Using the original land survey notes to reconstruct presettlement landscapes in the American West

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ABSTRACT.—Rectangular surveys completed between 1796 and 1825 by the General Land Office have frequently been used in the eastern and central U.S. to determine land cover prior to European settlement. These survey notes are less often used in the western U.S., although they are the only site-specific presettlement records available in many areas. Recent efforts to restore riparian and grassland habitats require an understanding of the conditions of these sites before settlement. General Land Office Survey notes provide a description of each township, including water supplies, timber resources, and agricultural potential. The width and course of rivers and streams were recorded on survey lines, along with notes on topography, vegetation, wetlands, mineral deposits, and soils. The township and section descriptions may be used with other historic information to reconstruct presettlement landscapes. Incomplete or vague descriptions, land use before survey, bias in recording data, and contract fraud limit the usefulness of some survey notes. However, survey notes have proved useful in establishing baseline conditions of riparian habitats in Colorado and Oregon and grasslands in Colorado and New Mexico.

Information from historic photographs, expedition journals, and original land survey notes have been used to reconstruct vegetation at the time of European settlement (Hutchison 1988, Noss 1984). The General Land Office (GLO) notes have been considered the most reliable source of historic landscape data because of standardized data collection and systematic coverage of most of the United States (e.g., Bourdo 1956). Many of the published studies using survey notes described regional patterns in upland forests of the north central and northeast U.S. (e.g., Grimm 1984, Cottam 1949). Land survey notes have been used to assist in determining fire return intervals (Lorimer 1977), to substantiate early explorers' records (Grimm 1984, Rankin and Davis 1971), and to assess range trends (Buffington and Herbal 1965). Few studies have used earlier metes and bounds survey notes available in the eastern states for vegetation characterization because of the lack of standardized data (Siccama 1971). Use of survey notes for site-specific studies, especially in the landscape of the American West, has not been evaluated. This review discusses the methods used by field survey crews, limitations of interpreting survey data, and site-specific applications in the western U.S.

GENERAL LAND OFFICE SURVEYS

Surveys east of Ohio were conducted at the local political level and did not use standardized techniques (Siccama 1971). The rectangular survey was initiated at the western boundary of Pennsylvania when the Land Ordinance of 1785 was passed by Congress. The Northwest Ordinance of 1787 encouraged the rapid settlement of new territories and states, creating the need for surveys. The Office of Surveyor General was created by the Land Act of 1796, when public lands were offered for disposal and further escalated the need for surveys. Several configurations of the rectangular survey were used between 1785 and 1796. Eventually the survey was standardized to partition the land into townships of thirty-six square miles that included one-mile-square sections (Fig. 1). Townships were aligned along north-south principal meridians and east-west baselines.

The General Land Office was formed in 1812 to oversee the national survey. Surveys were contracted to the lowest bidder until 1908 (Senti 1988, personal communication), the surveyor being compensated for each mile of line completed while also being accountable for errors in the survey. The contract holder hired the survey crew. Although each

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crew member and the surveyor took oaths to perform their duties faithfully (Cazier 1976), frequent fraudulent surveys caused the General Land Office to abandon contracting in 1908. Since 1908, salaried federal employees have conducted the surveys.

The surveys notes were transferred to each state as the survey was completed, but records for states with incomplete surveys in 1925 were retained by the General Land Office. The Office of Surveyor General was abolished in 1925 when most of the suitable public land had been surveyed, and duties were then reassigned within the General Land Offices. However, some remote areas were not surveyed by that time. In addition, privately held Spanish Land Grants, common in the southwestern U.S., were never part of the public domain lands of the United States and were not included in the rectangular survey system. Areas rich in locatable minerals, such as gold, silver, and lead, were usually not suitable for agricultural use and often were not surveyed in the rectangular survey system. Mining claims could be located on mineral deposits under the General Mining Law of
Fig. 2. The dates of the original land survey and location of field notes are listed for each state included in the General Land Office Surveys. The original colonies and Tennessee were surveyed prior to the rectangular surveys. Texas was not a public land state when admitted to the union. Data from White (1984).

1872. The mining claimant had to obtain an engineering survey of the claim to obtain a patent (deed). The field notes of these surveys often contain useful information, particularly in timbered areas where bearing trees were marked.

The Taylor Grazing Act of 1934 closed all unappropriated land to settlement and formed the Grazing Service. In 1946 the Grazing Service and the General Land Office were merged to form the Bureau of Land Management. Public land surveys are now conducted by the Branch of Cadastral Survey of Bureau of Land Management state offices. Figure 2 lists the dates of the survey and location of records for each state. Records are available for public use in state government offices or in Bureau of Land Management state and district offices.

Data recording evolved during the General Land Office Survey. At least twenty versions of the general instructions to surveyors were issued from 1804 to 1902 (White 1984). Outer township lines were always surveyed first, followed by section lines, usually starting at the southeast corner of the township and progressing east to west and south to north. Distances were measured in chains: 1 chain = 100 links (66 feet), 1 mile = 80 chains (5,280 feet), 1 acre = 10 sq. chains (43,560 sq. feet). The width and course of rivers and streams were recorded where the surveyed section lines crossed them. Notes on topography, timber and undergrowth, swamps, ponds, stone quarries, coal beds, mineral deposits, and fossil locations were also recorded. Later field notes also included descriptions of nearby settlements and roads. Figures 3A–C represent a sequence from the Yampa River in Routt County, Colorado, including a general township description, map from the 1877 survey, and map from a 1913 resurvey of the same area.

Vegetation.—After 1830, surveyors were instructed to map “prairies and swamps” with separate symbols on maps accompanying the field notes. Surveys after 1842 include a general description of the township following the survey notes. “Quality” of the soil for cultivation was categorized first rate, second rate, third rate, and unfit for cultivation. These categories appeared in some survey notes before 1843. These soil categories were never defined and should be considered relative.
Fig. 3A. General description of township including the Yampa River site.

For example, "second rate" soil in the Midwest may indicate something quite different from a "second rate" soil in the arid West. The description also was to include a list of tree species in descending order of abundance (Bourdo 1956). Recording the distance along a section line after leaving a river or creek bottom, prairie, swamp, grove, or windfall was required by instructions used after 1845. By 1850 the kinds of grasses and herbage present were required in the general description.

HYDROLOGY.—Water quality (fresh, saline,
or mineral) for all streams, lakes, ponds, and springs was also described after 1845. The quantity, location, and depth of inundation were recorded for “swamp and overflow” lands in states affected by the “Swamp Acts” of 1849, 1850, and 1860 (Cazier 1976). Swamp Acts granted states or territories title to wetland areas over forty acres to assist in reclaiming lands for agriculture. States affected by Swamp Acts were Alabama, Arkansas, California, Florida, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, Missouri, Ohio, Oregon, and Wisconsin. In other states, wetlands and streams were only located as section lines crossed them and estimated in the interior of sections (see Figs. 3B–C).
Witness trees.—In forested areas, witness and bearing trees were blazed at every mile and half mile. In most surveys the terms "witness trees" and "bearing trees" were used interchangeably. Two or four trees were marked at section corners, and two were marked at quarter sections at the half-mile point along section lines. In addition, section corners were marked with mounds, rock monuments, charred wooden stakes, or a combination of these, along with pits dug in the ground until 1908. Brass caps have marked corners since 1908. The common name of the tree and its diameter were also recorded. Bearing trees were distinguished from witness trees (Bourdo 1956). Unlike bearing trees, the distance and direction to witness trees were not required information. The common names and diameters of trees along section lines were also noted.

Limitations

Some limitations exist for use of land survey notes, in addition to the lack of coverage for some states, private land grants, and remote areas. Inconsistent descriptions, land use before surveys, bias and error in vegetation descriptions, and fraudulent surveys may restrict the use of land survey notes for characterizing natural vegetation. In addition, some notes are difficult to read because of illegible handwriting or poor microfiche reproductions of light handwriting.

Inconsistent descriptions.—Survey instructions standardized data collection for each state or region, but inconsistencies still existed between survey crews. Further, special instructions were often issued to field crews that may have modified general guidelines (White 1984). The detail of landscape description varies greatly between notes. Some surveyors would fully describe the soils, vegetation, landforms, and potential land use, whereas others would restrict comments to topography and a general land use statement. For example, survey notes were reviewed to determine whether active sand dunes near the Mississippi River in Minnesota originated from grazing and cultivation or were present prior to settlement (Galatowitsch 1984). Field notes from 1855 did not mention active dunes, only a "third rate" sandy prairie. However, since little detail was available throughout the surveyor's notes, no inference could be made concerning the origin of the dunes from the account.

Land use before surveys.—The land surveys were not conducted before European settlement in some regions. New Mexico, for example, had been inhabited by the Spanish for nearly 300 years before the surveys of the late 1800s and early 1900s. A survey near Santa Fe, New Mexico (Gross 1973), noted in a general township description of 1919:

... across the SW corner cuts the Denver and Rio Grande railroad. Bordering the railroad, approximately, is the wagon road leading to Antonito, Colo. ... The nearest post office and store is at Tres Piedras, on the railroad, three miles to the NW of the NW corner.

Gross (1973) was trying to characterize "pristine rangeland vegetation" in northwestern New Mexico from land survey notes. In addition to the effects of early Spanish settlement, much of the area had been influenced by the Anasazi until 1000 years before present and by other Native American cultures since. Overutilization of natural resources, primarily woodland vegetation, has been theorized as a cause of the collapse of the Anasazi society (Betancourt and van Devender 1981). If the landscape was radically modified, the original land survey notes can only represent data from a point in time rather than a "pristine baseline." The effects of pre-European land use should be considered in many parts of the western U.S.

Bias in vegetation description.—Bias in field notes for forest studies has been well documented. Bearing trees were selected to be easily relocated, not necessarily the closest to the section or half-section post. Bearing trees were selected by size, age, species longevity, distance from the corner, and conspicuousness (Grimm 1984). Statistical analysis of quantitative tree data from the field notes is flawed because certain sizes and species were favored and because the sample is systematic, not random (Grimm 1984). Bias in vegetation descriptions of nonforested habitats is difficult to assess. General instructions to surveyors required information on available forage; thus, descriptions of shrubs and forbs may be underrepresented.

Errors in species identification.—Species identifications are not standardized among surveys. For example, "bunch grass"
most likely refers to tall- and mid-grass prairie species such as *Andropogon* spp., *Sorghastrum nutans*, and *Panicum virgatum* in the Great Plains. Gross (1973) developed an equivalency table to interpret land survey data from New Mexico (Table 1). Grimm (1984) also developed an equivalency table for the Big Woods of Minnesota. “Soft maple” appears to refer to *Acer saccharinum* and *Acer rubrum*; “sugar maple” is *Acer saccharum*. White ash is assumed to be *Fraxinus pennsylvanica* since the study area is not within the range of *Fraxinus americana*. *Quercus borealis* and *Quercus ellipsoidalis* were variously categorized as “black oak” and “jack oak,” probably based on size.

**Survey Contract Fraud.**—Fraud with surveying contracts, most notably the Benson Syndicate, resulted in fictitious records being substituted for survey data. Fraudulent surveys were most common in California and other western states during the 1870s and 1880s (Cazier 1976). Fraud ranged from estimating some entries within a township to fabricating entire records. Some contracts that were not deliberately fraudulent compromised accuracy in areas deemed by the survey as unsuitable for agricultural purposes. For example, a mountain valley thought by the surveyor to be suitable for agriculture would be accurately located within a township, and the description and location of adjacent rough terrain would be estimated (Senti 1988, personal communication). Although surveys before 1880 are considered reliable in Colorado, as much as 15% of the land in the state may not have actually been surveyed. Figures 4A–B compare a fictitious survey map from 1889 in the Wolf Creek Pass area, Colorado, with the USGS 7.5'-series topographic map of the area. The extensive fraud of the late 1800s was eliminated after 1908, when surveys were no longer contracted. Distinctive features may be present to confirm the accuracy of a survey entry. In an area southwest of Denver, distance and direction to a sandstone ledge with a small spring were included in the field notes. Colorado Natural Areas Program staff located the no-longer flowing spring, confirming the reliability of the survey for that area.

**Applications**

**Riparian Habitat Restoration.**—Despite limitations of interpreting land survey data, this historic reference is the only record available at settlement for many site-specific studies. Riparian habitat restoration is a focus in the West because of degradation from livestock grazing and logging and hydrologic modification from water development and urbanization. Survey notes have been used to assess changes and establish restoration goals in some riparian areas. Sedell and Frogett (1984) compiled information on the position of river channels and distribution of riparian forests of the Willamette River in western Oregon. Most of the area was not yet homesteaded at the time of the survey during the 1850s. The U.S. Army Corps of Engineers
Fig. 4A and 4B. Figure 4A depicts an area in the vicinity of Wolf Creek Pass, Colorado (south portion of Township 38 North, Range 3 East of the New Mexico Principal Meridian), from survey notes of 1881. Compare this map with the USGS map of the same area from 1978 (Fig. 4B) and note the lack of agreement of stream locations. The positions of stream crossings along township lines are generally accurate, but the courses of streams within the township are fictitious. Apparently, township lines were actually surveyed, but interior section lines were not.

began snag removal from the river in 1868. Species composition of the forest has not changed since the survey: dominant species are Douglas fir (Pseudotsuga menziesii), Oregon white ash (Fraxinus oregana), cottonwood (Populus trichocarpa), willow (Salix spp.), alder (Alnus rubra), and big leaf maple (Acer macrophyllum). However, the Willamette River once consisted of multiple channels, filled with snags and fallen trees. Snag
removal and wing dam construction to facilitate navigation confined the river to one channel. Clear-cutting at settlement reduced the riparian forest that extended 1.5–3 km on either side of the river to a narrow ribbon along the channel. The changes in the Willamette River have resulted in a fourfold decrease in river shoreline and a loss of habitat diversity for aquatic animals.

Savonen (1985) investigated the feasibility of restoring West Bijou Creek in northeastern Colorado. Unlike many other streams in the Great Plains of Colorado, West Bijou Creek has a natural water regime: natural flooding, deposition, and erosion still occur. The original land surveys in 1866 and 1867 describe an area in the valley of West Bijou Creek as “good grass . . . good hayland on the creek bottom . . . creek bottom covered with good growth of grasses.” The soil was characterized as “first rate, good for agriculture.” Surveyors recorded the presence of cottonwood (Populus deltoides) and box elder (Acer negundo) along the creek 35 miles downstream from the headwaters. Willow (Salix amygdaloides and S. exigua) must have been present occasionally since surveyors “set a charred willow stake” in some places to mark sections and half sections near the creek. No other mention of timber was made. The dominant species have not changed, although wooded areas are more extensive. Records from the Colorado Historical Society substantiate the soil description for the West Bijou Creek valley made by the surveyors. In 1888 the soil in the valley was described as “dark, rich, brown and black sandy loam and is very deep . . . It is as nearly inexhaustible as any known soil.” Much of the area was subsequently cultivated and supported small grains, corn, onions, and cabbage without irrigation. The drought and dust storms of the 1930s resulted in severe erosion. The exposed soil adjacent to the floodplain is now clayey and has been converted to range-land. Although “bunch grasses” and “buffalo grass” were noted for adjacent uplands, the surveyors did not describe the species in the West Bijou Creek floodplain. The survey notes suggest that the riparian community has switched dominance from grasses to trees. Restoration of riparian areas along West Bijou Creek will be potentially difficult because of the loss of topsoil.

A riparian restoration was proposed for Tollgate Creek at the Plains Conservation Center, southeast of Denver. Several mature cottonwood trees (Populus deltoides) exist along the dry creek near an area intensively used by livestock since settlement. Land survey notes from 1865 were used by the Colorado Natural Areas Program to assess whether Tollgate Creek was a forested stream or a grassland draw before settlement. The 1865 survey indicated that although the area had not yet been settled, open-range livestock use may have occurred on this site. Tollgate Creek crosses section lines in eight places in the vicinity of the proposed restoration. At all eight locations Tollgate Creek was described as a dry ravine with clay soil. The surveyor described the township as “unsuitable for farming because of the lack of running water.” Unlike Tollgate Creek, where no reference to timber was made, the same surveyor described Coal Creek, a nearby stream, as “well-timbered with cottonwood . . . and never dry.” The survey notes demonstrate that Tollgate Creek is a naturally intermittent stream and suggest that a riparian grassland, not a cottonwood riparian forest, should be restored.

**Grassland Restoration.**—Grasslands have been a focus of restoration efforts because of agricultural conversion and effects of overgrazing. Vegetation changes on the Jornada Plain of New Mexico were described by Buffaloington and Herbel (1965) based on data from the land survey of 1858. Increases in three shrub species, creosotebush (Larrea tridentata), mesquite (Prosopis glandulosa), and tarbush (Flourensia cernua), appeared to occur when overgrazing reduced grass cover. Eight categories were established, based on combinations of the species recorded in the survey notes. Abundance of shrubs was based on surveyors’ use of the words few, some, and abundant. A vegetation map was constructed based on shrub species distribution and abundance. Reconnaissance range surveys of the area were conducted in 1915, 1928, and 1963. Maps were constructed for each data set by applying the same criteria to information from later surveys. “Good grass” was dominant on more than 90% of the study area in 1858. By 1963, “good grass” covered only 25% of the Jornada Plain. Mesquite invaded sandy sites, spreading from areas around stock water developments. Creosotebush occurred in low
abundance with grass in 1858. Areas dominated by creosotebush increased from about one section (640 acres) in 1858 to over 12,000 acres in 1963.

Bonny Prairie is a mixed-grass prairie dominated by little bluestem (Andropogon scoparius) in extreme east central Colorado. The prairie occurs on loess deposits on the summit and gentle side slopes of hills adjoining the South Fork of the Republican River. Similar remnant loess prairies have been characterized in western Kansas and Nebraska (Hulett et al. 1968). Considerable debate developed concerning the “pristine condition” of Bonny Prairie, since little bluestem may invade some short-grass prairie sites after cultivation. The land survey notes for the area in the mid-1870s preceded settlement of the area. Survey notes revealed that “grama grass” was common in the vicinity of Bonny Prairie, but that “bunch grasses” dominated the upper slopes above the river valley. The vegetation present on Bonny Prairie is assumed to represent a remnant mixed-grass prairie rather than an artifact from early cultivation.

The Comanche Lesser Prairie Chicken Natural Area is managed by the U.S. Forest Service as part of the National Grassland System. The site, which occurs in extreme southeastern Colorado, has the largest active lek concentration for the state-endangered Lesser Prairie Chicken (Tympanuchus pallidicinctus). The natural area was greatly modified during the drought of the 1930s and was overgrazed in the past. Sand sage (Artemisia filifolia) provides important cover for prairie chickens in the natural area. Blue grama (Bouteloua gracilis) and sand dropseed (Sporobolus cryptandrus) dominate the understory. No tall-grass species such as sand bluestem (Andropogon hallii) are present, although the site appears suitable and these species occur to the west and south of Comanche National Grassland. The land survey notes were reviewed to compare vegetation currently on site with pre-dust bowl conditions. Live stock grazing had already influenced the area by the 1879 survey: "This township is a rolling sandy plain devoid of water but making good enough range for New Mexico stock watering on the Cimarron [River]." Buffalo grass (assumed to be Bouteloua gracilis), sand grass (assumed to be Sporobolus cryptandrus), and bunch grasses are described from Comanche National Grassland near the study area. No equivalent for bunchgrass currently exists on the site. Surveyors did not mention shrubs in the grassland, although sand sage is presently the dominant cover. The general township description offers little insight:

the surface of this township consists of rolling prairie, sloping to the southeast, excepting the extreme southern part, which is somewhat broken and hilly. The drainage is southeast through broad, shallow ravines which run in a southeasterly course to the Cimarron River.

Additional historic records will be needed to develop a concept of the vegetation before the dust bowl.

**Summary**

The General Land Office survey notes are a systematic record providing landscape descriptions for each township and information along section lines concerning tree species, landforms, and streams and wetlands. Surveyor bias, fraudulent descriptions, timing of surveys, and species identifications may limit the use of field notes for reconstructing natural vegetation. However, survey notes are an important historic reference for site-specific studies and when used in conjunction with other historic records, such as photographs, diaries, and journals, provide a valuable image for focusing restoration efforts. Land survey notes are useful in characterizing the landscape at settlement in a number of riparian and grassland areas in the western U.S.

**Acknowledgments**

I thank Andy Senti of the Colorado Office of the Bureau of Land Management for introducing me to many aspects of the rectangular survey and for providing several of the examples used in this paper. David Kuntz and Tamara Naumann of the Colorado Natural Areas Program and Rick Atearn of the Bureau of Land Management reviewed the manuscript and provided many useful suggestions.

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Received 20 February 1990
Accepted 24 April 1990