5-1995

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Recommended Citation

Walker, Scott, C.; Mann, David K.; McArthur, E. Durant. 1996. Plant community changes over 54 years within the Great Basin Experimental Range, Manti-La Sal National Forest. In: Barrow, Jerry R.; McArthur, E. Durant; Sosebee, Ronald E.; Tausch, Robin J., compilers. Proceedings: shrubland ecosystem dynamics in a changing environment; 1995 May 23-25; Las Cruces, NM. Gen. Tech. Rep. INT-GTR-338. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 66-68.

Plant Community Changes Over 54 Years Within the Great Basin Experimental Range, Manti-La Sal National Forest

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Abstract—Plant community changes and natural succession over time impact forage values, watershed quality, wildlife habitat, and ecosystem dynamics. Comparisons were made between a vegetation map of community types completed in 1937 by the U.S. Forest Service, and vegetation maps compiled in 1990 of the same areas by satellite imagery, and through 1991 areal photo interpretation combined with ground truthing. The study area includes nearly all of the drainage in Ephraim Canyon located in central Utah which consists of 6,027 acres (2,439 ha). Elevation ranges from 6,600 to 10,400 feet (2,040 to 3,210 m). Vegetation types ranged from pinyon-juniper woodland through oakbrush, mountain shrub, aspen, conifer and subalpine herbland. The comparison showed significant plant community changes and successional trends over the 54 year period.

Natural succession is a dynamic property of plant communities. Over time intermountain rangelands have been exposed to a number of management practices that may accelerate community dynamics and succession of the vegetation types within these communities. Such management practices include the suppression of wildfire, grazing of domestic livestock, changing numbers of wildlife populations, and the introduction of exotic plant species that can compete with and displace native vegetation (Ellison 1949, 1960; Ellison and others 1951; Monsen and McArthur 1995; Walker and others 1995).

Changes in plant communities impact forage values, watershed quality, wildlife habitat, and ecosystem dynamics. Some vegetative communities seem to be more stabile or at least change at a slower rate. While other communities can change at a more rapid rate, undergoing a complete conversion from one community type to an other in a relatively short period of time.

Loss of aspen (*Populus tremuloides*) and subsequent conversion to conifer forests on the Wasatch Plateau is a concern to forest managers. Aspen is being displaced at an estimated rate of 1,600 acres per year (U.S. Department of Agriculture 1986). These changes are generally slow and are quite difficult to quantify, without the use of long-term ecological study sites. Harniss and Harper (1982) and Mueggler (1994) have documented long term demographics of aspen communities on the Wasatch Plateau, and show aspen is succeeding to conifer dominance on some study sites as well as on a broad scale.

This study was undertaken in an effort to better understand the community dynamics and changes that are occurring on the Great Basin Experimental Range of the Wasatch Plateau. A 1937 map of the vegetation or community types of the Great Basin Experimental Range and adjoining areas of Ephraim (Cottonwood) Canyon was used to compare with present distribution and occupancy. Comparisons between mapping dates offered an opportunity to quantify changes by vegetation types over a 54 year period. To compare present distribution of the major vegetation types to the information from the 1937 map, remote sensing techniques were used.

As the study was undertaken it presented an opportunity to compare vegetation censusing techniques. This paper compares the applicability of two censusing techniques as well as presenting quantified vegetative community changes.

Study Area

The study took place on the Great Basin Experimental Range, which is located on the west front of the Wasatch Plateau, about 5 miles (8 km) east of Ephraim, on the Manti-La Sal National Forest in central Utah. The Great Basin Experimental Range has been a focal point for conducting research dealing with community ecology and management practices affecting watersheds, rangelands, and forest types since it was established as the Utah Experiment Station in 1912 (Keck 1972; McArthur and Monsen in press).

The study area ranges in elevation from 6,600 to 10,400 ft (2,040 to 3,210 m). The area includes all of Ephraim Canyon, which is about 5 miles (8 km) long by 0.9 to 2.5 (1.4 to 4.0 km) miles wide. Total area of the study is 6,027 acres (2,439 ha). The major vegetation types occurring throughout the canyon include, big sagebrush (*Artemisia tridentata* ssp.), pinyon-juniper (*Pinus edulis*-*Juniperus osteosperma*), oakbrush-mountainbrush (*Quercus gambelii*, *Acer grandidentatum*, *Amelanchier alnifolia*, *Symphoricarpos* sp., *Cercocarpus* sp., *Prunus virginiana*, *Sambucus* sp.), aspen, aspen-conifer, spruce-fir (*Picea engelmannii*, *Picea pungens*, *Abies lasiocarpa*), mountain fir (*Abies concolor*, *Pseudotsuga menziesii*), and sub-alpine (including mostly grasses, tall

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forbs, sedges and shrubs), all interspersed with small meadows and small riparian corridors.

Methods

The historic vegetation map from 1937 was meticulously made. The vegetation communities were divided into 224 distinct vegetative types, including overstory and understory composition. This detail allowed a high confidence of the vegetative components of this area in 1937. The vegetation was subdivided into units as small as 0.25 acres (0.10 ha).

To acquire present vegetation coverage of the study area, remote sensing data from the Utah GAP Analysis project was suggested. As part of the GAP Analysis, Utah's land cover has been classified into 31 cover-types and 5 land-use classes. This classification was done using Landsat TM data from 1985-1993, modelling and ancillary data. Details of the process are contained in Edwards and others (1995). National GAP Analysis guidelines required individual pixel cover-type data be aggregated to a minimum mapping unit of 247 acres (100 ha), but through classification process minimum mapping unit data at 12.3 acres (5 ha) was made available for our project.

The UNESCO hierarchical classification system of vegetation (Driscoll and others 1984) has been adopted by the GAP Analysis project. Of the 31 cover-types or vegetation-type classifications in Utah, 19 appear within the Ephraim canyon study area. This compares to 224 vegetation types for the 1937 map.

To compare the 1937 Map with the GAP Analysis cover, the 1937 Map was scanned using a VEMCO Multiscan 5000 scanning and the CadImage/SCAN Version 1.3 software. ARC/INFO (ESRI, Redlands, CA) software was used to digitize and then register the 1937 Map coverage to UTM coordinates. The boundary of the 1937 map was used to clip out the same area from the GAP coverage.

To compare the vegetation categories of the 1937 map to the GAP Analysis vegetation cover-types, the 1937 vegetation types were reclassified to fit within the GAP codes.

In comparing the 1937 map to the GAP Analysis, it became clear that the detail of the GAP was greatly reduced. Whereas, the 1937 map was very accurate and detailed. For instance, white fir, as a major overstory species, is contained in 20 separate vegetation types. In the GAP Analysis, white fir is the primary tree species in one class and associated in only five other classes.

After initial comparison between the two coverages and conducting some ground truthing, it became apparent that the GAP Analysis had been designed for more broad area applications and would not be applicable to this detailed analysis. It was evident that another method of inventorying the present vegetation was necessary to accurately census the distribution of present vegetative communities. We commenced mapping vegetative communities using 1991 color aerial photos (1:13,000 scale). After acquiring the aerial photos of the study area, we proceeded to outline distinct vegetation types, and verified with ground truthing. When field work was completed, these photos were then scanned using the previously described scanning equipment. The images were then digitized and registered with the ARC/INFO software to UTM coordinates, and finally clipped to the 1937 map boundary.

Results and Discussion

In comparing the three vegetation coverages, distinct problems were found with the GAP for some vegetative types. For example the alpine herbland type, through ground truthing and other observation was expected to show little change. Yet, comparing the three coverages, the GAP showed significantly less sub-alpine area than was present in 1991 or 1937 (table 1).

Another vegetation type causing concern was the oakbrush. The GAP showed oakbrush decreasing from 907 acres (366 ha) in 1937 to 425 acres (172 ha) in 1989. This is much less than the 1,404 acres (567 ha) of oakbrush shown to be present in the 1991 photos (table 1). Through ground truthing we discovered the GAP coverage classified much of the oakbrush as aspen. This is also demonstrated by the large acreage shown by the GAP for aspen, and the small area shown for the aspen/conifer type. For other vegetation types including juniper, the GAP analysis correlated better with

Table 1—Area in acres[1] and percent of total area of specific vegetation types for three sampling methods.

Cover type	Method: 1937-Map Area	Percent	1989-Gap Area	Percent	1991-Photo Area	Percent
Aspen/Conifer	1,404	23	35	1	689	11
Alpine	1,194	20	70	1	1,018	17
Oak	907	15	425	7	1,404	23
Aspen	872	15	2,424	40	450	8
Conifer	734	12	1,727	29	1,171	19
Pinyon	208	4	208	4	262	4
Sagebrush	183	3	133	2	54	1
Mt.shrub	171	3	519	9	156	3
Total[2]	5,673		5,541		5,204	

[1]Multiply by 0.404 to obtain ha.
[2]Difference between totals, result from other minor cover types not included in the table.

our mapping (table 1). These differences and misclassification may be due to the specific spectral signature associated with the cover types.

Due to the ambiguity of the GAP analysis, comparisons among community types will only be made between the 1937 map and the 1991 photo interpretation.

Aspen-conifer association is of great concern for land managers who recognize that aspen is being displaced by conifer at an accelerated rate. From current mapping it is apparent that aspen has been reduced 422 acres (171 ha), a 48% reduction. Aspen stands are being maintained and spreading in some areas, but at a rate slower than it is being displaced by conifer. Less than half of the aspen present in 1937 (872 acres) are still pure stands in 1991 (450 acres). Sites consisting of a mixed aspen-conifer coverage in 1937 have been reduced from 1,404 acres (567 ha) to 689 acres (278 ha) in 1991, a 51% reduction. Sites initially supporting a mixture of aspen and conifer, are now mostly dominated by conifers.

Information obtained prior to this study indicated that conifer was displacing the aspen and mixed aspen types (U.S. Department of Agriculture 1986). The results of our findings support this information and confirm a definite increase in area and density of conifer. Conifers are also expanding into the alpine areas. Oakbrush is also expanding, while Big sagebrush is being lost (table 1).

Conclusions

Using the percentages as a guide (table 1), the study area can be characterized in 1937 as one dominated by mixtures of aspen/conifer, pure aspen, pure conifer, alpine herbland, with strong contributions from oakbrush. In 1937 the contribution from pinyon, sagebrush and mt. shrub were minor. From the areal photo data of 1991 the study area has changed from a two-level to a three-level system. In 1991 study sites were dominated by oak, pure conifer and alpine herblands. Presently there is a middle level of importance represented by aspen/conifer and aspen. Pinyon, mt. shrubs and sagebrush communities are rather minor components. Alpine herblands have remained quite constant, with about the same acres recorded in 1937 as in 1991. This is also represented in the percentage data (table 1).

In assessing the techniques used, it is apparent that the GAP analysis is not adequate for small areas and requires extensive ground truthing. Using aerial photographs to closely map the vegetation was much more accurate on the scale of this study. However, more information is required to increase the accuracy of this method.

The techniques used in this study demonstrate that pinpointing areas to equate ecological changes is possible and necessary. Management decisions can be addressed more specifically regarding each area. These techniques can be used in assessment of all major vegetation types throughout many environments. Managers have the opportunity to address questions and decisions within specific vegetative types, and determine if conversion patterns influenced by land management practices are desirable and acceptable. If not, perhaps management strategies need to be reevaluated and changed. A more proactive management can then be applied to alter conversion patterns.

Acknowledgments

This work was facilitated in part by the Pittman-Robertson Cooperative Wildlife Habitat Restoration Project W-82-R and by cooperative agreements INT-93778-RJVA and INT-95102-RJVA between the Intermountain Research Station and the Utah Division of Wildlife Resources. We appreciate meaningful discussions and assistance from Richard Stevens and Stephen B. Monsen. Cooperation and assistance from personnel of the Manti-La Sal National Forest Sanpete Ranger District and Supervisors Office was especially helpful in conducting this study.

References

Driscoll, R. S.; D. L. Merkel; D. L. Radoff; D. E. Snyder; J. S. Hagihara. 1984. An ecological classification framework for the United States. U.S. Forest Service Miscellaneous Publication 1439, Washington, D.C.

Edwards, T. C. Jr.; C. G. Homer; S. D. Bassett; A. F. Falconer; R. D. Ramsey; D. W. Wight. 1995- Utah Gap Analysis, An Environmental Information System. Final Project Report 95-1, Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, UT 84322-5210.

Ellison, L. 1949. The ecological basis for judging condition and trend on mountain rangeland. Journal of Forestry 47: 787-795.

Ellison, L.; Croft, A. R.; Bailey, R. W. 1951. Indication of condition and trend on high range-watersheds of the Intermountain region. Agriculture Handbook No. 19. Washington, DC: U. S. Department of Agriculture. 66 p.

Ellison, L. 1960. Influence of grazing on plant succession of rangelands. Botanical Review 26: 1-78.

Harniss, R. O.; Harper, K. T. 1982. Tree dynamics in seral and stable aspen stands of central Utah. Research Paper INT-297. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 7 p.

Keck, W. M. 1972. Great Basin Station-sixty years of progress in range and watershed research. Research Paper INT-118. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 48 p.

McArthur, E. D.; Monsen, S. B. 1996. Great Basin Experimental Range. In: Schmidt, W. C; Friede, J. L., compilers. Experimental forests, ranges, and watersheds in the Northern Rocky Mountains, U.S.A. a compendium of outdoor laboratories of the U. S. Forest Service and Universities in Utah, Idaho, and Montana. General Technical Report 334. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Research Station; 23-30.

Monsen, S. B.; McArthur, E. D. 1995. Implications of early Intermountain range and watershed restoration practices. In: Roundy, B. A.; McArthur, E. D.; Haley, J. S.; Mann, D. K., compilers. Proceedings: wildland shrub and arid land restoration symposium; 1993 October 19-21; Las Vegas, NV. General Technical Report INT-GTR-315. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Research Station: 16-25.

Mueggler, W. F. 1994. Sixty years of change in tree numbers and basal area in central Utah aspen stands. Research Paper INT-RP-478. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Research Station. 11 p.

U.S. Department of Agriculture, Forest Service, Manti-La Sal National Forest. Land and resource management plan. 1986. Price, UT: U. S. Department of Agriculture, Forest Service, Manti-La Sal National Forest.

Walker, S. C.; Stevens R.; Monsen, S. B.; Jorgensen, K. R. 1995. Interaction between native and seeded introduced grasses for 23 years following chaining of juniper-pinyon woodlands. In: Roundy, B. A.; McArthur, E. D.; Haley, J. S.; Mann, D. K., compilers. Proceedings: wildland shrub and arid land restoration symposium; 1993 October 19-21; Las Vegas, NV. General Technical Report INT-GTR-315. Ogden, UT: U. S. Department of Agriculture, Forest Service, Intermountain Research Station: 372-380.