increase. Some homes and other types of property are worth significantly more to a prospective buyer than to the present owner. Consider a residential property which is valued at $60,000 by the owner, Smith, for tax purposes. Jones finds the property particularly appealing and offers to buy at that price. Smith refuses the offer and revalues by five percent to $63,000. Jones raises his bid to $63,000 and Smith revalues to $66,150, reflecting another five percent increase. (The annual property tax would now be $662 compared to $600 under the original valuation.) Jones again raises his bid to the new assessment level, and Smith accepts it. Both parties are better off—Jones would rather have the house than the money, and Smith is willing to part with the property and put up with the aggravation of moving because the offer is far more than he feels the property is worth. The rest of the citizens are better off because the total assessed valuation for the area will have increased and the mill levy necessary to meet a fixed set of expenditures can be reduced or greater revenues raised at the existing mill levy.

Of course, if the self-assessment method were used statewide, the "among county" equity problem would also be resolved. All property in the state would be assessed at very close to market value; this would largely eliminate the nonlegislated redistribution of state funds from "overassessed" to "underassessed" counties.

Despite its obvious advantages, such a system is unlikely to be implemented. Resistance to change is especially strong in the political arena; even incremental changes in procedures and policies are not made without substantial discussion, delay, and, sometimes, consternation. To expect even a serious consideration of this proposal, regardless of its merits, is folly.

Summary

What is the likelihood that any or all of these alternative programs would be adopted for actual property tax administration? It depends on the locality and whether local government officials want to develop an equitable, efficient tax collection system. Certainly, the first option, involving the publication and wide distribution of tax data, could and ought to be implemented in all Utah counties. We all should be in a position to know what our neighbor is paying on his property and how that property is valued, without having to invest substantial time to find out. This change, in and of itself, would lead to significant pressure to minimize existing inequities in the valuation process.

A computer model combining multiple-regression equations with a set of property characteristics is being used in some parts of the United States and is under consideration in at least one county in Utah. The system offers tremendous advantages in terms of being able to revalue all properties in an area very quickly and at a minimal cost. Adjustments for inflation could be made annually, semiannually, or even quarterly with little difficulty. Although some professional expertise is required to develop the predictive equation or equations and write the computer programs, once the system is running, it could be easily maintained and updated by clerical personnel.

The self-assessment scheme is unlikely to be adopted. The uncertainties to property owners and government officials are so great that they preclude its being given serious consideration. Nevertheless, it may be the best way to eliminate inequities in the tax system.

One of the biggest roadblocks for property tax reform of any type is political inertia. For example, it was argued above that some county officials would oppose widespread publication and distribution of property tax data. The rationale probably would be in maintaining the status quo and minimizing the aggravation that would be forthcoming if the degree of property tax inequity was really understood by property owners. It seems reasonable to expect owners of properties that were significantly overvalued relative to their neighbors’ to descend on the county courthouse in large numbers to complain. Few political leaders want to confront that kind of problem.

Clearly, the magnitude of the tax inequity problem could be significantly reduced. The question is whether or not we and our representatives have the will to do it.

ABOUT THE AUTHOR

W. Cris Lewis is Professor of Economics at Utah State University. In addition to teaching economics, he is directing several research projects in the areas of land-use planning, regional economics, and resource development.
Tracking Individualistic Chromosomes
Sterling M. Ellsworth
Thomas D. Bunch
Stephan R. Paul

In the normal case of mammalian reproduction, the chromosomes carried by sperm and egg join as shown in Figures 1a and 1b. The process of multiplication begins, and eventually the result is a youngster that carries an equal input from both parents and is representative of his/her species.

Sometimes, however, the chromosomes don't follow the standard game plan. As illustrated in Figures 2a and 2b, the divergence can take the form of what is called Robertsonian translocation. Whether this occurs as a break in a chromosome with one of the pieces then joining an "alien" chromosome—or as the union of two normally separate chromosomes—the carrier fetus is bound to experience physiological and/or physical effects, and may be aborted or die before adulthood.

Translocations have been found in most mammalian species including cattle, sheep, goats, swine, and man. If the translocation-carrying animal reaches maturity, the chromosome aberration often proves to be structurally and/or physiologically detrimental, and generally reduces the capacities of the animal to reproduce. Occasionally, the opposite occurs, and the translocation gives its carrier enhanced adaptation or production abilities. In rare cases, a translocation has resulted in the creation of a new species.

About fourteen years ago, a Swedish scientist by the name of Gustavsson reported a translocation in Swedish Red-White Cattle that reduced the fertility in heterozygous cows. He referred to this translocation as the 1/29, because it involved the chromosomes numbered 1 and 29. Since Gustavsson's finding, two other Robertsonian translocations have been reported in cattle, namely the 2/4 reported in 1972 in the Friesian breed and the 11-12/15-16 reported in the Simmental breed (1973). Gustavsson observed in his original work that cows possessing the 1/29 translocation returned significantly more times for second service (18 to 24 percent). In other words, their reproduction potential had been adversely affected.

Identification of the chromosomes involved in translocations and their effects is essential to cattle producers who must upgrade their herds to maximum productive potentials.

One of the cows (number 3714) was found to possess a translocation. The next step was to test her progeny and close relatives. To date, none of her living progeny have inherited her translocation.

3714's translocation is not the 1/29-type reported by Gustavsson; it more closely resembles the 11-12/15-16 translocation reported by Bruère in the Simmentals. Most likely, it is a translocation that has never been identified in Holsteins or cattle of any breed.

Chromosomal examinations of cow number 3714's full sister and her four half sisters showed that each had a full complement of chromosomes (2n=60). This suggests that the translocation has arisen in the cow spontaneously.

Interestingly enough, the translocation-carrying cow shows phenotypic and behavioral signs that distinguish her from the rest of the herd, a situation never associated with previously described Robertsonian translocations. The cow has an unusual head that is distinctly shorter (Figure 5) than normal from poll to muzzle and wider than normal between the eyes. This cow also shows signs of reduced mental capacity. For example, she was exceptionally slow to learn while being taught to lead. She never could learn to use a circular track that was part of another experiment that posed no problem to any of the other participating cows.
In approximately 1 in every 36,000 cattle fertilizations, a translocation can arise spontaneously—

A USU cow has one . . .

Figures 2a and 2b. Abnormal fertilization resulting in translocation.
To date, nothing has been observed that would prove a relationship between these characteristics and the translocation. Yet, it is interesting that the only animal in the large herd exhibiting these signs also had the translocation.

This relationship (or coincidence) may be explained by the ongoing research into the nature of the translocation. The location of the breakage and whether or not chromosomal material is lost during the subsequent fusion process may provide the insights needed to evaluate how the cow's distinguishing characteristics may correlate with the genetic aberration she possesses. To obtain the data, G-banding and C-banding techniques are used to identify and determine the nature of the chromosomes. Nuclear organizer regions are located by silver-staining procedures.

The tracking of individualistic chromosomes has not only recognized the possibility of a new translocation but has also illuminated the relationship between the translocation and phenotypic and behavioral characteristics. Up until now, this has never been shown.

ABOUT THE AUTHORS

Sterling M. Ellsworth is a senior in animal science. His research has been sponsored by Undergraduate Research and Creative Opportunities (URCO) and the USU Department of Animal, Dairy, and Veterinary Sciences under the auspices of Dr. Robert Lamb. Mr. Ellsworth's professional interests for the future are in the medical sciences.

Thomas D. Bunch, Associate Research Professor, Animal, Dairy, and Veterinary Sciences, USU, was the cytogenetic advisor for this work. Some of his current research interests can be seen in this "Utah Science" issue in the article, "Desert Bighorn Sheep—Doomed by a Fly."

Stephan R. Paul, veterinarian, was involved in the field work associated with this project. He is currently with the University of California Veterinary Teaching Hospital at Davis.
DESERT BIGHORN—Doomed by a Fly?

Thomas D. Bunch
Henry E. McCutchen
Stephan R. Paul

If you’ve ever had a migraine headache—you know it is in a whole different league than a run-of-the-mill headache. We suspect the same kind of differential exists between a migraine and what some desert bighorn sheep are experiencing.

The record begins

It may have started earlier, but scientific literature did not carry descriptions of abnormal skulls of desert sheep (Ovis canadensis nelsoni) from Arizona and Nevada until the early 1960s. These bone abnormalities were more variable in ewe than in ram skulls. Wider areas of the ewe skulls were affected, although the frontal bone did not have as large lesions or cavities as had the ram skulls. Several of the ram skulls differed in the basal circumferences of their two horns.

Current details

The most recent and extensive descriptions of such osteonecrosis (bone death) in a living population of the desert bighorns are based on a captive herd held in Zion National Park, Utah. (It is reasonable to suppose, however, that other desert bighorns in Utah are also being affected.) The Zion herd was created in 1973, when 12 Nelson’s bighorn sheep were captured in Nevada and transferred to an 80-acre enclosure in Zion. The captive group was to be used as breeding stock to provide sheep for various areas within the park and in southwestern Utah. By 1976, the population numbered 22. Today, it stands at 12, primarily as a consequence of sinusitis.

In December, 1974, one of the Zion rams was described as having draining lesions in the nasal and frontal parts of his head. These were attributed to rutting season brawls. Between December 1974 and October 1975, this ram was seen to be steadily losing weight and general body condition, and the lesions were not healing (Figure 2). In October of 1975, the ram was captured. He was suffering from extreme osteolysis (breakdown of bone) and abscesses in the front of his head. The open, draining sores were treated and the ram was given shots of sodium iodide and penicillin. He died several days later.

When we necropsied (examined in detail after death) the ram, we found extreme necrosis of the frontal bone which extended over and within the bones (orbital and lacrimal) sheathing his left eye (Figure 3). The associated thinning of the ram’s brain case had resulted in two holes in his
skull which are assumed to have led to severe pain. These holes, however, permitted abscessing of the brain and pain-stopping death. The normal pneumatization within a bighorn sheep's horn cores (Figure 1a) had been completely destroyed. The ram was seven years old at the time of death and weighed only 100 pounds (his normal weight would have been 180 to 210 pounds). Our necropsy diagnosis was chronic sinusitis.

Between 1974 and 1977, two more rams and two ewes died in the Zion enclosure, without cause of death being determined. When we examined both ram skulls and one of the ewe skulls (1977), they all were diagnosed as having had sinusitis.

**Trial and error treatments**

The staff of the Department of Animal, Dairy, and Veterinary Sciences and the International Sheep and Goat Institute at USU became involved with the Zion herd of desert bighorns in October, 1977. At that time, a five-year-old desert bighorn ewe was brought from Zion National Park to an isolation unit at Utah State University. The animal had been diagnosed and treated by a veterinarian ten months earlier for sinusitis and panophthalmitis, which eventually led to a rupturing of the forward chamber of her right eye. At the time of diagnosis, she had been given one million units of procaine penicillin G and 1250 mg dihydrostreptomycin sulfate (Combiotic®), and her lesions were washed and drained. Her eye was cleaned and sutured shut and the following day she was given one million units of benzathine, penicillin G., and procaine penicillin G. (Flocillin®). She was then released back into the 80-acre enclosure with the herd. Within a month, she was visibly losing condition.

When she arrived at the USU facility, the ewe weighed only 69 pounds (average weight for a desert bighorn ewe is 110 to 130 pounds). She was not only extremely emaciated, but had become dehydrated and was in shock when we first saw her. Attempts to rehydrate her and provide therapy for her shock failed, and she died within 24 hours after transfer. Our necropsy confirmed the visually noted extremely poor body condition. In addition, her frontal sinuses were filled with a thick, purulent exudate. Her left eye was ulcerated and the anterior chamber was filled with dark red, irregular material, and fly larvae. Her right eye had irregular opaque plaques on the cornea. We isolated a few coliform and bacillus organisms from her sinus area and coliform were isolated from her eye lesions.
Figures 1a and 1b. Anatomically labeled illustration of a normal and an abnormal skull, respectively.
A second ewe, eight years old, was transferred to USU in November, 1977. For several years, this animal had been noted as being in poor body condition and low in the hierarchy of the herd. When captured, she had a half-inch fracture of the frontal bone that completely encircled the right horn. She died soon after being transferred to USU. Our necropsy examination revealed that her right frontal and cornual sinuses contained granular, purulent necrotic material, along with remnants of nasal bot larvae (possibly *Oestrus ovis*) (Figure 4). An intact, dead nasal bot was found in the upper posterior of her nasal cavity. Streptococci, corynebacteria, and proteus organisms were isolated from this ewe’s frontal sinus. As with the first ewe, no microorganisms other than bacteria were isolated.

**Two “early” cases**

Also in November, 1977, a three-year-old ram in considerably better condition than the ewes was brought to USU. This sheep had been ill for approximately one year before we saw him. He had been treated by a veterinarian for keratoconjunctivitis (pink eye), and sores above his eyes had been drained and perfused with hydrogen peroxide.

At USU, we took radiographs (x-rays) that revealed a large abscess in his right horn core and frontal sinus. We bored a half-inch diameter hole into that sinus, inserted a catheter tube and undertook extensive irrigation of the area with antiseptic and antibacterial agents such as oxytetracycline (Figure 5). Additional antibiotic therapy, primarily as a preventive measure, consisted of intravenous injections of 600 mg oxytetracycline HCl.

We kept this ram in an isolation stall for three weeks and then transferred him to a larger pen (Figure 6). His condition appeared to be improved, and he had become surprisingly docile and responsive to human beings. Two months after his initial isolation he was found dead in his pen. Even before necropsy, we suspected what had happened. Desert bighorn are extremely susceptible to stress diseases when kept in relatively small pens. We had been unable to give this ram sufficient space to keep him from experiencing such stress. Because of his docile attitude toward treatment and general responsiveness,
however, we'd hoped he might prove an exception to the rule. At necropsy, we found symptoms of chronic pneumonia.

Our examination of his skull showed a discrete abscess remaining in the right horn core (Figure 7). Our treatment of the frontal sinus had apparently failed to reach the basal region of the horn core. Although at necropsy the abscess was contained in the horn core, it most likely would have again penetrated the frontal sinus and ultimately caused a painful death. *Corynebacterium progenes* and *Proteus spp.* were isolated from the exudate.

The last desert bighorn that we treated at USU for chronic sinusitis was a three-year-old ewe. She was noted as being in trouble during a 1978 team effort (Figure 8) to capture and evaluate the health of the remaining Zion bighorn sheep. We did a general physical examination of each animal and collected blood samples. Each blood sample was analyzed to see if any of its components could be correlated with early cases of sinusitis and thus give us a practical diagnostic tool.

The three-year-old ewe had a draining lesion above her left eye, and an enlarged basal circumference of the left horn (Figure 9). Other than those problems, she was in good body condition. Upon transfer to USU, we bored a hole into her left frontal sinus and another into her horn sheath and core. A catheter was placed in the frontal sinus and the normal trabeculation (boney cross pieces) within the horn core (Figure 1a) was broken up to provide more efficient drainage. The problem areas were then irrigated with antiseptic and antibacterial solutions (NolvasanR and oxytetracycline). After three weeks, the ewe was returned to Zion National Park and released into the enclosure.

She recently lambed.

**Probable cause and process**

The suspected cause of the bighorn sinusitis is bacterial infection secondary to necrotic bot fly larvae, and the bot fly seems to be ubiquitous. But there are two types of bot fly—one that favors domestic sheep and one that primarily attacks mule deer. We do not know which is plauging the desert bighorns.

The occurrence of *Oestrus ovis* larvae in both domestic and wild sheep has been thoroughly described.5,6,7,9, Corbett and Mitchell4 have stated that dead larvae are always associated with inflammation of the mucosa in domestic sheep and sometimes cause death. Recently at the International Sheep and Goat Institute at Utah State University, a similar condition was seen in a Saint Croix ram (domestic hair sheep) and was associated with bot fly infection. This ram died from chronic sinusitis and the resultant osteonecrosis of the skull.

The sheep bot fly deposits its living young from early summer to autumn in the nostrils of sheep and occasionally goats and deer. The larvae migrate up the nasal passages into the animal's nasal and frontal sinuses, often traveling as far as the horns in rams. The larvae attach to the mucous membranes and may be found grouped close together and in various stages of development. The larvae pass through two molts within two to ten months and when mature (3rd instar) return to the nostrils and are sneezed out. They then enter the soil and pupate through a period of 27 to 36 days. As adult flies, they live 24 to 28 days, and after mating the female produces up to 500 larvae.

Horned sheep have special problems with the larvae because their frontal sinuses are relatively large, spacious, and continual into their horn core. Consequently, the incidence and severity of sinusitis in desert bighorn may be aggravated by the extensive pneumatization of their skulls, and particularly of their horn cores (Figures 1a and 1b). The brain of the bighorn is overlaid by two stratifications of bone separated with cross connections of bone. This double roof of bone extends from about 2 to 2.5 inches in front of the brain to the occiput (back of the skull). The highly pneumatized horn cores are formed from the upper skull roof and the chambering is continuous with the frontal sinus. The spaces surrounding the posterior region of the brain case are probably derived from the frontal sinus.

**Difficulties and importance**

Diagnosis of the sinusitis disease is difficult in its early stages. Radiography shows very little until later—when the sinus is filled with exudate. Thermography or the use of infrared light to identify areas that are inflamed and experiencing elevated temperatures has shown some promise, although its practicality under field conditions is questionable. Our work with blood profiles and serum chemistry indicates these are promising diagnostic tools, but we need more data, especially on sheep known to have sinusitis.

The boring of holes, irrigation, and draining is limited as a treatment to either captured animals or sheep available to capture. Based on our analysis of nine skulls and four live animals out of 22 animals a year old or older, the incidence of the disease in the desert bighorn sheep confined at Zion National Park is 41 percent.

*The disease seems to be present in other populations of these sheep and may be a serious mortality factor in all affected herds.*

Unless we can find a way to diagnose early and treat effectively, the disease is terminal, resulting in death 7 to 12 months after clinical signs develop. Affected sheep are usually at prime breeding ages, and their progressive symptoms can preclude breeding or successful raising of lambs. Aberrant behavior is generally accompanied by: frontal bone lesions of the skull, blindness, nasal lesions, harassing by other sheep, and weight losses of up to 50 percent. Sheep with sinusitis may seek total isolation. Ewes with the
disease that do produce lambs, may not be able to properly rear their young because of improper nutrition and mothering ability.

We plan to continue our research on the epidemiology of sinusitis. The type of bot fly infecting the sheep needs to be identified. Several state and federal agencies responsible for desert bighorn management in Nevada, Arizona, New Mexico, and California are trying to determine the extent and frequency of sinusitis in their herds. More blood data will be gathered, particularly on desert bighorns captured for transplanting programs. Blood data may become an important screening tool for early diagnosis of sinusitis since the disease is chronic in nature.

The sad truth is that, if bighorn sheep are infected with bot fly larvae, they are their own worst enemies since the life cycle of the bot is sustained by the presence of the sheep. Attempts will be made to offset bot flies (e.g. by relocating feeding and watering areas and using pesticides), especially where sheep are held in confinement. Management tactics to assist free-ranging sheep will have to be more ingenious.

The Foundation for North American Wild Sheep has identified this disease in the desert bighorn as a priority item and granted $4,000 to Utah State University to sustain our research into sinusitis in populations of desert bighorn.

ABOUT THE AUTHORS

Dr. Thomas Bunch joined the faculty at Utah State University in 1973. He is a Research Assistant Professor in the Department of Animal, Dairy, and Veterinary Sciences and Research Associate with the International Sheep and Goat Institute. His main research interests have involved various areas of cytogenetics and reproduction of domestic and wild sheep and goats.

Henry McCutchen, a Montana-trained Wildlife Ecologist, has been the Biologist at Zion National Park, Springdale, Utah, since 1974. He manages the desert bighorn sheep propagation program within the park and researches their comparative behavioral patterns under penned and wild conditions. Mr. McCutchen is currently enrolled in a graduate program at Colorado State University.

Stephan R. Paul was resident clinical veterinarian (large animal) with the Department of Animal, Dairy, and Veterinary Sciences, Utah State University, at the time of this study. He is now with the Veterinary Medical Teaching Hospital, University of California at Davis.
If you live close to the mouth of one of Utah's major canyons, you may be already convinced that wind-generated electrical power could be a practical reality in the state. The catch is that wind characteristics differ with the site, and basic data must be accumulated before any particular location can be evaluated. We have done some of that accumulating at three Utah sites.

The earliest use of wind energy of which we are aware, was about 1150 A.D. in Europe (Wentink, 1974). The early Dutch windmills were used both to grind grain and to pump sea water away from the lowlands.

In many parts of North America, farmers and ranchers found that windmills (Figure 1) were a reliable way to pump ground water to the surface of their land. In the early 1900s, many windmills dotted the rural United States, and factories produced millions of these machines. By 1930, however, rural electrification was a more expeditious energy source so that only areas far from power lines still relied on windmills to satisfy the water needs of stock.

The diameter of the multiblade was usually eight to ten feet. Many of the wells were designed so that during periods of little or no wind, the hand pump could be engaged and although inconvenient, it was a reliable backup. After power lines became accessible, electric pumps were often set in place beneath the windmill.

Some of the more notable past wind generators are indicated in Figure 2. Power ratings of such generators are calculated by plotting the power output against the wind speed that prevailed. For instance, one generator being tested by NASA,
is rated at 100 Kw (10^9 watts) in an eight meter per second (18 mile per hour) wind. The largest power plant, indicated in Figure 2, operated only a short time before the blade was destroyed and further testing was discontinued. Since 1974, NASA has been able to build 100 and 200 Kw designs.

**What causes wind power?**

In basic science courses, we learn that the kinetic energy of a body in motion is determined from its mass and velocity (\(mv^2\)). Of course, the wind delivers energy at a rate corresponding to its velocity, thus the cubic relationship between wind speed and wind power shown in Figure 3.

The wind itself is a result of interactions among the revolution of the earth, the heating of the sun, land mass distribution, and topographical influences. Utah’s landscape, of course, includes high mountains and low deserts, with mountain valleys, canyons, and basins in between. These great variations in landforms make Utah an especially interesting state in which to study winds.

Although some studies (Reed, 1974) have discussed wind power over large geographical areas, it has become apparent that a study of wind with respect to landform is essential. A general reference which recognized the need for localized information is available from the World Meteorological Organization (Davidson et al., 1964).

A multitude of factors affect winds on a given day. For instance, changes in the atmospheric pressure pattern can modify wind strength and direction. Nearby thunderstorms can increase winds in an area either because air is being drawn toward the main cell or due to the compensating air motion, usually referred to as downdraft. In addition, a cold front moving through an area can drastically affect surface winds. A valid evaluation of wind potentials, therefore, requires that hourly as well as seasonal variations be considered.

**Wind sites**

In this section, usable winds are defined as those capable of turning a generator blade, with the lower cutoff arbitrarily set at eight miles per hour. Hourly data had been taken for a long enough period to allow us to make a meaningful analysis at the Salt Lake City Airport and at the USU weather station in Logan. The Salt Lake City Airport is located in a large valley partly covered by the Great Salt Lake, and large lakes have a marked affect on their immediate environment. In contrast, the Logan/USU station is located at the mouth of a mountain canyon.

The two sites offered a contrast in wind characteristics, and we found that the pros and cons of installing a wind generator at one site versus the other became a study in trade-offs. In Figure 4, the usable wind at each site is depicted as the average number of minutes during each hour that the wind exceeded eight miles per hour.

Figure 2. The relationship between power generated and wind velocity for a few of the largest wind mills ever constructed. D is the diameter in meters.

Figure 3. How the power available changes with wind velocity.
be maintained until the transition is complete. This explains the low point in the Salt Lake City Airport curve. At the valley (Salt Lake City) site, afternoons offered the maximum in usable winds. In contrast, the maximum occurrence at the canyon (Logan) site, was during the late evening and early morning hours.

The way that winds are distributed throughout the day at any site has to be matched to the intended use of wind power. For example, wind energy could be used to pump water into a storage reservoir. If the reservoir were drawn down in the day, then the best energy source would be one that could work to increase the storage at night. A canyon site would be a logical consideration here. On the other hand, if one were concerned with satisfying demands on our conventional power company systems, the peaks of the electric-demand curve should be coordinated with the peaks on the wind supply curve. In addition to the diurnal changes shown in Figure 4, the winds also exhibit seasonal changes. This is exemplified by the study sites shown in Figure 5.

A limited wind record was obtained at Mount Pisgah, in Utah's Wellsville Range, during August and September of 1976. These data cannot substitute for long-time averages but they do provide some high-elevation (7000 feet) information. Usable winds were available over 60 percent of the observation time at Mount Pisgah.

The strength of the wind during usable periods at all sites was determined by averaging all the winds that exceeded eight miles per hour (Figure 5). Salt Lake City had stronger usable winds during the winter, while Logan/USU had its strongest winds during the summer. Mount Pisgah, however, could probably generate the greatest amount of power because our limited data indicate that it rates high in both categories.

Conclusions

Our preliminary findings indicate that mountainous terrain offers a variety of interesting wind phenomena. In regard to time, the nocturnal wind frequency near the mouth of a canyon complements the daylight peak in wind occurrence at both the valley and ridge locations.

It appears that upper elevation sites will offer the greatest potential for wind power in Utah. This study is now being expanded to include all available wind data in Utah. This will provide the information required to rank Utah among those states which have surveyed their wind energy potential.

REFERENCES


ABOUT THE AUTHOR

Kenneth G. Hubbard was recently appointed Assistant State Climatologist with the Utah State Department of Agriculture. In the past few years, he has been involved at the Utah Water Research Laboratory with research on weather modification, precipitation physics, and climate studies for consumptive water use in Utah. He is principal investigator for the Great Basin Climate Study (Range Fire Management) and for the Wind Energy Study reported in this article.
Population Changes in Rural Utah

William F. Stinner
Michael B. Toney
Stephen Kan

One of the more significant population changes in recent years has been the emergence of population growth in nonmetropolitan areas of the United States after many decades of population decline (Beale, 1976). Utah appears to be partaking of this renewed growth.

Ten of Utah's rural counties, whose largest population centers contain less than 2,500 people, declined in population during the 1960s, but gained during the 1970s (Table 1). The remaining three rural counties in Utah continued their growth of the 1960s into the 1970s, two of them at an accelerated pace. (Utah's eleven urban counties have also increased in population since 1970.) As to rates of growth, Emery and Kane counties, population losers during the 1960s, are now the state's fastest growing counties. Rich county has had the lowest rate of increase since 1970.

Throughout the nation, nonmetropolitan areas that had been losing populations to out-migration are now growing, in part at least, due to in-migration (Tucker, 1976). In addition to studying the volume of people moving into rural areas, researchers are also interested in determining why more people are deciding to live in rural areas as well as in comparing the characteristics of new-comers with long-term residents. In the work described here, we examined compositional differences among recent migrants, settled migrants, and natives in rural Utah. Our definitions for these categories were: recent migrants, persons who moved into the community since 1970; settled migrants, persons who moved into the community prior to 1970; and natives, those who were born in the community and have never lived elsewhere. The data were gathered from adults in eight rural Utah communities in 1975.

---

Table 1. Population sizes of and population changes in rural, urban, and metropolitan counties for 1960-1977

<table>
<thead>
<tr>
<th>Counties</th>
<th>Population sizes</th>
<th>Annual % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1950c</td>
<td>1960c</td>
</tr>
<tr>
<td></td>
<td>1950c</td>
<td>1960c</td>
</tr>
<tr>
<td>All Rural</td>
<td>69,754</td>
<td>70,224</td>
</tr>
<tr>
<td>Beaver</td>
<td>4,856</td>
<td>4,331</td>
</tr>
<tr>
<td>Daggett</td>
<td>364</td>
<td>1,164</td>
</tr>
<tr>
<td>Duchesne</td>
<td>8,134</td>
<td>7,179</td>
</tr>
<tr>
<td>Emery</td>
<td>6,304</td>
<td>5,546</td>
</tr>
<tr>
<td>Garfield</td>
<td>4,151</td>
<td>3,577</td>
</tr>
<tr>
<td>Kane</td>
<td>2,299</td>
<td>2,667</td>
</tr>
<tr>
<td>Millard</td>
<td>9,387</td>
<td>7,866</td>
</tr>
<tr>
<td>Morgan</td>
<td>2,519</td>
<td>2,837</td>
</tr>
<tr>
<td>Piute</td>
<td>1,911</td>
<td>1,436</td>
</tr>
<tr>
<td>Rich</td>
<td>1,673</td>
<td>1,685</td>
</tr>
<tr>
<td>San Juan</td>
<td>5,315</td>
<td>9,040</td>
</tr>
<tr>
<td>Sanpete</td>
<td>13,891</td>
<td>11,053</td>
</tr>
<tr>
<td>Summit</td>
<td>6,745</td>
<td>5,673</td>
</tr>
<tr>
<td>Wayne</td>
<td>2,205</td>
<td>1,728</td>
</tr>
<tr>
<td>All Urban</td>
<td>148,115</td>
<td>149,315</td>
</tr>
<tr>
<td>Box Elder</td>
<td>19,734</td>
<td>25,061</td>
</tr>
<tr>
<td>Cache</td>
<td>33,536</td>
<td>35,788</td>
</tr>
<tr>
<td>Carbon</td>
<td>24,901</td>
<td>21,135</td>
</tr>
<tr>
<td>Grand</td>
<td>1,903</td>
<td>6,345</td>
</tr>
<tr>
<td>Iron</td>
<td>9,642</td>
<td>10,795</td>
</tr>
<tr>
<td>Juab</td>
<td>5,981</td>
<td>4,597</td>
</tr>
<tr>
<td>Sevier</td>
<td>12,072</td>
<td>10,565</td>
</tr>
<tr>
<td>Tooele</td>
<td>14,636</td>
<td>17,868</td>
</tr>
<tr>
<td>Uintah</td>
<td>10,300</td>
<td>11,582</td>
</tr>
<tr>
<td>Wasatch</td>
<td>5,574</td>
<td>5,308</td>
</tr>
<tr>
<td>Washington</td>
<td>9,836</td>
<td>10,271</td>
</tr>
<tr>
<td>All Metro</td>
<td>470,993</td>
<td>665,530</td>
</tr>
<tr>
<td>Davis</td>
<td>30,867</td>
<td>64,760</td>
</tr>
<tr>
<td>Salt Lake</td>
<td>274,895</td>
<td>383,035</td>
</tr>
<tr>
<td>Utah</td>
<td>81,912</td>
<td>106,991</td>
</tr>
<tr>
<td>Weber</td>
<td>83,319</td>
<td>110,744</td>
</tr>
</tbody>
</table>

Perceptions and characteristics

Since rural communities are by definition small, an influx of new residents often entails social and economic changes, as well as increasing size (Morrison and Wheeler, 1976). In some cases, a small population appeared to be a primary criteria for migrants selecting a rural community. Ironically, this characteristic and the amenities associated with it are likely to be destroyed by an influx of migrants. In a "small" community it doesn't require many new people to create a housing shortage and over-crowd the schools and outrun the capabilities of other services. Such problems are then often compounded by the differences in background and outlook of newcomers and old timers. For example, the new residents may perceive a need for certain services such as street lights and paved streets that the natives consider frills. Frequently, recent migrants are more highly educated and younger than the natives. They often earn more money and in Utah may profess a different religion than does the established population. These differences can vitally affect value perceptions and priorities, thereby contributing to political conflicts.

In the rural Utah communities we investigated, recent in-migrants tended to be younger, more highly educated, less likely to earn low incomes, much less likely to own land, more likely to be politically independent of any party affiliation, and less likely to be Mormon than the settled migrants or natives (Table 2). Recent and settled in-migrants have a higher proportion of upper white-collar workers than do the native populations and the three groups have roughly the same proportions of men and women. Overall, the settled in-migrants and the natives were more similar to each other than either group was to the recent in-migrants. The difference between recent and settled migrants may be the result either of changes in the type of migrant moving in, or of changes in the attitudes and/or composition of the settled residents that occurred over time. In the latter case, the initial composition of the settled migrants would have been similar to that of current migrants, but such factors as heavy out-migration of particular subgroups, religious conversions, or even aging could have effected change. A similar process could then eventually alter the currently "recent" migrants.

Problems and opportunities

Rural Utah communities are undeniably growing, and that growth is changing the character of both the rural population and their communities along several important dimensions. Rapid in-migration into formerly isolated rural communities presents opportunities for invigoration and intercultural stimulation, but it also creates problems. Our results suggest that imaginative resourcefulness will be needed by local and state leaders as they formulate plans for implementing services in rural areas. To be effective, such plans must allow for the characteristics and perceived needs of all of our categories: natives and settled and recent migrants.
Table 2. Selected characteristics of recent in-migrant, settled in-migrant, and native residents of rural Utah adult residents*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Recent In-migrants</th>
<th>Settled In-migrants</th>
<th>Natives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39.8</td>
<td>42.4</td>
<td>42.0</td>
</tr>
<tr>
<td>Female</td>
<td>60.2</td>
<td>57.6</td>
<td>58.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)**</td>
<td>304</td>
<td>488</td>
<td>219</td>
</tr>
<tr>
<td>Age of household head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 30</td>
<td>40.0</td>
<td>10.6</td>
<td>19.6</td>
</tr>
<tr>
<td>30-44</td>
<td>38.7</td>
<td>22.8</td>
<td>17.4</td>
</tr>
<tr>
<td>45-64</td>
<td>15.7</td>
<td>39.9</td>
<td>34.2</td>
</tr>
<tr>
<td>65 or older</td>
<td>5.6</td>
<td>26.7</td>
<td>28.8</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>305</td>
<td>(491)</td>
<td>(219)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>2.3</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Married</td>
<td>90.7</td>
<td>84.9</td>
<td>82.0</td>
</tr>
<tr>
<td>Divorced-separated</td>
<td>3.0</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Widowed</td>
<td>4.0</td>
<td>11.3</td>
<td>13.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>300</td>
<td>(477)</td>
<td>(211)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>13.7</td>
<td>20.1</td>
<td>17.0</td>
</tr>
<tr>
<td>High school graduate</td>
<td>25.7</td>
<td>34.7</td>
<td>42.7</td>
</tr>
<tr>
<td>Some college</td>
<td>36.7</td>
<td>23.7</td>
<td>32.0</td>
</tr>
<tr>
<td>College graduate</td>
<td>24.0</td>
<td>21.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>300</td>
<td>(472)</td>
<td>(206)</td>
</tr>
<tr>
<td>Occupation of principal wage earner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper white collar</td>
<td>47.4</td>
<td>46.0</td>
<td>34.2</td>
</tr>
<tr>
<td>Lower white collar</td>
<td>9.3</td>
<td>13.5</td>
<td>14.7</td>
</tr>
<tr>
<td>Upper blue collar</td>
<td>35.8</td>
<td>35.1</td>
<td>41.8</td>
</tr>
<tr>
<td>Lower blue collar</td>
<td>6.9</td>
<td>3.0</td>
<td>7.1</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.7</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>291</td>
<td>(436)</td>
<td>(184)</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under $4,000</td>
<td>7.0</td>
<td>13.9</td>
<td>15.4</td>
</tr>
<tr>
<td>$4,000-$7,999</td>
<td>15.8</td>
<td>19.8</td>
<td>18.6</td>
</tr>
<tr>
<td>$8,000-$11,999</td>
<td>33.3</td>
<td>24.5</td>
<td>31.9</td>
</tr>
<tr>
<td>$12,000-$15,999</td>
<td>22.1</td>
<td>20.9</td>
<td>16.0</td>
</tr>
<tr>
<td>$16,000-$24,000</td>
<td>17.9</td>
<td>15.3</td>
<td>15.4</td>
</tr>
<tr>
<td>$25,000 or over</td>
<td>3.9</td>
<td>5.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>285</td>
<td>(445)</td>
<td>(188)</td>
</tr>
<tr>
<td>Amount of land owned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>64.0</td>
<td>38.3</td>
<td>25.5</td>
</tr>
<tr>
<td>Up to 5 acres</td>
<td>29.7</td>
<td>40.5</td>
<td>42.6</td>
</tr>
<tr>
<td>5 or more acres</td>
<td>6.3</td>
<td>21.2</td>
<td>31.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>286</td>
<td>(452)</td>
<td>(204)</td>
</tr>
<tr>
<td>Political affiliation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Republican</td>
<td>28.9</td>
<td>40.7</td>
<td>40.3</td>
</tr>
<tr>
<td>Democrat</td>
<td>27.3</td>
<td>30.7</td>
<td>29.4</td>
</tr>
<tr>
<td>American</td>
<td>5.5</td>
<td>2.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Independent</td>
<td>36.5</td>
<td>25.9</td>
<td>27.9</td>
</tr>
<tr>
<td>Other</td>
<td>2.0</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>293</td>
<td>(471)</td>
<td>(201)</td>
</tr>
<tr>
<td>Religious preference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.D.S.</td>
<td>61.8</td>
<td>78.4</td>
<td>91.6</td>
</tr>
<tr>
<td>Protestant</td>
<td>25.7</td>
<td>34.7</td>
<td>42.7</td>
</tr>
<tr>
<td>Catholic</td>
<td>7.2</td>
<td>3.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Other</td>
<td>6.1</td>
<td>4.7</td>
<td>2.0</td>
</tr>
<tr>
<td>None</td>
<td>7.8</td>
<td>3.0</td>
<td>3.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(N)</td>
<td>293</td>
<td>(472)</td>
<td>(203)</td>
</tr>
</tbody>
</table>

*Recent migrants are people who moved to one of the eight communities between 1970 and 1975. Long-term migrants moved to one of the communities at any point prior to that. The place of origin could include other communities within Utah.

**Number of cases (N).

REFERENCES


ABOUT THE AUTHORS

William F. Stinner is Associate Professor of Sociology in the Department of Sociology, Utah State University. His research interests lie in the area of United States population redistribution trends and their socio-economic implications as well as population dynamics in the Philippines and the Caribbean.

Michael B. Toney is Assistant Professor of Sociology in the Department of Sociology, Utah State University. His research interests are focused on the social and economic determinants and impacts of internal migration and population redistribution.

Stephen Kan is a graduate student in the Department of Sociology, Utah State University. He recently completed his M.S. thesis on household projections for Utah from 1970 to 2000.
"At first glance, it's tempting to think you've stumbled onto one of evolution's trials that turned out to be an error. But the more you look at molecular iron," says Thomas F. Emery, Professor of Chemistry and Biochemistry, "the more you come to respect the wisdom of what evolutionary time has created."

The general riddle posed by iron is too monstrous for even the most audacious scientist: Iron is the fourth most prevalent element in the earth's crust—but it is among the most inaccessible to plants and animals because its common forms are insoluble. The nature of iron becomes increasingly paradoxical when you realize that the element is essential to virtually every living cell—yet, once a cell manages to capture some iron, its other components threaten to tie that iron up before it can be used.

So the only way researchers such as Emery have been able to proceed has been to identify and "break out" compassable pieces of the puzzle. Emery himself has concentrated on iron's metabolic riddles. Since the mid 1960s, he has been thinking about and investigating how cells manage to get the iron they need to survive. And, because cellular mechanisms are prohibitively difficult to study in higher plants and animals, he has been using microorganisms such as bacteria and comparatively simple fungi.

As he puts it, "Researchers around the world are struggling to turn iron's metabolic mysteries into usable data. But all that effort has given us only a few more knowns than we had 15 or 20 years ago."

"For example, we know that most iron-deficient (anemic) microorganisms (including a few algae) excrete remarkably potent, specifically iron-seeking and iron-binding substances. We call those substances siderochromes, from the Greek words for iron and for star, or meteorite. The elegantly designed siderochromes first dissolve and then irresistibly bind nature's insoluble ferric forms of iron, much as an octopus embraces its prey. The siderochrome-engulfed iron is no longer a charged ion, and thus can get through the cell's usually resistant membrane."

The siderochromes that have been identified and worked with in research laboratories have proved capable of pulling iron out of stainless steel and glass containers—making it difficult to create the iron-free environments needed for experiments. The acute iron sensitivity of the producing organisms has also been a problem. Their siderochrome production machinery stops operating the instant they have access to minute (0.1 milligram per liter, which is roughly equal to a small bottle of iron supplement tablets dissolved in an Olympic-size swimming pool) amounts of iron. Research to date has also demonstrated that many microorganisms can accept only iron that is bound by their own type of siderochrome. Apparently a "share-the-wealth" philosophy relative to iron is rare in the world of microorganisms.

When asked how that world is relevant to you and me, Emery replied, "We may be able to exploit the bacterial need for iron by turning it against them when they invade our bodies. In a way, being slightly anemic may be an advantage when we're trying to throw off a bacterial infection."

"Then, too, because the cellular mechanisms of diverse species are often more comparable than their other characteristics, what we are learning about how bacteria and fungi obtain and metabolize iron is helping us better understand how the seemingly haphazard, human iron-management system functions. The siderochrome data has already been put to work treating cases of hemochromotosis (rusty liver), a disease that causes people to store instead of excrete most of the iron in their diet. The data have also been of value in treating acute, and otherwise fatal, cases of iron poisoning."

According to Emery, siderochrome-based insights have potential applications to agricultural production.
as well. Some of his current research is into the relationships among microorganism-produced siderochromes, alkaline/acid soils, and plant access to and metabolism of iron. The more alkaline the soil (Utah abounds in highly alkaline soils), the more impressive its siderochrome content.

Beyond these aspects, it seems that the accumulating siderochrome data are relevant to medical research on tumor detection. Working with fungi, Emery showed several years ago that the chemical similarities among iron, gallium, and aluminum, can confuse siderochrome systems despite their distinctive iron specificity. Then, more recently, radioactive gallium became a tool for detecting the presence of certain types of tumors in human beings.

A researcher associated with Yale University's School of Medicine, Paul Hoffer, is one of the physicians using gallium this way. In the course of his work, he noticed that the gallium was concentrating in tears and the milk of lactating women as well as in the tumors. Since the constituent common to both milk and tears is an iron-binding protein (lactoferrin), Hoffer's search for an explanation of the gallium concentration sites included iron as a possibly relevant factor. (In its normal functioning, lactoferrin binds iron to keep it away from bacteria that could otherwise thrive in an individual's eyes and in infants.)

When Emery's early work with siderochromes and his insight regarding aluminum and gallium came to Hoffer's attention, the two scientists began to cooperate in a research effort. Out of their work may come an increased use of gallium as a substitute for iron in various experiments. Its ability to trick the iron-transport system of an animal into accepting it as a passenger, coupled with its immobility once into a tissue, give it unique value as a research tool.

*Funded by the U.S. Department of Energy.

---

**Children: Categories and Concepts**

Categorization (labeling) can be exceedingly dangerous. Once "tagged" as uncooperative, or shy, or studious, or awkward, even an adult can find it difficult to change that image. For a young child or an adolescent, labels can be even more devastating.

Researchers such as Gerald R. Adams and J. Craig Peery, Assistant Professors of Family and Human Development, are well aware of the above psychological truisms. And yet, at least for now, categorization often seems an unavoidable first step towards helping youngsters (and adults) learn to cope with social, family, and personally produced pressures. So the regional research project "Development of Social Competencies in Children" (described in our Projects in Progress section of the December 1977 Utah Science) is identifying preschoolers and junior high school students who might be categorized by their teachers and peers as popular or unpopular. But the process has been designed to preclude labeling traumas, while optimizing usable insights.

According to Adams, "Our recent months of preliminary interactions with 100 junior high students and their teachers did help us refine our investigative techniques. And they also forced us to rethink one of our hypotheses.

'We had intuitively thought that the self-perception ratings we were collecting would show that social competence (popularity) was
predictive of relative ability to empathize. And we had a hunch that physical competence (athletic abilities) would directly correlate with social competence. As it turned out, the higher a youngster ranked himself or herself in social and/or physical competence, the lower they put themselves on the empathy scale."

Adams then commented that the findings might suggest that the most socially popular and physically adept children may be slow in developing certain social skills such as empathy. An over-emphasis upon popularity and athletic achievements may therefore have an undesirable influence on empathic skills.

It was the preschoolers, however, who gave the researchers their most exciting surprise. In the past, traditional personality/social competence surveys have produced two categories: popular and unpopular (rejected) and occasionally a third that was called isolated. But the USU group, led in this phase by Peery, devised a different way of evaluating data and ended up with four categories.

The 80 preschoolers that were finally chosen to participate averaged 4.4 years of age. Each child was asked to look at individual pictures of their classmates and say which one they played with (did not play with) outside; which they sat (did not sit) with on the rug for story-telling time, etc. In that way, the researchers gathered both positive and negative votes for each child in the sample.

From these votes, they identified the usual popular and rejected groups (high positive/low negative scores versus low positive/high negative scores)—both of which groups tend to have a definite social impact on their peers. They also had some isolated children (few votes, mostly negative). Then they came up with a previously unidentified category that they called amiable. These youngsters received few votes, but those few were mostly positive.

The next step was to measure the children's individual ability to empathize. This was done by showing each one pictures of four faces, each of which reflected a specific emotion (fear, happiness, sadness, anger). The child was asked to say how the person pictured was feeling.

Peery describes their empathy data as indicating that "youngsters in the popular group had high empathy scores, which we expected. The isolated group however, provided a major surprise by scoring higher than either the rejected or amiable groups and as high as the popular children. "Our observational data gave us another set of unexpected results. The popular children tended to flit from one activity to another. The rejects, in contrast, would generally persist with a particular activity for an extended time—suggesting a greater ability to concentrate.

Even at this preliminary stage of their investigation, the researchers are therefore having to question the standard adult desire to arbitrarily change the behavior of non-popular youngsters so they can be more popular. As Peery states, "It may be that we should be paying more attention to recognizing and capitalizing on the personality strengths of each child, whether or not this equates with popularity."

Although the preschool, participating children are predominantly from middle-class, white families, the emerging concepts could have significance for current social/educational practices in many situations. At USU, plans call for extending the preschooler research to children from rural, farming environments. One goal will be to determine whether (and how) limited peer interaction affects the development of social competence in an individual. If the results warrant, and time allows, some training in social skills may be devised and given to these children to facilitate their entrance into pre-school and kindergarten settings.
Tracking the Universal Carrier

The ease with which wind can be defined (air in motion) is deceptive since that motion can range from a gently caressing breeze to a rampaging tornado. And the deception goes further, because the variables inherent in the carrier we call wind encompass far more than its velocity. Especially in deep mountain valleys, wind patterns are intricate. That makes simply tracking the flows difficult, with prediction becoming the take-a-little-longer impossible dream.

So why bother trying? Well, Gene L. Wooldridge, Professor of Soil Science and Biometeorology, says the tracking (and eventual predicting) of wind behavior is basic to solving problems of dispersion of wind-borne materials. Those problems can include: do you get to breathe the smoke from my burning leaves; do we both inhale the dust from the dirt road that bounds the rear of our lots; and just how far do the pollutants from the factory smoke stack five miles away travel—and in what direction? The answers to those types of air quality questions will eventually come out of the data being accumulated by Wooldridge, cooperating USU faculty members and graduate students, and researchers working in similar terrain in Europe, Japan, and other locations within the United States.

The tools of the trade include free-flying 2- to 3-foot diameter rubber balloons that travel more or less vertically, expanding as they go, and 3- to 4-foot mylar plastic balloons that tend to travel horizontally until caught by substantial up (or down) drafts. The researchers also make limited use of tethered balloons, acoustical radar, and instruments on tall towers. In parts of Europe and the United States, instrumented aircraft supplement those tools and provide information that, unfortunately, cannot be directly transferred to other locations.

Even without aircraft, however, his local experiments and cooperative work with a European group have given Wooldridge data on how air generally circulates in deep valleys such as Cache Valley. The atmospheric energetics of that circulation are the subject of a project that is just beginning.

As Wooldridge explains, "There are generally two definite levels of wind action in Cache Valley. The one operates from the valley floor to an elevation of about 1500 feet above the floor. The other extends from that 1500-foot level to the tops of the mountains, where our valley circulation encounters the region's general atmospheric circulation. We quite often see our balloons being carried south by the low-level winds, and then returning on the northerly moving high-level winds."

"We know that individual deep valleys, even when they are as close together as Cache and Blacksmith Fork, can differ drastically in their air circulation patterns. On the other hand, site-specific data have to be coordinated into broader pictures to be optimally useful."

To help define a broader picture, the USU researchers are cooperating in a regional project. That project will ultimately produce computerized models indicating the extent to which activities in a part of, say Idaho, may affect the quality of air being inhaled in another area hundreds or even thousands of miles away.

At the same time, on bench areas west of Price, Utah, data will be collected that will correlate temperature readings with wind velocities and directions at various elevations. With the temperature inputs, Wooldridge and his students expect to get a handle on a valley's atmospheric energetics. Which, in turn, will facilitate their computer simulation of how human-generated heat releases to the atmosphere are likely to affect air circulation, whether in a valley or on a larger scale. (Such heat releases would be inherent in the operation of any coal-powered industry.)
Viruses play few favorites when choosing their targets. It only seems that way when you're in the midst of a series of virus-caused illnesses. Actually, many species of animals share our susceptibility to viral diseases, with some of the diseases producing similar effects in more than one species.

Cattle, for example, are subject to a leukemia that seems comparable to some forms of human leukemia. The disease occurs in up to 10 percent of all dairy cattle, and beef breeds can also be affected. This bovine leukemia, which was recognized only recently, is generating considerable interest at various laboratories. Some of the research effort is primarily geared to finding ways to lessen costly cattle losses. At USU, Robert W. Sidwell, Research Professor in the departments of Animal, Dairy, and Veterinary Sciences, and of Biology is leading a team of scientists who hope that as they characterize the disease process in cattle, they will simultaneously define a model applicable to human leukemias.

Without adequately comparable animal "models," researchers seeking ways to combat human diseases are seriously handicapped. Given access to animals that suffer from the same, or a virtually identical, naturally occurring disease, however, their investigations may be both simplified and shortened in duration.

The resources and talents combined in the Sidwell group (diagnostic and chemotherapeutic) can be expected to, at the very least, produce insights into how to identify "carrier" cattle. And, as more is learned about the virus and its modi operandi, the odds on developing effective treatments will steadily improve.

Besides the bovine leukemia research, Sidwell is leading a cooperative investigation of a virus (rotavirus) that is, he says, "a major cause of acute gastroenteritis (diarrhea) in infants and young children. Closely related viruses produce similar symptoms in calves, foals, piglets, mice, lambs, and the young of other animals. The infection is particularly dangerous if the host is suffering from malnutrition.

"In this research, as in the leukemia work, we hope to find a suitable model system—perhaps in mice—which will allow us to track how the virus does its damage. We'd then impose a variety of nutritional stresses on infected animals to see if we could pinpoint a dietary means of increasing resistance to the virus(es)."

If a significant nutritional factor is identified, the researchers will try to determine why it is influential. This would primarily involve intensive studies of how the factor affects specific immunological defenses of the host.

Prior to joining USU in 1977, Sidwell was instrumental in developing two of the remarkably few drugs that have been effective against virus-induced diseases. He'll naturally draw upon that knowledge in both the leukemia and rotavirus research. Particularly in the leukemia work, he plans to capitalize on the capacity of interferon to destroy abnormal cells. (Interferon is a substance produced routinely in the animal body. Unfortunately, the body's production mechanism generally fails to provide adequate quantities. And synthetic production is prohibitively expensive for most purposes.)

"After we have our suitable animal models," says Sidwell, "we will look for ways to enhance the seek-and-destroy properties of interferon. A likely possibility would be to biochemically 'soften up' its cellular targets before introducing the interferon into an animal's system. Ideally, the amount of interferon needed to cure certain cancers and other diseases could then be kept within practicable monetary limits."

Viruses are not likely to voluntarily abandon their successful fields of battle to researchers such as Sidwell. But we may soon be able to make them fight harder than before to stay in business.
Who Gives—Who Gets—How Much?

When those questions are asked about public land access and fees, few people would dare unequivocal answers. This is especially true when costs and benefits beyond monetary exchanges are considered.

To eliminate some of the unknowns, E. Bruce Godfrey, Associate Professor of Economics, and James Christensen, a graduate student, have started a "what if" research effort. Godfrey smiles ruefully when he admits that even at this early stage of their work, they are having "logical" hypotheses shaken, though not yet disproved. He also says, "Almost every fact we turn up raises more questions, instead of answering the ones we're asking."

Their central question had been posed originally by groups and individuals interested in public lands: What if all domestic animals were prohibited from grazing public lands? In designing their investigation, explains Godfrey, "We wanted to define how such a policy would affect ranch stability and ownership in Utah as well as its other socio-economic implications for this state. An early goal, therefore, is to find out whether Utah ranchers have viable alternatives to public land grazing as a ranching strategy.

"But we're more or less simultaneously looking at the cost/benefit effects on groups such as ORV riders, hunters, backpack campers, and day hikers who also use public lands. That, of course, is leading us to questions about the BLM's Organic Act and its requisite setting and collecting of market-value fees from all users. A prime unknown is who would ultimately get to spend the fee money; in other words, will 'outsiders' benefit at the expense of local communities?"

Godfrey went on to comment that the dollars and cents picture is further complicated by what are called in-lieu payments. Over past years, fees were established by the federal government for grazing and mining usage of public lands. At the same time it was stipulated that variable portions of those fees should revert to the state where the lands are located. Utah's legislature based its formula for allocating those monies within the state on certain perceived "needs" rather than on the fees' geographic points of origin. Thus, in Utah, even though 50 percent of a given county may be public land that generates grazing/mining fees, that county and those interests may get little or none of the federally returned in-lieu money.

Recently, of course, public lands have begun to feel substantial pressures from use-groups other than the traditional fee-payers and this change in demand pattern is too intensive and extensive to be ignored. So agencies such as the Forest Service and the Bureau of Land Management are trying to define monetary values for all possible uses, evaluate relative effects on land and society inherent in each use, and figure out if they should, and how to collect any fees assigned to the more or less transient users; e.g. hikers, rockhounds, and ORVers.

Godfrey and Christensen plan to concentrate their initial "what if" research on two very different locales in Utah. They want to be able to compare the effects of eliminating livestock grazing from a basically public-land, grazing-and-nothing-else economy with what would happen under similar circumstances within an economy that includes considerable privately owned land and in-place recreational developments.

By the close of their five-year project, the researchers will have begun to convert their baseline data on what has happened and is occurring under the new public land grazing systems into computer-simulated answers to "what if" propositions about multiple-use allocations. "Eventually," projects Godfrey, "we would get to the impact at the supermarket. But meanwhile, we'll be giving public land managers a better basis for making logical decisions that allow for predictable effects. We even hope to be able to give them relative energy cost/benefit data along with other dollar figures for each multiple-use option. At the same time, Utah ranchers should be helped by the information we collect about how their cohorts are solving problems relating to public lands."

SEPTEMBER 1978
UTAH SCIENCE is a quarterly devoted
to research in agriculture, land and water
resources, home and community life,
human nutrition and development, and
other wide-ranging research conducted at
Utah State University. Published by the
Agricultural Experiment Station, Utah
State University, Logan, Utah 84322.

The magazine will be sent free on request.

To avoid overuse of technical terms,
trade names of products or equipment
sometimes are used. No endorsement of
specific products or firms named is in-
tended, nor is criticism implied of those
not mentioned.

Articles and information appearing in
UTAH SCIENCE become public property
upon publication. They may be reprinted
provided that no endorsement of a
specific commercial product or firm is
stated or implied in so doing.

Please credit the authors,
Utah State University,
and UTAH SCIENCE.

Glen L. Taggart
President
Utah State University

Doyle J. Matthews
Director
Agricultural Experiment Station

C. Elmer Clark
Associate Director
Agricultural Experiment Station

Karen Kreutzer Kleinschuster
Editor

Lois M. Cox
Science Writer

Carol Grundmann
Graphic Designer

Lori R. Nelson
Editorial Assistant

"Utah State University is committed to a
policy of equal opportunity in student admis-
sion, student financial assistance, and faculty
and staff employment and advancement,
without regard to race, color, religion, sex,
age, national origin, or handicap."