can be punched and secured in a small binder with screw-type aluminum binding posts. A drawback is that sealing the specimen may obscure vegetative and floral characteristics needed for identification. The mounts also have a fogged appearance from the acetate adhesive.

Design and Application

A field herbarium which provides and maintains field mobility, specimen clarity, taxonomic verification, color, and a weather-proof mount can be constructed from self-adhering acetate cut to 4 × 6 in. sheets. The sheets are placed on a flat surface with the adhesive side up and the plant specimen and label are placed face down on the acetate. A piece of white botany paper is placed on the adhesive side to eliminate the fogged appearance of the acetate backing and improve visibility of the plant characteristics. Accurate identification can be enhanced by listing vegetative and floral characteristics on the back of the botany paper (Fig. 1). Characteristics needed for identification should include ligule diagrams for grasses or leaf characteristics for shrubs. Auricle, ligule, collar, and sheath characters are vital for vegetative or grazed grasses.

To weatherize the mounts, an additional 4 × 6 in. piece of self-adhering acetate can be applied over the botany paper. This provides a completely sealed mount which can be punched and placed in a pocket-sized binder for field use. An alternative to securing the specimens in binders is to store the mounts in small boxes, grouped by lifeform, in alphabetic order by genus (Fig. 2). In addition to taxonomic floras, several publications include vegetative descriptions and line-drawings which can be used as references for specific locations.

Self-adhering acetate sheets are available from most office suppliers in a variety of sizes. One 4 × 6 in. sheet of acetate and one 3 × 4 in. piece of botany paper is enough material for one mount, and costs about $1. Total time of assembly averages 30 minutes, depending on the number of identification characteristics included. Plant specimens can be collected and pressed before or at the time of seasonal vegetation sampling.

The field herbarium described has been used for several years by field crews with minimum botanical training. During this time, plant identification errors were reduced, less time was used keying plants, and the mounts retained their color and field durability. Field herbaria are useful for training field crews to maintain consistent plant identification from year to year by highlighting the most important characters of key species.

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Low Risk versus High Risk Range Improvements

A.S. Law

Out of many possible plans, selection of the most appropriate range improvement is of critical importance to any project. Determination of the best alternative lies in what criteria are considered important. Cost and effectiveness are the two most widespread concerns. However, using more than one criterion for evaluation can be cumbersome. A more expensive treatment may be more effective, but will it be sufficiently more effective to justify the additional cost? How much of an area treated with a less effective practice will have to be re-treated, and at what cost? This article discusses a method of combining cost and effectiveness for evaluation of improvement treatments.

Range improvement practices are often selected on the basis of which treatment is expected to return a given level of net benefits at the least cost. Net benefits are the expected return of a treatment minus the expected cost. The expected cost of a treatment is the total of the initial and re-treatment costs.

Initial costs are relatively easy to calculate, but re-treatment costs will depend on a number of factors, such as the likelihood that a treatment will fail to reach and maintain the stated minimum level of benefits with only the initial treatment.

There are three factors involved in calculating which treatment is the most economical: Expected Results, Cost of Treatment, and Probability of Success. Combination of these three factors produces what may be called the Expected Final Cost of a treatment. The Expected Final Cost of each treatment can be used to compare cost effectivness.

High Risk Versus Low Risk Treatments

The factor which makes this method of analysis different from standard benefit/cost analysis is Probability of Success. What is Probability of Success? How does a high risk treatment differ from a low risk treatment?

Probability is defined as the chance that an event will or

A.S. Law is currently a graduate student in the Department of Range Science at Colorado State University.

will not occur. The classic example is the chance of a coin landing heads up being 50%. If one bets on this chance, the risk of losing is 50% as well.

Probability can be estimated in a number of ways. It is possible to calculate it mathematically, but there usually isn't enough quantifiable data for a meaningful calculation. For most applications in range science, professional judgment of the chances of success or failure is at least as accurate. All examples in this article use probabilities based on professional judgment.

An event with high risk is just what it sounds like: risky! There is a large chance for failure. Why then would anyone choose such a treatment? The answer is high possible returns. Is it better to have a treatment with low expected benefits, but equally low risk, or a treatment with a lesser chance of high returns? How should one decide which is the better path to take? The answer lies in the objectives of the treatment, in other words, in the expected benefits.

The range manager must decide if the goal is to reach a set level of performance or to simply make a small, but relatively certain improvement in production. A clear understanding of the ultimate goal of a range improvement is required, since meeting one or the other of these two types of goals determines success or failure of the treatments.

These two viewpoints of high risk with the possibility of high return or certain but low return, however, are really simply different performance criteria along a gradient. Any viable range improvement must make a minimum gain in production to be worth considering investing time and money. Determining this break-even point is a common procedure. To determine if one treatment is more efficient in terms of Cost and Probability of Failure than another, a means of comparing the two must be developed.

Comparing Treatments by Looking at Cost Times Probability of Failure

Fixed Costs are those costs which will not vary between treatments being compared, while Variable Costs are determined by the particulars of the treatments. These costs would also include maintenance of the treatment over the estimated life of the treatment. All costs are added together to get the Total Cost of a treatment.

A treatment may be more expensive, but also more productive. Is it *enough* more productive to justify the additional costs? To determine this, simply multiply Probability of Failure by Variable Costs, then add this value to Total Cost of each treatment to get the Expected Final Cost of the treatment.

Example: **Thinning Sagebrush**

Fixed Costs per Acre

Initial Investment

a. Mortgage
b. Taxes
c. Lost Revenue

Maintenance

a. Fencing
b. Lower Stocking Rates

Fixed Costs = $5.00

Variable Costs per Acre

Burning	Spraying Chemical
$4.50	$15.00

Total Costs per Acre

Fixed + Variable Dollars

$5.00 + $4.50 = $9.50	$5.00 + $15.00 = $20.00

Probability of Failure

.3	.1

Expected Retreatment Costs per Acre

$4.50 × .3 = $1.35	$15.00 × .1 = $1.50

Expected Final Cost per Acre

$1.35 + $9.50 = $10.85	$1.50 + $20.00 = $21.50

Although considered riskier, it would still be cheaper to treat and re-treat by burning than it would be by spraying.

Another Example: **Revegetation of Strip-Mined Land**

Fixed Costs per Acre

Soil Preparation	$8380
Seeding	$125
Fertilizing	$845
Total	$9340

Variable Costs per Acre

Topsoiling 1 foot	Topsoiling 3 feet
$6200	$19,000

Total Costs per Acre

$9,340 + $6,200 = $15,540	$9,340 + $19,000 = $28,340

Probability of Failure

.3	.1

Expected Re-treatment Costs per Acre

$6200 × .3 = $1860	$19,000 × .1 = $1900

Expected Final Cost per Acre

$15,540 + $1860 = $17,400	$28,340 + $1900 = $30,240

Re-treatment Costs would vary with Prescribed Pre-treatment

When re-treating the problem area with the same treatment, the probability of a second failure may remain high. If the probability of failure is estimated to be .7, it means that, barring cumulative effects of the treatment and re-treatment, 70% of the area is expected to have to be re-treated. If it is re-treated with the same treatment, the probability of failure of the re-treated areas remains 70%. Seventy percent of 70% is 49% of the original area which will have to be treated again. The process will repeat itself until one of two things happens: (1) The land manager decides enough land has responded properly, or (2) The land manager decides to switch to a more effective (if more expensive) treatment.

What the above scenario suggests, however, is that a very cheap, but high risk treatment can be used initially, while treating the leftover spots with a more expensive and lower risk treatment.

Realizing that re-treatments can come from either Variable or Fixed Costs, the re-treatment costs in the last example would be as follows when extra fertilizer (with an estimated probability of failure of .4) is put on the 1 foot topsoiling treatment instead of adding more soil:

Re-treatment Costs per Acre

Fertilizing $845

Expected Re-treatment Costs per Acre

$845 × .4 = $338

Expected Final Cost per Acre

$338 + $15,540 = $15,878

Whether adding fertilizer is an adequate substitute for additional soil is a question which must be resolved through professional judgment and reflected in the probability of failure; according to the Expected Final Cost calculations of this example, quite a bit of fertilizer can be added before the cost approaches the cost of adding more soil.

Assuming that the fertilizer is deemed an appropriate re-treatment of the failed areas, fertilizing the entire area as an initial treatment then re-treating failed areas with the 1 foot of soil treatment is now less expensive than either of the other two proposed treatments. It is cheaper to treat with fertilizer and re-treat some areas with topsoil than to treat it once only with the more expensive topsoiling approach.

Conclusions

Range improvements can be evaluated on the basis of Expected Benefits, Total Costs, and Risks. Varied treatments can be used at different times in the treatment process to achieve various goals, such as to get a minimum response followed by spot treatments to correct problem locations.

The technique of combining Risk and Cost for the Expected Final Cost of a treatment can be applied to any quantifiable benefit curve. This technique, as with all tools, must be used with discretion, and should be subject to the judgment of experienced managers.

Management of Cattle Distribution

Derek W. Bailey and Larry R. Rittenhouse

What does the range manager mean when he says his goal is "good cattle distribution"? Is his goal uniformity of utilization? Is his goal to prevent over-utilization of some areas while enhancing utilization in others? Is his goal to leave a uniform residual standing crop? Is his goal to optimize ingestion rate?

Rangelands present a management challenge to livestock operators, whose raw materials are the nutrients found in forage. Those nutrients are not uniformly distributed in time or space. The challenge of the manager is to harvest those nutrients in the most cost-effective manner possible, while doing it in such a way as to insure the sustainability and productivity of the resource.

For many years, water and salt have been used to manipulate livestock distribution into under-utilized areas of a pasture (Cook 1967). Managers have recognized that other factors may limit livestock movement: cattle avoid steep slopes (Cook 1966), yearling cattle can travel farther than cows with young calves (Arnold and Dudzinski 1978), and impenetrable brush, cliffs, and ravines, may limit animal movement (Senft et al. 1987). Fertilization and burning can be used to "draw" animals into an area (Hooper et al. 1969, Samuel et al. 1980). Herding (drifting) can be a profitable method for improving the utilization of forage on steep slopes (Workman and Hooper 1968).

Experience has taught us a great deal about how water, salt, and topography affect utilization, but our ability to predict distribution of animals is limited. The objectives of this paper are: (1) to explore what is commonly meant by the word distribution, and (2) to examine mechanisms of distribution that might provide clues to management.

Conceptual Models of Cattle Distribution

One hypothesis is that animals simply move along a grazing pathway in some random manner. This grazing pathway may be constrained by physical phenomena, such as steep slopes, dense brush, or other barriers. The pathway ends when the animal stops grazing to meet its requirement for water, salt, or comfort.

An alternative hypothesis is that the distribution is based on a multi-level response by the animal to its environment. The animal's grazing pathway is constrained by non-interactive factors, such as mobility, barriers, and topography, but the decision of where to graze is based

Authors are research associate and professor, Department of Range Science, Colorado State University, Fort Collins 80523.
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