MAJOR PLANT COMMUNITIES OF LAKE MEREDITH NATIONAL RECREATION AREA AND ALIBATES FLINT QUARRIES NATIONAL MONUMENT

Guy L. Nesom
2925 Hartwood Drive, Fort Worth, TX 76109, USA
www.guynesom.com

Robert J. O'Kennon
Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76012

ABSTRACT

The plant communities of the parkland in LAMR/ALFL can be described as 12 major types, referred to here by their physiographic/geological setting: (1) sandhills and sand flats, (2) sandy valley bottoms, (3) gravelly slopes, (4) dolomite caprock, (5) red slopes, (6) gypsum outcrops, (7) river and creek sides (subdivided into riparian of larger tributaries; sedge meadows and corridors; cottonwood gallery forest; and hackberry-soapberry dry woodland), (8) lakeshore, (9) marsh, (10) borrow area, (11) lawns and mowed roadsides, and (12) old home sites. *Phytologia 90(3): 391-405 (December, 2008).*

KEY WORDS: Lake Meredith National Recreation Area, Texas, plant communities.

Lake Meredith National Recreation Area (LAMR) and Alibates Flint Quarries National Monument (ALFL) include Lake Meredith, which is about 25 miles long, and a relatively narrow rim of boundary property in Hutchinson, Moore, and Potter counties in the north-central panhandle region of Texas. LAMR includes 44,998 acres of water and land; ALFL (which is essentially imbedded within LAMR) includes 1371 acres. The primary topographic feature is the Canadian River, which runs through a steep-walled canyon about 1.5–2 miles wide; tributary streams feed from side canyons.

Major plant communities in LAMR and ALFL have been characterized by Wright and Meador (1987), Bell et al. (2000), and the National Park Service (2001)—our survey provides comparisons and other commentary relating to these studies. The NPS discussion is generalized and applicable with difficulty to the parkland under consideration. After an initial reconnaissance, Wright and Meador identified five major community types in LAMR and ALFL (bottomland, steep slope, gravelly slope, mesa top, and sandhill), selected sampling sites to characterize each community type, and constructed descriptions and a vegetation map from data taken by a 'step point' sampling method. Bell et al. identified four major community types in ALFL (clay loam, gravelly hills, rough breaks, and sandy and loamy bottomland), selected two transects to characterize each community type, and constructed descriptions from data obtained by the sampling procedures. In a study of 'breaks' vegetation in the vicinity of Ranch Creek in Potter County, Sikes and Smith (1975) recognized three relatively inclusive associations: mesquite-grassland, juniper-hairy grama, and salt cedar-dropseed.

Conclusions of the present assessment are similar in many respects to those of the previous studies, but our more subjective approach perhaps allows a more detailed regional characterization. We have attempted to define the major plant associations based primarily on physiographic and geologic boundaries, as these generally are correlated with the sharpest discontinuities between vegetation types, with recognition that overlap in species composition occurs among these communities and that some species are common in more than one community type. Geological concepts and terminology are drawn from a recent discussion by the National Park Service (2001: "Geologic Resources," adapted from Davis and Northcutt 1991).

Community descriptions are drawn from observations made from April 2002 through October 2002 (Nesom & O'Kennon 2003). Repeated visits to various areas within the parkland allowed modification and refinement, but objective tests of our subjective assessments are desirable.

1. SANDHILLS and SAND FLATS

Rolling hills and flats of relatively deep, loose sand (Ogallala Group: Clarendon Formation – Pliocene) are dominated by *Artemisia filifolia*, *Eriogonum annuum*, *Yucca glauca*, various grasses, and scattered *Prosopis glandulosa*. *Eriogonum annuum*, *Centaurea americana*, *Erigeron bellidiastrum*, and *Penstemon ambiguus* are relatively common and restricted to the deep sands and may be considered as indicators of sandy habitat. Other common species are *Aphanostephus ramosissimus*, *Cirsium undulatum*, *Gaillardia pulchella*, *Gutierrezia sarothrae*, *Hymenopappus flavescens*, *Machaeranthera pinnatifida*, *Ipomoea leptophylla*, *Mentzelia nuda*, *Monarda punctata*, *Monarda pectinata*, *Calylophus serrulatus*, *Gaura villosa*, *Krameria lanceolata*, *Chamaesyce fendleri*, *Croton texensis*, *Stillingia sylvatica*, *Cryptantha cinerea* var. *jamesii*, *Eriogonum longifolium*, *Tradescantia occidentalis*, *Commelina erecta*, *Chamaesyce missurica*, and *Corispermum americanum*. Common grasses are *Buchloe dactyloides*, *Vulpia octoflora*, *Schizachyrium scoparium*, *Sporobolus cryptandrus*, *Andropogon hallii*, *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Bouteloua pectinata*, *Bouteloua eriopoda*, *Aristida purpurea*, *Eragrostis curvula*, and *Muhlenbergia capillaris*. *Baccharis wrightii* is local in occurrence on sand flats of the Bugbee peninsula. *Chrysothamnus pulchellus* is local but abundant along a long, shallow draw in the deep sand above Spring Creek.

This community is equivalent to the “sandhills” community of Wright and Meador (1979), and probably also includes their “mesatop” category, at least in part. The most extensive sandhill area is along the margin of the northernmost portion of LAMR (south of Hwy 687); others are east of the Ranger Station in the Sanford-Yake area, the high part of the Fritch Fortress peninsula, and on the Blue West and Bugbee peninsulas. More recently deposited ‘valley fill” sands occur widely and support communities somewhat similar in floristic composition (see below, Sandy Valley Bottoms).

Ogallala sand caps the Fritch Fortress peninsula, but species diversity there is low, perhaps reflecting relatively recent grazing or other human modification. The area was controlled-burned in spring of 2002. We record the following as common species (post-burn): *Salsola tragus*, *Psilostrophe villosa*, *Solanum elaeagnifolium*, *Yucca glauca*,

Setaria leucopila, *Kallstroemia parviflora*, *Bouteloua eriopoda*, *Sporobolus cryptandrus*, *Munroa squarrosa*, *Bassia scoparia*, *Chamaesyce glyptosperma*, *Bouteloua gracilis*, *Sphaeralcea coccinea*, *Ipomoea leptophylla*, *Helianthus annuus*, *Machaeranthera pinnatifida* var. *pinnatifida*, *Croton texensis*, and *Bothriochloa barbinodis*.

An area of deep sand west of Hwy 1319 (along the northern park boundary) is highly reduced in plant diversity, probably reflecting recent overgrazing (before the property was acquired by the NPS. *Prosopis glandulosa*, *Eriogonum annuum*, *Mentzelia nuda*, *Yucca glauca*, *Prunus angustifolia*, *Artemisia filifolia*, and *Aristida purpurea* are the dominant species—few others occur. Cattle apparently do not eat the *Prosopis*, *Eriogonum*, and *Mentzelia*, or at least those species are low in grazing preference, because we have observed them in abundance in otherwise grazed sandy habitats outside the parkland.

Areas of deep, loose sand, alluvial and recent in origin, also occur in the bottom and along the margins of the Canadian River and larger streams, such as Big Blue Creek and Chicken Creek. Dune deposits are evident along the Canadian River in the Rosita area and an area slightly north of Bates Canyon. Conspicuous in these areas are *Prunus angustifolia*, *Artemisia filifolia*, *Mentzelia nuda*, *Eriogonum annuum*, *Dalea lanata*, *Cenchus longispinus*, *Cycloloma atriplicifolium*, *Chamaesyce missurica*, *Euphorbia hexagona*, *Palafoxia sphacelata*, *Helianthus petiolaris*, *Heliotropium convolvulaceum*, *Polanisia dodecandra*, *Amaranthus arenicola*, *Chenopodium leptophyllum*, and *Sporobolus cryptandrus*, *Andropogon hallii*, *Triplasis purpurea*, *Panicum capillare*, and other grasses.

Drainages or other erosional features that are cut through the sandhills into the dolomite strata usually support a flora similar to that of the slopes—common woody species are *Artemisia ludoviciana*, *Mimosa borealis*, *Rhus aromatica*, and *Vitis acerifolia*.

2. SANDY VALLEY BOTTOMS

Gently sloping valleys and broad flats characteristically are filled with sand recently derived from immediately surrounding, easily eroding Permian “redbed” slopes. Such ‘valley fill’ areas are conspicuous in the Bates Canyon-Alibates area and the Plum Creek

area. They commonly are dominated by grasses, especially *Panicum obtusum* and *Pascopyrum smithii*, with *Sporobolus cryptandrus*, *Setaria leucopila*, and *Bouteloua curtipendula* in lesser abundance. Other common species are *Grindelia ciliata*, *Centaurea americana*, *Euphorbia davidii*, *Croton texensis*, *Eriogonum annuum*, *Cucurbita foetidissima*, *Solanum elaeagnifolium*, *Gaillardia pulchellus*, *Symphyotrichum ericoides*, *Tidestromia lanuginosa*, *Bassia scoparia*, *Ipomoea leptophylla*, *Asclepias latifolia*, *Proboscidea louisianica*, *Kallstroemia parviflora*, *Argythamnia humilis*, *Hoffmannseggia glauca*, *Amaranthus blitoides*, *Amaranthus retroflexus*, *Chenopodium berlandieri*, *Bouteloua hirsuta*, *Bouteloua pectinata*, *Eragrostis cilianensis*, and *Muhlenbergia* sp.

3. GRAVELLY SLOPES

This is the "gravelly slope" category of Wright and Meador (1979) — "ridges, knolls, and undulating areas of the uplands with gentle to moderately steep slopes." These slopes, like the sandhills, lie above the dolomite caprock and are part of the Ogallala Group (Ogallala Group: Clarendon Formation – Pliocene), but the soil is a calcareous, gravelly loam "formed in stratified outwash beds of quartz gravel and sand" (Wright & Meador 1979, p. 20). Our observations are from the Sanford-Yake area. The "gravelly slopes" flora is similar to that of the steep slopes but species diversity is lower and the woody component is less evident. The dominant species are *Gutierrezia sarothrae*, *Yucca glauca*, *Mimosa borealis*, *Dalea formosa*, *Tetraneuris scaposa*, *Bouteloua curtipendula*, and *Bouteloua gracilis*. Other common species are *Ambrosia psilostachya*, *Berlandiera lyrata*, *Chaetopappa ericoides*, *Gaillardia pulchella*, *Machaeranthera pinnatifida*, *Machaeranthera tanacetifolia*, *Plantago patagonica*, *Croton texensis*, *Chamaesyce lata*, *Sphaeralcea coccinea*, *Lesquerella ovalifolia*, *Salsola tragus*, *Aristida purpurea*, *Bouteloua eriopoda*, *Bouteloua hirsuta*, *Buchloe dactyloides*, and *Muhlenbergia asperifolia*.

4. DOLOMITE CAPROCK

Surface exposures of white dolomite caprock (Quartermaster Group: Alibates Dolomite Formation – Permian), often flat or gently sloping, support characteristic communities similar to the red slope communities. In general, fewer species occur in the shallow soil accumulations and crevices of these limited areas, and several species

occur here that are uncommon on the slopes. The most common and characteristic species of the dolomite caprock community are *Dalea formosa*, *Mimosa borealis*, *Yucca glauca*, *Minuartia michauxii var. texana*, *Paronychia jamesii*, *Eriogonum longifolium*, *Tetraneuris scaposa*, *Gutierrezia sarothrae*, *Calylophus hartwegii* var. *pubescens*, *Tragia ramosa*, *Krameria lanceolata*, and *Aristida fendleri*. *Cercocarpus montanus* and *Tetraneuris acaulis* occur only on the caprock (and gypsum, in the LAMR area) and are very local in occurrence. *Calylophus hartwegii* var. *pubescens* and *Minuartia michauxii* var. *texana* also apparently are more or less restricted to the surface exposures of caprock. Other species commonly found in the caprock community are these: *Erioneuron pilosum*, *Panicum hallii*, *Chaetopappa ericoides*, *Machaeranthera pinnatifida* var. *pinnatifida*, *Melampodium leucanthemum*, *Thelesperma filifolium var. intermedium*, *Zinnia grandiflora*, *Comandra umbellata*, *Chamaesyce fendleri*, *Chamaesyce lata*, *Echinocereus reichenbachii*, *Opuntia polyacantha*, *Oenothera macrocarpa* subsp. *incana*, *Polygala alba*, *Rhus aromatica*, and *Yucca glauca*. *Opuntia leptocaulis*, *Opuntia phaeacantha*, and *Krascheninnikovia lanata* are conspicuous species also recorded from caprock communities but they are local in occurrence and occur in other communities as well.

5. RED SLOPES

Slopes of soft red sandstone and shale (Quartermaster Group: Whitehorse Sandstone – Permian) strewn with white dolomite boulders and fragments from decomposition of the upper caprock are a prominent feature over much of the park. The most abundant and conspicuous woody species of the red slopes, depending on slope aspect, are *Dalea formosa*, *Artemisia ludoviciana*, *Rhus aromatica*, *Ptelea trifoliata*, *Mimosa borealis*, *Forestiera pubescens*, *Vitis acerifolia* (in moist areas), *Juniperus monosperma* (locally common in the southeastern part of the park), and *Prosopis glandulosa* (scattered). Characteristic herbaceous species are *Gutierrezia sarothrae*, *Chaetopappa ericoides*, *Cirsium undulatum*, *Erigeron modestus*, *Hymenopappus tenuifolius*, *Liatris punctata*, *Solidago petiolaris*, *Tetraneuris scaposa*, *Hedeoma drummondii*, *Penstemon fendleri*, *Penstemon albidus*, *Evolvulus nuttallianus*, *Eriogonum longifolium*, *Calylophus serrulatus*, *Oenothera macrocarpa* subsp. *incana*, *Polygala alba*, *Comandra umbellata*, *Chamaesyce fendleri*, *Chamaesyce lata*,

Tragia ramosa, *Gilia rigidula*, *Lesquerella gordonii*, *Lesquerella ovalifolia*, *Mentzelia oligosperma*, *Krameria lanceolata*, *Astragalus lotiflorus*, *Astragalus missouriensis*, *Astragalus mollissimus*, *Oxytropis lambertii*, *Pediomelum linearifolium*, *Astragalus gracilis*, *Pascopyrum smithii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Bouteloua hirsuta*, *Bouteloua pectinata*, and *Schizachyrium scoparium*. *Echinocereus reichenbachii* and *Opuntia polyacantha* are common cacti.

The ALFL "gravelly hills site" of Bell et al. (2000) is included in our "red slopes" community. The basic substrate is the same as the steeper slopes—the red sandy-clay directly derived from the Whitehorse Formation—but the dolomite rocks are absent on low hills ("gravelly slopes") much below the caprock level. Plant associations on these low hills are essentially similar to those of the steeper slopes but lack a set of species that apparently are calciphilic (e.g., *Gilia rigidula*, *Astragalus gracilis*, *Tragia ramosa*, others etc.), perhaps reflecting the lack of influence of the disintegrating dolomite. The 'steep slope' community of Wright and Meador (1979), as well as part of their 'gravelly slope' association, is included within the 'red slopes' community. On the steepest slopes, which form the margins of the Canadian River 'breaks,' recurring landslides and erosion apparently prevent all but few species from holding to life.

6. GYPSUM OUTCROPS

Large exposures of gypsum (Quartermaster Group: Cloud Chief Gypsum Formation – Permian) occur in the Plum Creek area. The very sparse vegetation on these outcrops apparently is primarily due to the nature of the substrate, but ORV use across some of the Plum Creek outcrops apparently has eliminated portions of the flora. Other smaller accessible areas of gypsum or gypseous outcrops have been studied in Cedar Canyon, McBride Canyon, Spring Canyon picnic area, and the Rosita area. Transitions are generally sharp between the gypsum communities and adjacent habitats and communities (on steep red slopes and sand). The common gypsum-occurring species (in the park and immediately outside of it) are *Aristida purpurea*, *Calylophus hartwegii* var. *fendleri*, *Calylophus serrulatus*, *Lithospermum incisum*, *Hymenopappus filifolius*, *Phacelia integrifolia*, *Sporobolus cryptandrus*, and *Schizachyrium scoparium*. Other species include *Chamaesyce fendleri*, *Chamaesyce lata*, *Coryphantha vivipara*,

Echinocereus reichenbachii, *Opuntia phaeacantha*, *Oenothera macrocarpa* subsp. *incana*, *Oenothera macrocarpa* subsp. *oklahomensis*, *Mentzelia nuda*, *Mirabilis linearis* var. *subhispida*, *Allionia incarnata*, *Asclepias engelmanniana*, *Dalea arenicola*, *Dalea candida*, *Dalea tenuiloba*, *Polygala alba*, *Hedyotis nigricans* var. *papillacea*, *Echinacea angustifolia*, *Gaillardia pinnatifida*, *Haploesthes greggii*, *Hymenopappus tenuifolius*, *Liatris punctata*, *Machaeranthera tanacetifolia*, *Melampodium leucanthemum*, *Psilostrophe villosa*, *Tetraneuris acaulis*, *Tetraneuris scaposa*, *Thelesperma megapotamicum*, *Bouteloua curtipendula*, and *Aristida fendleri*. Species that may be considered "gypsum indicators" (observed only on gypsum outcrops) are *Phacelia integrifolia*, *Allionia incarnata*, *Oenothera macrocarpa* subsp. *oklahomensis*, *Calylophus hartwegii* var. *fendleri*, *Haploesthes greggii*, and *Hymenopappus filifolius*.

Mentzelia decapetala and *Eriogonum jamesii* are uncommon in LAMR—they apparently are restricted to sites with eroding red slopes and little competition from other plant species. Narrow veins of gypsum at these sites or the close proximity of larger gypsum deposits suggest that these species of *Mentzelia* and *Eriogonum* are gypsophiles, although they have not been observed growing directly on the gypsum outcrops.

7. RIVER AND CREEK SIDES

Riparian habitats vary in width and in species diversity. Some have broad, sandy terraces such as McBride Creek, Chicken Creek, and Big Blue Creek. Others are narrow bands along relatively small tributaries with permanent flow, such as Spring Creek (Spring Canyon) and an unnamed creek tributary to Big Blue Creek.

Riparian of larger tributaries

Along the larger drainages, in the wettest habitats are *Schoenoplectus pungens*, *Juncus torreyi*, *Phragmites australis*, and *Typha domingensis*. On the lowest terraces, usually in moist sand, are *Equisetum laevigatum* and *Apocynum cannabinum*. Slightly higher are *Populus deltoides* var. *monilifera*, *Salix nigra*, *Sapindus drummondii*, *Prunus angustifolia*, *Celtis reticulata*, *Rosa woodsii*, *Rosa arkansana*, *Vitis acerifolia*, *Toxicodendron rydbergii*, *Rhus aromatica*, *Salix interior*, *Salix exigua*, *Salix amygdaloides*, *Glycyrrhiza lepidota*, and

Amorpha fruticosa. Several species of grass are common: *Tridens flavus*, *Panicum virgatum*, *Sorghastrum nutans*, *Leersia oryzoides*, *Dichanthelium acuminatum*, *Echinochloa crus-galli*, *Elymus canadensis*, and *Schizachyrium scoparium* (upper terraces). More or less typical sand communities (see above, "Sandhills and Sand Flats") may develop on upper terraces.

Sedge meadows and corridors

Along relatively narrow channels of permanent or seasonal flow, sedge meadows (dominated by Cyperaceae) are characteristic, with *Eleocharis montevidensis*, *Eleocharis rostellata*, *Schoenoplectus pungens*, *Fuirena simplex*, *Dichanthelium acuminatum*, *Polypogon monspeliensis*, *Polypogon viridis*, *Sphenopholis obtusata*, and other grasses, *Equisetum laevigatum*, *Ranunculus sceleratus*, *Cicuta maculata*, *Berula erecta*, *Lycopus americanus*, *Verbena hastata*, *Lobelia cardinalis*, *Strophostyles leiosperma*, *Apocynum cannabinum*, *Oenothera jamesii*, *Pluchea odorata*, *Pyrrhopappus pauciflorus*, *Bidens frondosa*, *Vernonia baldwinii*, and *Solidago gigantea*. This plant association grades into that of the wider, sandy channels or may be abruptly distinct. Accessible examples of narrow channels with sedge meadows (or margins) are upper Mullinaw Creek, parts of upper Spring Creek, Chicken Creek, and Bugbee Creek.

Cottonwood gallery forest

A stand of mature, closely spaced cottonwoods (*Populus deltoides* var. *monilifera*, averaging about 80 feet tall, over an area of about five acres, occurs along the east terrace of the Canadian River, just north of the mouth of Chicken Creek. Numerous individuals of *Celtis reticulata* form an understory less than half the height of the cottonwoods. *Rhus aromatica* forms a distinct shrub layer, with scattered *Ribes aurea*, *Forestiera neomexicana*, *Vitis acerifolia*, *Prunus angustifolia*, *Prunus virginiana*, *Cephalanthus occidentalis*, and *Opuntia* aff. *macrorhiza*. *Parthenocissus vitacea* is a common vine. Common herbaceous species are *Panicum virgatum*, *Vernonia baldwinii*, *Tripsacum dactyloides*, and *Commelina erecta*. As far as known (fide J.W. Phillips, Fritch), this is the only large "gallery" stand of such large cottonwoods inside the park. Large (areal) cottonwood stands occur elsewhere in the Canadian River bottomland, and a

distinctive, extensive stand of small, relatively widely spaced cottonwood trees occurs over clay soil in the Rosita Creek bottomland.

Hackberry-soapberry dry woodland

On slightly higher creek and river terraces, a woodland similar in composition to the cottonwood gallery sometimes occurs, but the tall cottonwoods are absent. Cottonwoods are scattered on lower terraces. The canopy of these dry woodlands is dominated by *Celtis reticulata* (along the north side of lower Chicken Creek) or *Sapindus drummondii* (in lower McBride Canyon, Plum Creek, Big Blue Creek). *Rhus aromatica* forms a distinct subcanopy/shrub layer, with scattered *Ptelea trifoliata*, *Forestiera pubescens*, *Ribes aurea*, and *Juniperus monosperma*. Abundant *Artemisia filifolia* forms a lower shrub layer. *Opuntia macrorhiza*, *Cirsium ochrocentrum*, and various grasses are common.

8. LAKESHORE

On the exposed banks (sandy clay) of the immediate lake shore, various species appear as first colonizers. Where fluctuation of the water level is greatest (newly exposed substrate), the most common among these species are *Bassia scoparia*, *Salsola tragus*, *Salsola collina*, *Heliotropium curassavicum*, *Chenopodium glaucum*, *Chenopodium berlandieri*, *Chenopodium pratericola*, *Cycloloma atriplicifolia*, *Tamarix ramosissima*, *Schoenoplectus pungens*, *Schoenoplectus maritimus*, *Polygonum amphibium*, *Polygonum arenastrum*, *Polygonum ramosissimum*, *Panicum capillare*, *Echinochloa crus-galli*, *Leptochloa fascicularis*, *Cyperus odoratus*, *Sporobolus texanus*, *Symphyotrichum divaricatum*, *Pluchea odorata*, *Eclipta prostrata*, and *Sonchus asper*. Slightly higher on the reddish lakeshore alluvium are *Cynodon dactylon*, *Distichlis spicata* var. *stricta*, *Baccharis salicina*, *Grindelia ciliata*, *Populus deltoides* var. *monilifera*, *Salix interior*, and *Salix amygdaloides*.

Where the slope of the shore is less steep, sandy terraces may be present and species segregate ecologically in dense stands. In the lowest and wettest areas, where the lake shores grade into marsh, *Typha domingensis* occurs in extensive stands, exclusive of all other species; colonies of *Phragmites australis* may be intermixed. *Baccharis salicina*, *Populus deltoides* var. *monilifera*, *Tamarix ramosissima*,

Panicum virgatum, *Distichlis spicata* var. *stricta*, *Chenopodium berlandieri*, *Conyza canadensis*, and *Ambrosia psilostachya* occur slightly further upslope on sandy terraces. *Prunus angustifolia* may occur in moist microsites.

Floating aquatics apparently are uncommon in the lake, but a population of *Ranunculus trichophyllus* occurs in a shallow inlet at Cedar Canyon and *Myriophyllum spicatum* occurs in abundance at various sites: along the N-facing shore below the Sanford-Yake picnic area and other coves around the lake, including Harbor Bay, Bugbee Canyon, and Cedar Canyon.

The overlapping "lakeshore," "marsh," and "riparian" communities as described here are all treated within the "bottomland association" of Wright and Meador (1979), who noted that this association represents a "mosaic of microcommunities corresponding to a mosaic pattern of habitats." The discrete divisions represented in our analysis can be seen in many places, but intergradation is common and the mosaic pattern is the predominant feature at other sites. A relatively easily accessible place to observe an extreme mosaic is in the Canadian River bottom in the area of the McBride Creek entrance.

The "sandy and loamy bottomland sites" category of Bell et al. (2000) appears to combine our 'riparian' and "sandhills and sand flats" categories.

9. MARSH

Marsh habitat is common on the south end of the lake, where water levels are shallow and the lake is commonly not even filled. Extensive areas of *Typha domingensis*, exclusive of all other species, occur in various areas of the Canadian River bottom, and *Typha* populations of various sizes fill or line stream channels in many places (e.g. Mullinaw Canyon, Chicken Creek). A large *Typha* marsh is easily accessible to the northeast of the Bates Canyon boat ramp. An extensive marsh also begins relatively abruptly immediately below Sanford Dam—dominated by *Typha domingensis* and *Schoenoplectus pungens* in areas of deeper water, with *Phragmites australis* and *Chloracantha spinosa* around the edges.

In shallow but wet areas, *Schoenoplectus pungens*, *Schoenoplectus maritimus*, *Eleocharis montevidensis*, *Eleocharis rostellata*, *Polypogon monspeliensis*, *Phragmites communis*, *Distichlis spicata* var. *stricta*, *Puccinellia fasciculata*, *Sporobolus texanus*, *Sphenopholis obtusata*, *Pluchea odorata*, *Rayjacksonia annua*, *Suaeda calceoliformis*, *Flaveria campestris*, *Symphyotrichum expansum*, and *Atriplex patula* grow intermixed. Narrow channels with floating *Lemna valdiviana* and lined with *Typha domingensis* and *Schoenoplectus pungens* interlace through the shallower areas. *Zannichellia palustris* and *Potamogeton pectinatus* occur in deeper channels and pools. *Baccharis salicina*, *Tamarix ramosissima*, and *Distichlis spicata* var. *stricta* are characteristic of slightly higher ground of hummocks or periodically dry margins of the marsh. Shrubby *Salix interior* and *Salix exigua* also may form dense colonies in slightly raised, sandy sites within an otherwise marshy area.

In areas where shallow water has evaporated (by mid June) to leave a salty crust, *Distichlis spicata* var. *stricta*, *Suaeda calceoliformis*, *Rayjacksonia annua*, and several others constitute the few species growing there. Small salt flats such as these are evident on the northeast side of Spring Lake (below Sanford Dam).

10. BORROW AREA

On the northwest side of Sanford Dam, between North Canyon and Hwy 1319, large amounts of rock and soil were removed ca. 1962-1968 for construction of the dam. This area is now relatively flat, consistently scraped down to a level of reddish sandstone and sandy clay within the Whitehorse Formation and naturally revegetated over the last 40 years. *Prosopis glandulosa* is the dominant shrub/small tree of the borrow area; *Tamarix angustissima* is scattered through the habitat. Common subshrubby and herbaceous species are *Gutierrezia sarothrae*, *Symphyotrichum ericoides*, and the grasses *Bothriochloa ischaemum*, *Bouteloua curtipendula*, and *Sporobolus cryptandrus*. Others are *Grindelia ciliata*, *Dalea enneandra*, *Heterotheca stenophylla*, *Solanum elaeagnifolium*, *Desmanthus illinoiensis*, *Opuntia macrorhiza*, *Bothriochloa laguroides*, *Aristida fendleri*, and *Buchloe dactyloides*. In some areas along the east side of the borrow (almost certainly with gypseous substrate), *Isocoma pluriflora* is a dominant subshrub and the most conspicuous floristic element.

11. LAWNS and MOWED ROADSIDES

Lawns and periodically closely mowed roadsides occur in the sandy soils in the vicinity of Ranger Station and the Water Control Authority headquarters. Common species of these sites and others are *Bromus catharticus*, *Bromus japonicus*, *Buchloe dactyloides*, *Cenchrus longispinus*, *Cynodon dactylon*, *Hordeum pusillum*, *Chamaesaracha sordida*, *Descurainia pinnata*, *Descurainia sophia*, *Erodium cicutarium*, *Salsola tragus*, *Bassia scoparia*, *Evax prolifera*, *Evolvulus arvensis*, *Portulaca pilosa*, *Sphaeralcea coccinea*, *Plantago patagonica*, and *Verbena bracteata*. Other relatively common species are *Cryptantha minima*, *Eragrostis cilianensis*, *Elymus elymoides*, *Aphanostephus ramosissimus*, *Taraxacum officinale*, *Lactuca serriola*, *Tragopogon dubius*, and *Verbena pumila*.

Several species of trees are planted and healthy along the fenceline on the north side of the LAMR Ranger Station: *Fraxinus pennsylvanica*, *Morus alba*, and *Maclura pomifera*. *Thuja occidentalis* is planted at the 'check station' at the Cedar Canyon/Sanford-Yake road junction.

12. OLD HOMESITES

Near the west end of NPS property in Plum Creek Canyon, in the immediate vicinity of Plum Creek campground, concrete slabs and planted lines of cottonwood (*Populus deltoides* var. *monilifera*) and American elm (*Ulmus americana*) mark the site of an old ranch house. Individuals of *Ulmus americana*, *Ulmus pumila*, *Morus alba*, *Maclura pomifera*, and *Gleditsia triacanthos* apparently were planted in the close vicinity of the house, probably ca. 1920-1930. We did not observe successful reproduction by any of these non-native tree species, but all except the *Gleditsia* appear to be vigorous and healthy. All individuals are on or slightly above the upper terrace of the creek. Also in the close vicinity of the homesite (in a narrow draw, mixed with *Sapindus*) is the only known LAMR-ALFL occurrence for *Juglans microcarpa*, but this species (represented by two individuals) apparently occurs naturally here.

Another residence, about the same age as the one at Plum Creek, was located near the mouth of Chicken Creek. A large, healthy

tree of *Ulmus pumila* persists at this site, on a low, sandy bluff on the north side of the creek; we located two smaller individuals of the same species, ca. 5 meters and 8 meters tall, within the cottonwood gallery forest about 100 meters from the cultivated tree—these smaller ones almost certainly arose spontaneously from seeds of the persistent parental individual. In areas close to the town of Fritch, *U. pumila* is extremely abundant as a naturalized colonizer.

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