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Wetland Plants of Specialized Habitats in the Arid West

Robert Lichvar and Lindsey Dixon

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Cover: Desert bluebells in a dry wash in the Mojave Desert, CA.

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Abstract: The U.S. Army Corps of Engineers is currently regionalizing and updating the national wetland delineation manual. This manual will use new ecosystem boundaries for the nation. A separate effort by the Corps will update the National Wetland Plant List within these same new ecosystem boundaries. The Arid West is an area of particular interest in the revision of the plant list because of the problematic indicator statuses for certain groups of plants. Many species in the Arid West have morphological and physiological adaptations that allow them to occur in specialized habitats, ranging from wetlands to uplands. In delineations, the indicator status of these species is not always accurate for the specific location. A combination of literature reviews and recorded species data from previous studies for six specialty habitats are presented and discussed; the species groups are playa edge species, dry wash species, dry wash phreatophytes, hygro-halophytes, xero-halophytes, and phreatophytes with salt tolerance. A total of 421 species, with 93 of those species shared in more than one habitat type, are reported, including 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance. The list for each specialized habitat will be used to better understand species ecology and occurrences across the region and will ultimately help in assigning and increasing the reliability of wetland plant indicator statuses.

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Preface

This report was prepared by Robert W. Lichvar and Lindsey Dixon, Remote Sensing/GIS and Water Resources Branch, Cold Regions Research and Engineering Laboratory (CRREL), U.S. Army Engineer Research and Development Center (ERDC), Hanover, NH.

Many military installations over the years supported various types of studies that helped in generating a list of species that could be used in this study. These include White Sands Missile Range, NM; Edwards Air Force Base (AFB), CA; Dugway Proving Ground, UT; Twenty Nine Palms Marine Corps Base, CA; Camp Pendleton, CA; and Miramar Marine Corps Station, CA. Many supporters of other studies allowed for a robust list to be developed in this region, including the Navajo Nation and the San Francisco, Los Angeles, and Sacramento Districts, Corps of Engineers. The authors thank David Charlton of Edwards AFB for making comments on the list of species and their synonyms and Corinna Photos for reviewing and editing the manuscript. Finally they thank the vegetation working group for the Arid West wetland supplement, who felt that there was a need for such a list and discussion and that it would be helpful for wetland delineation purposes.

The report was prepared under the general supervision of Timothy Pangburn, Chief, Remote Sensing/GIS and Water Resources Branch; Dr. Lance Hansen, Deputy Director; and Dr. Robert E. Davis, Director, CRREL.

The Commander and Executive Director of ERDC is COL Richard B. Jenkins. The Director is Dr. James R. Houston.

1 Introduction

The U.S. Army Corps of Engineers is regionalizing and updating (Wakeley 2002) its national wetland delineation manual (Environmental Laboratory 1987). As part of this effort, the nation is being subdivided along ecosystem boundaries (Fig. 1) similar to those used for the indicators of hydric soils (NRCS 2006b). Starting in 2007, using these same boundaries, the Corps began to regionalize the Corps National Wetland Plant List as part of a Memorandum of Agreement (MOA) between the Corps of Engineers, the Fish and Wildlife Service (FWS), the Natural Resources Conservation Service (NRCS), and the Environmental Protection Agency (EPA). One of these new regions (the Arid West)



Figure 1. Plant list regional boundaries (red lines) currently used by the U.S. Fish and Wildlife Service's National Wetlands Inventory in the Arid West.

comprises five former U.S. Fish and Wildlife Service (FWS) regional areas. The FWS regional areas were defined by administrative boundaries and were previously used for regional wetland plant indicator status lists (Reed 1988). Due to the updating of the National Wetland Plant List along ecosystem boundaries, only those wetland species occurring within the new boundary of the Arid West region will be included in the revision of the wetland plant list for the region. In the new Arid West region, along with other new regions nationally, the ecosystem boundaries will be more closely aligned with climatic, geologic, landform, other environmental condition, and there will be an increased similarity of floristic composition within the region. The use of ecosystem boundaries for wetland plant lists in different regions will increase the reliability and accuracy of the wetland plant indicator statuses.

Species containing ecotypes or those with wide ecological amplitudes (Tiner 2006) can make determinations of hydrophytic vegetation challenging if they have the ability to occur in multiple habitats that range from wetlands to uplands. In the Arid West, certain species are located in specialized habitats, including riparian corridors, playas, and saline areas. Many of these habitats can be considered either wetlands or uplands, depending on specific site conditions. In wetland delineation, these habitats can be problematic when the vegetation is a mixture of hydrophytes (plants occurring in wetlands) and other species that have physiological or morphological adaptations for growing in these specialized western habitats (Gibson 1996, Nilsen et al. 1984, Hunt 1966). This is especially true if all of these adaptations are not factored into the wetland rating.

In wetland delineation, the determination of the presence or absence of hydrophytic vegetation at a site requires the use of species abundances, wetland indicator status ratings (Reed 1988), and several mathematical formulas to determine if hydrophytes dominate the site. For a reliable determination of hydrophytic vegetation, it is critical that a species be accurately assigned a wetland indicator status based on its frequency of occurrence in wetlands in the region (Table 1). The ability to sort these occurrences into different habitats or adaptations adds clarity to the wetland plant ratings. For instance, many of the specialized western habitats are highly saline areas with groundwater deeper than that required to be considered a wetland. In the Arid West many species have evolved morphological or physiological adaptations that allow them to

Table 1. Indicator categories.

Indicator code	Category	Definition	% Occurring in wetlands
OBL	Obligate Wetland	Occurs almost always in wetlands under natural conditions	>99%
FACW	Facultative Wetland	Usually occurs in wetlands, but often found in non-wetlands	67–99%
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands	34–66%
FACU	Facultative Upland	Usually occurs in non-wetlands, but often found in wetlands	1–33%
UPL	Obligate Upland	Occurs almost always in non-wetlands under natural conditions	<1%
NA	No agreement	The regional panel was not able to reach a decision on this species.	N/A
NI	No indicator	Insufficient information was available to determine an indicator status.	N/A
NO	No occurrence	The species does not occur in that region.	N/A
(+) or (-)	Facultative	A positive (+) or negative (-) sign was used with the Facultative indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands). A negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).	

An asterisk (*) following a regional indicator identifies uncertain designations based on limited information from which to determine the indicator status.

inhabit these sites. Clarifying differences in occurrences in specialized habitat types, such as wetlands, other waters of the United States (WoUS), or uplands allows for a better understanding of a species and its frequency of occurrence in wetlands, and this in turn will increase the reliability of wetland indicator statuses.

To support the updating of the vegetation section of the Arid West Regional Supplement and the revision of the Corps National List of Wetland Plants, an effort was undertaken to identify some of the specialized habitats of the Arid West and compile species lists for these habitats. To further assist regional panels of wetland specialists and botanists in assigning indicator statuses to these species, a detailed habitat description or discussion of morphological and physiological adaptations of species was developed using the literature and field knowledge to circumscribe these habitats for the Arid West. Previous efforts for reporting lists of species from these habitats in the literature generally provided only short representative lists of species as examples from these

habitats, or small groups of species capable of expressing certain types of adaptations. In this report, we present comprehensive lists of species associated with these habitats as a result of the compilation of species reported in the literature combined with extensive field records from many unique western habitats. It is our intent that these expanded lists will assist the new regional Arid West wetland supplement and the new Arid West regional wetland plant list panel in acknowledging and appreciating the ecological amplitude of these desert specialists.

2 Study Area

The ecosystem boundaries of this region follows the outline of the Arid West regional wetland supplement (U.S. Army Corps of Engineers 2006) and is overlain with the plant list regional boundaries currently used by the Fish and Wildlife Service (Fig. 1) (Reed 1988). This region contains mainly the lower elevation basins and does not include some of the higher elevation mountainous areas contained within the region; those are included in the Western Mountains, Valleys and Coast supplement (U.S. Army Corps of Engineers, in prep.). The region includes three main ecological habitats: the warm and cold deserts and the parts of California influenced by a Mediterranean climate.

3 Methods

An initial literature review was performed to identify species with physiological or morphological adaptations for life in specialized habitats. Unfortunately, the literature did not provide extensive lists of species for these habitats; therefore, personal data from the senior author's collection within this region during watershed-scale wetland delineations and other ecological studies completed over close to two decades were used to supplement the literature lists. The species lists compiled from the field records came from actual species observations recorded on data sheets. Species data were stored digitally, and records were supported by soils data and other site descriptions including geographic coordinates. The field data were sorted by habitat types and grouped into specialty categories. Data were then merged with the lists compiled from the literature to obtain the final version of species lists in each specialty habitat type.

Identification of species was done using many regional and local floras covering several floristic regions, including the Sonoran, Colorado Plateau, Great Basin, Chihuahuan, Apachian, Peninsular, Columbia Plateau, South Rocky Mountains Mogollon, and the Mojave areas (McLaughlin 1989). The groups of specialty habitats were developed from the literature and field visits to various locations. After species lists for each specialty group were compiled, wetland indicator statuses from the five FWS regions contained in the Arid West Region (Regions 6, 7, 8, 9, and 0) were derived from the 1988 Plant List (Reed 1988). Because of variations of synonyms in various floras across the region, depending on the date of publication, the synonyms were standardized using the List 88 names (Reed 1988) and their wetland plant indicator statuses. Current synonyms for many species are also provided based on the USDA PLANTS database (2007).

4 Results

Group Descriptions

The following discussion describes the specialty habitats and the adaptive physiological and morphological features of the species that inhabit them. We report a total of 421 species, with 93 of those species shared in more than one habitat type. There were 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance.

Playa Edges

Playas can be defined as the flat, lower portions of an arid basin with internal drainage that pond water periodically and accumulate sediment (Stone 1956). Because of harsh physical conditions within a playa, such as compacted soil, high salinity, and unpredictable cycles of inundated/dry conditions, much of the vegetation is restricted to the edge of the playa (Lichvar et al. 2006). Two types of playas exist: hard and soft playas (Stone 1956). Hard playas lack groundwater within 5 m from the surface, while soft playas typically have groundwater within 5 m of the surface (Motts 1970, Neal 1975). These two conditions influence the type of plant species and communities present along the playa edge. Hard playa vegetation varies from xerophytic species (found in saline dry habitats) that closely resembles upland conspecific species, to halophytic species (found in saline wet habitats) of the “alkaline sink scrub” vegetation type (Barbour et al. 1987). Soft playa vegetation consists of succulent chenopods of the “alkaline sink scrub” (Lichvar et al. 2006).

Thorne (1976) classified vegetation found along playa edges as “alkaline scrub,” which generally consists of scattered scrub of halophytic plants mostly in the Chenopodiaceae, Asteraceae, Brassicaceae, Fabaceae, and Poaceae families (Barbour and Billings 1988). Barbour and Billings (1988) also stated that 20% of this vegetation type consists of monocultures of single-perennial-species dominance. Vegetation found along the playa edges is often found on phreatophytic mounds (raised accumulations of soil and vegetation) that are 1–5 m high and have a circumference of 2–10 m (Lichvar et al. 2006, Lichvar and Sprecher 1996). The mounds form when wind-blown sand and silt accumulate around a phreatophyte

(species that have their roots in perennial groundwater or in the capillary fringe above the water table) (Hunt 1966) growing at the level of the playa surface and build successively upward (Lichvar et al. 2006). As you move away from the playa edge, salinity decreases; as a result the vegetation shifts from halophytic to xerophytic salt bush species, with a transition zone between the two stands. The xerophytic zone is then replaced by the Creosotebush community (Lichvar and Pringle 1992). Between the sandy edge of the playa and the foot of the mountains are highly permeable gravel fans where the water table is deep and xerophytes are able to thrive (Hunt 1966). Lower in elevation, some boundaries are seen where these gravel fans grade into sand at the edge of the playa; this boundary also correlates with the availability of groundwater. Adaptations expressed by the plants around the playa edge can include both salt- and drought-tolerance, depending on the species site requirements. Field experience has shown that the reliability of the status ratings of wetland plant species as indicators along playa edges is compromised by halophytes and phreatophytes responding to saline soils and groundwater at depths greater than the surface or near-surface hydrology required to meet wetland criteria (Lichvar et al. 2006). A list of 48 playa edge species is presented in Table 2.

Table 2. Species found along playa edges.

1988 synonymy	Current name	Playa type*	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Acamptopappus sphaerocephalus</i> (Harvey & Gray ex Gray) Gray 1,2		H	UPL	UPL	UPL	UPL	UPL
<i>Allenrolfea occidentalis</i> (S. Wats.) Kuntze		SH	FACW	FACW	FACW	FACW+	FACW+
<i>Artemisia spinescens</i> D.C. Eat 7	<i>Picrothamnus desertorum</i> Nutt.	H	UPL	UPL	UPL	UPL	UPL
<i>Atriplex canescens</i> (Pursh) Nutt. 2, 4,6,7		H	UPL	UPL	UPL	UPL	FACU
<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Wats. 2,7,8		H	UPL	UPL	UPL	UPL	UPL
<i>Atriplex lentiformis</i> (Torr.) S. Wats. 2,6,7		SH	NO	FACW	FAC+	NO	FAC
<i>Atriplex phyllostegia</i> (Torr. Ex.S. Wats.) S. Wats. 6		H	NO	NO	FACW	NI	FACW
<i>Atriplex polycarpa</i> (Torr.) S. Wats. 2		H	NO	FACU-	FACU	NO	FACU
<i>Atriplex spinifera</i> J.F. Macbr.		H	NO	NO	NO	NO	FAC
<i>Atriplex torreyi</i> (S. Wats.) S. Wats 8		H	NO	NO	FAC-	NO	FAC

Table 2 (cont.). Species found along playa edges.

<i>Chrysothamnus nauseosus</i> (Pallas ex Pursh) Britt ssp. <i>mohavensis</i> (Greene) Hall & Clements 6	<i>Ericameria nauseosa</i> (Pallas ex Pursh) Nesom & Baird ssp. <i>consimilis</i> (Greene) Nesom & Baird var. <i>mohavensis</i> (Greene) Nesom & Baird	H	UPL	UPL	UPL	UPL	UPL
<i>Delphinium recurvatum</i> Greene 7		H	UPL	UPL	UPL	UPL	UPL
<i>Distichlis spicata</i> (L.) Greene 5,6		SH	FACW+	FACW	FAC+*	FACW	FACW
<i>Erigeron bellidiastrum</i> Nutt. 12		H	UPL	UPL	UPL	UPL	UPL
<i>Forestiera neomexicana</i> Gray	<i>Forestiera pubescens</i> Nutt		FAC-	FACU	FAC+	NO	FAC
<i>Frankenia grandifolia</i> Cham. & Schlecht. 7	<i>Frankenia salina</i> (Molina) I.M. Johnston	S	NO	NO	NO	NO	FACW+
<i>Geraea canescens</i> Torr. & Gray		H	UPL	UPL	UPL	UPL	UPL
<i>Grayia spinosa</i> (Hook.) Moq. 7		SH	UPL	UPL	UPL	UPL	UPL
<i>Isocoma acradenia</i> (Greene) Greene		H	NO	NI	NI	NO	NI
<i>Helianthus ciliaris</i> D.C.12		H	FAC	FAC	NI	NI	NI*
<i>Heliotropium curassavicum</i> L.7		SH	FACW	FACW*	OBL	OBL	OBL
<i>Hoffmannseggia glauca</i> (Ortega) Eifert 12		H	FAC	FACU	FACU-	NO	FACU
<i>Hymenoclea salsola</i> Torr. & Gray ex Gray 2		H	UPL	UPL	UPL	UPL	UPL
<i>Hymenoxys odorata</i> D.C. 12		H	UPL	UPL	UPL	UPL	UPL
<i>Juncus bufonius</i> L.		SH	OBL	OBL	OBL	FACW+	FACW+
<i>Kochia californica</i> S. Wats.2,7,8	<i>Bassia californica</i> (S. Wats.) A.J. Scott	SH	NO	NO	FACW	NO	FACW
<i>Lepidium dictyotum</i> Gray 7,		H	NO	NO	FACW+	FACW	OBL
<i>Monolepis nuttalliana</i> (J.A. Schultes) Greene		SH	FACU*	FAC	FACW	FAC-	FACW
<i>Nama demissum</i> Gray		H	UPL	UPL	UPL	UPL	UPL
<i>Nitrophila occidentalis</i> (Moq.) S. Wats 2,7, 6		SH	NO	NO	FAC+	FACW	FACW
<i>Oligomeris linifolia</i> (Vahl) J.F. Macbr.		H	UPL	UPL	UPL	UPL	UPL
<i>Panicum obtusum</i> Kunth 12		H	FAC+	FAC	FACU	NO	NO
<i>Phacelia distans</i> Benth.2		H	UPL	UPL	UPL	UPL	UPL
<i>Pluchea sericea</i> (Nutt.) Coville 2,7		S	NO	NI	FACW-	FACW	NO

Table 2 (cont.). Species found along playa edges.

<i>Polypogon monspeliensis</i> (L.) Desf.		SH	FACW+	FACW+	FACW+	FACW+	FACW+
<i>Psathyrotes ramosissima</i> (Torr.) Gray		H	UPL	UPL	UPL	UPL	UPL
<i>Salicornia subterminalis</i> Parish 2,7	<i>Arthrocnemum subterminale</i> (Parish) Standl.	S	NO	NO	NO	NO	OBL
<i>Schismus barbatus</i> (Loefl. ex L.) Thellung		H	UPL	UPL	UPL	UPL	UPL
<i>Scirpus acutus</i> Muhl. ex Bigelow 2	<i>Schoenoplectus acutus</i> (Muhl. ex Bigelow) A. & D. Löve	S	OBL	OBL	OBL	OBL	OBL
<i>Sesuvium verrucosum</i> Raf. 7		SH	FACW-	FACW	FACW+	NI	FACW
<i>Sida leprosa</i> (Ortega) K. Schum 7,12	<i>Malvella leprosa</i> (Ortega) Krapov.	SH	FAC	FACW	FAC	FACU	FAC*
<i>Sphaerophysa salsula</i> (Pallas) DC. 12		H	NI	NI	FAC	UPL	NI
<i>Sporobolus airoides</i> (Torr.) Torr. 2,7		S	FAC	FAC	FAC	FAC-	FAC+
<i>Sisymbrium orientale</i> L.		H	UPL	UPL	UPL	UPL	UPL
<i>Suaeda suffrutescens</i> S. Wats. 4		SH	UPL	UPL	UPL	UPL	UPL
<i>Suaeda torreyana</i> S. Wats. 2,6,7,7,8	<i>Suaeda moquinii</i> (Torr.) Greene	SH	FACW-	FAC	FAC+	FAC	FAC+
<i>Tamarix aphylla</i> (L.) Karst. 4		S	FACW	FAC	FACW	NO	FACW-
<i>Wislizenia refracta</i> Engelm. 7		SH	FACW	FACU-	FACU-	NO	NI

*S = soft playa; H = hard playa; SH = soft and hard playa

- | | |
|-------------------------------|--------------------------------|
| 1 Barbour and Billings (1988) | 7 Thorne (1976) |
| 2 Barbour and Major (1977) | 8 Vasek (1983) |
| 3 Hunt (1966) | 9 Wallace et al. (1980) |
| 4 Hunt (1975) | 10 Went and Westergaard (1949) |
| 5 Scott et al. (2000) | 11 West (1983) |
| 6 Stone (1956) | 12 Wondzell et al. (1990) |

Dry Wash Species

Desert dry wash species occur in dry channel beds of intermittent and ephemeral streams that are dominated by woody phreatophytes, large shrubs, and trees, as well as scattered evergreen and drought-deciduous shrubs. Intermittent stream channels often have a groundwater table close to the surface that allows for a greater diversity of vegetation, while ephemeral streams do not have a water table as close to the surface,

therefore limiting the abundance of vegetation (Katz 2004). Many of the species found along dry washes occur in both the dry wash and adjacent upland habitats (Nilsen et al. 1984). As a response to channel disturbance it is common to find upland species that have been washed down into the stream channel during storm events; occasionally upland species invade the stream channel. Dry washes are often dominated by phreatophyte species, which have roots anchored deep below the surface in or near the water table (Rundel and Gibson 1996). However, not all dry wash species are phreatophytes; many other species, such as grasses and shallower-rooted shrubs, rely on groundwater discharge or precipitation (Scott et al. 2000). When there is a slight increase in soil moisture, there is also an increase in vegetation biomass, height, and stem density that is not found in the uplands areas (Lichvar and Wakeley 2004). Otherwise, dry washes tend to have lower species cover values because of frequent disturbances in the wash as a response to storm discharge events, lack of developed soils, and well-drained coarse soil textures that lack soil moisture. These disturbances and stresses affect germination rates and vegetative responses. Larger washes tend to have more scattered trees and shrubs, such as willows (*Salix* spp.), cottonwoods (*Populus* spp.), and mesquites (*Prosopis* spp.), that are able to survive because their root systems have the ability to make contact with deeper groundwater that is lacking immediately outside the slopes of the wash. Researchers in the Southwest have noted that some plant species seem to be restricted as obligate dry wash species, while others take advantage of the water reserves in the channel but are not restricted to it; these are also referred to as facultative dry wash species (Lichvar and Wakeley 2004). Because of these types of observations, Dick-Peddie and Hubbard (1977) noted that obligate riparian species of the Southwest may be facultative in more mesic regions. Table 3 lists 346 dry wash species.

Table 3. Dry wash species.

1988 synonymy	Current name	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Abronia villosa</i> S. Wats. 7		UPL	UPL	UPL	UPL	UPL
<i>Adenostoma fasciculatum</i> Hook. & Arn. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Adenostoma sparsifolium</i> Torr. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Agave americana</i> L. var. <i>expansa</i> (Jacobi) Gentry 7		UPL	UPL	UPL	UPL	UPL
<i>Agropyron intermedium</i> (Host) Beauv. var. <i>trichophorum</i> (Link) Halac.	<i>Thinopyrum intermedium</i> (Host) Barkworth & D.R. Dewey	UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Agropyron trachycaulum</i> (Link) Malte 2	<i>Elymus trachycaulus</i> (Link) Gould ex Shinners	FAC-	FAC	FACU	FAC	NI*
<i>Agrostis exarata</i> Trin. 2		FACW	FACW	FACW	FACW	FACW
<i>Alisma triviale</i> Pursh		UPL	UPL	UPL	UPL	UPL
<i>Allenrolfea occidentalis</i> (S. Wats.) Kuntze 1,2,10		FACW	FACW	FACW	FACW+	FACW+
<i>Alnus rhombifolia</i> Nutt.		NO	NO	NI	FACW	FACW
<i>Alyssum alyssoides</i> (L.) L.		UPL	UPL	UPL	UPL	UPL
<i>Amaranthus blitoides</i> S. Wats.		FAC	FACU	FACU	FACW	FACW
<i>Amaranthus palmeri</i> S. Wats.		FACU-	FACU	FACU	NO	FACU
<i>Ambrosia acanthicarpa</i> Hook.		UPL	UPL	UPL	UPL	UPL
<i>Ambrosia confertiflora</i> DC.		UPL	UPL	UPL	UPL	UPL
<i>Ambrosia dumosa</i> (Gray) Payne 1,2,7,9		UPL	UPL	UPL	UPL	UPL
<i>Ambrosia psilostachya</i> DC. 2		FAC-	FAC	FACU*	FACU+	FAC
<i>Amorpha fruticosa</i> L.		FACW	FACW+	FACW	NO	FAC*
<i>Amsinckia menziesii</i> (Lehm.) A. Nels. & J.F. Macbr. 2		UPL	UPL	UPL	UPL	UPL
<i>Amsinckia tessellata</i> Gray		UPL	UPL	UPL	UPL	UPL
<i>Anagallis arvensis</i> L.		FACW-	FAC	FAC+	FAC	FAC
<i>Anemopsis californica</i> (Nutt.) Hook. & Arn. 7		FACW+	OBL	OBL	NI	OBL
<i>Apiastrum angustifolium</i> Nutt.		UPL	UPL	UPL	UPL	UPL
<i>Apium graveolens</i> L.		NI	NI	NI	NI	FACW*
<i>Arctostaphylos glauca</i> Lindl. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Artemisia californica</i> Less. 2		UPL	UPL	UPL	UPL	UPL
<i>Artemisia douglasiana</i> Bess. ex Hook.		NO	NO	FAC	FACW	FACW
<i>Artemisia dracuncululus</i> L. 2		UPL	UPL	UPL	UPL	UPL
<i>Artemisia filifolia</i> Torr. 1		UPL	UPL	UPL	UPL	UPL
<i>Artemisia ludoviciana</i> Nutt. 2		UPL	UPL	FACU	UPL	FACU-
<i>Artemisia palmeri</i> Gray		UPL	UPL	UPL	UPL	UPL
<i>Artemisia tridentata</i> Nutt. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Artemisia tridentata</i> Nutt. ssp. <i>parishii</i> (Gray) Hall & Clements 2		UPL	UPL	UPL	UPL	UPL
<i>Arundo donax</i> L. 2,7		FAC+	FACW	FACW	NO	FACW
<i>Aster subspicatus</i> Nees	<i>Symphytotrichum subspicatum</i> (Nees) Nesom	NO	NI	FAC	FACW	FAC
<i>Astragalus lentiginosus</i> Dougl. ex Hook.		NO	NI	NI	NI	NI
<i>Atriplex californica</i> Moq.		NO	NO	NO	NO	FAC
<i>Atriplex canescens</i> (Pursh) Nutt. 1,2,7		UPL	UPL	UPL	UPL	FACU

Table 3 (cont.). Dry wash species.

<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Wats. 1,2,7,10		UPL	UPL	UPL	UPL	UPL
<i>Atriplex hymenelytra</i> (Torr.) S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Artemisia ludoviciana</i> Nutt. 2		UPL	UPL	FACU	FACU-*	FACU-
<i>Atriplex parryi</i> S. Wats. 1		NO	NO	FACW	NO	FACW
<i>Atriplex polycarpa</i> (Torr.) S. Wats. 1,2		NO	FACU-	FACU	NO	FACU
<i>Atriplex spinifera</i> J.F. Macbr.1		NO	NO	NO	NO	FAC
<i>Avena barbata</i> Pott ex Link		UPL	UPL	UPL	UPL	UPL
<i>Avena fatua</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Azolla filiculoides</i> Lam.		NO	OBL	NI	OBL	OBL
<i>Baccharis pilularis</i> DC. 1		UPL	UPL	UPL	UPL	UPL
<i>Baccharis sarothroides</i> Gray 1,7		NO	FAC-	NI	NO	FAC
<i>Baccharis viminea</i> DC.	<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers	NI	FACW	FACW	NO	FACW
<i>Barbarea verna</i> (P. Mill.) Aschers.		UPL	UPL	UPL	UPL	UPL
<i>Bassia hyssopifolia</i> (Pallas) Kuntz		FACW-	FACW-	FACW	FACW	FAC
<i>Beckmannia syzigachne</i> (Steud.) Fern.		NO	OBL	OBL	OBL	OBL
<i>Berula erecta</i> (Huds.) Coville		OBL	OBL	OBL	OBL	OBL
<i>Bothriochloa barbinodis</i> (Lag.) Herter		UPL	UPL	UPL	UPL	UPL
<i>Brassica nigra</i> (L.) W.D.J. Koch		UPL	UPL	UPL	UPL	UPL
<i>Brickellia californica</i> (Torr. & Gray) Gray 2		FAC	FACU+	UPL	FACU-	FACU
<i>Briza minor</i> L.		FAC+	NO	NO	FAC	FACW
<i>Bromus carinatus</i> Hook. & Arn.		UPL	UPL	UPL	UPL	UPL
<i>Bromus diandrus</i> Roth 2		UPL	UPL	UPL	UPL	UPL
<i>Bromus mollis</i> L.	<i>Bromus hordeaceus</i> L.	UPL	UPL	UPL	UPL	FACU
<i>Bromus rubens</i> L.	<i>Bromus madritensis</i> L. ssp <i>rubens</i> (L.) Husnot	NI	NI	NI	NI	NI
<i>Bromus tectorum</i> L. 2		UPL	UPL	UPL	UPL	UPL
<i>Calystegia longipes</i> (S. Wats.) brummitt		UPL	UPL	UPL	UPL	UPL
<i>Camissonia claviformis</i> (Torr. & Gr(Torr. & Frém.) Raven 2		UPL	UPL	UPL	UPL	UPL
<i>Cardamine californica</i> (Nutt.) Greene		NO	NO	NO	NI	UPL*
<i>Cardaria pubescens</i> (C.A. Mey.) Jarmolenko		UPL	UPL	UPL	UPL	UPL
<i>Carex barbarae</i> Dewey		NO	NO	NO	FAC+	FACW
<i>Carex praegracilis</i> W. Boott		FACW	FACW+	FACW	FACW	FACW-
<i>Carex spissa</i> Bailey		NO	NI	NO	NO	FAC*
<i>Carex triquetra</i> Boott		UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Caulanthus inflatus</i> S. Wats.		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus crassifolius</i> Torr. 1		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus cuneatus</i> (Hook.) Nutt. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus greggii</i> Gray 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus tomentosus</i> Parry 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus verrucosus</i> Nutt.1		UPL	UPL	UPL	UPL	UPL
<i>Centaurea calcitrapa</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Centaurea maculosa</i> auct. non Lam.	<i>Centaurea stoebe</i> L. ssp. <i>micranthos</i> (Gugler) Hayek	UPL	UPL	UPL	UPL	UPL
<i>Centaurea melitensis</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Centaurium venustum</i> (Gray) B.L. Robins.		UPL	UPL	UPL	UPL	UPL
<i>Cercocarpus minutiflorus</i> Abrams	<i>Cercocarpus montanus</i> Raf. var. <i>minutiflorus</i> (Abrams) F.L. Martin	UPL	UPL	UPL	UPL	UPL
<i>Chenopodium leptophyllum</i> (Moq.) Nutt. ex. S. Wats. 2		FACU	FACU	FACU	FACU	UPL
<i>Chorizanthe watsonii</i> Torr. & Gray		UPL	UPL	UPL	UPL	UPL
<i>Chrysothamnus nauseosus</i> (Pallas ex Pursh) Britt ssp. <i>albicaulis</i> (Nutt.) Hall & Clements 2,7	<i>Ericameria nauseosa</i> (Pallas ex Pursh) Nesom & Baird ssp. <i>nauseosa</i> var. <i>speciosa</i> (Nutt.) Nesom & Baird	UPL	UPL	UPL	UPL	UPL
<i>Chrysothamnus teretifolius</i> (Dur. & Hilg.) Hall 2	<i>Ericameria teretifolia</i> (Dur. & Hilg.) Jepson	UPL	UPL	UPL	UPL	UPL
<i>Cirsium occidentale</i> (Nutt.) Jepson		UPL	UPL	UPL	UPL	UPL
<i>Cirsium vulgare</i> (Savi) Ten.		FACU	FACU	FAC	FACU	FACU
<i>Claytonia parviflora</i> Dougl. ex Hook.		UPL	UPL	UPL	UPL	UPL
<i>Conium maculatum</i> L.		FACW	OBL	FACW	FACW-	FACW
<i>Conyza canadensis</i> (L.) Cronq. 1		UPL	FACU	UPL	FACU	FAC
<i>Cortaderia jubata</i> (Lem.) Stapf		UPL	UPL	UPL	UPL	UPL
<i>Cotula coronopifolia</i> L.		NO	OBL	NI	FACW+	FACW+
<i>Crassula aquatica</i> (L.) Schoenl. 2		OBL	OBL	NI	OBL	OBL
<i>Cressa truxillensis</i> Kunth 7		FACW-	FACW-	FACW	FACW	FACW
<i>Croton californicus</i> Muell.-Arg. 2		UPL	UPL	UPL	UPL	UPL
<i>Croton pottsii</i> (Klotzsch) Muell.-Arg.		UPL	UPL	UPL	UPL	UPL
<i>Cryptantha circumscissa</i> (Hook. & Arn.) I.M. Johnston		UPL	UPL	UPL	UPL	UPL
<i>Cryptantha clevelandii</i> Greene		UPL	UPL	UPL	UPL	UPL
<i>Cryptantha intermedia</i> (Gray) Greene		UPL	UPL	UPL	UPL	UPL
<i>Cryptantha nevadensis</i> A. Nels. & Kennedy		UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Cucurbita foetidissima</i> Kunth		UPL	UPL	UPL	UPL	UPL
<i>Cuscuta californica</i> Hook. & Arn.		UPL	UPL	UPL	UPL	UPL
<i>Cynara cardunculus</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Cynodon dactylon</i> (L.) Pers.		FACU+	FACU	FAC	FACU	FAC
<i>Cyperus eragrostis</i> Lam.		NO	NO	NO	NI	FACW
<i>Cyperus alternifolius</i> L.	<i>Cyperus involucratus</i> Rottb.	FACW+	NO	NO	NO	OBL
<i>Cyperus odoratus</i> L.		FACW	FACW+	NO	NO	FACW
<i>Cytisus multiflorus</i> (L'Hér.) Sweet		UPL	UPL	UPL	UPL	UPL
<i>Deschampsia danthonioides</i> (Trin.) Munro		NO	FACW-	FACW	FACW-	FACW
<i>Datura stramonium</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Descurainia pinnata</i> (Walt.) Britt. 1		UPL	UPL	UPL	UPL	UPL
<i>Distichlis spicata</i> (L.) Greene 1,2,7		FACW+	FACW	FAC+*	FACW	FACW
<i>Dudleya cymosa</i> (Lem.) Britt. & Rose		UPL	UPL	UPL	UPL	UPL
<i>Echinochloa crus-galli</i> (L.) Beauv.		FACW-	FACW-	FACW	FACW	FACW
<i>Echinochloa crus-pavonis</i> (Kunth) J.A. Schultes var. <i>macera</i> (Wieg.) Gould		OBL	OBL	FACW	FACW	OBL
<i>Echinochloa muricata</i> (Beauv.) Fern.		FACW	FACW	FACW	FACW	FACW
<i>Eleocharis macrostachya</i> Britt.		OBL	OBL	OBL	OBL	OBL
<i>Eleocharis montevidensis</i> Kunth		FACW+	FACW	NO	NO	FACW
<i>Eleocharis obtusa</i> (Willd.) J.A. Schultes		OBL	OBL	OBL	OBL	OBL
<i>Elymus cinereus</i> Scribn. & Merr. 1,2	<i>Leymus cinereus</i> (Scribn. & Merr.) A. Löve	NO	NI	NI	NI	NI
<i>Elymus glaucus</i> Buckl.		NO	FACU	FACU	FACU	FACU
<i>Elymus multisetus</i> M.E. Jones		UPL	UPL	UPL	UPL	UPL
<i>Encelia farinosa</i> Gray ex Torr. 1,2, 7		UPL	UPL	UPL	UPL	UPL
<i>Ephedra nevadensis</i> S. Wats.2,7, 9		UPL	UPL	UPL	UPL	UPL
<i>Epilobium canum</i> (Greene) Raven		UPL	UPL	UPL	UPL	UPL
<i>Epilobium ciliatum</i> Raf.		FACU	FACW	FAC	FACW-	FACW
<i>Erigeron foliosus</i> Nutt.		UPL	UPL	UPL	UPL	UPL
<i>Eriodictyon crassifolium</i> Benth.		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum deflexum</i> Torr.		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum fasciculatum</i> Benth. 1		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum inflatum</i> Torr. & Frém.		UPL	UPL	UPL	UPL	UPL
<i>Eriophyllum confertiflorum</i> (DC.) Gray 1, 2		UPL	UPL	UPL	UPL	UPL
<i>Erodium botrys</i> (Cav.) Bertol.		UPL	UPL	UPL	UPL	UPL
<i>Erodium cicutarium</i> (L.) L'Hér. ex Ait.		UPL	UPL	UPL	UPL	UPL
<i>Eucalyptus globus</i> Labill.		UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Eurotia lanata</i> (Pursh) Moq.	<i>Krascheninnikovia lanata</i> (Pursh) A.D.J. Meeuse & Smit	UPL	UPL	UPL	UPL	UPL
<i>Eustoma exaltatum</i> (L.) Salisb. ex G. Don		FACW	OBL*	NO	NO	OBL*
<i>Festuca arundinacea</i> Schreb.	<i>Schedonorus phoenix</i> (Scop.) Holub	FAC-	NA*	FACW-	FACU-	FAC-
<i>Festuca octoflora</i> Walt. 1,2	<i>Vulpia octoflora</i> (Walt.) Rydb. var. <i>octoflora</i>	NI	NI	UPL	UPL	UPL
<i>Festuca rubra</i> L.		FAC*	FACW-	FAC	FAC	FAC
<i>Foeniculum vulgare</i> P. Mill.		FAC	FACU	FACU	FACU	FACU
<i>Forestiera pubescens</i> Nutt. var. <i>neomexicana</i> (Gray) E. Murr.	<i>Forestiera neomexicana</i> Gray	FAC-	FACU	FAC+	NO	FAC
<i>Frankenia jamesii</i> Torr. ex Gray		UPL	UPL	UPL	UPL	UPL
<i>Fraxinus velutina</i> Torr. 2,7		FAC	FAC+	FAC	NO	FACW
<i>Galium angustifolium</i> Nutt. ex Gray		UPL	UPL	UPL	UPL	UPL
<i>Galium aparine</i> L.		FAC-	FACU	FACU	FACU	FACU
<i>Galium triflorum</i> Michx.		FACU	FACU+	FACU	FACU	FACU
<i>Geranium carolinianum</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Geranium molle</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Gilia latiflora</i> (Gray) Gray		UPL	UPL	UPL	UPL	UPL
<i>Gilia leptalea</i> (Gray) Greene	<i>Navarretia leptalea</i> (Gray) L.A. Johnson	UPL	UPL	UPL	UPL	UPL
<i>Gilia leptomeria</i> Gray	<i>Aliciella leptomeria</i> (Gray) J.M. Porter	UPL	UPL	UPL	UPL	UPL
<i>Gnaphalium beneolens</i> A. Davids	<i>Pseudognaphalium canescens</i> (DC.) W.A. Weber ssp. <i>beneolens</i> (A. Davids.)	UPL	UPL	UPL	UPL	UPL
<i>Gnaphalium californicum</i> DC.	<i>Pseudognaphalium californicum</i> (DC.) A. Anderb.	UPL	UPL	UPL	UPL	UPL
<i>Gnaphalium canescens</i> DC.	<i>Pseudognaphalium canescens</i> (DC.) W.A. Weber ssp. <i>canescens</i>	UPL	UPL	FACU	NO	FACU*
<i>Gutierrezia microcephala</i> (DC.) Gray		UPL	UPL	UPL	UPL	UPL
<i>Gutierrezia sarothrae</i> (Pursh) Britt. & Rusby 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Haplopappus acradenia</i> (Gray) Blake 7	<i>Isocoma acradenia</i> (Greene) Greene	NO	NI	NI	NO	NI
<i>Haplopappus cooperi</i> (Gray) Hall 2	<i>Ericameria cooperi</i> (Gray) Hall	UPL	UPL	UPL	UPL	UPL
<i>Helianthus annuus</i> L.		FAC	FAC-	FACU	FACU+	FAC-
<i>Heliotropium curassavicum</i> L.		FACW	FACW*	OBL	OBL	OBL

Table 3 (cont.). Dry wash species.

<i>Heliotropium curassavicum</i> L. var. <i>oculatum</i> (Heller) I.M. Johnston 7		FACW	FACW*	OBL	OBL	OBL
<i>Heteromeles arbutifolia</i> (Lindl.) M. Roemer 1		UPL	UPL	UPL	UPL	UPL
<i>Heterotheca grandiflora</i> Nutt. 1		UPL	UPL	UPL	UPL	UPL
<i>Hilaria mutica</i> (Buckl.) Benth. 1	<i>Pleuraphis mutica</i> Buckl.	UPL	UPL	UPL	UPL	UPL
<i>Hordeum leporinum</i> L. ssp. <i>leporinum</i> (Link) Arcang.		NI	NI	NI	NI	NI
<i>Hordeum murinum</i> L.		NI	NI	NI	NI	NI
<i>Hymenoclea monogyra</i> Torr. & Gray ex Gray 1,7		UPL	UPL	UPL	UPL	UPL
<i>Hymenoclea salsola</i> Torr. & Gray ex Gray 1,2,7,9		UPL	UPL	UPL	UPL	UPL
<i>Iris missouriensis</i> Nutt.		NO	FACW-	OBL*	FACW+	OBL
<i>Isocoma menziesii</i> (Hook. & Arn.) Nesom		NO	NO	NO	NO	FACW*
<i>Iva hayesiana</i> Gray		NO	NO	NO	NO	FACW
<i>Juncus actus</i> L. 2		NO	FACW	FACW+	NO	FACW
<i>Juncus balticus</i> Willd.	<i>Juncus arcticus</i> Willd. ssp. <i>littoralis</i> (Engelm.) Hultén	NO	NO	FACW	NO	NO
<i>Juncus dubius</i> Engelm.		NO	NO	NI	NI	FACW*
<i>Juncus mexicanus</i> Willd. ex J.A. & J.H. Schultes		FACW	FACW	FACW	NO	FACW
<i>Lactuca serriola</i> L. 1		FAC	FAC	FACU	FAC-	FAC
<i>Larrea divaricata</i> auct. non Cav. 1,7	<i>Larrea tridentata</i> (Sessé & Moc. ex DC.) Coville var. <i>tridentata</i>	UPL	UPL	UPL	UPL	UPL
<i>Lasthenia californica</i> D.C. ex Lindl.		NO	UPL	NO	UPL	FACU*
<i>Leman minor</i> L.		OBL	OBL	OBL	OBL	OBL
<i>Lepidium densiflorum</i> Schrad.		FAC	FAC	FACU	FAC-	FAC
<i>Lepidium fremontii</i> S. Wats. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Lepidium latifolium</i> L.		NO	NI	FAC	FAC	FACW
<i>Lepidium virginicum</i> L.		FAC-	UPL*	FACU	FACU	FACU
<i>Lepidospartum squamatum</i> (Forssk.) Aschers.		UPL	UPL	UPL	UPL	UPL
<i>Lessingia lemmonii</i> Gray		UPL	UPL	UPL	UPL	UPL
<i>Limonium californicum</i> (Boiss.) Heller		NO	NO	NO	NO	OBL
<i>Limonium limbatum</i> Small		FACW+	FACW	NO	NO	NO
<i>Lolium multiflorum</i> Lam.	<i>Lolium perenne</i> L. ssp. <i>multiflorum</i> (Lam.) Husnot	FACU	FACU	FACU	FACU	FAC*
<i>Lolium perenne</i> L.		FACU	FACU	FACU	FACU	FAC*
<i>Lonicera subspicata</i> Hook. & Arn		UPL	UPL	UPL	UPL	UPL
<i>Lonicera japonica</i> Thunb.		FAC	FACU*	FAC+	NO	NI

Table 3 (cont.). Dry wash species.

<i>Lotus corniculatus</i> L.		FAC	FACU+	NO	FAC	FAC
<i>Lotus scoparius</i> (Nutt.) Ottley 2		UPL	UPL	UPL	UPL	UPL
<i>Lupinus bicolor</i> Lindl.		UPL	UPL	UPL	UPL	UPL
<i>Lycium cooperi</i> Gray 2,7		UPL	UPL	UPL	UPL	UPL
<i>Lygodesmia exigua</i> (Gray) Rydb. 2		UPL	UPL	UPL	UPL	UPL
<i>Lythrum hyssopifolia</i> L.		NO	NO	NO	OBL	FACW
<i>Machaeranthera pinnatifida</i> (Hook.) Shinnery		UPL	UPL	UPL	UPL	UPL
<i>Macheranthera tortifolia</i> (Torr. & Gray) Cronq. & Keck 2,9	<i>Xylorhiza tortifolia</i> (Torr. & Gray) Greene var. <i>tortifolia</i>	UPL	UPL	UPL	UPL	UPL
<i>Marah macrocarpus</i> (Greene) Greene 2		UPL	UPL	UPL	UPL	UPL
<i>Marrubium vulgare</i> L.		FACW-	FAC+	FACU	FACU+	FAC
<i>Matricaria matricarioides</i> (Less.) T. Porter	<i>Matricaria discoidea</i> DC.	UPL*	FACU	FACU	FACU	FACU
<i>Medicago polymorpha</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Medicago sativa</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Melilotus alba</i> Medik.	<i>Melilotus officinalis</i> (L.) Lam.	FACU	FACU+	FACU	FACU	FACU+
<i>Melilotus indica</i> (L.) All.		FACU	FACU+	FACU	FACU	FAC
<i>Melilotus officinalis</i> (L.) Lam.		FACU	FACU+	FACU	FACU	FACU
<i>Mentha arvensis</i> L.		FACW	FACW	FACW	FAC	FACW
<i>Mentha spicata</i> L.		FACW	FACW*	FACW	OBL	OBL
<i>Mentzelia albicaulis</i> (Dougl. ex Hook.) Dougl. ex Torr. & Gray		UPL	UPL	UPL	UPL	UPL
<i>Mimulus aurantiacus</i> W. Curtis 2	<i>Diplacus aurantiacus</i> (W. Curtis) Jepson ssp. <i>aurantiacus</i>	UPL	UPL	UPL	UPL	UPL
<i>Mimulus guttatus</i> DC.		NO	OBL	OBL	OBL	OBL
<i>Muhlenbergia porteri</i> Scribn. ex Beal 1,2		UPL	UPL	UPL	UPL	UPL
<i>Muhlenbergia rigens</i> (Benth.) A.S. Hitchc.		FACU*	FACU*	UPL	NO	FACW
<i>Najas guadalupensis</i> (Spreng.) Magnus		OBL	OBL	OBL	OBL	OBL
<i>Nassella lepida</i> (A.S. Hitchc.) Barkworth		UPL	UPL	UPL	UPL	UPL
<i>Nasturtium officinale</i> Ait. F.		OBL	OBL	OBL	OBL	OBL
<i>Nicotiana glauca</i> (S. Wats.) S. Wats.		FAC	FAC	NI	NO	FAC
<i>Oenothera californica</i> (S. Wats.) S. Wats.		UPL	UPL	UPL	UPL	UPL
<i>Opuntia bigelovii</i> Engelm. 2	<i>Cylindropuntia bigelovii</i> (Engelm.) F.M. Knuth	UPL	UPL	UPL	UPL	UPL
<i>Opuntia littoralis</i> (Engelm.) Cockerell		UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Opuntia phaeacantha</i> Engelm. var. <i>discata</i> (Griffiths) L. Benson & Walkington 1	<i>Opuntia engelmannii</i> Salm-Dyck ex Engelm.	UPL	UPL	UPL	UPL	UPL
<i>Opuntia ramosissima</i> Engelm 1,2	<i>Cylindropuntia ramosissima</i> (Engelm.) F.M. Knuth	UPL	UPL	UPL	UPL	UPL
<i>Orthocarpus luteus</i> Nutt.		NO	FACU-	FACU	FACU-	FACU
<i>Oryzopsis hymenoides</i> (Roemer & J.A. Schultes) Ricker ex Piper 1,2, 9	<i>Achnatherum hymenoides</i> (Roemer & J.A. Schultes) Barkworth	FACU+	FACU-	UPL	UPL	UPL
<i>Oxalis albicans</i> Kunth		UPL	UPL	UPL	UPL	UPL
<i>Dichanthelium acuminatum</i> (SW.) Gould & C.A. Clark		FAC	FAC	FACW	FAC	FACW
<i>Panicum capillare</i> L.		FAC	FAC	FACU	FAC	FAC
<i>Panicum dichotomiflorum</i> Michx.		FACW	FAC	FACW	FACW	FACW
<i>Panicum hallii</i> Vassey		FACU	FACU	UPL	NO	NO
<i>Paspalum dilatatum</i> Poir.		FAC	FAC	NO	NI	FAC
<i>Pennisetum setaceum</i> (Forssk.) Chiov.		UPL	UPL	UPL	UPL	UPL
<i>Petalonyx thurberi</i> Gray 1,7		UPL	UPL	UPL	UPL	UPL
<i>Petroselinum crispum</i> (P. Mill.) Nyman ex A.W. Hill		UPL	UPL	UPL	UPL	UPL
<i>Phacelia tanacetifolia</i> Benth.		UPL	UPL	UPL	UPL	UPL
<i>Phalaris arundinacea</i> L.		FACW+	OBL	OBL	FACW	OBL
<i>Phleum pratense</i> L.		FACU	FACU	FACU	FACU	FACU
<i>Phytolacca americana</i> L.		FAC-	NI	NO	NI	NI
<i>Picris echioides</i> L.		NO	NO	NO	NO	FAC*
<i>Pinus coulteri</i> D. Don 1		UPL	UPL	UPL	UPL	UPL
<i>Plagiobothrys bracteatus</i> (T.J. Howell) I.M. Johnston		NO	NO	NO	FACW+	OBL
<i>Plantago elongata</i> Pursch		FACW-	NO	FACW	FACW	FACW*
<i>Plantago erecta</i> Morris		UPL	UPL	UPL	UPL	UPL
<i>Plantago lanceolata</i> L.		FAC	FAC	FACU	FACU+	FAC-
<i>Plantago major</i> L.		FAC+	FACW	FAC	FAC+	FACW-
<i>Plantanus racemosa</i> Nutt. 7		NO	NO	NO	NO	FACW
<i>Pluchea odorata</i> (L.) Cass.		NO	NO	NO	NO	NO
<i>Pluchea purpurascens</i> (Sw.) DC.	<i>Pluchea odorata</i> (L.) Cass.	NO	NO	NO	NO	NO
<i>Pluchea sericea</i> (Nutt.) Coville 1,2,7, 10		NO	NI	FACW-	FACW	NO
<i>Poa annua</i> L.		FAC	FAC-	FAC	FAC-	FACW-
<i>Poa glauca</i> Vahl var. <i>rupicola</i> (Nash ex Rydb.) Boivin	<i>Poa glauca</i> Vahl ssp. <i>rupicola</i> (Nash ex Rydb.) W.A. Weber	UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Poa pratensis</i> L.		FACU+	FACU	FACU	FACU+	FACU
<i>Poa secunda</i> J. Presl 2		UPL	UPL	UPL	UPL	UPL
<i>Polygonum lapathifolium</i> L.		FACW-	OBL	OBL	FACW+	OBL
<i>Polygonum punctatum</i> Ell.		FACW	OBL	OBL	OBL	OBL
<i>Polypogon monpeliensis</i> (L.) Desf.		FACW+	FACW+	FACW+	FACW+	FACW+
<i>Polystichum imbricans</i> (D.C. Eat.) D.H. Wagner		UPL	UPL	UPL	UPL	UPL
<i>Populus fremontii</i> S. Wats. 1,2,5,7		FACW-	FACW	FACW*	NO	FACW
<i>Populus tremula</i> L. 7		FAC-	FACU	FAC	FAC+	FAC+
<i>Portulaca oleracea</i> L.		FAC	FAC	FAC	FAC	FAC
<i>Prosopis glandulosa</i> Torr.1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Pseudocappia arenaria</i> Rydb.		UPL	UPL	UPL	UPL	UPL
<i>Pteridium aquilinum</i> (L.) Kuhn		FAC-	FACU	FACU	FACU	FACU
<i>Quercus agrifolia</i> Née 1		UPL	UPL	UPL	UPL	UPL
<i>Quercus chrysolepis</i> Liebm. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Quercus dumosa</i> Nutt. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Rhus integrifolia</i> (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Rhus ovata</i> S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ribes speciosum</i> Pursh		UPL	UPL	UPL	UPL	UPL
<i>Ricinus communis</i> L.		FACU	FAC-	NI	NO	FACU
<i>Rorippa nasturium-aquaticum</i> (L.) Hayek 2	<i>Nasturtium officinale</i> Ait. f.	OBL	OBL	OBL	OBL	OBL
<i>Rosa californica</i> Cham. & Schlecht.		NO	NO	NO	NI	FAC+
<i>Rudbeckia californica</i> Gray		NO	NO	NO	FACU+	FACW
<i>Rumex crispus</i> L.		FACW	FACW	FACW	FACW	FACW-
<i>Rumex hymenosepalus</i> Torr.		UPL	UPL	UPL	UPL	UPL
<i>Salicornia utahensis</i> Tidestrom 1	<i>Sarcocornia utahensis</i> (Tidestrom) A.J. Scott	FACW*	FACW	OBL	NO	OBL
<i>Salicornia virginica</i> L.	<i>Salicornia depressa</i> Standl.	OBL*	OBL	NO	OBL	OBL
<i>Salix exigua</i> Nutt. 7		FACW+	OBL	OBL	OBL	OBL
<i>Salix gooddingii</i> Ball 1,2,5,7		FACW+	OBL	FACW	NO	OBL
<i>Salix laevigata</i> Bebb 7		UPL	UPL	UPL	UPL	UPL
<i>Salix lasiolepis</i> Benth. 7		FACW	FACW	FACW	FACW	FACW
<i>Salsola tragus</i> L.		FACU	FACU	FACU	FACU	FACU
<i>Salsola kali</i> L. 1		FACU	FACU	FACU	UPL	FACU+
<i>Salvia apiana</i> Jepson		UPL	UPL	UPL	UPL	UPL
<i>Salvia carduea</i> Benth.		UPL	UPL	UPL	UPL	UPL
<i>Salvia columbariae</i> Benth. 2		UPL	UPL	UPL	UPL	UPL
<i>Salvia mellifera</i> Greene 2		UPL	UPL	UPL	UPL	UPL

Table 3 (cont.). Dry wash species.

<i>Sambucus mexicanus</i> K. Presl ex DC. ssp. <i>cerulea</i> (Raf.) E. Murr.	<i>Sambucus nigra</i> L. ssp. <i>canadensis</i> (L.) R. Bolli	FAC	FAC	FACU	NO	FAC
<i>Samolus ebracteatus</i> Kunth		FACW*	OBL	NI	NO	NO
<i>Sanicula crassicaulis</i> Poepp. ex DC.		UPL	UPL	UPL	UPL	UPL
<i>Sarcobatus vermiculatus</i> (Hook.) Torr. 1,2		FACU+	FACU+	FACU*	FACU+	FACU
<i>Schismus barbatus</i> (Loefl. ex L.) Thellung 2		UPL	UPL	UPL	UPL	UPL
<i>Scirpus acutus</i> Muhl. Ex Bigelow	<i>Schoenoplectus acutus</i> var. <i>acutus</i> (Muhl. ex Bigelow) A.& D. Löve	OBL	OBL	OBL	OBL	OBL
<i>Scirpus americanus</i> (Pers.) Volk. ex Schinz & R. Keller		OBL	OBL	OBL	OBL	OBL
<i>Scirpus californicus</i> (C.A. Mey.) Palla		OBL	OBL	NO	NO	OBL
<i>Scirpus cernuus</i> (Vahl) Roemer & J.A. Schultes		NO	NO	NO	OBL	OBL
<i>Scirpus microcarpus</i> J. & K. Presl		NO	OBL	OBL	OBL	OBL
<i>Scirpus robustus</i> Pursh	<i>Schoenoplectus robustus</i> (Pursh) M.T. Strong	OBL	NO	NO	NO	OBL
<i>Scrophularia californica</i> Cham. & Schlecht.		NO	FACW-	NO	FACW-	FAC
<i>Senecio vulgaris</i> L.		NI	NI	UPL	FACU	NI*
<i>Sesuvium verrucosum</i> Raf. 1,7		FACW-	FACW	FACW+	NI	FACW
<i>Setaria glauca</i> (L.) Beauv.	<i>Setaria pumila</i> (Poir.) Roemer & J.A. Schultes ssp. <i>pumila</i>	FAC	FAC	FACU	FAC	FAC
<i>Setaria viridis</i> (L.) Beauv.		UPL	UPL	UPL	UPL	UPL
<i>Sisymbrium altissimum</i> L. 2		FACU+	FAC	FACU-	FACU-	FACU
<i>Sisyrinchium bellum</i> S. Wats.		NO	NO	NO	FACW-	FAC
<i>Sitanion hystrix</i> (Nutt.) J.G.Smith 1,2	<i>Elymus elymoides</i> (Raf.) Swezey	FACU-	UPL	UPL	FACU-	FACU
<i>Solanum elaeagnifolium</i> Cav.		UPL	UPL	UPL	UPL	UPL
<i>Solanum parishii</i> Heller		UPL	UPL	UPL	UPL	UPL
<i>Solidago californica</i> Nutt.		UPL	UPL	UPL	UPL	UPL
<i>Solidago spectabilis</i> (D.C. Eat.) Gray var. <i>confinis</i> (Gray) Cronq.		NO	NO	NI	NO	FAC
<i>Sonchus arvensis</i> L.		NI	NI	FACU	FACU+	FACU
<i>Sonchus apser</i> (L.) Hill		FAC-	FACW	FACU	FAC-	FAC
<i>Sonchus oleraceus</i> L.		UPL*	UPL*	UPL	UPL	NI*
<i>Sporobolus airoides</i> (Torr.) Torr. 1,2		FAC	FAC	FAC	FAC-	FAC+
<i>Sporobolus contractus</i> A.S. Hitchc.		UPL	UPL	UPL	UPL	UPL
<i>Sporobolus wrightii</i> Munro ex Scribn.		UPL	UPL	UPL	UPL	UPL
<i>Stachys ajugoides</i> Benth.		NO	NO	NO	NO	OBL

Table 3 (cont.). Dry wash species.

<i>Stephanomeria exigua</i> Nutt.		UPL	UPL	UPL	UPL	UPL
<i>Stipa speciosa</i> Swallen 2	<i>Achnatherum diegoense</i> (Swallen) Barkworth	NO	NO	NO	NO	FACW*
<i>Achnatherum speciosum</i> (Trin. & Rupr.) Barkworth		UPL	UPL	UPL	UPL	UPL
<i>Streptanthella longirostris</i> (S. Wats.) Rydb.		UPL	UPL	UPL	UPL	UPL
<i>Suaeda moquinii</i> (Torr.) Greene		NO	FACW	FACW	FACW	NO
<i>Suaeda suffrutescens</i> S. Wats.		OBL	OBL	NO	NO	NO
<i>Tamarix parviflora</i> DC. 7		FACW	NI	FACW	NI	FAC
<i>Tamarix ramosissima</i> Ledeb. 7		FACW	NI	FACW	FACW	FAC
<i>Taraxacum officinale</i> G.H. Weber ex Wiggers		FACU+	FACU	FACU+	FACU	FACU
<i>Toxicodendron diversilobum</i> (Torr. & Gray) Greene		UPL	UPL	UPL	UPL	UPL
<i>Trifolium repens</i> L.		FACU+	NI	FACU	FACU+	FACU+
<i>Typha angustifolia</i> L. 7		OBL	NI	OBL	OBL	OBL
<i>Typha latifolia</i> L. 7		OBL	OBL	OBL	OBL	OBL
<i>Urtica dioica</i> L.		FAC	NI	FAC	FAC+	FACW
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook. f. ex Gray		FAC	FAC	FACU	NO	FAC
<i>Veronica americana</i> Schwein. ex Benth.		NI	OBL	OBL	OBL	OBL
<i>Veronica anagallis-aquatica</i> L.		OBL	OBL	OBL	OBL	OBL
<i>Veronica peregrina</i> L.		OBL	OBL	FACW+	OBL	OBL
<i>Vicia americana</i> Muhl. ex Willd.		NI	NI	NI	NI	NI
<i>Vicia cracca</i> L.		UPL	UPL	UPL	UPL	UPL
<i>Vitis californica</i> Benth.		NO	NI	NO	FACU	FACW
<i>Vitis girdiana</i> Munson		UPL	UPL	UPL	UPL	UPL
<i>Vulpia myuros</i> (L.) K.C. Gmel.		FAC	FACW	FACW-	FAC	FACU*
<i>Washingtonia filifera</i> (L. Linden) H. Wendl. 2,7		NO	FACW	NO	NO	FACW
<i>Xanthium strumarium</i> L.		FAC-	NI	FAC	FAC	FAC+
<i>Yucca brevifolia</i> Engelm.		UPL	UPL	UPL	UPL	UPL

1 Barbour and Billings (1988)

2 Barbour and Major (1977)

3 Hunt (1966)

4 Hunt (1975)

5 Scott et al. (2000)

6 Stone (1956)

7 Thorne (1976)

8 Vasek (1983)

9 Wallace et al. (1980)

10 Went and Westergaard (1949)

11 West (1983)

12 Wondzell et al. (1990)

Dry Wash Phreatophytes

Dry wash phreatophytes (Table 3) can be found along intermittent and ephemeral watercourses and in depressions where the stored water or water table is near the surface in arid riparian habitats. They are generally limited to areas where there is a permanent undergroundwater supply. This adaptation enables them to avoid the rigors of the arid environment by having roots in constant contact with the fringe of capillary water above a water table (Hunt 1966). Because of their deep rooting system, desert phreatophytes have low water stress tolerance and high water stress avoidance (Nilsen et al. 1984). These species, known as obligate phreatophytes, are usually limited to the narrow, gallery forest directly adjacent to the channel that is dominated by cottonwood (*Populus* spp.) willows (*Salix* spp.), and mesquite (*Prosopis* spp.) species (Scott et al. 2000, Lichvar and Sprecher 1996). Other species are able to take advantage of groundwater when present but can also tolerate periods of low water availability. These facultative phreatophytes occur where water and salts accumulate (Barbour et al. 1987). Dry wash phreatophytes have several mechanisms to avoid drought, especially in the summer when it is the hottest and driest; these include deciduousness and a very low stomatal conductance (Nilsen et al. 1984). Table 4 lists 62 dry wash phreatophytes.

Table 4. Dry wash phreatophytes.

1988 synonymy	Current name	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Adenostoma fasciculatum</i> Hook. & Arn. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Adenostoma sparsifolium</i> Torr. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Allenrolfea occidentalis</i> (S. Wats.) Kuntze 2,3		FACW	FACW	FACW	FACW+	FACW+
<i>Ambrosia dumosa</i> (Gray) Payne 2		UPL	UPL	UPL	UPL	UPL
<i>Atriplex canescens</i> (Pursh) Nutt. 2, 3		UPL	UPL	UPL	UPL	FACU
<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Wats. 1,2,7,10		UPL	UPL	UPL	UPL	UPL
<i>Atriplex hymenelytra</i> (Torr.) S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Atriplex parryi</i> S. Wats. 1		NO	NO	FACW	NO	FACW
<i>Atriplex polycarpa</i> (Torr.) S. Wats. 1,2		NO	FACU-	FACU	NO	FACU
<i>Atriplex spinifera</i> J.F. Macbr. 1		NO	NO	NO	NO	FAC
<i>Baccharis pilularis</i> DC. 1		UPL	UPL	UPL	UPL	UPL
<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers.		NI	FACW	FACW	NO	FACW

Table 4 (cont.). Dry wash phreatophytes.

<i>Baccharis sarothroides</i> Gray 2,7		NO	FAC-	NI	NO	FAC
<i>Baccharis viminea</i> DC. 1	<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers.	NI	FACW	FACW	NO	FACW
<i>Ceanothus crassifolius</i> Torr. 1		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus cuneatus</i> (Hook.) Nutt. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus greggii</i> Gray 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus tomentosus</i> Parry 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ceanothus verrucosus</i> Nutt. 1		UPL	UPL	UPL	UPL	UPL
<i>Chrysothamnus nauseosus</i> (Pallas ex Pursh) Britt ssp. <i>albicaulis</i> (Nutt.) Hall & Clements 2,7	<i>Ericameria nauseosa</i> (Pallas ex Pursh) Nesom & Baird ssp. <i>nauseosa</i> var. <i>speciosa</i> (Nutt.) Nesom & Baird	UPL	UPL	UPL	UPL	UPL
<i>Encelia farinosa</i> Gray ex Torr. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum fasciculatum</i> Benth 1		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum inflatum</i> Torr. & Frém. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Eucalyptus globulus</i> Labill.		UPL	UPL	UPL	UPL	UPL
<i>Frankenia jamesii</i> Torr. ex Gray		UPL	UPL	UPL	UPL	UPL
<i>Fraxinus velutina</i> Torr.		FAC	FAC+	FAC	NO	FACW
<i>Gutierrezia microcephala</i> (DC.) Gray		UPL	UPL	UPL	UPL	UPL
<i>Gutierrezia sarothrae</i> (Pursh) Britt. & Rusby 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Haplopappus acradenius</i> (Greene) Blake 7	<i>Isocoma acradenia</i> (Greene) Greene	NO	NI	NI	NO	NI
<i>Haplopappus cooperi</i> (Gray) Hall 2	<i>Ericameria cooperi</i> (Gray) Hall	UPL	UPL	UPL	UPL	UPL
<i>Heterotheca grandiflora</i> Nutt. 1		UPL	UPL	UPL	UPL	UPL
<i>Hymenoclea monogyra</i> Torr. & Gray ex Gray 1,7		UPL	UPL	UPL	UPL	UPL
<i>Hymenoclea salsola</i> Torr. & Gray ex Gray 1,2,7,9		UPL	UPL	UPL	UPL	UPL
<i>Isocoma menziesii</i> (Hook. & Arn.) Nesom		NO	NO	NO	NO	FACW*
<i>Lepidium latifolium</i> L.		NO	NI	FAC	FAC	FACW
<i>Lepidospartum squamatum</i> (Forssk.) Aschers.		UPL	UPL	UPL	UPL	UPL
<i>Lotus scoparius</i> (Nutt.) Ottley 2		UPL	UPL	UPL	UPL	UPL
<i>Petalonyx thurberi</i> Gray 1,7		UPL	UPL	UPL	UPL	UPL
<i>Plantanus racemosa</i> Nutt. 7		NO	NO	NO	NO	FACW
<i>Pluchea odorata</i> (L.) Cass.		NO	NO	NO	NO	NO
<i>Pluchea purpurascens</i> (Sw.) DC.	<i>Pluchea odorata</i> (L.) Cass.	NO	NO	NO	NO	NO
<i>Pluchea sericea</i> (Nutt.) Coville 3		NO	NI	FACW-	FACW	NO

Table 4 (cont.). Dry wash phreatophytes.

<i>Populus fremontii</i> S. Wats. 1,2,5,7		FACW-	FACW	FACW*	NO	FACW
<i>Prosopis glandulosa</i> Torr. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Quercus agrifolia</i> Née 1		UPL	UPL	UPL	UPL	UPL
<i>Quercus chrysolepis</i> Liebm. 1,2,7		UPL	UPL	UPL	UPL	UPL
<i>Quercus dumosa</i> Nutt. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Rhus integrifolia</i> (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Rhus ovata</i> S. Wats. 1,2		UPL	UPL	UPL	UPL	UPL
<i>Ribes speciosum</i> Pursh		UPL	UPL	UPL	UPL	UPL
<i>Salix exigua</i> Nutt. 7		FACW+	OBL	OBL	OBL	OBL
<i>Salix gooddingii</i> Ball 1,2,5,7		FACW+	OBL	FACW	NO	OBL
<i>Salix laevigata</i> Bebb 7		UPL	UPL	UPL	UPL	UPL
<i>Salix lasiolepis</i> Benth. 7		FACW	FACW	FACW	FACW	FACW
<i>Salsola kali</i> L. 1		FACU	FACU	FACU	FACU	FACU+
<i>Suaeda moquinii</i> (Torr.) Greene		NO	FACW	FACW	FACW	NO
<i>Suaeda suffrutescens</i> S. Wats. 3		OBL	NO	NO	NO	
<i>Tamarix parviflora</i> DC. 2		FACW	NI	FACW	NI	FAC
<i>Tamarix ramosissima</i> Ledeb 2.		FACW	NI	FACW	FACW	FAC
<i>Washingtonia filifera</i> (L. Linden) H. Wendl. 2,7		NO	FACW	NO	NO	FACW
<i>Xanthium strumarium</i> L.		FAC-	NI	FAC	FAC	FAC+
<i>Yucca brevifolia</i> Engelm. 1,2,7		UPL	UPL	UPL	UPL	UPL

1 Barbour and Billings (1988)

2 Barbour and Major (1977)

3 Hunt (1966)

4 Hunt (1975)

5 Scott et al. (2000)

6 Stone (1956)

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Hygro-halophytes

Hygro-halophytes are plant species found growing in desert lowlands under naturally saline conditions where water occurs within 1 m of the surface and is occasionally found at the surface (West 1983). In many locations, water occurs within 1 m of the surface as a result of mountain precipitation that has infiltrated into the headwaters of the aquifer where it enters the regional groundwater aquifer and flows down to the center of the basin or wash (West 1983). Here the groundwater table can intersect the ground surface and provide base flow to streams and water for vegetation (Scott et al. 2000). Hygro-halophytes can be found in dry washes where the groundwater table is near the surface and along the

playa edges. The roots of these species do not usually reach down to a permanent groundwater source; therefore, most species have adapted more of a fibrous-like root system, allowing them to obtain water at or near the surface. An example of a hygro-halophyte is iodinebush (*Allenrolfea occidentalis*), one of the most salt-tolerant plants in the desert, located in dry washes and around playa edges. *A. occidentalis* is found on salt-crust silty faces of carbonate soils. This species also occurs on saline flats where the ground is covered by a coating of salt in blister-like augmentation that is 2.54–5.08 cm (1–2 in.) high and 15.24–30.48 cm (6–12 in.) wide. This crust can contain up to 20% water-soluble salts and has the ability to retain moisture for long periods of time following a rain event (Hunt 1966). Adaptations of hygro-halophytes include postponing their major development until the warmest part of the year, when they are “sub-irrigated” by the snowmelt from the mountains and the runoff into the basins, resulting in delayed leaf growth that causes species to take on a greenish cast until summer (West 1983). In addition to delayed leaf growth, hygro-halophytes have developed mechanisms for salt tolerance and avoidance. The list of 32 of hygro-halophytic species is provided in Table 5.

Table 5. Hygro-halophytic species.

1988 synonymy	Current name	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Allenrolfea occidentalis</i> (S. Wats.) Kuntze 1,2,7, 10,11		FACW	FACW	FACW	FACW+	FACW+
<i>Aster frondosus</i> (Nutt.) Torr.& Gray 7	<i>Symphotrichum frondosum</i>	NO	NI	OBL	FACW+	OBL
<i>Baccharis sergiloides</i> Gray 7		NO	FAC-	FACU	NO	FAC
<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers. 3,7		FACW	FACW	FACW	NO	FACW-
<i>Chrysothamnus paniculatus</i> (Gray) Hall 7	<i>Ericameria paniculata</i> (Gray) Rydb.	UPL	UPL	UPL	UPL	UPL
<i>Cordylanthus canescens</i> Gray 7	<i>Cordylanthus maritimus</i> Nutt. ex Benth. ssp. <i>canescens</i> (Gray) Chuang & Heckard	NO	NO	OBL	OBL	OBL
<i>Cressa truxillensis</i> Kunth 7		FACW-	FACW-	FACW	FACW	FACW
<i>Distichlis spicata</i> (L.) Greene 7		FACW+	FACW	FAC+*	FACW	FACW
<i>Hemizonia pungens</i> (Hook. & Arn.) Torr. & Gray 7	<i>Centromadia pungens</i> (Hook. & Arn.) Greene ssp. <i>pungens</i>	NO	FACW+	FAC	UPL	FAC
<i>Juncus cooperi</i> Engelm. 7, 10		NO	FACW	FACW+	NO	FACW
<i>Juncus mexicanus</i> Willd. ex J.A. & J.H. Schultes 7		FACW	FACW	FACW	NO	FACW

Table 5 (cont.). Hygro-halophytic species.

<i>Limonium limbatum</i> Smal		FACW+	FACW	NO	NO	NO
<i>Muhlenbergia asperifolia</i> (Nees & Meyen ex Trin.) Parodi 7		FACW	FACW	FACW+	FACW	FACW
<i>Nitrophila occidentalis</i> (Moq.) S. Wats 2		NO	FAC+	FACW	FACW	FACW
<i>Salicornia utahensis</i> Tidestrom 2	<i>Sarcocornia utahensis</i> (Tidestrom) A.J. Scott	FACW*	FACW	OBL	NO	OBL
<i>Salicornia subterminalis</i> Parish 1, 11	<i>Arthrocnemum subterminale</i> (Parish) Standl.	NO	NO	NO	NO	OBL
<i>Sesuvium verrucosum</i> Raf. 7		FACW-	FACW	FACW+	NI	FACW
<i>Sporobolus airoides</i> (Torr.) Torr 1, 7		FAC	FAC	FAC	FAC-	FAC+
<i>Sarcobatus vermiculatus</i> (Hook.) Torr. 2		FACU+	FACU+	FACU*	FACU+	FACU
<i>Scirpus americanus</i> (Pers.) Volk. ex Schinz & R. Keller		OBL	OBL	OBL	OBL	OBL
<i>Scirpus californicus</i> (C.A. Mey.) Palla		OBL	OBL	NO	NO	OBL
<i>Scirpus olneyi</i> Gray 2, 7	<i>Schoenoplectus americanus</i> (Pers.) Volk. ex Schinz & R. Keller	OBL	OBL	OBL	OBL	OBL
<i>Scirpus paludosus</i> L. 7	<i>Schoenoplectus maritimus</i> (L.) Lye	NI	NI	NI	OBL	OBL
<i>Scirpus nevadensis</i> S. Wats. 7		NO	NO	OBL	OBL	OBL
<i>Suaeda depressa</i> (Pursh) S. Wats. 1,2	<i>Suaeda calceoliformis</i> (Hook.) Moq.	FACW-	FACW	FACW	FACW-	FACW+
<i>Suaeda moquinii</i> (Torr.) Greene		NO	FACW	FACW	FACW	NO
<i>Suaeda nigra</i> J.F. Macbr. 2	<i>Suaeda moquinni</i> (Torr.) Greene	NO	FACW	FACW	FACW	NO
<i>Suaeda suffrutescens</i> S. Wats. 3		OBL	OBL	NO	NO	NO
<i>Suaeda torreyana</i> S. Wats. 1,2,7	<i>Suaeda moquinni</i> (Torr.) Greene	FACW-	FAC	FAC+	FAC	FAC+
<i>Triglochin maritima</i> L. 2		NO	OBL	OBL	OBL	OBL
<i>Typha latifolia</i> L. 7		OBL	OBL	OBL	OBL	OBL
<i>Typha anugustifolia</i> L. 7		OBL	NI	OBL	OBL	OBL

1 Barbour and Billings (1988)

2 Barbour and Major (1977)

3 Hunt (1966)

4 Hunt (1975)

5 Scott et al. (2000)

6 Stone (1956)

7 Thorne (1976)

8 Vasek (1983)

9 Wallace et al. (1980)

10 Went and Westergaard (1949)

11 West (1983)

12 Wondzell et al. (1990)

Xero-halophytes

Xero-halophytes are located within dry saline habitats. These habitats are formed inside high-evaporation basins and lowlands of the desert topography. Within this area, xero-halophytes can be found growing in soils with salt concentrations up to 6% and a water table well below 1 m (Barbour and Billings 1988). Xero-halophytes do not have root systems like phreatophytes that can extend to the water table; they typically do not even extend to the top of the capillary fringe. Instead, they have a shallow root system that allows them to obtain water from rains, dews, and vadose water. Vadose water is the major source of water that is used to sustain xero-halophytes, and the availability has been correlated with many distribution patterns (Hunt 1966). Beyond the edge of a playa, xero-halophyte patches increase in size and density, but at the edge of the playa, intermittent patches are found on soil mounds (Barbour and Major 1977). These occurrences at the playa edge result from gravel fans extending from the mountains to the edge of the playa, providing an optimal habitat where the water table is deep and xero-halophytes are able to thrive in the dry environment (Hunt 1966).

To adapt to the dry conditions, many xero-halophytes have a set of larger leaves that are lost as soil conditions become severely dry; in addition, they develop a second set of smaller over-wintering leaves that photosynthesize through the winter (West 1983). Other adaptations include vesiculated trichomes (bladder-like tips of leaf cells that recycle salt back to the environment) (Mozafar and Goodin 1970) to deal with high concentrations of salt and succulent leaves to allow for greater water storage (Gibson 1996). Glenn and Brown (1998) noted that the salts in the soil actually enhance the performance of seedlings in the dry and salty soil; this is contrary to the previous idea that these conditions were stress factors. Soil salts help xero-halophytes survive by lowering the leaf surface-to-area ratio and growth rate, decreasing the rate at which soil water is depleted and in return giving the species a longer life span (Glenn and Brown 1998). There are 47 species listed for xero-halophytes in Table 6.

Table 6. Xero-halophytic species.

1988 synonymy	Current name	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Ambrosia dumosa</i> (Gray) Payne 2, 9		UPL	UPL	UPL	UPL	UPL
<i>Artemisia arbuscula</i> Nutt. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Artemisia spinescens</i> D.C. Eat. 1,2,7	<i>Picrothamnus desertorum</i> Nutt.	UPL	UPL	UPL	UPL	UPL

Table 6 (cont.). Xero-halophytic species.

<i>Artemisia tridentata</i> Nutt. 1, 7		UPL	UPL	UPL	UPL	UPL
<i>Atriplex canescens</i> (Pursh) Nutt. 1,2,7		UPL	UPL	UPL	UPL	FACU
<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Wats. 1,2, 7, 10,11		UPL	UPL	UPL	UPL	UPL
<i>Atriplex corrugata</i> S. Wats. 1,7,11		UPL	UPL	UPL	UPL	UPL
<i>Atriplex cuneata</i> A. Nels. 1,7,11		UPL	UPL	UPL	UPL	UPL
<i>Atriplex falcata</i> (M.E. Jones) Standl. 1, 7, 11		NO	NO	FACW*	UPL	FAC*
<i>Atriplex hymenelytra</i> (Torr.) S. Wats. 2, 3,7, 10		UPL	UPL	UPL	UPL	UPL
<i>Atriplex polycarpa</i> (Torr.) S. Wats. 2,3,7		NO	FACU-	FACU	NO	FACU
<i>Atriplex gardneri</i> (Moq.) D. Dietr 1,7,11		UPL	UPL	UPL	UPL	UPL
<i>Atriplex parryi</i> S. Wats. 2,7		NO	NO	FACW	NO	FACW
<i>Atriplex polycarpa</i> (Torr.) S. Wats. 2,3,7		NO	FACU-	FACU	NO	FACU
<i>Atriplex spinosa</i> (Hook.) Collotzi 1,7,11	<i>Grayia spinosa</i> (Hook.) Moq.	UPL	UPL	UPL	UPL	UPL
<i>Atriplex tridentata</i> Kuntze 1,7		NO	NO	FACW	NI	NO
<i>Baccharis viminea</i> DC. 1	<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers	NO	NI	FACW	FACW	NO
<i>Bromus tectorum</i> L. 1,11		UPL	UPL	UPL	UPL	UPL
<i>Ceratoides lanata</i> (Pursh) J.T. Howell 1,7,9,10,11	<i>Krascheninnikovia lanata</i> (Pursh) A.D.J. Meeuse & Smit	UPL	UPL	UPL	UPL	UPL
<i>Chrysothamnus nauseosus</i> (Pallas ex Pursh) Britt ssp. <i>arenarius</i> L.C. Anders. 2,7	<i>Ericameria nauseosus</i> (Pallas ex Pursh) Nesom & Baird ssp. <i>consimilis</i> (Greene) Nesom & Baird var. <i>mohavensis</i> (Greene) Nesom & Baird	UPL	UPL	UPL	UPL	UPL
<i>Coleogyne ramosissima</i> Torr. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Elymus cinereus</i> Scribn. & Merr. 1, 11	<i>Leymus cinereus</i> (Scribn. & Merr.) A. Löve	NO	NI	NI	NI	NI
<i>Encelia farinosa</i> Gray ex Torr. 2,3,7		UPL	UPL	UPL	UPL	UPL
<i>Eriogonum inflatum</i> Torr. & Frém. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Euphorbia prostrata</i> Ait. 3	<i>Chamaesyce prostrata</i> (Ait.) Small	UPL	UPL	UPL	UPL	UPL
<i>Grayia spinosa</i> (Hook.) Moq. 2,7,9		UPL	UPL	UPL	UPL	UPL
<i>Halogeton glomeratus</i> (Bieb.) C.A. Mey.1, 11		UPL	UPL	UPL	UPL	UPL
<i>Hymenoclea salsola</i> Torr. & Gray ex Gray 3,7,9		UPL	UPL	UPL	UPL	UPL

Table 6 (cont.). Xero-halophytic species.

<i>Kochia american</i> S. Wats. 1, 11	<i>Bassia american</i> (S. Wats.) A.J. Scott	FAC-	FAC	FACU	FACU	FAC+
<i>Larrea tridentata</i> (Sessé & Moc. ex DC.) Coville 2,3,7,9		UPL	UPL	UPL	UPL	UPL
<i>Lepidum perfoliatum</i> L. 1,11		FAC	UPL*	FACU-	FACU+	FACU
<i>Lycium andersonii</i> Gray 2,7, 9		UPL	UPL	UPL	UPL	UPL
<i>Menodora spinescens</i> Gray 2,7		UPL	UPL	UPL	UPL	UPL
<i>Oryzopsis hymenoides</i> (Roemer & J.A. Schultes) Ricker ex Piper 2,11	<i>Achnatherum hymenoides</i> (Roemer & J.A. Schultes) Barkworth	FACU+	FACU-	UPL	UPL	UPL
<i>Purshia glandulosa</i> Curran 2,7		UPL	UPL	UPL	UPL	UPL
<i>Purshia tridentata</i> (Pursh) DC. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Salsola kali</i> L.1, 11		FACU	FACU	FACU	UPL	FACU+
<i>Sitanion hystrix</i> (Nutt.) J.G. Sm 1, 11	<i>Elymus elymoides</i> (Raf.) Swezey	FACU-	UPL	UPL	FACU-	FACU
<i>Sphaeralcea ambigua</i> Gray 2,7		UPL	UPL	UPL	UPL	UPL
<i>Suaeda fruticosa</i> auct. non Forssk 1	<i>Suaeda moquinii</i> (Torr.) Greene	FACW-	FAC	FAC+	FAC	FAC+
<i>Suaeda suffrutescens</i> S. Wats. 3		OBL	OBL	NO	NO	NO
<i>Tetradymia axillaris</i> A. Nels. 2,7		UPL	UPL	UPL	UPL	UPL
<i>Tidestromia oblongifolia</i> (S. Wats.) Standl 2,3		UPL	UPL	UPL	UPL	UPL
<i>Wyethia mollis</i> Gray 2, 7		UPL	UPL	UPL	UPL	UPL

1 Barbour and Billings (1988)

2 Barbour and Major (1977)

3 Hunt (1966)

4 Hunt (1975)

5 Scott et al. (2000)

6 Stone (1956)

7 Thorne (1976)

8 Vasek (1983)

9 Wallace et al. (1980)

10 Went and Westergaard (1949)

11 West (1983)

12 Wondzell et al. (1990)

Phreatophytes with salt tolerance

Phreatophytes with salt tolerance are the dominant plants along playa margins and the extreme low slopes of alluvial fans. In these areas, the saturated zone, or the capillary fringe, is usually within 6 m of the land surface. It is here that the roots of the plant are anchored in order to access the water table (Lines 1979). Soils are sandy and silty and contain a high percentage of salts, which occur as hard layers on or just below the surface. Habitat conditions where these species grow allow them to have a dependable water supply, be independent of rains, and be able to respond to seasonal temperatures. The species reach their tolerance limit as the salinity of the groundwater increases farther into the playa, causing a precipitous decrease in numbers. The most abundant, salt-tolerant plants

found in this high tolerance zone are *Allenrolfea* and *Salicornia* (Hunt 1965). To flourish in these high salinities, species have to exclude the uptake of salts or have the ability to anatomically isolate and/or excrete them (West 1983). Table 7 lists 17 phreatophytes with salt tolerance.

Table 7. Phreatophytes with salt tolerance.

1988 synonymy	Current name	Region 6	Region 7	Region 8	Region 9	Region 0
<i>Allenrolfea occidentalis</i> (S. Wats.) Kuntze 2,3		FACW	FACW	FACW	FACW+	FACW+
<i>Atriplex canescens</i> (Pursh) Nutt. 2,3		UPL	UPL	UPL	UPL	FACU
<i>Baccharis sergiloides</i> Gray 3		NO	FAC-	FACU	NO	FAC
<i>Distichlis spicata</i> (L.) Greene 2		FACW+	FACW	FAC+*	FACW	FACW
<i>Juncus cooperi</i> Engelm. 2,3		NO	FACW	FACW+	NO	FACW
<i>Phragmites communis</i> Trin. 3	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	FACW	FACW+	FACW+	FACW+	FACW
<i>Pluchea sericea</i> (Nutt.) Coville 2,3		NI	FACW-	FACW	NO	FACW
<i>Prosopis juliflora</i> (Sw.) DC. 2,3		FACU-	FACU	NI	NO	FACU
<i>Prosopis pubescens</i> Benth 3		FAC+	FACW-	FAC	NO	FAC
<i>Sarcobatus vermiculatus</i> (Hook.) Torr. 2		FACU+	FACU+	FACU*	FACU+	FACU
<i>Scirpus olneyi</i> Gray 3	<i>Schoenoplectus americanus</i> (Pers.) Volk. ex Schinz & R. Keller	OBL	OBL	OBL	OBL	OBL
<i>Sporobolus airoides</i> (Torr.) Torr. 2,3		FAC	FAC	FAC	FAC-	FAC+
<i>Suaeda fruticosa</i> auct. Non Forssk. 2	<i>Suaeda moquinii</i> (Torr.) Greene	NO	FACW	FACW	FACW	NO
<i>Suaeda suffrutescens</i> S. Wats. 3		UPL	UPL	UPL	UPL	UPL
<i>Tamarix aphylla</i> (L.) Karst. 2,3		FACW	FAC	FACW	NO	FACW
<i>Tamarix gallica</i> L. 2,3		FACW-	NO	NO	NO	FACW

1 Barbour and Billings (1988)

2 Barbour and Major (1977)

3 Hunt (1966)

4 Hunt (1975)

5 Scott et al. (2000)

6 Stone (1956)

7 Thorne (1976)

8 Vasek (1983)

9 Wallace et al. (1980)

10 Went and Westergaard (1949)

11 West (1983)

12 Wondzell et al. (1990)

Application of the Lists

Compiling species lists from literature and field studies has traditionally been a mainstay of botanists for characterizing habitats. When knowledge of these specific adaptations and habitats are considered and organized into species lists, they can serve an important role in supporting the designation of wetland plant indicator statuses. In the past, wetland

indicator statuses have been assigned within regions based on presumed frequencies of occurrence in wetlands, but as discussed here in the context of habitat specific lists, they can also be used to evaluate and compare their occurrences in various wetland habitat types. Examples of the benefits of this approach can be seen in species that are found at the edges of playas. Of the two types of playas—hard and soft—25 of the 48 species reported from the playa edge list (Table 2) are generally associated with hard playas. Interestingly, the 25 species associated with hard playas had mostly UPL indicator status ratings, while those of soft playas had OBL and FACW ratings (Table 2). Soft playas typically have the three characteristics necessary to delineate a wetland: hydrophytic vegetation, hydric soils, and hydrologic indicators (Lichvar et al. 2006). In contrast, hard playas lack groundwater and vegetation and usually have only hydrologic indicators; therefore, they are considered WoUS and are delineated using Ordinary High Water Marks methods. This distinction between the different playa types helps put the differences in habitats in context and allows a refinement in the wetland plant indicator status by distinguishing wetlands from WoUS.

Besides these two types of playa species, there are opportunistic species that are occasionally found at the edge of playas that may also inhabit many other types of habitats. Many of these species in Table 2 have variable indicator statuses ratings that make them problematic for delineations. For example, *Monolepis nuttalliana* (J.A. Schultes) Greene is one of these opportunistic species that frequently occurs around playas and has a wetland plant indicator status ranging from FACW to FACU within the region. This species occurs around both soft and hard playas, and when occurring on a hard playa, its occurrence is more associated with salt content in the soil rather than soil moisture. Species with distribution patterns similar to this could be given different ratings for various playa types or assigned a rating that has a broader frequency of occurrence for wetlands. But without focusing on occurrence in different playa types, the reliability of the rating is lowered. By being able to put species in context with specific habitats, wetland plant indicator panels will be able to better judge the ratings they are assigning within the habitat context for species in these problematic groups.

Another supportive role of these specialized habitat lists is the ability to identify those species that occur in other habitats and assess their frequency based on their overall habitat preferences. For instance, *Suaeda moquinii* (Torr.) Greene, a halophytic species, occurred in each of the six

specialized groups. Since each of these habitats represents different hydrology and soil conditions, it is interesting to observe that this species has a FACW rating for its occurrences in a dry wash, where hydric soils almost never occur. The hydrology in dry washes is usually flashy; typically these habitats do not pond or stay saturated for more than 14 days and therefore lack the site conditions necessary to meet the hydrologic criteria of a wetland (Environmental Laboratory 1987). However, the site may be considered a WoUS based on other hydrology features used to delineate WoUS. In this ecological position, *S. moquini* may be best considered a FAC or even a FACU species, depending on further observations and considerations. In contrast, this species is frequently encountered along the edges of soft playas where wetland features do occur and should be considered a FACW hydrophyte when placed in that context. With lists of species for specialized habitats ranging from playas to dry washes, indicator statuses can be compared across different habitats to ensure the usefulness and reliability of their ratings.

Riparian corridors, unlike some of the other specialized habitats, offer many inclusions of different types of habitats; therefore, it isn't surprising that the number of species in the dry wash is large (346) compared to the other specialized habitats. Some of the species in this list are associated with groundwater discharge and tend to have OBL or FACW ratings, while others include many of the phreatophytic shrubs that tap deeper groundwater resources. There are many upland species that get washed into channels during storm events and survive by responding to disturbances and conditions, such as soil texture, that mimic other habitat conditions where they typically reside and germinate. Thus, dry washes can provide a variety of micro-habitats all within one general habitat type.

The differences in geographic distribution patterns are more obvious when all these species from specialized habitats are compared by habitat occurrences across the Arid West region. Many species are reported from one or a few of the FWS regions, while others occur in all FWS regions. These variations in occurrences represent species distribution patterns associated with different floristic provinces. These differences point out that the flora of the Arid West region is not contiguous and identical across the entire region. The scale of the new ecoregion includes several floristic elements within the provinces. To assist with the floristic differences within the Arid West region, the new digital distribution maps compiled by the Biota of North America Program (BONAP 2006) for the region can help clarify a species' geographic patterns.

5 Conclusions

Lists of species that occupy specialized habitats and are characterized by morphological and physiological adaptations can be used to better understand species ecology and occurrences across a region. This approach for considering all of a species' habitat preferences, range distributions, and special adaptations is valuable for assigning and increasing the reliability of wetland indicator statuses. Once wetland plant indicator statuses are assigned to a species, it is possible to double check the ratings by habitats to see if they fit the species occurrences across multiple habitats. It may not be possible to accomplish this for the entire wetland plant list for a region, but certain plant species and similarly acting species are recognized to have problematic wetland indicator statuses. For some of these species and groups, dividing species by habitats will allow for a better insight into wetland occurrence and will produce a more accurate hydrophytic vegetation determination.

Another method to develop more reliable wetland species lists is the use of subregions within a region. This has been done previously in the Northeast and Southeast regions, two former FWS regions, to accurately reflect the intraregional ecological variability of plant species (Reed 1997, Tiner 2006). The species occurrences shown in our tables imply that there are differences between different floristic provinces based on the presence or absence of species across the region. To adequately assign reliable indicator statuses to many species, it may be necessary, and helpful, for the Arid West region to be subdivided into smaller units, and then statuses can be assigned as needed on an individual basis by subregion.

The quality of the assigned wetland plant indicator statuses for any region relies on knowledge of a species' occurrence in wetlands, its occurrence in other types of habitats, and its biological responses to various habitat settings across its range. By having a more detailed perspective on a species' biological and distribution patterns, wetland plant ratings become more informative than just a frequency rating used in hydrophytic vegetation determinations. When evaluated within the context of how these ratings are used, the wetland plant list turns into a higher quality tool to be used by all wetland delineators and others who utilize the wetland plant list.

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14. ABSTRACT The U.S. Army Corps of Engineers is currently regionalizing and updating the national wetland delineation manual. This manual will use new ecosystem boundaries for the nation. A separate effort by the Corps will update the National Wetland Plant List within these same new ecosystem boundaries. The Arid West is an area of particular interest in the revision of the plant list because of the problematic indicator statuses for certain groups of plants. Many species in the Arid West have morphological and physiological adaptations that allow them to occur in specialized habitats, ranging from wetlands to uplands. In delineations, the indicator status of these species is not always accurate for the specific location. A combination of literature reviews and recorded species data from previous studies for six specialty habitats are presented and discussed; the species groups are playa edge species, dry wash species, dry wash phreatophytes, hygro-halophytes, xero-halophytes, and phreatophytes with salt tolerance. A total of 421 species, with 93 of those species shared in more than one habitat type, are reported, including 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance. The list for each specialized habitat will be used to better understand species ecology and occurrences across the region and will ultimately help in assigning and increasing the reliability of wetland plant indicator statuses.					
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