Phreatophytic Land-Cover Map of the Northern and Central Great Basin Ecoregion: California, Idaho, Nevada, Utah, Oregon, and Wyoming

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Pamphlet to accompany

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Conversion Factors

Multiply	By	To obtain
Length		
mile (mi)	1.609	kilometer (km)
Area		
acre	4,047	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abstract

Increasing water use and changing climate in the Great Basin of the western United States are likely affecting the distribution of phreatophytic vegetation in the region. Phreatophytic plant communities that depend on groundwater are susceptible to natural and anthropogenic changes to hydrologic flow systems. The purpose of this report is to document the methods used to create the accompanying map that delineates areas of the Great Basin that have the greatest potential to support phreatophytic vegetation. Several data sets were used to develop the data displayed on the map, including Shrub Map (a land-cover data set derived from the Regional Gap Analysis Program) and Gap Analysis Program (GAP) data sets for California and Wyoming. In addition, the analysis used the surface landforms from the U.S. Geological Survey (USGS) Global Ecosystems Mapping Project data to delineate regions of the study area based on topographic relief that are most favorable to support phreatophytic vegetation. Using spatial analysis techniques in a GIS, phreatophytic vegetation classes identified within Shrub Map and GAP were selected and compared to the spatial distribution of selected landforms in the study area to delineate areas of phreatophyte vegetation. Results were compared to more detailed studies conducted in selected areas. A general qualitative description of the data and the limitations of the base data determined that these results provide a regional overview but are not intended for localized studies or as a substitute for detailed field analysis. The map is intended as a decision-support aide for land managers to better understand, anticipate, and respond to ecosystem changes in the Great Basin.

Introduction

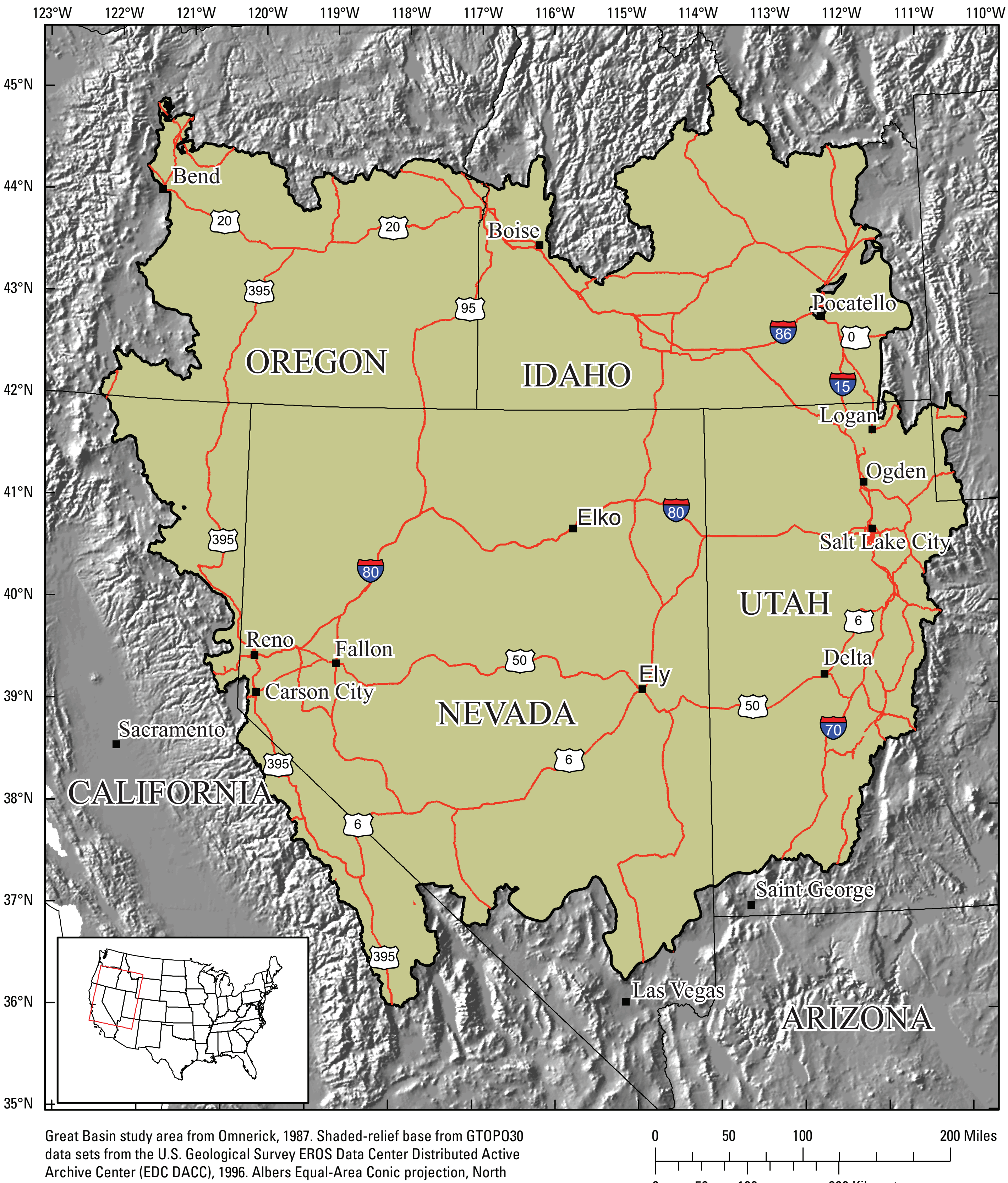
The withdrawals and interbasin transfers of groundwater within the arid Great Basin have increased as the human population and the demand for water have grown. As water has been developed and used, hydrologic flow systems in basins change and begin to re-equilibrate toward a new equilibrium. At the land surface, the vegetation distribution, which is dependent on groundwater and surface water, must adapt to the changing hydrologic regime (Naiman and Turner, 2000; Schultz, 2001; Elmore and others, 2003; Patten and others, 2007). The objective of this report is to delineate phreatophytic vegetation in the Great Basin using existing data sets and, thereby, provide a regional view of areas that may be potentially sensitive to groundwater extraction to aid land-management decision-making. For this report, phreatophytes are defined as plants that derive a substantial portion of their water needs from groundwater and that are dependent on groundwater for long-term survival. This definition includes wetland and riparian species, as well as more drought-stress-tolerant species that utilize groundwater from greater depths (White, 1932; Richards and Caldwell, 1987; Phillips, 1963). Water-level change, both rising and falling groundwater levels, can have consequences on phreatophytic communities (Namburg and others, 2005; Ridolfi and others, 2007). Phreatophytes are the principle mechanism of natural groundwater discharge within the Great Basin (Nichols, 1994) and are an important part of the groundwater budget for the region at nearly 40% (V.M. Heilweil, USGS, written commun., 2009). Long-term changes to the hydrology of the Great Basin, both anthropogenic and natural, will affect the distribution of phreatophytic communities and species behavior.

The study area for this investigation (fig. 1) is larger than the hydrographically defined Great Basin (Fenneman and Johnson, 1946) and is largely based on a combination of three Environmental Protection Agency (EPA) Level III ecoregions: Northern Basin and Range, Central Basin and Range, and Snake River Plain (Omernik, 1987). The study also includes areas that are part of the Bureau of Land Management (BLM) Great Basin Restoration Initiative (http://www.blm.gov/id/st/en/prog/gbri.html) that are not within the three EPA ecoregions. Consequently, the study boundary expands the traditional hydrologic definition of the Great Basin as a region of internal drainage (Fenneman and Johnson, 1946) and includes parts of the Columbia Plateau, which shares physical similarities (climate and vegetation) with the Great Basin, as well as many of the same management issues (Miller and others, 2010). Thus, the study area encompasses over 111 million acres in 6 western states (California, Idaho, Nevada, Oregon, Utah, and Wyoming). Almost 80 percent of this area is public land, including about 80 percent managed by the BLM.

Methods

The focus of our research was to identify areas within the Great Basin that have the highest potential occurrence of phreatophyte vegetation based on spatial analysis of existing land-cover data sets. For the purposes of this report and the accompanying map, phreatophytes are defined as plant species that utilize shallow groundwater. Phreatophytes, by definition, withdraw shallow groundwater and have tap roots that extend to depths of 10 to nearly 50 ft below the land surface, depending on the species (White, 1932; Richards and Caldwell, 1987; Phillips, 1963). Vegetation along upland stream channels and vegetation that might use groundwater from upland perched groundwater systems were not included in the analysis. The general approach to delineate coverage of phreatophytic vegetation was to identify and combine land-cover vegetation classes that were predominantly phreatophytic species, then to compare the distribution of those classes and combine the results with targeted landforms data generated from elevation data (specifically, slope and relief). The distribution of phreatophytic vegetation was estimated through multistep geospatial analysis described in more detail below.

Shrub Map, a regional land-cover data set developed from SW ReGAP data and produced using a decision tree classifier, was utilized as the primary source for the vegetation land cover (http://sagemap.wr.usgs.gov/ShrubMap.aspx). Shrub Map is a 30-m^2 resolution raster product of the U.S. Geological Survey SAGEMAP project and was created to assist research and management of sage grouse and shrubsteppe systems. For areas in the study area not covered by Shrub Map, 1990 GAP



Great Basin study area from Omnerick, 1987. Shaded-relief base from GTOPO30 data sets from the U.S. Geological Survey EROS Data Center Distributed Active Archive Center (EDC DACC), 1996. Albers Equal-Area Conic projection, North American Dautm of 1983. Standard parallels 25°30′00′′ and 45°30′00′′, central meridian, 96°00′00′′ W, latitude of origin 23°00′00′′

Figure 1. Great Basin Integrated Management study area, California, Idaho, Nevada, Oregon, and Utah.

data was used for California and Wyoming (http://gapanalysis.nbii.gov/portal). GAP data was created for states and regions to provide regional assessments of natural land-cover vegetation for applications in land management decision-making. For our analysis, the 90-m^2-resolution California and the 100-m^2 resolution Wyoming GAP data sets were resampled to a finer 30-m^2 resolution to facilitate data processing. Although resampling of coarse resolution data to higher resolutions is not a typical practice, the process was deemed appropriate owing to the extensive coverage of the 30-m^2 Shrub Map data within the study area.

Geomorphic features were identified from the USGS Global Ecosystems Mapping Project landforms data set (Cress and others, 2009; Sayre and others, 2009), which largely utilized a method developed by the Missouri Resource Assessment Partnership (MoRAP; http://morap.missouri.edu/). The MoRAP method to classify land surface forms uses only slope and local relief derived from neighborhood analysis on the cells of 30-m^2 elevation data with a 1-km^2 moving window and is a modification of earlier work by Hammond (1964a, 1964b), who developed classes from three topographic variables: slope, local relief, and profile type. The USGS landform data set contains ten geomorphic classes: flat plains (gently sloping and local relief ≤15 m), smooth plains, irregular plains, escarpments, low hills, hills, breaks/foothills, low mountains, high mountains/deep canyons, and drainage channels (Cress and others, 2009). The landform data set was used in this study to estimate, at a regional scale, plant communities (capable of phreatophytic behavior) that are likely drawing on groundwater in the Great Basin. Thus, only the flat plains category was used in our analysis, because it limited distribution to areas of shallow groundwater.

Mapping the distribution of phreatophytes involved the following general procedures: (1) compiling, merging, and integrating spatial and tabular data layers into a GIS; (2) identifying phreatophytic plant species from literature sources; (3) selecting targeted phreatophyte vegetation classes from Shrub Map, California GAP, and Wyoming GAP data sets; (4) analyzing landforms and land-cover data sets using conditional analyses to map phreatophytic plant communities; and (5) comparing results with published local studies. The appendix includes a list of phreatophyte plant species and the literature sources. Using the class descriptions documented for Shrub Map and GAP data sets (table 1), land-cover classes that included phreatophytic plants were identified by comparing the dominant species recorded for each class against the list of phreatophytic species compiled from the literature. The subsequent results were further checked (1) by consultation with Dr. Eric Peterson, a vegetation ecologist from the Nevada Natural Heritage Program, and (2) by comparison with groundwater discharge areas identified by the USGS Basin and Range Carbonate Aquifer System Study (BARCASS) (Smith and others, 2007). A list of land-cover classes used from each source data set are provided in table 2.

The vegetation land-cover classes were analyzed with the flat plains landform using a conditional analysis. A conditional spatial analysis performs an if/else evaluation on each input cell of an input raster (http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Conditional_evaluation:_Con). The California and Wyoming GAP rasters were resampled to 30-m^2 pixel resolution to facilitate data processing with the 30-m^2 native resolution of the landforms data set. Additional land-cover data filtering was done within the Snake River Plain Ecoregion boundary (Omernik, 1987); specifically, the Inter-Mountain Basins Big Sagebrush Shrubland was geospatially clipped because it was unlikely, given the groundwater and geomorphologic condition within this area, that the plant species identified as phreatophytes in other areas could function in the same manner. The results of these analyses, which removed terraces and upland regions from the land-cover categories, delineated the most probable areas for phreatophytes to grow in the lowest elevations of basins.

Hydrographic data shown on the final map product are derived from the USGS Streams and Water bodies of the United States data set (http://www.nationalatlas.gov/).

Table 1. Land-cover Data Documentation

- Shrub Map Land-cover Class descriptions: http://sagemap.wr.usgs.gov/FTP/Documents/Shrubmap_Legend_Decriptions.pdf
- California GAP Land-cover Class descriptions and general documentation: http://www.biogeog.ucsb.edu/projects/gap/gap_home.html
- Wyoming GAP Land-cover Class descriptions and general documentation: http://www.sdvc.uwyo.edu/wbn/gap.html

Additional references used to confirm playa locations and geographic place names in the map are listed after the References Cited section of this report. The image resolution of the phreatophytic map data was set to conform to the 30-m^2 Shrub Map land cover, because that data set covers the greatest extent of the study area. Although the California and Wyoming GAP data sets were resampled from coarser resolution to facilitate conditional analyses with the landforms data, the reliability of land cover in California and Wyoming retains the same data quality as their source GAP data (refer to the results section for further discussion).

Results

On the basis of our results, roughly 9 percent of the Great Basin study area is classified as phreatophytic vegetation land cover. Table 3 displays total area (in square meters and as percentage), mean patch size, patch number, and standard deviation of patch size identified by phreatophytic land-cover classes. A patch is a landscape unit defining a homogeneous area that differs from surrounding areas. Patches are physical and functional components affecting biomass, primary productivity, nutrient storage per unit area, and species composition and diversity (Forman and Gordon, 1986). Mean patch size is the mean size (square meters) of a land-cover class; patch number is the total number of patches, measuring the spatial character of a land-cover class; and standard deviation of patch size measures the variation of a land-cover class (Leitão and others, 2006). Mean continuous patch size, patch number, and standard deviation of patch size characterize each land-cover class on the landscape in terms of proportion.

Table 2. Source and description of selected land-cover classes.

Ecosystem class	Phreatophytic and potential phreatophytic species
Selected land-cover classes chosen from Shrub Map	
Inter-Mountain Basins Greasewood Wash	Greasewood, patches of Saltgrass Meadow
North American Warm Desert Wash	Greasewood; Catclaw; Desertbroom (Baccharis); Desertwillow; Butternut/Nogal/Walnut; Mesquite
Inter-Mountain Basins Big Sagebrush Shrubland	Big Sagebush; Juniper; Greasewood; Saltbush
Sonora-Mojave Desert Mixed Salt Desert Shrub	Saltbush; Pickleweed; Glasswort; Seepweed/Saltwort/Iodineweed/Inkweed; Sacaton; Saltgrass
Inter-Mountain Basins Greasewood Flat	Greasewood; Saltbush; Sacaton; Saltgrass
North American Warm Desert Riparian Mesquite Bosque	Mesquite; Arrowweed; Willow
North American Arid West Emergent Marsh	Tule; Desertrush/Wirerush/Wiregrass
Mediterranean Californian Alkali Marsh	Saltgrass; Wirerush/Wiregrass; Tule; Saltbush
Temperate Pacific Freshwater Emergent Marsh	Tule; Wiregrass/Wirerush
Riparian	No species information available
Invasive Southwest Riparian Woodland Shrubland	Salt Cedar (Tamarix)
Selected land-cover classes chosen from California GAP	
Great Basin Mixed Scrub	Great Basin Sagebrush, Antelope bush, Rabbitbrush, Saltbush
Big Sagebrush Scrub	Great Basin Sagebrush, Low sagebrush
Rabbitbrush Scrub	Rabbitbrush, Low sagebrush
Desert Greasewood Scrub	Greasewood, Bud sagebrush, Great Basin Sagebrush
Alkali Meadow	Saltgrass, Alkali sacaton, Saltbush
Great Basin Wet Meadow	Great Basin wet meadow spp., Freshwater sedge
Modoc-Great Basin Cottonwood-Willow Riparian Forest	Willow, Fremont cottonwood, Box elder
Modoc-Great Basin Riparian Scrub	Willow, Wet meadow Sedge, Rush, Water Birch, Great Basin Sagebrush
Selected land-cover classes chosen from Wyoming GAP	
Wyoming Big Sagebrush	Wyoming big sagebrush is the dominant shrub with total shrub cover comprising more than 25% of the total veg cover. This class type is variable: includes the full range from dense, homogenous Wyoming big sagebrush to sparsely vegetated arid areas where Wyoming big sage is the dominant shrub.
Greasewood Fans and Flats	Greasewood comprises more than 75% of the total shrub cover within areas where shrubs comprise more than 25% of the total veg cover.
Forest-dominated Riparian	Riparian zones where tree species dominate. Usually cottonwood species, but can also be aspen, box elder, or a variety of conifer species. (Trees must occupy more than 25% of the vegetation cover within the riparian zone.)
Shrub-dominated Riparian	Riparian zones where shrubs dominate. Shrubs often include willow species, Artemisia species and /or greasewood but other shrubs (e.g. hawthorn, wild plum, birch, alder, tamarisk, shrubby cinquefoil) may be present or dominant. Area also includes alpine riparian zones dominated by Salix species or other shrubs. (Shrubs must comprise more than 25% of the vegetation cover within riparian zone)

Of the 6,722,143 acres identified as phreatophytic land cover, Inter-Mountain Basins Greasewood Flat and Inter-Mountain Basins Big Sagebrush Shrubland vegetation classes account for the largest percentages at 52 percent and 34 percent, respectively. Shrub-dominated Riparian, Desert Greasewood Scrub, and Alkali Meadow have the largest mean continuous patch sizes at 1,234 acres, 976 acres, and 722 acres, respectively. Inter-Mountain Basins Big Sagebrush Shrubland had the largest number of individual patches (over 125,500) with a mean continuous patch size of 28 acres. This illustrates that, while the Shrub-Dominated Riparian is found in five patches, the areas are large, continuous areas; whereas, the Inter-Mountain Basins Greasewood Flat, the largest land-cover class by area, consists of many small, noncontinuous patches confined to valley floors. Caution must be used in assessing continuous mean patch size of classifications from the California and Wyoming GAP data, because the combining of these data sets with the more refined Shrub Map required the 100-m^2 resolution to be resampled into several continuous 30-m^2 cells—a process likely to produce erroneous pixel clustering in some locations.

The extent of the Flat Plains landform was used to limit the distribution of the land-cover classes to the lower part of the basin where groundwater levels typically are at or near land surface. In the northern Great Basin, along the Snake River Plain and Owyhee Uplands, the landscape differs from the majority of the Great Basin, because the area is dominated by flood basalts and does not have the typical basin and range structure. The conditional analysis that was conducted—where land-cover classes were isolated to the lowest portions of basins, or Flat Plains—assisted in limiting the occurrence of mapping anomalies from such classes as Inter-Mountain Basins Big Sagebrush Shrubland, which extends from the lowest parts of valleys into upland areas and significantly dominates vast amounts of acreage within the study area (table 3). Accordingly, the distribution of Inter-Mountain Greasewood became mottled but became more consistent when combined with observations made from field spot-checks after applying the Flat Plains landform restriction. Nonetheless, given the considerable percentage accounted for by these two classes, any mapping errors within the Inter-Mountain Basins Greasewood Flat and Inter-Mountain Basins Big Sagebrush Shrubland land cover could have a significant impact on the total estimate of phreatophytic vegetation.

As mentioned, phreatophytes withdraw shallow groundwater using tap roots that extend to depths as much as 50 ft below the land surface, depending on the species (White, 1932; Richards and Caldwell, 1987; Phillips, 1963). The ability of the plants to use water from these depths depends on a number of factors including plant type, annual precipitation, depth to the water table, soil properties including soil moisture, matrix potential, plant characteristics, and water quality (Nichols, 1994; Namberg and others, 2005; Dawson, 1993). A comparison of measured groundwater levels, precipitation, soil properties, and distributions of phreatophytic vegetation classes were beyond the scope of this study but would greatly improve the functionality of this map. Consequently, we reiterate that the design of the methodology for this study was designed for land-management decision-making at a regional scale.

Comparison with Other Mapped Groundwater Discharge Areas

Mapped phreatophytic vegetation communities were compared to existing Potential Groundwater Discharge Areas (fig. 2, map sheet) published for the Basin and Range Carbonate Aquifer System Study (BARCASS). The BARCASS Potential Groundwater Discharge Areas were derived using field techniques described in Smith and others (2007). The Potential Groundwater Discharge Areas were developed by combining and integrating phreatophyte boundaries delineated in previous studies, numerous mapping efforts, and phreatophyte extents mapped for the BARCASS study by an aerial survey done in 2005 (Smith and others, 2007). Because the focus of the BARCASS study was to delineate areas of groundwater discharge and to quantify evapotranspiration, the comparison of the two data sets is not straightforward. However, this comparison offers a quantitative assessment of the data derived for this study compared to an existing, published methodology. Table 4 shows the results of the comparison between the two data sets. The largest discrepancies in delineated acreage are in Snake Valley and Spring Valley, 279,571 acres and 95,186 acres, respectively, where the Shrub Map and landforms method underestimated when compared to the BARCASS methods. The major differences in acreage between the two studies may be attributed to the different methodologies. The map accompanying this report utilized existing, documented Shrub Map, GAP, and MoRAP data while the BARCASS Potential Areas of Groundwater Discharge compiled and integrated existing documented data and observed field data. The exclusion of the playa land-cover classes and the inclusion of riparian land-cover classes and other vegetation land-cover classes that may be utilizing localized groundwater systems may also have influenced the comparison. This comparison emphasizes that the accompanying map is for regional analysis only.

Limitations and Recommendations for Use

Because of the large geographic area analyzed, multiple input data sets with varying source data scales, collection dates, and analytical techniques/methodologies were required for use in our analysis. Combining such data sets, however, can introduce error. The Great Basin Shrub Map, which provides coverage for the majority of our study area, is an enhancement of the Southwest ReGAP with a minimum mapping unit of one acre (table 1). The Wyoming GAP analysis for the Great Basin study area was completed using image interpretation on scenes that were not atmospherically corrected or edge-matched (Merrill and others, 1996). An informal accuracy assessment was done by field checking classifications during the summer of 1994. Field checks indicated that about 80 percent of the 12 percent of the polygons reviewed were acceptable (Driese and others, 1997). However, it was noted that the minimum mapping unit of 1 hectare made ground verification difficult. A formal statistical evaluation was initiated to evaluate airborne videography as a tool to assess accuracy and to utilize the application of fuzzy accuracy assessment techniques (Reiners

Table 3. Representative statistics of total phreatophyte land-cover classes from the Phreatophytic Land Cover of the United States Great Basin Ecoregion map.

Land-cover class	Total area (acres)	Total area (%)	Mean patch size (acres)	Patch number	Standard deviation of patch size (acres)
Inter-Mountain Basins Greasewood Flat[1]	3,484,237	51.8	28	125,581	1,179
Inter-Mountain Basins Big Sagebrush Shrubland[1]	2,276,324	33.9	35	64,717	904
Riparian[1]	370,600	5.5	10	38,148	156
North American Arid West Emergent Marsh[1]	173,630	2.6	13	12,984	204
Great Basin Mixed Shrub[2]	113,416	1.7	289	393	1,574
Desert Greasewood Scrub[2]	104,418	1.6	976	107	7,471
Alkali Meadow[2]	84,444	1.3	722	117	4,215
Sonora-Mojave Desert Mixed Salt Desert Shrub[1]	34,138	0.5	22	1,571	237
Great Basin Wet Meadow[2]	26,904	0.4	292	92	722
Invasive Southwest Riparian Woodland Shrubland[1]	15,860	0.2	10	1,667	92
Temperate Pacific Freshwater Emergent Marsh[1]	8,619	0.1	19	447	272
Shrub-dominated Riparian[3]	6,168	0.1	1,234	5	2,682
Mediterranean CA Alkali Marsh[1]	5,809	0.1	22	270	139
Big Sagebrush Scrub[2]	4,851	0.1	323	15	690
Inter-Mountain Basins Greasewood Wash[1]	3,741	0.1	7	504	35
Rabbitbrush Scrub[2]	3,496	0.1	206	17	497
Wyoming Big Sagebrush[3]	3,046	0.0	66	46	222
Modoc-Great Basin Riparian Scrub[2]	1,726	0.0	58	30	181
Greasewood Fans and Flats[3]	267	0.0	19	14	46
North American Warm Desert Wash[1]	250	0.0	4	67	9
Modoc-Great Basin Cottonwood-Willow Riparian Forest[2]	125	0.0	16	8	31
Forest-dominated Riparian[3]	71	0.0	8	9	11
North American Warm Desert Riparian Mesquite Bosque[1]	4	0.0	1	4	1

[1]Shrub Map Land-Cover Class (http://sagemap.wr.usgs.gov/FTP/Documents/Shrubmap_Legend_Decriptions.pdf).

[2]California GAP Land-Cover Class (http://www.biogeog.ucsb.edu/projects/gap/gap_home.html).

[3]Wyoming GAP Land-Cover Class (http://www.sdvc.uwyo.edu/wbn/gap.html).

and others, 2000), but it was never completed. The California GAP analysis was completed using Landsat TM imagery from the summer of 1990, 1990 high-altitude color infrared photography, California Vegetation Type Maps based on field surveys conducted between 1928 and 1940, and miscellaneous vegetation maps and surveys conducted with a minimum mapping unit of 1 hectare near the time of the GAP analysis (Davis and others, 1998).

Estimates on area and classifications are sensitive to the accuracy and precision of the source data, as well as the map scale. Our analysis provides a regional overview of the distribution for potential areas of phreatophytic vegetation that could be affected by groundwater-level change. This study was designed to provide a regional context or a base content for finer-level analyses. These data are not designed to be used as a 1:24,000-scale or finer data source, nor are they a substitute for a detailed field analysis.

Summary

Utilizing existing data sets, phreatophytic vegetation was mapped in the Great Basin. Shrub Map and GAP vegetation data were combined with landform classes derived from elevation data to delineate phreatophytes that are utilizing groundwater from basin- and regional-scale groundwater flow systems. Our study documents the methods used to delineate the communities and the limitations of the derived data set. Inter-Mountain Basins Greasewood Flats were the most common phreatophytic classification found throughout the Great Basin and account for 52 percent of the mapped phreatophytes. The resulting geographic data set and map were derived from regional-scale data sets and contain limitations defined by the original base data.

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Table 4. Comparison of phreatophyte land-cover classes from the Phreatophytic Land Cover in the United States Great Basin Ecoregion map and the Basin and Range Carbonate Aquifer System Study (BARCASS) potential groundwater discharge areas.

Hydrographic area	Phreatophyte land-cover classes (acres)	BARCASS potential groundwater discharge area (acres)	Percent difference
White River Valley, NV	142,767	180,497	23
Steptoe Valley, NV	138,857	184,351	28
Butte Valley, NV	107,479	69,848	42
Lake Valley, NV	91,249	56,458	47
Spring Valley, NV	89,591	184,777	69
Snake Valley, NV	74,678	354,249	130
Long Valley, NV	64,309	18,371	111
Newark Valley, NV	56,380	86,713	42
Cave Valley, NV	33,158	13,499	84
Jakes Valley, NV	33,127	1,254	185
Little Smoky Valley, NV (northern part)	21,731	6,406	109
Little Smoky Valley, NV (southern part)	6,526	0	200
Tippett Valley, NV	781	7,819	164

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Appendix

List of common and potential phreatophytes in the northern and central Great Basin, western United States, that were identified from a detailed literature search (Carmen, 1993; Czarnecki and Stannard, 1997; Munz and Keck, 1968; Nichols, 2000; Robinson, 1958; Robinson and Waananen, 1970).

Common Name	Species	Subspecies
Alder	Alnus	
Alfafa	Medicago	Sativa
Arrowweed	Pluchea	Sericea
Ash, Arizona and velvet	Fraxinus	Velutina
Aspen, quaking	Populus	Tremuloides
Aster, spiny	Aster	Spinosus
Athel, tree	Tamarix	Aphylla
Baccharis	Baccharis	Sarothroides; Emoryi; Sergiloides
Batamote	Baccharis	Glutinosa
Bermuda Grass; Wire Grass	Cynodon	Dactylon
Boxelder	Scer	Negundo
Buffaloberry	Shepherdia	
Burrobush	Hymenoclea	Monogyra; Salsola
Butternut	Juglans	Micorcarpa
Camelthorn	Alhagi	Camelorum
Carrizo	Phragmites	Communis
Catclaw	Acacia	Greggii
Chamiso	Atriplex	Canescens
Chamiza	Atriplex	Canescens
Cinquefoil	Dasiphora	Fruticosa
Cottonwood	Populus	Acuminata; Angustifolia; Balsamifera; Deltoides; Fremontii
Cottonwood	Populus	Sargentii; Texana; Trichocarpa; Weslizeni
Cumaru	Celtis	Reticulata
Desertbroom	Baccharis	Sarothroides
Desertrush	Juncus	Cooperi
Desertwillow	Chilopsis	Linearis
Devilsclaw	Acacia	Greggii
Elder; Elderberry	Sambucus	
Glasswort	Salicornia	Europaea
Goldenrod	Aplopappus	Heterophyllus
Greasewood	Sarcobatus	Vermiculatus
Hackberry	Celtis	Reticulata
Heliotrope	Heliotropium	Eruassavicum
Inkweed	Suaeda	Torreyana
Iodinebush	Allenrolfea	Accidentalis
Iodineweed	Suaeda	Torreyana
Juniper, Rocky Mountain	Juniperus	Scopulorum
Kom	Celtis	Reticulata
Lenscale	Atriplex	Lentiformis
Lovegrass, alkali	Eragrostis	Obtusiflora
Mesquite	Prosopis	Juliflora; Pubescens; Veluntina
Mulefat	Baccharis	Viminea
Nogal	Juglans	Microcarpa
Oak, California live	Quercus	Agrifolia

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Common Name	Species	Subspecies
Oak, Roble	Quercus	Lobata
Palm, California and fan	Washingtonia	Filifera
Palo Verde, blue	Cercidium	Floridum
Pickleweed	Allenrolfea	Occidentalis
Purslane, lowland	Sesuvium	Portulocostrum
Pusley, Chinese	Heliotropium	Curvassavicum
Quailbrush	Atriplex	Lentiformis
Rabbitbrush	Chrysothamnus	Nauseosus; Pumilus
Reed; Reedgrass	Phragmites	Communis
Rosinbrush	Baccharis	Sarothroides
Sacaton	Sporobolus	Wrightii; Airoides
Sagebush	Artemisia	Tridentata
Saltbush	Atriplex	Canescens; Lentiformis
Saltbush	Atriplex	Parryi
Saltcedar, Tamarisk	Tamarix	Gallica; Aphylla; Pentandra
Saltgrass	Distichlis	Spicata; Stricta
Saltgrass, Mexican	Eragrostis	Obtusiflora
Saltwort	Suaeda	Depressa
Sea-purslane	Sesuvium	Verrucosum
Sedge	Carex	
Seepweed	Suaeda	Depressa; Suffrutescens; Torreyana
Seepweed	Suaeda	Fruticosa
Seepwillow	Baccharis	Glutinosa
Sequoia	Sequoia	Gigantea
Sesuvium	Sesuvium	Verrucosum
Smoketree; Smokethorn	Dalea	Spinosa
Sprangletop	Leptochloa	Fascicularis
Spruce, Englemann	Picea	Englemanni
Swampcedar	Juniperus	Scopulorum
Sycamore, Arizona	Platanus	Wrightii
Tornillo	Prosopis	Pubescens
Tule	Scirpus	
Una de gato	Acacia	Greggii
Vanadium bush	Cowania	Stansburiana
Vetch, sweet	Hedysarum	Boreale
Walnut	Juglans	Microcarpa
Watermotie; Waterwillow	Baccharis	Glutinosa
Waterweed	Baccharis	Sergiloides
Wildrose	Rosa	
Wildrye	Elymus	Triticoides; Condensatus
Willow	Salix	
Wiregrass; Wirerush	Juncus	Balticus
Yerba mansa	Anemopsis	Californica